

Logistics and Transport

BE 303 E

**Supply chain
of
the Shtokman field development project**

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Abstract

Supply chains are always fairly complex, and each industry's chain has its own quirks and characteristics. The strategic nature of the product makes the oil and gas supply chain distinct from other industries. The given work sets a task to investigate the supply chain in oil and gas on the example of the Shtokman gas and condensate field development project. It is quite a challenging mission if to take into consideration the size of the project and its unique character.

The given research is conducted to develop and extend the supply chain theory in oil and gas industry. The research objectives lead to use the theory-oriented type of research with stress on theory testing. Under these circumstances, the single-case study method and semi-structured interviews as a primary source of data are chosen.

To build the entire supply chain of the Shtokman project there is a need to describe it first. The history of the field exploration, selection of partners, engineering concept of the project are reflected in the empirical part. Additionally, the project's description includes the transportation system and marketing strategy of natural gas and LNG distribution. Moreover, the environmental and political aspects of the project which are essential for oil and gas field development find its reflection in the practical part of the work.

The analysis of the project with regard to the received from interviews data and other reliable sources of information helps to build the supply chain in the Shtokman project and put value on the supply chain integration and cooperation. The concept implements the theory in practice and develops some propositions that characterize the supply chain in oil and gas industry. Here is a main contribution to the theory development.

The research confirms importance and relevance of the stated problem. The future replication studies are significant in order to enhance the generalizability of the findings.

Foreword

This Master Paper is an obligatory final assignment for the Master of Science in Business Program at the Bodø Graduate School of Business, with Logistics and Transport chosen as the specialization.

The author would like to thank the Associate Professor of the Molde University College, Øyvind Halskau for his supervision, constructive critics and valuable comments for improvement of the research work.

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The author takes full responsibility for the contents of this Master Paper. Errors and deficiencies should be ascribed to the author.

Bodø, May 18, 2009

Veronika Afanasyeva

Sammendrag

Industriens mangfold av under leverandører, suppleringskjeder og samarbeids partnere gjør at hvert enkelt felt har sine egne særtrekk og kjennetegn, og samtidig ofte komplekst sammensatt.

Olje og gass industrien skiller seg ut med eget “supply chains”, noe som skal belyses, ved å se nærmere på Shtokman gass og kondensat felt utviklingsprosjektet. Det er både utfordrende og komplisert med tanke på omfang og størrelse på prosjektet, samt dets unike karakter.

Denne aktuelle undersøkelse og belysning er utført med tanke på å utvikle og teste teorien rundt supplerings kjeden innenfor olje og gass. Under disse omstendighetene er enkelt studier og flere intervjuer base for betraktninger og valg av data.

Får å bygge opp Shtokman’s “supply chain”, må det beskrives først. Historie om felt undersøkelser og utnyttelse, valg av samarbeidspartnere, ingeniør virksomhet, er belyst i den empiriske delen. I tillegg til prosjekt beskrivelse, inkluderer det transport system og markeds strategi for naturgass og LNG distribusjon. Dessuten er de miljømessige og politiske sidene for prosjektet, hvilket er vesentlig for olje og gass utvikling, å finne igjen i den praktiske delen av oppgaven.

Analysedelen av oppgaven basert på data fra intervjuer og andre pålitelige kilder, er med på å bygge leverandør-suppleringskjeden av prosjektet, og sette det i perspektiv. Tanken er å implementere teori i praksis, samt utvikle noen forslag som er karakteristisk for leverandør-suppleringskjeden innenfor olje og gass industri. Her ligger hovedbidraget til teoriutviklingen.

Denne oppgave og undersøkelse bekrefter viktighet og relevanse for denne problemstillingen. De fremtidige supplerende studier er betydningsfull for å forbedre utviklingen på dette området.

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Introduction

The given part presents general vision of the research background, gives clear understanding of the subject, formulates problem statement, limitations of the research and describes the structure of the paper.

Background of the research

The Global supply chain Forum, a group of non-competing firms and academic researchers with the objective to improve the theory and practice, defined Supply Chain Management as: "... the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders" (Lambert, 2001:100).

Any company is linked to other organizations, whether it is suppliers, customers, third-party logistics providers, or intermediaries. The performance of an individual firm is dependent on the strengths and weaknesses of its partners in the supply chain. The competition has moved from competition between firms at the same level in the production process to competition between supply chains, from raw materials to end customers. A company's ability to create trust-based and long-term business relationships with customers, suppliers, and other strategic partners becomes a crucial competitive parameter. The tendency towards increased integration and cooperation between the enterprises in the supply chain results in greater complexity in the management and control technology, which requires increased coordination of resources and activities (Birgit and Tage, 2005).

Every supply chain is unique. This makes the study of chains and their practical implementations an interesting and frequently challenging task. Different industries and varied products create different situations (Sadler, 2007). The oil and gas supply chain is exceptionally long, astonishingly complex and requires the investment of huge sums of capital (Heever, 2004). To add to this, the product in question is economically strategic, heavily politicized and is transported in huge volumes. The supply chain in oil and gas industry is divided into three main sections: upstream, midstream and downstream (Heever, 2004). Another important characteristic of the supply chain in oil and gas industry is that it consists of operators, main contractors, subcontractors and suppliers (Anderson, 2003).

The purpose of the given paper is to contribute to development of the theory on the supply chain in oil and gas industry. It is quite a challenging task which is provoked by the limited sources of literature on this topic. The implementation of the stated goal is going to be

realized in terms of the Shtokman gas project which is at initial stage of development. This project is of strategic significance for the Russian fuel and energy complex and possesses huge reserves of gas and gas condensate. The choice of the case of study can be explained by several factors: first, it is a unique offshore gas field development project in Russia, second, it is prioritized by authorities and oil and gas companies and attracts a lot of attention in mass media that provides the research with broad, reliable and comprehensive information about the project, and third, the project is now at its initial stage of development when the most important decisions on supply chain are made and when the operation process is not so complicated to be covered by one single research.

Problem statement

Generally, the problem statement of the given research sounds in the following way: *How the supply chain in the Shtokman field development project is built?* The research is going to explore the supply chain in oil and gas industry in order to test the propositions of the theory in the specific context and to extend the knowledge of the given object of study. The following steps have to be taken:

- to investigate the theory on supply chain in the context of oil and gas industry;
- to describe the Shtokman field development project in order to implement the supply chain within the case;
- to analyze the activities and operations within the Shtokman field development project through the prism of theoretical approaches; and finally
- to build the entire supply chain of the Shtokman project and to clarify the concept which contributes to development of the theory.

Limitations to the research

One of the main limitations of the given research is caused by the timeframe of the Shtokman project which as it was mentioned before is at initial phase of development. The lack of information about the downstream activities of the project which are not identified yet or under assumptions does not allow the supply chain model to be fully completed. From another point, it gives an opportunity to follow the process of the supply chain development from the early stages.

The aspect of getting access to potential respondents is not the least important, especially in case of Russia where relations of the business world to the academia are minimal, and personal connections are often required to establish contacts with a company.

Here the research was limited by the fact that the main company-informant which can provide the most reliable information was not available at all. It can be explained by strategic nature of the product and by company's policies.

And the last limitation is connected to the geographical context. The research is based on the project which takes place in the Russian Federation and is going to be executed in the Russian economic and political environment. It can be rather problematic to generalize the received results and to implement them in other countries. However, the concept of the supply chain which the research is going to create must have common features for any project in oil and gas industry.

Structure of the Mater Paper

The paper is structured in the following way:

Introduction presents the background and purpose of the research, defines problem statement and limitation of the research.

Methodology contains the frameworks on type of the research, its strategy and unit of analysis, clarifies the data collection method and includes the interview guide.

Theory represents the theoretical background of the research.

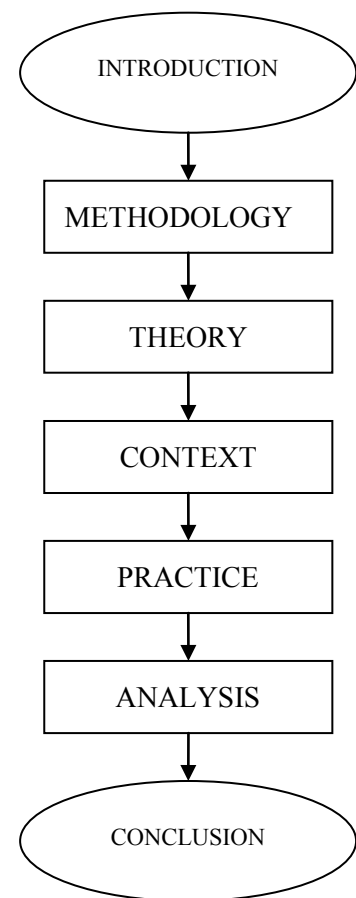
Context encloses the theory on supply chain in oil and gas industry.

Practice is the empirical part of the research which describes the Shtokman field development project.

Analysis scrutinizes data received during the interviews and implements it from the context of theory in oil and gas industry.

Conclusion embodies the received results and creates a concept which is going to contribute to development of theory on the supply chain in oil and gas industry

Note: The list of companies which are named in the given work (in italics) is presented in the end of the paper. The description of Gazprom is given in the first section of Analysis.



Chapter 1. Methodology

1.1 Introduction

This chapter discusses different methods and techniques which are going to be used to carry out the research. The aim is to detail precisely how to achieve the research objectives and to justify the choice of method. In the given work the methodology is the way to organize the investigation of the supply chain of the Shtokman field development project.

There are several fundamental stages in the research process which are common to all scientifically based investigations: identifying a research topic and a research problem; determining how to conduct the study (methodology); collecting the research data; analyzing and interpreting the research data; writing the report (Collis and Hussey, 2003). To find out the connection of all these stages the certain methodology should be employed. Methodology is therefore a prerequisite for a serious research.

The first part of this chapter covers the principles of the research. It determines the general research objectives: theory-oriented and practice-oriented types of the study, shows the difference between them and specifies which one will be use in the given research.

The next step gives an explanation of the general way in which the research will be carried out. The strategy of research and a unit of analysis are considered in this section. The explanation is based on the most effective way in order to meet the research objectives. This part gives an overall view of the method chosen and the reason for this choice.

The third part of the chapter goes into much more detail about the specification of the data which are to be collected. The distinction between qualitative and quantitative methods which influence the choice of primary and secondary data is an important issue of the given part. Additionally, the section clarifies the way of interview conduction, its intended duration and analysis. The list of the topics for interview is also presented.

And the last part puts special attention to the concepts of validity, reliability and sources of errors because the result of research must be both relevant and reliable.

1.2 Research objectives and type of research

Empirical research is building and testing statements about an object of study by analyzing evidence drawn from observation. After the research topic (or the research question) has been determined, the next decision is to identify the general research objective (Dul and Hak, 2008). Saunders et al. (2003) contend that research objectives are likely to lead to greater specificity than research and investigative questions. In case of the given work the research question is: How the supply chain in the Shtokman field development project is built, and the research objective is: To develop the theory of supply chain in the context of oil and gas industry on the study of a particular case.

Dul and Hak (2008) claim that there are two types of objectives: theory-oriented and practice-oriented. They define theory-oriented research as research that is aimed at contributing to the development of theory. Practice-oriented research is a research where the objective is to contribute to the knowledge of one or more specified practitioners responsible for a specific practice.

According to the difference between these types of researches, practice-oriented research is the systematic, methodologically correct, collection and evaluation of observable facts in the organization by which an empirically correct conclusion about practical object of study is reached. The purpose of theory-oriented research is to conclude something about a theoretical statement or proposition. The empirical finding that the intervention benefits the organization in this setting is a contribution to the robustness and generalizability of a specific theoretical explanation (Dul and Hak, 2008).

To make the research methodologically correct, it is important to define the characteristics of theory. A theory is a set of propositions about an object of study. Each proposition in the theory consists of concepts and specification of relations between concepts. The object of study is the stable characteristic in the theory. The concepts of the theory are the variable characteristics of the object of study. Concepts need to be defined precisely to allow for the measurement of their value in instances of the object of study. The propositions of a theory formulate causal relations between the variable characteristics (concepts) of the object of study. The domain of a theory is a specification of the universe of the instances of the object of study for which the propositions are believed to be true. The boundaries of domain should be specified clearly (Dul and Hak, 2008).

According to the given research, the object of study is supply chain in the context of oil and gas industry. The variable characteristics of the supply chain are upstream and

downstream activities which constitute the concepts of the theory. A set of propositions is presented by the components of the supply chain in oil and gas industry: operators, main contractors, suppliers and other companies which possess the casual relationships with activities inside the supply chain. The domain of the chosen theory states that the theory is true for all oil and gas projects. The research is performed on the study of a specific case, the offshore gas project, in a specific country but the results are generic for all types of projects in oil and gas industry. It is also important to mention that the theory in the given research is a combination of extant theory (supply chain) and empirical knowledge published in the scientific literature (supply chain in oil and gas industry).

The given research is a theory-oriented. The general objective of the study is to contribute to the development of theory regarding the topic of supply chain in the Shtokman field development project.

Theory development consists of two main activities: the formulation of proposition and testing whether they can be supported. Exploration is used for creatively combining information from different practical and theoretical sources in order to formulate propositions (Dul and Hak, 2008). The following figure shows the choice of the type of theory-oriented research. As it can be seen the decision depends a lot on the availability of propositions.

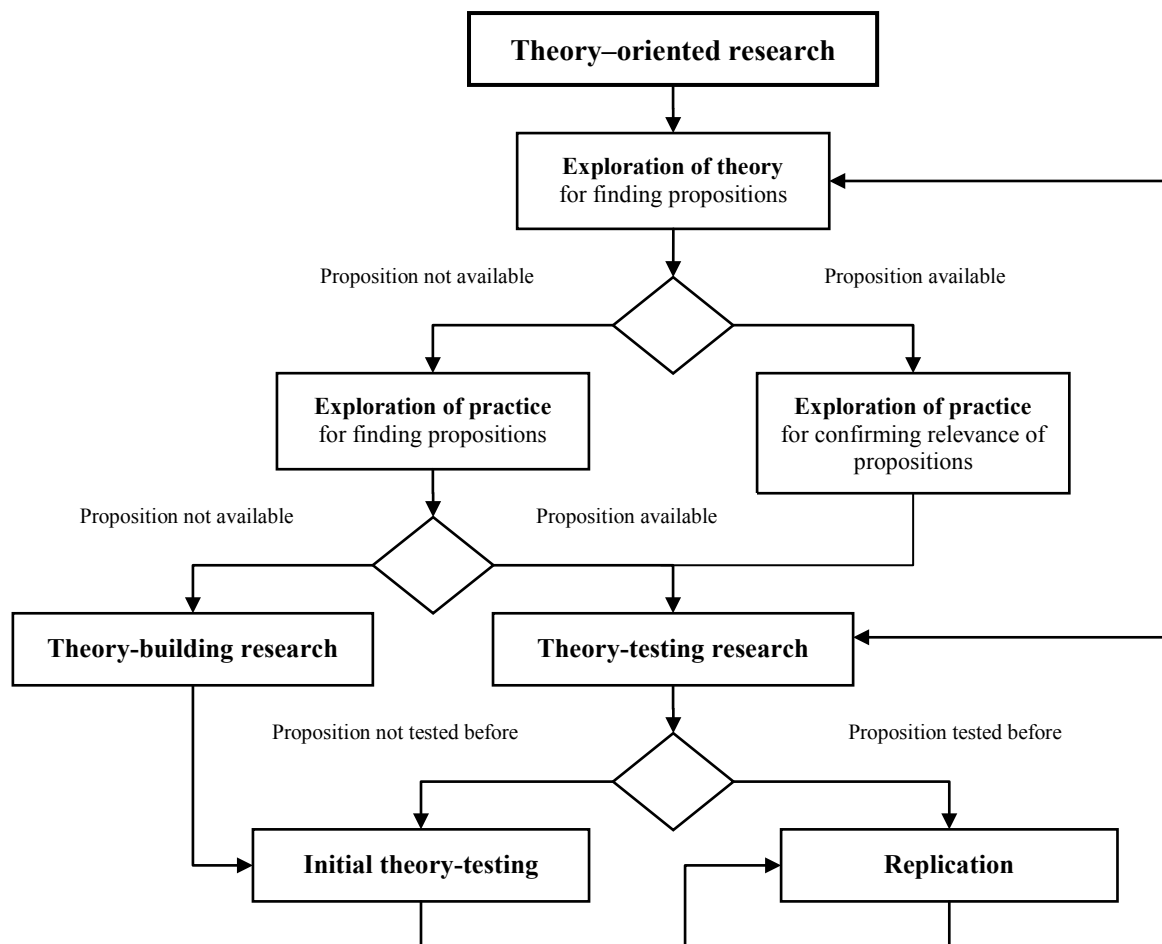


Figure 1. Deciding on the type of theory-oriented research (Dul and Hak, 2008:40)

According to the given study, the exploration of relevant theory and practice shows the presence of propositions regarding the research question. Collection and evaluation of theoretical information about the supply chain in oil and gas industry, from one side, and practical information on the same topic regarding the Shtokman gas project, from another side, is successful and the propositions are found. Because these propositions have never been tested before, the decision to conduct the initial theory-testing research is made.

In order to specify the propositions in theory-testing research, the correspondence between theoretical terms and terms of research has to be defined. According to Dul

Theory	Theory-oriented research
Propositions	Hypothesis
Concepts	Variables

Table 1. Correspondence between terms (Dul and Hak, 2008:66)

and Hak (2008), the term hypothesis is used in the context of a study. A hypothesis is a statement about a relation between variables, representing concepts, in the instances studied.

In the type of deterministic theory-testing (which answers for the given research) the hypothesis can be formulated in the following way: if the proposition specifies a sufficient condition (*If there is A, then there will be B*) and a case is selected in which the condition is present, the hypothesis is that the effect is also presented in that case. If a case is selected in which the effect is absent, the hypothesis is that the condition is also absent in that case (Dul and Hak, 2008). In relation to the given research, it means that if there are upstream activities in oil and gas project then the supply chain actors will also be. If the execution of the project is on initial stage and there are no downstream activities yet, then there will be no contractors and suppliers, and it will not be possible to build the supply chain.

According to other sources of literature on methodology, the types of research distinguish between exploratory, descriptive and explanatory. Exploratory research is conducted into a problem or issue when there are very few or no earlier studies on the issue or problem (Collis and Hussey, 2003). The main purpose of descriptive research is to establish a factual picture of the object of study. And explanatory research is directed towards studying the relationships between concepts and phenomena and explaining the causality and/or interdependency between these (Riley et al., 2000). Marshall and Rossman (2006) claim that many qualitative studies are descriptive and exploratory: they build rich descriptions of complex circumstances that are unexplored in the literature. Even this combined study does correlate with the chosen type of research; still the principles of the theory-oriented research find better implementation in the given work.

1.3 Strategy of research and unit of analysis

The next step is to identify the research strategy responding to the type of methodology. Saunders et al. (2003) name the list of strategies applicable for business research including experiment, survey, case study, action research, grounded theory, ethnography and archival research.

A case study is an extensive examination of a single instance of a phenomenon of interest (Collis and Hussey, 2003). Case studies are the preferred strategy when “how” and “why” questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context (Yin, 1989).

In the given work the case study is chosen as a research strategy. The reasons are rather clear. First, the question of the given study starts with a word “how”, second, the researcher has no opportunity to influence the process of the gas field development, and third, the phenomenon of the supply chain is implemented in the context of oil and gas industry on example of a real-life project.

Dul and Hak reviewed a number of publications on case study methodology explicitly in business research and found out that most of authors¹ consider case study research as a useful research strategy when:

1. the topic is broad and highly complex;
2. there is not a lot of theory available; and
3. “context” is very important.

According to the theory-oriented type of the given research, these factors confirm the usefulness of the case study strategy. The topic about the supply chain in a gas project is really broad and highly complex. The work is conducted in order to develop and extend the limited theory on supply chain in oil and gas industry where the context is of a great importance.

A unit of analysis is the kind of case to which the variables or phenomena under study and the research problem refer, and about which data is collected and analyzed (Collis and Hussey, 2003). The unit of analysis in the given work is the supply chain in the Shtokman project. The way a unit of analysis is defined within a case study strategy enables distinguishing between single case and multiple case designs. Though a single case will normally be less compelling than multiple case designs, the appropriateness of either design will naturally vary with the circumstances (Yin, 1994).

¹ Case study research has been advocated as a valid research strategy in marketing (Bonoma, 1985), operations management (McCutcheon and Meredith, 1993), management information systems (Benbasat et al., 1987), and strategy (Mintzberg, 1979; Eisenhardt, 1989; Larsson, 1993).

The single case study can be one way of testing an already well-formulated theory, investigating a rare or unique case, or observing a phenomenon which has previously not been accessible for study or has not even existed (three rationale explained below). On the other hand, the multiple-case study, whereby a number of individual situations are investigated, may prove very fruitful because of the ability to compare and contrast findings (Riley et al, 2000).

The single-case study is an appropriate design under several circumstances. First, recall that a single-case study is analogous to a single experiment. Thus, one rationale for a single case is when it represents the critical case in testing a well-formulated theory. To confirm, challenge, or extend the theory, there may exist a single case, meeting all of the conditions for testing the theory. The single case can then be used to determine whether a theory's propositions are correct, or whether some alternative set of explanations might be more relevant. In this manner, the single case can represent a significant contribution to knowledge and theory-building (Yin, 1989). The purpose of the given work is to contribute to development of the theory on supply chain in oil and gas industry, so the single-case study is the most appropriate in this case. Also it correlates with the goals of the theory-testing research which is used in the given work.

A second rationale for a single case is where the case represents an extreme or unique case. The stated goal of the given work is to build the supply chain of the Shtokman project. Even the gas project itself is not a unique case but the theory which is applied for its development is limited and almost not presented in the scientific literature. Taking into consideration that the given research is theory-testing, the extreme nature of the single-case study becomes evident.

A third rationale for a single-case study is the revelatory case. This situation exists when an investigator has an opportunity to observe and analyze the phenomenon previously inaccessible to scientific investigation (Yin, 1989). The oil and gas projects has been investigated before from different scientific angles (CSR, location study and others) but there are no researches conducted on the basis of supply chain management, and it is confirmed by almost not available literature in this sphere.

These three rationales serve as the major reasons for conducting a single-case study. Also Yin (1989) warns that until all of these concerns are covered it is no sense to commit oneself to the single case. The given research answers these requirements. Additionally, Dul and Hak (2008) confirm that despite the widespread belief that case study research is not an appropriate research strategy for theory-testing, the single-case study is the second-best (after experiment) strategy for testing a sufficient condition which is used in the given work.

1.4 Data collection methods

Data refers for known facts or things used as a basis for inference or reckoning. There are two main sources of data. Original data is known as primary data, which is data collected at source. Secondary data is data which already exists, such as books, documents and journals (Collis and Hussey, 2003).

1.4.1 Qualitative vs. quantitative data

Data can be described as qualitative or quantitative. As the names suggest, qualitative data is concerned with qualities and non-numerical characteristics, whilst quantitative data is all data that is collected in numerical form (Collis and Hussey, 2003). One of the main advantages of a quantitative approach to data collection is the relative ease and speed with which the research can be conducted. But the analytical and predictive power which can be gained from statistical analysis must be set against the issues of sample representativeness, errors in measurement and qualification, and the danger of reductionism. Qualitative data collection methods can be expensive and time consuming, although it can be argued that qualitative data in business research provides a more “real” basis for analysis and interpretation (Collis and Hussey, 2003).

According to Ritchie and Lewis (2003), data are very detailed, information rich and extensive. Qualitative data collection methods usually involve close contact between the researcher and the research participants, which are interactive and developmental and allow for emergent issues to be explored. That’s why qualitative methods have a danger of focusing too closely on the individual and people’s perceptions of “reality” rather than any independent “reality” that might exist external to them (Hopper and Powell, 1985), which cause problems relating to rigor and subjectivity (Collis and Hussey, 2003).

The given work is going to use the qualitative data because the problems stated in the research can not be evaluated in quantity as it will be of no use. The theory-oriented nature of the given research requires explanation and interpretation of results into some knowledge. In this case quantitative method will limit the understanding of the problem and give only poor statistical information. Additionally, the research question itself does not imply quantitative data collection; there is a need of responsive, flexible and interactive questioning techniques which allow gathering rich and interpretative data.

Six sources of evidence can be the focus of data collection for case studies: documentation, archival records, interviews, direct observation, participant-observation and physical artifacts (Yin, 1989). The given research relies mostly on the interviews as a primary source of data, and documentation as a secondary data.

1.4.2 Primary data

One of the most important sources of case study information is the interview (Yin, 1989). Most commonly, case study interviews are of an open-ended nature, in which an investigator can ask key respondents for the facts of a matter as well as for the respondents' opinion about events (Yin, 1989). The type of interview which is used in the given research is a focused interview, in which a respondent is interviewed for a short period of time. In such case, the interviews may still remain open-ended and assume a conversational manner, but the interviewer is more likely to be following a certain set of questions derived from the interview guide (Yin, 1989).

The main purpose of such interview is to corroborate certain facts which have been already established in the work from other sources of information. This type of interview has the same features to semi-structured data collection presented by Ritchie and Lewis (2003) and where there is more pre-specifying of order and question-wording. The structure of this interview allows the topics to be covered in the order most suited to the interviewee and responses to be fully probed and explored. Also it allows the researcher to be responsive to relevant issues raised spontaneously by the interviewee. The advantage of such kind of interview is that it is interactive in nature and can be generative in the sense that new knowledge or thoughts are likely to be created (Saunders et al., 2003).

The stated semi-structured in-depth interview is based on the interview guide setting out the key topics and issues to be covered during the interview:

1. Shtokman Development Company:
 - organizational structure;
 - tasks and purposes of the company;
 - operations and investments.
2. Partner selection:
 - Total;
 - StatoilHydro.
3. Supplier selection:
 - international companies;
 - national companies;
 - supplier selection criteria.
4. Marketing:
 - market of USA;
 - market of Europe;

- gas distribution:
 - natural gas vs. LNG;
 - gasification of regions
- 5. Cooperation:
 - suppliers associations.
- 6. Socio-economic impact.

With regard to the choice of respondents, it was one of the most difficult tasks. Since oil and gas industry is rather sensitive for sharing the information, especially in Russia, the access to the companies responsible for the project execution was almost closed. The first try to contact the company Giprospeftgaz (a subsidiary of Gazprom) which is conducting the engineering concept of the Shtokman project was not successful. Also the organizational structure of the company Shtokman Development AG was on the stage of formation, so any inside information was not available at that time.

The personal connections were important, since authorities and managers have no willingness to establish contacts and provide information to people from outside the organization. Finally, the researcher of the given work was lucky to be invited for conducting an interview at Gazpromregiongaz (a subsidiary of Mezhrefiongaz and Gazprom Transgaz Saint-Petersburg, both owned by Gazprom). The receiving party was the Finance Director, E.G. Usova. Even operation of the company did not serve the interests of the given research completely; the information which was gathered is rather fruitful and necessary for understanding the gas distribution system in Russia.

The key informant, Fadeev A.M., the PhD in Economics, is the senior research assistant of the Institute of Economic Affairs of the Kola Research Centre, the Russian Academy of Science (Apatity, Murmansk Region). He is also the ex-Executive Vice president of Murmanshelf, Association of suppliers for oil-and-gas industry (Murmansk). The respondent acted as an independent external consultant who provided the researcher with all the relevant insights into the project and suggested some sources of corroboratory evidence. Additionally, the interviewee expressed his subjective opinion which was compared with other sources of information in order to prevent the total dependency on the received from interview information and get a deeper knowledge of the project execution.

According to the interview conditions, both interviews were conducted in December 2008 in Saint-Petersburg, Russia. The interview with Usova E.G. was held at the office of the company Gazpromregiongaz and lasted less than one hour. The second interview was organized by means of personal meeting with the respondent. Taking into consideration, the

time required to compose notes and undertake the initial analysis of the data collected, the key informant, Fadeev A.M., was contacted several more times by telephone and e-mail to check the validity of the processed information and to conduct additional interviewing based on the questions appeared during the data analysis.

In addition to interviews, the participation in the conference (Leverandørkonferansen) which was held April 29, 2008 in Bodø, Norway, became a valuable source of primary information. The conference was organized by the Graduate School of Business and related to the suppliers of the Shtokman gas and condensate field development. The presentations of such companies as StatoilHydro (Norway), Murmanskelf (Russia), Sozvezdye (Russia) and others enabled receiving rich information on the research question and reliable points of view.

1.4.3 Secondary data

Secondary data relies on information collected earlier for other purposes. The data can be raw, where there has been little if any processing, or compiled that have received some source of selection or summarizing (Saunders et al, 2003). In business research external sources of secondary data include published books and journal articles, academic as well as professional and popular; a lot of secondary data is also available from internal sources, such as documents (Ghauri and Grønhaug, 2002).

As sources of professional magazines and books the library of the Bodø Regional University and Internet were used. Books on supply chain and articles on the same subject related to oil and gas industry have been studied to get a clear idea of the theoretical background of the given research. In regard to empirical part, the information was gathered from scientific journals on oil and gas industry such as *Neftegazovaya Vertikal (Oil and Gas Vertical)* and *Neft Rossii (Oil of Russia)* available only by subscription; from companies' publications such as news magazine of oil and gas suppliers MurmanskelfInfo (Murmanskelf), Gazprom's annual reports for 2006 and 2007 and fact books, *Gazprom in Figures 2002-2006* and *2003-2007*. The official websites of the companies-operators and companies-suppliers were used as the most valuable electronic sources of data collection. Finally, some research tools such as encyclopedias (Wikipedia), dictionaries and abstracts of closed articles found their appliance in the given work.

The secondary data was very helpful: first, in verifying the correct spelling and names of organizations; second, in making the researcher to be correctly critical in interpreting documents that are contradictory rather than corroboratory; and third, in extending knowledge about the chosen research objectives and preparing the key topic issues for interviews.

1.5 Reliability, validity and sources of errors

Since a research design is supposed to represent a logical set of statements, there is a need to judge the quality of any given design according to certain logical tests. Yin (1989) offers the following data quality issues and the ways to overcome them (only the appropriate for the given research are noted):

1. Construct validity – establishing correct operational measures for the concepts being studied.

The available tactics for increasing the construct validity are to use multiple sources of evidence, to establish a chain of evidence and to have the draft case study reviewed by key informants. The given research relies on two interviews and on documentations referring to the object of study, also a lot of information is used from conference presentations and companies' publications which represent the initial data base. According to the review of the draft case study, it was mentioned earlier that the key informant was contacted specially for this purpose.

2. External validity – establishing the domain to which a study's findings can be generalized.

Case studies rely on analytical generalization where the investigator is striving to generalize a particular set of results to some broader theory (Yin, 1989). Because the generalizability is not a characteristic of a study but of a proposition, the lack of generalizability of the case study is a misunderstanding (Dul and Hak, 2008). According to the given research, the case study is preferred as the strategy in order to test the theory on supply chain in the context of oil and gas industry. The propositions stated in the given theory have a similar nature for any oil and gas project, so their generalizability is quite evident.

3. Reliability – demonstrating that the operations of a study such as the data collection procedures can be repeated, with the same results.

The goal of reliability is to minimize the errors and bias. There are several ways to increase the reliability of case study research: first is by using the interview guide, and second, by developing the case study base. Even the second source is not reflected in the work, its presence can be seen by the structure and information richness of the final report.

According to the sources of errors, the researcher is trying to deal carefully with unclear questions and translation of the received data; and to be aware of personal prejudgments and subjectivity in the interpretations of the answers. Additionally, the key informant is not embarrassed by any company policies and it avoids failures in data collection.

1.6 Conclusion

Methodology is an instrument, an approach to solve the problems and to come up with a new understanding. Correct methodology gives the necessary system that helps to choose the right research techniques to explore the reality.

Dul and Hak (2008) define theory-oriented research where the academic community is the primary user of research findings, and practice-oriented research where members of the business community are the primary users of these research outcomes. The purpose of the given work is to contribute to development of the theory on supply chain in oil and gas industry, so the theory-testing approach is chosen for carrying out the research.

Because the choice of research strategy depends on the understanding of the research problem and genre of research, the most appropriate strategy for the given investigation is the case study. The case study is a study in which one case or a small number of cases in their real life context are selected, and scores obtained from these cases are analyzed in qualitative manner. Most of the case studies that are meant as a contribution to theory (either building or testing theory) state this explicitly in their title and/or abstract (Dul and Hak, 2008).

The unit of analysis in the given research is the supply chain in the Shtokman field development project. Being a single-case study, it requires careful investigation of the potential case to minimize the chances of misrepresentation and to maximize the access needed to collect the case study evidence (Yin, 1989).

The methods used to collect data in the case study include documentary analysis (secondary data) and interviews (primary data). The advantage of primary data is that it is tailored for particular research and therefore more reliable comparing with secondary data that have been already collected by others and possesses less relevance to this research. But primary data collection can be very costly and time-consuming when secondary data are time and resource saving.

The validity and reliability of data have an important bearing on whether any wider inference can be drawn from a single study since, in different ways, they are concerned with the robustness and “credibility” of the original research evidence (Ritchie and Lewis, 2003).

The development of theory takes place by incremental advances and small contributions to knowledge through well-conceptualized and well constructed research (Marshall and Rossman, 2006). Thus, the results of the research will constitute an extension of theory that will expand the generalizations or more finely tune theoretical propositions.

Chapter 2. Supply chain in theory.

2.1 Introduction

This chapter introduces supply chains as groups of companies which work together to source, produce and deliver goods and services to end customers.

To survive, and to be competitive, it is not sufficient for firms to restrict their vision to their own processes. Instead they must consider the whole flow of materials and goods and the information which communicates the specific needs of consumers to the various levels of suppliers. Firms should also consider the management of those flows and the part which they play within the coordination of the entire supply network. The challenge is for companies in partnership to collaborate in design and delivery of products and services so that a more effective service is given to consumers and each company prospers (Sadler, 2007).

The first part of the chapter presents a theoretical definition of supply chain and supply chain management, describes the components of supply chain management.

The second part tells about a structure of the chain, its upstream and downstream activities and different types of supply chain.

The next section put an emphasis on the integration of supply chain into business process and cooperation within supply chain. The given section also presents the specific factors of supply chain integration and its benefits.

Also the theoretical part of the work includes the description of logistics, its main functions, trends, strategies and its role in supply chain.

Further investigation of the given paper will use the theoretical explanation of supply chain in response to oil and gas industry.

2.2 Definition of supply chain and supply chain management

All organizations move materials. Manufacturers build factories that collect raw materials from suppliers and deliver finished goods to consumers; retail shops have regular deliveries from wholesalers; a television news service collects reports from around the world and delivers them to viewers, and so on. Organizations do not work in isolation, but each one acts as a consumer when it buys materials from its own suppliers, and then it acts as supplier when it delivers materials to its own consumers. Most products move through a series of organizations as they travel between original suppliers and final consumers (Waters, 2003).

According to Waters (2003), people use different names for these chains of activities and organizations. When they emphasize the operations, they refer to the process; when they emphasize marketing, they call it a logistics channel; when they look at value added, they call it a value chain; when they see how customer demands are satisfied, they call it a demand chain. Here the emphasis is made on the movement of materials and will be used the most general term of supply chain:

*A **supply chain** consists of the series of activities and organizations that materials move through on their journey from initial suppliers to final customers (Waters, 2003:7).*

An important management tool that systemizes all relevant processes across the businesses in the supply chain is called supply chain management (SCM). Definitions of SCM are presented by many authors but the one offered by Council of Supply Chain Management Professionals (CSCMP) seems the most comprehensive and appropriate:

***Supply chain management** encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all Logistics Management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers (Birgit and Tage, 2005:11).*

Birgit and Tage (2005) present their own definition of SCM related to several other explanations of what is supply chain management:

SCM is the management of relations and integrated business processes across the supply chain that produces products, services and information that add value for the end customer.

This definition contains several keywords. The first is relations, which is used here as the term for all activities linked with establishing, maintaining, and developing business relations with supply chain partners. The next keyword is integrated, defined as coordination across functional lines and legal corporate boundaries. The coordination may be organizational, for example, in the form of cross-organizational team and interfaces at many levels; system related, for instance, in the form of integrated information and communications systems, and electronic data interchange (EDI)² and Internet connections; or planning related, for example, in the form of exchange of order data, inventory status, sales forecasts, production plans, and sales and marketing campaigns. Business processes is the third keyword, which is directly related to the production of products, services, and information. Examples of business processes are Order Fulfillment, Customer Service, Product Development, and Materials Supply³.

2.2.1 Components of SCM

Birgit and Tage (2005) claim that supply chain management can be divided into three components, which are tightly interconnected:

- Network structure
- Business processes
- Management

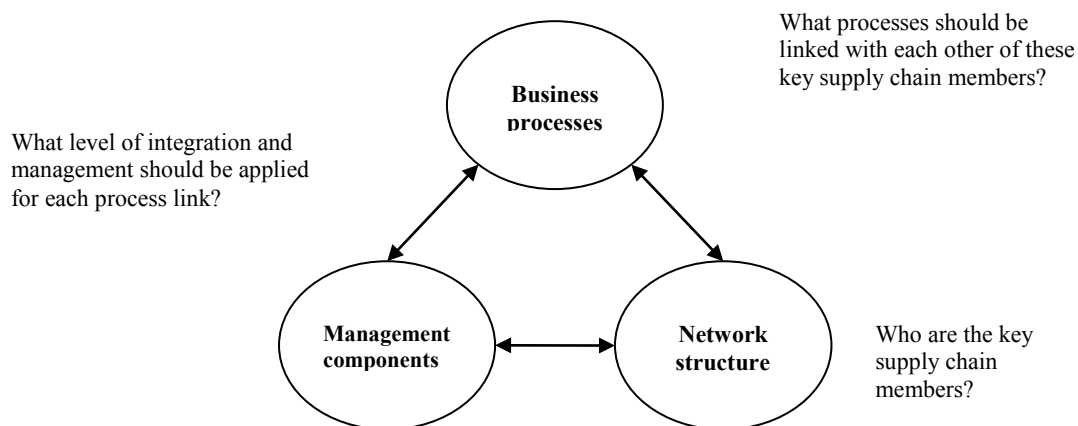


Figure 2. Components in the SCM concept (Birgit and Tage, 2005: 16)

Network structure. The network structure comprises the most important collaboration partners in the supply chain, as well as relationships between these players. It is neither

² Electronic data interchange (EDI) - a means of transferring data instantaneously between computers in different companies in the format required for each database (Sadler, 2007).

³ All these business process will be explained later in the chapter.

possible nor desirable to establish a SCM cooperative network that includes all participants in a business network. Moreover, it is important to focus available resources on the relations that are of strategic importance for the competitiveness of business.

Working towards creating and maintaining the right relationships becomes part of the business strategy. Lambert (1998) suggests dividing relations into four main categories:

1. Relationships that the business in focus wishes to lead and coordinate.
2. Relationships that are non-critical for the business in focus, but which still should be monitored in order to ensure that the activities are completed satisfactorily by the other businesses involved in the network.
3. Relationships that the business in focus does not deem to be critical or worth sacrificing management or monitoring resources on.
4. Relationships to other supply chains. A business can simultaneously be a supplier for several internally competing supply chains. These relationships are not viewed as part of the relationships in the actual supply chain, but can, of course, have an important influence on the supply chain's effectiveness and competitiveness.

Business processes. Business processes encompass the activities and flows of information that are connected with conducting materials, products, and services through the supply chain and on to consumers. Here are the main business processes:

- Order processing. This business process includes all of the activities that are tied in with expediting customers' orders: the placement of the order, including transmission, the receiving of the order, as well as the credit check, the actual expedition of the order, the distribution, and finally, the customer receiving the order and invoicing. The total time that passes between when the customer places their order until the customer receives the desired goods is often referred to as the order cycle.
- Customer service. The term "customer service" includes a number of services before, during, and after the actual sales transaction.
- Distribution. Distribution is specified as the process starting with the completion of the products until their receipt by customers. In some situations, it can also include replacement parts and return transport of damaged, outdated, or scrapped products.

- Product development / Time-to-market. The goal of such activities as concurrent engineering, having a key supplier and organizing the customer focus groups is to speed up production development, so that time-to-market can be reduced.
- Supply. This process includes all of the activities from choosing a vendor, coming to an agreement in framework contracts, and the continued organizing of purchasing. The increasing tendency to outsource production processes to the supplier link in the supply chain made the supply process more strategic.

Management components. There are a number of management components, which span business processes and the roles of participants in the supply chain. Lambert (1998) divides these components into two main groups:

1. Physical and technical components:

- Planning and control systems – cooperative planning ensures that the supply chain moves in the desired direction, while control ensures that the actual results for the entire supply chain can be compared with the projected goals on an ongoing basis.
- Process structure – is an indicator of how the company executes its activities and assignments. The degree of process integration between companies within the supply chain indicates how process oriented the supply chain is.
- Organization structure – shows how integrated the different functional departments within the business are, as well as the extent to which integration between the distinct participants in the supply chain takes place.
- The structure of information flow – information exchange between affected departments and companies is decisive if the development and adaptation of cooperative resources and goals are to become possible.
- The structure of product flow – tells something about the complexity of the control activity: for example, the number of production sections and the degree of suppliers' involvement in the product development process.

2. Operational and behavioral components:

- Management principles – encompass the company's philosophy and the management methods and philosophies that dominate the businesses in focus.

- The power structure – in a supply chain conveys something about who has the potential to affect the participants in a given direction. The implementation of the SCM concept leads to a creation of a basis for establishing a form of cooperation that makes it possible for all motivated participants to exchange their experience and knowledge, despite the fact that the dominant company controls the goals and initiatives.
- The payment / Wage structure – the reward structure in the supply chain must reflect the amount of resources at stake for the individual participant, as well as the risks the participant runs by becoming actively involved in SCM cooperation.
- Company structure – if the participants in a supply chain come from very different company cultures or if employee attitudes do not complement cooperation, then it is difficult to implement SCM cooperation. Motivating employees to engage in cross-organizational cooperation demands a goal-oriented effort in the form of attitude workshops and continuing-education programs (Birgit and Tage, 2005).

Supply chain as it seen from the previous discussion is an important tool for developing and making the business more competitive. There are many types of supply chains with different length and closeness of relationships but all of chains are constituted using the basic organizational structures. The next part will make an overview of the structural features of supply chains.

2.3 Structure of supply chain

Sadler (2007) presents a basic supply chain as a structure of four main components:

1. A focal company, which forms goods or services for a set of consumers;
2. A range of suppliers of raw materials and components;
3. Distributors, which deliver the goods to consumers, and
4. Modes of transport which move products between each location in the chain.

2.3.1 Upstream and downstream activities

According to Waters (2003) the simplest view of a supply chain has a single product moving through a series of organizations, each of which somehow adds value to the product. So that activities in front of the organization in focus – moving materials inwards – are called upstream; those after the organization – moving materials outwards – are called downstream.

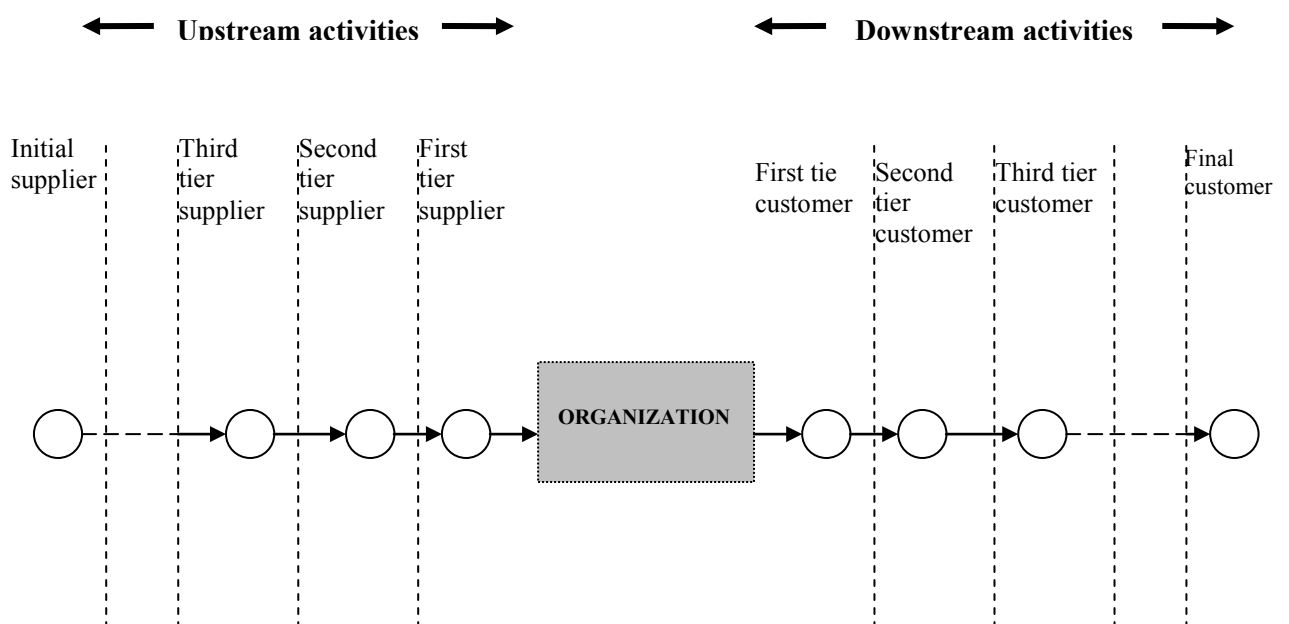


Figure 3. Activities in the supply chain (Waters, 2003: 9)

The upstream activities are divided into tiers of suppliers. A supplier that sends that sends materials directly to the operations is a first tier supplier; one that send materials to a first tier supplier is a second tier supplier; one that sends materials to a second tier supplier is a third tier supplier, and so on back to the original sources. Customers are also divided into tiers.

In practice, most organizations get materials from many different suppliers, and sell products to many different customers. Then the supply chain converges as raw materials move in through the tiers of suppliers, and diverges as products move out through the tiers of

customers. A manufacturer might see sub-assembly providers as first tier suppliers, component makers as second tier suppliers, materials suppliers as third tier suppliers, and so on. It might see wholesalers as first tier customers, retailers as second tier customers, and end users as third tier customers (Waters, 2003).

Each product has its own supply chain, and there is a huge number of different configurations. Some are very short and simple; others are surprisingly long and complicated. But they all use the same general approach; the only difference is the role the suppliers and customers play. Waters (2003) argues that the reality is even more complex, as each organization works with many – often thousands – of different products, each of which has its own supply chain.

2.3.2 Length and breadth of supply chain

An appropriate structure for supply chain depends on the types of intermediary (who form suppliers and customers in the chain), number of these intermediaries and other factors. Perhaps the key questions here concern the supply chain's length and breadth (Water, 2003):

- Supply chain length is the number of tiers, or intermediaries, that materials flow through between source and destination.
- Supply chain breadth is the number of parallel routes that materials can flow through.

The best choice of length and breadth depends on many factors, with three of the most important being the amount of control that an organization wants over its logistics, the quality of the services and the cost. A manufacturer delivering directly to customers has a short, narrow supply chain. This gives a lot of control over logistics, but it may be difficult to achieve either high customer service or low costs. Broadening the chain gives higher customer service, but it increases costs and reduces the manufacturer's control. Making the supply chain long and narrow can use intermediaries to reduce costs, but the manufacturer loses some control and customer service does not improve. Making the supply chain both long and broad removes most control from the manufacturer, but customers get good service (Waters, 2003).

2.3.3 Push and pull types of supply chain

Companies operating in the western fashion are characterized by confrontational intercorporate politics encompassing marginal short-term commitment, competitive tendering, and multisourcing, as well as low levels of mutual investment and cross-equity alliances. In a push supply chain costs are transmitted up the chain; inputs costs for the members of the chain are determined by the selling price of the preceding level. This imposition of profit margins at successive points in the production chain constructs value. While some suppliers may enjoy

the fruits of this approach, it is fundamentally flawed in that there is no guarantee that the next level in the chain will be able to afford the goods, still less that the end customer will find the price attractive. This framework therefore imperils the long-term commercial viability of the chain.

In stark contrast to the cost plus approach, a pull supply chain operates on the principle that the supply chain must be able to deliver to market a product at an affordable level. It is the responsibility of everyone in the chain to ensure that operational costs and commercial structures support this objective. Suppliers know that, as the price is set by the customer, their profitability derives from their own input costs, to their internal efficiencies, and external costs. Consequently, pull supply chains place downward pressure on suppliers to become more efficient and to operate for the common good (Lambert, 2001).

2.3.4 Network structure

Some people argue that the term “supply chain” gives too simple view. It tends to suggest a linear arrangement of organizations conducting operational activities in a particular sequence. So they prefer to talk about a supply network or supply web. Dicken and Thrift (1992) recognized that “the inter-firm structure of large corporations is increasingly better represented as a network than as a hierarchy as such firms strive to create more flexible organizational structures” (Hall and Braithwaite, 2001:94). Not only large corporations build supply networks, also small and medium enterprises have a great number of network organizations to enhance flexibility, delivery, and cost factors.

The degree to which the particular supply chain needs to be managed depends on several factors, such as the complexity of product, the number of available suppliers, and the availability of raw materials. Dimensions to consider include the length of the supply chain and the number of suppliers and customers at each level. The closeness of the relationships at different points in the supply chain will also differ. Lambert (2001) suggests that three primary structural aspects of the company’s network structure are:

1. The members of the supply chain.

They include all companies/organizations with whom the focal company interacts directly or indirectly through its suppliers or customers, from the point of origin to the point of consumption⁴. *Primary members* of a supply chain are: all those autonomous companies or strategic business units who carry out value-adding activities (operational and/or managerial)

⁴ The *point of origin* of the supply chain occurs where no previous primary suppliers exist. All suppliers to the point of origin members are solely supporting members. The *point of consumption* is where no further value is added, and the product and/or service is consumed (Lambert, 2001:106).

in the business process designed to produce a specific output for a particular customer or market. In contrast, *supporting members* are companies that simply provide resources, knowledge, utilities, or assets for the primary members of the supply chain. It is important to mention that the same company can perform both primary and supportive activities.

2. The structural dimension of the network.

There are three dimensions of the network that are essential for managing the supply chain. The *horizontal structure* refers to the number of tiers across the supply chain. It may be long, with numerous tiers, or short, with few tiers. The *vertical structure* refers to the number of suppliers/customers represented within each tier. A company can have a narrow vertical structure, with few companies at each tier level, or a wide vertical structure, with many suppliers and/or customers at each tier level. The third structural dimension is the company's *horizontal position within the supply chain*. A company can be positioned at or near the initial source of supply, be at or near to the ultimate customer, or somewhere between these endpoints of the supply chain. The principle, known as functional spin-off, that allows a company to transfer the servicing of small customers to distributors, thus moving the small customers down the supply chain from the local company, was also found by Lambert's research team.

3. The different types of process links across the supply chain.

The integration of process links across the supply chain varies from link to link. Some links are more critical than others. But all of them show the closeness of the relationships between the focal company and other companies/organizations within the supply chain, and, consequently, the degree of interaction, managing, and information exchange.

Most of supply chains are so complicated that it can be a serious problem to implement and to manage them. But there are good reasons for having a longer supply chain such as simpler transport, economics of scale, less stock, and so on. Supply chains exist to overcome the gaps created when suppliers are some distance away from customers. They allow for operations that are best done – or can only be done – at locations that are distant from customers or sources of materials. As well as moving materials between geographically separate operations, supply chains allow for mismatches between supply and demand. Supply chains can also make movements a lot simpler (Waters, 2003).

The benefits of well-designed supply chain are evident but the process of integration of supply chains in the business activities is rather complicated and needs efforts from all the participants. This topic will be discussed in the next section.

2.4 Integration of supply chain

One of the biggest challenges for businesses is to integrate supply chains for the benefit of customers and to make a profit. Numerous studies show that almost all businesses contain enormous amount of waste⁵: misdirected efforts, poor or missing information, ineffectual management, lack of leadership, authority or trust, power plays, delays and excessive inventory (Sadler, 2007). Hence the need to reduce waste throughout the supply chain must be considered, so that customer receives more value and the companies get more return for their efforts.

According to Sadler (2007), the word “integrated” is added to supply chain to emphasize that it advocates a system view across the entire chain. It is not useful to improve only one partner in the supply chain. Rather chain leaders should strive to make each part work highly effective in the performance of the entire chain. “Integrated” also distinguishes this term from the careless use of “supply chain” to refer to the logistics of one company.

The objective of supply chain integration is to synchronize the requirements of the customer with the flow of materials from suppliers in order to achieve a balance between the goals of high customer service, low inventory investment and low unit cost.

Sadler (2007) argues that each process in the integrated supply chain can be considered as comprising four factors:

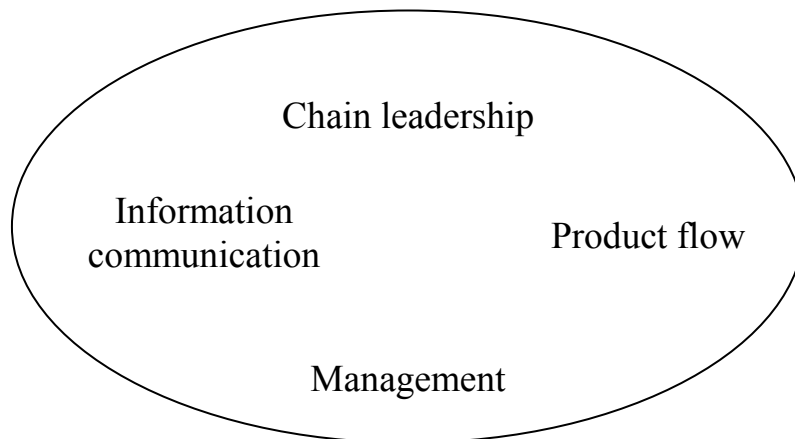


Figure 4. Major constituents of a process (Sadler, 2007: 5)

1. *Information communication.* Information exchange between partners enables them to work closely in line with end customer need, even though the firm may be several stages removed from product or service delivery. Information communication within the firm derives from the actual or forecast mix of product needed in a period, leading to all the data required

⁵ Waste is any activity which absorbs resources but creates no value (Sadler, 2007)

to process that order⁶. Company use computer information systems to achieve these information requirements. An order-processing system is used to carry out checks⁷ on the incoming order. A warehouse management system keeps track of all the goods in the warehouse as they are received, put away, moved and picked-to-door. Many manufacturing companies have an enterprise resource planning system to assist them to purchase and manufacture all the required parts to assemble a complex of finished product. The companies involved in distribution use a distribution requirements planning system to track each finished product from the factory through levels of warehouses to the end customer.

An important source of information for operators and management is summaries of performance over a period of time. Key performance measures, such as quality, on-time delivery and costs, enable managers and supervisors to check that they are achieving their customers' requirements.

Birgit and Tage (2005) describe this factor as information integration and argue that it permits management to examine the operations of the organization as a whole and not in a fragmented, functionally isolated manner. The participants in a supply chain can be linked by information technology, thereby facilitating logistics activities, delivery planning and coordination. Integration often requires coordination of disparate functions among supply chain partners in geographically dispersed locations. It also involves the sharing of pertinent knowledge and information among members of a supply chain. Consequently, information integration makes inventory and production visible throughout the supply chain, creating a more congenial climate for collaborative planning and forecasting.

A reliable communication infrastructure paves the way for timely and efficient information exchange among partners. The integration of many IT-enabled electronic commerce tools – bar coding, electronic messaging, electronic data interchange (EDI), global network management, and the Internet – allows supply chain partners to attain significant productivity gains.

2. *Physical product flow*. The organization of product flow is essential process of business activities that makes the delivery of products and services to the end customers physically possible.

According to this case, managers of the partner firms in the supply chain have three tasks:

⁶ A purchase order is a list of materials or components required from a supplier (Sadler, 2007)

⁷ Typical checks are to find out whether the orders fits within the range of products and services made and to make sure that the customer is able to pay for the goods ordered (Sadler, 2007)

- to plan the flow of materials and goods along the chain by information exchange;
- to make the necessary physical movements and conversions in the required quantities and at the required times for end consumers, and
- to manage changes and developments to the benefit of all companies without disadvantaging customers.

The effectiveness and efficiency of this process depends a lot on the managers' ability to coordinate the common efforts and work for the benefit of the entire supply chain.

3. *Management coordination.* The term "management" refers to the organization and control of all the internal logistics functions within one partner firm in the chain. It includes the performance measurement, such as planning, organizing, leading and controlling production or service facilities, towards the supply chain's goals to ensure resources match destination aims. Managers have to take strategic decisions, which alter the whole position of the company, tactical decisions, which fill out the specifics of strategy, and operational decisions, a huge number of short-term decisions to keep the company running properly (Sadler, 2007).

4. *Chain leadership.* The coordination of the whole chain, to ensure that it functions as an effective system to provide goods and services, is called by Sadler (2007) chain leadership. Leadership includes the means of getting to that required goal by instructions, regulations and coaching. It also signifies strategic organization and control of the value chain⁸ by the focal company and its partners.

The four factors in each link⁹ of the chain need to be properly designed so that the overall chain capability is achieved. The supply chain, as a total system, will only work effectively and efficiently if proper consideration is given to these factors.

2.4.1 Design of supply chain

To get full benefit from supply chain it is necessary to link all the partners involved so that goods and services flow effectively to consumers. This is achieved by working collaboratively with customers, suppliers, trading partners and service providers. The overall aim is to create a flow of products exactly as required by customers, responding dynamically to changes to their orders. Sadler (2007) presents it as a new element of supply chain integration and sees it as an opportunity, which information system offer, for firms to be

⁸ The objective of the supply chain is to maximize the overall value generated, where value is the difference between what the final product is worth to the customer and the effort the chain expends in filling the customer's request (Sadler, 2007). The concept of a value chain originated with Michael Porter.

⁹ Sadler (2007) uses the word "link" to a company which performs some function within a supply chain, joining other parts into a complete chain. Another name for the link is a partner firm that is also used by this author.

responsive to customer orders rather than to anticipate orders by making goods in advance. Because the differences between plans and results increase costs and risks it frequently lead to competitive relationships between supply chain “partners”. The sharing of information enables firms to improve the speed and accuracy of supply chains and so to be more responsive than anticipatory. When all the partners in the chain synchronize their operations, inventory can be reduced and duplicate practices eliminated.

The first step is to design a chain, starting with its strategic purpose in delivering to a set of customers. Design, presented by Sadler (2007), contains three elements:

1. Content – the area of “order winners”¹⁰ and policies, covering processes, information and physical operations, which are tools to obtain a customer-satisfying strategy.
2. Process – the method by which a supply chain strategy will be constructed by a group of managers and approval obtained for the resultant action plans.
3. Implementation – the way in which the action plans will be operationalized sequentially through all the necessary firms and employees.

It is important to integrate the physical and information process across each link, achieving an effective flow of goods and provision of services. According to Sadler (2007), this requires consideration of such issues:

- Establishing of supply chain boundary - it is a decision which firms and which stages are important enough to influence the flow of goods to customers, rather than those that serve or do not affect the system. It is made by reviewing the structure of supply chain, the information flow and other drivers. It is possible to go upstream forever, but it is better to consider how far downstream to go.
- Location of decoupling point¹¹ – that is the point at which planned production of materials and components changes to exact assembly and delivery of products and services pulled by customer orders. It separates unassigned materials and products from those allocated to particular customers. Push leads to material requirement planning (MRP) systems where plans start in advance, materials are purchased and manufacturing is completed: uses past experience and forecasts to produce an expected order.

¹⁰ Order winners are the needs of end customers which, if fully met, will cause the customers to buy the product or service (Sadler, 2007).

¹¹ Decoupling point is the position in the supply chain at which materials or products designated to a particular customer. In international supply chains, decoupling points have a wider meaning, including major points of transfer, production and international distribution (Sadler, 2007).

- Finding a flow-creating criteria - to organize the order flow that will lead to well-integrated supply chain there is a need to find a small number of qualifying criteria, which the chain must attain, and a number of order-winning criteria, which the chain will pursue to satisfy customers, and gain orders at the expense of competitors.
- Type of physical and human resources – there is a need for competitive physical and qualified human resources to be build up a capability will confer distinctive competencies compared to other supply chains.

The second step is to develop the coordination between the participating companies and to create relationships inside the entire supply chain in order to meet efficiently the customer wishes, to receive their satisfaction and to get the return on efforts. It will be discussed further in the chapter after one of the most important parts of the product flow activities is described.

2.4.2 Selection of suppliers

As it was mentioned above, the planning of supply chain starts with strategic aims, and moves down to organize the flow of materials, make sure that resources are available, and continuously looks for better methods (Waters, 2003). In a supply chain, each organization buys materials from upstream suppliers, adds value, and sells them to downstream customers. The mechanism for initiating and controlling the flow of materials is provided by purchasing, or procurement. Usually, purchasing refers to the actual buying, while procurement has a broader meaning. Procurement is responsible for acquiring all the materials needed by an organization. It includes different types of acquisition as well as the associated work of selecting suppliers, negotiating, expediting, monitoring supplier performance, materials handling, transport, and receiving goods from suppliers (Waters, 2003).

The most important part of procurement is finding the right supplier. The supplier must be capable of doing the work, giving high quality, working to a schedule, with acceptable costs, and so on. A qualified supplier is one who can actually deliver the materials needed. In general, organizations look for suppliers who (Waters, 2003):

- are financially secure with good long-term prospects;
- have the ability and capacity to supply the necessary materials;
- accurately deliver the requested materials;
- send materials of guaranteed high quality;
- deliver reliably, on time;
- quote acceptable prices and financing arrangements;
- and flexible to customer's needs and changes;

- are experience and have expertise in their products;
- have earned a good reputation;
- have been used successfully in the past and can develop long-term relationships.

In different circumstances, many other factors might be important, such as convenient location, ability to deal with variable demand, and so on.

Most of organizations have a list of approved suppliers who have given good services in the past, or who are otherwise known to be reliable. If there is no acceptable supplier on file, the organization has to search for one. A useful approach for choosing the best supplier for a product has the following steps:

- build a long list of qualified suppliers who can deliver the products;
- compare organizations on this list and eliminate those who are less desirable until there is a shortlist of the most promising suppliers;
- prepare an enquiry, or request for quotation, and send it to the shortlist;
- receive bids from the shortlist;
- make a preliminary evaluation of bids to eliminate those with major problems, a technical evaluation to see if the products meet all specifications, and a commercial evaluation to compare the costs and other conditions;
- discuss condition bids and terms of agreement with the remaining suppliers;
- choose the supplier that is most likely to win the order (Waters, 2003).

This is clearly a time-consuming and expensive procedure. Normally, an organization will spend little time looking at alternative suppliers if it is buying low value materials, there is only one possible supplier, there is already a successful arrangement with a supplier, or the organization has a policy of selecting specific types of supplier.

Sometimes, particularly with government work, procurement has to be visibly fair (Waters, 2003), and all potential suppliers must be given an opportunity to submit quotations. Rather than forming a shortlist of qualified suppliers, an organization will widely advertise that it is seeking quotations for particular work or materials. The organization compares all the bids submitted and reduces the one that best meets the prescribed criteria. This is called open tender. A variation reduces the administrative effort by putting some qualifications on suppliers, perhaps based on experience, size or financial status. This gives limited tender.

The described above case is about customers selecting suppliers; it assumes that suppliers are happy to serve all the customers they can find (Waters, 2003). But sometimes suppliers have more power and effectively choose their customers. This might happen when a

supplier has a monopoly of some material or service. It might also happen when there is a temporary shortage of some commodity, and supplier choose the customers they will supply, giving preference to larger organizations, those who pay more, or those who have long-term agreements.

According to number of suppliers, Waters (2003) specifies two policies: single-sourcing and multi-sourcing. The advantages of single-sourcing are strong relationships between supplier and customer (often formalized in alliances and partnerships), economies of scale and price discounts with larger orders, and less variation in materials and their supply which leads to easier way of keeping requirements and conditions. However, the single-sourcing may leave an organization vulnerable to the performance of an individual company, and causes severe problems if something goes wrong. To avoid this, some organizations have a policy of building the same materials from a number of competing suppliers. The multi-sourcing reduces prices because of competition between suppliers; it can deal easily with varying demand and avoids disrupted deliveries by switching suppliers. It gives access to wider knowledge and information and is more likely to encourage innovation and improvement.

Procurement is clearly an important function within every organization because it is responsible for a reliable supply of materials. If to take a broader view, procurement is important because it forms an essential link between organizations in the supply chain and gives a mechanism for coordinating the flow of materials between customers and suppliers (Waters, 2003).

2.4.3 Cooperation within supply chain

Cooperation between firms belonging to the same supply chain is now recognized as a powerful source of competitive advantage. Such companies do not transfer costs along the supply chain. They cooperate to increase overall sales and reduce total cost rather than competing for a bigger share of a fixed profit. Companies are unlikely to achieve significant supply chain integration unless they develop close relationships with key partners up and down the supply chain (Sadler, 2007).

The firms along the supply chain are independent companies with separate owners, managers and stakeholders. Such sovereign companies are not used to working closely together for the good of the whole chain. Their managers keep product volume and cost information to themselves. They do not trust each other sufficiently. They work predominantly with their immediate suppliers and customers (Sadler, 2007) So that suppliers set rigid conditions and try to make as much profit from each sale as possible, and, at the same time, organizations have no loyalty and they shop around to get the best deal. The result is

uncertainty about the number and size of orders, constantly changing suppliers and customers, changing products and conditions, different times between orders, no guarantee of repeat orders and changing costs (Waters, 2003).

To avoid these problems, organizations have to recognize that it is in their own interest to replace conflict to agreement. So the challenge is to overcome the inertia of past practices and to implement transparent planning, scheduling and operating for every transaction for every product in the chain. In short, to build up relationships and organize partnerships.

Types of cooperation

Waters (2003) argues that there are several ways that organizations can cooperate.

1. Informal arrangement.

It means that organizations can simply do business together. If an organization has a good experience with a supplier, it will continue to use it and over some period will develop a valuable working relationship. The key point with these informal arrangements is that there is no commitment. Japanese companies take this approach further forming Keiretsu¹².

An informal arrangement has the advantage of being flexible and non-binding. On the other hand, it has the disadvantage that either party can end the cooperation without warning, and at any time that suits it. This is why many organizations prefer a more formal arrangement, with a written contract setting out the obligations of each party. These are common when organizations see themselves as working together for some time.

More formal agreements have the advantage of showing the details of the commitment, so that each side knows exactly what it has to do. On the other hand, they have the disadvantage of losing flexibility and imposing rigid conditions.

2. Partnership.

When an organization and a supplier are working well together, they may both feel that they are getting the best possible results and neither could benefit from trading with other partners. Then they might look for a long-term relationship that will guarantee that their mutual benefits continue. This is the basis of a partnership. Waters (2003) names it a strategic alliance. The supplier knows that it has repeat business for a long time, and can invest in improvements to products and operations; the organization knows that it has guaranteed – and continually improving – supplies.

¹² Japan's industrial structure is dominated by the *keiretsu*; there are two types: *yoko* (horizontal) and *tate* (vertical). The former are large groupings of companies with common ties to a powerful bank, while the latter are large companies connected to thousands of subservient companies, linked by a production theme, and arranged in tiers (Hall and Braithwaite, 2001:94).

Sadler (2007: 169) offers the next definition of business partnership:

“Partnering is a defined business relationship based on mutual trust, openness, shared risk and shared rewards that yield a competitive advantage, resulting in greater business performance that the companies could achieve individually”.

The main features of partnerships are that organizations are working closely together at all levels; they have joint development of products and processes, continuous improvements in all aspects of operations, guaranteed reliable and high quality goods and services. Their relationships are characterized by openness and trust, shared business culture, goals and objectives, flexibility and willingness to solve common problems, long-term commitment.

Sadler (2007) specifies the types of partnerships and put them into the order from the least to the most advanced:

- Transactional partnering implies that transactions between the two firms are carried out in a seamless ways without the companies being committed to a long-term relationship (this type was already described before).
- Strategic partnering exists because the customer, or buying partner, wishes to create new value by moving some operational parameter in the provision of goods and services to the supplier in exchange for the customer obtaining a higher profit or reference sales.
- Exclusive partnering demands that the customer will have exclusive rights over some supplier capabilities, such as capacity, products or product lines, in return to committed growth for the vendor

An important part of the supply chain design is to decide which type of partnership is most appropriate for a particular relationship. The point is to develop and care for these relationships, so that the “best fit” can be achieved. The benefits the companies can offer each other should be utilized, but time should not be wasted on projects, services, and activities that do not generate increased value for the supply chain (Birgit and Tage, 2005)

It can be difficult to form a successful partnership. Waters (2003) claims that a company can not really expect any benefits from the alliance if it only buys a few materials; or is changing its manufacturing base; or is sensitive about confidentiality; or cannot find reliable suppliers. Most organizations, however, can see potential benefits, and they should start looking at possible arrangements.

According to Sadler (2007), there are three main steps to set up a mutually rewarding partnership. The first step is to achieve internal readiness. Each partner must be led by its CEO¹³ and must treat its own employees as family members. The partner company has to have a uniform culture across its organization to achieve internal readiness. It also helps to have a small number of suppliers as is feasible.

The second step is to set up partnership. It is important to identify the right partner. Companies need to compare value systems and their emphasis on short-term gains versus long-term development. It is important to establish mutual expectations for the partnership: set measurable targets and the means to attain them. It is also necessary to integrate business processes and technology, and to define the items in case of not sharing databases.

The third step is to maintain the partnership. Regular feedback between the two partners enables urgent matters to be addressed and prevents dislocations. Any failures should be eliminated by recovering the partnership aims and redrawing the expectations.

Of course, forming a partnership is only the first stage, and still it needs a lot of effort to make it success. Some factors that contribute to a successful partnership are summarized by Lambert et al. (1996):

- drivers, which are the compelling reasons for forming partnerships, such as cost reduction, better customer service, or security;
- facilitators, which are the supportive corporate factors that encourage partnerships, such as compatibility of operations, similar management styles, common aims, and so on;
- components, which are the joint activities and operations used to build and sustain the relationship, such as communication channels, joint planning, shared risk and rewards, investment, and so on.

Partners within a supply chain have to put efforts to make the system work for the common benefit. Close collaboration is the basis of successful relationships between companies. For supply chains to work well, it is necessary for each link company to be prepared to share the exigencies of business life as they happen with upstream suppliers and downstream customers to become one supply enterprise. Successful partnering in supply chains is at odds with some of the new tenets of corporate governance. Successful movement

¹³ CEO - Chief Executive Officer. Chief Executive is typically the highest-ranking corporate officer (executive) or administrator in charge of total management of a corporation, company, organization, or agency, reporting to the board of directors (Wikipedia).

to a coherent supply enterprise should amply satisfy all stakeholders, including shareholders (Sadler, 2007).

Waters (2003) claims that alliances are becoming increasingly popular. But they are certainly not the best answer in every circumstance. Some purchases are small, or materials are so cheap, that the effort needed for an partnership is not worthwhile; sometimes an organization may not be able to find a partner willing to make the necessary commitment or the partner with necessary skills; organizational structures or cultures may be too different; or it may be impossible to reach the necessary level of trust and information sharing, and so on. So there is one more type of cooperation that may become more appropriate for joint arrangements.

3. Vertical integration.

If an organization wants to go beyond partnerships, it has to own more of supply chain. One common arrangement has an organization taking a minority share in another company. This gives it some say in their operations, but it does not necessarily control them.

Another option, offered by Water (2003) is for two organizations to start a joint venture, where they both put up funds to start a third company with shared ownership. For example, a manufacture and supplier might together form a transport company for moving materials between the two.

The most common arrangement has one organization simply buying other organizations in the supply chain. This increases its level of vertical integration. Waters (2003) gives a definition of vertical integration as the amount of a supply chain that is owned by one organization. If the organization owns initial suppliers, does most of the value adding operations, and distributes products through to final customers, it owns a lot of supply chain and is highly vertically integrated. If the organization owns a lot of the supply side it has backward or upstream integration; if it owns a lot of distribution network, then it has downstream or forward integration.

In some circumstances vertical integration is the best way of getting different parts of the supply chain to work together. More often, widespread vertical integration would be very expensive, leading to huge organizations that spread their resources to thinly, needing specialized skills and experience that one organization does not have, reducing flexibility to respond to changing conditions, and so on. So vertical integration is not necessarily desirable and is not so easily achievable.

2.4.4 Characteristics of successful cooperation

Experiences from implementing the supply chain concept in companies show that the following attributes typically characterize successful cooperation (Birgit and Tage, 2005):

- Strategic supply chain management implementation. This stage explains the way of supply chain integration in the overall business strategy. The implementation of the concept internally and in relation to cooperation partners is a process that affects activities in many areas.
- Frequent and reciprocal information exchange between actors regarding inventory status, forecasts, production plans, sales and marketing strategies. The goal is to reduce uncertainty and reaction time for the entire supply chain. Ideally, the information is as readily accessible to all parties as it is for any single participant in the supply chain cooperation.
- “Fair” sharing of the advantages and risks, making the individual participant feel that the rewards of entering into the cooperative effort are evenly balanced between the resources invested and the risk of loss. Therefore, it is important with regard to long-term cooperation that participants, who invest a relatively large amount of resources, receive a corresponding proportion of the gains.
- Development of integrated information systems among actors. Today, many companies have implemented Enterprise Resource Planning¹⁴ (ERP) systems. They make it possible to integrate activities and processes within the individual company, and offer the potential to transfer information to other actors via EDI or Internet.
- Openness and trust between cooperation partners. Trust can be demonstrated by informing each other about development plans, visions and strategies, by using “single sourcing”, and by sharing ideas.
- Credible commitments between the involved parties. They can be demonstrated through, for example, long-term contracts, employee exchange, and joint competency development.

¹⁴ Enterprise Resource Planning (ERP) – a computer system which encompasses all the planning and control functions necessary to run a manufacturing plant and which records the current status of data in other functions throughout the divisions of a whole company (Sadler, 2007).

- Organizational adaptation and proportional risk adjustments among the involved parties. The goal is to create a process-oriented attitude among employees, while focusing on the entire supply chain.
- The use of customers' needs and desires as a starting point. Performance targets for a company in the supply chain should result from focusing on customer satisfaction and customer loyalty.

In conclusion it is necessary to say that the tendency towards increased integration and cooperation between the enterprises in the supply chain results in greater complexity in the management and control technology, which requires increased coordination of resources and activities (Birgit and Tage, 2005).

2.4.5 Specific factors of supply chain integration

The implementation of the supply chain management concept will always be contingent on the specific situation. That is, the number of specific factors will be decisive in how far the concrete working relationship progresses towards integrated coordination (Birgit and Tage, 2005).

1. Innovative or functional products.

The classification of products on the basis of their demand patterns, according to Fisher (1997), has two categories: primarily innovative and primarily functional¹⁵. Each category requires different kind of supply chain integration.

Firms that compete with innovative products and technology have less incentive to share sensitive product and/or business information with supply chain partners. They are expected to have a relatively low degree of integration. While there may be very close partnerships between these firms culminating in sharing planning and logistics data, partners are not likely to join forces on the design and development of core items.

For companies offering primarily functional products with a fairly stable and predictable demand and long life cycles, the incentive to integrate with their supply chain partners is high as these products naturally attract more competition, thereby enhancing the need for cost efficiency (Birgit and Tage, 2005).

¹⁵ Functional products include the staples that people buy in a wide range of retail outlets, such as grocery stores and gas stations. Because such products satisfy basic needs, which don't change much over time, they have stable, predictable demand and long life cycles. But their stability invites competition, which often leads to low profit margins. To avoid low margins, many companies introduce innovations in fashion or technology to give customers an additional reason to buy their offerings (Fisher, 1997).

2. Governance structure.

Using similar reasoning, it is easy to see why a firm marketing a new product in the early stage of its life cycle would not be keen to engage in a close inter-organizational relationship with its supply chain partners. Birgit and Tage (2005) argue that governance is the mechanism through which a firm manages an economic exchange.

For standard off-the-shelf types of items or functional products, firms rely on market governance when they interact with other firms. For innovative products at the early stages of a product's life cycle, firms usually more rely on product-specific assets or, in other words, they use hierarchical governance where the required assets are available within the boundaries of the firm. At a mature stage of a product's life cycle, when more competitors have entered the market, firms may try to leverage supply chain partner's complementary skills in addition to their own in order achieve higher cost efficiency and stay competitive. It leads to what Birgit and Tage call intermediate governance when alliances with supply chain partners are resorted to and inter-organizational integration results.

3. Industry maturity.

An industry in early phase of its life cycle exhibits a high degree of uncertainty and changing technology. During this phase, firms and organizations tend to safeguard their selfish interests acquiring as much market share as possible, they tend to discourage too close partnerships with external entities and are generally averse to sharing too much sensitive information. Companies try to organize all activities such as manufacturing, sales and marketing, logistics, distribution and service support within the firm boundaries.

As customers, dealers and other service providers become more knowledgeable of the technology and as the reliability of products improves, the manufacturers do not feel the same compulsion to maintain total control of all activities. Also, as industries mature and firms dig in and consolidate market share, the scale of production is increased, uncertainty is reduced, and products and processes undergo standardization. In a less uncertain environment, companies experience less need for vertical integration.

Therefore, in a mature industry, while there is no intense competition, it is frequently the case that there is no single company that produces everything. Instead, companies become more open to close inter-organizational relationships with capable external entities for the efficient provision of products and services. It is easy to argue that as firms find investments needs beyond their reach, they adopt more pragmatic strategies and look for supply chain partners who can complement their capabilities and resources. Thus, as products and

processes mature and undergo standardization, companies begin to rely more heavily on the market for recurrent acquisition of parts and components, which leads to greater supply chain integration (Birgit and Tage, 2005).

4. Dominance.

Power is seldom distributed equally among participants in a supply chain. A firm's power in a supply chain represents its potential for influence on other participants' attitudes and behavior. Often, one participant has a dominant position, either because of purchasing power, market share, or access to proprietary technology and knowledge.

Birgit and Tage (2005) consider power and dominance as an important factor in determining the extent to which a supply chain is suitable for integration and the level of supply chain integration. In supply chains where one firm is highly dependent on the other participants but not vice versa, the less dependent firms will have a power advantage and can force strong and effective relationships in the supply chain. In situations where there is a low degree of dependency between the dominant firm and the other firms in the supply chain, one would expect to find low integration. Supply chain integration blossoms when the self-seeking dominant partner is convinced of the need for integration and takes an initiative to mobilize all the partners.

In the case of supply chain that enjoys a high degree of dominance in a market with low competition, low integration is to be expected. If on the contrary the dominant player is operating in a competitive environment, the company can be expected to be more proactive, and aim for high integration with its supply chain partners.

However, if none of the partners in the supply chain has a dominant position and the market competition is relatively low, a stable situation with a low degree of integration is likely to arise. In highly competitive market situations and balanced power relationships among the participants in the supply chain, the degree of integration depends very much on industry culture and traditions. In some industries, limited integration and a reactive adoption of new technology are likely to occur. In other industries, there might be a tradition for collaboration and specialization.

2.4.6 Benefits of supply chain integration

An integrated supply chain requires movement of materials, parts and products, and the provision of service, in the value chain. Better design and execution of provision and flow, by all partner firms in concept, will improve the efficiency of operation. The system-wide

perspective allows the firms to make appropriate trade-offs¹⁶ between variable costs such as purchasing, production, transport, inventory and distribution and between the resource costs of equipment, information systems and people. Close coordination between these operations and the strategic environment produces high levels of service and performance for customers while reducing the total costs incurred, so that value is sustainably generated for all chain partners (Sadler, 2007).

Waters (2003) shows the following benefits from supply chain integration:

- genuine cooperation between all parts of supply chain, with shared information and resources;
- lower costs – due to balanced operations, lower stocks, less expediting, economies of scale, elimination of activities that waste time or do not add value, and so on;
- improved performance – due to more accurate forecasts, better planning, higher productivity of resources, rational priorities, and so on;
- improved material flow, with coordination giving faster and more reliable movements;
- better customer service, with shorter lead times, faster deliveries and more customization;
- more flexibility, with organizations reacting faster to changing conditions;
- standardized procedures, becoming routine and well-practiced with less duplication of effort, information, planning, and so on;
- reliable quality and fewer inspections, with integrated quality management programs.

Supply chain integration, for a chain of manufacturing and service companies, requires the major stages in the location, transformation and movement of raw materials and finished goods to be “bounded”, designed and operated very competitively. As well as physical movements, the concept of supply chain needs to be applied to information, leadership and management of constituent firms within network. Supply chain provides an opportunity for operators to work together through shared information to provide and deliver goods and services to customers. The cooperation between the participant companies gives advantages in cost reductions, greater customer satisfaction and higher performance of activities for the entire supply chain and each integrated firm individually (Sadler, 2007).

¹⁶ Trade-off is the choice to carry out a supply chain function at one point so as to save greater effort or cost at another point (Sadler, 2007).

2.5 Logistics and supply chain

The understanding of supply chain management has been reconceptualized from integrating logistics across the supply chain to the current understanding of integrating and managing key business processes between the supply chain participants. In October 1998, the Council of Logistics Management announced a modified definition of logistics that declares a logistics management as only a part of SCM. The definition is:

“Logistics is that part of the supply chain process that plans, implements, and controls the efficient flow and effective storage of goods, services, and related information from the point-of-origin to the point-of-consumption in order to meet customers’ requirements”.

It is easier to understand that why executives would want to manage their supply chains to the point of consumption because whoever has the relationship with the end user has the power in the supply chain (Lambert, 2001).

Logistics is responsible for the movement and storage of materials as they move through the supply chain. Water (2003) names the following activities that are normally included in logistics:

- Procurement or purchasing – the flow of materials is initiated when procurement sends a purchase order to a supplier. It means that procurement finds suitable supplier, negotiates terms and conditions, organizes delivery, arranges insurance and payment, and does everything needed to get materials into the organization.
- Inward transport or traffic – moves materials from suppliers to the organization’s receiving area. It has to choose the type of transport, find the best transport operator, design a route, and get deliveries on time and at reasonable costs.
- Receiving – makes sure that materials delivered.
- Warehousing or stores – move materials into storage, and takes care of them until they are needed. Also warehousing makes sure that materials have the right saving conditions, treatment and packaging to keep them in good condition.
- Stock control – sets the policies for inventory. It considers the materials to store, overall investment, customer service, stock levels, order sizes, order timing, and so on.
- Order picking – finds and removes materials from stores.
- Materials handling – moves materials through the operations within an organization. The aim is to give efficient movements, with short journeys, using

appropriate equipment, with little damage, and using special packaging and handling where needed.

- Outward transport – takes materials from the departure area and delivers them to customers.
- Physical distribution management – is a general term for activities that deliver finished goods to customers, including outward transport.
- Recycling, returns and waste disposal – after the products delivery to customer the need to return the goods can occur. Activities that return materials back to an organization are called reverse logistics or reverse distribution.
- Location – some of the logistics activities can be done in different locations. Logistics has to find the best locations for stocks of finished goods, warehouses, and other activities, it also considers the size and number of facilities. These are important decisions that affect the overall design of the supply chain.
- Communication – is the associated flow of information. This links all parts of the supply chain, passing information about products, customer demand, materials to be moved, timing, stock levels, availability, problems, costs, service levels, and so on. Coordinating the flow of information can be very difficult: “Supply chain competitiveness is based upon the value-added exchange of information” (Christopher, 1996).

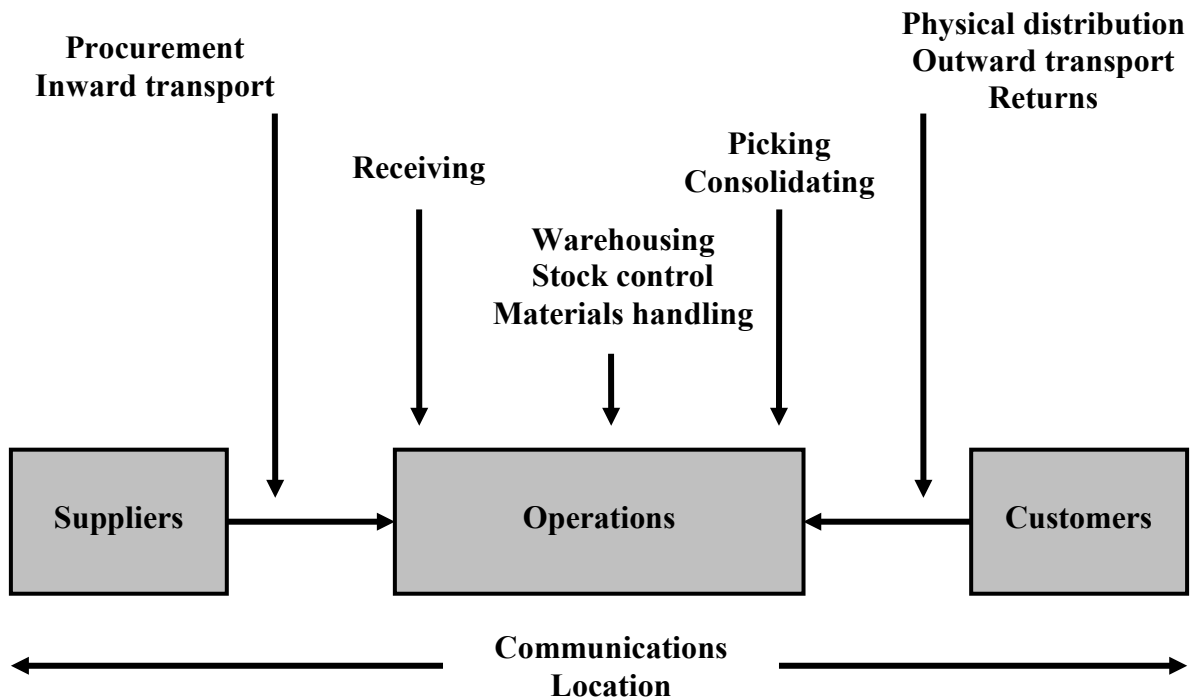


Figure 5. Summary of logistics activities (Water, 2003: 35)

Depending on circumstances, many other activities can be included in logistics. The important point is not draw arbitrary boundaries between functions, but to recognize that they must all work together to get an efficient flow of materials. Sometimes all the activities are organized in a single department reporting to a logistics director; sometimes they are part of a larger department such as marketing and production; sometimes they are spread out in small pockets throughout the organization; sometimes they are contracted out to third-party suppliers (Water, 2003).

Ultimately, the success of every organization depends on customer satisfaction. Any organization can give outstanding customer service if it is prepared to allocate enough resources. The problem, of course, is that more resources come with higher costs. Then a realistic aim of logistics balances the service given to customers with the cost of achieving it. According to Waters (2003), the overall aim of logistics is to achieve high customer satisfaction. It must provide a high quality service with low – or acceptable –costs.

In terms of perceived customer value, logistics adds value by making products available in the right place and at the right time. If a product is available at the place it is needed, logistics is said to have added place utility; if it is delivered at the right time, logistics has added time utility. Waters (2003) offers Harrington’s saying about the double role of logistics (planning and executing): “... logistics is both the glue that holds the materials and product pipeline together and the grease that speeds product flow along it”.

2.5.1 Importance of logistics

Logistics is essential for every organization. Without logistics, no materials move, no operations can be done, no products are delivered, and no customers are served. Not only is logistics essential, but it is also expensive. The cost of logistics varies widely between different industries. So the true picture depends on circumstances within each organization.

Logistics has the awkward combination of being both essential and expensive. It affects customer satisfaction, the perceived value of products, operating costs, profit and just about every other measure of performance. No organization can expect to prosper if it ignores logistics and organizing logistics properly can give competitive advantage. Waters (2003) summarizes the importance by saying that it:

- is essential, as all organizations, even those offering intangible services, rely on the movement of materials;
- is expensive, with costs often forming a surprisingly a high proportion of turnover;
- directly affects profits and other measures of organizational performance;

- has strategic importance with decisions affecting performance over the long term;
- forms links with suppliers, developing mutually beneficial, long-term trading relationships;
- Forms links with customers, contributing to customer satisfaction and added value;
- Has a major affect on the lead time¹⁷, reliability and other measures of customer service;
- Determines the best size and location of facilities;
- Can be risky, because of safety, health and environment concerns;
- Prohibits some operations, such as moving excessive loads or dangerous goods;
- Can encourage growth of other organizations – such as suppliers and intermediaries offering specialized services.

2.5.2 Trends in logistics.

Logistics continually meets new challenges, and is changing faster now than at any time in the past. According to Waters (2003), there are several current trends in logistics:

1. Improving communication.

Perhaps, the most obvious change is the increasing use of technology. Some of this appears directly in the movement of goods – such as electronic identification of packaging, satellite tracking of lorries and automotive guidance systems – but the greatest impact has come with communications.

The simple transaction of purchasing orders, contract terms, shipping papers, delivery details, invoices, and etc. seem complicated and time consuming. The first improves that revolutionized these communication were fax machines. The next step had arrived with electronic data interchange (EDI). This allows remote computers to exchange data without going through any intermediaries. Also the use of EPOS – electronic point-of-sale data – gave less paperwork, lower transaction costs, faster communications, fewer errors, more integrated systems, and closer business relations.

Over the next few years (after 2000) electronic trading became more sophisticated and widespread. This comes in many forms, all based on the direct exchange of data between a supplier's computer and a customer's. Two main versions are B2B (business-to-business, where one business buys materials from another business) and B2C (business-to-customer, where a final customer buys from a business).

¹⁷ The explanation of the term “lead time” will be done further in section 2.5.2 (Improving customer service).

Two associated technologies have developed to support EDI. The first is item coding, which gives every package of material moved an identifying tag. The logistics system knows where every package is at any time, and automatic materials handling can move, sort, consolidate, pack and deliver materials. The second technology is electronic fund transfer (EFT). When the delivery of materials is acknowledged, EFT automatically debits the customer's bank account and credits the supplier's. This completes the loop, with EDI to place orders, item coding to track the movement, and EFT to arrange the payment.

2. Improving customer service

Many organizations have reduced their logistics costs to levels that affect their whole operations. Lower transport costs, for example, make it feasible to sell products over a wider geographic area. Similarly, efficient transport can move products quickly over long distances, so there is no need to build traditional warehouses close to customers.

While striving for lower costs, organizations obviously have to maintain their service levels. A problem, of course, is finding the features that customers really want and the level of service they are willing to pay for. A first key factor is the lead time. This is the total time between ordering materials and having them delivered and available for use. Ideally, the lead time should be as close to zero as possible, and one approach to this uses synchronized material movement. This makes information available to all parts of the supply chain at the same time, so that organizations can coordinate materials movements, rather than wait for messages to move up and down the chain.

Another key factor for customer satisfaction is personalized products. This is mass customization, which combines the benefits of mass production with flexibility of customized products. It uses B2C to give direct communications between a final customer and a manufacturer, and it needs supply chains that are flexible, that move materials very quickly, and respond to varying conditions.

3. Other significant improvements

Apart from increasing technology and emphasis on customer satisfaction, there are several other important trends in logistics. The following list presented by Waters (2003) includes some of the most significant:

- Globalization – improved communications and better transport mean that physical distances are becoming less significant. Efficient logistics makes a global market feasible, and other factors that encourage international trade include less restricted financial systems, consumer demand for imported products, removal of import

quotas and trade barriers, and the growth of free trade areas. Meersman and Van de Voorde (2001) name two directions in international trade: globalization of the production process, where a high domestic demand allows moving abroad, and globalization of product markets, which is stimulated by the easier and less expensive entrance rates.

- Reduced number of suppliers – the current trend is to develop long-term relationships with the best suppliers.
- Outsourcing – more organizations realize that they can benefit from using specialized companies to take over part, or all, of their logistics. Third-party logistics (3PL) is the use of a transport company to carry out a variety of transport and distribution tasks along the supply chain. The 3PL operator specializes in this area and can achieve economies of scale beyond those available to most small or medium-sized companies. Using a third party for materials movement leaves an organization free to concentrate on its core activities.
- Postponement – when there are many variations on a basic product, this can give high stocks of similar products. Postponement moves almost-finished goods into the distribution system, and delays final modifications or customization until the last possible moment.
- Cross-docking – traditional warehouses move materials into storage, keep them until needed, and then move them out to meet demand. Cross-docking coordinates the supply and delivery, so that goods arrive at the receiving area and are transferred straight away to a loading area, where they are put onto delivery vehicles. This dramatically reduces stock level and associated administration.
- Other stock reduction methods – keeping stocks is expensive, so organizations continually look for ways of reducing the amount stored in the supply chain. One approach uses just-in-time¹⁸ operations to coordinate activities and minimize stock levels. Another approach has vendor managed inventory¹⁹, where suppliers manage both their own stocks and those held further down the supply chain.
- More collaboration along the supply chain – organizations in a supply chain increasingly recognize that they should not compete with each other, but should cooperate to get final customer satisfaction.

¹⁸ Just-in-Time (JIT) logistics is the principle that goods are delivered at the right quantity at the right place immediately in advance of their requirement (Hall and Braithwaite, 2001). This is JIT delivery. There is one more concept: JIT production refers to the delivery of components to the production process only when needed.

¹⁹ Vendor managed inventory (VMI) is an arrangement between a supplier and a manufacturer or distributor whereby the supplier takes responsibility for replenishing stocks at the manufacturer's premises (Sadler, 2007).

All the trends are related. Increasing technology, for example can give less stock, lower costs, shorter lead times, higher customer satisfaction, and so on. The overview of the trends leads to point that the next section, where the main logistics strategies are presented, is grown out of the last changes in logistics development.

2.5.3 Logistics strategies

For many organizations recognition that logistics has a strategic impact is one of the most important developments of recent years. It changes the way that they manage the supply chain, and links it more closely with other strategic decisions. The understanding that logistics has a long-term effect on overall performance has moved it from the periphery to the centre of decision making. Waters (2003) argues that all long-term decisions about logistics form a logistics strategy:

The logistics strategy of an organization consists of all the strategic decisions, policies, plans and culture relating to the management of its supply chains.

The logistics strategy forms a link between the more abstract, higher strategies and the detailed operations of the supply chain. While the corporate and business strategies describe general aims, the logistics strategy concerns the actual movement of materials needed to support these aims.

Organizations have to choose a specific focus for their logistics strategy, showing which factor they consider to be the most important: low cost, good customer service, fast delivery, flexibility, using high technology, and so on. In logistics there are two main approaches: lean and agile strategies (Waters, 2003).

1. Lean strategies.

A reasonable objective is to minimize the total cost of logistics, while ensuring acceptable levels of customer service. The aims of a lean logistics are to do every operation using less of each resource – people, space, stock, equipment, time, and so on. It organizes the efficient flow of materials to eliminate waste, give the shortest lead time, minimum stocks and minimum total cost. The approach includes such principles (Waters, 2003): designing a product that has value from a customer' perspective; designing the best process to make the product and setting the requirements of supply chain; only making products when there is customer demand; and looking for continuous improvements to get closer to the aim of perfect operations.

A lean strategy looks for the ways to identify and eliminate the waste. The waste appears in such areas as low quality, wrong production level or capacity, poor processes, in waiting for operations, materials or equipment, in holding too much stock and making unnecessary movements. Lean operations maintain customer service while using fewer resources – they do not just minimize costs. But they might not work when there are variable and uncertain conditions. An alternative is a more flexible strategy based on agility.

2. Agile strategies

An agile strategy concentrates on the other side of the “efficient versus responsive” – or lean versus agile – debate. Its supporters say that lean operations put too much emphasis on costs, and cannot deal with changing conditions, increasing competition, or more sophisticated and demanding customers. The aim of an agile strategy is to give a high customer service by responding quickly to different or changing circumstances.

There are two aspects of agility. First, there is the speed of reaction; agile organizations keep a close check on customer demands and react quickly to change. Second, there is an ability to tailor logistics to demands from individual customers. These are different aspects of customer service, and the implication is that end-customer satisfaction is a prime concern, even if this comes at somewhat higher price. Organizations with satisfied customers have the obvious benefit of bringing them back with repeat business.

In practice, there is not such a clear divide between the two strategies. Both accept that customer satisfaction and low costs are dominant themes, but they use different descriptions of the process to achieve them.

3. Strategic alliances

A third strategy develops the ideas of integration. An organization can put so much emphasis on close cooperation with other parts of supply chain that it has a strategy of forming alliances with suppliers and customers. The purpose of this strategy is to get efficient supply chains, with all members working together and sharing the benefits of long-term cooperation.

Usual reasons for a strategy of forming partnerships include better customer service, increased flexibility, reduced costs, avoidance of investment in facilities, and lack of expertise with the organization. The most common area for partnerships is transport, where around three quarters of companies use contract providers. Other areas for collaboration include warehousing, import/export services and information processing (Waters, 2003).

4. Other strategies

There are several other general strategies, where organizations emphasize other aspects of performance. Time-based strategies aim for a guaranteed faster delivery of products. Benefits from these strategies include lower stocks, improved cash flow, less risk and simpler operations. The main assumption, though, is that faster delivery gives better customer service. Increased productivity strategies use available resources as fully as possible. Facilities, such as warehouses, have high fixed costs and using them as full capacity spreads these costs over more units. Value-added strategies make an organization to add as much value as possible. Organizations adds value by delivering to the place and at the time preferred by customers, or by doing more work such as installing the machines, offering service contracts, and so on. The strategy of diversification in organizations offers the widest range of services and satisfying as many customers as possible. Other organizations have a strategy of specializing in a narrow range of services, but being the best provider in their chosen area.

2.5.4 International logistics

The trade is based on the recognition that an organization can buy things from a supplier in one country, use logistics to move them, and then sell them at a point to a customer in another country. Improved communications, transport, financial arrangements, trading agreements, and so on, mean that organizations search the world to find the best location for their operations. Then international logistics move the related materials through long and complex supply chains. Waters (2003) gives such a definition:

International logistics occur when supply chains cross national frontiers.

Some people prefer the term global logistics, to suggest integrated operations in an international setting. This can bring a whole range of new problems. Some are practical, such as physically moving materials across a frontier and organizing transport over longer distances; some are cultural, such as speaking new languages and meeting different customer demands; some are economic, such as paying local taxes and tariffs.

Essentially, any decision about the relocation of production or parts of the production process to a country other than the country where the product is sold depends on cost considerations. Meersman and Van de Voorde (2001) offer the following factors that influence such a decision:

- the extent of modulation and standardization of the production process;
- the evolution of the local consumption level;

- the possibility of spread existing technologies geographically;
- the share of the transport cost in the overall cost structure.

On the other hand, a rising local consumption, stimulated by economic growth, will lead to a sufficiently high demand to allow local production. As a consequence, companies will go international and invest a considerable amount of their financial assets abroad. However, declining real transport costs, possible enhanced by an increasing value of the goods transported and a declining ratio of weight against volume, is conducive to a concentration of production in specialized factories. Declining telecommunication and computer costs may contribute further to a smoother internationalization of the production process (Meersman and Van de Voorde, 2001).

Waters (2003) argues that greater prosperity allows efficient logistics, but at the same time logistics can contribute to prosperity and encourage economic growth. The argument is that lower costs for logistics reduces the cost of delivered products – and thereby encourage sales, increases trade, opens new markets, breaks down local monopolies, increases competition and generally encourages business. To put it simply, trade increases prosperity, and trade depends on logistics.

Waters (2003) also point on some facts that maintain the increasing trade, just to name the few: growing demand in new markets and demand for foreign products; specialized support from international companies that can organize the other company's activities (outsourcing); integration of supply chain that becomes possible only when the national frontiers are transparent; improved communication among customers, which increases brand recognition and encourages convergence; and removal of trade barriers that is one of the major stimulation of international trade.

Decisions about entering international markets depend on factors ranging from the organization's strategy through to forecasts for economic growth. These are inevitably difficult, and need a clear appreciation of the costs and operations involved.

The incentive for international operations must come from the business strategy, which contains an aim of expansion. This includes the decision to work nationally, internationally, multinationally or globally. Waters (2003) describes all these types like this:

1. *National* organizations only work within their home market; if they want a presence in international markets, they export to marketing organizations in foreign countries;

2. *International* companies have facilities in different countries, but their work is really centered in one home country from which they control the activities of all subsidiaries;
3. *Multinational* lose the central control and have loosely linked, largely independent companies working in different geographical regions. The separate divisions have more flexibility to adjust operations and products to local needs. Two dominant structures have divisions organized by geography or product.
4. *Global* companies see the world as a single market; they usually make standard products for shipment anywhere in the world, using the locations where they can work most effectively and efficiently.

In reality, organizations have to be flexible and respond to local conditions, practices and demand. This needs a looser structure that can include many different types of operation, but gives a unified culture for the overall organization.

If a company wants to send its products internationally, it does not have to work internationally itself. Waters (2003) offers five basic alternatives for a company to reach foreign markets:

- licensing or franchising, where a local organization makes the products to designs supplied by a foreign company; depending on circumstances, the foreign company might specify a range of procedures for operations, quality, suppliers, and so on;
- exporting finished goods and using local distributors to market them; the main risk here comes from increasing production to satisfy a demand that depends on the marketing company;
- setting up a local distribution network; products are still exported to meet demand but the foreign company increases control of the supply chain by replacing the local marketing company by an owned subsidiary;
- exporting parts and using local assembly and finishing; this needs facilities in the home market, but these can start very small, as seen in “postponement”;
- full local production with new manufacturing facilities either built specially or taken over from an existing company. This gives access to local knowledge and is often the only way of getting a presence in a controlled market.

A sixth alternative is to set up some form of joint venture with a local company. More substantial facilities can be opened through a partnership, allowing shared ownership,

management skills, knowledge and risk. The level of commitment here can vary considerably, but local conditions often limit foreign ownership to no more than 49% of any joint venture.

Usually, organizations cannot afford opening full production because of huge investments and risks, and they adopt a more cautious approach. Typically, they expand their operations in a series of steps. In effect, they move down the list above, slowly increasing their investment and only moving on when each previous stage has proved successful.

Managing the logistics of a global organization is immensely complicated. It can involve the movement of huge quantities of materials around the world. Each organization has to find its own model for a global supply chain. Waters (2003) mentions the following five common models for global logistics:

1. Sell globally but concentrate production and sourcing in one area. Logistics then has a fairly simple job of moving materials from local suppliers into the organization, but there are more problems with distribution from operation to international customers. To some extent this model gives fairly easy logistics, as the organization is a pure exporter with global marketing rather than global operations.
2. Concentrate production in one centre but buy materials and components from around the world. Materials are now collected from distant suppliers, and products sold to distant customers. This gives, perhaps, the most difficult logistics with potential problems for both inward and outward logistics. It gives more widespread economic benefits, but the main value-adding activities are still concentrated in one location.
3. “Postponement” moves the finishing of production down the supply chain. In a global context, postponement typically opens limited local facilities to complete production. This gives some opportunities for local value, but all components and parts are imported from main production centers. Because of the limited local input, low added value, and competition for local manufactures, this kind of “screwdriver” operation can be unpopular with host countries.
4. Operating as a local company, buying a significant proportion of materials from local suppliers. The inward movement of materials is easier, as it becomes a local matter. Of course, this means that it may be vulnerable to changing local conditions. The products might be destined for local markets, or operations could be big enough to export to international customers. This is the most popular

approach with host countries as it develops local skills and brings considerable economic benefit.

5. Some global operations have limited need of logistics. A chain, for example, might work globally, but practicalities demand that it does not have an extended supply chain, but buy almost all materials locally and sells to local customers.

The features of the product and the company structure set the overall shape of a supply chain. A global company, for example, is unlikely to use the first model with centralized operations, as this is more like an “international” company. There are, of course, many variations on these basic themes.

Supply chain management has grown out of the logistics concept but is distinct from this concept in several ways. Logistics is typically based on the individual business with the objective of making the enterprise’s logistics system more efficient through internal and external planning and control. SCM is based on the external relationships between the players in the entire supply chain and focuses how to improve trading in general. The SCM concept thus provides a broader perspective across supply chain than has been the traditional approach within logistics (Birgit and Tage, 2005)

2.6 Conclusion

The supply chain is the physical movement of materials and products between each partner firm along the chain until they reach the consumer in the required form when needed (Sadler, 2007).

Every supply chain is unique. It differs in some way from other chains. This makes the study of chains and their practical implementations an interesting and frequently challenging task. Different industries and varied products create different situations. There is a great contrast between clothing manufacture, car production, meat processing and selling petrol. Generally, supply chains only comprise part of the range of activities carried out by the firms which constitute links in the chain. Supply chains are frequently not linear, they are really networks. Chains do not last forever: they form, work for a while and then change their configuration (Sadler, 2007).

An efficient, integrated supply chain plays a major part in success of the business strategies of its constituent companies. It is now recognized that, in many cases, competition is between supply chains rather than individual companies. Getting the product and service to the end consumer when they want it is critical. Consequently, the partners companies should work closely together to define and execute a supply chain strategy which will both satisfy customer needs and allow them to make an adequate return (Sadler, 2007).

Logistics is the time-related positioning of resources, or the strategic management of the total supply chain (Water, 2003). It is responsible for the flow of materials through a supply chain. So that logistics is an essential part of supply chain activities.

Chapter 3. Supply chain in oil and gas industry

3.1 Introduction

This chapter presents the theoretical issues of supply chain in regard to oil and gas industry.

Oil and gas industry has some characteristics that make it distinct from other industries. The strategic nature of the product, volatile pricing, and political pressures influence the supply chain of oil and gas industry. The entire supply chain consists of three main sectors: upstream, midstream, and downstream that add more complexity in the problem because each sector has its own features the companies have to deal with.

The first part of the given chapter provides an overview of the entire supply chain in oil and gas industry and main limits for its implementation.

In addition, the next section presents the strategies that can be used to improve the work of the entire supply chain. The question of supply chain integration is also considered in this part of the chapter.

Moreover, the problems of LNG supply and its contribution to the development of gas market find their reflection in the current chapter. This part also specifies the weaknesses and strengths of LNG market and features of LNG integration.

Pipelines with its specific characteristics are also taken into account as a part of the transportation activities and presented in the fourth part.

In the end of the chapter the description of national oil companies and international oil companies with the emphasis on their role in oil and gas market and development of supply chain is done.

So that the further study of the project relies on a comprehensive theoretical basis and can be investigated according to the problem statement.

3.2 Definition of upstream, midstream and downstream activities in oil and gas industry

In order to understand the main characteristics of the supply chain in oil and gas industry it is important to see the structure of this industry and the main differences among its parts. The information is presented by *Petroleum Services Association of Canada* (PSAC).

When a man fill up his car with gasoline or pay his natural gas heating bill, he is the final link in a long chain of businesses that make it possible for people to enjoy these clean, convenient and economical forms of energy. The entire chain is known as the petroleum industry. However, the industry is usually divided into three major components: upstream, midstream and downstream.

The upstream industry finds and produces crude oil and natural gas. The upstream is sometimes known as the exploration and production (E&P) sector. The upstream petroleum industry includes exploration and production companies as well as hundreds of associated service businesses such as seismic and drilling contractors, service rig operators, engineering firms and various scientific, technical, service and supply companies.

The midstream industry processes, stores, markets and transports commodities such as crude oil, natural gas, natural gas liquids (NGLs - mainly ethane, propane and butane) and sulphur. The midstream provides the vital link between the far-flung petroleum producing areas and the population centers where most consumers are located. The term is sometimes used to refer to those industry activities that fall between exploration and production (upstream) and refining and marketing (downstream).

The downstream industry includes oil refineries, petrochemical plants, petroleum products distributors, retail outlets and natural gas distribution companies. The downstream industry touches every province and territory-wherever consumers are located-and provides thousands of products such as gasoline, diesel, jet fuel, heating oil, asphalt, lubricants, synthetic rubber, plastics, fertilizers, antifreeze, pesticides, pharmaceuticals, natural gas and propane.

Midstream operations are usually included in the downstream category.

3.3 Oil and gas supply chain

Supply chains are always fairly complex, and each industry's chain has its own quirks and characteristics. The first thing to note about the oil and gas supply chain is that it is exceptionally long, astonishingly complex and requires the investment of huge sums of capital. Each one of these factors would make optimising this supply chain difficult. To add to this, the product in question is economically strategic and is shipped in huge volumes (Heever, 2004).

Another important characteristic of the supply chain in oil and gas is that it consists of operators, main contractors, subcontractors and suppliers. Operators are oil and gas companies that hold operating licenses; main contractors are often traditional engineering/construction/service companies; and subcontractors and suppliers are manufacturers and service companies or regional agents with added value in the form of engineering (Anderson, 2003).

The supply chain is divided into three main sections: upstream, midstream and downstream, each of which forms a more or less discrete ecosystem (Heever, 2004).

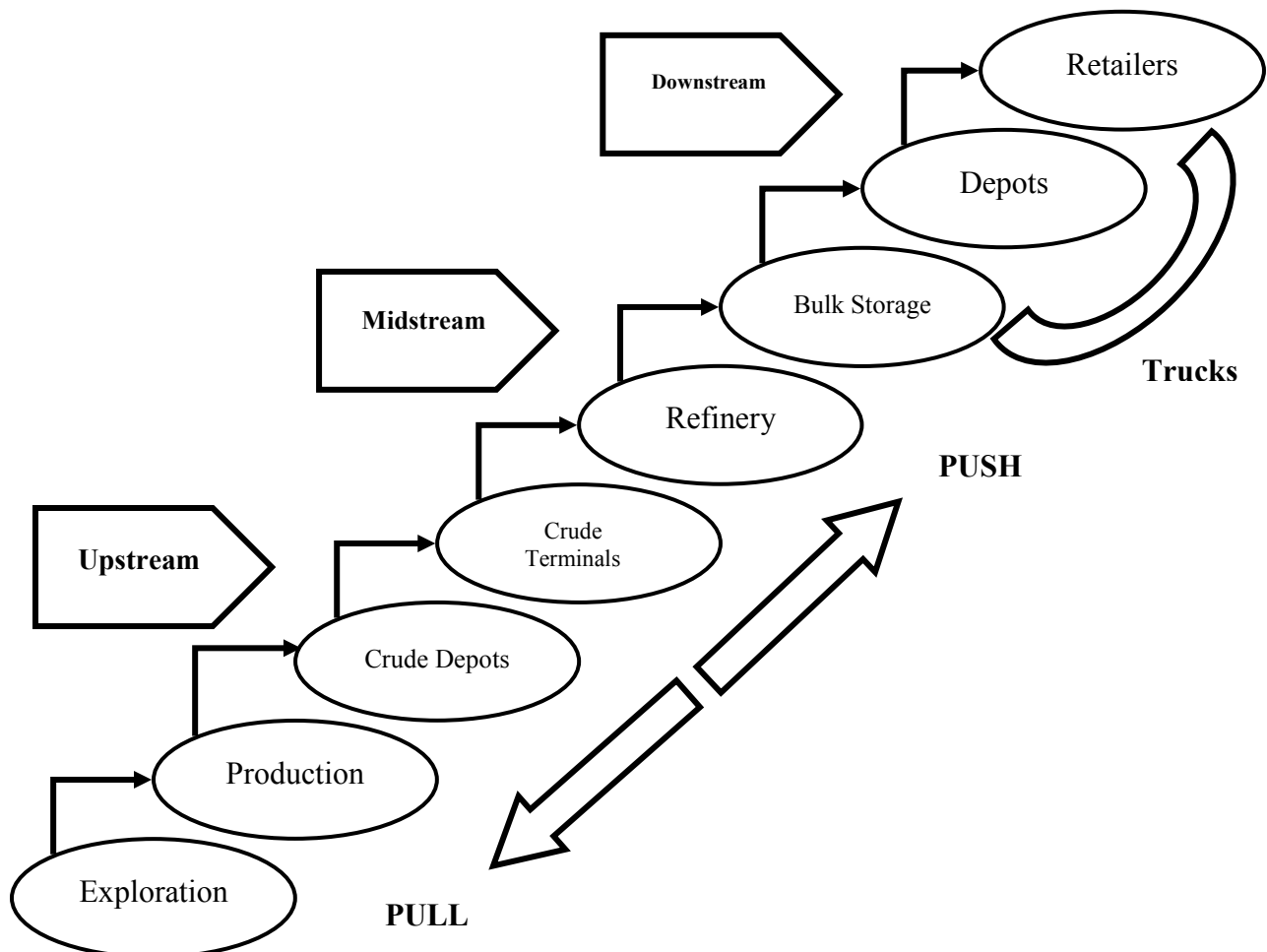


Figure 6. The entire supply chain in oil and gas industry (Heever, 2004)

3.3.1 Upstream supply chain

The upstream portion of the supply chain covers exploration for reserves, the conveyance of the crude or gas into storage tanks, its sale and transport to the storage facilities of the new owner and its conveyance to the refinery. As *Peoplesoft's* solution consulting manager, Dave Macdonald, observes: "Reserves are the primary asset of all the oil companies and a great deal of money goes into the exploration projects" (Heever, 2004).

Developing new fields or even new production regions requires heavy investments, while increasing production from existing facilities is usually less costly. The capacity utilization and availability in existing infrastructure and the potential need for construction of new infrastructure presents a considerable factor of uncertainty for the costs of new supplies (IEA, 1995).

According to gas industry, the cost of production for non-associated gas should reflect the costs of exploring and developing a gas field and bringing the gas to the wellhead. The main factors for the cost of production of non-associated gas are the type and location of reservoirs, the difficulty in developing and producing it and the available and applicable technologies. The cost for associated gas is more difficult to estimate as it is produced jointly with oil. When associated gas is perceived as a byproduct of oil production, it tends to be cheaper than non-associated gas because the costs of production often are considered to be covered by oil revenues or because the resulting production profile makes it difficult to sell at a higher price. In general, total costs of gas or oil production tend to be higher for offshore than for onshore production and higher the harsher the production environment is. This can partly be offset by the size of the field, as large amounts of producible gas or oil lower the unit of production through economies of scale (IEA, 1995).

According to Heever (2004), there are several characteristics of the supply chain in upstream industry:

1. Authorization for expenditure (AFE).

These are often joint ventures with multiple partners, so here project management and sophisticated financial modelling are very important. A key element here is the authorisation for expenditure (AFE), which allows the expenditure to be monitored in terms of the agreed-on, phased project plan.

2. Asset optimization.

Another important discipline here is asset optimisation as a consequence of the huge capital sums involved.

Once the deposits are in production, the crude has to go to storage facilities. Depending on where the well head is, this will involve pipelines or tankers with the attendant scheduling problems.

3. Complicated stock movement

The oil business is supremely a volume game, so from a supply chain point of view the question is one of not only moving huge quantities of material that is hazardous and highly polluting, but also trying to ensure that it doesn't remain in one place for too long – the normal supply chain principles of keeping the stock moving towards the next payment point is complicated by the volumes and the inherent slowness. Another prime characteristic of this industry is the price volatility, which can see cargoes being traded several times during the course of the journey as the oil majors attempt to minimise the prices of their feedstock and ensure that it matches the kind of end products each refinery will be producing.

4. Use of Internet facilities.

An industry-sponsored internet-based portal allows users of the pipeline visibility over its scheduling to enable them to perform their own scheduling. It is planned to extend this functionality to cover shipping as well.

Once the crude reaches the destination, it must be pumped into storage terminals and then sent to the refineries. Road and rail tankers supplement the pipeline as required.

5. Long lead times.

One of the defining characteristics of the whole upstream supply chain is its long lead times. On arrival at each storage point, for example, the crude must settle for several days. So it is important to know exactly where and when the crude must be delivered because mistakes cannot be rectified quickly.

3.3.2 Midstream supply chain

The midstream portion of the supply chain is essentially where the manufacturing takes place, where the crude oil (feedstock) is transformed into a variety of products: diesel, leaded petrol, unleaded petrol, specialty chemicals and so on. All of the general, familiar manufacturing challenges are present with, of course, many specific ones.

The refining process is a complex one. All crudes are not equal, and different types of crude are better suited for all the various outputs that the refinery could produce. It is one of the challenges to match the kind of crude bought some weeks or months back with the kind of outputs that will maximise the refinery's profit mix. Also, the specifications of fuels do evolve

over time, and this has obvious implications for the refining process. The quality of the end product is of great importance in the fuels area as engines become more sophisticated and as environmental issues receive legislative attention, and it is paramount as far as the specialty chemicals are concerned.

Heever (2004) names also several elements that characterize midstream supply chain:

1. Linear programs.

Within the refinery, linear programs are used to maximise the profit for the refinery. Because there are multiple processes, not necessarily linear, and because there are always margins of error (often centred on the fact that volumes fluctuate according to temperature and pressure), the linear programs are based on sets of assumptions. To obtain greater accuracy and optimise performance through more exact prediction, linear programs are now being linked to simulation programs. And this has to link into the ERP system.

2. Uptime or availability.

Within the refinery, other key issues include obtaining product visibility across the entire process and managing the asset lifecycle of the capital equipment. Uptime or availability is clearly a prime consideration here as the crude coming towards the refinery started its journey some weeks back (at least), and cannot be stopped because of unscheduled downtime.

3. Distribution of differentiated product flows. Transport logistics are very important.

From the location point of view, the industry makes extensive use of product exchanges ex-refinery. In terms of this model, the various additives that differentiate refining companies are added at the depot, while there are certain highly differentiated products unique to a particular company which are only produced at its refinery. Transport logistics mean that the solution is likely to be adding capacity but even then, this does not solve the problem of a constraint in some places of the route.

The refinery is the point in the supply chain where the most value is added and therefore must be very sensitive to the demands of the market. If the refinery can integrate sufficiently well with the upstream and downstream portions of the chain, then it will be in a position to plan its production in terms of the margins currently offered by the various products. Margins are all important in business, but particularly in this one as they are generally low and the price of the raw material (and frequently the end product) is not influenced by the oil majors who own the refineries (Heever, 2004).

3.3.3 Downstream supply chain

Downstream begins outside the refinery as the petrol goes to the depots around the country and then on to the retailers. One of the peculiarities of this supply chain is that the customer is actually the filling station or retail outlet, and not the motorist or user. In part at least, this is because the product itself is perceived to be, basically, a commodity and brand loyalty is attenuated. In this market, location is everything and the need to fill up with petrol trumps all other considerations. The dynamic between oil major, filling station and motorist is a difficult one to get right and appears to be one of the areas receiving a great deal of attention (Heever, 2004).

Total, for example, has a pilot in vendor-managed inventory currently running in terms of which in-tank gauging links to the depots, so that fuel can be delivered as needed. This will imply a new business model in terms of which the stock is managed by *Total* while it is in the tanks. Company expects this to reduce delivery costs significantly, and enable the company to plan deliveries around demand patterns. *Total* is also expecting this scheme to bring the ideal of demand forecasting closer (Heever, 2004).

Total's vendor-managed inventory pilot goes to the heart of one of the enduring challenges of the downstream environment: optimising stock holdings at the depots and getting it to the filling stations most economically. It is a problem to fulfil all the requirements of a customer for multiple types of fuel while maximising the load on each road tanker and to serve all the orders of customers spread over a wide area with a limited fleet of vehicles operating under tight cost parameters. Most of the oil majors have outsourced this part of the chain to third party logistics suppliers. But if a retailer is completing this process alone, without outsourcing the activities, then to do it successfully, integration of data real-time across the system becomes very important (Heever, 2004).

The traditional answer to this conundrum is to carry stock within the system at various points. The depot is the most obvious and widely used one – just-in-case production. It's debatable whether just-in-time truly exists in any industry or whether it's just transferring stock holdings from one company to another. One thing is certain: just-in-time in the classic sense is never going to be possible in this industry (Heever, 2004). However, minimising the amount of stock lying idle in depots will continue to receive attention from oil companies. Peoplesoft believes that this challenge will in time be met by consensus forecasting rather than the current statistical models now in use.

Heever (2004) argues that a particular challenge for the supply chain is the leg from refinery to customer for the specialty chemicals that are also refinery products. These are

typically higher value products and customers could be anywhere in the world, making label management a real supply chain issue. This means that the transit documents for each cargo have to be completed in the relevant languages of the countries through which it will pass, and meet the differing regulatory requirements for this type of dangerous material. Batch tracking is also a growing requirement partly because of quality and also because of legal liability. Technology can play a big role in the tracking required here, and in due course technologies like radio frequency identification²⁰ (RFID) may come to play a role. *Engen* confirms that this technology is one of the ones under review for this function across the supply chain, as is global positioning.

As already mentioned, one of the characteristics of the downstream supply chain is the unusual dynamic between producer (oil major), customer (filling station) and customer's customer (motorist). This dynamic is also giving rise to a whole new industry based on the forecourt and the forecourt shop. Forecourt shops had a relatively brief incarnation as vehicle accessory outlets, but have now firmly established themselves as convenience stores in the cities and roadside restaurants on the national routes, and are doubtless playing a role as differentiators for the filling stations. Such non-fuels supply chain is one which will benefit from a collaborative approach with suppliers and other partners (Heever, 2004).

In addition to the Heever's (2004) previous discussion of the main features of the supply chain there is also one interesting point of view presented by Foti (2006). In this case the author considers the midstream supply chain as a part of the downstream chain.

Accenture's benchmarking study²¹, which includes 14 global integrated major companies and regional mid-tier companies, shows that the downstream energy industry lags in many areas when it comes to supply chain excellence compared to retail and other industries. Although the study found that the downstream petroleum supply chain has relative lack of analytical sophistication, organizational alignment, information integration, and technological sophistication (Foti, 2006).

Supply chain capabilities are the set of processes, technology, and people that enable acquisition, inventory management, and distribution of a company's products. The supply chain starts at crude acquisition and ends with the customer sale (Figure 6).

²⁰ Radio-frequency identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders. The technology requires some extent of cooperation of an RFID reader and an RFID tag. An RFID tag is an object that can be applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader (Wikipedia).

²¹ A Benchmark Study is a financial "snapshot" of an industry group that allows individual business owners to compare their operations to others of similar size and type (<http://www.brs-seattle.com/bench.html>).

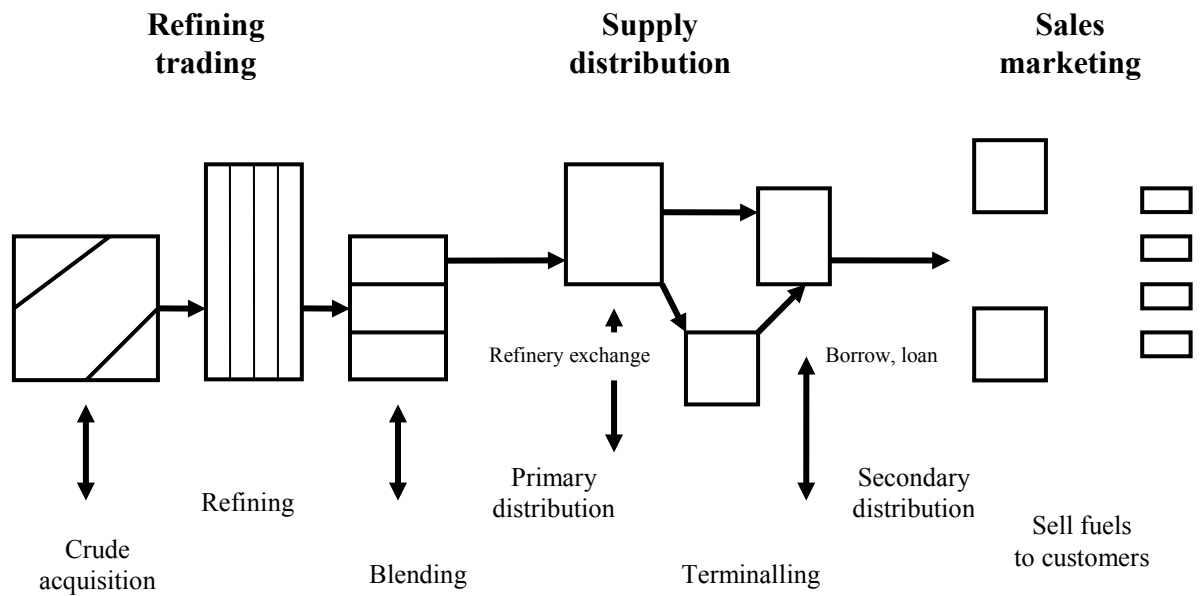


Figure 7. Downstream supply chain (Foti, 2006: 51)

Because downstream companies have turned their focus on improving long-neglected supply chain capabilities, it is natural for them to examine and use best supply chain practices developed in other industries. According to Foti (2006), some of the recent major areas of focus for supply chain improvement have centered on:

- Collaboration. There is much room for improving communication between jobbers²², marketers, and pipeline and marine transportation providers, but the current industry structure is not set up to take advantage of Collaborative Planning, Forecasting, and Replenishment²³ (CPFR).

For instance, retail stations – especially now that more are being sold to jobbers - do not communicate directly with refiners and wholesale marketers in advance to relay impending demand. The wholesale marketer-jobber relationship is defined by supplier-customer behavior versus that of supply chain partners.

²² Jobber is a middleman in the fuel industry. In the United States, an intermediary in the apparel industry who buys excess merchandise from manufacturers and brand owners and sells to retailers at prices that are typically 20-70% below wholesale. Because of the emergence of the discount retail sector since the 1990s, jobbers have grown in stature and are more appropriately referred to as "off-price specialists" (Wikipedia).

²³ Collaborative Planning, Forecasting, and Replenishment (CPFR) is a concept that aims to enhance supply chain integration by supporting and assisting joint practices. CPFR seeks cooperative management of inventory through joint visibility and replenishment of products throughout the supply chain. Information shared between suppliers and retailers aids in planning and satisfying customer demands through a supportive system of shared information. This allows for continuous updating of inventory and upcoming requirements, making the end-to-end supply chain process more efficient. Efficiency is created through the decrease expenditures for merchandising, inventory, logistics, and transportation across all trading partners (Wikipedia).

- Inventory and logistics management. The introduction of radio-frequency identification (RFID) technology is another supply chain innovation making headlines. The promise of RFID is a near-real-time look at inventory regardless of location with minimal human intervention.

For most downstream companies, there is often a need for more accurate and timely inventory information and many companies have launched initiatives in the past few years to upgrade their metering and third-party terminal communication systems. RDIF, however, will likely have near-zero applicability in the downstream sector in the near future given the physics of the product.

- Application for advanced analytics. Companies continue to realize the value of advanced analytics in day-to-day business. The expectation is that “partnerships between mathematicians and computer scientists are bulling into whole new domains of business and imposing the effectiveness of math”. Better analytics around demand and inventory management are contributing to improvements that help retailers reduce inventory by large percents.

This is an area that is especially lacking in most downstream company’s supply chains as they make do with antiquated processes and spreadsheets run by undertrained staff. The advantage is that with such poor starting point, applying some rigorous mathematics offers rich opportunities to those refiners that can make the transformation.

All of these innovations provide valuable lessons for downstream petroleum supply chain improvement. The most significant difference between downstream petroleum and other industries is that product price volatility complicates the simple goal of matching supply and demand. Downstream petroleum needs innovations to incorporate these lessons in addition to creative solutions that fit its unique industry parameters and implementation strategies that recognize downstream petroleum’s relative starting point compared to other industries (Foti, 2006).

The supply chain in oil and gas industry is a complicated process so there are many challenges across it. The next section provides the view of the main quirks and problems within this supply chain and also offers several strategies and opportunities to the companies that are integrated in this process.

3.4 Challenges, strategies and supply chain integration

As it was mentioned before, the supply chain in oil and gas consists of operators (oil companies), main contractors, subcontractors and suppliers. Procurement is performed during the development and abandonment of oil and gas fields and during operation of fields (production). During development, the majority of procurement is structured as project execution tasks. Projects are unique and typically range in size from the tens of millions of dollars to billions of dollars for large offshore new builds. Big projects perform like fiscal expansion in an economic sense (Anderson, 2003).

Forces that govern the supply chain in oil and gas are internal (business-related) and external (political/economic). Large operators interface with governmental entities worldwide and some are closely linked to governments themselves. Main contractors have been nurtured under years of protective development policies. Expertise is the common factor that binds this supply chain network together with the assumption that requirements for safety and uninterrupted operation are never compromised (Anderson, 2003).

3.4.1 Challenges across supply chain

The characteristics of this supply chain create its problems and militate against their solution. Heever (2004) names some of them:

- Its *physical length*, from remote oil or gas fields to virtually every village on earth;
- Its *strategic nature*, meaning that it is heavily politicized and that failure in the supply of its product means more than a lost sale – commerce itself suffers;
- Its *volatile product pricing* means that already-low margins are also unreliable;
- It transports *high volumes of hazardous liquid*; and the volumes vary. Measurements are thus never exact; environmental, health and safety considerations must always be considered;
- Because it is a *low margin, high volume chain* covering great distances, it needs to make use of slow and expensive bulk transportation methods like tankers, pipelines and road tankers – lead times thus become inflexible, and planning and forecasting become correspondingly important. These attract high capital costs.

These characteristics make it very difficult for the supply chain to be optimised, and yet this optimisation is increasingly important as demand continues to grow and geopolitical uncertainties threaten the smooth supply of raw crude.

Anderson (2003) also names several factors that influence supply chain and differentiate oil and gas sector from other business sectors. First one is that oil companies are subject to various political pressures. The supply chain associated with such an infrastructure is a huge

economic asset that governments try to control in various ways. Governments in Organization for Economic Co-operation and Development²⁴ (OECD) countries have traditionally been using subsidies, duties, influence and establishment of isolationist trade blocks to lock out competition mainly from less-developed countries. From the standpoint of supply chain management, subsidies are embraced, while duties are frowned upon. In reality, both are detrimental, since protectionism in any form throws a wrench in the survival-of-the-fittest concept and reduces efficiency by protecting the inefficient, causing the efficient to go out of business. The alternative of an artificially protected high-price market is not sustainable in the long run because it will make the cost of oil and gas production too high.

Internalization is another important characteristic of the supply chain in oil and gas industry. There is a trend for the supply chain to relocate to ever-lower-cost countries. Although there is an inherent resistance to internationalization and it has already begun within sourcing of human resources. One solution to this in the past has been to bring in low-cost temporary staff from abroad, but now, with Internet communications gaining ground, it is becoming apparent that it is more efficient to develop and use specialized engineering and service expertise locally in low-cost countries with high quality education and untapped brainpower (Anderson, 2003).

Another phenomenon, of minor importance but interesting conceptually nonetheless, is related to the business cycle. When the economy is strong, oil and gas prices increase due to high demand; however, the inflated energy prices in turn reduce growth. For countries that have an economy that is highly dependent on oil and gas exports the business cycle is often opposite to that of the rest of the world. A natural result of this phenomenon would be a crossover of mobile elements of the supply chain for such countries when the cycles are at their turning points (Anderson, 2003).

The last factor is that oil companies are big and getting even bigger – mostly through mergers. Among operators, it is commonly thought that only the biggest will survive because they can absorb risk better and have lower relative operating costs. After optimum size is reached, companies become difficult to manage, logistics clog up and supplies run out. However, with improvements in information technology (IT), optimum size keeps increasing, therefore oil companies still merge, unite their buying power and make it more difficult for new entrants to compete in what could be coined “oligopoly infanticide” (Anderson, 2003).

²⁴ The Organisation for Economic Co-operation and Development (OECD is an international organisation of thirty countries that accept the principles of representative democracy and free-market economy. Most OECD members are high-income economies or newly industrialized countries with a high HDI and are regarded as developed countries (Wikipedia).

It is no wonder that many companies consider their supply chain as a competitive advantage. This advantage is not in terms of getting product to market more quickly or even creating a better product, as it might be in a more conventional supply chain. As it was already pointed out, these are products that are relatively undifferentiated and where demand exists in a highly regulated market. The competitive advantage lies in growing these slim margins reliably at various points along the chain, given the huge numbers of volumes produced and sold even a few cents a litre mounts up into quite a significant sum (Heever, 2004).

3.4.2 Supply chain strategies

As it was mentioned before, oil and gas companies have a tendency to merge and become bigger and bigger. The result is being felt at the top end of the supply chain – “bigger” means stronger buying power. With increased buying power, long-term supply chain strategy such as “win-win”²⁵, which was still an issue in the 1990s, tends to lose out to short-term strategy such as reverse auction²⁶. In theory, the rate of main contractors and suppliers being taken over or going under should increase as a function of increasing operator buying power. This, in itself, could be a supply chain strategy, since “survival of the fittest” is a legitimate concept in today’s economy (Anderson, 2003).

Size also induces firms to take charge of procurement in links further down the supply chain, increasing the effective procurement volume and potential savings from use of buying power. Anderson (2003) points on several ways (intentional or unintentional) to accomplish it:

- Having the main contractor buy on behalf of the operator on a reimbursable basis instead of on a lump sum basis essentially transfers all savings due to lower price to the operator.
- Abandoning the engineer, procure, install and commission (EPIC) or EPC(I) contract concept and going back to smaller module and assembly contracts instead transfers responsibility for some of the larger elements in the supply chain back to the operator.
- Shortening the project execution time means that more front-end “company-provided” orders of large equipment packages are required.

²⁵ A win-win game is a game which is designed in a way that all participants can profit from it in one way or the other. In conflict resolution a win-win strategy is a conflict resolution process that aims to accommodate all disputants (Wikipedia).

²⁶ A reverse auction is a tool used in industrial business-to-business procurement. It is a type of auction in which the role of the buyer and seller are reversed, with the primary objective to drive purchase prices downward. In an ordinary auction (also known as a forward auction), buyers compete to obtain a good or service. In a reverse auction, sellers compete to obtain business (Wikipedia).

For the operator, taking over control of the supply chain comes at a price: increased risk. On the other hand, for the main contractor, the price of reduced risk is less ability to differentiate competitively. With profit margins already down to a minimum, the way around this is to compete on shorter execution time. This is exactly what main contractors are attempting to do. The focus on logistics and cross-functional knowledge is growing in supply chain management (Anderson, 2003).

A popular way to shorten project execution time is to implement e-business solutions. While e-procurement has been the focus in many industries, it will be e-collaboration that is important in oil and gas, and it should be the main contractors that take the lead in this. Several existing document control applications are being developed to handle e-collaboration and this is a logical approach since built-in integration between document control and project execution, including procurement administration and management, will simplify project execution. Reverse auction applications, on the other hand, can stand alone because they are not time-saving devices as much as price-reducing devices.

Foti (2006) relating to this benchmarking study also provides some potential winning strategies:

1. Developing supply chain excellence – getting basic capabilities in place.

Refining economics' linear-programming²⁷ (LP) planning models have dominated the downstream supply chain. These models take a simple, fairly fixed view of the supply chain outside of refinery gate. In the model, downstream supply and marketing is viewed as an administrative arm to distribute product. This approach is increasingly becoming unsustainable because the major companies have begun shedding or sharing their terminal assets, divesting their retail distribution channels, and increasingly outsourcing logistics and trucking to third-party firms.

Most downstream companies must start building the required foundation before they can progress to next level of the supply chain. The basic capabilities - inventory management, demand forecasting, allocation, volume control, pricing execution, and contract management - generally will not provide a sustainable competitive advantage; it does not mean that they are without value to the supply chain. As markets continue to show high volatility and dynamic structural changes, downstream companies must master these core capabilities or risk finding themselves at a competitive disadvantage (Table 2).

²⁷ In mathematics, linear programming (LP) is a technique for optimization of a linear objective function, subject to linear equality and linear inequality constraints. Informally, linear programming determines the way to achieve the best outcome (such as maximum profit or lowest cost) in a given mathematical model and given some list of requirements represented as linear equations (Wikipedia).

Core supply chain capabilities	Required basic functionality
Inventory management	Daily inventory visibility; Forward inventory view.
Demand forecasting	Development of consensus forecast between sales, marketing, and supply and trading; Demand forecasts that use demand drivers.
Allocations, volume control	Ability to allocate and enforce at both proprietary and third-party terminals; Ability to track and enforce contractual lifting limits.
Pricing execution	Capability to invoice on and communicate an intraday price change; Ability to implement new effective price frames.
Contract management	Ability to store contract provisions in a central location, such as min/max lifting limits; Ability to track the sales pipeline in a central location, especially those that can dramatically impact the supply chain.

Table 2. Supply chain capabilities (Foti, 2006: 51)

Once foundational capabilities are in place, then companies can begin creating value by linking them with the commercial functions: marketing, pricing and supply and trading. Linking supply chain capabilities to commercial considerations allows companies to position themselves to generate sustainable above-market returns as traditional marketing objectives are evaluated and balanced against increasingly dynamic market opportunities.

2. Leveraging the connections between pricing and the supply chain.

Most downstream companies use competitor price-following behavior for spot and rack sales and index-based pricing for term sales. Strategic pricing combines the disciplines of finance and marketing and is focused on maximizing profits. Strategic pricing behavior in the downstream energy sector would include these behaviors. For term deals:

- risk-based pricing including the cost of jobber “gaming” behavior;
- pricing that includes the cost of providing jobbers with location optionality;
- analytical methods to price contracts including differences in using Platts²⁸ versus OPIS²⁹ indices;
- differentiating pricing based on a defined channel management strategy;
- commoditizing term offers by providing customers unique products or services.

²⁸ Platts is a provider of energy information around the world that has been in business in various forms for more than a century and is now a division of The McGraw-Hill Companies. Products include Platts Energy Economist, industry news and price benchmarks for the oil, natural gas, electricity, nuclear power, coal, petrochemical and metals markets. Platts pricing has been the benchmark for oil trading for generations (Wikipedia).

²⁹ OPIS – Oil Price Information Service – the world’s most widely accepted fuel price benchmark for supply contracts and competitive positioning (www.opisnet.com).

For rack sales and spot deals:

- using market foresights such as competitor price predictability;
- pricing optimally by understanding day-to-day location and product price elasticity and demand forces;
- having the systems in place to deal with market conditions to price multiple times every day;
- having end-to-end, real-time supply chain transparency to recognize the organization's ability to take on spot deals by balancing term deal reliability against near-term opportunities.

3. Integrating the supply chain and supply and trading.

A strong collaboration between marketing and supply is a demonstrated best practice from other industries but is often lacking in many downstream organizations. There is often an internal tension between marketing and supply due to misaligned performance measures and cultures. A second area of weakness is the inadequate data infrastructure that facilitates information sharing between marketing and supply and trading. Marketing-related information flows have been often designed for invoicing and financial supporting information to optimize the supply chain.

Best-practice downstream players have defined processes and key performance indicators that both encourage and enforce collaboration between marketing and supply and trading to align behavior throughout the value chain. These organizations also have invested in information technology to facilitate the dissemination of both nearer-time operational information (lifting patterns and inventory levels) and data that are core to the collaboration processes (new sales coming online from marketing).

4. Linking the supply chain and channel management strategy.

Traditional channel management for most downstream companies has focused on reliability and access to product on contractual basis. With the emergence of newer nontraditional players, downstream marketers need to understand better both the unique business needs and their costs to serve these disparate players³⁰. This means having a robust cost-of-goods sold system that can tie cost back to product terminal and having the analytical and marketing savvy to enact differentiated service, product, and pricing strategies for each defined customer channel.

³⁰ The downstream market continues to bifurcate between branded and unbranded class of trades; the unbranded market is rapidly taking a larger percent of the market. This structural shift is stressing historic downstream business models around margin capture as the larger and more sophisticated players gain greater influence and newer nontraditional players emerge (Foti, 2006).

Whatever strategies are used, it is fundamental that there be an understanding of true product costs throughout the supply chain and the flexibility to optimize profits across all available buyers.

3.4.3 Supply chain integration

As will by now be clear, the three elements of oil and gas supply chain operate separately to greater or lesser degrees. The communication between each of them is low and tends to be restricted to what is necessary, whereas the opportunities to create lasting value have generally not been exploited. And yet, every consultant or vendor or even oil company continues to speak about the benefits of integration and indeed, to the outside observer, there are blindingly obvious areas where integration would surely yield benefits (Heever, 2004).

The upstream industry is the most separate of the three parts of the chain. It has many unique characteristics and it is relatively unaffected by the permutations of customer demand – exploration and drilling are such long term projects that only the broadest trends are material. The midstream and downstream portions, however, are more intimately connected, and refinery output is (or should be) directly influenced by market dynamics (Heever, 2004).

This fragmentation means that there are different work processes across the chain and that standardizing would have to precede integration. According to Heever (2004), there are several opportunities to make the supply chain integration in oil and gas industry successful. The author relies on the ideas and opinions of the role oil and gas players presented in the articles (Total, Engen, SAP and Peoplesoft). Here is a list of the main supply chain principles:

1. Human resource management.

The management of human talent is one of the key success factors in a supply chain of this complexity and requiring great specialisation.

2. Vertical integration versus centralization

A related point in this regard is the view expressed by many that this industry remains one in which the principle of vertical integration is dominant. This might at first glance be supportive of integration, but is actually more likely to lead to centralization – that is, to attempt to control the supply chain rather than collaborate with its stakeholders. The industry has yet to fully work through this tangle of principles, perhaps because there is still so much integration to achieve within the oil majors themselves, which each form by far the most important part of their own supply chains.

3. Cost allocation.

One way of positioning integration for success across the supply chain is to rethink how profit and cost centres are allocated – too often, the current silo approach is created by parts of the supply chain effectively competing against the others because each is considered a separate profit or cost centre. This is essentially a question of organisational or supply chain maturity.

4. Customer versus supplier relationship management.

Peoplesoft's Macdonald believes that supplier relationship management is a growing trend in the oil supply chain – “the flipside of customer relationship management”. The benefits of collaborating with suppliers are well known, and this kind of “integration” raises few of the concerns regarding strategic advantage that are the result of cross-industry collaboration. In the meantime, electronic data interchange (EDI) is used extensively to swap data with suppliers and customers.

5. Enterprise resource planning (ERP).

Enterprise resource planning software is clearly seen as the vehicle for enabling integration. The elimination of Excel spreadsheets across the organisation is one of the first targets of any integration strategy, with all business process support being moved onto the enterprise resource planning software. *SAP*'s solution manager says that the biggest hurdle to the integration of this supply chain on the back of the enterprise resource planning system is the validation of the data produced by the various systems. This requires a huge effort because if it is going to support decision-making, it has to be real time. There is also a fear out there of contaminating the enterprise resource planning system with suspect data.

6. Technology development.

Engen tries to re-engineer its business processes to use technology more effectively and automate wherever possible. Engen has taken the view that technology plays an enabling role in enhancing efficiency and flexibility, and also in collaborating with other companies in the supply chain. The supply chain integration is not so easy to implement based on the fact that the technology platforms are now being put into place.

Accenture points that one of the reasons for the scepticism currently associated with supply chain improvement initiatives is that they are difficult to measure, and so to justify to the business. The oil and gas supply chain is notoriously difficult to come to grips with, and to manipulate – but the fact remains that it presents the oil companies with a wealth of ungrasped opportunities for margin enhancement (Heever, 2004).

3.5 LNG supply chain

A cliché of the energy business has been that “oil markets are global, while gas markets are continental” (Howard, 2004: 18). With development of new technologies the growth of LNG market is evident and rather rapid. The entire gas supply chain between the continents includes LNG transportation, so it is important to make an economic overview of the gas liquefaction process.

While natural gas can be piped in its gaseous state, it needs to be liquefied in order to be transported by ship. A full LNG chain consists of a liquefaction plant, generally with at least two trains, ships to transport the LNG and a regasification terminal including storage at the point of arrival. For a LNG chain liquefaction accounts for 50 to 60%, transport for 25 to 35%, and regasification for some 15% of the full costs (excluding the costs of the gas to be liquefied).

The construction cost of LNG facilities can vary geographically depending on the cost of land, environmental and safety regulations, labor costs and other local conditions. Liquefaction is rather energy intensive. Thus, about 12% of the gas intake in a plant is used as fuel for liquefaction, while annual operating and maintenance costs amount to around 4% of capital investment. The distance between producer and market and the volume to be transported are both important determinants of the cost of shipping. A greater number of smaller carriers offers more flexibility and translates into more frequent port calls and reduced storage requirements, but offers little scope for economies of scale. LNG carriers are more costly to operate and maintain than oil tankers of similar size. Regasification costs depend mostly on costs for port development, required storage volume and safety regulations. The liquefaction costs per unit can be reduced with increasing capacity, while regasification and transportation costs per unit are unaffected by volumes (IEA, 1995).

3.5.1 LNG supply chain evolution

Some 15 years ago the traditional model for all LNG supply chains composed of integrated upstream groups (gas production + liquefaction + shipping), consisting of major international oil and gas companies (IOCs) and state-owned national oil and gas companies (NOCs), which were selling LNG to integrated downstream groups, consisting of creditworthy state-controlled gas or electricity utilities. Moreover, the LNG sales contract was 20 years or longer, with CIF³¹ delivery terms, involving rigid take-or-pay terms with prices linked to

³¹ Cost, Insurance and Freight (CIF) is a common term in a sales contract that may be encountered in international trading when ocean transport is used. It must always indicate the port of destination. When a price is

crude oil or to fuel oil but including a floor price to protect investors in liquefaction plant construction from price collapse. Sales contracts with at least two buyer consortia were relatively simple, they suited both buyers and sellers with long-term security of supply; and projects relatively easy to finance and insure with limited credit risks for lenders (Figure 7) (Wood (1), 2005).

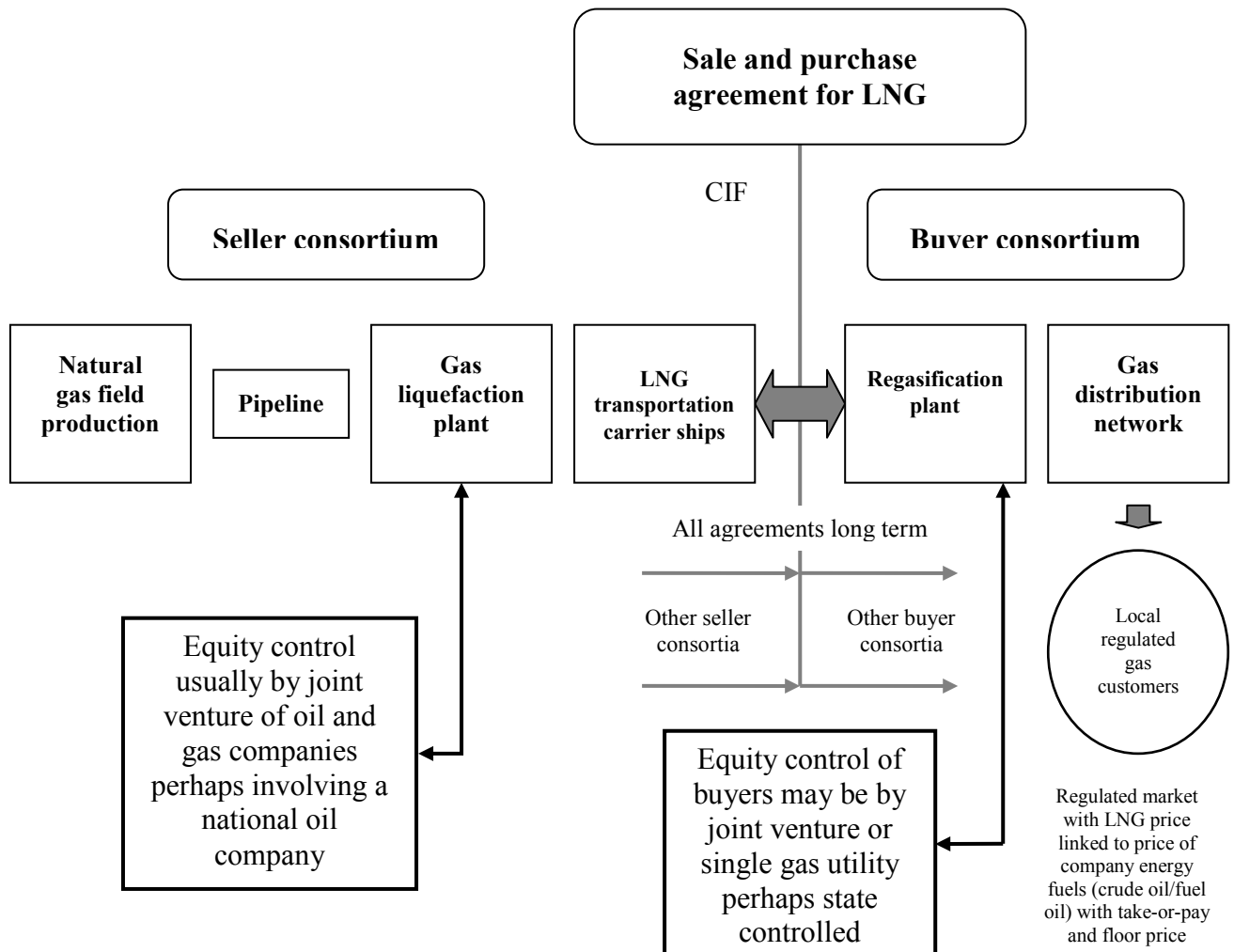


Figure 8. Fully integrated (traditional) model (Wood (1), 2005: 54)

During the 1990s partially nonintegrated LNG supply chains emerged with buyers involved in separate arms-length consortia operating the shipping and purchasing the LNG on the FOB³² basis at the liquefaction plant port. This arrangement provided long-term buyers more flexibility in managing their LNG supplies. Equity interests in the arm-length shipping company usually involved participants from both upstream and downstream consortia. In

quoted CIF, it means that the selling price includes the cost of the goods, the freight or transport costs and also the cost of marine insurance. CIF is an international commerce term (Incoterm 2000) (Wikipedia).

³² FOB is an initialism for Free On Board or Freight On Board. Generally, FOB deals with the shipping of goods. It specifies which party (buyer or seller) pays for which shipment and loading costs, and/or where responsibility for the goods is transferred. The last distinction is important for determining liability for goods lost or damaged in transit from the seller to the buyer (Wikipedia).

some contracts the floor-prices were replaced by moderated crude pricing equations that softened LNG price increases in high-oil-price environments and LNG price decreases in low-oil-price environments, providing a more stable pricing mechanism. Cross-involvement of participants from their traditional positions in the LNG supply chain became common during the 1990s in conjunction with new liquefaction projects (Wood (1), 2005).

In certain LNG supply chains, the components have become more fragmented since the late 1990s. Liberalization, and in some cases full deregulation of the downstream sector, short-term contracts, swap sales, removal of destination clause in many of the more recent sales contracts have introduced much more flexibility in the LNG markets. The building of many new receiving terminals worldwide has also opened up new long-term and short-term markets. IOCs and some ship builders have seen competitive advantage in owning shipping capacity that is contracted to specific LNG supply chains and capable to supply LNG to different markets at different times. This has further led IOCs to purchase some LNG on an uncontracted basis without a specified destination - the so-called LNG merchant model (Wood (1), 2005).

In certain upstream markets, gas fields in different licenses held by different joint-venture groupings have combined to fund the building of tolling liquefaction plants³³ where liquefaction plant and upstream gas development is nonintegrated. In such arrangements it is possible to have several upstream components to the supply chain (gas fields involving several equity groupings; feed-gas pipelines to liquefaction plants involving distinct equity holdings; one or more liquefaction plants with several trains each with distinct equity holdings).

Similarly it is possible to have several components in the downstream LNG supply chain if open-access rules are applied to the import and regasification terminal. Several different companies could contract portions of the capacity available in an LNG receiving terminal from its owners for specified periods at market rates. This would enable each of these capacity holders to source LNG from different supply chains and deliver regasified gas to different buyers through capacity purchased in the transmission system (Wood (1), 2005).

Wood ((1), 2005) says that the recent LNG market is characterized by the diversification of LNG supplier and buyer countries away from those traditional LNG buyers with high credit ratings. At the upstream end, countries pose challenges for financing, insurance, security of supply, and fiscal stability. At the downstream end, countries also pose financing and

³³ Tolling plants charge gas producers a processing fee to liquefy their gas, which is then sold under contracts involving gas field producers and LNG buyers, not necessarily involving the equity owners of the liquefaction plant itself (Wood (1), 2005: 59).

insurance challenges and concern for sellers over the long-term fiscal and contractual stability. Concerns over lack of experience and best-practice standards also raise short-term concerns over operational reliability and safety. Diversification, de-integration and deregulation are adding complexity to contractual framework of planned LNG supply chains.

3.5.2 LNG strengths and weaknesses

The evolution and developments described in the previous section have fundamentally changed the nature of the international LNG industry. In order to identify the key issues that now influence the industry, the strength and weaknesses of the LNG supply chains will be presented.

Wood ((2), 2005) names the next main strengths of LNG industry:

- strong gas demand growth in existing and new markets;
- widening customer base in existing markets;
- supply and demand diversifying to involve many countries;
- new market opportunities opening with deregulation;
- more open-access evolving in liberalized markets;
- no international gas cartel equivalent to OPEC³⁴;
- competing liquefaction technologies and suppliers;
- maturing and proven technology, engineering and construction;
- technology advances continue to reduce costs;
- LNG viable in many areas where gas pipelines are not;
- fewer international barriers than for gas pipelines;
- cleaner fuel than oil-coal-competitive substitute.

Among the main weaknesses of LNG industry are (Wood (2), 2005):

- high capital costs and long build and delivery times;
- long complex supply chain and technologies with many links;
- new large liquefaction plants need long-term contracts;
- vulnerable to low prices, fiscal changes and political risks;
- competition for available markets, regasification capacities;
- long-lead times for sanctioning new projects;

³⁴ The Organization of Petroleum Exporting Countries (OPEC) is a cartel of twelve countries made up of Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela. The organization has maintained its headquarters in Vienna since 1965. One of the principal goals is the determination of the best means for safeguarding the Organization's interests, individually and collectively. It also pursues ways and means of ensuring the stabilization of prices in international oil markets with a view to eliminating harmful and unnecessary fluctuations; giving due regard at all times to the interests of the producing nations and to the necessity of securing a steady income to the producing countries; an efficient, economic and regular supply of petroleum to consuming nations, and a fair return on their capital to those investing in the petroleum industry (Wikipedia).

- state involvement and control of liquefaction;
- limited resources to finance many LNG projects;
- contractual and risk-management complexities;
- boil-off losses and handling constraints along lengthy supply chains;
- high energy requirement of liquefaction process;
- depleting gas reserves limit long-term sustainability.

To make a conclusion, it is important to mention that the growing complexity of contractual relationships and structures of some modern LNG supply chains is evinced by international oil and gas companies, national oil companies, and utilities now participating at several points along a typical supply chain in order to extract more value, spread risk, and establish more security of off-take or supply. This contractual complexity, increased diversification, and de-integration result in some risks increasing, others being offset, and new opportunities materializing (Wood (2), 2005).

3.5.3 LNG integration

In a world where only a handful of pipeline gas crosses from one continent to another and the LNG market is significantly smaller than the pipeline market, there has been good reason to be skeptical about the global integration of gas market. However, developments in gas trade around the world point to a growing role of gas in ways that increase the global nature of the business. Howard (2004) argues that a global gas market is already here, although the degree of integration is modest. To make the case for global integration of gas market, two elements are needed:

1. A mechanism to transmit market forces physically from one market to another;
2. Price shifts that reflect active arbitrage³⁵ in the market.

Logistics matter when integrating markets. At first look, the LNG market appears unlikely to provide the needed trade mechanism. Oceans create long distances between gas markets in different countries. There is only a small fleet of LNG tankers compared with the fleet of oil carriers. Long-term contracts for LNG are not flexible; they often limit take-or-pay terms, and limit the impact of one gas market on another. But nowadays increase in contractual and operational flexibility allows players in the LNG business to be more responsive to market shifts than in the past. According to Howard (2004) such flexibility is showing up in LNG market in several ways:

³⁵ In economics and finance, arbitrage is the practice of taking advantage of a price differential between two or more markets: striking a combination of matching deals that capitalize upon the imbalance, the profit being the difference between the market prices. In the most simple example, any good sold in one market should sell for the same price in another (Wikipedia).

- Contracts increasingly provide for FOB delivery, rather than CIF delivery, allowing the customer to divert a cargo to an alternative market;
- Customers for long-term gas increasingly own (or charter) their own LNG tanker fleet, allowing greater control over delivery and destination;
- Terms for volumes in LNG contracts are increasingly flexible;
- LNG liquefaction plants are now being built without firm contracts for the full output.

Growth of LNG in volume and flexibility is likely to raise this integration over time, making a global gas market increasingly important. There are limitations to market integration, however, including the inherent logistics of gas trade and the contractual basis for such trade (Howard, 2004). The logistics inherent to LNG suggests the next limits for this commodity:

- Shipping cost – the cost per mile of shipping LNG is greater than moving oil;
- Quality – customers order different types of gas that add a cost to meet local standards;
- Boil-off – LNG shipments are subject to boil-off, the loss of roughly 1% of the cargo per week on board. As a result, LNG tankers rarely change destination after beginning a trip;
- Spare tankers – there is a much smaller pool of spare LNG tankers in the world than the pool of crude carriers. By the way of contrast, the crude tanker fleet has greater short-term flexibility in the face of market shift.

In addition, the time horizon of current contract gas supplies in some markets may limit the degree of integration. According to contractual basis of the trade, as swing volume increases and flexibility in contracts grows, arbitrage opportunities will expand and the piece link between markets almost certainly will grow stronger. The volume of gas moving to arbitrage-favored markets is likely to double and redouble in the coming decade, even though much of the swing volume will originate with contract customers (Howard, 2004).

International LNG trade continues to experience significant growth and diversification. Analysts suggest that growth of LNG supply over the next decade will average up to 10% per year, based upon project commitments with several more exporter and importer countries about to join the trade. Such growth will require continued huge capital investments along the entire LNG supply chain. More sophisticated supply chain structures and contractual interactions are developing in conjunction with the more flexible, short-term LNG trading arrangements that seem destined to expand during the next decade (Wood (1), 2005).

3.6 Pipelines as a part of supply chain

Materials, parts and products in the pipeline to supply end customers are a vital strategic choice, affecting everything else. The pipeline is measured in terms of days of use of these inventories at current rates of sales. Normally international pipelines for commodities are many times longer than for single country supply chains. There are many reasons why pipelines should be short, especially customer responsiveness, cost and quality (Sadler, 2007).

Pipelines are used to transport oil and gas from oil or gas field to the customer over the distance from 1 km, that is next door, to 5000 km, say from Russia to Western Europe. Pipelines are almost always made of steel. They are usually buried and out of sight. Where a route can be expected to be used for several years, for a significant quantity of oil, gas or product, they offer an economic, safe, and environmentally attractive means of transport (Cranmore and Stanton, 2001).

Petroleum pipelines serve a dual role. Initially, they gather crude oil from the producing field and transport it to the refinery; then they transport the refined products to various markets. Although natural gas is a hydrocarbon that is produced from an underground reservoir, often with crude oil, pipeline transportation of natural gas is a separate industry from the pipeline transportation of crude oil. Pipelines are vast networks of gathering, transporting, and distribution systems comprised of hundreds of thousands of miles of pipe (Berger and Anderson, 1992).

Natural gas may be produced from a gas reservoir, or it may be produced from a formation that produces both crude oil and gas. When it is produced with crude oil, both share the initial surface flow line from the wellhead to the gas separator. From the separator onward, the natural gas is transported in its own pipeline system, except in some special installations where two-phase pipelines are used. Technically, a gas pipeline system is similar to both crude oil and products pipelines with respect to the actual pipe and fittings used, and the methods of constructing the system. However, there are certain pertinent differences between them. Gas is moved through the pipeline system by compressors and compressor stations rather than by pumps and pumping stations. Gas pipelines usually operate at higher pressures than crude or products lines (Berger and Anderson, 1992).

It is also important to mention that there are two different types of pipelines in respect to the geographical location of the wellhead and production facilities: onshore and offshore lines. The offshore pipelines serve the same purpose as those in an ordinary oil and gas field onshore. There are some differences in construction and used materials, and the price of

building and maintaining. The underwater pipelines are mostly used for transportation of oil or gas from the wellhead to onshore facilities. Now there are some examples of the offshore pipelines that connect the producer with the end customer (Berger and Anderson, 1992).

According to the costs of gas pipelines, there are several characteristics. The physical lifetime of a pipeline can be around 50 years. However, its economic life, defined by the period of utilization, can be much shorter and will determine over which period initial investment should be depreciated. Whether a pipeline is a direct link between producer and consumer or forms part of a network, the same factors are principal in the determination of construction costs (IEA, 1995):

- the length of the pipeline;
- the maximum flow required for a day of peak demand;
- the trade off between pipeline diameter and the number of compressor stations;
- terrain, rights of way, etc.

A generic formula for costing pipelines is based on diameter, pressure and distance. Laying pipelines requires high capital costs, whereas compressors have higher operating costs and lower capital costs. Generally, it is more economic to build pipelines with smaller diameter and more compressors, if peak capacity is only to be used for a short period each year or if the necessity for increases in peak capacity seems less likely. As long distance pipelines require extremely high capital costs, operation at high load factors is usually crucial to maintain viability (IEA, 1995).

Pipelines are a critical part of the fixed infrastructure of an oil and gas province or system, and can be either a temporary or permanent limit on the total production; that is, cause a production plateau, or encourage local exploration to fill up the infrastructure to its capacity. Also, pipeline capacity may be shared with, bought or leased from other operators, which can result in very complex and sophisticated systems. Pipelines are part of the oil and gas system and need to be managed along with the upstream fields and storage and the downstream terminal and customers' requirements (Cranmore and Stanton, 2001).

Pipelines have the advantage of moving large quantities over long distances. But they have the disadvantages of being slow (typically moving at less than 10 km per hour), inflexible (only transporting between fixed points), and only carrying large volumes of certain type of fluid. In addition, there is the huge initial investment of building dedicated pipelines. Despite this initial investment, pipelines are the cheapest way of moving liquids – particularly oil and gas – over long distances. Local networks can add flexibility by delivering to a wide range of locations such as gas to homes (Waters, 2003).

3.7 National and international oil companies in supply chain

In the energy industry, concentration of oil and gas resources in a handful of small, powerful, and resource-nationalistic governments and their representative national oil companies (NOCs) has created an uneven playing field for international oil companies (IOCs). The rules of the game are being challenged and altered in midcourse by NOCs at host-government direction. The changing competitive landscape will transform the role of traditional IOCs, completing a process that began 40 years ago with a shift in the balance of power favoring NOCs and resource holders. Vikas and Ellsworth ((1), 2007) says that today over 100 NOCs control over three fourth of the world's oil reserves and production.

3.7.1 Roles of oil and gas companies

IOC access to equity oil and gas reserves decreased over the past 40 years. Currently, IOCs are finding it increasingly challenging to acquire new oil and gas reserves, and many of the promising worldwide basins for exploration and development are firmly under the control of NOCs. IOCs appear to be realigning their business strategies and may have to move away from their traditional role of full equity developers of oil and gas fields, to pursuing a variety of commercial arrangements with host countries and governments – from full equity interest to partial equity sharing and fee-for-services (Vikas and Ellsworth (1), 2007).

As their power and wealth grew, NOCs began to assert themselves in world energy markets, expanding their upstream as well as downstream footprints. Now, some NOCs are searching outside their home countries for equity oil and gas and are forming joint ventures and alliances with IOCs. NOCs need IOC technology and oil-field management expertise and are inviting IOCs to serve as contractors for field development. As the role of IOCs has changed, the NOCs have been busy transforming themselves from domestic, sovereign companies into global competitors. Those companies that have been partially privatized and are run like commercial entities are “entrepreneurial NOCs”. They are typically venturing abroad in search of equity oil and gas (Vikas and Ellsworth (1), 2007).

3.7.2 Main strategies

NOC goals and priorities differ from those of IOCs. NOCs' strategic priorities include optimization of resource development, revenue growth, supply security, and economic security. Many NOCs also have political priorities and are expected to execute government policies, which are sometimes in harmony and sometimes at odds with commercial strategies. Priorities for IOCs and entrepreneurial NOCs include increasing stockholder value, deploying technology, and expanding market access. According to Vikas and Ellsworth ((1), 2007), the

classification scheme has four dimensions: resource, technology, finance, and markets. So the categories are:

- *Resource providers* – companies that process reserves sufficient to meet in-country demand and serve as primary exporters of oil and gas. These companies are generally national asset owners and usually are not actively involved in acquiring additional overseas reserves (big NOC oil and gas exporters).
- *Resource seekers* – companies with indigenous reserves insufficient to meet in-country demand that are active in domestic exploration and acquiring equity reserves overseas. These companies are generally NOCs whose mission is to find and develop reserves at home and overseas to secure supply. Resource seekers include IOCs, which must add reserves to maintain company value.
- *Technology providers* – companies highly adept at technology development and deployment. Companies at this category are willing and able to bring their technologies to the global exploration and production (E&P) marketplace. IOCs and entrepreneurial NOCs are becoming technology providers rather than equity developers.
- *Technology seekers* – companies that are less adept with technology and need advanced technologies to explore and develop the resources they control. Companies in this category generally are resource rich NOCs.
- *Market seekers* – companies that actively seek markets in which to sell indigenous or overseas equity oil and gas for maximum value. IOCs routinely look for the best prices for oil and gas from their global operations and can be considered market seeker. Most large NOCs also are market seekers.
- *Finance seekers* – companies that have access to resources sufficient to meet in-country demand but that lack finances for exploration and development. These companies generally have difficulty raising capital from international markets because they lack a transparent and credit worthy economic system.

The competitively best-positioned companies are both resource providers and technology providers. The worst-positioned companies are those which seek both resources and technologies. IOCs are very strong technology providers but also are resource-seekers. The entrepreneurial NOCs generally fare the best, being resources holders as well as technology providers. NOCs and IOCs have mutual interest in marrying technology and

resources. Despite this apparent alignment of interests, host-government national policies and politics often limit cooperation.

From the point of the upstream and downstream focus, IOCs possess a relatively balanced portfolio of upstream and downstream assets, while most of NOCs emphasize upstream operations, in some cases because other companies operate refineries (Vikas and Ellsworth (1), 2007). Some NOCs are also moving down the supply chain, expanding downstream into refining, distribution, and retail to secure markets for their oil and gas and provide insulation from upstream price volatility. This provides greater competition to IOCs in traditional markets as they become increasingly squeezed in both production as well as downstream and in wholesale and retail markets (Vikas and Ellsworth (2), 2007).

3.7.3 Future expectations

In the future, IOCs and NOCs will collaborate and compete with each other on two forms. The first is the international market, where NOCs can be competitors and sometimes collaborate with IOCs. The second is the country-specified market, where NOCs represent the state and where IOCs act more than before as contractors and partners and less as resource owners in developing host-country resources. There is no doubt that markets will become more politicized (Vikas and Ellsworth (2), 2007).

Vikas and Ellsworth ((2), 2007) present the main changes and expectations concerning the role and strategies of IOCs and NOCs:

- IOCs are focusing exploration and production (E&P) activities in regions where they can operate outside NOC territory.
- As their equity-share production declines, IOCs are changing their role from suppliers of energy to suppliers of technology. NOCs seek to collaborate with IOCs on projects that clearly need the IOCs' technological and financial expertise.
- IOCs will need to continuously develop upstream and downstream technologies to remain valuable to NOCs as partners or contractors.
- IOCs will adjust their focus further down the supply chain and move more into downstream activities, building and expanding refineries and retail operations.
- IOCs will be involved in greater collaboration with NOCs and other commercial companies in downstream activities in order to increase global refinery capacity. This will reduce the bottle-necks that have become apparent in some major consumer markets and are putting upward pressure on oil prices.

- IOCs will move from their traditional role as operators of oil and gas fields to oil-field managers and primary contractors for developing major projects. NOCs will tend to place greater reliance on IOCs expertise in coordinating all aspects of complex project execution. IOCs may be expected to preselect traditional service companies, experts, local manpower, consultants, and miscellaneous service providers in order to provide end-to-end service on oil field development.
- IOCs and NOCs will have to work as partners in order to provide sustainable long-term development within the host country. This may involve IOCs providing a supporting role for NOCs in maximizing the benefits for the country economy as well as optimizing resources development for the benefit of future generations.

Currently, IOCs' equity stakes and, by extension, reserves replacement are the primary bases for market evaluation. As IOC roles change in response to NOC changes, they may focus less on short-term revenue maximization and more value creation for NOCs, long-term sustainable partnerships with NOCs, and new technology developments. These factors may become more important indicators of future profitability and sustained revenue growth for IOCs (Vikas and Ellsworth (2), 2007).

3.8 Conclusion

The supply chain in oil and gas industry is divided into three main sections: upstream, midstream and downstream, each of which forms a more or less discrete ecosystem (Heever, 2004).

The upstream portion of the supply chain covers exploration for reserves, the conveyance of the crude or gas into storage tanks, its sale and transport to the storage facilities of the new owner and its conveyance to the refinery. The midstream portion of the supply chain is essentially where the manufacturing takes place, where the crude oil is transformed into a variety of products (Heever, 2004). The downstream supply chain starts at crude acquisition and ends with the customer sale (Foti, 2006).

The specific characteristics of oil and gas industry make it very difficult for the supply chain to be optimised, and yet this optimisation is increasingly important as demand continues to grow and geopolitical uncertainties threaten the smooth supply of raw crude (Heever, 2004). Also the fragmentation of the entire supply chain and different work processes across the chain make the integration more difficult and need more sophisticated technologies and implementation of different management tools.

Growth of LNG in volume and flexibility is likely to raise this integration over time, making a global gas market increasingly important. There are limitations to market integration, however, including the inherent logistics of gas trade and the contractual basis for such trade (Howard, 2004). Pipelines have their own role in the transportation of oil and gas across the supply chain.

The changing role and main strategies of NOCs and IOCs have impact on the structure of the entire supply chain and influence the mechanisms of oil and gas market. The regulatory and commercial influence of NOCs is changing terms of participation of IOCs in the resource development. IOCs work as primary contractors on projects and provide technical and oil field management expertise as well as financing. They are more likely to move further in the downstream activities and search for regions outside NOC territory because NOCs have taken all the responsibility for upstream activities. The need for collaboration is stronger for the reason that both types of companies are interested in long-term sustainable relationships.

Chapter 4. Shtokman gas and condensate field development project

The Shtokman gas and condensate field development project is of strategic significance for Gazprom. The field will become a resource base for Russian pipeline gas as well as liquefied natural gas (LNG) exports to the Atlantic Basin markets.

Shtokman gas and condensate field was discovered in 1988. This field is located in the central part of the Russian sector of the Barents Sea shelf, about 600 km northeast of the city Murmansk at local sea depths varying from 320 to 340 m.

The field's C1+C2 reserves account for 3.8 tcm of gas and approximately 37 mln tons of gas condensate.

The Shtokman development project envisages annually producing some 70 bcm of natural gas and 0.6 mln tons of gas condensate comparable to annual gas output of Norway, one of the largest European gas suppliers.

Phase one contemplates annually producing 23.7 bcm of natural gas with the startup of gas supply via the gas pipeline in 2013, and liquefied natural gas supply – 2014.

Sevmorneftegaz (a 100 % subsidiary of Gazprom) holds the license to search for, explore, and produce gas and condensate from the Shtokman field.

4.1 Introduction

This chapter is about the Shtokman gas and condensate field development project, one of the main strategic gas reserves fields of Russia.

The given chapter consists of several parts including the history of the project, which describes the most important phases of its exploration, the pros and cons of the project development, and the main reasons for its realization.

The next part tells about the participation of international companies in the project and their interest in developing the gas and condensate field in the Barents Sea together with Gazprom.

Then the chapter presents engineering concept of the Shtokman project, including technical and technological proposals from the participating in tender companies. The concept of a united extraction-transport-processing facilities complex engineered by JSC Giprospeftgaz is introduced in this section.

The transportation system of the project consisting of both LNG and pipeline distribution of gas is of main interest in the forth part of the given chapter. The problem of facilities location, lack of infrastructure and transport capacities, and development of the Murmansk port are reflected here.

The next part is looking through the marketing strategies for the Shtokman project where the main directions of the gas supply are taken into consideration.

The last two parts of the chapter are connected to such problems as ecological compatibility and influence of political factors.

The purpose of this chapter is not just to make a descriptive presentation of the project but to prepare the basis for further analysis of the entire supply chain of the Shtokman development project.

4.2 History of the Arctic Offshore development

The Arctic shelf of Russia is extremely rich with natural resources. The ultimate reserves of oil and gas of the Arctic Ocean exceed those of the other oceans. Compared to the Pacific the undiscovered potential resources here are five times more (Dmitrievsky, 2008). According to the Ministry of Natural Resources³⁶ of the Russian Federation, the extractable reserves of hydrocarbons on the Russian continental shelf are assessed to be 10.8 bln tons in oil equivalent, and hydrocarbon recoverable resources are estimated to be 98.7 bln tons in oil equivalent. The prospective oil and gas territory in the Russian sea areas is estimated at 4 mln km² of the total area of the continental shelf of 6.2 mln km² (Bambulyak and Frantzen, 2007).

The specialists of the shelf zone resources development from the Institute of oil and gas problems of the Russian Academy of Science³⁷ (RAS) name the world ocean “a biggest storehouse of oil and gas”. According to the statistics, more than 3000 deposits of hydrocarbons are opened in the sedimentary pools of the continental outskirts of the world, the recoverable reserves are assessed at 95-97 bln tons of oil and 55-57 tcm of gas. It is about half of the world’s reserves of oil and one third of gas (Slavinskaya, 2001).

In general, natural gas reserves are classified in three groups: proved, probable, and possible reserves. Proved reserves are located in thoroughly explored reservoirs which already are in production or under development. They correspond to discoveries of which production is feasible under current economic and technical conditions. Probable reserves identify discovers reserves exhibiting a good probability of being produced under economic and technical conditions similar to those of proved reserves. Probable reserves are measured more roughly and the reservoirs are not yet equipped to produce. Possible reserves correspond to identified reservoirs in undrilled zones adjacent to proved or probable geological volumes. The identification of such reserves is dubious and their assessment relies on assumptions of geometry and impregnation of these reservoirs (IEA, 1995: 116).

The Russian reserves system is based solely on an analysis of the geological attributes of reserves and takes into consideration the actual physical presence of hydrocarbons in geological formations or the probability of such physical presence. Explored reserves are represented by categories A, B, and C1; preliminary estimated reserves are represented by category C2; prospective resources are represented by category C3; and forecasted resources are represented by categories D1 and D2. According to the Russian reserves system, explored natural gas reserves in categories A, B and C1 are considered to be fully extractable (Gazprom in Figures, 2002-2006: 23).

As it was mentioned before, the Russian shelf occupies approximately 6 mln km² that is a considerable part of the world ocean. The province of the western-arctic shelf is the largest

³⁶ The Ministry of Natural Resources of the Russian Federation (MNR of Russia) is a federal executive body performing the functions related to state policy formulation and normative and legal regulation in the sphere of the study, renewal, and conservation of natural resources (<http://www.mnr.gov.ru/part/?pid=398>)

³⁷ The Russian Academy of Sciences was established pursuant to the order of the Emperor Peter I by the Decree of the Ruling Senate dated January 28 (February 8), 1724. The Academy was reinstated by the Decree of the President of the Russian Federation dated November 21, 1991 as the supreme scientific institution of Russia. The Russian Academy of Sciences (RAS) is a civil self-governed non-commercial organization (institution). Principal aim of the Russian Academy of Sciences consists in organization and performance of fundamental researches for the purpose of obtaining further knowledge of the natural, social and human development principles that promote technological, economic, social and cultural development in Russia (<http://www.ras.ru/>).

one (Slavinskaya, 2001). Also the western sector is the most explored area with large and unique deposits such as Shtokmanovskoye and Ledovoye (in the Barents Sea), Leningradskoye and Rusakovskoye (on the South-Kara pit prevail), Prirazlomnoye (Pechora Sea) and others (the total of 22 deposits) (Bambulyak and Frantzen, 2007). The Barents Sea³⁸ together with Pechora Sea³⁹ and Kara Sea⁴⁰ include approximately 80% of total resources of the Russian Arctic shelf with gas and condensate prevailing in the Barents and Kara, and oil – in the Pechora Sea (Gazprom News, 2009). But if to add the Sea of Okhotsk⁴¹ reserves where gas and oil production conditions are identical to the Arctic regions the total value will approximate 90%, i.e. some 87-88% (Dmitrievsky, 2008).

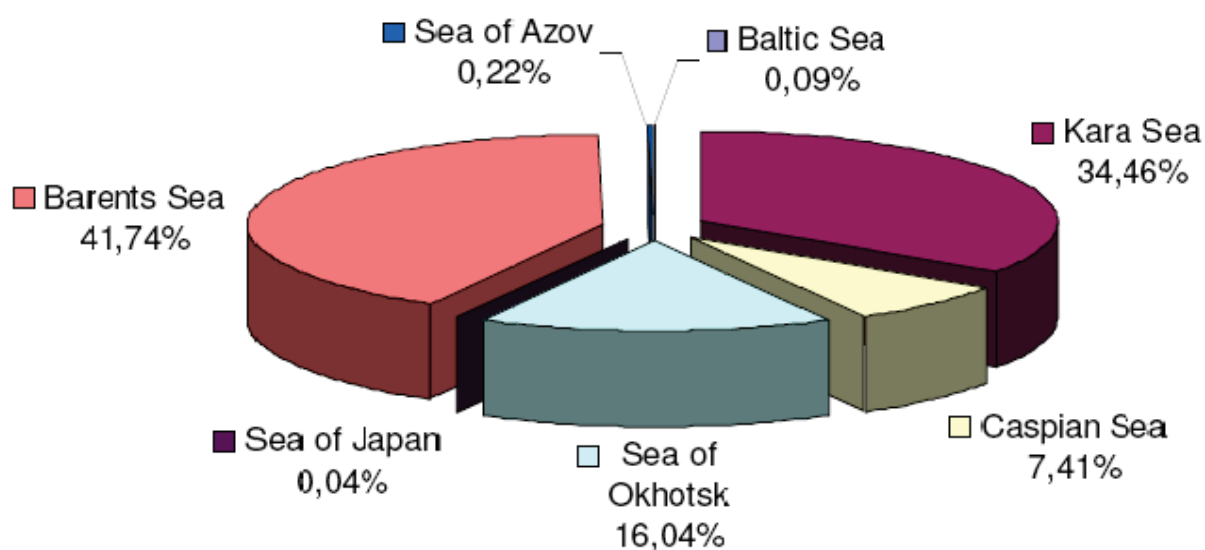


Figure 9. The distribution of oil and gas reserves between the various seas on the Russian continental shelf as estimated in 2005 (Lesikhina et al., 2007, Ch.1)

³⁸ The Barents Sea (Norwegian: *Barentshavet*, Russian: *Баренцево море*) is a part of the Arctic Ocean located north of Norway and Russia. It is a rather deep shelf sea bordered by the shelf edge towards the Norwegian Sea in the west, the island of Svalbard (Norway) in the northwest, and the islands of Franz Josef Land and Novaya Zemlya (Russia) in the northeast and east. Novaya Zemlya separates the Kara Sea from the Barents Sea (Wikipedia).

³⁹ Pechora Sea (Russian: *Печорское море*, or *Pechorskoye More*), is a sea at the northwest of Russia, the southeastern part of the Barents Sea. The western border of the sea is off Kolguyev Island, while the eastern border is the western coasts of Vaygach Island and the Yugorsky Peninsula, and the northern border the southern end of Novaya Zemlya (Wikipedia).

⁴⁰ The Kara Sea (Russian: *Карское море*) is part of the Arctic Ocean north of Siberia. It is separated from the Barents Sea to the west by the Kara Strait and Novaya Zemlya, and the Laptev Sea to the east by the Severnaya Zemlya. Compared to the Barents Sea, which receives relatively warm currents from the Atlantic, the Kara Sea is much colder, remaining frozen for over nine months a year (Wikipedia).

⁴¹ The Sea of Okhotsk (Russian: *Охотское море*; English Transliteration: *Okhotskoye More*) is a part of the western Pacific Ocean, lying between the Kamchatka Peninsula on the east, the Kuril Islands on the southeast, the island of Hokkaidō to the far south, the island of Sakhalin along the west, and a long stretch of eastern Siberian coast (including the Shantar Islands) along the west and north. It is named after Okhotsk, the first Russian settlement in the Far East (Wikipedia).

The Russian shelf of the Barents Sea is the largest one in area extent among other shelf areas of Russia (1136.3 thousands km⁴²). The reserves of gas are mostly concentrated in the Eastern-Barents oil and gas province and form more than 4 tcm⁴³. The core of the gas production complex is the Shtokman gas-condensate field which reserves account for 3.8 tcm together with Ledovoe (500 bcm) and Ludlovskoe (220 bcm) fields that make it a relevant resource base. The common resources of this potential region of gas production are estimated at not less than 5-6 tcm of gas (Gagelgants et al., 2005).

4.2.1 Exploration on the Arctic shelf

The exploration and development of the Arctic shelf started long time before the Shtokman field was discovered. 29 structures were put into drilling on the Arctic shelf of Russia⁴⁴ over a period from 1982 to 2007. The area of prospecting and exploratory drilling averaged out at 156 000 m; 15 raw hydrocarbon deposits were discovered, among them 3 belong to unique, 9 to large-scale, 2 refer to medium sized fields, and one small deposit. Almost all the deposits were discovered by the first well. The successful ratio of oil prospectors was 0.8. The ultimate discovery additions on a drilled well composed from 500 mln to 1 bln tons⁴⁵ in oil equivalent (Banko, 2007, №15).

But these achievements do not apply to the last five years of the Arctic shelf exploration. The country does not put enough priority on the geological exploration work, but for speeding up the process it requires the state support. On the Arctic shelf 24 000 m were drilled by financing from the government budget in 1988, but starting from 1994 and during the economic reforms, only one-two wells were drilled to the orders of Gazprom and *CJSC Arktikshelfneftegaz*. The extent of geological exploration decreased by 85-90% comparing to the Soviet period. The material and technical base for prospect drilling was also cut down on the Arctic shelf (Banko, 2007, №15).

⁴² Measures of length in this paper will be designated as stated below:

- km – kilometer;
- m – meter.

⁴³ Quantities of natural gas are measured in normal cubic meters or in standard cubic feet (Wikipedia).

In this paper volume measures of natural gas will be designated in the following way:

- tcm – trillion cubic meters = 10^{12} m³;
- bcm – billion cubic meters = 10^9 m³;
- mcm – million cubic meters = 10^6 m³.

⁴⁴ In order to make an easy overview of the Russian territory, the map of the Russian is presented in Appendix 1.

⁴⁵ Quantities of crude oil is measured in tonnes (metric tons) or barrels. About 7.2 barrels of oil are equivalent to 1 metric ton of oil. In this paper volume measures of oil will be designated in the following way:

- bln tons – billion tons;
- mln tons – million tons.

Sapun (2005, №12) confirms that the extent of reserve exploration on the shelf of the northern seas – Barents, Pechora, Kara and Sea of Okhotsk (only by the regions of Gazprom's exploration works) reaches hardly more than 12% from the ultimate potential reserves of gas and even less of oil – only 7%. Here most of the ultimate gas reserves are concentrated on the Barents and Kara Seas shelf as the most explored. The reserves of oil are concentrated primarily on the shelf of the Pechora and Kara Seas while the highest extent of exploration of oil falls at Pechora and Sea of Okhotsk. From the viewpoint of Sapun (2005, №12), if to put up the offshore deposits on auction no one among subsurface users will pay a high bid because they are poorly explored.

Four steps to industrial development of the Western Arctic shelf

The western part of the Arctic shelf of Russia occupies a vast territory, about 2 mln km², and is covered by the waters of the Barents and Kara Seas. From the south it is connected to the territories of Murmansk⁴⁶, Arkhangelsk⁴⁷ and Tyumen⁴⁸ Regions. From the north the shelf is closed by the island of Spitsbergen⁴⁹ and the Franz Josef Land⁵⁰. On the western part the Russian shelf borders the Norwegian sector where a zone of contestable jurisdiction appeared for the reason of disagreement about the frontier line. From the east the given water area is confined by archipelago Novaya Zemlya⁵¹. Except the western part of the Barents Sea which is year-round free from ice, the rest of the water area is covered with ice (Borisov, 2008).

⁴⁶ Murmansk Region (*Russian: Мурманская область, Murmanskaya oblast*) is a federal subject of Russia (an oblast), located in the north-western part of Russia. Its administrative center is the city Murmansk. Geographically it is located mainly on the Kola Peninsula, and it is a part of the larger Lapland region that spans over four countries. Murmansk Region borders Karelia, Finnmark County in Norway and Lapland Province in Finland. Norrbotten County in Sweden is also located nearby (300 km) (Wikipedia).

⁴⁷ Arkhangelsk Region (*Russian: Архангельская область, Arkhangelskaya oblast*) is a federal subject of Russia (an oblast). It includes Franz Josef Land and Novaya Zemlya islands, and also Nenets Autonomous District. Arkhangelsk is the administrative center of the region. Arkhangelsk Region, which includes Nenets Autonomous District, borders Kirov Region, Vologda Region, the Republic of Karelia, the Komi Republic, and the White Sea (Wikipedia).

⁴⁸ Tyumen Region (*Russian: Тюменская область, Tyumenskaya oblast*) is a federal subject of Russia (an oblast). Its administrative center is the city of Tyumen. It has administrative jurisdiction over two autonomous districts, Khantia-Mansia and Yamalia. Tyumen is the largest city, with over half a million inhabitants. As of 2006, it is by far the richest federal subject of Russia, with an average GDP per capita several times the national average (Wikipedia).

⁴⁹ Spitsbergen (formerly known as West Spitsbergen, and sometimes misspelled *Spitzbergen*) is a Norwegian island, the largest island of the Svalbard archipelago in the Arctic Ocean (Wikipedia).

⁵⁰ Franz Josef Land, Franz Joseph Land, or Francis Joseph's Land (*Russian: Земля Франца-Иосифа, Zemlya Frantsa-Iosifa*) is an archipelago located in the far north of Russia. It is found in the Arctic Ocean north of Novaya Zemlya and east of Svalbard, and is administered by Arkhangelsk Region. It has no native inhabitants (Wikipedia).

⁵¹ Novaya Zemlya (*Russian: Новая Земля, also spelled Novaya Zemlja, lit. New Land; also known in English and in Dutch as Nova Zembla, Norwegian Gåselandet (Goose Land)*) is an archipelago in the Arctic Ocean in the north of Russia and the extreme northeast of Europe at Cape Zhelaniya. The archipelago is administered by Arkhangelsk Region as Novaya Zemlya Island Territory (Wikipedia).

A. Borisov (2008) claims that there are four main milestones in the history of the region's hydrocarbon potential development. The first step which continued until the year 1978 is characterized as a period of regional geological development. During this period the geological survey of the archipelago Spitsbergen, Novaya Zemlya and of the shelf's bottom surface were conducted by the scientists of the Research Institute of Geology in Arctic. At the same time significant drilling operations in the area of the Barents Sea were organized by the *Marine Arctic Geological Expedition (MAGE)* in 1972 which allowed substantially itemize the image of the region and its oil and gas prospects. On the basis of these findings the regional tectonic structure concepts were made. This confirmed the persistence of the tectonic elements of the earth and, as a consequence, the continuity of the oil-and-gas bearing basins of Pechora syncline and Western Siberia in the water area of the Barents and Kara Seas.

The scientific production association *Sevmorgeo* was established by Ministry for Geology of USSR in 1972 for the purpose of regional investigation and prospecting works on the Arctic shelf. This association organized the first systematic geological and geophysical researches. Also a huge contribution in the study of the bottom structure of the Barents and Kara Seas was made by marine arctic exploration expedition which was a member of the *Sevmorgeo* association. In 1972 several geologists and scientists carried out a first quantitative assessment of hydrocarbon potential of the continental shelf which highly estimated the oil-and-gas content of the Western Arctic Seas.

The results of the first phase showed that this assessment appeared to be minimal and that initial reserves of the Western Arctic are much higher than it seemed before. So such a conclusion was reported to the State Bureau of Science and Technology and became a reason for government's decision to deploy the exploration on the Russian continental shelf and especially on the Western Arctic shelf.

The second phase of exploration during which a huge raw material hydrocarbon resource base of Russia was discovered started in 1978. With a view to increase the geophysical works on the Arctic offshore areas a marine scientific production association *Soyuzmorgeo* was relocated from Gelendzhik⁵² to Murmansk⁵³ and a special geophysical expedition was created and later transformed into the trust *Sevmorneftegeofizika*. Also for the purpose of prospect drilling conduction and preparation of oil and gas fields for reservoir engineering a company *Arktikmorneftegazrazvedka* was created in 1979. The specialists of this company have made a

⁵² Gelendzhik (*Russian: Геленджик*) is a resort town in Krasnodar Krai, Russia, situated on the Gelendzhik Bay of the Black Sea, between Novorossiysk and Tuapse (Wikipedia).

⁵³ Murmansk (*Russian: Мурманск*) is a city and the administrative center of Murmansk Region, Russia. It lies on the cliffy eastern coast of the Kola Bay of the Barents Sea.. One of the important ports in Russia (Wikipedia).

great contribution to oil and gas fields' exploration, including the discovery of the Shtokman gas and condensate field in 1988.

During the short period of time, from 1979 to 1992, the joint efforts of the union Arktikmorneftegazrazvedka contributed to discovery of 10 deposits, including 3 unique (Shtokmanovskoye, Leningradskoye and Rusanovskoye) and 5 major fields; also 21 sites were put into preliminary drilling; 34 prospect and exploratory wells were constructed. The geophysical unions Soyuzmorgeo and Sevmorgeo worked out 330 000 of seismic profiles; revealed 102 local structures, 32 of which were prepared for drilling. The high effectiveness and efficiency of the exploratory works comparable with the best national and international indicators of performance were achieved. The volume of probable (category C1) and possible (category C2) hydrocarbon reserves of the 10 discovered on the shelf deposits exceeds the similar reserves of the adjacent and one of the oldest in Russia Timan-Pechora⁵⁴ oil-and-gas bearing province for the whole period of its development.

Name of the field	Year opened	Hydrocarbon status	Size of the field
<i>Pechora Sea</i>			
Pomorskoye	1985	Oil and gas condensate	average
Severo-Gulyaevskoye	1985	Oil and gas condensate	average
Prirazlomnoye	1989	Oil	large-scale
Varandey Sea	1955	Oil	average
Medynskoye Sea	1997	Oil	large-scale
Dolginskoye	2000	Oil	large-scale
<i>Barents Sea</i>			
Murmanskoye	1983	Free gas	large-scale
Severo-Kildinskoye	1985	Free gas	average
Shtokmanovskoye	1988	Gas condensate	giant
Ludlovskoye	1992	Free gas	large-scale
Ledovoye	1992	Gas condensate	large-scale
<i>Kara Sea</i>			
Rusanovskoye	1989	Free gas	giant
Leningradskoye	1990	Free gas	giant

Table 3. Commercial fields in the oil and gas-bearing province of the Western Arctic shelf (Lesikhina et al., 2007, Ch.1)

⁵⁴ The Timan-Pechora Basin is an oil field basin in northern Russia. It is south of the Pechora Sea. A planned project to mine its oil and gas was conceived in the mid-nineties and approved by United States and Russian Governments. As of September 29, 2004, Conoco and LUKoil planned to jointly develop this Basin

The Government of Russian Federation took the given findings seriously and instructed to prepare in a short while a work program of the future development of the Western Arctic shelf and firstly the shelf of the Barents and Kara Seas. In May 1994 the specialists of the associations Arktikmorneftegazrazvedka, Soyuzmorgeo, an institute VNIIOkeanogeologiya⁵⁵, and other organizations conducted and sent for a government's consideration "The study and development concept of the hydrocarbon resources of the Barents Sea province" in the market-driven economy. The main conditions were: geological survey, prospecting works and development of the shelf sites the rights for which are conveyed on the competitive base will be financed by the owners of licenses; and regional geological investigation on the rest of the shelf has to be funded from the government's budget. The concept was signed by the directorate of Mintopenergo⁵⁶ and Minprirody⁵⁷ and approved by the council of experts under the Russian Government on January 17, 1995.

The third phase of development started in 1992 when a famous decree of the President of the Russian Federation № 1517 on November 30 was enacted. According to this decree, a joint stock company "Rosshelf" has got an executive right for development of the Shtokmanovskoye and Prirazlomnoye deposits without a tender. As required by the license agreement the company has to prepare a feasibility study and a project development of these fields in 1994. It was assumed that the third phase would become a step of the accelerated development of the discovered oil and gas fields on the Arctic shelf. But for some reasons there is almost no production in the offshore area of the Western Arctic.

The third step to industrial development is characterized by a sudden decrease of the exploration activities. The volumes of drilling works on the Barents Sea region in the end of 80th had reached the level of 24 000 m per year, in the beginning of XXI century it did not exceed 3.5 – 4 000 m, and in 2007 only 2 500 m were drilled. The association Arktikmorneftegazrazvedka on commission from Gazprom conducted the drilling works on

⁵⁵ VNIIOkeanogeologiya is translated as All-Russia Research Institute for Geology and Mineral Resources of the World Ocean. It is a state enterprise under control of Ministry of Natural Resources of the Russian Federation. The main office is located in Saint-Petersburg (<http://www.vniio.nw.ru/index.eng.htm>).

⁵⁶ Mintopenergo is the Ministry of Fuel and Energy of the Russian Federation. It is a federal executive body which regulates the fuel and energy complex of Russia, and also coordinates activities of enterprises and organizations of oil producing, oil refining, gas and coal producing industries; executes control over main pipeline systems of gas, oil and its products transport, machine-building, building, scientific and engineering organizations (http://www.nasledie.ru/vlact/5_4/mintn/article.php?art=2).

⁵⁷ Minprirody is the Ministry of Natural Resources of the Russian Federation (MNR of Russia). The Ministry of Natural Resources of the Russian Federation (MNR of Russia) is a federal executive body performing the functions related to state policy formulation and normative and legal regulation in the sphere of the study, renewal, and conservation of natural resources. The Ministry of Natural Resources of the Russian Federation exercises coordination and control of the activity of the Federal Nature Management Supervision Service, the Federal Subsoil Use Agency, the Federal Forestry Agency, and the Federal Water Resources Agency which are under its authority (<http://www.mnr.gov.ru/part/?pid=398>).

the new sites so that new oil fields were discovered. It confirmed the high prospects of the Barents Sea region. Nevertheless, it was a single success because in a large water area extent only one well a year was drilled. The third step occurred during the period of dissolution of the socialistic system and transition to the market economy so that these years appeared to be lost for the development of the Barents Sea resources (Borisov, 2008).

The beginning of the fourth step is considered to be 2004 when the “Long-term State Program of Reproduction of the Mineral Resources Base for the Period of up to 2020” was developed by the Ministry of Natural Resources of Russia and approved on the government meeting in November 2004. Also the “National Strategy on Research and Development of the Oil and Gas Reserves on the Russian Continental Shelf” was adopted in 2005.

The main purpose of the strategy is creation of the resource base of hydrocarbons that secure energy and economic safety of nation and sustainable development of the fuel-energy complex in energy-requirement economy. Its main task is to stimulate the exploration and development of the hydrocarbon resources of the Russian continental shelf for the period of up to 2020. One of the conceptual states of the strategy defines the principle of financing of the geological survey on the continental shelf deposits. The financing from budget is going to be applied first of all on the phase of the regional exploration. The bulk of exploratory works is assumed to be financed by the subsurface users specifically on the plots that the state puts up to auction.

In 2007 Gazprom decided on partners in the Shtokman gas condensate field development. The participants of the project made a plan to extract first gas in 2013. If scenario is put into operation than the fourth phase of exploration will become a first stage of industrial development on the offshore fields and a revival of the large-scale exploration on the Western Arctic shelf (Borisov, 2008).

Plans for future exploration of the Arctic shelf

As it was mentioned before, there is a great need of exploration of Arctic shelf oil and gas-bearing areas which provide the opportunities for the future development of the Russian continental shelf. Such measures are prepared by the governmental organizations.

The geological exploration program offered by the Ministry of Natural Resources of the Russian Federation is based on the amount of financing for the exploration work on the Arctic shelf for the period of 2005-2020 which is predetermined by the long-term state program for reproduction of small and medium sized enterprises. It is expected that the result of the shelf exploration program implementation in 2007-2015 will be pretreatment of 10-15 promising areas where, in prospect, from 2011 to 2020 the oil will be stricken (Sapun, 2005, №12).

Under the total budget expenses of about \$1.2 bln and subsurface user’s investments of approximately \$4.5 bln, the exploration work on the shelf will provide discovery addition to recoverable reserves of hydrocarbons at 4.6 – 8.1 bln tons in oil equivalent by the most

conservative estimates. The stimulation work on the shelf during the period from 2006 to 2020 includes the regional proprietary survey and is divided in two phases (Sapun, 2005, №12):

1. *Preliminary period* (2006-2010). On the first phase 60% of exploratory work falls on the West Arctic and about 29% on the Seas of East Arctic and Far East. At the same time the tenders on 32 subsurface sites of the Arctic and Far East Seas will be held.
2. *Fundamental period* (2011-2020). During the second phase about 70% of work will be located on the West Arctic and the rest on the Barents-Kara and Okhotsk Seas regions. The tenders on more than 65 new sites of subsurface resources will be also held.

The Russian Federal Agency for Natural Resources⁵⁸ (Rosnedra) has prepared a program for licensing mineral resources areas on the continental shelf, proposing holding auctions till 2010 and forecasts for the period ending in 2020. As proposed by the Program's current draft, there should be 6 auctions held up until 2010. According to Bambulyak and Frantzen (2007), the land use auctions will issue land-use rights for 20 areas in the western sector of the Arctic shelf Barents-2 (4 sectors in the eastern part of the Pechora Sea); Barents-3 (Barents-Pechora region); Barents-4 (4 sectors in Southern Prirazlomnoye region); Barents-5 (2 sectors in Pri-Novozemelsky region); Barents-6 and Barents-7(central and western parts of the Barents Sea). The structure of licensing during the period from 2011 to 2020 is presented in Appendix 2.

According to Gazprom's Work Program on the Russian Federation shelf until 2030, the bulk increment of gas reserves is planned to be obtained on the shelves of the Kara and Barents Seas (respectively 71.7% and 20.7% of the total expected reserves growth on the shelf). The increment of oil reserves is mainly on the shelf of the Pechora and Okhotsk Seas (68% and 32% respectively). As planned during the period until 2030 the sales proceeds of the Program for Gazprom's activities aimed for hydrocarbon resources development on the Russian continental shelf will figure up to \$170 bln with capital investment in these regions equal to 24% of the sum (almost \$41 bln) (Sapun, 2005, №12).

The Program for Gazprom's activities aimed at hydrocarbon resources development on the Russian Federation shelf until 2030 was elaborated in fulfillment of the resolution of the Company's Management Committee "On the Concept of Gazprom's activities on the Russian Federation shelf", dated November 27, 2003. The basic provisions of the Program were approved by the Gazprom Management Committee in September 2005. The Arctic offshore is recommended by the Program as a sector of paramount study, resource base development and new oil and gas extraction provinces formation (Gazprom News, 2009).

⁵⁸ The Federal Agency for Natural Resources (or Rosnedra) is a federal executive body which exercises the functions of the public services provision and the administration of state property in the sphere of subsurface use. The agency comes under the jurisdiction of the Ministry of Natural Resources of the Russian Federation. It organizes: the national geological survey on subsoil; the project appraisal of the geological survey, the economic-geological and cost evaluation of the mineral resources deposits and subsoil blocks, holding of competitive tenders and auctions for the right to subsurface use and so on (<http://www.rosnedra.com/>).

According to the Minister of Natural Resources Yuri Trutnev, the country is coming to the period of extensive crude hydrocarbon field development on the shelf, but it will not happen before 2015 (Sapun, 2005, №12).

4.2.2 Pros and cons of activities on the Arctic shelf

The importance of the Russian Arctic shelf development was promoted by three main directions. First, the resources of the Arctic shelf form 85% of the Russian offshore oil and gas reserves. Second, the offshore Arctic regions are the primary resource for the fuel and energy complex development of Russia in XXI century. Third, the offshore hydrocarbon production demands unique technologies (Pokrovskiy, 2001), which can be provided by domestic defense enterprises and foreign companies that possess expertise in offshore projects.

Increase of expected reserves

Between 2005 and 2008 the implementation of geological exploration on the Russian shelf increased Gazprom's reserves by more than 1.54 bln tons in oil equivalent. The expected growth of Gazprom's hydrocarbon reserves on the Russian shelf between 2009 and 2020 will reach in the order of 5.6 bln tons in fuel equivalent (Gazprom News, 2009).

In 2006, Gazprom completed drilling an appraisal well №7 in the Shtokman field. A preliminary analysis enables the anticipation of a further increase in Shtokman's production potential (Bambulyak and Frantzen, 2007). Well №7 is located 550 km from the Kola Peninsula⁵⁹ with the sea depth of up to 340 meters. The drilling customer is CJSC Sevmorneftegaz, which holds licenses for geological exploration and production of gas and condensate in the Shtokman field. The general contractor is JSC *Gazflot* (a 100% subsidiary of Gazprom) (Gazprom News, 2006).

In January 2006, the Russian Federation Nature Ministry's State Commission for Mineral Reserves approved an increase in the Shtokman gas condensate field reserves. The reserves were increased based on the data obtained through 3D seismic survey. In 1995 Shtokman's C1+C2 reserves approved by the Russian Nature Ministry's State Commission for Mineral Reserves (Protocol №379 on May 17, 1995) accounted for 3.2 tcm and 31 mln tons of gas and condensate, respectively. Now the reserves account for 3.8 tcm of gas and about 37 mln tons of gas condensate (Appendix 3). The reserve hike is another indication of the high production and economic potential of the Shtokman field (Gazprom News, 2006).

⁵⁹ The Kola Peninsula (Russian: *Кольский полуостров*, or *Kol'skij poluostrov*) is a peninsula in the far north of Russia, part of the Murmansk Region. It borders upon the Barents Sea on the North and the White Sea on the East and South. The west border of the Kola Peninsula stretches along a meridian from the Kola Gulf through the Imandra Lake, Kola Lake, and the Niva River to the Kandalaksha Gulf (Wikipedia).

Energy Strategy of Russia

Another essential impetus for exploration and development activities on the Russian continental shelf is a state document which concretizes aims, tasks and main trends of a long-term energy state policy. Initially, the Government of the Russian Federation approved the Main Provisions of the Russian Energy Strategy on November 23, 2000. The new version of the Energy Strategy for the Period of up to 2020 was approved by the Decree No. 1234-p on May 22, 2003. Some of the document's key parameters became more detailed and ambitious, while external priorities for developing the energy sector were also set (Ivanov, 2003).

The aim of energy policy is to make most effective use of the natural fuel and energy resources and of the potential of energy sector for economic growth and improvement of life quality. The strategic guiding lines of the long-term state energy policy are the energy safety, energy effectiveness, budget effectiveness and ecological energy security. Subsoil use and management of the state subsoil fund, development of internal fuel energy markets, forming of rational fuel energy balance, regional and external energy policy, social, scientific and technical and innovation policy in the energy sector are among these lines.

The main instrument of their realization will be a number of measures of economic regulation such as prices, customs, taxes and antimonopoly regime. Creation of a consistent and flexible system of economic regulation is one of the main tasks and suppositions of economic effectiveness of the energy policy.

The implementation of the Energy Strategy in Russia will result in an effectively developing fuel and energy complex and competitive energy market which will satisfy the demands of developing economy in energy resources and will integrate into world energy markets (Minenergo, 2003).

The expected production volume of gas will significantly vary depending on one or another option of the social and economic development of Russia. By the optimistic scenario in case of a favorable development in Russia, production volume will reach approximately 645-665 bcm in 2010 and increase up to 710-730 bcm in 2020. By the moderate scenario, gas extraction is predicted in the volume of up to 635 bcm in 2010 and up to 680 bcm in 2020. According to the critical scenario, gas production begins to decline and stabilizes on the level of 555-560 bcm in 2010. And only during the second decade the growth of gas output will come up to the level of the first half of 90th, that is 610 bcm (Gazforum, 2003).

Meanwhile, Gazprom's gas production will account for no less than 570 bcm in 2010, will reach 610-615 bcm in 2015 and 650-670 bcm in 2020. This is a fundamentally higher level than provided in the Russia's Energy Strategy (Gazprom Production, 2008). According to Ministry of Energy⁶⁰ (2003), in the long-term prospective the increase of gas production by

⁶⁰ Ministry of Industry and Energy was transferred in two separate ministries in 2008: Ministry of Energy of the Russian Federation and Ministry of Industry and Trade of the Russian Federation by a President's Decree from 12 May 2008. The first one is a federal executive body which is responsible for development of energy resources of the country, energy safety and energy strategy (<http://minenergo.gov.ru/>). The second one is a federal executive body with policy-making and regulatory functions in the civil and defense industries, as well as in aviation technology development, technical standardization and metrology, and with functions of authorized federal executive body carrying out state regulation of foreign trade activities (<http://www.minprom.gov.ru/eng>)

independent producers is expected: from 73 bcm in 2002 (12% from the whole production) up to 105-115 bcm (17%) in 2010 and 140-150 bcm (20%) in 2020.

The gas production will be realized and developed both in the traditional gas producing regions, the main of which is the Western Siberia, and in the new oil and gas producing provinces: in the Eastern Siberia and on the Far East, on the European North (and offshore in the Arctic seas) and on the Yamal Peninsula⁶¹ (Minenergo, 2003).

Declining of mineral raw material base

The current state of oil and gas development in Russia is characterized by reduction in exploration, and low rates of regeneration. The volumes of geological survey do not ensure regeneration of the mineral raw materials base within the oil and gas industry. The most profitable parts of the fields and deposits are being developed. Oil and gas extraction on the principal mainland fields has fallen over the last few years. Development of only the most accessible and profitable deposits and reserves is taking place. The probability of opening up new, large-scale hydrocarbon fields on the mainland had already decreased by the start of the 1970s. The yield of proven volumes of oil and gas resources present on the mainland currently stands at 50% (Lesikhina et al., 2007).

According to the Energy Strategy of Russia 2020, by now the base fields of the Western Siberia which provide the bulk of the current gas production are worked out to a great degree (Medvezhye field on 75.6%, Urengoy field on 65.4%, Yamburg field on 54.1%). The primary gas production region for considerable period still remains the Yamal-Nenets Autonomous District⁶² where 72% of all the Russian reserves⁶² are concentrated (Gazforum, 2003).

At present, the All-Russian Scientific Research, Geological and Petroleum Institute within the Ministry of Natural Resources is drafting a “Program Concerned to the Integrated Study and Development of Oil and Gas Reserves and Resources in the North-West Region”, including a strategy for implementing geological survey work, on the basis of energy strategy regulations. This program makes provision for the replenishment of the oil and gas raw materials base. The Ministry of Natural Resources foresees that if the pace of work on the shelf picks up, oil production will increase to 10 mln tons by 2010, and to 95 mln tons, by 2020, while gas will increase to 30 bcm and 320 bcm, respectively (Lesikhina et al., 2007).

⁶¹ The Yamal Peninsula (*Russian: полуостров Ямал*), located in Yamal-Nenets Autonomous District of northwest Siberia, Russia, extends roughly 700 km and is bordered principally by the Kara Sea, Baydaratskaya Bay on the west, and by the Gulf of Ob on the east (Wikipedia).

⁶² Yamalo-Nenets Autonomous District (*Russian: Ямало-Ненецкий автономный округ, Yamalo-Nenetsky Avtonomny Okrug*), or Yamalia, is a federal subject of Russia. The Yamalo-Nenets Autonomous District is the largest administrative division of Tyumen with an area 750 300 km². The administrative center of the autonomous district is Salekhard. The area is rich in natural gas (Wikipedia).

The development of the Shtokman field seems to be the most attractive and far-reaching alternative to compensate the declining production in the West Siberian fields (Pokrovskiy, 2001).

Estimation of the Arctic shelf attractiveness

At the joint meeting of Energy Policy Committee of the Russian Union of Industrialists and Entrepreneurs⁶³ and Energy Strategy and Development Committee of the Russian Chamber of Commerce and Industry⁶⁴ the *Shell's* representative named the main factors of success according to the problem of exploration and development of hydrocarbon reserves on the Russian continental shelf. Here they are:

1. Good geological potential;
2. Legal and fiscal systems which comply with operating conditions;
3. Innovative technologies.

According to the Vice President of Shell Exploration and Production in Russia, the comparison of resources worldwide speaks in favor of Russia. The international investors think highly of the shelf resources (on the picture in Appendix 4 the area and sedimentary deposits of the whole North Sea⁶⁵ correspond almost to any of the 9 marked offshore regions in Russia) (Analytical service NGV, 2007). The shelf of the Barents and Pechora Seas is attractive for investors in terms of average volume of reserves but its geological and economical perspectives depend on the probability of new field discoveries which are insecure because of region's poor exploration (Donskoy and Vigon, 2005).

⁶³ The Russian Union of Industrialists and Entrepreneurs (RSPP) is an independent non-governmental organization. The Union has a membership base of over 120 regional alliances and industry associations representing key industries of the economy, including the fuel and energy industry, the machine-building industry, the investment-banking sector as well as the military industrial complex, the building industry, the chemical industry, and light and food industries (<http://www.rspp.ru/Default.aspx?CatalogId=2879>). It is based in Moscow. Its president is Alexander Shokhin, vice-premier of Russia from 1991 to 1994, and subsequently a Duma depute for eight years (Wikipedia).

⁶⁴ The Chamber of Commerce and Industry of the Russian Federation (RF CCI) is a nongovernmental, nonprofit organization uniting its members for meeting the tasks and goal objectives set out in the Russian Federation Law on Chambers of Commerce and Industry in the Russian Federation and the Chamber's own Charter. It represents the interests of small, medium-size, and big business and it encompasses all business sectors – manufacturing, domestic and foreign trade, agriculture, the finance system, and the services. It promotes the growth of the Russian economy and its integration into the world economic system and it provides favorable conditions for the advancement of all business sectors (<http://eng.tpprf.ru/ru/main/general/activities/>).

⁶⁵ The North Sea is a marginal, epeiric sea on the European continental shelf. It is more than 970 km long and 580 km wide, with an area of around 750 000 km². The North Sea is bounded by the Orkney Islands and east coasts of England and Scotland to the west and the northern and central European mainland to the east and south, including Norway, Denmark, Germany, the Netherlands, Belgium, and France. In the south-west the North Sea becomes the English Channel connecting to the Atlantic Ocean. In the east, it connects to the Baltic Sea via the narrow straits that separate Denmark from Norway and Sweden, respectively. In the north it is bordered by the Shetland Islands, and connects with the Norwegian Sea (Wikipedia).

In terms of resources availability the risk of shelf development in Russia for investors is not so high, but there is a pitfall of legal framework and fiscal system. Here the project party defines its correlation to water depths, object distance from infrastructure, ice cover, average field size, and efficiency of wells. The attractiveness of the fiscal system and its stability plays an important role.

In order to hasten the process of geological survey, prospecting work and development of the Russian offshore deposits, it requires serious future adjustments and regulatory changes in federal legislation (Analytical service NGV, 2007). If to take into consideration the high cost of exploration works on the Arctic shelf, the development of the favorable legal and tax regimes is of a high priority for the legislative base improvements. It is reasonable to implement some of the measures taken from the foreign experience such as general deduction of tax burden on extractive enterprises by cutting export duties, calculating royalty by actual selling price, not by export price of oil. Also it is possible to stimulate the exploration having applied tax holidays and abolishment of regular payment for subsoil use during the period of exploration (Analytical service NGV, 2006).

The last ingredient of success is implementation of breakthrough technologies which Russia does not possess. A good example is development of the North Sea which after 40 years of exploration has changed from a hard-to-reach area into well-developed petroleum bearing province. In this case Russia has to develop its own technical infrastructure and/or to borrow the experience from abroad (Analytical service NGV, 2007).

So it is important to conclude that activities on the Arctic shelf may become successful for the reason of high resource potential and need for new fields extraction. The participation of international oil companies will only improve the situation of lack of technologies and experience in development of deposits in the arctic conditions.

4.3 Participation of international oil companies in the Shtokman project.

The major international oil and gas companies are participating in exploration and development of hard-to-reach and challenging from economical, technological and environmental point of view fields which require new technologies and huge investments. The offshore areas of the world ocean hold large deposits of hydrocarbons and in the case of declining production on the mainland more and more companies are going offshore.

According to the Russia's Energy Strategy for the period of up to 2020, energy policy priorities in the North-West Federal District will entail development of the oil and gas industry on the coast of the Arctic Ocean and the shelf of the Arctic Seas. The strategy stresses that the Yamal Peninsula and the Russian northern seas will become the strategic priority region in terms of gas production over a long period (Lesikhina et al., 2007).

The region's biggest hope is the Shtokman gas field in the Barents Sea shelf. The Shtokman project development has several sides and challenges – economical, technological, environmental and political. The Shtokman gas and condensate field development project is of strategic significance for Gazprom. The Shtokman development process will involve using state-of-the-art technologies and technical know-how. Authoritative international companies will be invited for these purposes as contractors, with strict compliance to work deadlines and costs to be a critical contract clause (Bambulyak and Frantzen, 2007).

There were some uncertainties and disputes about the need of foreign participation in the project of the Shtokman gas and condensate field development. According to the first public censure of a new version of the federal law “On Subsoil” which was brought to State Duma⁶⁶ on June 17, 2005 there was an opinion that the deposits of the continental shelf has to be developed only by national companies. International companies could gain access to the other Russian fields but the entrance to the shelf resource has be closed for them (Rubashkin, 2005).

According to the top-manager of Gazprom V. Podyk, Russia has no capabilities, no technologies to develop costly offshore projects at an adequate technical and ecological level (Rubashkin, 2005). The large scale of the project requires huge investments, so that the projects execution without foreign capital inducement is scarcely probable (Mereshin et al., 2001).

⁶⁶ The State Duma (Russian: Государственная дума (*Gosudarstvennaya Duma, Gosduma*) in the Russian Federation is the lower house of the Federal Assembly of Russia (legislature), the upper house being the Federation Council of Russia. The Duma is headquartered in central Moscow. Its members are referred to as deputies. The State Duma adopts decrees on issues referred to its authority by the Constitution of the Russian Federation. Additionally, there are constitutionally 450 deputies of the State Duma (Article 95), each elected to a term of four years (Article 96) (Wikipedia).

The Energy Strategy of Russia states that in order to satisfy the sustainable gas demand of the country's economy, to raise effectiveness of gas industry development and operation, it is necessary to implement a long-term state policy which provide the improvement of subsoil use and taxation with the aim of creating conditions and incentives for building up exploration and production of new gas fields, including small and medium-sized, exploitation of mature production fields and fields with reserves difficult to recover (Gazforum, 2003). For many international companies, and not only in oil and gas industry, simple and transparent rules of the game are very important. It is necessary to realize under which conditions they will be allowed to work both offshore and onshore (Rubashkin, 2005).

As it can be seen the participation of international companies which can provide their offshore experience and technologies is a significant factor in development of the Shtokman project. The only question is how it will be done from the legislative point of view.

4.3.1 Legislative base for participation in the Shtokman project

The process of conditions' stipulation for international involvement in the Shtokman project under the terms of Production Sharing Agreement (PSA) started in 1995. Mesherin et al. (2001) claims that in order to gain success in the work performance it is essential to take some measures, the most important of which are: formulation of the "rules of the game" for the foreign companies; formalization of the partnership relations; and also organization of the project financing. All the above mentioned measures together with industrialization of domestic producers of pipes, gas compressor units and offshore platform facilities will result in implementation of the Shtokman project on schedule.

Federal law "On Subsoil"

First of all it is important to look through the Russian legislative system connected to subsoil use and access of international companies to the country's national reserves.

Federal Law No. 2395-1 dated February 21, 1992 "On Subsoil" (Subsoil Law) is a fundamental Russian normative and legislative act in the sphere of subsoil use. Subsoil use in Russia is a subject to fees. The law recognizes the importance of subsoil regulation for people and for the economy and its significant influence on the environment (Lesikhina et al., 2007). In 2004, the Subsoil Law was amended with regard to the issuance of licenses. The main provisions of the law are presented in the end of the given paper.

The positive effect of the law is that it gives the right for development of subsoil plots to the entities that discovered the deposit by themselves. This fact stimulates the exploration works and fastens the process of the rehabilitation of mineral resource base. Also the Law on

Subsoil provides the use of concession and PSA contracts in conjunction with a licensing system to stabilize the investment environment and to attract foreign capital. But the law does not clarify the conditions for subsoil access not only for international but also for Russian companies. Also the definition of the strategic fields and special economic zones is not clear in the law so the problem of international participation in the continental shelf resource development remains uncertain (Analytical service NGV (2), 2005).

Production Sharing Agreement

In December 1993, Yeltsin⁶⁷ issued a presidential decree establishing the basic regulatory framework for Production Sharing Agreement (PSA) (Krysiek, 2007).

A production sharing agreement is an internationally binding commercial contract between an investor and a state. A PSA defines the conditions for the exploration and development of natural resources from a specific area over a designated period of time. According to the terms of a standard oil and gas PSA, the state retains ownership of the hydrocarbons and the investors bear responsibility for extracting the resource. The investors receive the majority of early revenue from the project, known as cost oil, as compensation for the cost of exploration and development. Once the project reaches the cost recovery stage, subsequent revenue, known as profit oil, is shared between the investors and the state according to a pre-negotiated formula (Krysiek, 2007).

Initially, the Putin⁶⁸ administration encouraged investment in the Russian Barents region through the series of regional development programs but this strategy produced disappointing results. In response, the government opened the bidding to international oil companies. In 2003, Putin signed the legislation that greatly reduced the number of oil and gas fields eligible for development under PSAs. For that reason IOCs interested in investing in the Barents region prefer to form partnerships with Russian companies to reduce their exposure to political risk (Krysiek, 2007).

At a meeting of the Security Council⁶⁹ of the Russian Federation in December 2006, it was declared that the practice of concluding production sharing agreements for the offshore fields is not keeping with the Russian national interests. This is linked to the fact that investors participating in such agreements own a part of the raw materials recovered. The argument behind the decision in the Security Council is that, since raw materials prices may increase, an agreement of this nature may become unprofitable for the state (Lesikhina et al., 2007).

⁶⁷ Boris Nikolayevich Yeltsin (*Russian: Борис Николаевич Ельцин*; 1 February 1931 – 23 April 2007) was the first President of the Russian Federation, serving from 1991 to 1999 (Wikipedia).

⁶⁸ Vladimir Vladimirovich Putin (*Russian: Влади́мир Влади́мирович Пу́тин*; born 7 October 1952 in Leningrad, USSR; now Saint Petersburg, Russia) was the second President of Russia and is the current Prime Minister of Russia (Wikipedia).

⁶⁹ The Security Council of the Russian Federation (SCRF) (*Russian: Совет Безопасности Российской Федерации*) is a consultative body of the Russian President that works out the President's decisions on national security affairs. Composed of key ministers and agency heads and chaired by the President of Russia, the SCRF was established to be a forum for coordinating and integrating national security policy (Wikipedia).

According to Krysiak (2007), the cost and complexity of Arctic oil and gas development forced the Putin administration to renege on its vow to develop the Shtokman offshore gas field without foreign partners. So in 2007 Gazprom granted shares in project participation to some international companies (more detailed below).

Tax regime and fiscal policy

Production sharing gives investors a predictable tax regime for the entire life of a project in countries with a volatile economic regime. In Russia, licence holders can apply for production sharing if they consider a project can be implemented only with tax exemptions. The government and many domestic oil firms say that the regular tax regime has become much more predictable in the last few years, enabling international majors to invest in Russia without seeking tax exemptions (Reuters, 2003).

Under tax regimes, the oil sector is subject to a royalty that constitutes compensation for the use of oil and a regular tax on profits. Royalty payments are imposed on all oil output, with the possible exception of oil used for internal consumption and production losses. In theory, the amount of royalty should be based on the price of oil at the wellhead (Reuters, 2003).
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Russian fiscal policy allocates a large share of the net present value (NPV) of an oil deposit to the government (in excess of 90%). The rate of profit tax is equal to 24% of gross income less allowable deductions (6.5% is the federal rate and 17.5% is the regional rate, which might be reduced by up to 4% at the discretion of the region). Deductions include expenses necessary for business, royalties, interest, losses carried forward from up to 10 years earlier, and taxes paid before profit tax is assessed (Alexeev and Cornad, 2009).

Prior to the introduction of the Russian Tax Code, the royalty charge was a per unit amount adjusted for inflation. That regime was changed in 2001 to transform the tax into an ad valorem royalty of 16.5% (close to the offshore U.S. rate) imposed on the Urals price. The tax holiday and depletion factors were added to certain types of oil fields in 2007 and the average rate of royalty was changed as of 2009. The main distinction of the tax regime is that Russia's royalty (the Mineral Extraction Tax) is unusual by international standards because it is pegged to the price of the Russian export blend Urals (Alexeev and Cornad, 2009).

Another interesting feature of the Russian tax system is the presence of an export tax. The export tax has a marginal rate of 65% and an increasing average rate structure similar to that of the Mineral Extraction Tax. Although Russian law specifies only the upper limit of the export tax and it can always be lowered by government decree. To a large extent due to the high royalty rate and the presence of the export tax, the Russian government has been able to collect relatively large revenues from its oil producers (Alexeev and Cornad, 2009).

There are other distinctive features of the Russian tax regime. Tariffs on imported inputs are still imposed. In addition, development expenses are amortized over five years, which is a more stringent policy in comparison with those in the other oil producing countries. Also the excess profits tax (Resource Rent Tax) systems impose an additional tax on abnormal profits of oil-producing companies. This tax is applied on the portion of the oil company's returns that remains after the investor has recovered costs and has received a "normal" return (Alexeev and Cornad, 2009).

The last critical area in the Russian tax regime is tariffs of the custom and excise authorities which are unacceptable. For the reason that Russia has not been exporting such a product as liquefied natural gas (LNG), only customs duty on liquefied petroleum gas (LPG) exists and is highly priced. In order to operate efficiently such a capital intensive and risky project as the Shtokman field development, an optimal export tax on LNG is required. In this case the best solution is to implement the floating rate of LNG export tariff according to the world's market price (Sapun, 2005, №16). In December 2005, the Russian Government adopted a decision to cancel export duties on LNG. According to the Ministry of Economical Development and Trade, this decision should create attractive terms for investment in LNG plants and would help to enter new markets (Bambulyak and Frantzen, 2007).

The current tax regime is oriented to benefit from companies' super profits gained by favorable pricing environment and not so high capital investments. The fiscal policy is insufficient for development of new capital-intensive projects in the Arctic shelf because of a negative net present value and high charges. Also it is characterized by high volatility and risk because the oil taxation is changing several times a year (Donskoy and Vigon, 2005).

Implementation of regulations in the Shtokman project

As it was mentioned before, the development of the Shtokman gas and condensate field was first planned to be realized without international involvement. The improvements in the legislative base were directed to create a favorable environment for national companies. Still the tax regime in Russia remains not attractive for international companies to participate in such capital-intensive projects. As it was said by Subbotin (2006), the beginning of the Shtokman field development may change a "sick" condition of the Russian legal and tax regimes into a healing stage. It is a primary governmental task to define such "rules of the game" which will stimulate the exploration and development activities of license holders, both national and international oil companies, on the Russian shelf (Belyakov, 2006).

The alternative design of the Shtokman project development presented by the international companies differs from the version of Gazprom. The main distinctions are the

later date of the project development; the requirement to export 100% of gas produced in the initial phase and the bulk of gas from the deposit in whole (Mesherin et al., 2001).

The consequence of such an approach is the expansion of the project framework and willingness of the international companies to participate in the entire supply chain from deposit to customer. Several requirements which conflict with the interests of the Russian party were made by international companies: separation of the project from other activities in the country, granting the companies which are going to participate in the first phase with an exclusive right for the future cooperation within the project, possible assignment of existing contracts of Gazprom on the gas supply to Europe. These conditions provide the international companies with a leading position in the structure of the project and an opportunity to dictate their own terms. In this case the best solution for Gazprom is to divide the realization of the project on the phases and conduct the work on each phase independently with participation of different investors on a competitive base in order to protect the country's interests in the project consistently (Mesherin et al., 2001).

In 2005 it became clear how the authorities consider the process of shelf development – with attraction of foreign technologies and investments but with strengthening the role of domestic state companies as the operators of the project. a short-list of bidders for participation in the Shtokman project became a starting point in development of the Russian oil and gas sector (Andrianov, 2006).

4.3.2 Potential partners in the Shtokman field development

Between 2004 and 2005 Gazprom has sealed a string of memoranda with prominent energy firms that brought forward their technical and commercial support packages for the project, containing Shtokman field development options, proposals on potential swaps of assets being of interest for Gazprom and expected share in the project. All the submitted packages fitted with the requirements set out by Gazprom. Memoranda of understanding have been sealed with such companies as *Statoil*, *Hydro*, *Shell*, *Total*, *ConocoPhillips*, *Chevron* and *ExxonMobil*. A study of potential location sites for a natural gas liquefaction plant and options for gas transmission, regasification and marketing in the USA has been performed within the memoranda execution (Gazprom News, 2005).

In November 2005 Gazprom's Management Committee has endorsed a short-list of companies – potential partners of Gazprom in executing the first phase of the Shtokman gas condensate field development project, including the construction of a natural gas liquefaction plant. After performing an analysis of the suggested project timing, preliminary commercial

packages and bidders' track record of similar projects, Gazprom has chosen 5 companies which are invited for intense commercial talks (Gazprom News, 2005):

- Statoil (Norway);
- Total (France);
- Chevron (USA);
- Hydro (Norway);
- ConocoPhillips (USA).

The released to public short-list is not a prize list. The Russian gas monopoly will sign the interim agreements with all the companies which are included in the short-list about the cooperation. In several months Gazprom will select two or three companies that will form a consortium for the Shtokman project implementation (Sapun, 2005, №14).

The selection criterion is based on several measures:

1. Experience in development of the continental shelf;
2. Experience in LNG production;
3. Marketing opportunities on the USA market (Vinogradova, 2006).

The identification of the strategic project partners for development of the Shtokman gas and condensate field is going to be made according to these factors. So it is important to estimate the strengths and weaknesses of the companies, and also their commercial offers.

Statoil

Statoil is operator of the Snøhvit⁷⁰ field on the shelf of the Barents Sea. The company is responsible for all the stages of development: plan for development and operation, well drilling, production, construction of offshore sub-sea pipeline, onshore gas supply, liquefaction, transport to the target markets and export sales. Such an unrivalled expertise the company will implement on the Shtokman field which can be seen as a twin of Snøhvit according to the technological and environmental characteristics.

The company together with German group of companies *Linde* has developed its own technology of gas liquefaction – the process Mixed Fluid Cascade. According to LNG transportation Statoil holds interest in three liquefied gas tankers.

⁷⁰ The Snøhvit field in the Barents Sea supplies gas to the world's first LNG plant with carbon capture and storage. The field has been developed with seabed installations and a 145 km multiphase transport pipeline to shore. An LNG factory has been built on the island of Melkøya near Hammerfest. There, the gas is liquefied by cooling it down to -163 C⁰ so that it can be exported by ship to Europe and the USA. Production started in October 2007 (<http://www.statoilhydro.com/en/>)

On the North American market Statoil is working almost 15 years and has established own marketing and trading group there. According to regasification terminal facilities of LNG the company signed an agreement with *Dominion* for 1/3 of the receiving Cove Point⁷¹ (on the east coast of USA, Maryland) terminal capacities for the period of 20 years.

Statoil qualifies for 25% participation interest in the Shtokman project and offers Gazprom 10% stake in the Snøhvit field (Vinogradova, 2006).

Norsk Hydro

Norwegian Hydro is a transnational company with diversified activities in regard to both industrial and geological aspects. The bulk of oil and gas fields of the company are located in the North Sea and on the Norwegian continental shelf. Hydro produces oil and gas in Canada, Gulf of Mexico⁷², Iran and Angola. In the Norwegian sector of the North Sea the company is an operator of 13 oil and gas fields.

In 1997 the company discovered gas deposit Ormen Lange⁷³ on the North Sea shelf. The field's gas reserves average to 397 bcm. Hydro holds an 18% interest in the project and is operator for the phases of development and operation planning and pipelining. The gas is planned to be exported on the market of Great Britain, the largest gas market in Europe.

Starting from 1989 the company was participating in works on the Shtokman development project. In 2003, being a leader in the sphere of subsea field development and operation, the company offered a concept of the Shtokman field development on the basis of technologies used in Ormen Lange.

⁷¹ Dominion Cove Point LNG, LP is located on the Chesapeake Bay in Cove Point, Maryland, south of Baltimore. It is one of the nation's largest liquefied natural gas (LNG) import facilities. Dominion acquired Cove Point from Williams on September 5, 2002, and began receiving ships in the summer of 2003. Dominion Cove Point has a storage capacity of 14.6 bcf (billion cubic feet) and a daily send-out capacity of 1.8 bcf. The terminal connects, via its own pipeline, to the major Mid-Atlantic gas transmission systems of Transcontinental Gas Pipeline, Columbia Gas Transmission and Dominion Transmission. At Dominion Cove Point, LNG is off-loaded at an offshore dock, stored for subsequent gasification and then delivered into the pipeline (<http://www.dom.com/about/gas-transmission/covepoint/index.jsp>).

⁷² The Gulf of Mexico (Spanish: *Golfo de México*) is the ninth largest body of water in the world. Considered a smaller part of the Atlantic Ocean, it is an ocean basin largely surrounded by the North American continent and the island of Cuba. The gulf basin is approximately 1.6 mln km². Almost half of the basin is shallow intertidal waters. The shelf is exploited for its oil by means of offshore drilling rigs, most of which are situated in the western gulf and in the Bay of Campeche (Wikipedia)

⁷³ The development of the Ormen Lange field in the Norwegian Sea is one of the largest and most demanding industrial projects ever carried out in Norway. The field has been developed with sea-floor installations at depths of between 800 and 1.100 m, combined with an onshore plant at Nyhamna in Aukra municipality in Norway, for processing and exporting the gas. Following a gradual increase in production over the first two to three years, the field will produce 70 mcm of gas per 24-hour period. With recoverable gas reserves estimated at 397 bcm, deliveries are likely to continue for 30 to 40 years. The field will be able to cover as much as 20% of Britains gas needs, for up to 40 years. The gas will be exported through the 1.200 km long pipeline Langeled, to the reception centre in Easington on the east coast of the UK. Norske Shell took over as operator on 1 December 2007 (<http://www.statoilhydro.com/en/>).

Hydro would like to get a 20% stake in the project, it is ready to take part in the whole value chain from production to distribution and invest funds proportionally to its share. In exchange for participation in the Shtokman project the company offers Gazprom some part of the Ormen Lange's stake (it is a matter of negotiation). If to take into consideration the interest of Gazprom in the market of Great Britain, such an offer together with company's experience in the north shelf development can be rather attractive (Vinogradova, 2006).

Total

The company is working in 130 countries, in 44 countries it is involved in upstream activities, and carries out the commercial oil and gas production in 27 countries being the largest producer in Africa and Middle East.

During the last several years Total reinforces its position with regard to the North American gas market especially in supply of LNG. Total is operating 40 years on the world market of LNG. Nowadays, Total participates in 5 current projects such as Adgas (Abu-Dhabi), Bontang (Indonesia), Nigeria LNG, Qatargas and Oman LNG which aggregate the capacity that is equal to 40% of the world's LNG production. It characterizes the company as one of the leaders in the industry: the share of the company in production of LNG is 7.5 mln tons per annum that forms 5% of the world's activities. Total lies in the third place after Shell and ExxonMobil in terms of LNG sales. The company is taking part in plant construction in the projects Snøhvit (Norway), Yemen LNG, Pars LNG (Iran) and Angola LNG.

Along with its own share of gas Total signs long-term LNG purchase agreements of additional volumes for its onward sale on the leading markets. Starting from 2007 and during the next 20 years the company is going to supply the markets of USA and Europe with 1.5 bcm of gas from the plant Nigeria LNG, 1 bcm from the project Snøhvit. Since 2009 the company is going to sell 2.7 bcm of LNG from the plant in Yemen on the American and European markets.

According to LNG downstream sector, Total holds a 26% stake in the project Hazira (India) and a 25% stake of the terminal Altamira⁷⁴ with peak capacity of 7.3 bcm per annum. The company is also taking part in construction of the receiving terminal Fos Cavaous in France.

⁷⁴The Altamira LNG regasification terminal is located near Tampico on the eastern coast of Mexico, Tamaulipas state. In August 2006 the Altamira LNG terminal received its first cargo of LNG and the plant was commissioned. The Terminal de LNG de Altamira S. A. de C. V. is a joint venture of Royal Dutch Shell (50%), Total (25%) (joined in 2003), and Mitsui & Co (25%) (joined in 2004) and is the country's first LNG regasification terminal. The Altamira LNG terminal has been constructed (construction began in 2003) because of fast growing natural gas demand in north-eastern Mexico, which is largely driven by increases in electric power demand (<http://www.hydrocarbons-technology.com/projects/altamiralingmexico/>).

The Total's presence on the gas market of North America is measured by 3 bcm of gas production and 15 bcm of gas sales. Besides, a 100% subsidiary of the company, Total LNG USA signed a 20-years long contract with *Cheniere* LNG on conditions of 10 bcm per year capacity utilization on the Sabine Pass terminal⁷⁵ in Texas.

The scientific unit of Total carries out research and has patented technologies in the sphere of gas distribution from the shelf to onshore, and development of subsea cryogenic lines of gas transmission like "pipe-in-pipe" (Vinogradova, 2006).

ConocoPhillips

If to take into consideration the merger with Burlington Resources in 2004, ConocoPhillips is the largest company in terms of gas reserves and volume of extraction in USA. The company executes works in 40 countries.

ConocoPhillips is a so-called pioneer in the LNG industry: the company through acquisition with Phillips in 2002 got a 70% interest in one of the oldest LNG plants in the world which is located in Alaska and from which Japan is supplied with LNG already 40 years long. Another operating facility of the company in upstream sector is a new on-stream LNG plant in Darwin (Australia) with an annual capacity of 3.6 mln tons and company's interest of 57%. ConocoPhillips takes part in construction of LNG plant in Brass project (Nigeria) with capacity of 8 mln tons per annum and another plant Qatargas 3 with peak capacity of 7.8 mln tons and partnership interest of 70%.

The company has no current regasification facilities but takes part in the projects of 3 receiving terminals construction: two in the Gulf of Mexico and one in California. Also the company entered into an agreement with *Cheniere* LNG and got a quota in capacities of the terminal FreePort⁷⁶ in Texas which is also under construction.

ConocoPhillips has an important advantage of possessing own technology of natural gas liquefaction "CoP LNG Process" which is used all over the world (Vinogradova, 2006).

⁷⁵ The Sabine Pass LNG terminal is located along the Sabine Pass River on the border between Texas and Louisiana, in Cameron Parish, Louisiana. The terminal has two docks. Phase I of Sabine Pass LNG commenced service in April 2008, with 10.1 bcf of LNG storage in three tanks and a maximum continuous regasification rate of 2.6 bcf per dock. The first stage of Phase II will include the addition of a fourth and fifth storage tanks that will bring the maximum continuous regasification rate up to 4.0 bcf per dock with a peak sendout capacity of 4.3 bcf per dock. The terminal will be capable of receiving and unloading about 400 LNG vessels each year after Phase II is complete (http://www.cheniere.com/LNG_terminals/sabine_pass_lng.shtml).

⁷⁶ Freeport LNG Development, L.P. operates one of the first LNG terminals in the U.S. built after a 20-year hiatus in LNG terminal development. The storage and regasification facility is located on Quintana Island, about 70 miles south of Houston, Texas. The first phase of this world-class regasification facility has a send-out capacity of 1.75 bcf per day and is fully contracted long-term. Phase II will ultimately add another 1.15 bcf per day of marketable capacity plus additional peaking capacity for a total of 3.25 bcf per day of vaporization. The Freeport terminal location has favorable economic, geographic and infrastructure characteristics (<http://www.freeportlng.com/>)

Chevron

Taking into account the merger with Unocal, Chevron holds a fourth position in terms of disposed reserves and second in production of gas in USA. In global scale the company enters the five majors (Appendix 5) having control over huge reserves in Australia, Western Africa and other regions. In USA the company owns pipeline net for oil and gas transmission about 16 000 km of total length.

In the sphere of LNG-upstream the company participates in the operating project West Shelf LNG Venture in Australia which executes delivery of gas to Japan and South Korea during the last 20 years. In Australia the company runs one more LNG project which based on resources from the Gorgon area on the north-west shelf of the country. ChevronTexaco is operator (50%) of the project development in consortium with Shell (25%) and ExxonMobil (25%). Two more gas projects with participation of Chevron take place in Western Africa: Brass in Nigeria and Angola LNG.

For the purpose to receive gas from new projects ChevronTexaco is planning to build 4 LNG receiving and regasification terminals in North America. Two of them, Port Pelican on the Gulf of Mexico shelf with capacity of 10 bcm per annum and another on the shelf of Baja California with capacity of 14.5 bcm per annum which are already approved by the authorities of USA and Mexico, respectively. The third terminal Pascagoula in Mississippi State with annual capacity of 13.4 bcm is under consideration by the Federal Energy Regulatory Commission. If all the proposed projects are implemented Chevron will possess the receiving and regasification capacity of 45.6 bcm per annum on the terminals of North America. Additionally, the company has a 20-years long quota for 10 bcm annual capacity of the terminal Sabine Pass in Texas (Vinogradova, 2006).

State of play of the companies from the short-list

During the public discussion one interesting supposition was made. The structure of the project development consists of several independently integrated directions – production, LNG and marketing – that can be a reason for separation of consortium on parts. The membership of short-list indirectly proves it: Norwegians are strong in production, French Total has experience in LNG plants, and American companies can be responsible for marketing strategy (Sapun, 2005, №14).

The above-mentioned criteria for selection are important conditions but not the sufficient ones. This can be proved by the fact that from the initial list of bidders dropped out two companies which absolutely comply for submitted requirements: the largest producers of

LNG Shell and ExxonMobil (Vinogradova, 2006). Concerning the Gazprom's refusal from the offers of Royal Dutch Shell, there is some logic. The monopoly has exchanged the assets with Shell in the Sakhalin II⁷⁷ project (50%, plus one share). So there is no need for Gazprom to give a competitive advantage to one company if it is possible to have good relationships with all the majors (Sapun, 2005, №14).

In order to estimate the chances of all the five companies from the short-list to participation in the Shtokman development project, it is better to classify their advantages according to the selection criteria. The data below refers to Sapun (2005, №14).

1. Technological side

Both Norwegian companies have almost equal field experience, are aware of operation in the Arctic shelf conditions, and possess some investment resources. From one point, the decision to invite both companies for participating in the project can be rational because Gazprom becomes a stakeholder of two gas projects in the North Sea at once – Ormen Lange (8-10%) and Snøhvit (10%). From another point, this will result in technology duplicating. According to competitive advantage, Statoil can provide Gazprom with access to regasification capacities of the Cove Point terminal. Also the cost estimation of the first phase of the Shtokman project by Statoil was lower (\$9-12 bln) than by Hydro (\$12 bln).

2. Gas liquefaction

According to liquefied gas production aspect of the project, Gazprom gives preference to the French company. Total possesses rather high level of experience in large-scale LNG development projects and also in activities based on project financing. Cooperation with Total is critical for Gazprom in terms of LNG supply to France; also the company can contribute to Russia's entry to the promising LNG market of Spain.

It is entirely possible that in this part of the project development some Japanese companies will be involved on the terms of contracts and subcontracts – financial industrial group *Sumitomo* and *Mitsui* Corporation. With Mitsui Gazprom was cooperating in the project Blue Stream (description in part 4.6.1), and the companies already signed a memorandum of understanding.

⁷⁷ The Sakhalin II project stipulates phased development of the Piltun-Astokhskoye and Lunskeye fields located 13-16 km offshore the north-eastern coast of Sakhalin Island in the Sea of Okhotsk. Sakhalin II recoverable hydrocarbon reserves amount to over 600 bcm of gas and 170 mln tons of oil and gas condensate. It is a first project executed in Russia which is based on the PSA. A first LNG production plant in Russia was built in Sakhalin II. The Phase 1 (launched in 1996) consists of the development of the Astokh structure. The Phase 2 (launched in 2003) envisages an integrated oil and gas development of the Piltun-Astokhskoye and Lunskeye fields. In December 2006, JSC Gazprom, Royal Dutch Shell plc, Mitsui & Co., Ltd. and Mitsubishi Corporation signed the Protocol on Gazprom's joining Sakhalin Energy Investment Company Ltd. (Sakhalin Energy) as the main shareholder (<http://www.gazprom.ru/eng/articles/article25792.shtml>).

3. Marketing

In case of marketing strategy, ConocoPhillips and ChevronTexaco have almost equal odds to win the “race”. But ConocoPhillips became earlier interested in development of the Shtokman gas and condensate field and was working under the project feasibility study. Also the company bought the stock of shares in *Lukoil* and was accepted as a capable investor in Kremlin. It is rather essential because position of Chevron on the political arena is much lower. The only positive moment in terms of Chevron is that it is not presented in the Russian oil and industry. If the authorities prefer diversification of investments then ConocoPhillips has to enjoy its Timano-Pechora field development together with Lukoil. In this case ChevronTexaco will have some advantage. Additionally, the share exchange offers made by both companies will be important where Chevron seemed to be more open-handed.

The estimation of possible strengths and weaknesses of the technical and commercial support packages for the project presented by the companies in the short-list are collected in the table:

<i>Competitive strength of the companies from the short-list</i>	Shelf development expertise	Gas production experience in the Arctic conditions	LNG production expertise	Own liquefaction technologies	Regasification capacities	Trade operation in USA/GB markets	Participation in previous consortium	Joint ventures with Russian companies	Total (-/+)
ConocoPhillips	+	-	+	+	+	+	+	-	7/2
Chevron	+	-	+	-	+	+	-	-	4/5
Total	+	-	+	-	+	+	+	+	7/2
Hydro	+	+	-	-	-	+	+	+	6/3
Statoil	+	+	+	+	+	+	-	+	8/1

Table 4. Panel of judges (Vinogradova, 2006: 59)

One interesting offer in terms of the marketing strategy was made by a “small” *Sempra Energy*. It is a trade company of American-Mexican origins with the amount of gas sales about 90 bcm per year. Sempra without asking for a share in the project offers the Russian gas monopoly to set up a joint venture on the American market with Gazprom’s almost overall control. The company possesses huge experience in LNG marketing and trading that enhances its value for the Shtokman project to the level of majors. That’s why Gazprom considers Sempra Energy beside the competition and leaves opened a question about creation of two consortiums: one for production and one for marketing (Sapun, 2005, №14).

According to this, Gazprom's Management Committee Chairman, Alexey Miller said that gas extraction and LNG plant construction are the most important tasks for the initial stage of development, and the marketing strategy will be developed together with companies from the short-list taking into consideration that there are some companies which are ready to participate only in the marketing part of the project (Sapun, 2005, №14).

4.3.3 Final decision on participation in the Shtokman project

A Framework Agreement on the main conditions of cooperation at the first phase of the Shtokman gas and condensate field development was signed on July 13, 2007 at the JSC Gazprom Head Office by Alexander Ananenko, the Acting Chairman of the Gazprom Management Committee, Christophe de Margerie, the President of Total S. A. Holding, and Yury Komarov, the Director General of Sevmorneftegaz. Under the agreement, the parties will establish a special-purpose company to manage engineering, financing, construction and exploitation of installations at the first phase of the Shtokman field development (Gazprom News, 2007).

Gazprom's stake in the new company's authorized capital will be 75%, while Total will receive 25%. Upon completion of the exploitation period of the Shtokman's first phase, Total will hand over its stake to Gazprom. The agreement envisions the possibility to attract other international partners with the cumulative involvement up to 24%, with a respective change of Gazprom's stake to 51%.

Later, on October 25, 2007 at Gazprom Headquarters Alexey Miller, the Chairman of the Gazprom Management Committee and Helge Lund, the President and CEO of StatoilHydro⁷⁸ have signed a Framework Agreement on the main conditions of cooperation at the first phase of the Shtokman gas condensate field development. In accordance with the agreement, StatoilHydro receives a 24% stake in the authorized capital of the special-purpose company established for designing, financing, constructing and operating the facilities provided for the first phase of the Shtokman field development (Gazprom News, 2007).

The final step was made on February 21, 2008 when Gazprom, Total and StatoilHydro signed a Shareholder Agreement establishing Shtokman Development AG special purpose company (Figure 10). Gazprom owns 51%, Total – 25% and StatoilHydro – 24% of the company's stock. The company is registered in Switzerland (Gazprom News, 2008).

⁷⁸ In December 2006 Statoil revealed a proposal to merge with the oil business of Norsk Hydro, a Norwegian conglomerate. Under the rules of the EEA the proposal was approved by the European Union on May 3, 2007 and by the Norwegian Parliament on June 8, 2007. Former Statoil's shareholders hold 67.3% of the new company StatoilHydro, which started operations on 1 October 2007 (Wikipedia).

Shtokman Development AG will be organizing the project engineering, development, construction, financing and exploitation of the first phase facilities related to the Shtokman field development. The Company will be the owner of the first phase infrastructure of the Shtokman gas condensate field for 25 years since its commissioning⁷⁹.

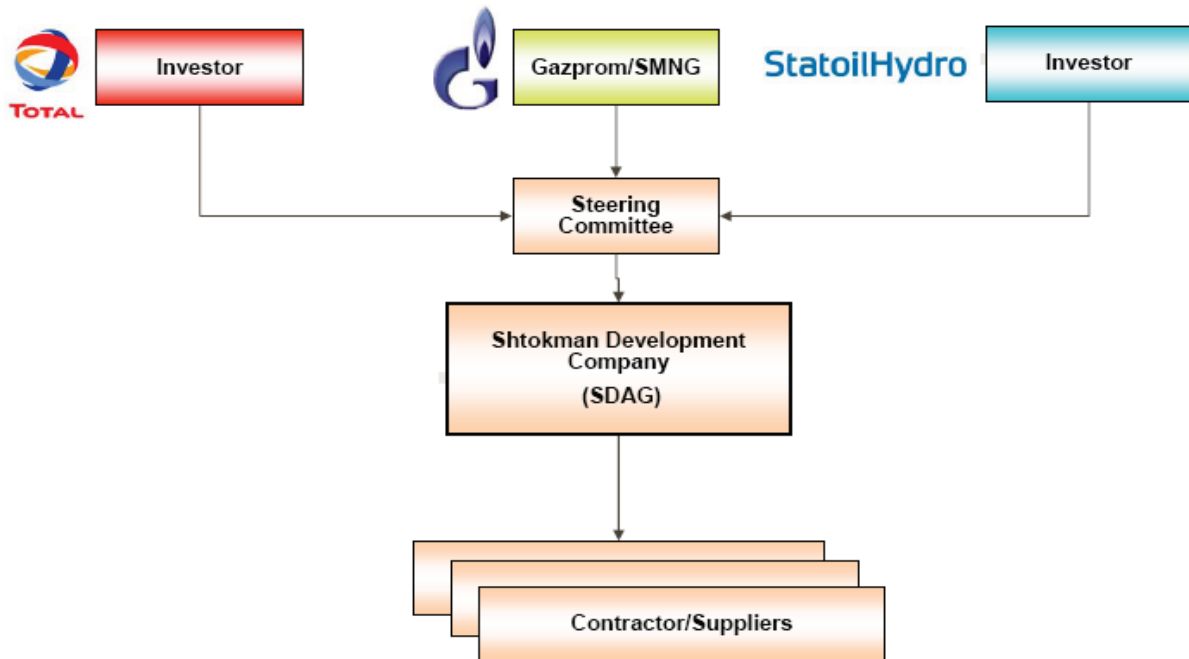


Figure 10. Project organization (Kjærnes, 2008)

«This strategic partnership of our companies brings together long experience, vast resources and advanced technologies which are fundamental to the success of this unique project, which will guarantee reliable and long-term gas supplies for European consumers. The establishment of the Shtokman Development Company marks the starting point in the realization of the development of the Shtokman field», said Alexey Miller (Gazprom News, 2008).

The development of the Shtokman gas and condensate field is impossible without the international oil companies which can bring new technologies, offshore experience and significant investments. The establishment of the joint venture allows beginning of the front-end engineering design (FEED) phase when all the main decisions on the engineering concept of the project are made. The next section will describe the technological complex of the field.

⁷⁹ Relations between the special-purpose Company and Sevmorneftegaz will be governed by a contract, by which the established company will bear all financial, geologic and technical risks involved in extraction of natural gas and condensate, as well as in LNG production. 100 % of Sevmorneftegaz shares in the company holding the license for the Shtokman field as well as all the rights for marketing of the commodities will be retained by Gazprom (Gazprom News, 2008).

4.4 Engineering concept of the Shtokman field development project

The Shtokman field complex development is planned to be carried out in three phases: systems of gas, condensate and water delivery from the deposit to the shore, LNG production plant; and onshore transport and technological complex. Related to the field's remoteness from the shore and tough climatic conditions the engineering concept of the Shtokman field development project is a complicated one and based on the studies and expertise of international companies.

4.4.1 International concepts of the Shtokman field development project

According to a study of potential location sites for a natural gas liquefaction plant and options for gas transmission, regasification and marketing in the USA which has been performed within the memoranda execution, the most interesting variants of technical concepts were presented by Norwegian companies Statoil and Hydro.

One of the schemes performed by Statoil is similarly to the technical solution the Norwegian deposit Snøhvit is built on. The company suggests implementation of subsea injection technology for the field's development. The length of the subsea pipeline will depend first, on the volume of gas condensate which will be piped together with gas and second, on the distance to the shore which is one of the hardest tasks. Another technical requirement is an electrical supply which can be solved by production of electricity onshore and its cable delivery to platform or by generation of electric energy right on the place. The concept of LNG factory can be replaced from the one used on the island of Melkøya (near Hammerfest⁸⁰).

So the company submitted 5 different draft projects of the Shtokman technical development (Sapun, 2005, №12):

- 100% subsea development of the field;
- installation of a support vessel over the deposit;
- the same vessel but of wider functions including allocation of all the technical facilities and direct export of gas;
- construction of a platform between the deposit and the shore on the maximum depth of 50 m;
- construction of a floating platform straight over the field and implementation of a complete gas treatment facility for LNG production on the shore.

⁸⁰ Hammerfest is a city and municipality in Finnmark county, Norway. The municipality encompasses parts of three islands: Kvaløya, Sørøya, and Seiland (Wikipedia).

According to the project costs, Statoil assumes that 60% amount to LNG plant, 25% of cost allocation is gas transmission and expenses on the sea, and 15% left for drilling operations and well injection. It is important to mention that the company possesses expertise in both platform and subsea production techniques and provides well development technologies with 70% cost reduction (Sapun, 2005, №12).

Norwegian Hydro does not make public the information about the details of the technological and production decision but it is known that among all the proposed variants it tends towards the decision to use subsea field development method which is implemented on the Ormen Lange field. It has a benefit of having a choice between liquefied and piped gas production. Hydro expects that on the second phase of the project the gas export to Europe via the pipeline is more feasible. The main problems the company sees are the subsea gas transmission of the multiphase flow to the shore under the rugged seabed relief; long distance to the coast and low temperatures on the sea bottom (Sapun, 2005, №12).

As it was mentioned by the companies, the environmental conditions play an important role in the engineering concept development because it influences the choice of platform, track of gas pipeline, need of additional capacities for the ice protection and environmental safety. So before bringing the engineering concept of the Shtokman field development to light some of the natural climatic conditions will be described.

4.4.2 Environmental conditions of the Shtokman field

The subsurface area of the Shtokman deposit is related to the III category of complexity (extra complexity) according to the engineering and technical conditions. It is determined by development of weak clay soil from sea-bottom with 15-20 m depth; by complicated subsurface geology; by severe topography; and by multiple discontinuous faults of Mesozoic formation. The water depth of the deposit area fluctuates from 320 to 380 m. The seabed of the Shtokman gas and condensate deposit is located in the zone of all-the-year-around original water temperatures below a freezing point. The ground temperature of the surface layer is negative, up to -0.5 C^0 and only on the depths of 10-15 m becomes positive. It can be rather challenging to predict the ground activity while installing an engineering construction (Mesherin et al., 2001).

The most dangerous and obscure situation is in places with shallow depth and incomplete straight freezing. When sub-ice facilities are installed at the depth of 25-30 m, they can be damaged by active ice. So hydrates location is to be explored and the measures are to be taken to prevent the destruction of hydrate rich primary rocks (Dmitrievskiy, 2008)

The area of the Shtokman gas and condensate field is characterized by windiness with wind velocity of up to 40 m/c and gusts of up to 53 m/c with frequency 1 time in 100 years. It is defined by wave height equal to 19.4 m with the same type of repetition. The ice covering of the topside facilities is possible during the period from October to May. The ultimate frost mass which emerges in case of spray freezing aggregates up to 830 kg/m². There is no ice formation in the water area of the Shtokman gas and condensate field. Ice floe comes from northern and eastern part of the Barents Sea. The thickness of flat ice of 1% occurrence is 1.49 m, the upper limit floe size is 13 km, the dominate size – 1.1 km. Maximum speed of the ice drift is equal to 0.9 m/c. The ice conditions of the basin in the area of Kola Peninsula become mild, and approximately 2/3 of the southern part of trace is ice-free all-the-year-around (Mesherin et al., 2001).

The environmental studies are necessary for marine structures designing, engineering and geological estimation of the field development conditions on the shelf. In fact the ice floe of the Arctic Seas has a disturbing force capable to dispose the drilling rig. Also the grounded hummocks with their underwater canines can break like a thread even a buried oil and gas pipeline (Banko and Evtishina, 2008).

4.4.3 Shtokman field complex development concept

The raw material base of the project of the Shtokman field complex development is located in the central part of the Russian sector of the Barents Sea shelf, 650 km northeast from Murmansk, 920 km northeast from Arkhangelsk⁸¹, and 290 km west of the island Novaya Zemlya. The local sea depth is varying from 320 to 340 m (Piotrovskiy, 2008).

The Shtokman development project envisages annually producing some 70 bcm of natural gas and 0.6 mln tons of gas condensate comparable to annual gas output of Norway, one of the largest European gas suppliers. The phase one contemplates annually producing 23.7 bcm of natural gas with the startup of gas supply via the gas pipeline Murmansk - Volkhov due to 2013, and liquefied natural gas supply – 2014 (Gazprom About, 2008).

Remoteness of the field from the shore, arctic ice and hydrometeorological conditions create some technical and economic problems which are possible to solve with implementation of the latest technical and technological decisions. The wide range of technical concepts was considered during the conceptual engineering feasibility study of the Shtokman field development (Piotrovskiy, 2008):

⁸¹ Arkhangelsk (Russian: *Архангельск*), formerly called Archangel in English, is a city and the administrative center of Arkhangelsk Region, Russia. It lies on both banks of the Northern Dvina river near its exit into the White Sea in the far north of European Russia (Wikipedia).

- field infrastructure;
- gas transmission from the deposit to the shore facilities including two types of transportation: two phase and multiphase flows;
- several alternatives of gas liquefaction and LNG transportation facilities by sea.

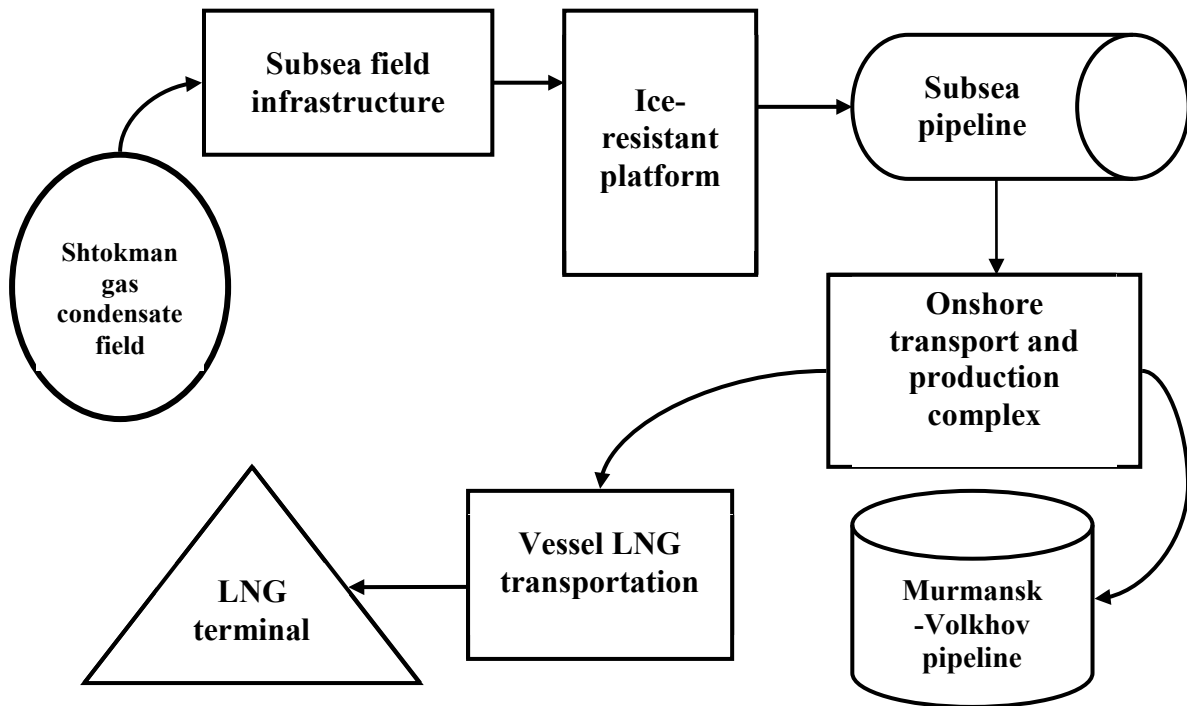


Figure 11. The engineering concept of the complex Shtokman gas and condensate field development (Piotrovskiy, 2008:14)

The engineering concept of the complex Shtokman gas and condensate field development (Figure 11) was made by a subsidiary of Gazprom JSC Giprospeftgaz (S-Pb). According to the concept, a united extraction-transport-processing facility built up integrating:

- subsea field infrastructure;
- ice-resistant processing platforms;
- subsea pipeline systems;
- onshore transport and production complex consisting of:
 - LNG plant;
 - complete gas treatment facilities;
 - special purpose sea port;
- marine objects supply base;
- Murmansk-Volkhov gas main;
- vessel LNG transportation (Piotrovskiy, 2008).

Subsea infrastructure and floating platforms

According to the Chief Engineer of the Shtokman project, Piotrovskiy A.S. (2008), the key element in the process of the field construction is implementation of the subsea technologies with the systems of subsea well injection which are installed on the seabed. The up-to-date technologies of natural gas extraction on the shelf proposed in the engineering concept include the systems of subsea well structure equipped with wellhead fittings, automatic adjustable chokes, hydrating inhibitor package and injection. The equipment is settled on the seafloor templates and manifolds. The project considers the construction of the subsea production operating complex consisting of 7 integrated complexes (base plates and manifolds) for 8 wells each and platforms with gas compressing and gathering stations for the following pipeline gas transmission.

During the feasibility study several types of producing platforms (TLP and SPAR) for the process of gas conditioning for transport were investigated.

TLPs are floating platforms tethered to the seabed in a manner that eliminates most vertical movement of the structure. TLPs are used in water depths up to 2000 m. The platform is permanently moored by means of tethers or tendons grouped at each of the structure's corners. A group of tethers is called a tension leg. A feature of the design of the tethers is that they have relatively high axial stiffness (low elasticity), such that virtually all vertical motion of the platform is eliminated. This allows the platform to have the production wellheads on deck (connected directly to the subsea wells by rigid risers), instead of on the seafloor. The "conventional" TLP is a 4-column design which looks similar to a semi-submersible platform (have hulls (columns and pontoons) of sufficient buoyancy to cause the structure to float, but of weight sufficient to keep the structure upright) (Wikipedia).

SPARs are moored to the seabed like TLPs, but whereas a TLP has vertical tension tethers, a SPAR has more conventional catenary mooring lines. SPARs have to-date been designed in three configurations: the "conventional" one-piece cylindrical hull, the "truss SPAR" where the midsection is composed of truss elements connecting the upper buoyant hull (called a hard tank) with the bottom soft tank containing permanent ballast, and the "cell SPAR" which is built from multiple vertical cylinders. The SPAR has more inherent stability than a TLP since it has a large counterweight at the bottom and does not depend on the mooring to hold it upright. It also has the ability, by adjusting the mooring line tensions (using chain-jacks attached to the mooring lines), to move horizontally and to position itself over wells at some distance from the main platform location (Wikipedia).

For the technical operation the ice-resistant platform SPAR-type which has an opportunity to be disconnectable in the case of iceberg threat and to cope with heavy topsides weight was chosen. It is supposed to build three operational platforms and three for gas compression on the stage of pressure fall in the reservoir (Piotrovskiy, 2008).

Offshore and onshore pipelines

To deliver formation fluid consisting of natural gas, condensate and waters from the field to the shore a subsea pipeline of more than 540 m long will be constructed. The pipeline-route profile has essential elevation changes and maximum depth of about 320 m.

During the feasibility study different variants of gas transport to the onshore facilities were examined: transmission of gas flow in a single-phase, in a double-phase and in a multifhased state. Today there are no projects with multi- og double-phase flow gas transportation on such a long distances but the modern exploratory methods and high technologies of subsea gas transport operations provide an opportunity for a multiphase concept realization. It is assumed to build three lines of the gas main from the field to Opasova Bay (Kola Peninsula) for two-phase gas transmission landfall (Piotrovskiy, 2008).

The complex Shtokman gas and condensate field development includes a pipeline Murmansk - Volkhov which will supply gas from the Shtokman field to the Unified Gas Supply System of the Russian Federation (UGSS). Under the feasibility study, the route of gas pipeline with compressor stations is determined. The length of the route is equal to 1.300 km. It goes through the 3 federal subjects of the Russian Federation, 15 districts; passes more than 450 bodies of water, including 12 with more than 200 m broad; more than 200 km of rocky areas; 235 km of muskegs; 16 railways crossings and 76 through the motorways. The route lies in a highly varying terrain (Piotrovskiy, 2008).

The gas pipeline will be laid underground. The route of the pipeline is divided using the linear valves into sections of no more than 30 km. The depth of the pipeline's foundation underground is 0.6 - 1 m. The laying of the gas pipeline through water barriers is envisaged using a trench method, i.e. excavating the trench (ditch) at right angles to the bed of each river, laying the pipe and filling in the trench. In case of an accident on a particular section of the gas pipeline, this section will be closed off from the rest of the pipe by the linear valves. Then gas can be blown off into the atmosphere through the blow-off pipes located at the various ends of the leaking section. The sanitary protection zone in relation to the gas pipeline is 350 m and 700 m in relation to the compressor stations (Lesikhina et al., 2007).

The advantage of this route lies in the following facts:

- minimum distance from the field to be connected with UGSS;
- the shortest gas pipeline route which enters the regions with developed industrial and economic infrastructure;
- close to the urban areas and industrial centers of the Murmansk and Leningrad⁸² Regions, Republic of Karelia⁸³ so that gasification of these regions will require lower investments (Mesherin et al., 2001);

⁸² Leningrad Region (*Russian: Ленинградская область, Leningradskaya oblast*) is a federal subject of Russia (a region). The district was named after the city Leningrad. Leningrad Region is bordered by Finland in the

LNG production and transportation

The first phase of the Shtokman field development considers production of natural liquefied gas. The project proposes construction of the onshore transport and production complex which include LNG plant, gas storage facilities, special purpose sea port, and gas treatment facilities for surface transportation.

Liquefied natural gas or LNG is natural gas that has been converted temporarily to liquid form for ease of storage or transport. It is odorless, colorless, non-toxic and non-corrosive. LNG typically contains more than 90% methane. It also contains small amounts of ethane, propane, butane and some heavier alkanes (Piotrovskiy, 2008).

The main advantage is that liquefied natural gas takes up about 1/600th the volume of natural gas in the gaseous state. The liquefaction process involves removal of certain components, such as dust, acid gases, helium, water, and heavy hydrocarbons. The natural gas is then condensed into a liquid at close to atmospheric pressure by cooling it to approximately $-162\text{ }^{\circ}\text{C}$.

LNG offers an energy density comparable to petrol and diesel fuels and produces less pollution, but its relatively high cost of production and the need to store it in expensive cryogenic tanks have prevented its widespread use in commercial applications. It can be transported by specially designed cryogenic sea vessels (LNG carriers) or cryogenic road tankers. The reduction in volume makes it much more cost-efficient to transport over long distances where pipelines do not exist.

The most important infrastructure needed for LNG production and transportation is an LNG plant consisting of one or more LNG trains, each of which is an independent unit for gas liquefaction. Then LNG is loaded onto ships and delivered to a regasification terminal, where the LNG is reheated and turned into gas. Regasification terminals are usually connected to a storage and pipeline distribution network to distribute natural gas to local distribution companies (Wikipedia).

To liquefy natural gas, construction of the onshore LNG plant with a total capacity of about 30 mln tons per annum is planned. There will be from one to four production lines with capacity of 7.5 mln tons each. The increase of production capacity will correspond to the volumes of gas extraction starting from 7.5 mln tons per annum in 2014 and up to 30 mln tons in 2020 (Banko, 2007, №15). The factory's facilities will include production, loading, administrative and subsidiary support complexes. The LNG production plant is going to be located in the Orlovka Bay of the Teriberka settlement area, Murmansk Region (Piotrovskiy, 2008).

The production of LNG will consist of the following main technological blocks:

- acid gas removal unit;
- dehydration unit;
- mercury removal unit;

northwest, Estonia in the west, as well as five federal subjects of Russia: Republic of Karelia in the northeast, Vologda Region in the east, Novgorod Region in the south, Pskov Region in the southwest, and the federal city Saint-Petersburg on the west. The most populous town of the district is Gatchina (Wikipedia).

⁸³ The Republic of Karelia (*Russian: Республика Карелия, Respublika Kareliya*) is a federal subject of Russia (a republic). The Republic is located in the north-western part of the Russian Federation, taking intervening position between the basins of White and Baltic seas. It is bordered internally by Murmansk Region, Arkhangelsk Region, Vologda Region, Leningrad Region, and internationally by Finland. Lake Ladoga and Lake Onega are the largest lakes in Europe (Wikipedia).

- liquefaction unit;
- nitrogen recovery unit (Piotrovskiy, 2008).

The storage of liquefied natural gas is planned to be in the cryogenic storage tanks with reservoir capacity of 160 000 m³ each which are working under the pressure of 3045 Mbar and temperature -162 C⁰.

For liquefied gas offloading and delivering to the target markets, several possible destinations of LNG supply on the terminals of USA and Europe were estimated. Taking into consideration the distance to receiving terminals, volumes of shipment, speed of gas-carrier vessels and other parameters, the optimization of the tanker fleet was made. The results show that 20 vessels of the volume up to 220 000 m³ are necessary for LNG export from the Shtokman gas and condensate field (Piotrovskiy, 2008). There are two types of LNG tankers that can be used: gas carriers based on the moss-technology with ball-shaped tanks and carriers with containers of membranous design (Braginskiy, 2007).

LNG plant location: Teriberka versus Vidyaevo

Already when Gazprom was granted with a license to develop the Shtokman gas and condensate field, several places where the underwater gas pipeline has to reach the shore were taken into consideration. Among them were Vidyaevo and Teriberka. The LNG plant construction was decided to be located in Teriberka by the following reasons:

- the length of the subsea pipeline is 593 km comparing with 638, especially if to take into account the cost of each km of the concrete pipeline;
- lower navigation density;
- favorable gas pipeline landfall;
- availability of sites for industrial purposes and in case of gas expansion;
- existence of the automobile road (Banko, 2005, №16).

The choice of LNG plant location in Teriberka has two main disadvantages: shallow depth near to the shore and openness for wind and waves. As a result, the offshore moorings and two wave breaking jetties (protecting structures) 2 km each has to be built. Also Teriberka same as Vidyaevo is a seismically active region.

According to Vidyaevo, there the navigation conditions are better, but it has more rugged relief and sharper coastline. The main reason for not choosing this settlement as a base for onshore transport and production complex is that it is a closed administrative-territorial entity. Vidyaevo is a basing site of the North fleet's nuclear submarines where it is forbidden to create any business activity with participation of foreign capital (Banko, 2007, №.15).

4.4.4 Social and economic impact of the Shtokman project development

The development of the Shtokman gas and condensate field will provide favorable conditions for the industrial and social infrastructure formation which has a great impact on the region's economic strategy and efficiency. The project will definitely have both macroeconomic and geopolitical meanings, as well as significant potential in terms of economic development of the North-West Region and the country as a whole. In Russia the following infrastructure facilities will appear:

- on the continental shelf it is production complex consisting of subsea systems and floating platforms, subsea pipelines;
- on the territory of the Murmansk Region – LNG production complex with storage facilities, trunk gas lines (Piotrovskiy, 2008).

The social positive effect will be also reached in the area of Teriberka settlement. There is planned to build 29 four-floor houses, 2 child care centers, 3 secondary schools, sport and recreation center with a swimming pool and a sport gym, supermarket, canteen, service center and hospital together with a medical center. Also for people engaged in fishing industry mini fish plant and berth for small size vessels is promised to be built. The main thing is that the project will provide the habitants of Teriberka with 200 jobs, and the whole region with 700 jobs (Banko, 2007, №15).

The execution of the project will begin gasification of the Murmansk Region that is one of the main aspects of its development. The investment of resources into industrial facilities will vitalize the activities of the adjacent sectors including construction of new plants and modernization of old facilities, increase of business activity in the region, preservation and creation of jobs (Piotrovskiy, 2008).

The engineering concept of the Shtokman gas and condensate field is a complicated one. It is explained by tough environmental conditions which require additional measures for protection of platform and safety systems from icing and low temperatures, respectively. Also the development of the offshore facilities in the Arctic requires long distance logistics and appropriate infrastructure in order to deliver the produced natural gas and LNG to the end customers according to the project' marketing strategy. The next section has an aim to investigate the transport system of Russia for availability of infrastructure facilities for the Shtokman project realization.

4.5 Transport system of the Shtokman field development project

The system of hydrocarbons and products of their processing transportation includes subsystems of pipelines, railways and marine transport, and necessary port terminals. Railway and marine transport belong to public use types of transport as distinct from pipelines, which are a specialized type of transport that underpins the entire system of transportation of hydrocarbons (Bambulyak and Frantzen, 2007).

The Energy Strategy of the Russian Federation for the period of up to 2020 envisages development of the transport infrastructure for the oil and gas sector: first, for timely formation of transportation systems in the new oil and gas extracting regions; second, for diversification of supplies to internal and external markets by direction, mode and route; and third, in order to increase returns on the export of gas, oil and petroleum products (Bambulyak and Frantzen, 2007).

The proposed by the Energy Strategy shore-marine oil and gas producing complexes in large part may use existing and projected system of oil and gas pipelines which are designed to meet national and export demands of Russia. These are, in particular, the gas supply system of the North-West Federal District and sea transport with transshipment in Murmansk, which are important for development of the onshore and offshore fields of the Barents and Pechora Seas (Gagelgants et al., 2005).

4.5.1 Transport system in the North-West of Russia

Russia has its most advanced transportation infrastructure in the European part of the country. In May 2005, the Ministry of Transport⁸⁴ of Russia adopted the “Transport Strategy of the Russian Federation for the Period of up to 2020” (Bambulyak and Frantzen, 2007). Russia’s Transport Strategy decides and regulates the transport infrastructure of the country’s oil and gas complex, the need to establish new export routes, the availability of sufficient reserves for transit capacity and the possible expansion of pipeline transport (Lesikhina et al., 2007). It is going to be realized with carrying out a number of big infrastructure projects, among them (Bambulyak and Frantzen, 2007):

- Modernization of existing roads and building new ones in the North and newly developed regions.

⁸⁴ Ministry of Transport of the Russian Federation is a federal executive body in the sphere of transport, which is performing development of the state policy and normative legal regulation of civil aviation, use of air space of the Russian Federation, aerospace rescue and recovery wing, of marine (including the sea ports), inland water, railway, automobile, electric street railway (including underground system) and industrial transport, and also road facilities (<http://www.mintrans.ru/>).

- Modernization of the Arctic transport system will secure strategic control of the Russian Arctic, increase the life-quality for people above the Polar Circle, stimulate natural resource exploration in the north, and create prerequisites for transits along the Northern Sea Route⁸⁵.
- Development of the Baltic Pipeline System⁸⁶ in combination with establishment of the vessel traffic management system in the Baltic.
- Development of the port complex Ust-Luga⁸⁷ in the Baltic Sea⁸⁸;
- Construction of the pipeline system to the Barents Sea coast and harbor complexes, with oil terminals for increasing the possibilities of oil transport from Russia to North American and European markets.

Realization of the Transport Strategy of the Russian Federation should, in particular, allow reaching the following results: capacity of the ports infrastructure will supply up to 90-95% of export-import operations; transit transportation through the Russian territory will be on the level of 90-100 mln tons a year; and especially it will help to create the transport system of the Shtokman gas and condensate development field (Appendix 6).

4.5.2 Sea transport in the North-West Region

Today, the backbone of sea transportation in Russia is comprised of 44 commercial seaports, 146 private wharfs, 10 large state and corporate sea shipping companies and about 300 private sea shipping operators. The seaports of the North-West Region take the leading position in the ports freight turnover. After the fall of the USSR⁸⁹, the sea transportation capability for international trade and internal transportation sharply deteriorated and the

⁸⁵ The Northern Sea Route (*Russian: Северный морской путь, Severniy morskoy put'*) is a shipping lane from the Atlantic Ocean to the Pacific Ocean along the Russian coasts of the Far East and Siberia. The vast majority of the route lies in Arctic waters and parts are only free of ice for two months per year (Wikipedia).

⁸⁶ The Baltic Pipeline System (BPS) is a Russian oil transport system operated by the oil pipeline company Transneft. The BPS transports oil from the Timan-Pechora region, West Siberia and Urals-Volga regions to Primorsk oil terminal at the eastern part of the Gulf of Finland. The project started in 1997 and construction was completed in December 2001. In April 2006 the Baltic Pipeline System reached full design capacity, transporting 1.3 mln barrels of oil a day (Wikipedia).

⁸⁷ Ust-Luga (*Russian: Усть-Луга*) is a settlement and railway station in the Kingisepsky District of the Leningrad Region, Russia, situated on the Luga River near its entry into the Luga Bay of the Gulf of Finland, about 110 kilometres west of St. Petersburg. Ust-Luga is the site of an important coal and fertiliser terminal. Construction works started in 1997, in part to avoid dry cargo shipments through the Baltic States, and were accelerated in 2001. In May 2008, Putin confirmed that Ust-Luga will be the final point of the projected Second Baltic Pipeline, an oil transportation route bypassing Belarus (Wikipedia).

⁸⁸ The Baltic Sea is an inland sea located in Northern Europe. It is bounded by the Scandinavian Peninsula, the mainland of Europe, and the Danish islands. The Baltic Sea is artificially linked to the White Sea by the White Sea Canal and to the North Sea by the Kiel Canal. The Baltic is bordered on its northern edge by the Gulf of Bothnia, its northeastern edge by the Gulf of Finland, and on its eastern edge by the Gulf of Riga (Wikipedia).

⁸⁹ The Union of Soviet Socialist Republics (USSR) was a constitutionally socialist state that existed in Eurasia from 1922 to 1991. The common short name is Soviet Union (Wikipedia).

development of the Northern Sea Route was given a greater priority. In particular, this concerned the development of the seaports in the Russian part of the Barents region (Bambulyak and Frantzen, 2007).

An analysis of the regional directives adopted by the Maritime Doctrine of the Russian Federation, Russia's national maritime policy, shows that in the north of the country large-scale installations which guarantee the transport of hydrocarbons by sea are either already established, or at various stages of planning and construction.

The Maritime Doctrine of the Russian Federation for the Period up to 2020 was ratified by Decree of the President of the Russian Federation NoPR-1387 on July 27, 2001 and expresses the main direction of national maritime politics, including in the country's regions. The national maritime policy on the Arctic region is defined by the following factors: the particular importance of ensuring free access of the Russian Fleet to the Atlantic Ocean, the wealth of the exclusive economic zone and continental shelf of the Russian Federation, the decisive role of the Northern Fleet for state defense on the seas and the oceans, and the growing significance of the Northern Sea Route for the sustainable development of the Russian Federation. The basis of national maritime policy consists of creating conditions for Russian Fleet activity in the Barents, White and other Arctic Seas, in the corridor of the Northern Sea Route, and in the northern portion of the Atlantic Ocean (Lesikhina et al., 2007).

The Maritime Doctrine names among the main projects the construction of large-scale pipeline systems: the North European Gas Pipeline (Nord Stream) and the pipeline system from the Shtokman gas condensate field, and the development of the Murmansk transport terminal for ensuring the export of oil to international markets (Lesikhina et al., 2007).

The marine transport to Western Europe and USA through the transshipment in Murmansk is the main direction of infrastructure construction and extension for the future offshore development of the Pechora and Barents Sea deposits (Gagelgants et al., 2005).

Tanker fleet in the Arctic regions

The projected modernization of the Arctic transportation system should ensure Russia's strategic control of the Russian Arctic regions, establish steady export along the Northern seas communications, as well as promote the development of natural resources in the northern territories. In order to implement these plans, Russia is building nuclear icebreaking and tanker fleets of a new generation (Bambulyak and Frantzen, 2007). According to the estimated data of the Ministry of Industry and Energy⁹⁰, in order to develop the continental shelf of Russia the country requires 40 ice-resistant drilling and production offshore platforms, 12 gas production platforms, 55 ice-class shuttle and storage tankers, up to 20 units of shuttle gas-carriers of ice-class (Andreev, 2007).

⁹⁰ Ministry of Industry and Energy was transferred in 2008 into two separate ministries: Ministry of Energy of the Russian Federation and Ministry of Industry and Trade of the Russian Federation by a President's Decree from 12 May 2008.

The development of oil and gas complex of Russia is not possible without increase in hydrocarbon movement by sea transport. In this case there is a great need in unification of the national shipyards and their activities and formation of companies with consolidated structure. One example of such policy is a merger of the 100% state owned JSC “Seaborn Energy Solutions” (*Sovcomflot*) and JSC “Novorossiysk Shipping Company” (*Novoship*, 67.1% shares of stock) in 2007. The consolidation of the companies’ assets is going to increase investment in research and development.

Sovcomflot Group is the countries largest marine shipper which specializes in the marine transport of energy resources. Of its total fleet, 47 vessels are tankers and gas carriers with a total deadweight of 4.2 mln tons. By 2008, Sovcomflot Group intends to become the world leader in the shuttle movements of hydrocarbons in icy conditions. For the period from 2007 to 2010, Sovcomflot plans to receive 19 new tankers and gas carriers with the total deadweight of 1.6 million tons. It is actively expanding its businesses in the Russian Arctic (Bambulyak and Frantzen, 2007).

In February 2008, JSC Sovcomflot and LLC Gazflot made an agreement on cooperation in transport support of the future shelf projects of Gazprom. The plans of Gazflot, a 100% subsidiary of Gazprom, concern the development of the onshore infrastructure to secure Gazprom’s activities in the Arctic region. The gas monopoly made a decision to transfer some of the functions to Gazflot concerning the Murmansk base facilities development. Now Gazflot possesses huge facilities in the Murmansk port from both sides of Kola Bay. The company is planning to increase its capacities and transfer the port into a powerful transport and logistic center. The supply of the drilling rigs and platforms operating on the Prirazlomnoye and Shtokman fields is supposed to be made on the base of the Murmansk port facilities (Banko and Evtishina, 2008).

Development of the Murmansk Port Traffic Centre

In the “Strategy of Transport Development in the Russian Federation for the Period of up to 2010”, a great emphasis is given to the increase of seaports’ capabilities. The Ministry of Transport of Russia and the Administration of the Murmansk Region propose to build up the Murmansk multi-modal port complex using both eastern and western coasts of the Kola Bay (Bambulyak and Frantzen, 2007).

Murmansk was competing with Saint-Petersburg for the status of an energy transit hub of Russia. The idea of the port construction on the Baltic Sea was declined mostly because of the low traffic handling capacity of the sea provided both by EU restrictions and shallow

water areas. Another disadvantage is that the Gulf of Finland⁹¹ is covered with ice most of the year, so there is a need of the icebreaker support, use of ice-class tankers that leads to additional costs, extension of delivery time and supply disturbance (Banko, 2007, №7).

In this case port of Murmansk has a lot of advantages. First, there is no more other deep-water port in the European part of Russia which allows receiving ultra-large crude carriers (supertankers). Second, the distance to the market of USA is the shortest through the Atlantic Ocean. Another important characteristic is that Murmansk port is ice-free. Additionally, the Murmansk Region has rather developed transport infrastructure, high energy potential, and ship repairing capacities. Here the problem of navigation safety, tug and accident support, and environment protection are easy to be solved. The main reason for the Murmansk port extension is that construction of the terminal in this area is necessary on the ground of started hydrocarbon development activities in the Arctic shelf (Banko, 2007, №7).

According to the Master Growth Plan for the Murmansk Port Traffic Centre elaborated by *LenmorNIiproekt*, the Kola Bay's east coast will boast the following transshipment complexes (Bambulyak and Frantzen, 2007):

- Special complexes for bulk freight with the capacity of 8.3 mln tons after renovation and expansion;
- Special coal complex that will occupy two areas by existing piers №13-14 and a new pier №22 (330 m);
- Complex for mixed freight with 2 mln tons capacity, located in I and II regions of the port;
- Special oil products terminal complex on the territory of the Shipyard №35 with the capacity of up to 10 mln tons a year;
- Special complex for oil products at the pier №20 with up to 8 mln tons shipping capacity.
- Oil products will be delivered to the terminals in the eastern coast by rail and shipped to tankers. The Kola Bay's west coast in the area of Lavna and Kulonga rivers will house new complexes consisting of:
 - Oil terminal complex with shipping capacity of 4.5 mln tons a year, consisting of 470 m long pier to moor tankers from 120 000 to 300 000 tons deadweight, oil storage for 400 000 m³, and rail trestles.
 - Complex for coal transshipment with 15 mln tons capacity;
 - Complex for transshipment of mixed freight and containers with capacity of up to 3 mln tons a year;
 - Supply Depot and Oil Terminal Complex at the mouth of the Lavna River with the capacity of up to 25 mln tons (crude oil), 0.86 mln (bunker fuel) and 0.13 mln (provision cargo) a year.

Taking into consideration that Murmansk is a Russia's gate to Arctic, an important part of the main arctic traffic artery (the Northern Sea Route), there is a heighten interest of USA and China to its transit potential (Banko, 2005, №15).

⁹¹ The Gulf of Finland (*Russian: Финский залив; Finskiy zaliv*) is the easternmost arm of the Baltic Sea that extends between Finland (to the north) and Estonia (to the south) all the way to Saint Petersburg in Russia, where the river Neva drains into it. As the seaway to Saint Petersburg, the Gulf of Finland has been and continues to be of considerable strategic importance to Russia, also (Wikipedia).

The realization of this project will enable creation, on basis of the Murmansk sea port, of a large port traffic centre with a strategic deepwater seaport. This will not only increase the export of primary energy but also integrate the Russian transport system into the global transport and logistics scheme (Ivankov et al., 2008).

LNG transport perspectives

The main projects for creation of LNG production facilities in Russia are connected with the possible deliveries of LNG to USA and East Asia, where the Russian natural gas could not be delivered by pipeline in the foreseeable future. Gazprom plans to produce LNG for the future deliveries to the North American market at the Shtokman field in the Barents Sea and Kharasaveiskoye field on the Kara Sea coast in Yamal (Bambulyak and Frantzen, 2007).

All the Russian LNG projects (especially Shtokman field development) along with strong sides such as rich raw material resource base and possibility for ultra-large scale capacities creation have many weak points. Here they are:

- high competition - a lot of mature producers of LNG consider the American market as a main target;
- some of the major countries-producers of LNG are located much closer to the terminals of USA, Canada and Mexico, and therefore compare favorably in terms of transport costs;
- rich resource base of the Russian LNG projects has a negative effect in terms of cost increase, higher investments and transport risks. In this case there is a need to diversify the consumer market because orientation only on the markets of Japan and USA may cause a problem of overproduction;
- the lack of own specific tanker fleet for LNG transportation may put at risk the Russian prospects of the LNG sales market. Also the price of vessels construction and the charter rate is growing (Braginskiy, 2007).

The first Russian LNG plant was built on the Sakhalin Island. It consists of two process trains, each having the throughput capacity of 4.8 mln tons of LNG per annum. The plant is projected to reach its design capacity of 9.6 mln tons in 2010. Around 65% of the Sakhalin LNG will be supplied to 9 purchasers from Japan. The remaining volumes are intended for consumers of South Korea and North America (Gazprom News, 2009).

Another liquefaction plant is a Baltic LNG which is planned to be built in the Leningrad Region in cooperation with *PetroCanada*. By Gazprom's estimates, the plant is going to have

a design capacity of 4.1-6.9 bcm per annum and its construction will cost \$1.3-1.5 bln. The plant is going to be supplied from the Nadym-Pur-Taz gas province. The end product will be shipped to the projected terminal on the eastern coast of Canada, Quebec (Braginskiy, 2007).

In 2008 the Management Committee of Gazprom declared that the realization of the Baltic LNG project is counter-productive. The feasibility study of the project showed that development of the Shtokman field and construction of LNG plant according to its concept is more competitive. So Gazprom decided to concentrate all the company's resources on the implementation of the prioritized project (Gazprom News, 2008).

According to the plans of the Shtokman field development, gas will be delivered to the LNG plant in Teriberka on the Barents Sea coast (Bambulyak and Frantzen, 2007). From LNG plant, it will be shipped by gas carriers to USA and European States (Appendix 7) (Lesikhina et al., 2007). In case of transport mode, it makes sense to use the same tankers which were commissioned for the Norwegian project Snøhvit because of the similar climatic conditions of these deposits-twins (Braginskiy, 2007).

In December 2005, Sovcomflot Group signed an agreement with Gazprom to collaborate in the projects for shipping oil and gas, particularly in the LNG sector. Sovcomflot operates a fleet of 47 tankers, including four gas carriers: two of them are for LNG - SCF Polar and SCF Arctic - bought in 2006. Four more LNG tankers are under construction for Sovcomflot. Grand Elena and Grand Aniva for 145 000 m³ each has to be delivered by Mitsubishi Heavy Industries in 2007; another two for 145 700 m³ each are built at *Daewoo* Shipbuilding and Marine Engineering Company and will be delivered in 2008 (Bambulyak and Frantzen, 2007).

Additionally, the company won a tender for LNG transportation in the Sakhalin II project in 2004 and in the Tangy project (Indonesia) in 2005. According to this, Sovcomflot considers its participation in LNG projects as an opportunity to gain experience and to be prepared to work with national gas exporters (Vladimirov, 2005)

As it can be seen, the national companies are preparing for a new era of oil and gas resources development on the Arctic seas. The production of huge resources requires well-developed infrastructure and facilities for its extraction and transportation.

4.5.3 Gas pipeline system in Russia

A key priority of the Russian Energy Strategy for the period of up to 2020 is the preservation of the Unified Gas Transportation System (Appendix 8), and its development through the construction or integration of new facilities of any forms of ownership, including the basis of partnership (Bambulyak and Frantzen, 2007).

The United Gas Transportation System of Russia (UGS) is a powerful and in many ways unique production complex. The UGS infrastructure comprises of 155 000 km of trunk gas pipelines and branches; 6100 km of gas condensate pipelines; 264 compressors with a capacity of 44.8 mln kW of aggregate power; 24 underground gas storage facilities. The gas transportation system accounts for about 85% of the basic production assets of Gazprom and more than half of its length are large diameter gas pipelines of 1220 and 1420 mm. Russia's Unified Gas Supply System is the property of Gazprom (Gazprom, Transmission, 2008).

In 2005, 31 independent producers got access to the gas transport system. The tariff for producers when transporting gas through the main gas pipelines owned by Gazprom is determined by the following federal executive authorities of the Russian Federation: the Federal Tariff Service and the Department for State Regulation of Tariffs and Infrastructure Reform within the Ministry of Economic Development⁹². In addition, the Russian Government is planning to adopt a General Plan for Developing Pipeline Transport for the period of up to 2020. According to this plan, the main strategic objective will be an increase in the capacity of the pipeline system (Lesikhina et al., 2007).

The investment program of Gazprom envisages a wide range of measures to get rid of the bottlenecks in the UGS. One of the most significant investment projects in this sector is a Nord Stream – building the North European Gas Pipeline (NEGP, or also North Stream) (Bambulyak and Frantzen, 2007). Because the pipeline will be laid on the bottom of the Baltic Sea there are no transit countries on its route, which enables to reduce Russian gas transmission costs and exclude any possible political risks. The Shtokman gas and condensate field will be a resource base for gas deliveries via Nord Stream.

Nord Stream will link Russia's Baltic coast near Vyborg with Germany's Baltic coast in the vicinity of Greifswald⁹³. The pipeline length will average 1.200 km. Planned for commissioning in 2011, Nord Stream's first line will have a throughput capacity of 27.5 bcm per year. The second line construction by 2012 is projected to double Nord Stream's throughput capacity to 55 bcm.

The Nord Stream project is implemented by Nord Stream AG, a joint venture set up for the planning, construction and follow-up operation of the offshore pipeline. After N.V. *Nederlandse Gasunie* entered the project in 2008, Nord Stream AG shareholdings are split like this: Gazprom – 51%, *Wintershall* Holding and *E.ON AG* – 20% each, N.V. *Nederlandse Gasunie* – 9%.

Current status: Nord Stream AG is pursuing a constructive approach toward implementing the gas pipeline construction project and as part of the permitting process is maintaining an active dialogue with all of the Baltic Sea countries for the purpose of conducting a detailed environmental impact assessment (Gazprom, Nord Stream, 2008)

The plan to transport natural gas from the Shtokman gas condensate field to consumers by pipeline also includes establishment of an overland gas pipeline between Murmansk in

⁹² The Ministry of Economy merged with the Ministry of Trade to form the Ministry of Economic Development and Trade under the order of President Vladimir Putin in May 2000. The Ministry of Economic Development and Trade of the Russian Federation is a main government body responsible for carrying out the state's investment policy in relation to foreign investment, domestic and international trade, organizing international tenders, preparing concession agreements and production-sharing agreements, infrastructure development, and negotiating credits agreements (http://www.globalsecurity.org/military/world/russia/min_ec.htm).

⁹³ Greifswald is a town in northeastern Germany. Situated about 200 km to the north of Berlin in the state of Mecklenburg-Vorpommern, it borders the Baltic Sea and is crossed by a small river called the Ryck (Wikipedis).

Murmansk Region, and Volkhov in Leningrad Region. The gas pipeline will supply gas to the Unified Gas Transportation System which will deliver gas to national consumers. That's why the endpoint of the onshore pipeline is Volkhov through which the pipe string of the gas main Yamal-Europe is passing (Lesikhina et al., 2007).

Additionally, the construction of a new gas pipeline Gryazovets⁹⁴ - Vyborg⁹⁵, which links the North European Gas Pipeline and UGS and meets the gas needs of St. Petersburg and the Leningrad Region has been started (Bambulyak and Frantzen, 2007). The gas pipeline length is 917 km. Between 2006 and 2007, over 300 km of the linear part of the gas pipeline were put into operation. Another 163 km of the linear part are planned to be commissioned in 2008 (Gazprom, Gryazovets-Vyborg gas pipeline, 2008).

The development of the Shtokman project as any major oil and gas project requires a developed and reliable infrastructure which allows commissioning of the project on schedule and performing the functions according to its strategy. The construction of the new strings of pipeline system is important in order to connect the field with the end customers on the territory of the country and other adjacent countries. The own fleet of gas carriers has a function to deliver the produced LNG to the end customers on the other continents of the world. The next chapter is making an emphasis on the marketing strategy of the Shtokman field development project and the main directions of gas distribution.

⁹⁴ Gryazovets (*Russian: Грязовец*) is a town in Vologda Oblast, Russia, located 47 km south of Vologda (Wikipedia).

⁹⁵ Vyborg (*Russian: Вы́борг*) is a town in Leningrad Region, Russia, situated on the Karelian Isthmus near the head of the Bay of Vyborg, 130 km to the northwest of St. Petersburg, 38 km south from Russia's border with Finland, where the Saimaa Canal enters the Gulf of Finland (Wikipedia).

4.6 Marketing strategy of the Shtokman development project

Russia is a world's second largest exporter of oil and the leading exporter of energy in all its forms, including natural gas and oil products, coal and also some electricity. Energy industries occupy 25% of its gross domestic product, providing for one-third of industrial output and consolidated budget revenues, as well as about half of export earnings and the proceeds of the federal budget (Ivanov, 2003).

According to the Energy Strategy of Russia for the period of up to 2020, the state energy policy must be directed on the change from the role of a supplier of raw resources to the role of a substantive member of the world energy market. During the forthcoming 20 years, it is important to realize the export abilities of Russian fuel energy complex and secure the economic safety of the country, remaining the stable and reliable partner for the European countries and for the whole world community (Minenergo, 2003).

Russia, being one of the largest producers, exporters and consumers of energy resources in the world, will have a dialogue both with the countries-producers and countries-consumers, cooperating with the industrially-developed countries on the basis of cooperation with IEA⁹⁶ and in the framework of G8⁹⁷ and with the leading countries-exporters of oil, independent and the members of OPEC, in order to provide the fair prices for energy resources.

Effective external trade policy must be based on the estimation of the prospective energy markets. The market of Central and Western Europe remains one of the greatest markets in the forthcoming 20 years. The USA can become a prospective sale market of Russian LNG. Russia's main partners in the economic cooperation with the Asia-Pacific Region⁹⁸ (APR) and Southern Asia will be China, Korea, Japan, and India (Minenergo, 2003).

The Shtokman gas and condensate field development project is of strategic significance for Gazprom. It is necessary to mention that 85% of production and 100% of gas export is due to Gazprom (Korzhubaev et al., 2007). The field will become a resource base for Russian pipeline gas as well as liquefied natural gas (LNG) exports to the Atlantic Basin markets (Gazprom, Shtokman project, 2008).

⁹⁶ The International Energy Agency (IEA) is a Paris-based intergovernmental organization established under the umbrella of the OECD in 1974 in the wake of the oil crisis. The IEA was initially dedicated to responding to physical disruptions in the supply of oil, as well as serving as an information source on statistics about the international oil market and other energy sectors. The IEA acts as a policy advisor to its 28 member countries, but also works with many countries outside of its membership, especially China, India and Russia (Wikipedia).

⁹⁷ The Group of Eight (G8) is a forum, created by France in 1975, for governments of eight nations of the northern hemisphere: Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States; in addition, the European Union is represented within the G8, but cannot host or chair (Wikipedia).

⁹⁸ Asia-Pacific is that part of the world in or near the Western Pacific Ocean. The area includes East Asia, Southeast Asia, Australasia and Oceania (Wikipedia).

4.6.1 Foreign markets

As of today there are three key regional gas markets in the world — North-American, European and post-Soviet sector⁹⁹. Gas demand is growing annually especially in the Asian-Pacific Region. Close geographical location and huge potentials of the Asian-Pacific market make Russia to consider it as a significant direction for export supplies. But at present the European countries are the main consumers of Russian energy resources and will keep this position for a long time (Yazev, 2008).

European gas market

The strategic gas partnership of Russia and Europe is proved by the years of fruitful cooperation. The level of the parties' economic interdependency is rather high (Yazev, 2008). The major Western European consumers of Russian gas include Germany, which depends on Russia for more than 32% of its supply, and Italy and France, which depend on Russia for about 25% of their gas. The dependence of Eastern European countries on Russian gas averages some 73% of annual gas supply, with Lithuania, Latvia, Estonia and Slovakia being completely dependent on gas from Russia (Wood, 2007, №7).

During the next three decades, the EU's energy production is expected to decline by about 17%, while net energy imports are expected to grow by 15%. The dependence of European countries on imported energy is high and growing, projected to rise up to 70% by 2030. The level of external dependence for natural gas will reach 80%. The IEA forecasts that Russia would deliver about 200 bcm of gas to Europe as soon as 2010, rising to 244 bcm by 2030 (Ivanov, 2003).

By the strategic decision to diversify export shipments, the structure of the Russian export will be changed in the way so that the routes of gas supply will be diversified via Nord Stream and Blue Stream¹⁰⁰ extension to countries of Central Europe and southern regions of Italy (Bambulyak and Frantzen, 2007).

⁹⁹ The post-Soviet states, also commonly known as the former Soviet Union (FSU) or former Soviet republics, are the 15 independent nations that split off from the Union of Soviet Socialist Republics in its breakup in December 1991. The 15 post-Soviet states are typically divided into the following five groupings: Baltic states (Estonia, Latvia and Lithuania), Eastern Europe (Belarus, Moldova, Ukraine), Transcaucas (Armenia, Azerbaijan, Georgia), Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.), Eurasia (Russian Federation) (Wikipedia).

¹⁰⁰ The Blue Stream gas pipeline is designed to transit Russian natural gas to Turkey across the Black Sea bypassing third countries. The pipeline will supplement the existing gas transmission corridor from Russia to Turkey crossing the territory of Ukraine, Moldova, Romania and Bulgaria. The total length of the Blue Stream gas pipeline accounts for 1.213 km. In 2006 and 2007, the Blue Stream supplied 7.5 bcm and 9.5 bcm of gas respectively. The design capacity of the Blue Stream gas pipeline totals 16 bcm per annum. The Italian ENI acts as the owner of the offshore pipeline section and the Beregovaya compressor station. Gazprom is the owner and operator of the onshore pipeline section (Gazprom, Blue Stream, 2008).

In October 2006 the Gazprom Management Committee decided to give priority to the pipeline gas deliveries from Shtokman gas condensate field to the European market. It was determined that Shtokman field would become the resource base for the Russian gas exports to Europe via the North Stream gas pipeline (Gazprom News, 2007).

Due to a direct connection between the world's largest gas reserves located in Russia and the European gas transmission system, Nord Stream will be able to satisfy approximately 25% of the foregoing extra demand for imported gas (Gazprom, Nord Stream, 2008). From Germany the gas can be transported to Denmark, the Netherlands, Belgium, the UK, and France, with a possible new pipeline spur to Sweden (Clark and Rach, 2006).

The construction of the Nord Stream gas main will contribute to strengthening further economic cooperation not only between Russia and Germany but also the whole European Union. This gas main is assigned a «TEN» status (TransEuropean Net). This means that the North European Gas Pipeline is a key project on the establishment of the most important trans-boundary transport facilities and is of great importance for meeting the growing natural gas demand of the European market (Yazev, 2008).

Nord Stream will be an alternative gas supply channel that allows diversification of the transport routes. It is a shorter and cheaper way of gas transmission that provides lower price on gas when entering the distribution system. It is important to mention that the output of the working pipelines will remain for existing contracts performance (Galichanin, 2007). Because Nord Stream does not cross any transit states it allows eliminating any eventual political risks.

In regard to the market of Great Britain, Gazprom is planning to increase its share up to 10%. The supply by North Stream will not exceed 15-20 bcm because the rest of export gas from the Shtokman field will go to Europe. If to take into consideration the participation of Norwegian Hydro (now StatoilHydro) in the Shtokman project which plans to deliver gas from the Ormen Lange field to Great Britain¹⁰¹, the perspectives of the monopoly on the British market are high. In April 2006, Gazprom Marketing & Trading Limited¹⁰² effectuated the first LNG shipment to the UK-based Isle of Grain¹⁰³ terminal (Sapun, 2005, №12).

¹⁰¹ The Ormen Lange field requires subsea gas export pipelines on the Norwegian continental shelf consisting of a two-part pipeline of about 1 200 km to an onshore processing plant in Aukra, then to the Sleipner installation in the North Sea, and on to the natural gas terminal at Easington - Dimlington, UK. The total system has been dubbed "Britpipe" (True, 2004).

¹⁰² Entering the Gazprom Group of companies, Gazprom Marketing & Trading Ltd. was established in the UK in 1999. Gazprom Marketing & Trading Ltd., which is part of the Gazprom Group of companies, has registered in June 2006 its Houston-based Gazprom Marketing & Trading USA, Inc. and Paris-based Gazprom Marketing & Trading France SAS subsidiaries (Gazprom News, 2006).

¹⁰³ The Grain LNG Terminal is situated in Kent in the Isle of Grain on the river Medway only 30km east of London. The LNG terminal has the capacity to receive and process up to 3.3 mln tons of LNG (4.4 bcm of gas) a

According to the export shipments to the countries of CIS¹⁰⁴, the structure of Russian gas export will be gradually replaced by supplies of the imported Central Asian gas. As a result the export of Russian gas to this region will drop by 37 bcm and its share in total exports by 20% to 6% (Bambulyak and Frantzen, 2007).

Cooperation with the EU implies not only the new opportunities but also some pitfalls. They are connected with the current serious system reforms of the European gas market (Yazev, 2008). The European Union makes no secret of the fact that its increasingly high and growing import dependence on Russia has to be kept within certain limits (Ivanov, 2003). Europe, itself short of gas, is keen to bring in new supplies and diversify from Russian dependence (Wood, 2007, №6) on the basis of energy dialogue with countries of the Caspian region, Africa and others (Slavinskaya, 2005). Some of the European interest in LNG is partly motivated by this desire. Emergence of North American interest in LNG appeared to offer Russia a diversification option of its own (Jensen, 2008).

North American market

There is no global market for natural gas so far due to high transportation outlays, depending on the distance. Besides, producers and consumers are tightly linked to each other by the policy of agreements and pipelines. As of now, Gazprom depends to a large extent on the existence of pipelines and on the attitudes of transit countries. LNG is an alternative to pipeline gas transportation and is winning a growing share of the market (Bambulyak and Frantzen, 2007). The main advantage of LNG is an opportunity to diversify the routes and volumes of supply that allows adjustment to dynamic environment of the global market. Currently, the sales volume of LNG approaches 27.4% of the global natural gas trade. It is expected that in 2010 the share of LNG in the world's gas export will reach 30% (Piotrovskiy, 2008).

The major part of Shtokman's LNG supposed to be sold on the markets of USA and Canada (Bambulyak and Frantzen, 2007). In comparison with the markets of ATR and Europe the market of USA has some advantages (Sapun, 2005, №16):

year, equivalent to 0.13 bcm of gas a day. The Grain LNG site is one of four strategically located LNG terminals being developed in the UK (<http://www.hydrocarbons-technology.com/projects/grainlngkent/>).

¹⁰⁴ CIS – Commonwealth of Independent States is a regional organization whose participating countries are former Soviet Republics. The organization was founded on 8 December 1991 by Belarus, Russia, and Ukraine. The concept of membership: a member country is defined as a country that ratifies the CIS Charter. CIS included 12 of the 15 former Soviet Republics. The three Baltic states – Estonia, Latvia, and Lithuania – decided not to join, preferring to pursue membership of the European Union. Initially, 11 countries were the members of the organization: Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan, then Georgia has joined the organization. Ukraine and Turkmenistan did not ratify the CIS Charter and they are thus legally not the member countries to this day (Wikipedia).

- high capacity and sound liquidity of the market;
- favorable geographical location in relation to Russian raw material base;
- favorable forecast of LNG prices in a long-term perspective;
- gas consumption increases with the growth of population and development of economy (approximately 2% per year), also own gas production is declining;
- USA is located far from the sources of gas comparing to developing markets of China and India that makes America a market with an added value.

Concerning the places of delivery, Gazprom considers that it will be the Gulf of Mexico (terminals in Texas and Louisiana) and the north-eastern coast of USA (first of all, terminal Cove Point in Maryland). Produced LNG is planned to be shipped for export on two types of tankers: one with capacity of 155-160 thousands m³ will serve the USA's north-western coast (New-York, Washington) and Canada; and another – 210-220 thousands m³ which will deliver gas to the Gulf of Mexico (Sapun, 2005, №16).

The region of Texas Gulf Coast begins to complete and start up the first wave of new US import capacities (Appendix 9). Terminal commissioning has been ongoing in 2008 at two terminals Freeport LNG Development LP's Quintana terminal (about 70 miles south to Houston) and Cheniere Energy's Sabine Pass terminal (in Cameron Parish, Louisiana, along the Sabine River border near Port Arthur, Texas) (True, 2008, №16).

Two more US terminals, also in Louisiana and Texas, are in final stages of construction and expect to start up in the first quarter 2009. ExxonMobil Corporation's Golden Pass¹⁰⁵ terminal lies across Sabine River from Cheniere's terminal. And east of Sabine Pass, near Hackberry, 18 miles from the Gulf of Mexico, Sempra Energy subsidiary Sempra LNG is in the final months of building its Cameron¹⁰⁶ LNG terminal (True, 2008, №15).

Cove Point is one of the US nation's largest liquefied natural gas import facilities. The advantage of Cove Point terminal is its shorter distance from Murmansk than the coast of the Gulf of Mexico where the primary construction of receiving terminals is located, and especially in relation to the LNG terminals in the USA's neighbor countries (Sapun, 2006).

¹⁰⁵ Golden Pass LNG Terminal LLC and Golden Pass Pipeline LLC are developing a Liquefied Natural Gas (LNG) receiving terminal located near Sabine Pass, Texas and an associated pipeline connecting to the existing U.S. pipeline infrastructure. Golden Pass LNG Terminal is expected to be 70% owned by an affiliate of Qatar Petroleum, 17.6% owned by an affiliate ExxonMobil, and 12.4% owned by an affiliate of Conoco Phillips. Construction on the Golden Pass Terminal is progressing and terminal start-up is expected to occur in mid-2010. The Golden Pass Pipeline was completed in April 2009 (<http://www.goldenpasslng.com/>)

¹⁰⁶ The Cameron LNG receipt terminal and associated facilities will be built in Cameron, Louisiana, which is located approximately 148 miles east of Houston, Texas, and 230 miles west of New Orleans, Louisiana. The \$850 mln project will have the capacity to regasify up to 1.5 bcf of natural gas per day, and the site can accommodate expansion up to 2.65 bcf per day. The terminal is scheduled to begin commercial operations mid 2009. It is 100% owned by Sempra Energy (<http://www.sempralng.com/Pages/Terminals/Cameron/default.htm>).

As it was mentioned before, the bulk of LNG from the Shtokman field is planned to be sold on the markets of USA and Europe. But in October 2006 Gazprom announced that all gas produced at the Shtokman deposit would be supplied via the North European Gas Pipeline. Later Gazprom stated that realization of the Shtokman LNG project would be delayed to after 2013, when the field itself should be set in production (Bambulyak and Frantzen, 2007).

Yet North America is a potentially valuable market for Russian gas. Despite the decisions apparently made on the export route for Shtokman gas, it remains clear that Russia and Gazprom remain keen to export LNG to the US. They continue to take positions to enter that market. Gazprom has set up a trading company US in Houston (Wood, 2007, №7). Gazprom Marketing and Trading USA, Inc. will be engaged on behalf of JSC Gazprom in LNG and natural gas marketing operations in the USA as well as contribute to expanding the Group's presence in the USA on a long-term basis (Gazprom News, 2006).

Dittrick (2006) confirms that Gazprom is building its LNG experience, particularly in North American markets. The first commercial debut of Gazprom took place when the company delivered its first LNG to the US in September 2005. It bought Egyptian LNG in August from *BG Group*, a British gas producer, and sold it to Shell which delivered LNG on the regasification terminal Cove Point. Gazprom has been in talks with companies operating in North Africa and Europe, to provide gas supplied to Europe by pipelines in exchange for LNG in the US (APS Review, 2005).

The uncertainties concerning the plans to deliver the gas from the Shtokman field to the market of North America are affected by political situation in the world. The fact that remains constant is that Europe will always be prioritized as the main export direction for the Russian gas, no matter LNG or natural gas via pipelines. And, of course, the domestic needs of the country will be supplied first of all.

4.6.2 Domestic market

Among other types of fuel gas is “number one” according to the volumes produced. Thus it takes a leading position in the sphere of consumption. Gas share in fuel balance of the Russian Federation exceeds the cumulative share of other fuel types. The extension of gas consumption and increase of the volumes consumed referred mostly to power energy and export-related branches. The situation in social sector has also changed considerably. It should be mentioned that gas consumption in the community services increased in 2.2 times and for residential needs – in 2.6 tomes. The growth of consumption by both above mentioned groups of consumers made up 48.3 bcm (Golubev, 2008).

According to the Energy Strategy of Russia for the period of up to 2020, which considers natural gas as the basis for internal demand, its part in the expenses for energy resources will lower from 50% nowadays to 45-46% in 2020. The territorial structure of energy consumption during the described period will not change. The main consumers of energy resources will remain Volga¹⁰⁷ Region and Central¹⁰⁸ Federal District (about 22% and 20% respectively) and also the Siberia¹⁰⁹ and Ural¹¹⁰ regions (18% and 17%). The energy consumption in the North-Western¹¹¹ and Southern¹¹² Federal Districts will be 9-10% for each, the Far East¹¹³ Federal District – 5% (Minenergo, 2003).

The priority trends of natural gas use are the domestic and communal needs (heating, hot water supply, preparing of food) with the corresponding development of gas supply; state needs (defense, reserves and so on), providing of non-fuel needs (production of mineral fertilizations, material for the gas chemistry and so on) (Minenergo, 2003).

A small portion of gas from the Shtokman field going by the Murmansk-Volkhov pipeline will in the nearest future deliver gas to consumers of the Murmansk Region, the Republic of Karelia and the Leningrad Region. The proposed gasification of the regions

¹⁰⁷ Volga Region (*Russian: Поволжье, or Povolzhye*) is a historical region of Russia that encompasses the territories adjacent to the flow of Volga River. According to the flow of the river, it is usually classified into the Middle Volga Region and Lower Volga Region. In modern Russian Federation, the Volga Region is associated with the Volga Federal District and Volga economic region (rather different entities) (Wikipedia).

¹⁰⁸ Central Federal District (*Russian: Центральный федеральный округ, or Tsentralny federalny okrug*) is one of the seven federal districts of Russia. The word “Central” is of political and historical meaning; actually the district is situated in the extreme West of Russia. It comprises 17 federal districts around Moscow, capital of Russia and the largest metropolitan city in Europe (Wikipedia).

¹⁰⁹ Siberia (*Russian: Сибирь, or Sibir*), is the name given to the vast region constituting almost all of Northern Asia and for the most part currently serving as the massive central and eastern portion of the Russian Federation. Geographically, it includes a large part of the Eurasian Steppe and extends eastward from the Ural Mountains to the watershed between Pacific and Arctic drainage basins, and southward from the Arctic Ocean to the hills of north-central Kazakhstan and the national borders of both Mongolia and China. It makes up about 77% of Russia’s territory (13.1 mln km²), but only 25% of Russia’s population (36 mln people) (Wikipedia).

¹¹⁰ Ural (*Russian: Урал*) is a geographical region around the Ural Mountains, mostly within Russia but also including a part of northwestern Kazakstan. This is a historical, not an official entity, with the boundaries overlapping its western Volga and eastern Siberia neighbor Regions. At present time, there are two official namesake entities, the Urals Federal District and the Urals economic region. Yekaterinburg is administrative center only of the Urals Federal District (Wikipedia).

¹¹¹ North-Western Federal District (*Russian: Северо-Западный федеральный округ, or Severo-zapadny federalny okrug*) is one of the seven federal districts of Russia. It consists of the northern part of European Russia. It has several subdivisions: Arkhangelsk, Kaliningrad (with no land connection to the rest of Russia), Murmansk, Novgorod, Pskov, Vologda and Leningrad Regions, Republic of Karelia and Komi Republic; and federal city of Saint-Petersburg (Wikipedia).

¹¹² Southern Federal District (*Russian: Южный федеральный округ, or Yuzhny federalny okrug*) is one of the 7 federal districts of Russia. It is located in the extreme southwest, between Ukraine and Kazakhstan. The largest cities of the district are Rostov-on-Don and Volgograd with just above 01 mln inhabitants each (Wikipedia).

¹¹³ Russian Far East (*Russian: Дальний Восток России, or Dal’niy Vostok*) is a term that refers to the Russian part of the Far East, i.e., extreme east parts of Russia, between Siberia and the Pacific Ocean. The Russian Far Eastern Federal District, which covers this area, should not be confused with the Siberian Federal District, which does not stretch all the way to the Pacific (Wikipedia).

designated above is respectively 4.4 bcm, 2.42 bcm and 0.3 bcm by linking to gas pipeline branches (Lesikhina et al., 2007).

The program of Russian regions' gasification is the major social-oriented project of Gazprom. The implementation of this Program covering 58 Russian regions will allow the increase of natural gas gasification level in Russia in average up to 62%. The environmental constituent of the Gasification Program is the displacement of coal and other «dirty types of fuel» burnt with the minimum efficiency from the power consumption. Considering the successful implementation of the regional Program in 2005-2006, the decision to increase the investments was made and thus 5 federal subjects of the Russian Federation were included additionally into the gasification program (Ananekov, 2008).

Currently, low domestic gas prices make Gazprom's revenues and investment programs almost entirely dependent on exports. This situation will change with increased gas prices, improving further from 2010-2020. By 2010 domestic gas tariffs are expected to be balanced by European gas market prices adjusted for transit fees, import tariffs and other duties. As a result gas prices will be triple the level of regulated prices by 2010 (Ivanov, 2003).

Gazprom's development strategy for the domestic gas market prioritizes:

- transiting from regulated wholesale natural gas prices to tariff regulation in the gas transportation sector, while securing state-regulated prices in the residential sector;
- forming the gas trading sector based on negotiated prices established on the basis of a price formula. A resolution by the Russian Federation Government prescribes gradually bringing domestic gas prices to the level ensuring an equilibrium of returns on domestic and foreign gas sales;
- expanding gas marketing via an electronic trading platform and stock exchange (Gazprom, Business strategy, 2008).

In September 2006, Gazprom for the first time was permitted to sell the produced gas in the volume of up to 5bcm at non-regulated prices at "Mezhregiongaz ETP"¹¹⁴ (Electronic Trading Platform). The experience of "Mezhregiongaz ETP" affords ground to suppose that the participants of the Russian gas and financial markets can both establish the instruments of real-time price indication and reproduce in Russia the systems of price indication for a long period thus mastering the exchange trade with gas futures contracts (Golubev, 2008).

¹¹⁴ Gazprom and independent producers sell gas at the Mezhregiongaz ETP since November 2006 in compliance with the Russian Government Directive "On Experimental Gas Sales via an Electronic Trading Platform" and the Russian Ministry of Industry and Energy Order "On Experimental Gas Trading via an Electronic Trading Platform" (Gazprom Release, 2008).

The Natural Gas Stock Exchange is a more sophisticated structure. Instead of the price formula related to the oil price the long-term contracts of new generation include a provision stating that the price in the accounting month is set based on the exchange prices and gas supply for the current month (Golubev, 2008). On the basis that all transactions should be held in compliance with Russia's legal system and in Russian currency, the priority orientation at domestic clearing centers is considered (Gazprom News, 2008).

As both structures (Electronic Trading Platform and Natural Gas Stock Exchange) assure complete and complex coverage of the gas market needs, Gazprom accepted a concept of parallel development of both trends. Due to gas transmission facilities expansion and gas markets liberalization in the CIS and EU, Gazprom plans to use both the ETP experience and results of the affiliated structures' activity¹¹⁵ in the ECC¹¹⁶ market (Golubev, 2008).

It is important to conclude that the marketing strategy of the Shtokman field development considers two main directions – Europe through pipeline and USA and Canada with LNG. But still this question remains undecided. According to Jensen (2008), the uncertainties involving Russia's gas export plans have a substantial impact how Atlantic Basin LNG develops. If Russia decides to concentrate on pipeline exports, which it knows best, and if the European customers grow more comfortable with Russian gas policies, it would have two effects on future LNG trade. It would reduce Russia's LNG offerings, but it also would reduce European competition for LNG. Europe has the pipeline as well as the LNG option. North America and most of the Pacific Basin must rely on LNG for interregional trade.

The previous several sections gave a complete description of the Shtokman gas and condensate field development project, including the partner selection, engineering concept, system of gas transportation and marketing strategy. Only two more important topics are left for discussion: environmental and political. So the last two sections will cover the main aspects of the problems stated by these topics.

¹¹⁵ Currently Gazprom Group participates in the exchange trade in Europe via 100% affiliated company Gazprom Marketing and Trading, Ltd. (Great Britain) carrying out the activity at the trade platforms of Great Britain (NBP), Belgium (ZHub), France (PEG), Netherlands (TTF). Moreover the company conducts the trading activity at European gas exchanges APX (UK), EEX (Germany), APX (NDL), Powernext (France) (Golubev, 2008).

¹¹⁶ The European Economic Community (EEC) (also referred to as simply the European Community, or the Common Market) was an international organization created in 1957 to bring about economic integration (including a single market) between Belgium, France, Germany, Italy, Luxembourg and the Netherlands. When the European Union (EU) was created in 1993, the EEC was transformed into the European Community, one of the EU's three pillars, with EEC institutions continuing as those of the EU (Wikipedia).

4.7 Ecological aspect of the Shtokman field development

The environmental aspect is undoubtedly one of the vital for the development of oil and gas resources of the Arctic shelf. The nature of the North is really vulnerable and people are aware of the consequences. Ecology will be obviously the main constraining factor in the development of these reserves (Dmitrievsky, 2008).

The risks associated with development of oil and gas fields and transporting of oil and gas are considerably higher on the continental shelf of the Russian Federation, than in other regions. This is due to:

- difficult natural climatic conditions;
- need to employ unique technologies and equipment;
- inadequate level of infrastructure development;
- imperfect nature of the normative base; and
- large number of freight operations, caused by small tankers operating in the Russian waters reloading to super tankers used for export (Lesikhina et al., 2007).

It seems obvious that when the Arctic shelf is concerned, the risks brought about by exploring oil and gas reserves are higher than anywhere else. So it is the necessary to advance the industry in the difficult conditions of the northern environment and climate – which calls for the application of unique technologies and equipment – while both infrastructure and the legislative norms of safety remain underdeveloped (Lesikhina et al., 2007).

4.7.1 Ecological features of the Barents Sea

The Barents Sea is the most productive and therefore most valuable in terms of resources in comparison with other Arctic seas. The sea is shallow; the average deep is only 230 meters. The first feature is that the icy waters of the Arctic, the short winter day length, and a limited influx of oxygen all ensure a slowed natural purification in the environment. Second, more than 300 species of micro algae are registered in the Barents Sea. There are about 150 fish species, the most important commercial fish is cod, capelin and herring. Different types of top-predators such as seal, whale and ice bear are also important species in the Barents Sea. The region consists of ecologically significant and vulnerable areas (fishing areas, wetlands, breeding grounds, stopover points, spawning areas and migration routes) and is extremely important in terms of bio resources (Lesikhina et al., 2007).

The special ecological features of the Barents Sea determine its high level of biological productivity and variety of species but, at the same time, its ecosystem is very vulnerable to

the effects of pollutants, and the regeneration of elements destroyed by pollution requires a long time. Oil pollution on the sea surface reduces the reproductive capability of living organisms. Oil spills are particularly pernicious for sea birds (Lesikhina et al., 2007).

The greatest damage caused by oil spills is experienced by coastal ecosystems, near to which are located breeding areas and spawning grounds for fish, as well as resting places for migratory birds. The deterioration in coastal marine ecosystems and the contamination of seafood with toxic compounds has a negative impact on people's health. All activity connected with exploration, extraction and transportation cause physical, chemical and biological disruptions in the open water, on the sea floor and in the atmosphere. The field development process results in large quantities of emissions into the atmosphere and the sea. Also oil and gas activity is one of the main sources of greenhouse gases which form from burning fossil fuels and cause climate change. In this regard, practically all the chains in the marine and coastal ecosystems are under serious threat (Lesikhina et al., 2007).

An active growth of oil and gas exploration in the region may become a death sentence for its environment. The natural world of the northern seas is so sensitive and so vulnerable that even a slightest breach in its structure can lead to consequences one will be unable to reverse. Furthermore, these consequences will be difficult to prognosticate as the ecosystems of the northern seas today have yet to be fully studied. Therefore, all activity connected with exploration, extraction and transportation should be strictly regulated and controlled (Lesikhina et al., 2007).

4.7.2 Environmental assessment of the Shtokman field development project

The technology concept of the Shtokman field development provides full range of ecological activities which give an opportunity to locate the production facilities so that to ensure its environmental impact in acceptable limits both for construction and operation. Also these measures enable to minimize casualty-producing capacity, to prevent the emergency situations and effectively eliminate the damage caused by the accidents. The process solutions and environmental measures to the full extent secure technical and ecological safety and reduce environment footprint.

According to the Shtokman field development concept, allocation of environment assets for construction of pipeline system excludes the irrevocable loss of the region's natural-resource potential. The system of industrial ecological monitoring provides control over the natural environment components on all the stages of the field's exploration and development; construction and exploitation of LNG plant and gas pipeline. It guarantees before-the-fact prevention of dangerous pollution and emergency situations. The measures of monitoring of

the gas pipeline system condition and the state ecological survey afford minimal impact on the surrounding environment caused by the facilities under construction or during the operation. That will reach a high level of ecological safety of the projected activity.

The current environmental profile will not undergo the sufficient changes under the development and exploitation. During the period of construction such an influence may have short-term and local character. The project includes engineering solutions and complete list of organizational and operational arrangements for accident-preventive measures and post-accident clean up (Piotrovskiy, 2008).

On October 23, 2006 the Federal Nature Management Supervision Service¹¹⁷ (Rosprirodnadzor) granted the state ecological expertise approval for the Investment Rationale for the first phase of the Shtokman field development embracing liquefied gas production and sea-borne transportation (Gazprom, Shtokman field, 2008).

At a meeting with environmental organizations, a representative of the Shtokman Development Company confirmed that high environmental standards will be applied in the huge Barents Sea gas project. Also new technology on climate gas emissions will be used (Murmanshelf News, 2008). The equipment which is going to be implemented for the project realization has to meet the requirements of the international standards “Euro-3” and “Euro-4” allowing for no negative impact on the eco system and the reproductive process of fishery resources (Banko, 2007, №15)

According to use of nuclear energy, the Russian nuclear industry suggests the construction of nuclear-powered underwater drilling ships, as well as using nuclear-powered icebreakers and floating nuclear power plants in the development of offshore hydrocarbon projects (Murmanshelf News, 2008). *Bellona* Foundation argued against the use of floating nuclear power plants in the conditions of drifting ice floes and high waves during storms at sea (Kireeva, 2008). The head of StatoilHydro’s Russia office confirmed that the Shtokman Development Company is not considering the use of nuclear energy in the Shtokman project (Murmanshelf News, 2008).

The last important thing is that Gazprom and the Northern Fleet are supposed to cooperate when executing projects concerned the construction of facilities for converting and transporting of oil and gas. According to the agreement, the Northern Fleet will also participate in designing and building infrastructure facilities for the Shtokman gas condensate

¹¹⁷ The Federal Nature Management Supervision Service (Rosprirodnadzor) is a federal executive body performing the function related to control and supervision in the sphere of natural resource use, organization of the safety of special environmental zones, maintenance of the environmental legislation and international norms and standards in the marine sphere and on the continental shelf, an so on (<http://control.mnr.gov.ru/>).

field, and the LNG plant in Teriberka, and construction work on the North European Gas Pipeline (NEGP). This memorandum also designates the establishment of an integrated security system for production facilities and the transportation of oil and gas by sea, including provision of an emergency rescue system, and the development of a joint transport provision plan, which includes transport by sea, air and other forms (Lesikhina et al., 2007).

4.7.3 Environmental assessment of the North European Gas Pipeline

In regard to construction of the North European Gas Pipeline, particular attention will need to be paid to the environmental impact of the gas pipeline on the bottom of the Baltic Sea (Bambulyak and Frantzen, 2007).

The pipeline route of Nord Stream is projected, as far as possible, in form of a straight line and adjusted with regard of certain areas such as environmentally sensitive areas; chemical weapons dump sites, military zones, critical navigation routes and other dedicated areas serving business or recreational purposes. Its route is designed so as not to cross the World War II ammunition dump sites. The Baltic Sea territory along the pipeline route will be examined in detail before the pipe laying starts. Nord Stream is a transnational project and its construction is regulated by the international conventions and national legislation of each state, which territorial waters and/or exclusive economic zone the pipeline will cross. Construction work will be preceded by a detailed environmental impact assessment. Nord Stream will be built in compliance with the most rigid environmental standards and without the Baltic Sea ecosystem disruption (Gazprom, Nord Stream).

According to the Energy Strategy of Russia for the period of up to 2020, the strategic gas production region of a high priority for the long-term outlook becomes the offshore areas in the North seas of Russia. The field development of this region calls for significant investments and high technologies relative to its remoteness from the existing gas pipeline system, difficulties in connection with construction of wells and production facilities in the constant soil congelation region, laying of gas pipelines, implementation of new technologies and technical decisions which secure the environmental safety in the tough conditions of the Polar region (Gazforum, 2003).

4.8 Political aspect of the Shtokman development project

Russia has an abundance of natural gas available and is just starting to come on board with the ability to develop and produce these resources. Western advanced technology, financial strength and high demand, coupled with Russia's lack of capital and exceptional reserves seem to make the countries ideal partners. The Kremlin, however, clearly intends to expand and maintain a strong foothold in its energy sector. Russia's renegeing on international deals creates a challenging and dangerous business environment for potential Western business partners. The example with Shtokman demonstrates the potential hazards of doing business in Russia.

4.8.1 Access of international companies to resources

First of all the problem concerns the access of international companies to the Russian natural resources and opportunity to make business in joint venture with Russian state company. In the early 1990s, a group of five Western companies¹¹⁸ was created to participate in the field's development. In 1992, however, the foreign consortium was pushed by the CJSC Rosshelf consortium, a Gazprom subsidiary that comprised 19 Russian companies mainly engaged in defense production. The key factor in Rosshelf's victory over the Western consortium was that it would provide greater employment in Russia (Hurst, 2007).

The second problem occurred after announcement of the companies short-list. Gazprom began suggesting that it might not include US companies in the list of winners. The one saving grace for the US was that Russia required access to the American gas market. Norsk Hydro and Statoil has allegedly offered stakes in Norwegian fields and LNG gas export projects in their bids, while ConocoPhillips and Chevron allegedly offered stakes in US LNG terminals in their bids. Then, Gazprom stunned the gas industry by announcing that it would develop Shtokman alone, without any foreign partners, and ship the gas directly to Europe via pipelines rather than including an LNG component to export to North America (Hurst, 2007).

Two month later Gazprom changed its decision again. According to Hurst (2007), it happened after the US and Russia reached a deal for the US to support Russia's WTO¹¹⁹

¹¹⁸Since 1989 the consortium "Arctic Star" had been working under the "Temporal Agreement on International Cooperation" aimed at the development of the Shtokman gas and condensate field. The consortium was comprised of representatives from three western oil companies – Conoco (USA), Norsk Hydro (Norway), Finnish Barents Group (Finland) – and the Russian company for oil and gas exploration Arktikmorneftegazrazvedka (Murmansk) which was carrying on exploration drilling on the Russian Arctic offshore. The consortium began making estimates of SGCF development several years before Rosshelf was established (Velikhov and Kuznetsov, 1997).

¹¹⁹ The World Trade Organization (WTO) is an important selective, mainly private, international organization designed by its founders to supervise and liberalize international trade. The organization officially commenced

membership bid, Gazprom said that there was still a chance of opening the door to foreign companies as stakeholders.

Russia continues striving toward complete domination of the industry, which likely will one day exclude foreign companies altogether. For now, however, Russia will continue to include foreign companies as long as it needs the technology they bring (Hurst, 2007). Russian government wants to retain as much control over the Russia's energy resources and revenues to give the country a new source of wealth and power (Clark and Rach, 2006).

Russia already has successfully seduced many majors IOCs with the offer of access to huge reserves in return for capital investment in the country and, more importantly, equity interests in key assets outside the country. Wood (2007, №6) claims that there is a growing suspicion that the Russian government ultimately will manipulate the taxation mechanisms to ensure that the IOCs make little or no profit from their investments.

Russia is charged by the international sources of information against its politics of controlling gas exports from the Caspian states and limiting access of its gas supply competitors to the Western Europe market (Wood, 2007, №37). Also the same author claims that Russia seeks to manipulate and control countries – Ukraine, Belarus and Poland – that have transit pipelines to Europe and to block the development of pipelines from Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan in Central Asia to Europe (Wood, 2007, №6). There is an opinion that Russia's growing monopoly on the natural gas sector comes with such potential side effects as increased policy leverage over countries highly dependent on this resource, a strengthening of its military and unfair control over pricing (Hurst, 2007).

It is all about politics and relationships between the countries. The main thing is that Russia still has many unexplored fields. And the international companies are attracted by access to reserves and ready to share their technologies and make huge investments in the joint venture projects. The Shtokman project is a good example of it.

4.8.2 Energy balance of Russia

In social science the “energy balance” refers to the amount of energy put into a system compared to that taken out. In the energy balance of the Russian natural gas system, the following four factors are particularly important: “maintenance of infrastructure”; “domestic consumption”, “political price elasticity”; “development of new northern fields”; and “control over Central Asian gas”.

on 1 January 1995, succeeding the 1947 General Agreement on Tariffs and Trade (GATT). The WTO has 153 members, representing more than 95% of total world trade and 30 observers, most seeking membership. The World Trade Organization deals with regulation of trade between participating countries (Wikipedia).

Because these factors jointly influence Russia's energy balance, they also affect each other. For example, currently Russia imports and re-exports large amounts of Central Asian gas. If Russia's loses control over the flow of this gas due to geopolitical competition with the US in Central Asia and the Caucasus, then that will put further strain on Russia's energy balance. The strain will in turn make it necessary to accelerate the development of new fields such as Stockman and Yamal, which in turn will make it necessary to bring foreign companies back into the warmth again faster and on more beneficial premises. The conclusion is that the development of the Arctic fields in which Norwegian actors are interested and European energy security about which other European actors worry are relatively closely connected with each other through the web of factors that make up Russia's energy balance (Øverland, 2007).

4.8.3 Several uncertainties in relation to the territory of the Barents Sea

The shelf of the Arctic Seas concentrates huge reserves of hydrocarbons, it forms 25% of the worldwide reserves, 15.5 bln tons of oil and 84.5 tcm of gas. The possibility of the territory increment of the Russian sector of the Arctic shelf on 1.2 mln km² may allow Russia to accumulate the prospect reserves of oil and gas on 10 bln tons in oil equivalent. This can happen in the case if Russia proves that this sector of the Arctic shelf is a continuation of the Siberian continental platform. According to the maritime law convention of the United Nations Organization¹²⁰ (UN) from 1982 which was ratified by 7 Arctic countries, the rights for the natural resources which are located in 200 miles economic zone from the country's coast have the countries which prove its continental origin (Banko, 2007, №15).

During the last several years international and national geologists were searching for significant evidence that proves the rights of the country for its part of the shelf. The year 2007 became an international polar year when Russia decided to organize wide research activities in the Arctic Ocean in order to prove the frontier line of the Russian Arctic shelf. The Russian scientists had established the fact of geologic structure continuity while making deep-water seismic probing. This can become an important basis for Russia to claim for its rights on 1.2 mln km² zone in the Arctic shelf (Banko, 2007, №15).

Another undecided problem is a Russian-Norwegian dispute about a "grey area" that has a length of approximately 155 000 km² between Kirkenes¹²¹ and Spitsbergen and may content

¹²⁰ The United Nations (UN) is an international organization whose stated aims are to facilitate cooperation in international law, international security, economic development, social progress, human rights, and achieving world peace. The UN was founded in 1945 after World War II to stop wars between countries, and to provide a platform for dialogue. There are currently 192 member states (Wikipedia).

¹²¹ Kirkenes is a town in the municipality of Sør-Varanger in the county of Finnmark with a population of about 3,300. Kirkenes is located in the extreme northeastern part of Norway on the Bøkfjorden, which is a vast bay connected to the Barents Sea near the Russian-Norwegian border (Wikipedia).

significant mineral resources. Russia and Norway have controversies about this question starting from 1970. The “grey area” dispute is about a method of border division. The Russian party claims to mark the frontier by sectoral principle which prolongs the line of the Soviet Polar possession to the north as it was defined in 1926. Norwegians do not accept this line referring to the international practice of water area division starting out from the outlines of the coastal area of the border countries. By this method the North Sea was divided on sectors between Norway, Great Britain and Denmark in the middle 1960s (Sapun, 2005, №12).

The hydrocarbon production on the Norwegian continental shelf started in 1969. Several years ago the oil extraction in the country has reached the peak output and began to decline. According to the Norwegian Ministry of Petroleum and Energy estimates, one third of total hydrocarbon reserves of Norway are located on the Norwegian part of the Barents Sea. The advisor of the Minister of Petroleum and Energy, M. Gradvæl declared that only the south part of the Norwegian territory of the Barents Sea will be under development in the nearest future. The north part which is considered to be a “grey area” and the most delicate question of the Russian-Norwegian energy policy remains untapped until the problem of the frontier boundary line is decided (Sapun, 2005, №12).

Sapun (2005, №12) offers two reasons why this problem is not solved yet from the Russian side: first, it decreases the competition on the energy markets; second, it makes the Norwegian companies invest in development of oil and gas fields on the Russian continental shelf. The latest news about this problem confirms that Russia and Norway agreed on legal techniques for the future discussion about the frontier line in the Barents Sea that will put the end to more than 30 years long dispute (Murmanshelf, 2008).

The political aspect of the Shtokman field development is rather complicated according to the international view of the Russian energy politics itself. But there is no need to hide that this project is of a great significance for the country’s energy strategy and national security.

4.9 Conclusion

The Arctic shelf of Russia is extremely rich with natural resources. The Russian shelf of the Barents Sea is the largest one in area extent. The reserves of gas are mostly concentrated in the Eastern-Barents oil and gas province and form more than 4 tcm. The core of the gas production complex is the Shtokman gas and condensate field, the reserves of which are estimated at 3.8 tcm of gas and about 37 mln tons of gas condensate.

According to the project viability assessment, the following prerequisites speak in favor of successful execution of the Shtokman field development project:

- large gas reserves secure sustainable long-term supply and provide an opportunity to considerably expand gas production depending on the market situation;
- favorable feedstock composition allows minimizing gas separation and treatment costs;
- low regional temperatures provide for reducing gas liquefaction energy-related costs;
- availability of a developed infrastructure on the Kola Peninsula creates a favorable environment for the project execution;
- an opportunity provided to diversify supplies through parallel pipeline and liquefied natural gas shipments to Europe and the USA varying directions as the market situation requires;
- no transit countries along the natural gas delivery route from the Shtokman field to Germany boosts the project competitiveness;
- relatively small distances between the field and end users (the US Eastern Coast, Canada, Mexico) will make Russian LNG competitive;
- absence of ices and permafrost – a favorable factor for the Shtokman field development versus other Arctic fields (Gazprom, Shtokman field, 2008).

The given chapter made a deep insight into the Shtokman project, its engineering concept, transportation system and marketing strategy. This information is relevant and helpful to analyze the supply chain implementation in the process of the Shtokman field development and to clarify the main tendencies of its supply chain integration.

Chapter 5. Supply chain of the Shtokman project

5.1 Introduction

This chapter shows the implementation of the theoretical background of the supply chain in the development of the Shtokman gas and condensate field. It will make an overview of all the sides of the supply chain of the proposed project.

The first part gives a full description of Gazprom as operator of the Shtokman gas and condensate field development project. The presented information relies on Gazprom's official web-site (Business Strategy, Gazprom Today, and Major Projects). Then the section distinguishes its role in the project's supply chain from the theoretical point of view.

The second part presents the entire supply chain of the Shtokman project including the choice of contractors and suppliers. It will analyze the concept of the project, the executed work, the current activity and the future plans for the project development. Also this part will give an overview of the companies, both national and international, which take part as suppliers and contractors in the project execution.

The last section is going to clarify the features of the project's supply chain development such as cooperation between the companies, suppliers association and participation of the federal regions and authorities in the project execution.

The main task of the given chapter is to build the structure of the supply chain of the Shtokman development project. The presented below analysis of the Shtokman project supply chain applies on the interviews with the PhD in Economics and ex-Executive Vice President of Murmanshelf, Fadeev A.M. and the Finance Director of Gazpromregiongaz, Usova E.G., presentation of the Vice President of StatoilHydro Russia, Kjærnes P.A, Gazprom's official website and some sources of information which provide the verified data. Taking into consideration that the development of the Shtokman field is on the phase of planning and front-end engineering, some of the features of the supply chain are not identified yet or made by assumption.

5.2 The role of Gazprom in the Shtokman project development

First of all it is important to make a presentation of Gazprom as operator and license holder of the Shtokman gas and condensate field development project. Gazprom is the main Russian producer of natural gas; it is close to monopolist in both production and export infrastructure and, therefore, has a dominant position in the Russian energy sector.

5.2.1 About Gazprom



Gazprom is the world's largest gas company basically focused on geological exploration, production, transmission, storage, processing and marketing of gas and other hydrocarbons. The state owns a 50.002 % controlling stake in Gazprom.

Gazprom possesses the world's largest natural gas reserves. The company's share in the global and Russian gas stocks makes up 17% and 60%, respectively, with its overall reserves estimated at 29.85 tcm and currently priced at \$182.5 bln. In 2006 an increase of Gazprom's explored gas resources up to 590.9 bcm substantially outpaced the extraction rate. According to preliminary data, an increase in the company's natural gas reserves totaled over 585 bcm in 2007, which exceeds its production output (Appendixes 10 and 11).

According to Gazprom's oil and gas production strategy, by 2010 gas production by Gazprom will account for no less than 570 bcm to reach 610-615 bcm by 2015 and 650-670 bcm in 2020. This is a substantially higher level compared to the targets set in Russia's Energy Strategy which was adopted several years ago.

Gazprom's share in the global and Russian gas production is nearly 20% and 85%, respectively. In 2006 Gazprom Group extracted 556 bcm of gas, 1 bcm up on the production level in 2005. According to operating data, natural gas production totaled 548.5 bcm in 2007, a little down on 2006, which is caused by the European consumption cutback due to the warm winter of 2006-2007 (Appendix 12).

Gazprom owns the world's largest gas transmission system – the Unified Gas Supply System of Russia stretching for 156 900 km. Gazprom Group of companies also service 514 200 km (80%) of the national gas distribution pipelines, and in 2006 supplied 316.3 bcm of gas to 79 750 population centers in Russia (Appendix 14).

Gazprom exports gas to 32 countries within and beyond the former Soviet Union (FSU), and continues reinforcing its positions on conventional international markets. In 2006 the company sold 161.5 bcm of gas to European countries along with 101 bcm to the CIS and Baltic States (Appendixes 15 and 16).

Major projects

- *Blue Stream.* In 2005 Gazprom brought to full capacity the Blue Stream gas pipeline which is going from Russia to Turkey.
- *Nord Stream.* In 2005 the Nord Stream gas pipeline construction has been launched. The pipeline will enable to substantially enhance the reliability and flexibility of gas supply to Europe.
- *South Stream.* In 2006 Gazprom and Italian *ENI* signed a Memorandum of Understanding for the South Stream¹²² gas pipeline project execution. This project is also aimed at reinforcing the European energy safety. The South Stream offshore section will be laid through the Black Sea¹²³ bottom: from Russian to Bulgarian coast.
- *Murmansk – Volkhov gas pipeline.* The 1 365 km long gas pipeline will make it possible to deliver gas from the Shtokman field to consumers in northwestern Russia and to export gas via the North Stream project.
- *Gryazovets-Vyborg gas pipeline.* It is intended for securing gas deliveries to the Nord Stream gas pipeline and supplying consumers of Russia's Northwestern Region.
- *Yamal Megaproject.* The Yamal Peninsula is a strategic oil- and gas-bearing region of Russia. Commercial development of fields onshore and offshore Yamal is crucial for securing Russia's gas production build-up beyond 2010.
- *Shtokman project.* Preparations are underway for the Barents Sea offshore located Shtokman field that will be the resource base for Russian gas export to Europe via the Nord Stream.
- *Sakhalin II project.* It is together a first project executed in Russia based on the PSA; first LNG production plant in Russia; first enter of Russian gas the energy markets of the Asia-Pacific Region and North American coast.

¹²² The South Stream project is aimed at strengthening the European energy security. The project provides for South Stream's offshore section to run under the Black Sea from the Russian coast (Beregovaya compressor station) to the Bulgarian coast. The total length of the offshore section will be around 900 km, maximum depth – over 2 km and full capacity – 63 bcm. Two possible routes are under review for South Stream's onshore section from Bulgaria– one, northwestwards and the other, southwestwards (Gazprom, South Stream, 2008).

¹²³ The Black Sea is an inland sea bounded by Europe, Anatolia and the Caucasus and is ultimately connected to the Atlantic Ocean via the Mediterranean and Aegean Seas. These waters separate eastern Europe and western Asia. It also connects to the Sea of Azov. The Black Sea forms in an east-west trending elliptical depression which lies between Bulgaria, Georgia, Romania, Russia, Turkey, and Ukraine (Wikipedia).

Gazprom LNG

Step-by-step Gazprom builds up its presence in LNG market. This helps to extend the company's business geography. In 2005 Gazprom supplied its first LNG cargo to the USA. In 2006 LNG was delivered to the Great Britain, Japan and South Korea. Since 2005 Gazprom has been effectuating LNG spot deals using LNG/pipeline gas swap operations. In future, the company is planning to boost the volumes of spot trading and develop mid-term operations on swap of pipeline gas for LNG in Europe.

To efficiently access the global LNG market, Gazprom is taking the opportunities of engagement into already existing LNG projects. In 2007 Gazprom engaged into the Sakhalin II project. At a subsequent stage of its strategy Gazprom sets out to organize LNG production in Russia and third countries, placing a focus on independent LNG marketing operations. The Shtokman field will be the resource base for the Nord Stream gas pipeline and for LNG production. LNG will be primarily delivered to the markets of the USA, Asia-Pacific and Europe (Appendix 13).

Business priority

A business priority of Gazprom is the development of the Yamal Peninsula, Arctic continental shelf, Eastern Siberia and the Far East. By order of the Russian Federation Government, Gazprom coordinates the implementation of the Development Program of the integrated gas production, transportation and supply system in Eastern Siberia and the Far East with due regard of potential gas exports to China and other Asia-Pacific countries (Eastern Program). Russia's East is planned to see the development of a gas processing and gas chemicals industry that will enable to rationally use substantial reserves of helium and other valuable components of Eastern Siberia's gas.

Due to Russia's geographical position, Gazprom has the potential to become an energy bridge between European and Asian markets via supplies of own natural gas and gas transit services rendered to other producers.

Business diversification

Gazprom goes on streamlining the corporate governance structure. The reform is aimed at enhancing effectiveness of Gazprom's business as vertically integrated company. The initial steps made to set up subsidiaries specializing in underground gas storage, underground repair, hydrocarbons processing and oil recovery.

Oil business development and competitive presence in the power generation industry are the strategic goals of Gazprom on its way to become a global energy company. The

acquisition of Sibneft has allowed the company to become a key player on the Russian oil market. Gazprom's core businesses also cover power generation, which currently tends to undergo integration with the gas business worldwide and helps to achieve a considerable synergetic effect.

Environment and social responsibility

Environment protection and ensuring ecological safety in the production operation regions, pollution reduction, industrial and ecological safety during new facilities construction are Gazprom's environmental priorities. Gazprom's environment costs increased in 2006 by 30.6% and reached RUB¹²⁴ 12.7 bln.

The largest socially oriented project of Gazprom is the Gasification Program for Russian Federation regions over 2005 to 2007, which prioritizes gasifying the rural area, with a total of RUB 43 bln to be invested in the construction of gasification facilities. The Program will result in a further 13 mln of the country's citizens starting to use natural gas.

Gazprom elaborated and is implementing now the Target Complex Program on developing the gas-filling net and natural gas vehicle park for 2007-2015. Also implementing the Energy Strategy of Russia and the Energy-Saving Concept of Gazprom for 2001-2010, the company performs a complex work on increase of energy efficiency, reduction of technological losses of natural gas and saving of fuel and power resources.

Gazprom on global market

Gazprom is confident about its future. In 2007 the company's capitalization grew by 21.18% to \$ 329.563 bln. In terms of market capitalization, Gazprom entered the list of the three world's largest energy companies after PetroChina (China) and ExxonMobil (USA). According to market capitalization Gazprom entered the list of the five largest energy companies in the world.

This is a considerable step to achieve the strategic goal of Gazprom – taking leading positions in the global energy market, increasing the company's authority and influence in the world community and ensuring the long-term value growth.

Gazprom's mission is to provide effective and well-balanced gas supply to Russian customers and to safely implement long-term gas export contracts.

Gazprom's strategy is to acquire the leading position among the global energy companies by entering new markets, diversifying core business activities and ensuring reliable supplies.

¹²⁴ The ruble (*Russian: рубль*) is the currency of the Russian Federation. ISO 4217 code: RUB (Wikipedia).

5.2.2 Gazprom in the supply chain of the Shtokman project

The literature about the supply chain in oil and gas industry distinguishes two types of companies competing and collaborating on the world market of energy resources: national oil companies (NOCs) and international oil companies (IOCs). Gazprom is a national gas company of the Russian Federation and belongs to NOCs.

NOCs goals and priorities differ from those of IOCs. NOCs' strategic priorities include optimization of resource development, revenue growth, supply security, and economic development. Many NOCs also have political priorities and are expected to execute government policies, which are sometimes in harmony and sometimes at odds with commercial strategies (Vikas and Ellsworth (1), 2007).

For example, Gazprom's gas prices are kept artificially low for their home market in order to bolster domestic support for the government. This policy depresses domestic profits and distorts commercial decisions for the company. It requires Gazprom to subsidize its domestic commitments from revenues received from export customers (Wood (1), 2007). Only the recent years Gazprom's strategy is targeted at reducing of the regulated sector and corresponding expansion of the deregulated one. The company is implementing the programs of bringing step-by-step domestic gas prices to the level of market prices with a view to secure state-regulated prices in the residential sector. Also Russia's Gazprom recently has been seeking to capture value for its exports by raising prices to former Soviet republics towards parity with European gas prices (Vikas and Ellsworth (1), 2007).

Some NOCs are also moving down the supply chain, expanding downstream into refining, distribution, and retail, particularly in Europe and the US, to secure markets for their oil and gas and to provide insulation from upstream price volatility (Vikas and Ellsworth (1), 2007). Gazprom is also diversifying its activities by getting more involved in downstream activities as well as by buying shares in foreign companies (IEA, 1995). Strengthening its position in the traditional natural gas market of Europe, at the same time Gazprom is entering the global gas market, by using the model of swapping piped gas for LNG (APS Review, 2005).

According to the classification of IOC and NOC's strategies, Gazprom belongs to resource providers which are generally national asset owners and usually are not actively involved in acquiring additional overseas reserves. As it was mentioned above, Gazprom possesses the world's largest gas reserves estimated at 29.85 tcm. According to Gazprom's strategic goals, the development of the Shtokman gas and condensate field which reserves account for 3.8 tcm of gas and approximately 37 mln tons of gas condensate is of a great

priority. Internationally, Gazprom is active in Central Asia, India, Vietnam, Venezuela, Bolivia, Algeria, and Libya (Gazprom, Business strategy, 2008).

Technology seekers are generally resource rich NOCs such as Gazprom, which need advanced technologies to explore and develop the resources they control (Vikas and Ellsworth (1), 2007). The development of huge gas and oil reserves of the Russian Arctic requires new technology and technical solutions which the monopoly does not possess at the present moment.

Gazprom can be also ranged in a category of finance seekers which lack finances for exploration and development (Vikas and Ellsworth (1), 2007). Taking into consideration the high-priced exploration and development of the Shtokman project, Gazprom demands international investments and budget financing.

As for IOCs, their priorities include increasing stockholder value, deploying technology, and expanding market access (Vikas and Ellsworth (1), 2007). Total and StatoilHydro operate as IOCs in the Shtokman field development project.

The technology developers are willing and able to bring their technologies to the global exploration and production (E&P) market place. An example is Gazprom's overture to Statoil to develop the Shtokman field to benefit from Statoil's expertise in operating in the Arctic offshore environments (Vikas and Ellsworth (1), 2007).

Partially privatized Statoil of Norway has interests around the globe as well as in the Norwegian North Sea. The company conducts exploration, production, transportation, refining, and marketing. Gazprom has recently shown interest in working with Statoil in developing Shtokman gas and condensate field in the Barents Sea. Statoil is considered a leader in arctic offshore operations, subsea production technology, and deepwater LNG facilities. It developed its LNG expertise in the North Sea and with the Snøhvit liquefaction plant (Vikas and Ellsworth (2), 2007). Finally, Statoil which already merged with another Norwegian company from Gazprom's short-list got an opportunity to participate in the Shtokman field development project.

Some of IOCs, which must add reserves to maintain company's value, are also resource seekers. The French company Total belongs to this type of IOCs. Total is a major world-class energy company. Its sphere of activities covers more than 130 countries and encompasses all components of the oil-and-gas production chain, from production to sales of processed commodity to end users (Total Profile, 2009). Since France is one of the European consumers of gas, the company has to acquire equity reserves overseas to meet in-country demand and to

develop its downstream activities. The development of the Shtokman field is of a great significance for the company to get access to huge reserves of the Russian Arctic seas. Also Total possesses high expertise in LNG production and transportation which can be implemented in the Shtokman project.

NOCs need IOC technology and oil-field management expertise and inviting IOCs to serve as contractors for field development. In 2006, Gazprom rejected all partner and equity bids from IOCs to develop giant Shtokman gas field of the Russian Arctic (Vikas and Ellsworth (1), 2007), but some time later it brought in StatoilHydro and Total on the basis of a shareholder agreement.

According to Vikas and Ellsworth (2007, (2)), IOCs and NOCs collaborate and compete with each other on two fronts. The first is the international market, where NOCs can be competitors and sometimes collaborate with IOCs. The second is the country-specific market, where IOCs act more than before as contractors and partners and less as resource owners in developing host country resources. In case of the Shtokman field development, IOCs and Gazprom are collaborating on the Russian gas market which is characterized by limited access to reserves and is highly politicized. Vikas and Ellsworth (2007, (1)) add that privatization in the 1990s created opportunities for IOCs to actively participate in oil and gas development without restriction on equity participation. Recently, however, the Russian government has exerted greater control over resource development.

IOCs may focus less on short-term revenue maximization and more on value creation for NOCs, long-term sustained partnerships with NOCs, and new technology development. These factors may become more important indicators of future profitability and sustained revenue growth for IOCs (Vikas and Ellsworth (2), 2007). Both Total and StatoilHydro are ready to share their experience and technologies with the assumption for a future participation in the project, in the second and third phases.

IOCs generally have negotiated favorable production-sharing agreements with NOCs and are acting as technology providers and resource holders (Vikas and Ellsworth (1), 2007). The development of the Shtokman project is not going to be realized on PSA conditions because Gazprom will save the rights for product marketing.

According to the alternatives for a company to reach foreign markets (Waters, 2003), there is one of setting up some form of joint venture with a local company. Creation of the Shtokman Development Company which serves as example of such partnership allows sharing of ownership, management skills, knowledge and risk. The level of commitment limits the foreign ownership to 49% of company's stake (Total and StatoilHydro).

5.3 Supply chain of the Shtokman field development project

A supply chain consists of the series of activities and organizations that materials move through on their journey from initial suppliers to final customers (Waters, 2003). The supply chain in oil and gas industry is exceptionally long, complex and divided into three main components: upstream, midstream and downstream (Heever, 2004). The supply chain consists of operators, main contractors, subcontractors and suppliers (Anderson, 2003).

The Shtokman gas and condensate field development has the same structure. The upstream activities are presented by exploration and development which prepare the field for the future operations. Construction of the united extraction-transport-processing facility including ice-resistant processing platforms, pipeline systems, and LNG production complex is a part of the upstream processes. The midstream sector refers to the transmission of produced gas by pipelines and liquefied gas by sea to the target markets of Europe and North America. There the gas regasification terminals and natural gas distribution companies will deliver the product to the end customers. Additionally, the gasification of adjacent federal subjects of Russia and the delivery of gas to domestic customers through the unified gas supply system will be the part of the downstream activities of the supply chain.

In the Shtokman field development project a Shtokman Development AG special Purpose Company will act as operator. Total and StatoilHydro perform the function of investors. The Company is the owner of the first phase infrastructure of the Shtokman gas condensate field for 25 years since its commissioning. A 100% subsidiary of Gazprom, Sevmorneftegaz holds the license to search for, explore, and produce gas and condensate from the Shtokman field. Gazprom in this case retains 100 % of Sevmorneftegaz's stock and all rights to market an output.

During the project execution, contractors and suppliers will be invited. Main contractors are seismic and drilling companies, service rig operators, engineering firms, and scientific and construction companies. Subcontractors and suppliers are manufactures and service companies or regional agents. Among all the companies there will be national entities which have been nurtured under years of protective development policies and international suppliers which possess high technological and technical expertise.

Expertise is a common factor that binds this supply chain network together with an assumption that requirement for safety and uninterrupted operation is never compromised. The capacity to provide timely, reliable supplies, the quality of materials and good reputation will be also estimated. The companies will be chosen on the basis of bids for a contract.

The Shtokman development project envisages annually producing some 70 bcm of natural gas and 0.6 mln tons of gas condensate. Phase one contemplates annually producing 23.7 bcm of natural gas with the startup of gas supply via the gas pipeline in 2013, and liquefied natural gas supply – 2014 (Gazprom, Shtokman project).

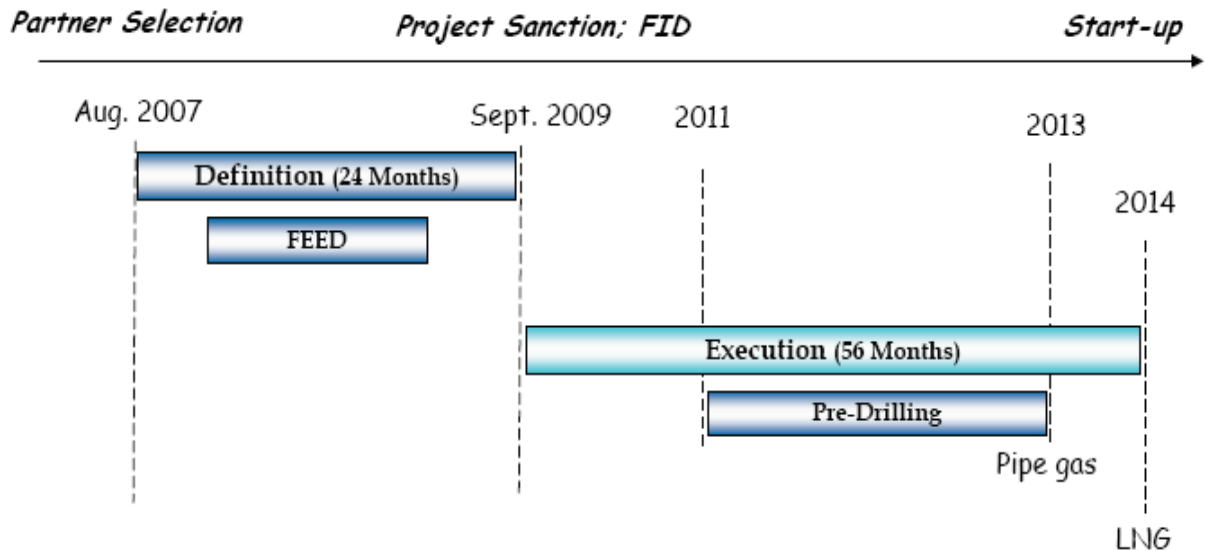


Figure 12. Timeline Perspective - Phase I (Kjærnes, 2008)

The Shtokman project execution is on the phase of planning and front-end engineering and development when the most tactical decisions relevant to supply chain management are made. As it was mentioned before, there are still some uncertainties in the process of contractors and suppliers selection related to the timeframe of the project execution. The presented below data reflects the participation only of these companies which were announced by official sources of information.

5.3.1 Project definition phase

The organizational structure of the Shtokman project was defined in 2008 when the joint venture company between Gazprom, Total and StatoilHydro was created. According to Fadeev A. M., the company which is going to develop and execute the first phase of the Shtokman gas and condensate field is at the stage of front-end engineering and design (FEED). He said that exploitation of such a large deposit requires elaborate preparation which includes the project feasibility study and estimation of project’s commercial viability. After the technical and economic assessment which is planned to be ready in September 2009, a final investment decision (FID) and volume of investments for the first phase of development will be revealed. These economic results will create a basis for successful project execution.

On additional question about the probability of a positive investment decision, the answer was that it can not be predicted now. But according to official data, it is planned to enter some gas from the Shtokman field into export contracts. It means that the part of the gas which will be produced in the nearest future is already sold. From one side, the energy safety of the European countries is of a great importance. From another side, if economic assessment has a negative result there will be no sense to develop the field without commercial benefits. Here, the fact that onshore reserves are declining plays also an important role. Taking into consideration the implementation of the Russian Energy Strategy for the period of up to 2020, the main addition to reserves is planned to be reached by means of the offshore deposits development.

According to the project capital investments, Fadeev A.M. confirmed that Gazprom has fulfilled its obligations for 2007 and invested in the project RUB 17 bln as it was underlined in the company's budget. After two international companies Total and StatoilHydro entered the project the joint capital for the project execution went to the expenses of \$ 800 mln. The fund for exploration and development was set in the budget for 2008-2009.

On the question about the operation of the special purpose company Shtokman Development AG, its functions and main tasks, Fadeev A.M. answered that the main function of the company is the infrastructure development of the first phase of the Shtokman project which is planned for 2013-2030. According to the agreement, the participating companies will have to leave the project if new agreements are not reached. The second and the third phases of the Shtokman gas and condensate field development comprise an increase of gas extraction which leads to extension of production facilities and pipeline capacities.

One more interesting fact about the company Shtokman Development AG is that it is registered in Switzerland and has its main office in Moscow. Two more affiliate branches are located in Murmansk – representative office, and in Teriberka – operational business unit. The personnel of the company are presented by the specialists and managers from different areas of responsibility.

The last question in this section of the interview was about the partner selection. Why StatoilHydro and Total were chosen among other companies from the short-list?

The answer complied with the previous analysis of the companies' advantages. Total is a long-term business partner of Gazprom and has huge engineering and technical facilities in possession. StatoilHydro was named the company №1 in the world in terms of Arctic offshore development expertise. So both companies have good technical and economical potential and enough experience to provide fruitful cooperation in the project.

5.3.2 Project execution phase

The project execution includes several stages. First is an exploration and development of the field when the seismic data is prepared, preliminary drilling is made and geological analysis of the deposit area is conducted. Second step is a front-end engineering and design of the project, when the engineering concepts are developed; the technical documentation is prepared; and the decisions on platforms, subsea infrastructure, pipeline systems and LNG plant are made. Here the requests for quotation by main contractors are issued. The next step of the facilities' construction begins when the final investment decision is accepted. And the last step in the project execution is a field operation when gas production comes on stream; it requires the systems' maintenance, supply and services on sea and on land. After the start-up a marketing strategy is implemented to make the product find its end customer (Figure 13).

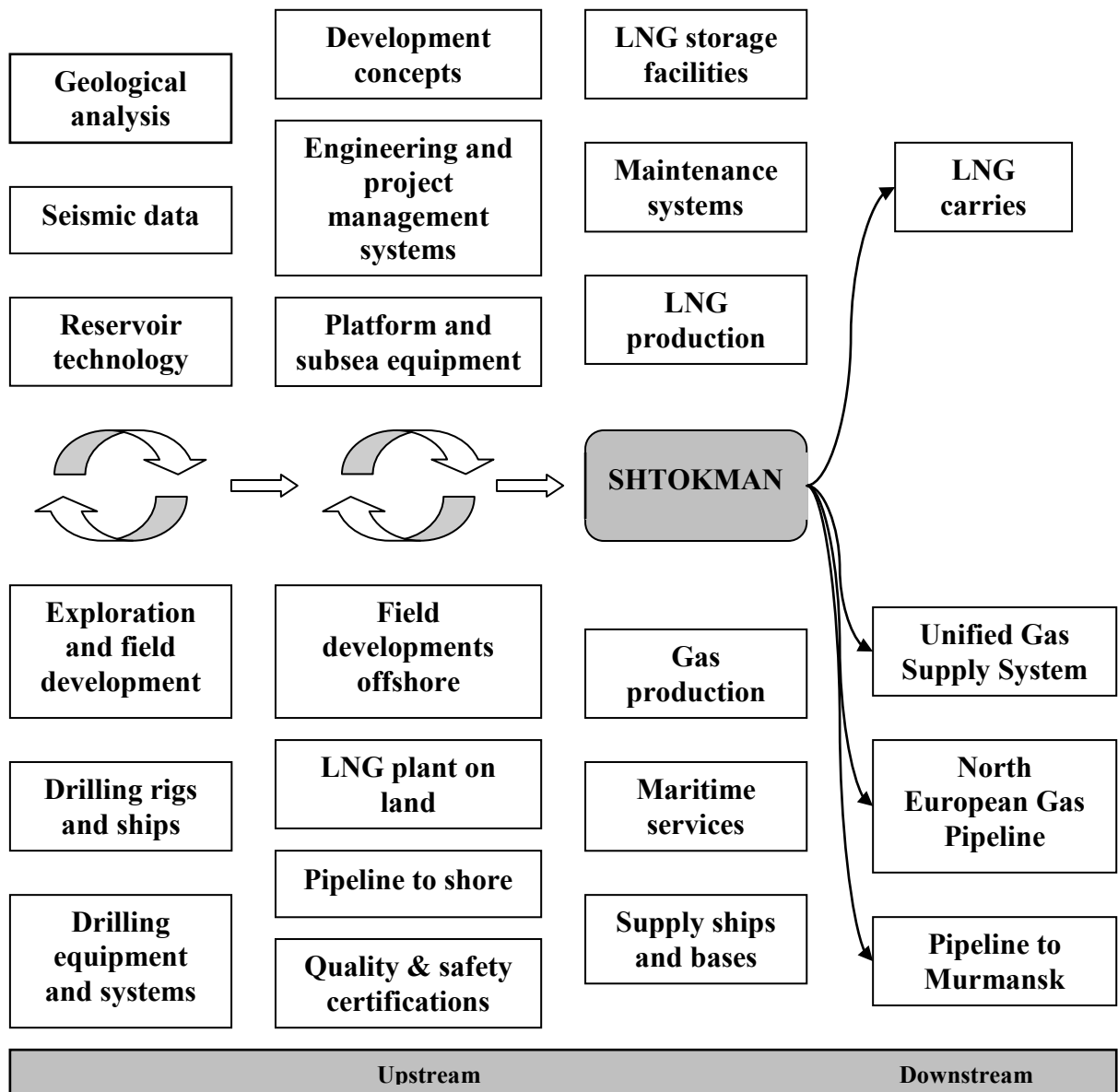


Figure 13. Supply chain of the Shtokman field development project

The exploration and development phase of the Shtokman project began when the field was discovered in 1988. However, the exploratory works in the Barents region which gave occasion for the strike of gas in the area of the Shtokman field started even earlier. In 1972 significant drilling operations in the area of the Barents Sea were organized by the Marine Arctic Geological Expedition (MAGE) which allowed substantially itemize the image of the region and its oil and gas prospects (Borisov, 2008). This organization has made a great contribution to the geological analysis of the field and conduction of the seismic data.

At the same time the scientific production association Sevmorgeo was established for the purpose of regional investigation and prospecting works on the Arctic shelf. This association organized the first systematic geological and geophysical researches (Borisov, 2008). Also for the purpose of prospect drilling conduction and preparation of oil and gas fields for reservoir engineering a company Arktikmorneftegazrazvedka was created in 1979. In particular, the Shtokman gas and condensate field was discovered by the specialists of this company.

Fadeev A.M. confirmed the information that the operation of the Federal State Unitary Enterprise Arktikmorneftegazrazvedka which consists of prospecting, exploratory, research and engineering works on the shelf of the Arctic seas contributed to discovery of many deposits including the giant Shtokman field.

It is also important to mention that all the drilling and geophysical operations of the companies and expeditions on the continental shelf in 1979-1992 were conducted on the basis of the latest scientific and technological innovations for that time. The Federal State Unitary Enterprise *Techmorgeo* was art and part in the exploration works on the continental shelf as constructing company which developed and produced devices and equipment for marine works and engineering and geological investigations (Banko and Evtishina, 2008).

Nowadays, Gazflot, a 100% subsidiary of Gazprom, is conducting the exploratory works on the offshore deposits of the Arctic seas. The company has allotted a task to be main contractor for the work execution in the Shtokman gas and condensate field project.

To the order of Gazflot a company Arctic Marine Engineering Geological Expeditions (*AMIGE*) continues to conduct the engineering-geological survey on the area of the Shtokman field. The surveying work of the company prefaced the construction of the probe well №6 in 2003 and completive well №7¹²⁵ in 2006. In 2007 the engineering investigations for the berthing facilities in the area of Teriberka settlement and along the route of gas pipelines were

¹²⁵ An interesting point about drilling the well №7 which put an end point in developing the Shtokman field is it was made with the Deep-sea Delta semi-submersible drilling rig provided on a contractual basis by the Norwegian Hydro company (Gazprom News, 2006).

prospected. Additionally, the company expects to conduct the geotechnical surveys of the field's area for siting the production and technological platforms and subsea production complexes (Banko and Evtishina, 2008).

The second step of the project execution is a front-end engineering and design when the construction solutions are adopted. The Shtokman Development has announced the start of the FEED work in 2008. FEED contracts will be implemented in 15 month's period, the work will be finished in the second quarter of 2009, which corresponds to the time schedule of the project and makes it possible to take the FID before the end of 2009 (Kjærnes, 2008).

In March 2008 the Shtokman Development AG, operating the development of the first phase of the Shtokman gas and condensate field, has approved the contractors to prepare the front-end engineering design. Three foreign contractors were selected to work in conjunction with Russian companies:

- *Doris* (France) jointly with the *Rubin* design bureau (Russia) for FEED on the subsea production system and the offshore technological platform;
- *JP Kenny* (UK) jointly with Giprospetsgaz (Russia) for FEED on the sea pipeline;
- *Technip* (France) and its subsidiary Technip CIS (Russia) for FEED on the onshore gas technological complex, including the LNG plant (Kjærnes, 2008).

According to News service NGV (2008), now only these international contractors which will conduct the design works within the framework of the first phase of the Shtokman project were selected. Among the selected contractors there are no Norwegian companies¹²⁶, only Russian, French and British enterprises. But in the latter half of 2009 new contractors and suppliers of equipment will be invited in the project.

Foreign contractors have done a big job to mobilize human and technological resources, involving Russian project institutes and enterprises. The agreed share of the Russian

¹²⁶ The Norwegian journal Scandinavian Oil and Gas Magazine wrote in 2008 that StatoilHydro may withdraw from the Shtokman Development AG before the final investment decision. It is connected to a problem of the supplier and contractor selection criterion which is not determined yet. Also one of the company's representative said that the commissioning period depends on qualification of contractors because "only then it will be clear if they can implement an obligation within the stated deadline and yield the first gas in 2013" (News service NGV, 2008).

The same problem occurred earlier with the second participating company Total. The company was not satisfied with the project organization and discontent with the fact that the international contractors are not well received in the project. According to this question, Fadeev A.M. answered that the tenders are not opened yet and there is no reasons to worry because the project is on the stage of technical and economic assessment. The News service NGV (2008) also commented on the StatoilHydro's notice that the company just wants the Norwegian contractors to be involved in the project.

contractors' participation in the FEED constitutes over 35% of the total scope of work (Kjærnes, 2008).

According to participation of national and international companies in the Shtokman project as contractors and suppliers, Fadeev A.M. said that Gazprom being a company №1 in the development of onshore reserves has no experience in offshore projects. Such activities as underwater drilling, bottom pipeline installation, construction of LNG plant, where the Russian companies, suppliers of oil and gas industry, has no experience will be fulfilled by the international companies. For example, only few companies in the world carry out the construction of LNG factories, among them are Japanese *Chiyoda*, American *Chicago Bridge & Iron*, French Technip¹²⁷. So the companies which have experience will be preferred for the technology intensive works. As it was said by one of Gazprom's partners, "... there will be no experiments on Shtokman". The companies which have no experience in such works will not be qualified for tenders.

Fadeev A.M. also put several cases of the international supplier's participation in oil and gas projects. The first example was the Norwegian project Snøhvit. There 20-25% of all the works involved international companies, the rest has been fulfilled by the national oil and gas suppliers. It resulted in technological exchange and fruitful cooperation. In case of the field development on Sakhalin, 75% of the works were completed by the foreign companies. It reduced the interchange of experience and work orders for national enterprises. From a host country's side, such a high percent of international participation does not provide the national companies with supply contracts while decreasing their taxpaying capacity; also it does not create new working places and reduces the participation of the regular labor force in such long-term projects. For that reason the government has to provide as much Russian enterprises as possible with participation in the project development.

According to the presentation of the Vice President of StatoilHydro Russia, Kjærnes P.A, there are more than 500 suppliers in the Rogaland¹²⁸ County comparing with the Arkhangelsk and Murmansk Regions which together has less than 50 potential subcontractors. StatoilHydro is interested in cross-border synergies for suppliers in developing technology and securing successful projects based on cooperation. The company sees the Norwegian suppliers as competitive but expects fierce competition from the Russian side (Kjærnes, 2008).

¹²⁷ Freeport LNG which employs an ambient-air system designed to draw heat from the air to regasify LNG has been built under a "fixed-price, date-certain, turnkey" contract by a consortium consisting of Technip USA Corp., and others (True, 2008, №16).

¹²⁸ Rogaland is a county in Norway, bordering Hordaland, Telemark, Aust-Agder and Vest-Agder. It is the center of the Norwegian petroleum-industry. The third largest urban area of Norway is located in Rogaland. Stavanger, along with Sandnes, Randaberg and Sola, is ranked above Trondheim (Wikipedia).

In terms of participation of the Russian enterprises in the Shtokman field development; there is a question about their capability to provide competitive and required technologies for the project realization. In this case Fadeev A.M. suggested that in order not to repeat the mistakes of the previous experience (example with the Sakhalin field development), in the Shtokman project there will be employed as much Russian suppliers as possible, so-called “Russian Content”. These companies will take part in less technology intensive operations of the field facilities’ construction. The area of responsibility will include onshore pipeline laying, road construction and infrastructure extension, construction of social facilities, in other words these spheres of operation where they have experience. Under otherwise equal conditions the Russian companies will get advantage over other participants.

There are already several examples of the national companies’ participation in the Shtokman field infrastructure development. Some of the companies won a contract for construction and supply of different facilities, and some just prepared the operations for the future participation.

Gazflot signed an agreement with JSC *Vyborg Shipyards* for construction of two semi-submersible platforms of a new generation for the Shtokman project. Two offshore platform topside areas are going to be built by *Samsung Heavy Industries*, a South Korean company. The terms of delivery to the customer (CJSC Gazflot) is defined in the following sequence: the first platform must be ready in 2010, the second in 2011 (Banko and Evtishina, 2008).

According to Murmanshelf News (2008), the *Baltic Works*, Saint-Petersburg, the Leningrad Region, is going to deliver metal for semi-submersible platforms which are under construction on the Vyborg Shipyards. Also when the upper- and understructures of the two offshore platforms are ready, the hydraulic engineering works for its mating will be completed by the 35th Shipyard, Murmansk, a subsidiary of the state machine-building enterprise *Zvyozdochka*, Arkhangelsk Region.

In December 2008 the Vyksa Steel Works, the Nizhni Novgorod Region, has absorbed a technology of epoxy corrosion-resistant coating of pipes designed for use in well structures of the oil and gas offshore deposits. Also the enterprise won a tender in 2008 and began to produce the set of large-diameter pipes with wall thickness of 30.9 mm, 34.6 mm and 41 mm which are unique for pipes of such diameter and grade. These pipes are going to supply the lead-in sections of the two lines of the bottom gas pipeline Nord Stream (Vyksa News, 2009).

In relation to the Arkhangelsk Region, Fadeev A.M. said that it is a center of the shipbuilding industry. Even the Murmansk Region was preferred over the Arkhangelsk Region to become an operational base for the Shtokman field development for the reasons of

better climatic conditions, lower intensity of navigation, and closer location to the deposit and shorter distance to the markets of the Atlantic Basin, the capacities of the Arkhangelsk Region will be in demand. There are some enterprises which have the opportunity to become suppliers of the Shtokman project such as production association *Sevmash*¹²⁹ and state machine-building enterprise *Zvyozdochka*, both located in Severodvinsk¹³⁰.

And the last step in the project execution is a field operation which requires the system maintenance, supply and services on sea and on land. Because the start-up is planned on 2013 for gas and 2014 for LNG, now only several steps are made.

A contract between Gazflot and the Central Design Bureau *Baltsudoproekt* on the project development of 11 vessels for the oil and gas tanker fleet including support and banking vessels of ice-class, fuel replenishment tankers, yard tugs, and oil spill response ships is signed. After design works are completed, the tenders for construction of vessels and ships will be issued. Sovcomflot is also engaged on a contract with Gazflot to supply the Shtokman project with transport services (Banko and Evtishina, 2008). The company operates a fleet of 47 tankers, including 4 gas carriers, and expands its activities in LNG transportation services.

According to the extension of the Russian tanker fleet in the Arctic region, the construction of the biggest in the world nuclear icebreaker named “50 Let Pobedy” (50 Year Anniversary of the Victory) was completed at Baltic Works in January 2007 (Bambulyak and Frantzen, 2007).

Gazprom places the direct orders for material, machines equipment, construction and assembly works for the implementation of different projects of the company with Russian enterprises. The cooperation with the defense enterprises allows Gazprom to refuse import of technological equipment and facilities of a rather wide range and on the other hand the defense enterprises could preserve over 40 thousand work places for skilled employees (Ananekov, 2008).

During the execution phase, the companies-operators will try to bring their own suppliers into the project. It is explained by the companies' needs of reliable and proven suppliers. Gazprom in this case relies a lot on the enterprises of defense industry.

¹²⁹ Today enterprise realizes one of the greatest projects of the national gas concern – building of marine ice-resistant stationary platform “Prirazlomnaya” meant for development of Gazprom’s Prirazlomnoye oil field in Pechora Sea. The company is also expecting an order from Gazprom for construction of the similar installations for the Shtokman field development (Starozhilov, 2008).

¹³⁰ Severodvinsk (*Russian: Северодвинск*) is a city in Arkhangelsk Region, Russia, located in the delta of the Northern Dvina, 35 kilometers west of Arkhangelsk (Wikipedia).

5.3.3. Marketing strategy

After the start-up the marketing strategy for gas shipments to the end customers will be implemented. In case of the Shtokman project there will be two types of product: liquefied natural gas and natural gas which will be delivered by gas carriers and pipelines, respectively. An approximate scheme of the downstream activities is presented in the following picture:

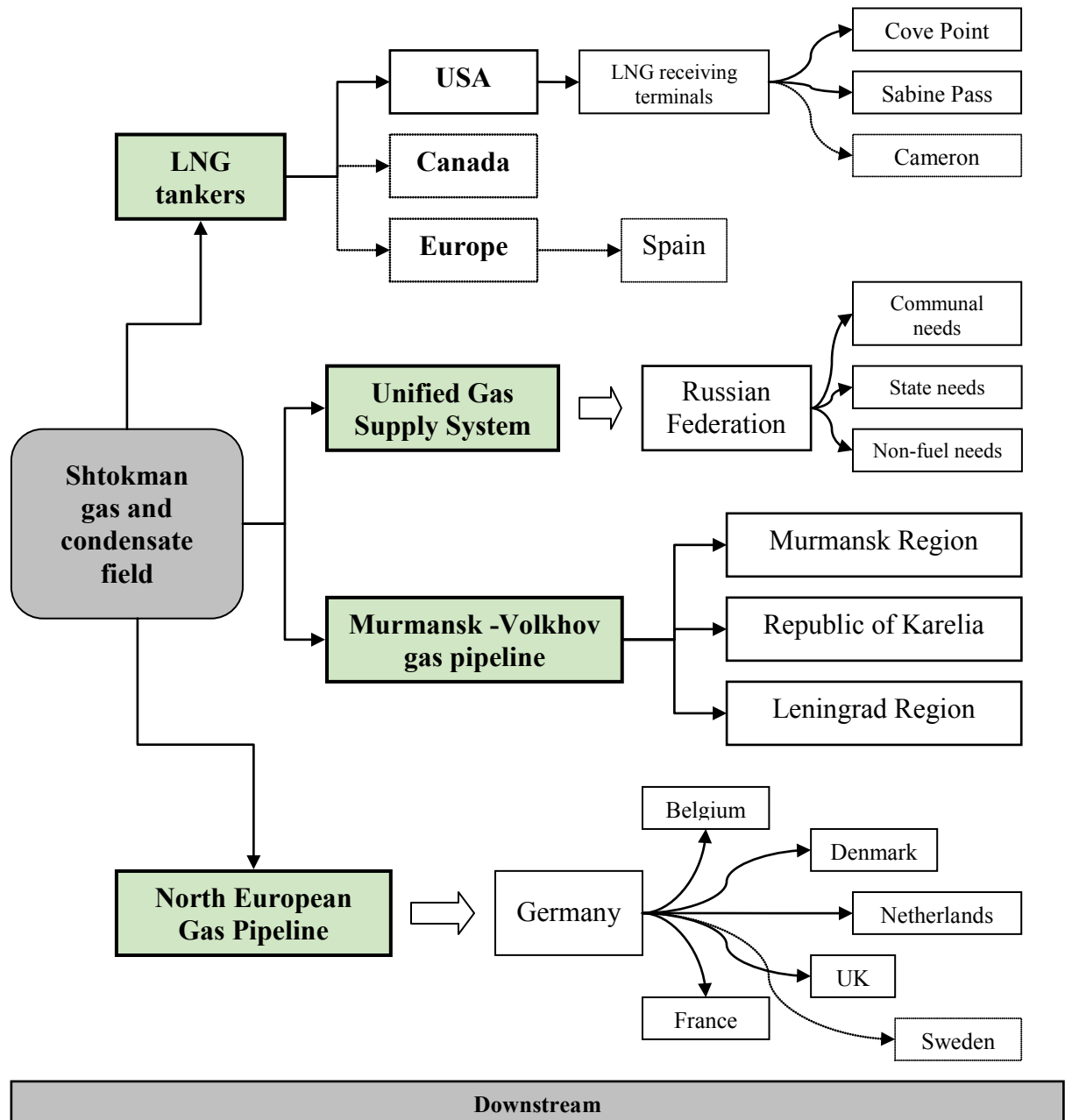


Figure 14. Gas distribution from the Shtokman gas and condensate field

The main question of the marketing strategy is whether the Shtokman field becomes a raw material resource base for LNG shipments to the North America or it is going to supply the increased consumption of the European countries with natural gas through the Nord Stream pipeline. Fadeev A.M. evasively answered that much of it depends on political factors.

If Russia and USA are on bad terms than there will be no deliveries of LNG, if in friendly relationships – the Shtokman field will supply the North American customers. It is understood that the Shtokman gas and condensate field is a resource base for Gazprom's export commitments. Mostly, gas from the developing deposit will be set into export; only 5% of the produced gas will remain for the Murmansk Region's gasification.

According to Banko (2007, №15), the gasification of the Murmansk Region amounts to 0.29 bcm on the initial phase of the field development with annual production of 23.7 bcm and up to 4.7 bcm when the designed capacity is reached and it is contemplated to produce 71.1 bcm of gas annually in 2021 (the optimistic forecast proposes 90 bcm of gas output).

Usova E.G. added that the gas consumption in the North-West Region of Russia is rather low. The minimum consumption is observed in the Murmansk Region, the region's gasification is on the ground level. The primary power system mainly consist of mazut (or oil fuel) and atomic power produced by an outdated nuclear power plant on the Kola Peninsula.

The question about the entrance to the market of USA and the regasification terminals which has to receive gas from the Shtokman field was almost left without an answer. Fadeev A.M. repeated that it depends on political situation when the field is commissioned. The plans to deliver gas on the LNG terminal in Canada are under consideration as well.

The presented above figure shows a pattern of the gas distribution directions. For LNG deliveries it is the markets of USA and Canada. According to the USA terminal capacities of the partners of Gazprom in developing the Shtokman gas and condensate field, the access to regasification facilities of the North American market will be gained on the Sabina Pass (Total) and Cove Point (StatoilHydro) terminals (indicated by straight-line frame). In case of trade joint ventures with Sempra Energy Gazprom will deliver gas extracted in the Barents Sea to its Cameron LNG terminal, Texas (indicated by dotted-line frame).

If the North American market is covered with political uncertainty than what are the reasons for Gazprom to swap the pipeline gas to LNG and sell it on the markets of the UK and USA? Fadeev A.M. clarified the situation like this. He said that the piped gas bears additional risks related to pipelining on the territory of the transit countries whose interests must be taken into consideration. In this case LNG is a product which is easy to redirect. Concerning the marketing side, gas is a cleaner and cheaper source of energy, and most of the countries assign the task to increase its share in the energy balance. Usova E.G. added that the cost of LNG is lower than for example of petroleum gas (LPG) which includes butane-propane fraction. Also the pipeline construction is a costly process; therefore gas supply by sea seems to be a rather profitable deal.

Additional question appeared in connection with LNG deliveries to Europe. Considering the increasing construction of the receiving LNG terminals and expansion of the world's tanker fleet, the LNG from the Shtokman field can be also shipped to Europe. Fadeev A.M. assumed that it is possible but along with the pipeline gas.

An interesting opinion about the supply of LNG and pipeline gas to Europe was made by Pravosudov (2007). The author claimed that the whole world puts a lot attention on the liquefied natural gas because it can be delivered by tankers at any place of the world comparing to the limited routes of the piped gas. In this case Gazprom's decision to send the bulk of gas from the Shtokman field to North European gas pipeline and to make LNG production a backstopping project goes against the world's energy stream. But it is not rational for Russia to enter the European market with large volumes of LNG from the Shtokman field because then the Russian liquefied gas will compete with the own pipeline gas. Besides, LNG delivery is economically feasible only on the distances of more than 4.000 km. If Gazprom decides to liquefy the whole Shtokman's gas then it has to find the remote markets for selling huge volumes of the extracted "blue fuel". That's why the main market for LNG is considered to be USA and Canada. LNG export to Europe can be seen as an adjunct to existing deliveries. In case of gas shortage or sharp rise in prices the Russian monopoly can meet the requirements of European consumers at the expense of LNG shipments, and even more can enter the market of Spain where the company has no activities yet. So Gazprom has to give a high priority first to the adjacent countries – it is more cost-effective, and then to use LNG from the Shtokman as additional source for diversification of the raw material supply.

According to the competition on the European market which is specified by empowerment of the Norwegian gas shipments and the policy of supply diversification initiated by the European Union, Fadeev A.M. expressed his subjective opinion that Gazprom will not face a rigorous competition. Gazprom can not assure the market alone, so other players, including Norway, are important to provide the reliable and uninterrupted gas supplies for European customers. Gazprom has a lot of export commitments¹³¹ in Europe so the development of the Shtokman field will ensure compliance with these obligations.

According to Wood (2007, № 37), the emergence of a strategic alliance between Statoil (now StatoilHydro), which focuses on developing further infrastructure ties with both Western and Eastern Europe and exploiting Barents Sea gas resources, and Gazprom could have a major impact on global long-term gas supply dynamics.

¹³¹ According to the Director General of Gazprom Export, Medvedev A., in 2006 the long-term contracts were extended with Italy (until 2035), France (until 2031), the Czech Republic (until 2035), Austria (until 2027), and Germany (until 2035). And for the first time an agreement was signed with Denmark (Gazprom Export, 2008).

5.4 Cooperation within the supply chain in the project

Supply chain provides an opportunity for operators to work together through shared information to produce and deliver goods to customers. Business supply chains are more likely to survive, grow and profit if they integrate the development of new products with a balanced supply chain in which a partner company combines to provide the goods that consumers want. Cooperation between firms belonging to the same supply chain is now recognized as a powerful source of competitive advantage (Sadler, 2007).

According to Waters (2003), there is one type of cooperation that may become more appropriate for joint arrangements. One of the options of a vertical integration is to start a joint venture, where organizations put up funds to set up a third company with shared ownership. The Shtokman Development AG was created on this principle. As it was mentioned before, the task of the company is the infrastructure development of the first phase of the Shtokman project.

Birgit and Tage (2005) define the number of specific factors of how far the concrete working relationship progresses towards integrated coordination. The first specific factor of the supply chain integration is a product classification. Gas is a functional product with a fairly stable and predictable demand. The incentive to integrate within the supply chain is high in order to implement new technologies, improve the cost efficiency, enhance investment and share the risks. The second feature is a governance structure of the integrated supply chain. Gas extraction from the Shtokman field can be defined as development of a mature product but in new conditions. Gazprom has to place greater reliance on the partners' expertise in coordinating all aspects of complex project execution, especially in relation to new technologies and work experience in the arctic conditions. The participants in their turn will bring in their suppliers and contractors in the project to provide a better design and execution of the operations. The third factor is an industry maturity. Even oil and gas industry is a mature one the companies try to organize all activities such as production, marketing, distribution and service support within the firm boundaries. It is explained by strategic nature of the product and its significance for the country's energy safety and export reliability. So the level of integration is limited by the company's policy and country's needs. The last feature which characterizes integration is dominance, or power distribution among participants in the supply chain. In case of the Shtokman field development Gazprom saves the rights for marketing the product. Whoever has the relationship with the end user has the power in the supply chain (Lambert, 2001). Also Gazprom is among these large operators which interface with governmental entities and are closely linked to governments itself (Anderson, 2003). The

supply chain integration will blossom if the dominant partner is convinced of the need for integration and takes an initiative to mobilize all the partners (Birgit and Tage, 2005). Gazprom was changing its decision about the joint development of the Shtokman field but finally invited two international partners in the project due to high costs of development and need for new technical solutions.

According to Birgit and Tage (2005) the degree of integration depends very much on industry culture and traditions. In oil and gas industry, limited integration and a reactive adoption of new technology are likely to occur. Still most of the costly and technology intensive projects have a common feature of joint development of products and processes. The cooperation between the participant companies gives advantages in cost reduction, shared risks, higher performance of activities and technology exchanges.

5.4.1 Associations of suppliers

Supply chain management may require various actors at all levels of hierarchy to work together to achieve a common goal. Organizational integration can become a catalyst by facilitating information sharing within and among firms (Birgit and Tage, 2005). A good example of such cooperation is associations of suppliers for oil and gas industry: *Murmanshelf* (Murmansk) and *Sozvezdye* (Arkhangelsk).

Fadeev A.M., as the ex-Executive Vice President of Murmanshelf, told the whole story about the Murmanshelf organization and its main tasks. The establishment of the association Murmanshelf is one major area of cooperation between Government of the Murmansk Region and the oil and gas company Statoil ASA. After the ex-Governor of Murmansk Region, J. Yevdokimov visited the Kingdom of Norway in August 2005, the company offered to study the work experience of the association for oil and gas suppliers *Petro Arctic* which activity in Norway surpassed all the expectations. In order to adopt the procedures and to create a similar company in Russia, a working group was created. It consisted of the representatives of the Murmansk Region Administration and the Union of Industrialists and Entrepreneurs (Employers) under the guidance of Statoil and Petro Arctic. As the result the association of oil and gas suppliers Murmanshelf was registered on May 12, 2006 in Murmansk.

A major task of the company is to enhance the competence of the enterprises - suppliers of oil and gas industry. Because the Murmansk Region has absolutely different areas of activities (it was always a fishing region), there is a need of production reorientation which allows cooperation in oil and gas field development of the Arctic shelf. It takes long time to diversify production, re-educate personnel, purchase new equipment, and so on. The oil and gas industry imposes heavy demands on quality and places first priority in Health, Safety and

Environment (HSE). So the suppliers have to comply with these requirements for securing the orders. The aim of the association is to develop the Russian oil and gas suppliers' market, enhance the companies' competence and increase their competitive ability. Even there is a tendency of the local content creation; the market is driven by competition.

Murmanshelf Association includes 190 members, among them more than 20 international companies. The presence of foreign partners stimulates and enhances the qualification of the Russian companies. International enterprises have a longer working experience in oil and gas industry; possess high technologies and quality certificates. So there are a lot of things that can be adopted. During the association's activity 22 international seminars for the members of the association were organized. It helped some of the Russian companies "*to change themselves remaining who they are*". Fadeev A.M. concluded that now some of them are ready to compete with international suppliers.

Another regional network of oil and gas suppliers Sozvezdye works for development of the enterprises located in the Archangelsk Region, assisting potential companies to become suppliers of goods and services to the oil and gas industry. The industrial capacities of Arkhangelsk enterprises are in a well-situated position to be involved into the work on the implementation of the Shtokman activities. The development of the gas and condensate field will require large supplies of structural steel, work wear, food, paint and varnish products; handling of construction, exploration, transport, research and other supplies of goods and services (Sozvezdye, 2009).

According to interaction between these suppliers associations, Fadeev A.M. said that Murmanshelf signed a cooperation agreement with Petro Arctic (Norway) in September 2006 and with Sozvezdye (Arkhangelsk) in October 2006. It is important to mention that the companies Murmanshelf and Sozvezdye are the prototypes of Petro Arctic which joins together about 360 enterprises-suppliers of oil and gas industry. The associations arrange seminars and workshops specially adjusted to their members' needs. Statoil participates as advisor and provides contributors on the basis of non-repayable help. The company shares its experience, supports the associations with guidance within such areas as supplier requirements, qualifications, contracting and purchasing, and issues related to procurement and logistics. Also an agreement on cooperation was signed with a Norwegian organization *INTSOK* in November 2007 so that Murmanshelf became a regional partner of the company on the territory of the Murmansk Region and the Republic of Karelia.

The cooperation occurs also inside the association between its members. It is essential in order to reduce costs and improve competitive power, to strengthen relationships and build up

trust. Creation of the regional industrial clusters, alliances and consortiums allows companies, especially of a small and medium-size business, to increase qualification and competence, and as a consequence, their competitive capacities on the market. A good example of such incorporation is consortium “Murmanshelf-Construction” which represents a union of building companies. They are going to bid for the future tenders on participation in the Shtokman field development offered by the companies-operators.

So the main goal of the suppliers association is to promote the interests of the members, to support the suppliers of oil and gas industry in respect to the requirements of the project operators. Because the Shtokman field project is on the phase of FEED development, no tenders were issued yet so the companies are just preparing their activities and capacities for the future participation in the project.

5.4.2 Cooperation on a higher level

Another type of cooperation which is represented in the Shtokman field development is between the companies and the federal subjects of Russia. Because a major gas project both onshore and offshore has need of a solid infrastructure development ensuring gas extraction and its transportation to domestic and export markets (Yevdokimov, 2006), the determination of the strategic partners such as the Murmansk Region and the Russian Federal Navy are of a great significance for Gazprom and other operators.

Gazprom and the Russian navy, the Northern Fleet, signed a memorandum on joint cooperation and action in the Russian North in 2002. Gazprom and the Northern Fleet are supposed to cooperate when executing projects concerning the construction of facilities for the oil and gas converting and transporting. According to the agreement, the Northern Fleet will also participate in designing and building infrastructure facilities for the Shtokman gas condensate field, and the plant in Teriberka for producing liquefied natural gas, and construction work on the North European Gas Pipeline.

This memorandum also designates the use of the naval auxiliary, shipbuilding and ship repair factories, and navy territory; the establishment of an integrated security system for production facilities and the transportation of oil and gas by sea, including provision of an emergency rescue system; and the development of a joint transport provision plan, which includes transport by sea, air and other forms (Lesikhina et al., 2007).

Strong assistance to the project execution is scheduled to be received from the Murmansk Region Administration based on the cooperation agreement with Gazprom dated November 2005 (Bambulyak and Frantzen, 2007).

By signing the five-year agreement, the parties confirmed mutual interest in stepping up the following paramount activities in the Murmansk Region:

- developing and implementing the Barents offshore oil and gas fields development programs, including the Shtokman field project, with a special working group to be set up for that purpose;
- implementing gas pipeline and processing and transmission infrastructure construction projects;
- erecting infrastructure for cargo reception, transfer and storage and for gas and its processing products sea-borne transportation;
- supplying gas to localities, creating and developing a sustainable gas supply system in the Murmansk Region;
- making use of the Murmansk Region's industrial capacities (Gazprom News, 2005).

The regional authorities will assist Gazprom in performing design and survey and construction works in the region, providing Gazprom and its subsidiaries with area for construction of the Shtokman gas condensate field infrastructure and organizing liquefied gas production and transmission. Additionally, the Regional Government will contribute to enacting legislation fixing tax benefits for the companies engaged in targeted investment and social gas supply programs. The parties will also take measures to improve the regional energy balance and will promote the implementation of high-efficiency projects in the Murmansk Region with the view of expanding the competitive products manufacture for Gazprom's needs (Gazprom News, 2005).

The fact that gas from the Shtokman field will come to the Murmansk Region means not only start-up of a new and prospective LNG production, consolidation of the Russian competitive position on the gas export markets, but also positive socio-economic impact on the Murmansk Region. The development of the Shtokman gas and condensate field will significantly effect the further economic growth of the region, the strengthening and maintenance of the social sphere, and as a result, it will increase the welfare of people (Yevdokimov, 2006).

Fadeev A.M. also was telling about a multiplier socio-economic effect of a new project development. First, it involves allied industries; second, it increases employment, stimulates labor power intake and gives opportunities for graduates and undergraduate applicants. And third, as consequence, it will improve the region's socio demographic conditions. The

construction of roads, social facilities and residential buildings, installation of communication facilities and infrastructure development will also be covered by the socio-economic impact. Additionally, the territorial area of Teriberka where LNG factory is planned to be built will change significantly in a positive way.

The strongest effect of the Shtokman project development is gasification of the Murmansk Region. As it was mentioned before, Murmansk is using mazut which is expensive and not easy to be delivered because of railroad workload. According to Usova E.G., the gasification of the Murmansk Region is the keystone of the region's successful development.

The Murmansk Region has all the chances to become a new gas province of Russia and one of the most attractive regions in the world (according to words of Usova E.G. and Fadeev A.M., respectively).

StatoilHydro is also interested in sharing experience with Northwestern Russia. It promotes cross-border cooperation, sharing of opportunities and responsibility for environment and society. The company renewed cooperation agreements with Murmansk in January 2008 and with Arkhangelsk in February 2008 (Kjærnes, 2008). The President of StatoilHydro in Russia, B.L. Hansen claimed that the Shtokman project affords an opportunity for cooperation with Russia on strategically important issues. The management of the company is of opinion that the development of the Shtokman field may become such kind of a motive power which will bring the company to other Arctic projects and enhance the relationships with Gazprom and the whole Russian oil and gas industry (Interview NGV, 2008)

In conclusion it is reasonable to repeat the words of Y. Yevdokimov, the ex-Governor of the Murmansk Region, who said that the Shtokman project in the Barents Sea can serve as a model for international cooperation in the Arctic (Murmanshelf News, 2008).

5.5 Conclusion

The given chapter illuminates the implementation of the supply chain concepts in accordance to the Shtokman project development. It described Gazprom as operator and its role in the project execution; the tasks and objectives of two participating as investors companies; and the main thing is that the chapter gives an overview of the supply chain, including the upstream and downstream activities and selection of contractors and suppliers.

Even the final investment decision is not made yet; there are some evaluations of the preliminary cost of the first phase of the Shtokman field development. According to News service NGV (2008), it accounts to \$14-15 bln. Such numbers speak for themselves. That's why the creation of a stable and reliable supply chain is of a great importance for the long-term execution of the project.

The upcoming field development of the Shtokman deposit creates large market opportunities for international and national suppliers of the oil and gas industry. More and more companies have a wish to participate in the project execution. In this case two factors have to be emphasized: the technological expertise of the supply chain participants and the share of the national and regional companies in the project.

Also the cooperation which allows developing close relationships with key partners up and down the supply chain is of a great importance for successful project execution. These relationships must be characterized by openness and trust, shared goals and objectives, flexibility and willingness to solve common problems, and long-term commitment. A great job was done already and will be done even more by the suppliers associations Murmanshelf and Sozvezdye in this case.

And as any major project the development of the Shtokman gas and condensate field will bring a lot of positive tendencies in development of the region's economy and society.

Conclusions

The given research was conducted for the purpose of the supply chain study in oil and gas industry on the model of the Shtokman field development project. The work started with formulation of the problems represented in introduction. In order to get deep understanding and knowledge about the research question the theoretical investigation was created. This theoretical background together with methodology allowed recognizing the data needful for research, the way how to implement it and how to compose the interview guide.

Then theory was presented in the context of oil and gas industry that became a background for analysis of the Shtokman gas and condensate field development from the supply chain point of view. The description of the Shtokman project as a basis for supply chain implementation was presented in the empirical part of the given paper. It included such spheres as exploration works, partner selection, engineering concept, transportation system and marketing strategy, and also ecological and political aspects of the project. Final step of the given research was made to structure and analyze the received data in order to create the entire supply chain of the chosen gas project and answer the stated question.

The analysis of the supply chain of the Shtokman project was presented in the previous chapter. The empirical data found its reflection in the theoretical background of the given paper. The distribution of the upstream and downstream activities according to the concept of the project development was shown. All the stages of the project execution were explored and all the possible at this stage contractors and suppliers were named.

Having analyzed the empirical data in the theoretical framework the next conclusions were made. They are presented in the following table. The structure of the table is developed in such a manner so that the upper row shows the main steps of the project execution starting from exploration and drilling works and finishing with operation activities. Since only the first phase of the Shtokman project is defined, the table does not include decommissioning of the field. The column from the left side presents the supply chain consisting of operators, contractors, product suppliers, service companies and research institutes. In the boxes the companies and enterprises which *were, are or will* perform particular activities and works in relation to their roles in the supply chain of the Shtokman project development are presented.

Because of limitations specified in introduction the operation phase does not include such activities as logistics and transportation, well services, maintenance and modifications, project management and environment protection. These operations will be defined when the Shtokman Development Company holds tenders for the contracts, after FEED is completed.

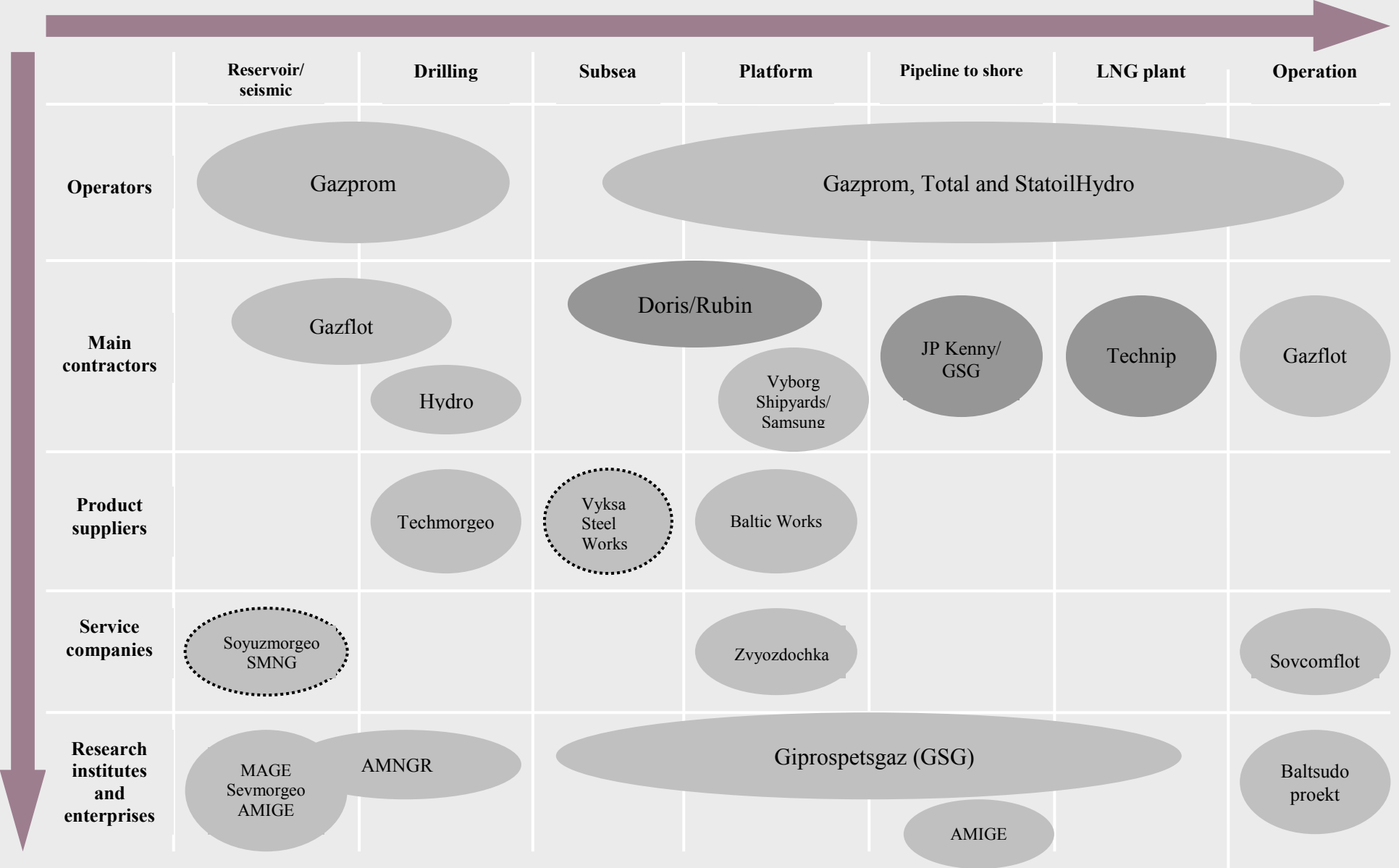


Table 5. Supply chain of the Shtokman field development project

There are some specifications in the table that have to be clarified. The companies which are ringed with a dotted line do not effect execution of the Shtokman project directly. The common efforts of the companies Soyuzmorgeo and Sevmorneftegeofizika increased the geophysical works in the Arctic offshore areas but it was not clearly defined in the literature if they participated in discovery of the Shtokman field. According to the Vyksa Steel Works, the company has absorbed a technology of pipes coating designed for use in well structures and as supplier for Nord Stream pipeline has a good chance to win a tender. The last thing is that the companies which are marked by darker color were selected at this stage to prepare the front-end engineering and design in the indicated areas. Since most of these companies provide total spectrum of services, they will participate in construction of the designed facilities.

The given table presents only the upstream activities of the Shtokman field development. The downstream activities which mostly consist of the operations covered by the marketing strategy were given as assumption in relation to Gazprom's export commitments and diversification of supplies to the markets of Europe and North America. The decisions on gas distribution routes and selection of suppliers for gas shipment and related activities will be taken before the field's startup and LNG plant commissioning.

This table carries much more information than it can be seen from the first sight. It reflects the participation of the companies in the project development, their activities and roles. The balance between the national and international companies is clearly arranged in the table. The share of the national enterprises is rather high in this project, especially in the area of the research and development. The international companies are more presented in the technology intensive works such as subsea complexes, platforms and LNG plant construction.

As it was mentioned before, the table reflects only part of the project execution and participation only of these companies which perform the work for this phase. When the FEED is completed and FID is accepted, the tenders for construction, product supplies, system integration and other services will be issued. So the number of participating companies will grow extremely. The size of the table will extend but the approach remains the same. Here is a novelty of the given work and a good basis for the future investigations. The following direction of researches can be interesting and relevant:

- comparison study of supply chains in offshore and onshore projects;
- balance between national and international companies in supply chain of a field development project;
- implementation of the supply chain management concepts in oil and gas industry.

Cooperation within the supply chain is also one of the most important factors of a successful project execution. Since the main table does not reflect the integration of the companies, another figure was prepared to make it clear. As it can be seen the associations of oil and gas suppliers are collaborating internally, organizing joint seminars, education programs, and providing info services. Their main task is to increase the competence and competitive capacity of the

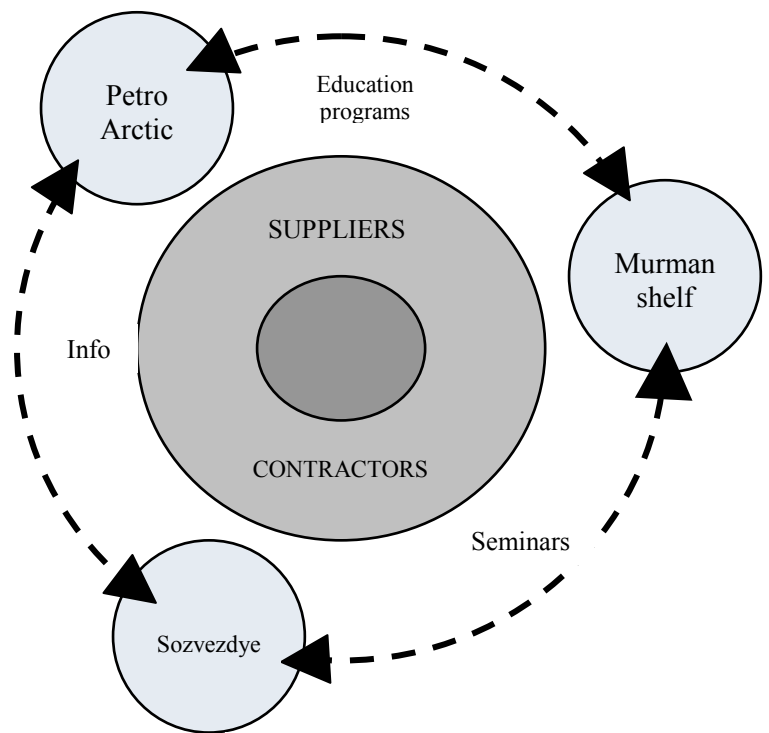


Figure 15. Cooperation in the project

suppliers and to bring these companies closer to the project execution. The supplier relationship management is a growing trend in the oil and gas supply chain operation.

The researcher has no opportunity to influence the development process but he or she can gather data, present it and estimate from the theoretical framework. It is the main task of the given research. The results of this work give a new understanding and knowledge of the supply chain in oil and gas industry and can be used as theoretical background in other case studies of oil and gas field development projects.

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LIST OF COMPANIES

1. **PSAC**

The Petroleum Services Association of Canada is the national trade association representing the service, supply and manufacturing sectors within the upstream petroleum industry. PSAC represents a diverse range of over 270 member companies, employing more than 62 000 people and contracting almost exclusively to oil and gas exploration and production companies. PSAC member companies represent over 80% of the business volume generated in the petroleum services industry (<http://www.psac.ca/>).

2. **PeopleSoft**

PeopleSoft, Inc. was a company that provided Human resource management systems (HRMS), customer relationship management, Manufacturing, Financials, Enterprise Performance Management, and Student Administration software solutions to large corporations, governments, and organizations. PeopleSoft is also the name of the company's product suite. In december 2004, Oracle announced that it had signed a definitive merger agreement to acquire PeopleSoft (Wikipedia).

3. **Total**

Total S. A. (France) is a leading multinational energy company with 96 400 employees and operations in more than 130 countries. Together with its subsidiaries and affiliates, Total is the fourth largest publicly-traded integrated international oil and gas company in the world. Total engages in all aspects of the petroleum industry, including upstream operations (oil and gas exploration, development and production, LNG) and downstream operations (refining, marketing and the trading and shipping of crude oil and petroleum products). Total also produces base chemicals (petrochemicals and fertilizers) and specialty chemicals for the industrial and consumer markets. In addition, Total has interests in the coal mining and power generation sector (http://www.total.com/en/group/activities/activities_871.htm).

4. **Engen**

Engen Petroleum Ltd, currently the second largest integrated oil company in Southern Africa after Sasol, was created in 1989. Engen has a sophisticated refinery in Durban. Engen is the major oil product marketing company in the region with a product range that includes fuels, lubricants and chemicals. Engen holds major strategic interest in Energy Africa (<http://www.mbendi.com/coen.htm>; <http://www.engen.co.za/home/server/default.asp>).

5. **Accenture**

Accenture is a global management consulting, technology services and outsourcing company. Combining unparalleled experience, comprehensive capabilities across all industries and business functions, and extensive research on the world's most successful companies, Accenture collaborates with clients to help them become high-performance businesses and governments (www.accenture.com).

6. **SAP**

SAP AG is the largest European software enterprise and the fourth largest in the world, with headquarters in Walldorf, Germany. It is best known for its SAP ERP Enterprise Resource Planning (ERP) software. SAP is the world's second largest business software company and the third-largest independent software provider in terms of revenues (Wikipedia).

7. **Arktikshelfneftegaz**

Closed Joint Stock Company "Arktikshelfneftegaz" (ASNG) was founded in January, 2002 by "Arktikmorneftegazrazvedka" (AMNGR) – a 100% Russian State Owned Company and by "Promyshlennye Investitsiy" ("Industrial Investments") Joint Stock Company, with the main objective of production of oil from the Barents Sea continental shelf and its direct export to the world market. The company is licensed for a wide range of activities, related to oil and gas production and marketing (exploration, production, research, design engineering, appraisal and remedial work, commercial activity, including export of oil and gas). Along with having the licenses for exploration and

production of the Medyn-Varandey, Pomorsky and Koloklmorsky blocks, ASNG is a sole proprietor of an extensive shore base in the Kola Bay (Murmansk) with piers, storage facilities and supply depot. The company is located in Murmansk (<http://www.ashng.ru/english/>).

8. **MAGE**

Joint Stock Company Marine Arctic Geological Expedition (JSC MAGE) is one of the leading marine companies in Russia, provides comprehensive seismic and geological-geophysical services for exploration of the shelf and the World Ocean mineral resources. The seismic surveys encompass 2D, refraction, wide angle deep seismic profiling, magnetic gradientometry, marine gravity, bottom sea sampling and high resolution seismic. It owns three research vessels: “Geolog Dmitriy Nalivkin”, “Professor Kurentsov”, “Geofizik”. The company Marine Arctic Geological Expedition was founded in Murmansk in 1972 to explore new hydrocarbon provinces of the Arctic shelf. In 1994 it became a joint stock company (<http://www.mage.ru/indexe.html>).

9. **Sevmorgeo**

The Federal State Unitarian Research and Production Company for Geological Sea Survey (SEVMORGEO) was established as an independent legal entity in November, 1991. Company founder is the USSR Ministry for Geology. On December 31, 2004 the Sevmorgeo was placed under the authority of the Federal Agency for Resources Management (http://www.sevmorgeo.com/eng/frame_e.html).

10. **Sevmorneftegeofizika**

Joint Stock Company “Sevmorneftegeofizika” (SMNG) is the largest marine geophysical company in Russia with a 30 years track record. It renders a wide range of marine geophysical services, including 2D/3D marine seismic acquisition, navigation positioning, seismic data processing and integrated interpretation of seismic data. Sevmorneftegeofizika (SMNG) was established in 1979 to provide geological/geophysical exploration for oil and gas across Arctic Seas of the former Soviet Union. Over 1979-2003 SMNG was a state-owned enterprise. In the end of 2003, the Federal State Unitary Enterprise “Sevmorneftegeofizika: was transformed into the Joint Stock Company “Sevmorneftegeofizika” (JSC SMNG), with a 100% share in federal property. JSC SMNG's head office and the management are in Murmansk (<http://www.smnggeophysics.com/eng/about-us.html>).

11. **Arktikmorneftegazrazvedka**

The Federal State Unitary Enterprise “Arktikmorneftegazrazvedka” (AMNGR) was created in 1979 for the purpose of execution of prospecting, exploratory and engineering works in the oil and gas deposits in the shelf of the Arctic Seas. The company's structure secure the implementation of complete complex of marine geological surveyance drilling of the probe wells of the oil and gas fields, including planning and building of wells and development and construction of oil and gas fields (<http://www.amngr.ru/>).

12. **Rosshelf**

On May 7 and 8, 1992, the Russian close-stock company for offshore development, Rosshelf, was established. On May 29, 1992, Rosshelf was registered in Severodvinsk. Nineteen Russian state enterprises in the oil and gas complex, defense shipbuilding, geological services and regional executive agencies became the founders of this company. In 1993 ten more concerns entered the company as stockholders. Rosshelf's main goal was to develop resources on the continental shelf of the territorial seas and the offshore exclusive economic zone of Russia. On March 15, 1993, the licenses for the right to use the Shtokmanovskoye gas field and Prirazlomnoye oil field reserves were granted to Rosshelf (together with Gazprom receiving the controlling stock). The contributions of the company in the Shtokman field development are: evaluation of reserves and some exploratory drilling, the feasibility study of the field's facility construction and an enormous amount of engineering, geological and environmental research (Velikhov and Kuznetsov, 1997).

13. **Soyuzmorgeo**

JSC Soyuzmorgeo is a Russian company which provides geological services in oil and gas indutry. It was participating in the exploration of the Russian Continental Shelf, especially in the water area of the Barents Sea. It is located in Gelendzhik, Krasnodar Territory.

14. **Gazflot**

CJSC Gazflot is a 100% subsidiary of JSC Gazprom which was created for the purpose of performing the common policy in the sphere of geological prospecting works and development of oil and gas fields on the Continental Shelf of the Russian Federation. Gazflot holds licenses for well drilling onshore and offshore, development of oil and gas deposits, carrying out transportation of freight and passengers. It has two divisions: one in Murmansk and one in Kaliningrad. The Murmansk division provides the drilling operations and oil and gas extraction in the Prirazlomnoye, Shtokmanovskoye fields and Peninsula Yamal (<http://www.gazflot.ru/>).

15. **Sevmorneftegaz**

JSC Sevmorneftegaz was created in January 2002 by the decision of JSC Gazprom and JSC Rosneft for the purpose of exploration and development of the Prirazlomnoye (oil) and Shtokman (gas and condensate) fields which are located on the shelf of the Pechora and Barents Seas (<http://www.sevmorneftegaz.ru/>). Sevmorneftegaz holds the license to search for, explore, and produce gas and condensate from the Shtokman field (Gazprom, Shtokman project, 2008).

16. **Shell**

Royal Dutch Shell plc, commonly known simply as Shell, is a multinational oil company of Dutch and British origins. It is the second largest private sector energy corporation in the world, and one of the six “supermajors” (vertically integrated private sector oil exploration, natural gas, and petroleum product marketing companies). The company’s headquarters are in The Hague, Netherlands, with its registered office in London (Shell Centre) (Wikipedia). With around 102 000 employees in more than 100 countries and territories, Shell helps to meet the world's growing demand for energy in economically, environmentally and socially responsible ways. Royal Dutch Shell consists of the upstream businesses of Exploration & Production and Gas & Power and the downstream businesses of Oil Products, Chemicals and Oil Sands (<http://www.shell.com/>). In Russia company is participating in such projects as Sakhalin II, development of Salim fields, and in Caspian pipeline Consortium (http://www.shell.com.ru/home/content/rus/aboutshell/shell_businesses/).

17. **Statoil**

Statoil ASA was a Norwegian petroleum company established in 1972, now part of StatoilHydro. The brand Statoil is retained as a chain of fuel stations owned by StatoilHydro. Statoil was the largest petroleum company in the Nordic countries and Norway’s largest company, employing over 25 000 people. While Statoil was listed on both the Oslo Stock Exchange and the New York Stock Exchange, the Norwegian state still held majority ownership, with 64%. Statoil was one of the largest net sellers of crude oil in the world, and a major supplier of natural gas to the European continent, Statoil also operated around 2000 service stations in 9 countries (Wikipedia).

18. **Hydro**

Norsk Hydro ASA is a Norwegian aluminium and renewable energy company, headquartered in Oslo. Hydro is the fourth largest integrated aluminium company worldwide. It has operations in some 40 countries around the world and is active on all continents. The Norwegian state holds a 43.8 % ownership interest in the company, which employs approximately 28 000 people. In 2007 Norsk Hydro took the step in its restructuring process, merging its oil and gas operations with Statoil, creating StatoilHydro. What remained was the new Hydro: a global, integrated aluminium company (<http://www.hydro.com/en/>).

19. **ConocoPhillips**

As a global company that uses its pioneering spirit to responsibly deliver energy to the world, ConocoPhillips has assets and operations in more than 30 countries. Headquartered in Houston, Texas, the company has more than 30 000 employees worldwide and assets of \$143 bln. Through its Exploration and Production (E&P) segment, ConocoPhillips explores for and produces oil, natural gas and natural gas liquids (NGL) throughout the world. Its portfolio includes strong legacy producing assets in the Lower 48 U.S. states, Alaska, Canada, the United Kingdom and Norway; and growth opportunities offered through major development projects in the Middle East, North Africa and the Asia Pacific region. ConocoPhillips is the second-largest refiner in the United States; and the world’s fourth-largest non government-controlled refiner (<http://www.conocophillips.com/index.htm>).

20. **Chevron**

Chevron is one of the world's largest integrated energy companies. Headquartered in San Ramon, California, it conducts business in more than 100 countries. It is engaged in every aspect of the crude oil and natural gas industry, including exploration and production, manufacturing, marketing and transportation, chemicals manufacturing and sales, geothermal, and power generation. The company is also investing in renewable and advanced technologies. The diverse and highly skilled global workforce consists of approximately 62 000 employees and about 5 000 service station employees. In 2008, Chevron produced 2.53 mln barrels of net oil-equivalent per day. Chevron had a global refining capacity of more than 2 mln barrels of oil per day at the end of 2008. The marketing network supports more than 22 000 retail outlets on six continents (<http://www.chevron.com/>).

21. **ExxonMobil**

ExxonMobil Corporation is an American oil and gas corporation. It is a direct descendant of John D. Rockefeller's Standard Oil company, and was formed on November 30, 1999, by the merger of Exxon and Mobil (Wikipedia). ExxonMobil is the world's largest publicly traded international oil and gas company. It holds an industry-leading inventory of global oil and gas resources. It is the world's largest refiner and marketer of petroleum products. And its chemical company ranks among the world's largest. Worldwide, ExxonMobil markets fuels and lubricants under three brands: Esso, Exxon and Mobil (<http://www.exxonmobil.com/corporate/>). The company has 38 oil refineries in 21 countries constituting a combined daily refining capacity of 6.3 mln barrels. The company employs over 82 000 people worldwide with approximately 4 000 employees in its Fairfax downstream headquarters and 27 000 people in its Houston upstream headquarters (Wikipedia).

22. **Linde**

The Linde Group, registered as Linde AG was founded in 1879. The group is headquartered in Munich, Germany, with some functions in Surrey, England (Wikipedia). The Linde Group is a world leading gases and engineering company with almost 52 000 employees working in around 100 countries worldwide. In the 2008 financial year it achieved sales of EUR 12.7 bln. Gases Division is one of the leading suppliers of industrial gases in the world. It is also focusing on expanding the fast-growing business with medical and therapeutic gases. Engineering Division is focused on promising market segments such as hydrogen, oxygen and olefin plants and natural gas processing plants (<http://www.linde.com/international/web/linde/like35lindecom.nsf/docbyalias/homepage>).

23. **Dominion**

Dominion is one of the nation's largest producers and transporters of energy, with a portfolio of approximately 27 400 megawatts of generation, 1.2 tcf equivalent of proved natural gas and oil reserves, 14 000 miles of natural gas transmission, gathering and storage pipeline and 6 000 miles of electric transmission lines. Dominion operates the nation's largest natural gas storage facility with 975 bcf of storage capacity and serves retail energy customers in 12 states. Corporate headquarters are in Richmond, Virginia, USA (<http://www.dom.com/about/index.jsp>).

24. **Cheniere**

Cheniere Energy, Inc. is developing a platform of three, 100%-owned, onshore liquefied natural gas, or LNG, receiving terminals along the U.S. Gulf Coast. Cheniere plans to leverage its terminal platform by pursuing related LNG business opportunities both upstream and downstream of the terminals. Cheniere Marketing, Inc., a wholly-owned subsidiary of Cheniere Energy, Inc. was created in 2005 to commercialize Cheniere's network of LNG receiving capacity. Cheniere is also the founder of and holds a 30% limited partner interest in a fourth LNG receiving terminal project, participates in an LNG shipping venture, and operates an oil and gas exploration company in the shallow waters of the U.S. Gulf of Mexico. Cheniere is based in Houston, Texas, with offices in Johnson Bayou, Louisiana, and London, U.K. (<http://www.cheniere.com/default.shtml>).

25. **Sumitomo**

Sumitomo Group is one of the largest *keiretsus*, founded by Masatomo Sumitomo (Wikipedia). Sumitomo Corporation is a leading general trading company, boasting 150 locations in 70 countries throughout the world. The entire Sumitomo Corporation Group consists of nearly 900 companies and more than 60 000 personnel (<http://www.sumitomocorp.co.jp/english/>). Sumitomo Heavy Industries, a

comprehensive manufacturer of industrial machinery, manufactures and sells various products that range from general industrial machinery to cutting-edge precision control machinery and components (<http://www.shi.co.jp/english/index.html>).

26. **Mitsui**

Mitsui Group is one of the largest corporate conglomerates (*keiretsu*) in Japan and one of the largest publicly traded companies in the world. Companies currently associated with the Mitsui family include Mitsui & Co., Mitsui Construction Co., Mitsui Engineering and Shipbuilding Co., Mitsui Mining & Smelting Co., Mitsui Mining Co., Mitsui OSK Lines Ltd., Mitsui Petrochemical Industries Ltd, Mitsui-gold, Mitsui Real Estate, Tri-net Logistics Management, Mitsui Chemicals and Pacific Coast Recycling, Mitsui-Soko Co, Ltd. (Wikipedia).

27. **Lukoil**

Lukoil (LUKoil) is one of the world's leading vertically integrated oil and gas companies. Main activities of the company are exploration and production of oil and gas, production of petroleum products and petrochemicals, and marketing of these outputs. Most of the company's exploration and production activity is located in Russia, and its main resource base is in Western Siberia. Lukoil owns modern refineries, gas processing and petrochemical plants located in Russia, Eastern and Western Europe, near-abroad countries. Most of the company's production is sold on the international market. Lukoil petroleum products are sold in Russia, Eastern and Western Europe, near-abroad countries and the USA. The company has around 1.1% of global oil reserves and 2.3% of global oil production. Lukoil dominates the Russian energy sector, with 18% of total Russian oil production and 19% of total Russian oil refining (http://www.lukoil.com/static_6_5id_29_.html).

28. **Sempra**

Sempra Energy was created in 1998 by a merger of parent companies of two long-established, and highly respected, investor-owned utilities with rich histories dating back more than 100 years. Based in San Diego, Sempra Energy is a Fortune 500 energy services company with 2008 revenues of nearly \$11 bln. With 13 600 employees worldwide, the Sempra Energy companies develop energy infrastructure, operate utilities, and provide related products and services to more than 29 mln consumers worldwide. Sempra LNG is working to bring natural gas to North America to meet the growing demand. Sempra LNG is developing three receipt terminals: Energia Costa Azul in Baja California which began commercial operations in May 2008; Cameron LNG in Louisiana will begin commercial operations in mid 2009; and Port Arthur LNG in Texas is in development (<http://www.sempra.com/>).

29. **StatoilHydro**

StatoilHydro became a reality on October 1, 2007, after the plan for the merger was announced between Statoil and Hydro's oil and gas division on December 18, 2006. The Norwegian parliament, the Storting, approved the merger plan in June 2007, and the new company has both the size and the strength to expand internationally. Today, Norway is one of the world's most productive petroleum provinces and a test lab for technology development (<http://www.statoilhydro.com/en/>). StatoilHydro is the biggest offshore oil and gas company in the world and the largest company by revenue in the Nordic Region. The company is a fully-integrated petroleum company with production operations in 13 countries and retail operations in 8. StatoilHydro is in 2008 ranked by Fortune Magazine as the world's 11th largest oil and gas company, and as the world's 59th largest company (Wikipedia).

30. **Giprospetsgaz**

Joint Stock Company Giprospetsgaz is the oldest project institute of gas industry which was founded in 1938. The design bureau works on development of prospective gas facility construction programs and the technological engineering. The main directions of activities are: engineering of the trunk pipelines, oil and gas facilities of the field development on the continental shelf, compressor stations, underground storage facilities, gas supply systems of industrial enterprises and so on; different prospecting and survey works (geodetic, geological, hydro-meteorological and environmental); technological studies of the pipeline systems (<http://www.gsg.spb.ru/>). Giprospetsgaz is a subsidiary of Gazprom which was conducting the engineering concept of the Shtokman project. Its office is located in Saint-Petersburg, Leningrad Region.

31. **Sovcomflot**

Joint Stock Company Sovcomflot (JSC “Sovcomflot”) is Russia’s largest shipping company, one of the world’s leading energy transporters. Its fleet is amongst the five leading tanker companies in the world: 132 vessels and 31 vessels in order. It has one of the most modern tanker fleets in the world: average age is about 6.4 years and all tankers are double-hulled. Sovcomflot provides such services for the transportation of energy to its customers: operating crude oil tankers in Suezmax and Aframax segments; product tankers, chemical carriers; liquefied natural gas and petroleum gas-carriers; ice-class ships; logistical support for offshore development (shuttle oil deliveries in ice conditions, Floating Storage and Offloading units (FSO) services); and rendering port-related services including management of oil terminals and tugs operations (<http://www.sovcomflot.ru/>).

32. **Novoship**

Joint Stock Company “Novorossiysk Shipping Company” (JSC “Novoship”) is a member of Sovcomflot Group. The Novorossiysk shipping company is the largest Russian navigation company on the Black sea. On the 30th of June of 2008 the fleet operated by Novoship Group consisted of 52 vessels and the average age of 7.4 years. The Company’s new buildings portfolio includes 13 vessels due before the end of 2010 (<http://www.novoship.ru/>).

33. **Gazflot**

Russian ship owning company LLC Gazflot is an entity with limited liability founded by 100% capital of JSC Gazprom. The company was formed in 1994 for the following purposes: development of oil and gas fields on land and sea shelf and construction and operation of the own floating technical facilities. From the very beginning up until the present time ship owning company Gazflot has completed 5 sea vessels and continues construction of others. One of the main tasks of the company is development of oil and gas resources of the continental shelf and land including participation in the realization of project the Blue Stream and execution of boring operations in the Barents, Pechora and Kara Seas. The branch offices of the company are located: in the non-freezing ports of the Kaliningrad region on the Baltic Sea and in the port of Murmansk on the Barents Sea (<http://users.gazinter.net/kf-gazflot/eng/index.html>)

34. **LenmorNIiproekt**

Joint Stock Company LENMORNIIPROEKT (LenmorNIiproekt) is a modern multi business engineering and consultancy company specializing in port design and transport projects. Over the years of its existence LenmorNIiproekt has developed construction/ reconstruction and modernization projects for the majority of the Russian ports and many abroad. In the last years, LenmorNIiproekt has delivered master plans for the St. Petersburg transport hub (the Big Port of St. Petersburg), ports of Primorsk, Ust-Luga, Vyborg, Vysotsk, Murmansk and others (<http://www.lenmor.ru/english/>).

35. **PetroCanada**

PetroCanada is a Canadian oil and gas firm. Its headquarters are in the Petro-Canada Centre in Calgary, Alberta. Petro-Canada is Canada’s second-largest downstream company with refining and supply operations, retail and marketing networks, and a specialty lubricants business. Currently the main assets within Petro-Canada’s International and Offshore Business are East Coast Canada, United Kingdom (North Sea), Netherlands (North Sea), Libya, Syria and Trinidad and Tobago. These and all the other sites outside of North America are run by the International and Offshore Business Unit of Petro-Canada with its headquarters in London Bridge, London (Wikipedia).

36. **Mitsubishi**

Mitsubishi Heavy Industries, Ltd, or MHI, is a Japanese company. It is one of the core companies of Mitsubishi Group. The main products lines and businesses are: aerospace systems, shipbuilding/marine structures, steel structures and construction, power systems and traction batteries, machinery, wind turbines, air conditioning and refrigeration systems, paper and printing machinery, military combat tanks and so on. Mitsubishi Heavy Industries - Nagasaki Shipyard & Machinery Works is the primary shipbuilding division Mitsubishi Heavy Industries. It produces primarily specialized commercial vessels, including LNG carriers, oil tankers, and passenger cruise ships. In addition, it is also a producer of a wide variety of machinery for power plants, energy production and aerospace use (Wikipedia).

37. **Daewoo**

Daewoo (Korean for “Great Universe”) was a major South Korean chaebol (conglomerate). There were about 20 divisions under the Daewoo Group, some of which survive today as independent companies. Daewoo Shipbuilding and Marine Engineering Co., Ltd or DSME is one of the largest shipbuilders in the world and one of the “Big Three” shipbuilders of South Korea. It produced containerhips and oil tankers. It spun off in 2000 and became an independent company, DSME, re-listing on the Korean stockmarket in 2001 (Wikipedia).

38. **Gasunie**

Gasunie is a European gas infrastructure company. Its network ranks among the largest high pressure gas pipeline grids in Europe, consisting of over 15 000 km of pipeline in the Netherlands and northern Germany, dozens of installations and approximately 1 300 gas receiving stations. The annual gas throughput totals approximately 125 bcm. Gas Transport Services B.V. (GTS) is the national network operator and is responsible for providing gas transport services and expanding the domestic pipeline network and its accompanying installations. GTS is a fully owned subsidiary of N.V. Nederlandse Gasunie (<http://www.nvnederlandsegasunie.nl/en/index.htm>).

39. **Wintershall**

Wintershall AG is the largest crude oil and natural gas producer in Germany. The company is based in Kassel, Germany. Wintershall is a wholly owned subsidiary of BASF, based in Ludwigshafen. In 2005, the company had 1 700 employees worldwide. Wintershall pioneered the cooperation with Gazprom by launching joint natural gas trading activities for Western Europe (http://www.wintershall.com/index_2.php?catId=home&l=en). In 1993, WINGAS GmbH, the joint venture of Wintershall (50% plus one share) and Gazprom (50% minus one share) was established. In 2005, Wintershall, Gazprom and E.ON Ruhrgas agreed to build the Nord Stream natural gas pipeline from Russia to Germany. In 2006, Wintershall got a stake in Yuzhno-Russkoye gas field (Wikipedia).

40. **E.ON**

E.ON AG is an energy corporation based in Düsseldorf, Germany. E.ON is one of the major public utility companies in Europe and the world’s largest investor-owned energy service provider. The Company came into existence in 2000 through the merger of VEBA and VIAG. In 2003 E.ON entered the gas market through the acquisition of Ruhrgas (now E.ON Ruhrgas). E.ON Ruhrgas is represented in more than 20 countries in Europe (Wikipedia).

41. **BG**

A leading player in the global energy market, BG Group is a dynamic growing business with operations in some 27 countries over five continents. While the headquarters are in United Kingdom (UK), over 60% of the talented professionals who make up the BG team are located outside the UK. The company’s focus is on understanding, building and supplying natural gas markets around the world. It operates in four key business sectors – Exploration and Production, Liquefied Natural Gas, Transmission and Distribution, Power (<http://www.bg-group.com/Pages/BGHome.aspx>).

42. **Bellona**

The Bellona Foundation is an international environmental organization established in 1986 and based in Oslo, Norway. At the end of the 1980s Bellona became well known first and foremost through spectacular actions against Norwegian industrial companies with more or less significant cases of environmental contamination on their conscience. Since then, it has taken on a more international focus, particularly through our work on nuclear contamination in Russia (<http://www.bellona.org/>). It serves as a nuclear watchdog focusing on developments in Russia (Bellona has branches in Murmansk and Saint Petersburg). The organization also has offices in Washington, D.C. and Brussels (Wikipedia).

43. **ENI**

Eni S.p.A. is an Italian multinational oil and gas company, and currently Italy’s largest industrial company with a market capitalization of € 87.7 bln. Eni was founded on February 10, 1953, by the Italian government to promote and develop a national energy strategy based on the concentration of all the activities in the energy sector into one group. As of July 2008, the Italian Government owns a 30%

golden share in the company (Wikipedia). Eni is an integrated energy company, committed to developing its activities in research, production, transport, transformation and marketing of oil and natural gas. Eni is active in 70 countries with a staff of about 79 000 employees (http://www.eni.it/en_IT/home.html).

44. **Sibneft**

Gazprom Neft was created under the name Sibneft in 1995 by Presidential Decree №872, issued on August 24, 1995. Sibneft initially combined Russia's largest oil refining complex in Omsk, an oil and gas production enterprise based in the city Noyabrsk in the Yamal-Nenets autonomous district, a geological exploration enterprise and an oil products distribution network. In September 2005, Russia's largest corporate takeover occurred when Gazprom bought 73% of Sibneft's shares for \$13.1 bln. Later, Sibneft was renamed Gazprom Neft. Gazprom Neft is the fifth largest oil producing and refining company in Russia. It's the oil arm of Gazprom, which owns 80% of Gazprom Neft's shares. Gazprom Neft's central office is located in Moscow; however, the company is already registered in St. Petersburg where it also has an office (Wikipedia).

45. **PetroChina**

PetroChina Company Limited is the largest oil and gas producer and distributor, playing a dominant role in the oil and gas industry in China. It is not only one of the companies with the biggest sales revenue in China, but also one of the largest oil companies in the world. PetroChina was established as a joint stock company with limited liabilities by China National Petroleum Corporation on November 5th, 1999. It is engaged in wide range of activities related to oil and natural gas, including: exploration, development, production and marketing of crude oil and natural gas; refining, transportation, storage and marketing of crude oil and oil products; production and marketing of primary petrochemical products, derivative chemicals and other chemicals; transportation of natural gas, crude oil and refined oil, and marketing of natural gas (<http://www.petrochina.com.cn/ptr/>).

46. **Techmorgeo**

The Specialized Design Bureau for Marine Geological Prospecting Engineering of the Ministry of Geology of USSR was founded in 1981. Later it was reformed into FSUE Techmorgeo. The enterprise is engaged in researches and design, and works under agreements on developing facilities for geological-geophysical and engineering-geological operations on the Arctic shelf at depths up to 6 000 meters, and produces small series of equipment. Techmorgeo research and development projects have been extensively applied by MAGE, AMIGE and other organizations. (http://www.arcticshelf.ru/Conf2004/Rus/2/index.php?Itemid=38&id=1&lang=en&option=com_content&task=view)

47. **AMIGE**

Arctic Marine Engineering Geological Expeditions (AMIGE) is a Public Corporation which carries out an integrated engineering survey offshore Russian Arctic and worldwide. AMIGE conducts detailed offshore engineering survey for exploratory and prospecting oil and gas drilling, prospective field development, marine pipelines and loading terminals, harbors, tidal hydropower stations and other marine constructions. The geography of engineering hydrometeorological investigations conducted by AMIGE is wide enough: oil and gas prospective areas in the Barents and Kara Seas, Varandey and Kolguev Islands, coastal areas of the Baydaratskaya Bay, Opasov Bay, Ob and Taz Bays, and others (<http://www.amige.ru/eng/index1.htm>).

48. **Doris**

DORIS Engineering is experts in the field of engineering for the offshore oil and gas industry. DORIS Engineering began in 1965 as a continuation of the SEGANS Company, studying methods for carrying gas through very deep areas of the Mediterranean Sea. For over 40 years, DORIS Engineering has been developing cutting-edge solutions facilitating the production of oil and gas in frontier areas in a cost-effective manner. Today, DORIS Engineering continues to carry out a large amount of research and development activity, to maintain the high level of creativity and innovation that has become the company's trademark (<http://www.doris-engineering.com/>).

49. **Rubin**

Public Joint Stock Company “Central Design Bureau for Marine Engineering “Rubin” (CDB ME Rubin) is a diversified and dynamically developing enterprise. It is one of the main Russian centers of submarine design, having produced more than two-thirds of all nuclear submarines in the Russian Navy (Wikipedia). CDB ME Rubin was established more than 100 years ago. After multiple transformations and renaming the enterprise got its current name on September 2, 2001. Rubin at present is successfully implementing the state-of-the-art techniques into the development of different science-intensive civil projects. CDB ME “Rubin” was carrying out works on the platform design for Shtokmanovskoye gas and condensate field since the end of the 1980-s. It also takes part in the design of offshore ice-resistant fixed platform for Prirazlomnoye field from the early stages of development (<http://www.ckb-rubin.ru/eng/index.htm>).

50. **J P Kenny**

J P Kenny is one of the world’s largest and most innovative pipeline and subsea engineering and management contractors, with over 30 years experience, and 1 300 professional staff in 10 worldwide offices. J P Kenny is wholly owned by Wood Group, a publicly-listed company with sales of \$5 bln, employing 28 000 employees in 46 different countries. Under the umbrella of Wood Group, J P Kenny has a number of sister companies that provide complementary services (<http://www.jpkenney.com/>).

51. **Technip**

Technip is a world leader in engineering, technologies and project management for the oil and gas industry. Technip is a key contributor to the development of technologies and sustainable solutions for the exploitation of the world’s energy resources (<http://www.technip.com/english/index.html>). Technip is a French engineering company, headquartered in La Défense, Paris. It has a workforce of over 23 000 people worldwide, and annual revenues of over € 7 bln. Technip ranks among the biggest full-service engineering and construction groups in the field of oil and gas, hydrocarbons and petrochemicals. Technip has offices all over the world including the Americas, Australia, Europe, Middle-East and Asia (Wikipedia).

52. **Chiyoda**

Chiyoda Corporation is a large Japanese engineering company specialising in industrial facilities, particularly oil refineries and LNG facilities. Most of its business takes place outside Japan, normally in the Middle East. In the late 1960s it built the Jeddah and Riyadh refineries in Saudi Arabia; at present its large projects include LNG plants in Qatar, the Sakhalin-II project in eastern Russia, and a variety of specialist-chemical and pharmaceutical plants in Japan itself (Wikipedia). Chiyoda has invaluable experience in all phases of gas processing projects from feasibility studies through planning, design to financing in addition to overseeing large-scale gas processing projects such as NGL/LNG projects. In addition, Chiyoda has been continuously awarded Front End Engineering and Design (FEED) or Project Specification (PS) works by major LNG projects to bring measurable benefits to investors. (<http://www.chiyoda-corp.com/biz/e/hpi/gas.shtml>).

53. **Chicago Bridge and Iron**

Chicago Bridge & Iron Company (Chicago Bridge & Iron Company N.V.), known commonly as CB&I, is a large multinational conglomerate engineering, procurement and construction (EPC) company. CB&I specializes in projects for customers that produce, process, store and distribute the world’s natural resources. CB&I operates from more than 80 locations around the world, and as of August 1, 2008, CB&I has a total of approximately 18 000 employees. CB&I was founded in 1889 in Chicago, Illinois, USA. CB&I’s global business sectors are: CB&I Lummus which includes the (infrastructure projects); CB&I Steel Plate Structures (vessels and storage); and Lummus Technology (process technology licensing) (Wikipedia).

54. **Vyborg Shipyards**

JSC Vyborg Shipyards is a building enterprise in the town Vyborg, Leningrad Region. The company specializes in construction of offshore platforms for development of the shelf areas and vessels of small and medium tonnage. It has a staff of about 1700 employees. The shipyard was built in 1947 and privatized in 1994. JSC Vyborg Shipyards won a tender for construction of two ice-resistant platforms for the Shtokman field development project (Wikipedia).

55. **Samsung**

Samsung Heavy Industries or SHI is one of the largest shipbuilders in the world and one of the “Big Three” shipbuilders of South Korea. Samsung Heavy Industries was established in 1974. Samsung Shipbuilding and Daesung Heavy Industries were merged under Samsung Heavy Industries in 1983. A core subsidiary of the Samsung Group, South Korea’s largest conglomerate, SHI’s main focus is on shipbuilding, offshore floaters, digital devices for ships, and construction and engineering concerns. SHI specializes in the building of high added-value and special purpose vessels, including [LNG](#) carriers, offshore related vessels, oil drilling ships, FPSO/FSO’s, ultra large container ships and Arctic shuttle tankers. In recent times SHI has concentrated on LNG tankers and drillships, for which it is the market leader (Wikipedia). SHI holds the world record for having built the largest number of ships in the LNG and FPSO sectors (<http://www.shi.samsung.co.kr/eng/>).

56. **Baltic Works**

JSC Baltic Works (Baltiysky Zavod) is one of the leading enterprises in the Russian shipbuilding industry. In 2006, the shipyard is celebrating its 150th anniversary. During this century-and-a-half period, the shipyard has delivered over 500 naval ships, submarines, and commercial vessels. The shipyard’s production facilities and equipment are capable of producing modern ships that meet all necessary international requirements. Currently the Baltic Works specializes in construction of icebreakers and ice-classed vessels (with nuclear-powered propulsion, as well as conventionally powered), large commercial vessels for carrying various types of cargo, and naval ships. One of the most promising fields of the shipyard’s activity is the construction of floating nuclear power plants (<http://www.bz.ru/>).

57. **Zvyozdochka**

State Machine-Building Enterprise Zvyozdochka is a leading ship repair enterprise of Russia. The dockyard provides the repair and design of light cruisers, surface ships and diesel and nuclear-powered submarines, the marine engineering of civil designation. It possesses chamber docks for the utilization of nuclear-powered submarines. The shipyard is located in Severodvinsk, Arkhangelsk Region.

58. **Vyksa Steel Works**

Vyksa Steel Works (VSW) is one of Russia’s oldest metallurgical centers which was established in 1757. Vyksa Steel Works is a major domestic producer of longitudinal welded pipes with various diameters designed for oil and gas production and transport, construction, and the housing and utility sector. The potential pipe production capacity of Vyksa Steel Works is over 2 mln tons of pipes per year. Vyksa Steel Works is the world’s major producer of solid wheel designed for railroad passenger and freight cars, railroad engines, and subway trains. Vyksa Steel Works is one of the most technically equipped and modernized steel works in the Russian Federation. Being the leader in pipe production, the main supplier of railway wheels for JSC «Russian railways», VSW continues to develop and improve the manufacture (<http://www.vsw.ru/en/>).

59. **Sevmash**

Joint Stock Company “Production Association “ Northern machine building enterprise” JSC “PO “Sevmash” is the largest ship-building complex in Russia, the only shipyard of the country, the main task of which is atomic submarines building for Navy. The enterprise, occupying the area of more than 300 hectares, includes in its structure more than 100 subdivisions. More than 25 000 people work on the basic enterprise of Severodvinsk, Arkhangelsk Region (<http://www.sevmash.ru/>).

60. **Baltsudoproekt**

Central Design Bureau “Baltsudoproekt” was founded in 1925, and in 1999 was placed under the Federal State Unitary Enterprise Shipbuilding Research Institute of the Kruglov. During the company’s operating period, 170 projects were conducted that allowed construction of 2 600 vessels of the overall deadweight of 11 mln tons. The company provides the designing works, testing services, application engineering services, development of recommendations for propulsion units and so on. In regard to increased development of the northern offshore fields, the company is conducting modernization of the ships for the Murmansk Shipping Company (<http://www.ksri.ru/rus/ins/struct/balt.htm>).

61. **Murmanshelf**

Association for suppliers of oil and gas industry “Murmanshelf was established on May 12, 2006. It includes 190 members together with the foreign companies. The association gives a wide spectrum of services for the members, among them development of manufacturing potential of local enterprises; contribution to increasing the competence level of small and medium-size enterprises; complex support and promotion of business projects of the members; facilitation of contacts and development of cooperation between Association members and operators; and protection of rights, common interests and private of estate of Association members in public bodies and organizations incl. international ones (<http://eng.murmanshelf.ru/>).

62. **Sozvezdye**

Regional suppliers’ network “Sozvezdye” works for the development of enterprises located in the Archangelsk region, assisting potential companies to become suppliers of goods and services to the oil and gas industry. Sozvezdye offers their member companies to provide updated information about market opportunities in oil and gas production projects; to be a coordinator assisting establishing contacts and further cooperation between the network members and oil and gas producing companies.; establishment of relations and the development of opportunities for strategic partnerships between members in the network; providing customers with detailed information about potential partners/suppliers from the regional network; and to develop meeting points for small and medium size enterprises positioning as supplier of goods and services (<http://www.sozvezdye.org/index.php?mod=service>).

63. **Petro Arctic**

Petro Arctic was established in 1997. Statoil and members of the Association finance the Association’s operations. The Association has its own Board elected from member companies, and HONU AS in Hammerfest provides the secretariat responsible for day-to-day business. The Association works in cooperation with Statoil, local and regional authorities, and not least, with contractors and sub-contractors. The main aim of Petro Arctic is to obtain the maximum possible deliveries of goods and services from member companies to Snøhvit and future expansion projects in North Norway and the Barents Sea. This will be achieved by marketing member companies to the developers and by motivating and preparing members through participation in networking and skills development programmes. The Association is constantly building up its database of companies wishing to supply Snøhvit and future petroleum projects in the North. The database is actively used in promotion to developers and their sub-contractors. Petro Arctic also represents an important link between developers and regional business (http://www.petroarctic.no/index.php?page_id=1235)

64. **INTSOK**

INTSOK - Norwegian Oil and Gas Partners - was established in 1997 by the Norwegian oil and gas industry and the Norwegian Government. INTSOK’s objective is to work with companies throughout the industry to expand the business activities in the international oil and gas markets on the basis of the industry’s leading edge experience, technology and expertise. INTSOK is an effective vehicle for promoting the Norwegian offshore industry’s capabilities to key clients in overseas markets and providing market information to its partners. INTSOK is a network-based organization where the partners exchange experience and knowledge of market developments internationally. Per January 2009, the number of INTSOK partner companies has exceeded 180 Partners (<http://www.intsok.no/>).

LAW “ON SUBSOIL”:

Landowners and land users

The legislative proposal states that the subsoil on territory of the Russian Federation including the mineral resources, energy and other types of resources are the federal property. The subsoil on territory of the Russian Federation, its continental shelf and sea bottom of exclusive economic zone forms the State subsurface fund. The right to subsurface site use can be given to legal entities which were established in accordance with the legislation of the Russian Federation. The exception is made for international legal entities and individual persons which discovered the deposit by themselves. The subsoil user on the terms of production sharing agreement can become Russian and foreign legal entity and also association of legal entities. The right of ownership on extracted commercial minerals and mineral raw materials belongs to subsoil user (Analytical service NGV, 2005).

Contractual relations

The law provides the transfer to civil law relations in subsurface use. The right of subsoil plot use is a property right. The period to which the right of subsurface site use is granted for exploration and operation of mineral resources is defined by the limitation of deposit efficiency. In this case the granting of subsoil for production of mineral resources is allowed only after conduction of the regional reserves commission. The subsoil user has the right for outsourcing. The subsurface user is legally obliged to compensate for loss caused by non-execution and improper performance of the subsoil use agreement's terms (Analytical service NGV, 2005).

Licenses

The license gives its owner the right to use subsoil areas within specified boundaries for the purpose stated in the license during a specified period, provided the owner observes conditions agreed upon beforehand. The license certifies the right to carry out work on all forms of subsoil regulation, including the geological study of the subsoil; the development of mineral resource deposits; the utilization of the subsoil for purposes not connected with the extraction of mineral resources, and so on. The license for subsoil regulation consolidates the conditions and form of contractual relations pertaining to subsoil regulation (Lesikhina et al., 2007).

Auction

According to the amended law, production licenses are issued based on a decision of the tender or auction commission. The federal authority responsible for the management of subsoil resources is the Federal Agency for Subsoil Use. The Subsoil Law states that subsoil use rights may be granted to persons that engage in entrepreneurial activities, including members of simple partnerships, foreign citizens, and legal entities, unless federal law provides for restrictions on the granting of subsoil use rights. The auction announcement should clearly specify the deadlines for the submission of documents and the making of deposits, and the date of the auction itself. The Subsoil Law stipulates that licenses should be issued on the basis of the auction commission's decision. The Subsoil Law indicates that such decisions should be made on the basis of the results of the tender or auction (Polonsky and Stepanov, 2005).

Payments

Along with taxes and dues stipulated by the law of taxation, the subsoil users pay one-time and periodic payments for subsoil use, fee for participation in the auction and rate for geological information about subsoil. In this regard the amount of initial payment must be not less than 10% of mineral extraction tax amount. The rate of regular payment for subsoil use during the exploration period is taken for 1 km² of subsurface site area (it is much lower for offshore in comparison with onshore territories) (Analytical service NGV, 2005).

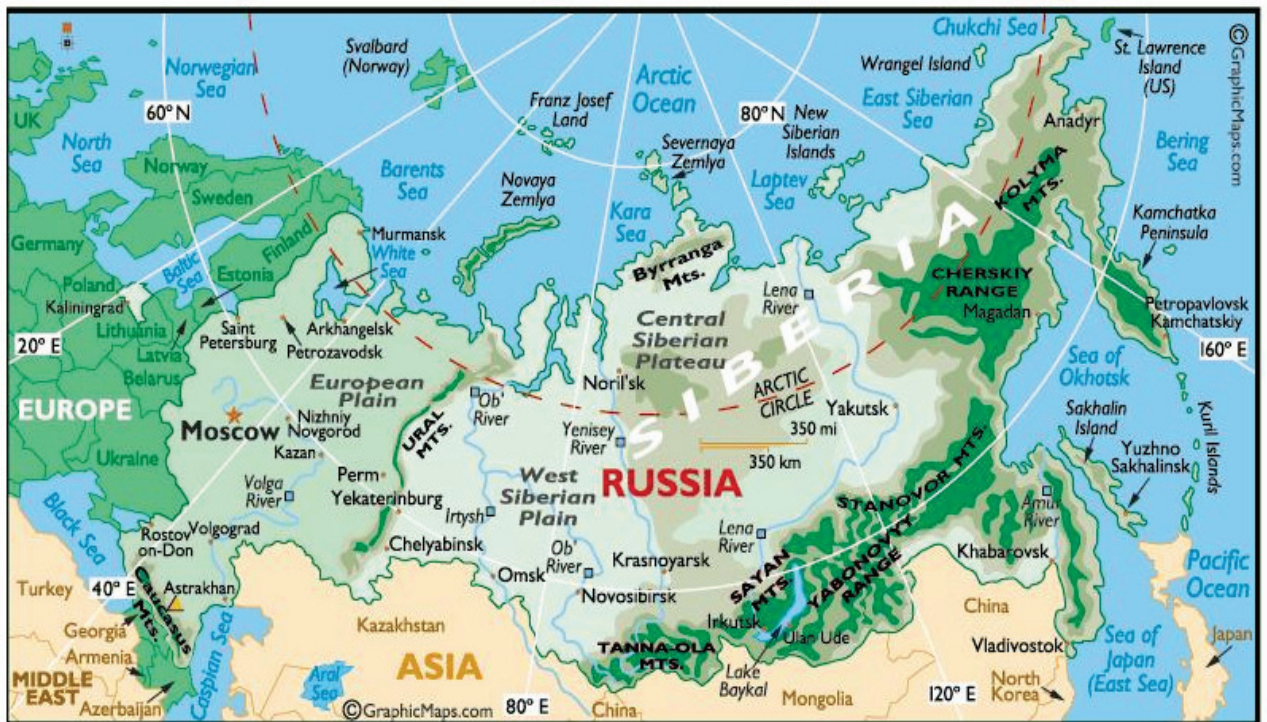
APPENDIX

Appendix 1. Map of Russia

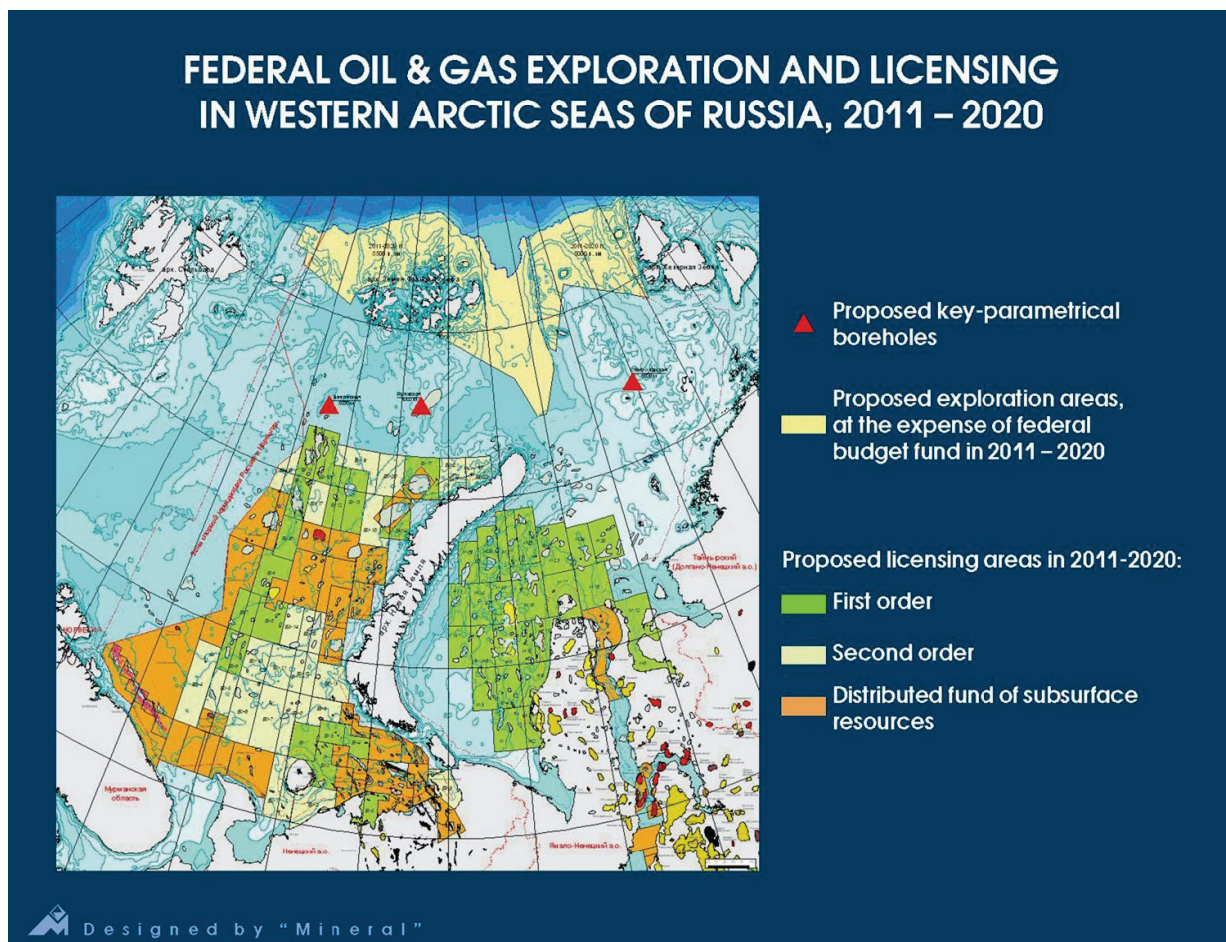
1. Regional distribution



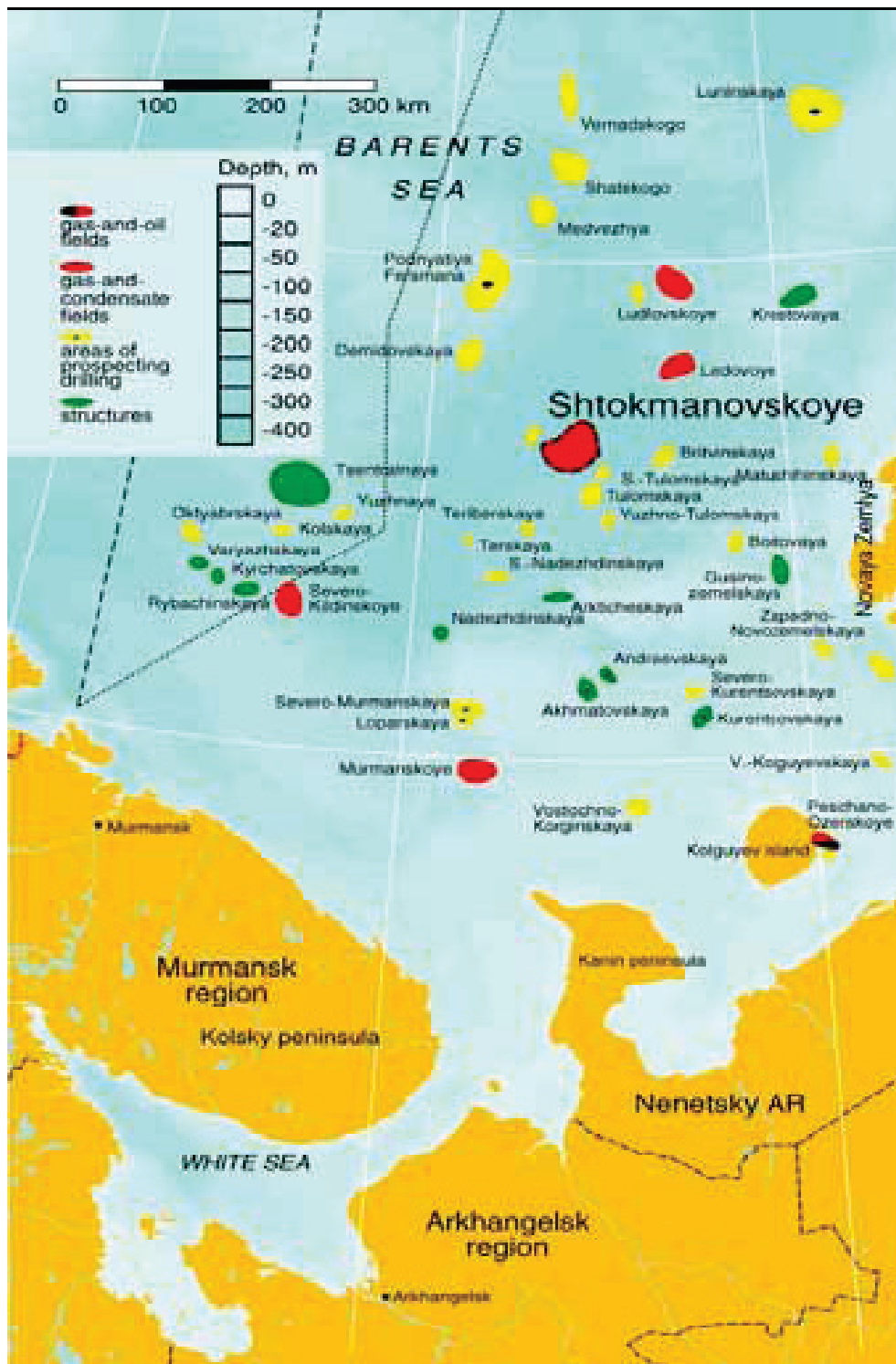
2. Geographical distribution



Appendix 2. Oil and gas exploration and licensing in the Russian Western Arctic seas, 2011-2020 (Bambulyak and Frantzen, 2007: 10)



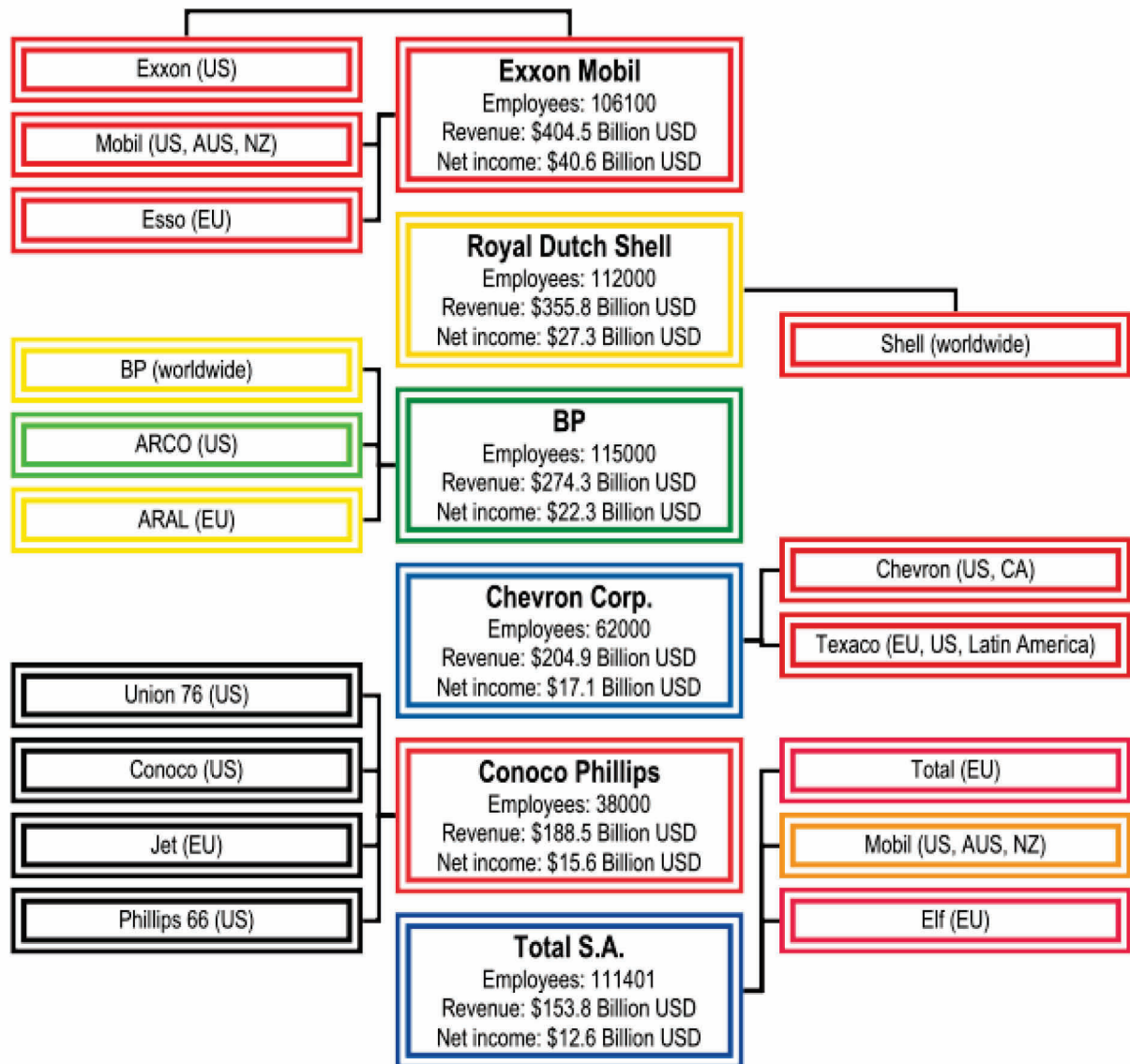
**Appendix 3. The explored reserves of Shtokman gas and condensate field
(Bambulyak and Frantzen, 2007: 16)**



Appendix 4. Comparison of North Sea (inside picture) with some of oil and gas-bearing basins of the Russian Federation (Analytical service NGV, 2007)



Appendix 5. Chart of the major energy companies dubbed “Big Oil” sorted by latest published revenue (Wikipedia)



Appendix 6. Transport system of the Shtokman gas condensate development project (Gazprom, Shtokman project)

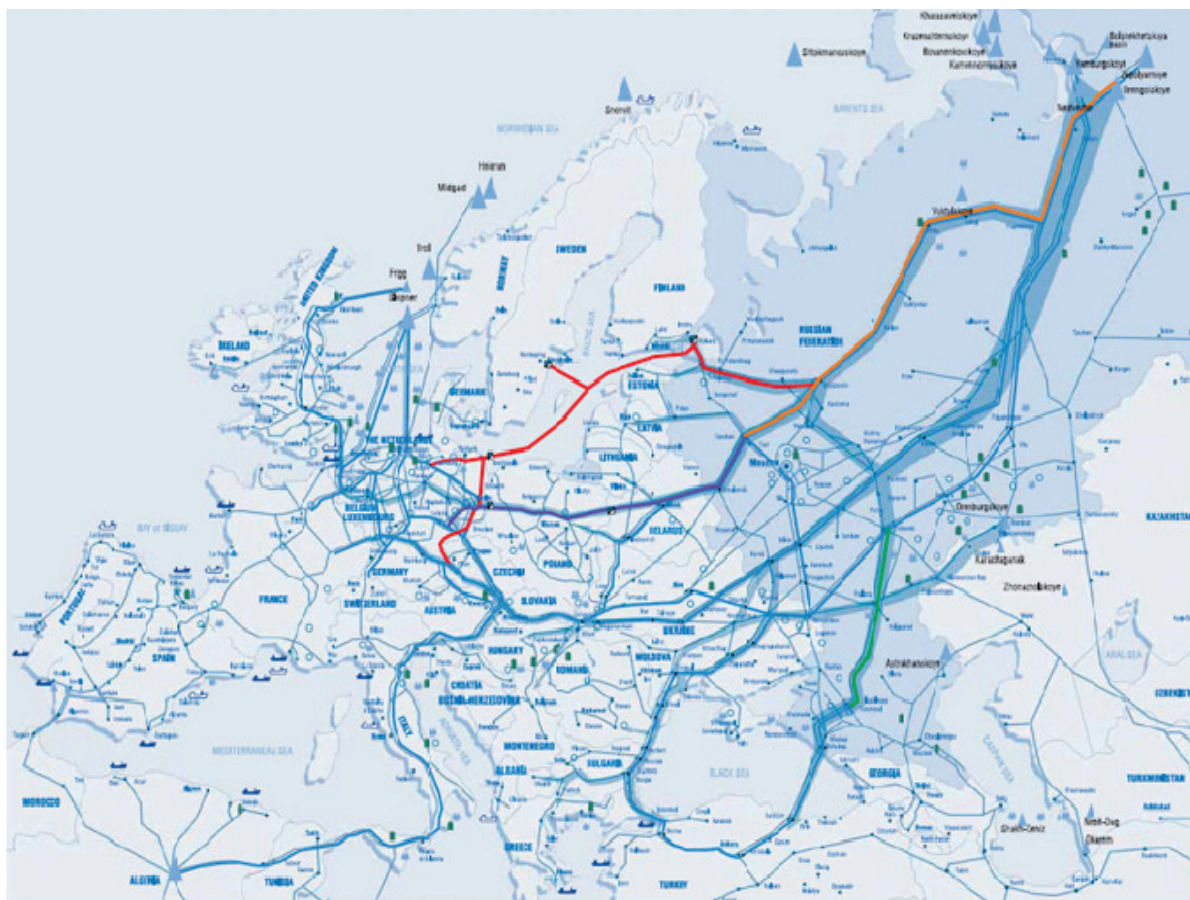














1. Subsea pipeline system from field to Opasova Bay
2. Onshore gas pipeline Murmansk – Volkhov
3. Link to United Gas Supply System of Russia
4. Nord Stream gas pipeline from Vyborg to Greifswald (Baltic Sea)
5. LNG supply from Teriberka LNG plant to markets of USA and Europe (Barents Sea)

**Appendix 7. The scheme of LNG transportation from Shtokman field
(Bambulyak and Frantzen, 2007:28)**

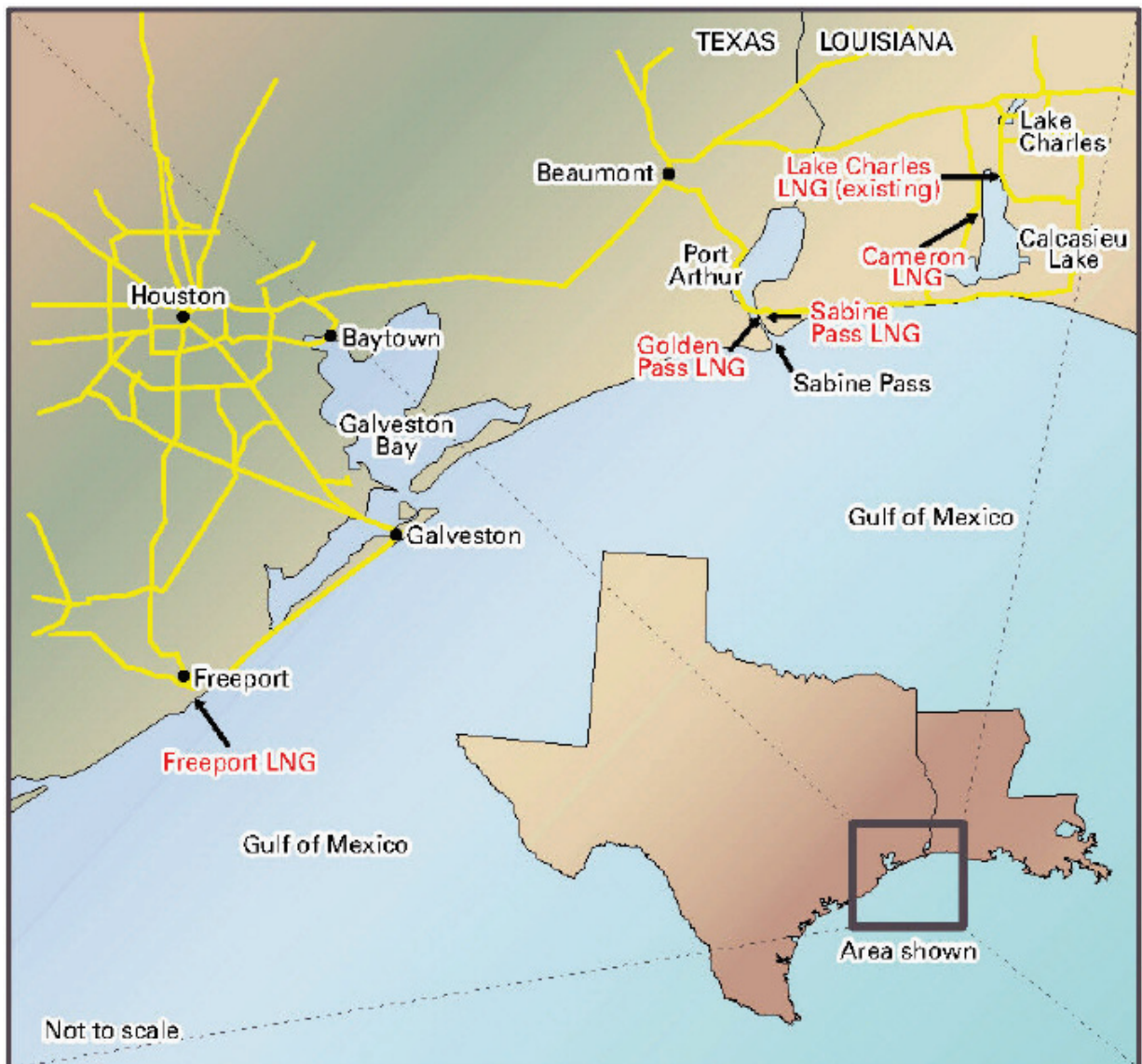


Appendix 8. Unified Gas Supply System of Russia (Gazprom, Transmission, 2008)

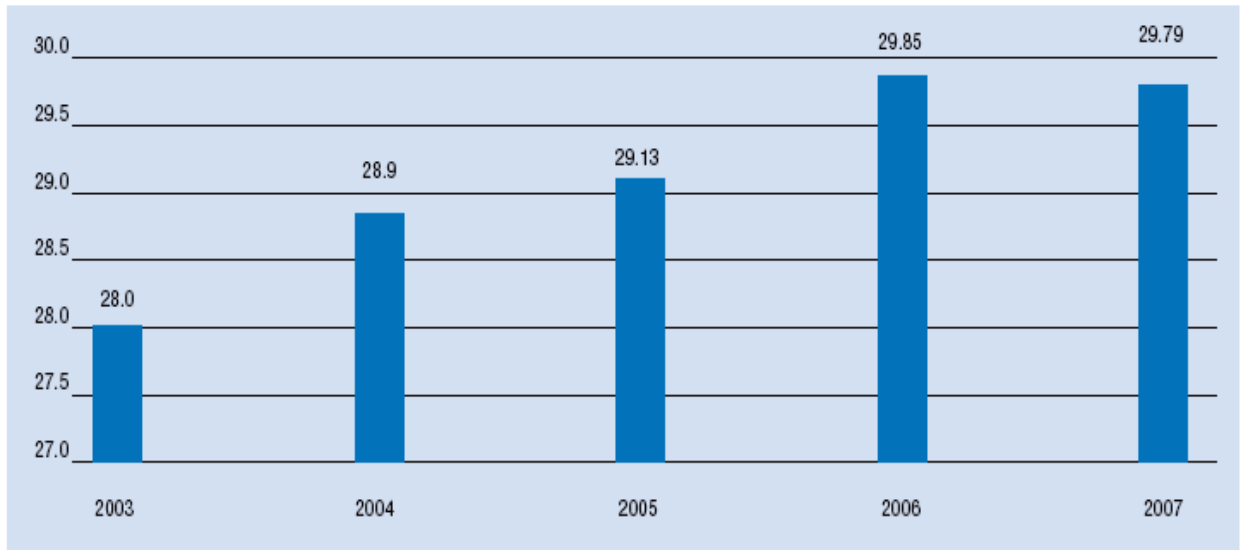


- | | |
|---|---|
|  Major acting gas pipelines |  Fields |
|  North European Gas Pipeline Project |  Major USFS |
|  Yamal-Europe Gas Pipeline |  Major gas refineries |
|  SRTC-Torzhok Gas Pipeline |  Acting LNG terminals |
|  Gas pipeline Pochinki – Izobilnoye
(Petrovsk-Frolovo-Izobilnoye segment) |  Perspective LNG terminals |
| |  Gas delivery point |
| |  Russian gas export directions |

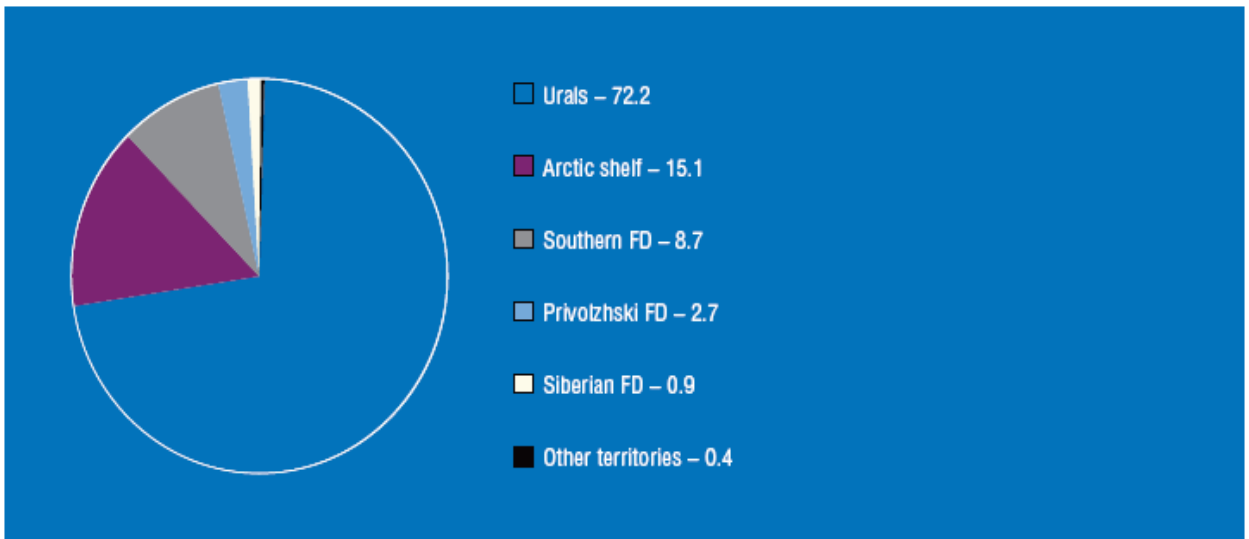
Appendix 9. USA Gulf Coast LNG terminals (True, 2008, №16: 54)



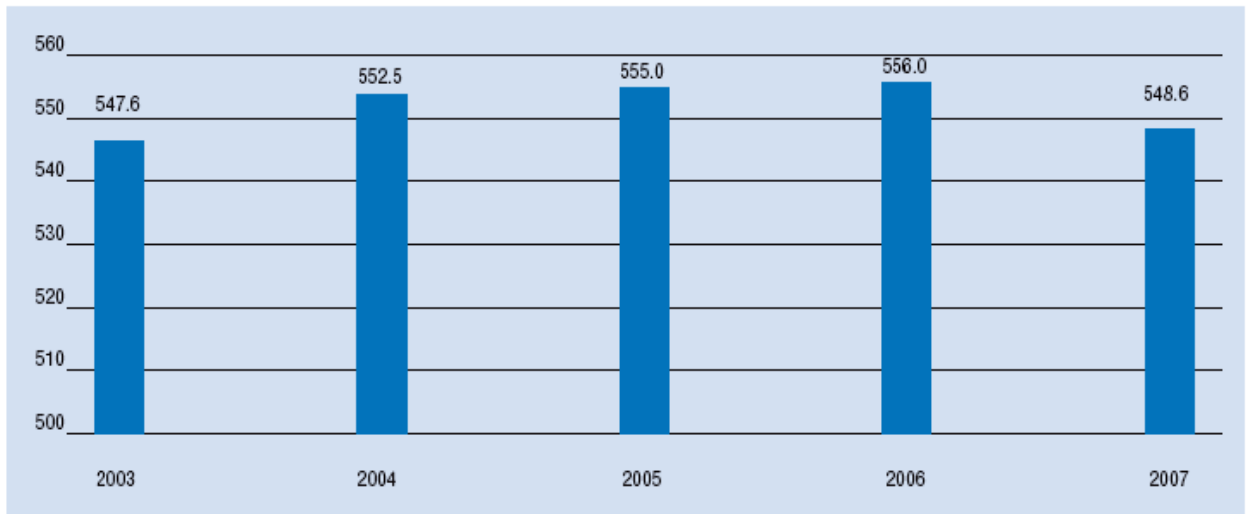
**Appendix 10. Gazprom's Natural Gas Reserves (categories A+B+C1), tcm
(Gazprom in Figures, 2003-2007:17)**



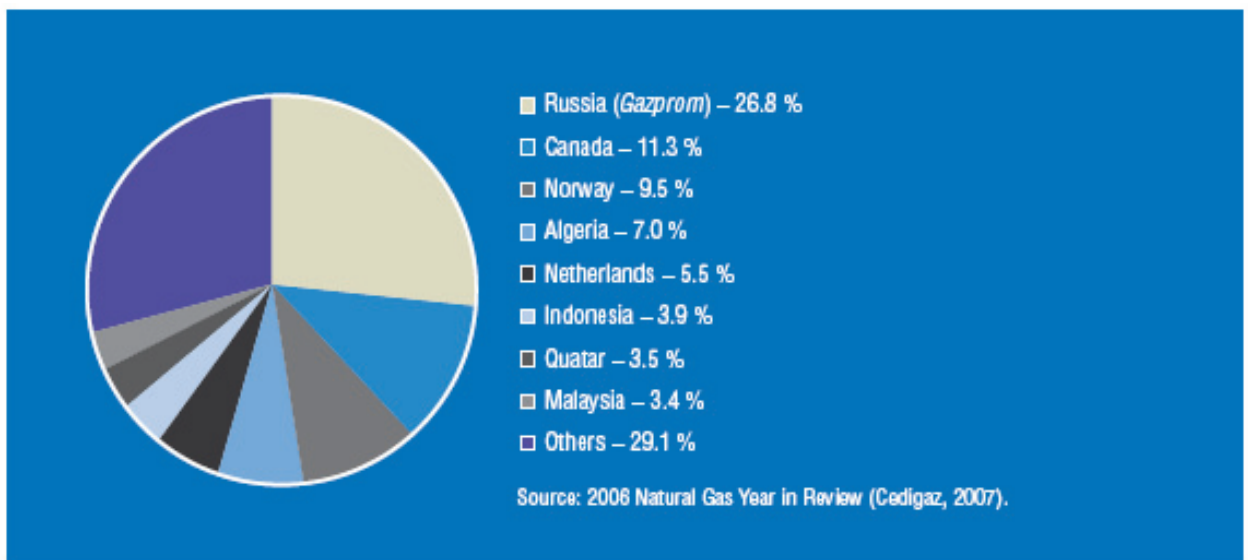
Appendix 11. Territory Distribution of Gazprom's Gas Reserves (categories A+ B+C1) (Gazprom in Figures, 2003-2007:19)



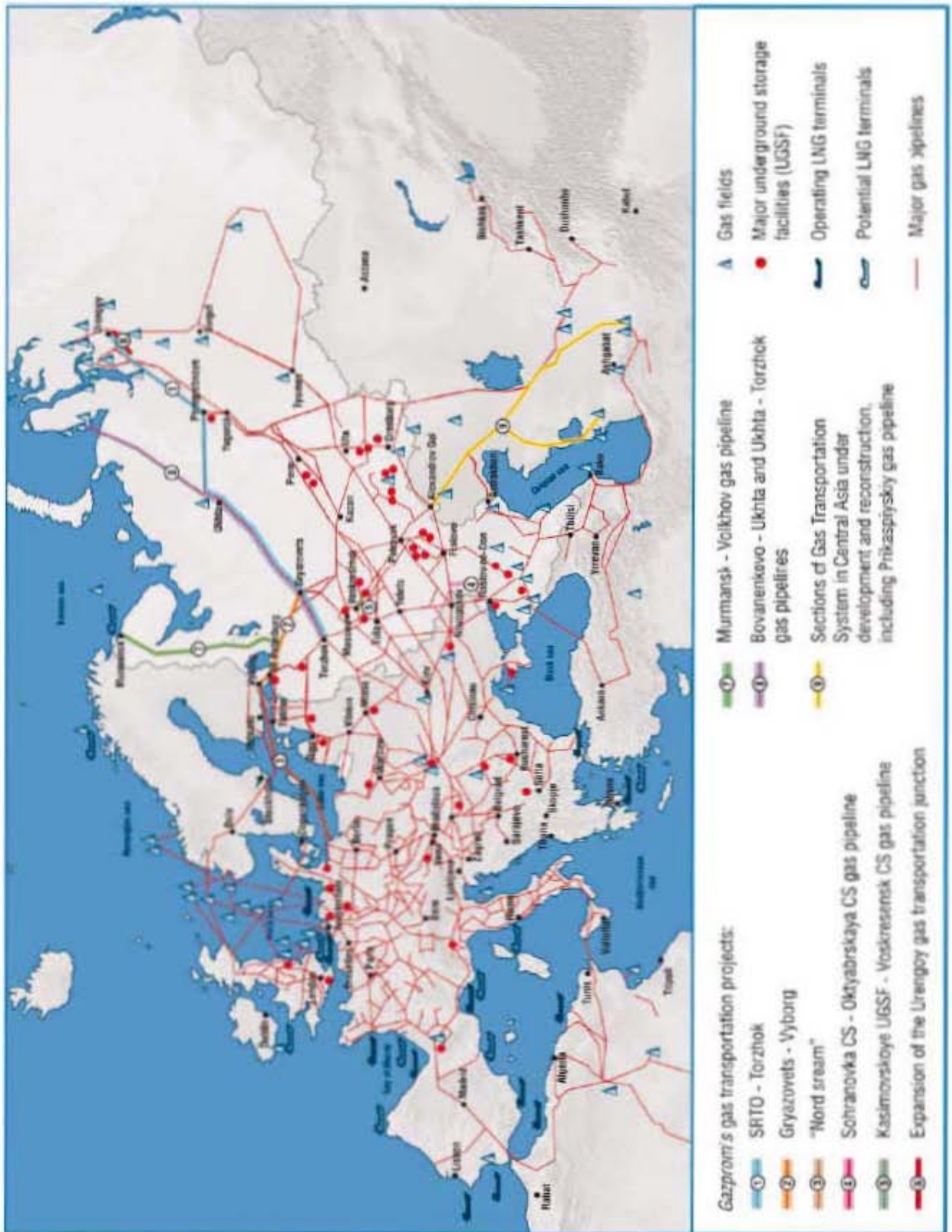
Appendix 12. Gazprom's Natural Gas Production, bcm (Gazprom in Figures, 2003-2007:32)



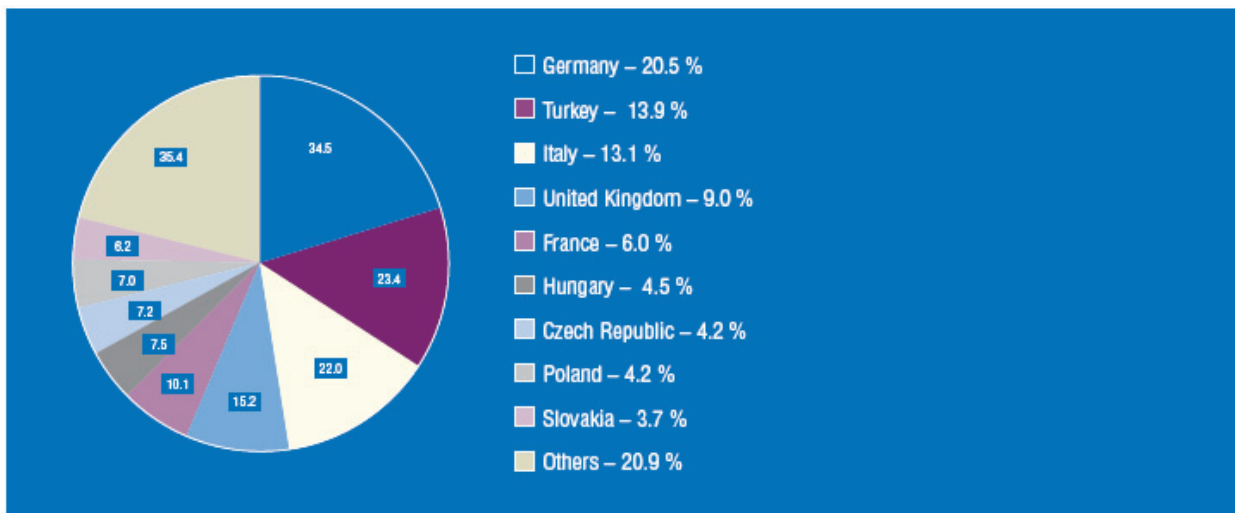
Appendix 13. Main Exporters of Natural Gas in 2006 (Pipelines and LNG) (Gazprom in Figures, 2002-2006:9)



Appendix 14. Eurasian Gas Transportation System (Gazprom in Figures, 2003-2007:38)



Appendix 15. Volume and Structure of Gazprom's Gas Sales Far Abroad in 2007, bcm and % (Gazprom in Figures, 2003-2007:55)



Appendix 16. Volume and Structure of Gazprom's Gas Sales in CIS and Baltic States in 2007, bcm and % (Gazprom in Figures, 2003-2007:56)

