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Associated Petroleum Gas in Russia

Reasons for non-utilization

Tonje Hulbak Røland

FRIDTJOF NANSENS INSTITUTT
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Tonje Hulbak Røland

tonje.roland@gmail.com

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Abstract

This report studies the factors hindering increased utilization of associated petroleum gas (APG) in Russia. The issue of flaring versus utilization is studied from a Technology Innovation System (TIS) perspective, seeing the non-utilization issue as a problem of technology diffusion. There are many technological options available for APG utilization, but a main blocking mechanism in the Russian case is the Gazprom monopoly on gas transportation via their pipelines. A commonly discussed solution is policy to ensure third party access, but this study finds that this solution holds little potential, as its ramifications are too extensive and unacceptable to the key actor Gazprom. More promising solutions may be found in small, emerging engineering companies.

Key Words

Orders to:

Fridtjof Nansen Institute
Postboks 326
N-1326 Lysaker, Norway

Phone: (47) 6711 1900
Fax: (47) 6711 1910
Email: post@fni.no
Internet: www.fni.no

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Foreword

This report is based on my master thesis written within the Environment and Resource Management Master's programme at Instituut voor Milieuvraagstukken (IVM) at the Vrije Universiteit in Amsterdam. My work on this project was done as a student scholar at the Fridtjof Nansen Institute (FNI) in Lysaker, Norway, where a student scholarship was financed by the RussCasp project.

The topic of this research project, utilization of associated petroleum gas (APG) in Russia, falls within some of the core research areas of FNI. Primary fields of research at FNI are foreign affairs, environmental and energy policy, Russia and the High North. As a student with a great interest in Russian environmental and energy policy, a student scholar position at FNI was a very valuable opportunity. Being surrounded by researchers with expertise on the various aspects of the case I was studying was both motivating and educating.

The responsibilty for any mistakes or misrepresentations in this paper is mine alone.

My supervisor at FNI was Arild Moe, and at IVM my supervisor was Onno Kuik. The second supervisor at IVM was Matthjis Hisschemöller. They have all provided me with valuable feedback throughout the process, for which I am very grateful. Other researchers at FNI have through sporadic discussions at the work place been of great inspiration.

Great thanks and high appreciation also, to all the experts who gave time to me in my search for information. Torleif Haugland and Francois Sammut, Valery Kryukov, Nina Poussenkova, and Elena Kutepova have all provided me with invaluable insights.

I would also like to give thanks to friends and family for support and motivation. Finally, I wish to give warm thanks to my fellow students, both at IVM and FNI, for an inspirational, supportive and enjoyable work environment.

Lysaker, September 2010

Tonje Hulbak Røland

1 Introduction

Associated petroleum gas (APG) is a common byproduct in oil production. The gas can, after processing, be utilized in a number of ways, i.e. be included in the natural gas distribution networks, used for on site electricity generation, reinjected for enhanced oil recovery, or used as feedstock for the petrochemical industry (Knizhnikov and Poussenkova 2009). Some APG must be flared for safety reasons, but in Russia (particularly Western Siberia), approximately 45%[1] of this gas is currently flared on site, a much higher rate than what is required for safety (PFC Energy 2007). The flaring has great environmental implications in addition to being economically wasteful. Despite this, a number of oil producers continue flaring their APG. The Russian Government has set a goal of increasing the average utilization rate from 55% to 95%, but much remains to be done. Various types of utilization technology exist, but are only applied to a limited extent by the oil producers. Considering the political attention to the problem and the availability of utilization technologies, it is unclear why flaring volumes remain high in Russia. The reasons may be related to economic or market issues, power struggles between actors, or other fields of the APG utilization system. The goal of this paper is to identify the key mechanisms blocking increased APG utilization. The research question is thus *which factors are the main hindrances to a radical increase in APG utilization in Russia, and can these be addressed by policy?*

In order to identify the blocking mechanisms, it is necessary to have a complete overview of the APG utilization problem and the factors and actors involved. This paper will use a Technology Innovation System (TIS) framework to map out the APG utilization field. This framework includes a wide variety of technical and non-technical factors relevant for the increased utilization of a given technology, and may thus shed light on relevant blocking factors in the APG utilization case. As previous studies have been focused on actor conflict and dynamics, this aspect should be put under additional scrutiny. In order to to this, perspectives from the Advocacy Coalition Framework (ACF) will be applied.

The outline of the paper will be based on the step-by-step approach of the TIS framework. Chapter 2 starts off with a brief literature review, followed by a discussion of the method and data, as well as introductions to the ACF and TIS framework follows. Chapter 3 provides an overview of the factual background of flaring, as well as information on the technical options available for APG utilization. Chapter 4, the main analytical chapter, then follows, using the TIS steps as a guide to map out the actors, institutions and functions of the APG utilization technology system. Chapter 5 is a discussion of the main blocking and inducement mechanisms for APG utilization, as well as the policy implications these findings have. In chapter 6 I will discuss the applicability and usefulness of the TIS framework for this type of analysis.

1.1 Literature review

APG flaring and utilization are well known topics globally, as APG is a component of all oil extraction. Worldwide, the oil industry has always had to deal with APG in some way, either by flaring, venting or utilizing it. In the current era of global climate concerns, polluting and energy wasting activities such as flaring receive increased attention politically and in civil society. Not all oil producing countries have high levels of flaring, and the literature on the topic is thus primarily focused on those countries that do sustain high levels of flaring. There is substantially more literature on APG in Russia written in Russian than in English. English is the working language of the author of this paper, and for non-Russian speaking researchers and policy makers, the available literature giving an overview of the flaring issue is limited.

One of the most comprehensive studies of the flaring problem and the reasons for low utilization levels was published in Russian in 2008. It is a 340 page overview of APG issues in Russia entitled *Institutional analysis of conditions for rational integrated use of petroleum resources: The case of associated petroleum gas* which, despite its insightful and comprehensive discussion of the issue, is unavailable to large segments of the international community.

The complexity and non-transparency of Russian politics and industry may be a reason why few non-Russian scholars have ventured into a study of APG issues in Russia. Illustrative of this is the report 'Gas Flaring and Global Public Goods' (Christiansen and Haugland 2001), in which Russia is not included in the presentation of the global flaring issue, due to lack of official Russian statistics. A number of reports have been written by consultancies and NGOs but few scholarly or peer-reviewed articles are published on the topic. The scholarly articles that have been written on APG related issues in Russia are purely geological or, to some extent, technical.

The World Bank (via its Global Gas Flaring Reduction Public-Private Partnership, GGFR) and the International Energy Agency (IEA) have initiated reports on flaring. The World Bank commissioned the consultancy PFC Energy to write the report 'Using Russia's Associated Gas' in 2007. This report presents the flaring problem and assesses the (economic) potential of the various utilization options. Another report by the World Bank was issued in 2008 on 'Energy Efficiency in Russia: Untapped Reserves', but in the 120 page report, flaring was only mentioned briefly. IEA produced a report themselves in 2006 entitled 'Optimizing Russian Natural Gas', taking account of and assessing the potential of the Russian gas industry in general. In this report, APG is treated separately in one chapter.

The American consultancy IHS CERA (Cambridge Energy Research Associates) issued a report in 2009 on APG utilization in Russia, primarily focusing on the political struggles over influence on the policy making (Webb 2009). At about the same time as this report was published, a report on flaring and utilization was issued by World Wide Fund for Nature (WWF) Russia, in cooperation with the Institute of

World Economy and International Relations of the Russian Academy of Sciences. The report, entitled ‘Russian Associated Gas Utilization. Problems and Prospects’, is written by Aleksey Knizhnikov and Nina Poussenkova. The report describes the flaring volumes and potential ways of utilizing the gas, as well as providing an overview of the policies which have been and will be implemented to increase APG utilization.

In addition to these reports, a growing number of news reports provide updated information on government actions towards flaring. The Russian Federation Council themselves published a small informational report/ press release in June 2010 detailing their current actions to make legislation on APG flaring and utilization (Ryzkhov and Zhambalnimbuev 2010).

2 Method, assessment framework and data

As the above literature review suggests, there is English language information available on APG flaring and utilization, but it is very limited. In addition, the published reports often present one particular perspective, focusing either on the potential of utilization options or political decision-making issues. A comprehensive study, providing an overview of all relevant factors, thus has an intrinsic value in providing information on several aspects of the APG issue in relation to each other.

Such an overview study is by definition empirical, as the goal is to map out the factors and actors involved, rather than test the theoretical implications of the case. The Russian case is very atypical, and theory testing or theory building on the basis of a study of Russia may not hold great potential. Empirical studies may be an important contribution to case-specific knowledge, as theory is not expected to be applicable. Lundevall et al (2002) argue that a framework approach such as the one used in this study should indeed be an inductive one, but emphasize that a higher level of theorizing, through more research, is needed. On that note, this study may be a contribution to the pool of research on technology innovation systems and socio-technical change, thus strengthening the base for possible future theories on technology innovation systems. Flyvbjerg (2006) on the other hand, argues that qualitative, context-dependent studies have an intrinsic value, as they help provide a nuanced view of reality – the basis of scientific knowledge. As the Russian case is a complex one which have been studied systematically only to a limited extent, the empirical systemic overview provided by this paper could therefore be of use.

In order to ensure that all aspects of the APG issue is covered, a structured framework for systemic studies is useful. By applying a systemic scheme of analysis, we can be more certain that all possibilities have been explored in the search for influential factors and actors. Explanatory variables and models may be provided by disciplines as diverse as economics, social or organizational sciences, technological sciences, or geography. As the goal of this study is to map out the main reasons for the low level of APG utilization, it is desirable to include all relevant disciplinary perspectives; it is not a given which one holds the major explanatory variables. A systemic approach is consequently the most appropriate for addressing the APG utilization issue.

2.1 Assessment framework

The research question relates to the application and diffusion of various utilization technologies, and can thus be studied either as a process of socio-technical change, or as a decision making problem. As models on socio-technical change are generally found within the field of innovation analysis, a study of the Russian APG case within such a scheme of analysis entails the assumption that the case is a matter of innovation. Innovation is 'the doing of new things or the doing of things that are already being done in a new way' (Schumpeter 1947:151). When speaking of innovation, new inventions and technological breakthroughs often come to mind, but innovation is a much broader concept than this. First of all, innovation is not invention (Schumpeter 1947). Innovation relates as much to the way in which a technology is used, as the technology itself. Secondly, innovation is a process which often takes decades to complete, and includes phases of development, diffusion and application. The innovation process is finalized when the technology is fully diffused and established in the industry, market and/or society. A third aspect of innovation relates to *what* is innovated. I have until now referred to technology, but innovation may, according to Schumpeter's classification, be divided into five types: new products, new methods of production, new sources of supply, the exploitation of new markets, and new ways to organize business (Fagerberg 2005). For the Russian APG case, two of these types of innovations are relevant; new products – in the form of APG utilization technologies – and new ways to organize business – in the form of the structure of the Russian hydrocarbon industries. The former is the basis of this study, the latter is one of the explanatory variables, and will be discussed later.

The basic technologies traditionally used for APG utilization are not innovations in the strictest sense. The Russian oil industry has been utilizing APG for a long time, despite not reaching the point of utilizing all of it (Kryukov, personal communication). This latter aspect, the inability to continue the long-running utilization regime, is what makes Russian APG utilization case interesting as an innovation study, and forms the basis of the research question of this paper. When studying the flaring issue in an innovation framework, we assess both the technological developments and the context in which that technology is to diffuse. The innovation perspective allows us to identify at which level the hindrances to increased APG utilization are, whether technical, economic, or societal.

Such an innovation perspective on the APG utilization issue stands out from previous research on the matter, which either has focused on economic matters or actor conflicts and dynamics (PFC Energy 2007, Webb 2009). By including aspects of a model for advocacy coalition analysis, we can gain a better understanding of the role this actor dynamic plays in relation to the factors found in the innovation perspective. As the scope of this study does not allow for a parallel application of both models in full, I will use the innovation perspective as the organizing framework of the study, and apply advocacy coalition perspectives when this is relevant. In the following, the two schemes of analysis will be introduced.

2.1.1 Technology Innovation Systems (TIS)

The systemic study of technology innovation is a fairly new approach. Traditionally, technological innovations were studied as artefacts developed in individual organizations (firms), but in the last two decades, the focus has increasingly shifted towards a broader, more systemic perspective (Geels 2004). Such system theories and models are based on the notion that innovation and its diffusion is heavily influenced by context and external factors, and should be studied as such (Fagerberg

2005). Analytical frameworks based on this innovation system approach have successfully been applied for a number of studies on energy technology trajectories (van Alphen et al 2009). Innovation systems studies are plentiful, but they vary greatly in focus and are 'in need of substantial elaboration and refinement' (Fagerberg 2005:20).

In one attempt to address this, Anna Bergek and colleagues developed the Technology Innovation System (TIS) framework which synthesized the diverse appraoches into one comprehensive model (Bergek et al 2008). Previous focus had to a large extent been on structural reasons for failures in the establishment of a system, but this model emphasized that it is just as important, or more important even, to look at *how* these structural components affect the TIS; the functions of the system. Other studies have focused on one or a few functions, but the TIS framework sets out to include all – or at least most of – the relevant factors (Bergek et al 2008). To conduct such a comprehensive study, the authors propose a scheme of analysis, or a step-by-step model, which may be used as a framework for studying a given TIS.

By allowing for assessment of the system performance and identification of the factors that influence that performance, the analytical framework may be used by researchers and policy makers to 'analyze specific innovation systems in order to identify key policy issues and set policy goals' (Bergek et al 2008:408).

The framework has six steps which, albeit being presented in a linear fashion, in reality are expected to involve numerous iterations. The first step is to define the TIS. This entails making a choice between a specific product or a knowledge field, as well as defining the breadth, depth and spatial range of the study. The second step is to identify the structural components of the TIS, which may be actors, institutions and networks. The third step is the most comprehensive one; mapping out the functional pattern of the TIS. The functions identified by Bergek et al (2008) are knowledge development, influence on the direction of search, entrepreneurial experimentation, market formation, legitimation, resource mobilization, and development of positive externalities. The fourth step is to evaluate how well the functions are in fact performing, and specify what goals could and should be reached for the TIS. To do this, it is necessary to establish what level of performance is to be expected. This may be done either by identifying which level of development the TIS is in, and comparing the functioning of the TIS to the 'standard' for that particular level of development, or by comparing the TIS with another, similar TIS. Having done this, the mechanisms which induce or block development should be identified in the fifth step. The sixth and final step is to specify key issues in the TIS – discovered through the five previous steps and related to the goals specified in the fourth step – that should be addressed by policy (Bergek et al 2008).

2.1.2 Advocacy Coalition Framework (ACF)

The Advocacy Coalition Framework (AFC) was developed by Paul Sabatier and others beginning in the late 1980s. It is a framework for policy analysis focusing on how competition between advocacy coalitions and policy-oriented learning affect policy change in policy subsystems (University of Colorado 2010). According to ACF, three processes affect policy change over time: interaction between advocacy coalitions in a policy subsystem, societal changes external to the subsystem, and changes in relatively stable system parameters such as basic societal structures and values (Hisschemöller et al 2009).

An advocacy coalition is a formal or non-formal network of actors who shares views and beliefs about the preferred development of a policy subsystem (Hisschemöller et al 2009). In the case of this study, the Russian APG utilization system is the policy subsystem, comprising numerous actors divided in advocacy coalitions. In the policy subsystem, advocacy coalitions will compete for influence on the final policy outcome, altering their perceptions as learning takes place with the aid of a policy broker [2] (Hisschemöller et al 2009).

ACF has three basic premises. Firstly, the time perspective of policy change must be a decade or more. This is first of all because the process of learning – a core aspect of ACF – takes time, and secondly because a time perspective of more than a decade allows for at least one cycle of policy formulation/implementation/reformation (Sabatier 1988). The second basic premise is that the most useful way to study policy change is within a policy subsystem. This entails public, administrative and legislative bodies on all levels as well as civil society, media, scientists and others who contribute to the overall development, dissemination and assessment of policy ideas within the policy area. The third basic premise is that policy programs and policies 'incorporate implicit theories about how to achieve their objectives […] and thus can be conceptualized in much the same way as belief systems' (Sabatier 1988:132). Belief systems entail values, perceptions of reality, beliefs regarding causal relationships and efficiency of various policy instruments (Sabatier 1988).

The ACF provides a framework for analyzing policy change and its origins. Learning and the impact of external events are taken into consideration, as well as the role played by scientific and technical information (University of Colorado 2010). This may prove useful in studying APG utilization in Russia, as policy change in the direction of increased APG utilization is subject to competition for impact by powerful coalitions. On the other hand, no actors have APG as their main focal point. APG related issues are hard to isolate, and are part of the wider interests of the actors involved.

2.1.3 The complementarity of ACF and TIS

The ACF may supplement the TIS framework invaluably, as one of the major aspects of the APG utilization issue relate to powerful stakeholders and their impact on policy making. However, the TIS also include numerous important aspects that are not accounted for in the ACF, such as technicalities, market formation, and resource mobilization. These are all factors expected to be of importance in the APG utilization system. The TIS also has a more evenly divided focus on the potentially relevant aspects, whereas ACF has a considerably narrower scope on one given category of policy analysis, where other factors are merely secondary.

However, it is in its narrowness the ACF finds its strength in comparison to the very general TIS. As strong advocating actors are expected to be one of the major issues relating to APG utilization, it is useful to complement the broad TIS framework with components of ACF in order to shed some additional light on these aspects.

2.2 Data

To gather the extensive necessary information for this research project, I have relied on a number of scientific and expert reports written on the topic. I have also conducted interviews with experts and gathered information directly from some of the actors involved. This breadth of sources is expected to cover the vast field of information needed. Not all of the reports used are peer-reviewed, but their reliability is strengthened by assessing these alongside peer-reviewed articles and each other, as well as verifying the information with experts.

The interviewees are some of the foremost Norwegian and Russian experts on flaring of APG in Russia. As the research for this paper was done at the Fridtjof Nansen Insititute (FNI) in Lysaker, Norway, I could draw upon the knowledge and contacts of the researchers there. One of my informants was Arild Moe, Deputy Director and head of the Russia Programme of the research institute. In addition to the contacts from FNI, the 'snowball effect' helped me get in touch with NGO workers in Russia, i.e. Elena Kutepova of World Wide Fund for Nature (WWF) Russia. Two of the Russian experts, Valery Kryukov and Nina Poussenkova, are authors of some of the few substantial written works on flaring in Russia. Kryukov is Deputy director of the Institute of Economics and Industrial Engineering at the Russian Academy of Sciences, Siberian Division, and professor at Moscow Higher School of Economics. Poussenkova is a Senior Researh Fellow at the Institute of World Economy and International Relations. Torleif Haugland and Francois Sammut are researchers and consultants working in the Norwegain consultancy Carbon Limits with Russian actors to get flaring projects in Russia approved under the Kyoto mechanisms, i.e. Joint Implementation (JI). They thus hold substantial and updated information on the motivations of the actors involved.

The communications with all the experts were in person, except with Elena Kutepova, with whom I communicated via e-mail. The interviews were conducted in an informal manner. The questions were not standardized, but specified for the field of expertise of the interviewee, although many of the same subjects were covered in several interviews. The interviews were open ended, allowing the flow of the conversation and the subjects that came up, to lead the way to other subjects. This format allowed for the inclusion of issues that the interviewer was unfamiliar with, and hence had not addressed directly in any question.

3 APG options: flaring, venting and utilization

3.1 Flaring and venting

In oil reservoirs, there is always a certain amount of natural gas present. Depending on the pressure in the reservoir, the gas can either be dissolved in the oil, or lay as a cap above the oil. When the oil is extracted, the dissolved gas, also labelled associated petroleum gas (APG), follows (PFC Energy 2007). The gas-to-oil (GOR) ratio varies greatly from one oil field to the next, ranging from 1-2 m^3 to thousands of m^3 of gas per ton of oil (Knizhnikov and Poussenkova 2009). When the oil and gas mixture reaches the surface, the gas has to be separated from the oil before the oil enters the pipelines. The gas can either be processed and utilized, released directly (venting) or flared[3] (International Energy Agency 2006). Venting is for safety reasons not a common practice, and I will thus focus the following discussion on flaring and utilization.

Flaring is open-air burning of APG (Bott 2007). Some flaring is needed for safety; in case of equipment failure, power outages or other emergencies disturbing the drilling or processing operations, disposing of gas to avoid dangerous build-up of pressure is necessary (Bott 2007). However, most of the gas can be collected while only a low percentage is flared for safety. Despite this, oil-producers in numerous countries, such as Russia, flare a large part of the gas.

3.1.1 Metering

Unnecessary flaring of APG is a world-wide problem, but specific levels of flaring in different countries, regions or specific oil fields are difficult to estimate. Metering equipment on the oil well makes for specific measuring of APG production, and the amount of APG utilized or flared may thus be identified rather straightforwardly. However, such metering equipment is not widespread in Russia. Flaring levels must in those cases be estimated either by calculations based on the gas-to-oil ratio (GOR) expected in a specific oil field, or though satellite observations. It is clear that neither of these options provide exact numbers for the amount of APG flared, and when addressing flaring volumes in Russia, the numbers are always estimates. Such estimations of flaring volumes in Russia vary greatly, ranging from 75% (EurActiv 2010) to 27% (Ministry of Natural Resources, cited in Knizhnikov and Poussenkova 2009). The consultancy PFC Energy have in a report commissioned by The World Bank, a key player in combating APG flaring, estimated that Russia flares 45% of its APG (PFC Energy 2007).

The problem of incomplete measuring of APG production and flaring is on the political agenda in Russia, and is made part of the new Russian policy on flaring adopted in 2009; sites without metering equipment have to pay higher fees for flaring than sites with such equipment (Kristalinskaya 2010). The uncertainty concerning APG production and flaring levels is politically important because it complicates the prediction of expenses associated with increased APG utilization, as well as the possible economic and environmental gains from this (Webb 2009).

3.1.2 Flaring volumes

As the estimates of APG flaring volumes are highly disputed, I will in this presentation primarily focus on the World Bank estimates, as these provide a median number. Also, the World Bank holds comprehensive information on numerous countries, and all the volumes presented here will thus be comparable.

The World Bank assumes that globally as much as 150 billion m^3 (bcm) of APG is being flared each year (Global Gas Flaring Reduction 2010a). This is equivalent to 30% of the European Union's annual gas consumption. Despite high levels of flaring, not all oil-producing countries contribute equally to the flaring; Russia is the worst, at estimated 40 bcm per year (2007), Nigeria is second at 14 bcm per year, and Iran third with 10 bcm annually (Global Gas Flaring Reduction 2010b). The global level of flaring has, according to the World Bank estimates, decreased from 162 bcm in 2005 to 140 bcm in 2008, and Russia alone took account of 15 bcm of this decrease (ibid.).

3.1.3 Consequences of flaring

Flaring is a problem because it pollutes and is economically wasteful. The environmental damages are mainly linked to greenhouse gas emissions, and are hence global in scope (Christiansen and Haugland 2001). The emitted gases are primarily carbon dioxide and methane. As the burners used to flare APG in Russia are notoriously inefficient, more methane is released than from more efficient flares. Methane is a much more potent greenhouse gas than carbon dioxide (PFC Energy 2007, Knizhnikov and Poussenkova 2009). PFC Energy (2007) estimates that flaring in Russia releases between 30 and 100 million tonnes carbon dioxide equivalents annually.

The environment in the close vicinity of APG flares is also affected. As the APG is seldom completely clean methane, and the burners are not 100% efficient, a number of chemicals in addition to carbon dioxide and methane are released (Bott 2007). These include carbon monoxide, nitrogen oxides, polycyclic aromatic hydrocarbons, volatile organic compounds (VOC), sulphur dioxide, carbon disulphide and carbonyl sulphide (Bott 2007). Some of these compounds, most notably sulphur, may cause acid rain in the surrounding regions (Christiansen and Haugland 2001). Combinations of the compounds may cause ground level ozone and smog. Some of the compounds, i.e. the VOC benzene, is known to be carcinogenic (Bott 2007). The emitted gases can affect not only human health, but also biological habitats, forests, and agriculture. In Western Siberia, the region in Russia with the highest levels of flaring, there are few settlements and no agriculture. The environmental impact is thus rather invisible, only affecting remote forests and greenhouse gas concentrations in the atmosphere.

3.2 The options for utilizing the APG

Instead of flaring the APG, it can be utilized[4] in a number of ways, or, if the primary goal is reducing greenhouse gas emissions, flaring can be done in a more effective way or replaced by incineration. Incineration is the burning of the gas in a closed chamber, controlling the release of soot, carbon dioxide etc. The composition and quality of the gas, as well as issues relating to infrastructure and economy, are important in considering which options are available to a given producer. APG contains varying amounts of ethane, butane and propane, other organic compounds, water, carbon dioxide, and hydrogen sulphide. These impurities are to a large extent decisive with regards to what the gas may be used for. Even gas that is meant for on-site use (power generation) must be processed. This chapter will outline the technological options available for APG utilization. The focus will be on the technical qualities of the options, but as institutional factors often are inseparable from technical, some primary comments on institutional factors will be made.

The technical options available for utilizing the APG are:

- Reinjection (for disposal or enhanced oil recovery)
- Power generation, local or regional
- Compression for sale as dry gas
- Processing of APG into liquefied petroleum gas (LPG – propane and butane), petrochemical feedstocks, or diesel (gas to liquids – GTL)

The attractiveness of each of these utilization options will vary between oil fields due to a number of reasons related to e.g. size, location, and capital allocation considerations. According to a study by PFC Energy (2007) local electricity generation is the best option for small fields, whereas very large fields that may connect to the power grid may benefit most from combined cycle gas turbine (CCGT) power generation. The utilization option which is currently most common among Russian oil companies is power generation (Kryukov, personal communication).

3.2.1 Reinjection

Reinjection is a purely local option. This is primarily done to maintain the pressure to sustain the level of oil production (enhanced oil recovery), but the gas may also be reinjected for preservation for future usage (or to be left in the reservoirs, thus avoiding CO2-emissions, as well as providing safe disposal of acid gases) (Bott 2007). Reinjection is a somewhat uncertain option as different geological foundations to different degrees lend themselves to hold gas. It is thus, for geological reasons, not applicable in all oil fields, and in Western Siberia, the region where most of the flaring takes place, the sedimentary rock is not suited for reinjection. Reinjection may in certain cases also be costly, because the gas needs to be compressed before injected into the reservoir (International Energy Agency 2006, PFC Energy 2007). The fact that reinjected gas in itself does not produce any revenues, makes this option economically unattractive to oil companies (Haugland and Sammut, personal communication). On the other hand, if the reinjected gas can contribute to enhance oil recovery, reinjection may be a more attractive option. In Russia however, enhanced oil recovery have generally been done by injecting water rather than gas, and the most widely applied drilling technologies (turbine drills) in Russia are based on this alternative (Kryukov, personal communication).

3.2.2 Power generation

Power generation may be either local or regional. Local power generation produces electricity for use on the oil field, thus saving the oil company expenses in purchased electricity or diesel for power generation. However, not only are the processing facilities capital intensive, the energy need of an oil field is also limited, and in some cases the energy needed is much less than the available power produced from APG. If there are no local consumers (industry or communities) in the vicinity that could take advantage of excess power production, local power generation is thus only a limited solution (PFC Energy 2007). Regardless of local or regional consumers, power generation also requires access to a regional power grid to dispose of surplus power.

Regional power generation gathers gas from a number of wells, and thus entails even larger processing and infrastructure investments. The revenues from gas sales to electricity generators, assuming a sufficiently high price level for electricity, is however a motivator for oil producers to go for this alternative (PFC Energy 2007). Another option for power generation are joint ventures between oil companies and power generating companies.

3.2.3 Compression of APG for sale as dry gas

An often discussed option for utilizing APG is compression for sale as dry gas. APG has a much lower density than natural gas, and as the APG needs to be transported with the natural gas pipelines, it is necessary to compress the APG. The APG needs to go through the compression process numerous times to reach the required density to enter the pipelines. This process is expensive, and for it to be economically worthwhile for the oil companies, they need to be able to sell the compressed gas at a sufficiently high price (Kryukov, personal communication). There is evidently also larger potential for profits if the flow of APG is substantial and stable, allowing for economies of scale.

In remote areas such as Western Siberia, where most of the oil production in Russia takes place, the long distances makes it impossible for the oil companies to construct their own gas pipelines. Gazprom, the Russian gas monopoly, does however own an extensive grid of gas pipelines in Russia. The oil companies can either sell their gas directly to Gazprom, or rent space in the pipelines. The problem is that Gazprom has no interest in allowing other gas producers into their monopoly, and hence offer very low prices to the oil companies for the dry gas made from APG, or demand high rent for space in the pipelines. These economic terms are unacceptable to the oil companies.

Laws on third party access to Gazprom pipelines have been passed, but Gazprom is only required to allow other gas producers use the pipelines if they have spare capacity and the gas is of sufficient quality. As there is no external monitoring of the Gazprom pipelines, Gazprom can effectively exclude anyone from their pipelines. In Western Siberia, Gazprom does in fact have high production volumes themselves, and thus actually have little spare capacity in their pipelines. Gazprom have proposed cooperative programmes with the oil companies in which the oil companies contribute financially to the construction of more pipelines, but as APG is not a prime concern to the oil companies, they do not consider such expenses worthwhile (Kryukov, personal communication).

3.2.4 Processing of APG

Processing the gas into Liquefied Petroleum Gas (LPG), petrochemical feedstocks, and gas-to-liquids (GTL) diesel for sale are other options for utilizing the APG which may generate income for the oil company. These options may however be highly capital intensive, requiring both gathering infrastructure and processing facilities. In the case of LPG, access to external processing facilities is generally a requirement (PFC Energy 2007). There are, however, not enough gas processing facilities in Russia, and state owned Sibur owns more or less all of these, holding a de facto monopoly on gas processing. The oil companies have to negotiate with Sibur to sell their APG, and due to the monopoly, Sibur can demand more or less what it wants. These large processing facilities were built before the fall of the Soviet Union, and hence are not modern. Russian authorities have an overall strategy that Russia should be an expert in advanced gasproducts, not just dry gas, but this require a substantial modernization of the processing facilities.

GTL processing also requires external processing facilities, and a certain scale is normally required for processing to be worthwhile. As there are only two such facilities in Russia, it is thus necessary to bring together gas from multiple fields (PFC Energy 2007). It is also in most cases commercially not viable (Kryukov, personal communicaton). This issue may however be overcome in the relatively near future, as technology is currently being developed for smaller scale GTL processing (Haugland and Sammut, personal communication). An advantage of this option is that by liquefying the gas, the problem of access to Gazprom pipelines is bypassed.

4 The Russian case in the TIS model

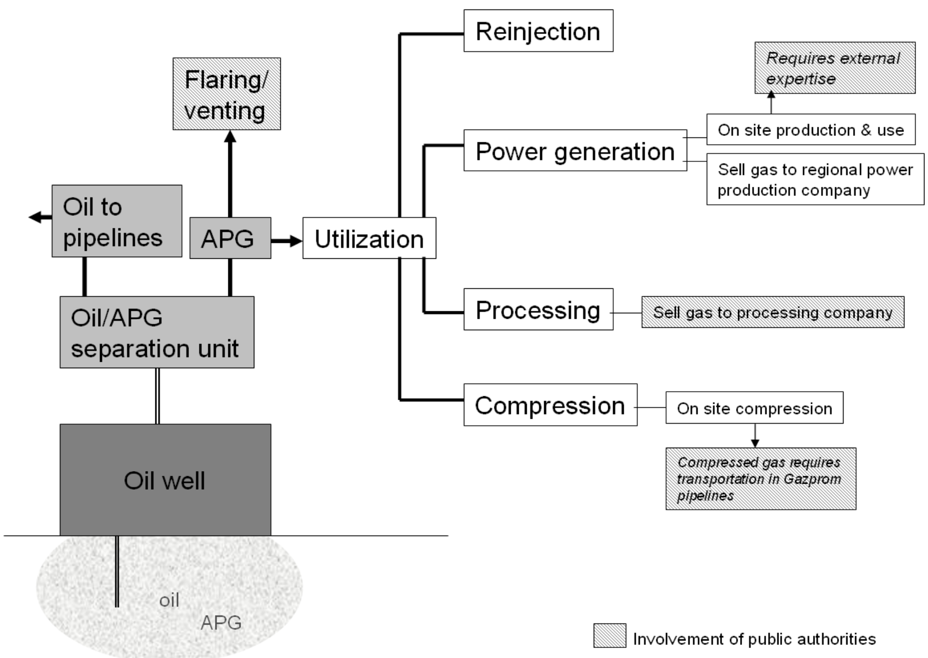
The TIS-model presented in chapter 2 will now be applied to study the Russian APG utilization system. As mentioned above, the scope of this paper and the holistic nature of the TIS framework impose certain limitations on the level of detail that can be presented here. As previously discussed, ACF will be utilized where applicable.

4.1 Step 1: Defining the TIS

Defining the system to be studied may seem trivial, but it has great implications for the analysis and the applicability of the TIS-framework. TISs are 'socio-technical systems focused on the development, diffusion and use of a particular technology (in terms of knowledge, product or both).' (Bergek et al 2008.408). A technology may relate to either a specific product or a knowledge field, in this case our TIS is the latter: the knowledge field of APG utilization. In defining the TIS, we also need to specify the boundaries of the TIS in terms of level of aggregation, range of applications of the technology in question and spatial focus. Regarding the level of aggregation, the analysis of the APG utilization TIS will be broad, focusing on the knowledge field of gas utilization technologies rather than one specific technology. However, it will be limited to only studying this technology when applied for APG, thus having a narrow range of applications. The spatial focus is Russia.

APG has its origin in the oil industry, but the system boundaries do not stop at the oil field. Transportation, processing, consumers and public authorities are all factors and actors that influence the TIS, despite not being in the immediate institutional or technical vicinity of the oil extraction or flaring. Figure 1 illustrates the APG utilization TIS.

Figure 1. The APG utilization TIS



4.2 Step 2: Identifying the structural components of the TIS

Having defined the system, the structural components – actors, networks and institutions – of the TIS needs to be identified and analyzed. In the following, I will first study the actors of the APG utilization TIS. As the actors, their interests and networks are synonymous to advocacy coalitions, I will after introducing the actors discuss them in light of the ACF. After this, I return to the TIS analysis and introduce the institutions of relevance to the APG utilization TIS.

4.2.1 Actors and networks

A principal feature of the actors involved in the APG utilization TIS, is the way in which they are structured. Traditional Soviet and Russian organizational preferences made a clear distinction between the oil and gas industries, a feature that still persists. This preference is both based on culture and tradition, and the geographic separation of gas and oil fields in Russia (Kryukov, personal communication). Another aspect of this traditional organizational perspective is that giant industrial units were preferred over small scale options. This also persists today, making the system inflexible to change (Moe, personal communication).

4.2.1.1 Oil industry

The oil industry has a number of large companies, and a substantial amount of subsidiaries to these. Due to the limited scope of this study, I will only focus on the largest oil companies in this section.[5] Together they represent over 90% of the flaring in Russia. The five oil companies Surguteneftgaz, TNK-BP, Rosneft, Lukoil, and Gazprom Neft alone represent 80% of the flared gas in Russia (Knizhnikov and Poussenkova 2009). The state owned oil company Rosneft is the largest oil producer in Russia, just ahead of Lukoil (Rosneft 2010, Lukoil 2009a). Rosneft is among the oil companies with the lowest level of APG utilization, at just 64.2%, but it has plans to build a number of Gas Turbine Power Plants (GTPPs) which may produce power for feeding into the Western Siberia power grid (Knizhnikov and Poussenkova 2009). Lukoil, operating primarily in Western Siberia has a utilization rate of 75% (ibid.). Ranging alongside Lukoil is TNK-BP, which is the only one of the major independently operating oil companies which is not purely Russian. Bashneft and Russneft, relatively small oil companies, also retain high levels of APG utilization at approximately 80%. However, the leading oil company in terms of APG utilization in Russia is Surgutneftegaz (Knizhnikov and Poussenkova 2009). In 2006, Surgutneftegaz utilized 93.5% of its APG (Knizhnikova and Poussenkova 2009). The oil company Tatneft has had an even higher utilization rate of 95% (Knizhnikova and Poussenkova 2009), but this rate was lowered as Tatneft extended their operations to regions outside of Tatarstan with less dense settlements and less developed infrastructure (Knizhnikova and Poussenkova 2009).

The primary interest and concern of the oil companies is oil extraction. APG is considered a by-product of the oil production, and is only interesting to the oil companies if it can generate extra revenues.

4.2.1.2 Processing and engineering companies and Joint Ventures

The oil companies may either sell the APG to companies utilizing it, or process it themselves. If an oil company sells the gas for gas processing, Sibur, a Gazprom subsidiary, is in reality the only potential buyer, holding a de facto monopoly on gas processing in Western Siberia (PFC Energy 2007). Sibur has JVs with Gazprom Neft, Rosneft and TNK-BP, and such JVs may contribute to increasing APG utilization levels substantially, and until now, Webb (2009) finds that these types of efforts are the ones that have contributed most to increased APG utilization. However, the monopoly allows Sibur to offer very low prices for the APG[6], and oil companies may therefore prefer looking for alternative solutions. The gas may for instance be sold to regional power producers, as these are generally small actors with little leverage in price negotiations with oil companies (Poussenkova, personal communication). However, the low regional electricity needs may already be covered, hence diminishing the demand for APG for power generation purposes.

A final option for selling the APG is for the oil company to compress the gas and sell it to Gazprom, the pipeline monopolist in Russia. The oil company may also choose to rent space in the Gazprom pipelines, remaining the legal owner of the gas. A law was passed in 1997 to ensure third party access to the Gazprom pipelines, provided that the gas is of sufficient quality and that Gazprom has spare capacity in its pipelines. As there is no external monitoring of the pipeline capacity, Gazprom can, to avoid allowing the entry of competing gas sellers, simply declare that the quality of the gas is too low or there is no capacity to spare (PFC Energy 2007). In Western Siberia there is in fact little spare capacity, it is not just a monopolistic statement by Gazprom (Kryukov, personal communication). Regardless of this, the issue of third party access is an important one, and as Gazprom has a vested interest in remaining a monopolist, it is unlikely that anything will change soon with regards to third party access (Kryukov and Moe 2008).

The oil companies may also themselves utilize the APG, either via reinjection, power generation or small scale gas compressing or liquefying. This is generally either outsourced or done as joint ventures (JVs) with specialized engineering companies. There are a large number of companies operating in Russia in the field of petrochemicals and gas processing, generally answering to the outsourcing needs of the oil and gas industries. Most of these are not specialized in APG, but still hold important knowledge on oil and gas products and possess necessary technology. Despite the fact that most of the knowledge needed for APG utilization already exist in the oil or gas industry, the link between the two industries is weak, and about 10-15% of the knowledge needed for APG utilization is APG specific and not found within other production or processing operations (Kryukov, personal communication). This market segment has since 2003 been filled with a number of specialized engineering companies holding expertise on APG utilization and working on innovation and development of new utilization technologies, as well as new ways of applying existing technologies (Poussenkova, personal communication). Globotek, Metaprocess, and New Technologies are examples of such companies (Kutepova, personal communication). Globotek, for instance, has developed processing technology based on a number of building blocks which may be assembled and combined in various ways to cover the needs of a given oil company. However, this solution is only applicable in small scale, not for large fields (Kryukov, personal communication). The largest of these new companies is Metaprocess, but after the financial crisis the company struggles economically. This is currently the situation for a number of these small engineering companies (Poussenkova, personal communication). These companies have a strong interest in the increased utilization of APG, as it forms the basis of their business.

The oil companies may also choose to 'do it themselves', generating electricity for on site use. This only requires the involvement of a provider of gas turbines, as well as contact with the regional electric grid owner, as any spare electricity needs to be fed into a grid. The former type of actor often works in JVs with the oil company. Examples of such JVs are between Lukoil and Iskra-Energetika and Aviadvigatel. An example of the latter is cooperation between TNK-BP and OGK-1. Some oil companies, such as Rosneft, even operate their own petrochemical facilities where APG may be utilized (Poussenkova, personal communication). Lukoil is also planning to build such facilities (Kryukov, personal communication).

4.2.1.3 Public actors

In addition to the industrial actors, a number of public bodies and institutions at the regional and national levels are of great importance to the APG utilization TIS. Persons within these bodies may also be of relevance, according to Webb (2009).

4.2.1.3.1 Regional authorities

At the regional and local levels, the authorities play a major role (Kryukov, personal communication). The previously mentioned differences between both flaring levels and political attention to this problem, is largely linked to the public regional authorities. We can particularly see this in the Khanty-Mansiysk Autonomus Okrug[7], where flaring levels are high, but there is great focus on the issue, and efforts are being made through e.g. operational permits being made contingent on flaring reductions. In addition, the regional authorities have gone to the peculiar step of joining the World Bank's Global Gas Flaring Reduction (GGFR) Public-Private Partnership, as the only representative from public Russia (GGFR 2010d). GGFR will be more thoroughly introduced later.

4.2.1.3.2 Federal bodies

At the national level, the Ministry of Natural Resources (MNR), Ministry of Industry (MI), Ministry of Public Health and Social Development, Ministry of Economic Development and Trade, and the Ministry of Finance have some role in the APG utilization matter. The MNR and MI are by far the most prominent of the ministries within this field, and they have very different perspectives on flaring. MNR has a stronger focus on energy efficiency than MI, and are hence stronger proponents of increased APG utilization. MI, on the other hand, is protecting existing industries, i.e. the oil companies and Gazprom (Moe, personal communication). Oil companies with influence in the MI have made this ministry reluctant to stronger regulations as suggested by MNR. It should be noted, however, that the overall political mood and global perception of APG utilization issues play a major role for both these ministries; when the Russian Gas Society in 2001 proposed a law on flaring, it was not taken on, but after flaring data in 2007 were made globally available, Russian authorities changed their general perception of the problem (Knizhnikova and Poussenkova 2009). Under these overarching waves of public interest, the opposition between MNR and MI continues. MNR generally wants strict regulations and rapid enforcement, as well as 'sticks' as political means to achieve the goals. MI on the other hand, promotes softer regulations, longer transition periods and 'carrots' as political instruments (ibid.). MNR is the strongest of the two, and the Oil and Gas-department within the MI is extremely weak (Kryukov, personal communication).

Under MNR, we find Rostekhnadzor, the federal body for ecological, technological, and atomic oversight. In late 2007, Rostekhnadzor proposed a very strict flaring regime, but their proposal was watered down by MI and MNR. The final text, Decree no. 7 of 2009, was both in terms of transition time to the new and stricter regime and in terms of the size of fines much more liberal than the Rostekhnadzor proposal (Government of the Russian Federation 2009, Knizhnikov and Poussenkova 2009).

Rostekhnadzor is only important when the regulations are clearly defined and strong, but at the moment, there are no strict laws for Rostekhnadzor to monitor in the APG field. In addition, they do not conduct inspections very often (Kryukov, personal communication). Webb (2009) points out that a change in leadership within Rostekhnadzor was of vital importance in the focus and efforts of the inspectorate, and hence its commitment to increased APG utilization. When Konstantin Pulikovsky was the leader from 2005 to 2008 Rostekhnadzor held an extremely tough stance on flaring, so tough that other environmental issues could be neglected (Webb 2009). When Nikolay Kutin took over in 2008, the focus has shifted to organizational issues and fighting corruption.

Other federal agencies of relevance are the Russian Federal Anti-Monopoly Service and the Federal Tariff Service (Federal Energy Commission). The former is of importance with regards to the de facto monopolies of Gazprom and Sibur, and has already mitigated in conflicts regarding third party access between Gazprom and Rosneft (Kupchinsky 2009). The Federal Tariff Service (FTS) is organized under the Ministry of Economic Development and Trade, and regulates prices of a number of products such as oil and gas. APG was regulated by FTS until 2008 (Knizhnikov and Poussenkova 2009).

4.2.1.3.3 President and Prime Minister

The role of the office of the Prime Minister and the President is potentially important. The presidential system in Russia grants the President with great powers, and his influence could thus be big (Remington 2008). The Prime Minister is generally one step behind the President, but in the current situation, Prime Minister Vladimir Putin has a personal network in the power circles in Russia that far exceeds that of President Dmitry Medvedev. His role could thus also be very important for the APG utilization TIS.

Of the two leaders, only Prime Minister Putin has so far made strong statements on the issue. He first addressed the issue in 2005 as president, and has made some rather aggressive statements on the flaring issue (Haugland and Sammut, personal communication). Dmitry Medvedev held the presidential office when Decree no.7 – demanding 95% utilization of APG by 2012 – was passed on 8 January 2009, but he has not made many strong statements on APG flaring and utilization. Taking into consideration that his presidential profile is one of modernization and effectivization, this topic would however fit well on his agenda (Moe, personal communication).

Both Medvedev and Putin have had close ties to Gazprom, and although Arild Moe (personal communication) does not believe this will be crucial in defining their positions on APG utilization, it is still expected to have a certain effect on the way in which they deal with APG utilization issues (Kryukov, personal communication). Perhaps a more influential individual when it comes to APG utilization policies is the deputy Prime Minister with responsibility for energy – Igor Sechin. He is chairman of Rosneft, and it is generally believed that when he was appointed to the post of deputy Prime Minister, he may have tilted the power balance in the federal bureaucracy to the advantage of the oil industry (Webb 2009).

4.2.1.4 NGOs, interest organizations and academia

NGOs play a limited role in the APG utilization system. Environmental NGOs are few and weak in Russia, and World Wide Fund for Nature (WWF) Russia is the only organization doing research on and engaging in the issues. Its level of influence is disputed, Valery Kryukov (personal communication) stating that despite their knowledge and production of papers on the issue, they have little real impact. Torleif Haugland and Francois Sammut (personal communication) agree, stating that the proposals made by WWF are rather unrealistic. Nina Poussenkova, who is affiliated with WWF, on the other hand points out that WWF works *with* the industry, taking on their perspectives and thus gaining respect and impact as a constructive environmentally conscientious partner to the industries. Other NGOs that are involved in the matter have economic interests in it, according to Haugland and Sammut.

Industry associations are more actively trying to lobby and influence policy making directly. Some of the major ones trying to influence APG utilization policy are the Russian Gas Society and the Russian Union of Industrialists and Entrepreneurs (RSPP). The former has amongst other things presented proposals of laws on APG utilization to the Russian government, in addition to functioning as a network of knowledge-sharing and mutual assistance (Knizhnikov and Poussenkova 2009, Russian Gas Society 2010).

Not actively participating in the industry disputes, but still important as a source and generator of knowledge, is academia. This is a diverse group who can contribute equally to all sides of the APG utilization issue. According to Haugland and Sammut (personal communication) academic institutions are involved both commercially and as consultants.

4.2.1.5 International actors

There are few international actors who has any relevance for the APG utilization TIS in Russia. Most notable is the Global Gas Flaring Reduction Public-Private Partnership of the World Bank. Partnership in this programme is offered to all interested actors, and a number of oil producing countries and transnational oil companies are members. The Russian Federation is not a member, neither is any Russian oil company. The only Russian actor involved is Kahnty-Mansiyski Okrug. The lack of interest in this partnership is illustrative of the attention and concerns that Russian oil companies have to the APG utilization issue (Knizhnikov and Poussenkova 2009). The international attention that GGFR puts to the flaring issue, as well as reports produced on flaring countries, may nevertheless have an influence on the Russian perception and awareness of the flaring problem.

As an international body working on APG flaring and utilization, GGFR is quite solitary. The International Energy Agency (IEA) does some work on the matter, but does not have an active policy to affect change.

4.2.2 ACF: Networks, actors and interests

As the above presentation of the actors of the APG utilization system shows, there are few formal networks of actors. There are however convergences in the views the various actors have on the preferred development of the TIS. These informal networks are what constitute the basis of the ACF. The actors may be divided into three groups – or rather coalitions – based on their view on APG utilization. One opposes APG utilization, one promotes it, and the final group is indifferent (but important none the less).

The core set of actors in the APG utilization TIS, the oil companies, are, if not indifferent, negative to APG utilization. They consider it a nuisance and an expense, and they do not want to be subject to further flaring regulations. The oil companies are supported by parts of the federal authorities. Gazprom is indifferent to flaring in itself, but is an indirect supporter of this coalition in that it – deliberately or not – shares its opposition to the pro-utilization coalition.

The coalition that promotes APG utilization consist of small engineering companies specialized in APG utilization, certain public authorities (e.g. Rostekhnadzor – at least until 2008, regional authorities in Khanty-Mansiysk, and Prime Minister Putin), GGFR, and WWF. As advocacy coalitions aim at influencing policy making, the fact that certain policy making actors are (at least partial) members of this coalition is one of its strong suits.

The ‘coalition’ of indifferent actors is far from unimportant. A prominent member of this group is Gazprom, which holds a key role in facilitating APG utilization, but has little interest in APG utilization or flaring as such. If Gazprom is compensated sufficiently, utilization may be beneficial to them. But the way the APG utilization system has developed thus far rather indicates that Gazprom will have to give up their monopolist control and allow third party access without the generous compensation they have been hoping for. This powerful actor is thus expected to lean more in the direction of the coalition opposing APG utilization, despite not actually being interested in the APG issue.

The time perspective is a core component of the ACF. As the discussion above of the members of the different coalitions indicates, there are strong dynamics at play. Actors may advocate APG utilization under certain circumstances, but not under others. As mentioned in the presentation of ACF in chapter 2, there are three key processes within the ACF which may affect policy change over time. These are interactions between coalitions, external societal changes, and changes in core parameters of society (values and structures).

Interaction between coalitions is somewhat limited. As discussed previously, there is little communication between the oil and gas industries in Russia. Most of the members of the coalition advocating increased APG utilization (small engineering companies, GGFR and WWF) are also so weak that they are not heard by their opponents. However, the one set of actors within this coalition who *is* heard by the opponents – the Prime Minister and the regional authorities, has an exceptionally large potential for influence. The potential of one coalition to influence the other is in other words skewed; generally the anti-utilization coalition has the upper hand, but if the authorities choose to use their potential influence, the balance shifts.

The second process which may influence policy change relates to external changes in society. One such influential change is in the global economy. The global financial crisis that started in 2008 has strengthened the views of the oil companies, who now are even less prone to accept having to invest in additional utilization equipment. On the other hand, the financial crisis gave some leverage to calls made by the advocacy coalition for increased APG utilization for energy efficiency and saving.

The third process, changes in stable system parameters, is evident when going back two decades. The fall of the Soviet Union and the subsequent restructuring of Russian society, economy and industry have, over time, had great influence on the respective positions of the advocacy coalitions. The strict divide between the actors of the different coalitions (most notably the oil companies and Gazprom) has its origin in these developments.

In sum, the advocacy coalitions are part of a dynamic political subsystem that makes it difficult to predict the outcome of the struggle between the coalitions. External factors tilt in favour of the coalition against APG utilization, whereas the key position of certain coalition members is the most powerful card on the hand of the coalition for increased APG utilization. The uncertainty of future developments thus lies in the willingness of those key members to act.

4.2.3 Institutions

Returning to the TIS framework, institutions such as laws, norms, regulations, routines and culture also need to be identified (Bergek et al 2008). These are important in the development of any TIS, as they are what constitute the framework in which the TIS exists. Generally, the institutions need to be 'aligned' for a new technology to diffuse, but this alignment is unpredictable and affected in different and often opposing directions by the actors involved (ibid.).

4.2.3.1 Legal basis

APG utilization is not a well developed system in legal terms. The first laws concerning APG were issued in 1997 (Poussenkova, personal communication), but now there are 21 federal laws and 37 decrees which directly or indirectly affect APG utilization (Ryzhkov and Zhambalnimbuev 2010). These include environmental protection, atmospheric pollution and industrial safety laws, deregulation and competition laws, and decrees directly linked to APG utilization. The large number of laws is not equivalent to a strict regime – many laws are made superfluous by non-monitoring or punishment for non-abidance so low that breaking the law is worth paying the fine (Kryukov, personal communication). This has until now been the case for flaring of associated gas. Utilizing the gas is much more expensive than paying the fines for flaring.

On a general level, the Federal Mineral Resource Act is of principal importance as it is the document that stipulates the oil companies' ownership of the APG. The Mineral Resource Act does not set any limits to flaring, but it does exempt oil companies from paying mineral tax for APG (Kryukov, personal communication). In January 2009 however, no.7 was passed, stating that 95% of the APG should be utilized by 2012 (Government of the Russian Federation 2009). A working group in the Federation Council is currently working on draft laws to follow up this decree (Ryzhkov and Zhambalnimbuev 2010).

Gazprom, WWF and other stakeholders contribute to the work on the draft, and although all the involved actors technically hold the same privileges, 'some [Gazprom] are more equal than others' in their influence on the final proposals (Poussenkova, personal communication). As the proposed law is currently being drafted, it is not yet clear what will be the main utilization focus. Until now, the process has been focused on encouraging on site power generation. In other oil producing countries with different geographical and geological conditions (such as Saudi Arabia and Malaysia), gas processing is the most common APG utilization technique (Poussenkova, personal communication).

One instrument for reducing flaring which is included as an instrument in Decree no. 7 (2009), is increased fines for flaring. In 2005, a first effort in this direction was made when methane emission – covering all emissions, including flaring - fines were increased a thousandfold. This made the new maximum flaring fine 250 rubles per 1000 m^3. In 2007, efforts were aimed directly at the flaring problem, when Rotzenkador proposed a very strict flaring regime, increasing the fines for flaring by a factor of 350, starting early 2008. This suggestion was strongly opposed by other public bodies as well as by the oil industry, and Rotzenkador's suggestion was since watered down immensely by MIE and MNR. The flaring regime that was finally adopted had an increase in fines by a factor of 4.5, starting on 1 January 2012. Oil producers who have not installed measuring equipment by then have to pay a fee by a factor of 6. A number of other, related laws and amendments which would further institutionalize this goal have been processed by the MNR and MIE, but disagreements between the ministries have stalled the process (Knizhnikov and Poussenkova 2009).

4.2.3.1.1 Legislation on aspects other than flaring

Although the above discussion of legislation related directly to flaring is at the core of the relevant legislation, laws and regulations addressing actors and processes on the subsequent steps of the APG utilization chain are also of great importance as they regulate the context in which the APG utilization TIS develops.

One of the most prominent of these issues is third party access to Gazprom pipelines, as discussed above. This newly passed law has little effect, as it grants Gazprom extensive provisions to continue refusing oil companies access.

Laws regulating the gas prices are similarly important. From 2002-2008, the Federal Tariff Service set the price levels for APG, but in 2008, APG was exempt from this system in an effort to decrease flaring and increase utilization. The impact of gas prices on the development of the APG utilization TIS will be discussed later.

Despite the ownership rights of oil companies being stipulated in the Federal Mineral Resource Act, the regions uphold certain rights to regulate the extraction activities. The regions generally do not set limits on flaring, but there is one exception; the previously mentioned Khanty-Mansiysk region has made APG flaring provisions a standard part of their demands to the oil companies operating in their region (PFC Energy 2007). They have set a 5% flaring limit, but oil companies are allowed to exceed that limit if they have due reasons for it – and the oil companies use that right actively (GGFR 2010c). Despite the many related regulations and laws, there is no overarching policy programme on APG utilization (World Bank 2008).

4.2.3.2 Culture and tradition

4.2.3.2.1 Path dependency

Culture, routines, and practices are also institutions to be identified. A principal concept in this regard is path dependency. This relates both to the traditional structure of the oil and gas industries, and to the perceived ideal size of companies. Under the Soviet era, the oil and gas industries were always clearly separated, a structure not found in any other oil and gas producing country (Poussenkova, personal communication). In spite of this, as the two industries were state owned and part of the same centralized state bureaucracy, their planning and strategizing was quite coordinated. When the Soviet Union fell, and the industries were privatized, this centralized contact seized. As a consequence, there are still strong structures keeping the oil and gas industries separate, with APG issues falling between the two.

Under the Soviet system, utilization levels did, according to Kryukov (personal communication) reach almost 80%. However, the lack of contact between the oil and gas industries which followed the privatization of the industries halted this practice.

The economic depression which followed in the wake of the fall of the Soviet Union made matters worse with regards to APG utilization. The oil companies focused only on oil production to stay in business, and when oil production started to increase they were not able to adapt their APG strategies to the new institutional system (Kryukov, personal communication).

4.2.3.2.2 Perception of APG in the oil industry

Another attribute of the Russian petroleum business culture concerns their view of APG. The focus of the oil industry has been on oil production, and APG has been a by-product of little interest (IEA 2006). This also relates to the previously discussed lack of integration between the oil and gas industries. However, due to geological attributes of Western Siberia, the oil companies are now showing increasing interest in APG utilization and the whole flow of the hydrocarbon production process (Kryukov, personal communication). The geological attributes relate to the area East of the Ural mountains, where there is a giant basin of sedimentary rocks with oil and gas. This is capped in below by a layer of crystallized rock. The reservoirs filled with more or less pure oil (low GORs) are now being depleted, and the oil companies have to move on to extract oil from the smaller reservoirs which are closer to the ground level. These reservoirs, higher up and further out on the shallow sides of the basin, have a higher GOR, thus much more APG than the reservoirs first developed. As the GOR increase, the oil companies have to put increasing effort into separating the oil and gas. As this is costly, it is in itself an incentive to utilize the gas, and when the amount of gas is larger as well, a more secure flow of revenues is available (Kryukov, personal communication).

4.2.3.2.3 Lack of environmental and energy concerns

Another cultural or normative aspect which has an impact on the development of the TIS concerns the general lack of interest in environmental issues in Russia. Civil society in Russia is very limited, and even if it was not, Haugland and Sammut (personal communication) expect that people would not take too much interest in the flaring issue simply because it is not visible to them. The flares are ‘in the middle of nowhere’, where no one is directly affected by them (as opposed to e.g. Nigeria, where people often live close to the flares). This issue is reinforced by the lack of transparency in Russia. International flaring estimates are much higher than the estimates used by the Russian authorities, and due to this, the problem seems less crucial to the Russian public than it actually is (Haugland and Sammut, personal communication). To the extent that oil companies have APG utilization strategies, it is because of administrative decisions, not an overarching environmental concern (Kryukov, personal communication).

Lack of environmental concerns is not the only cultural asset that has an effect on the perception of APG flaring and utilization in Russia. As a country with immense energy resources in the form of oil and gas, energy efficiency has not been a primary concern. This attitude has also been shaped by the artificially low energy prices (Øverland and Kjærnet 2010).

Despite the lack of environmental concerns in Russia, flaring has made it onto the political agenda as an energy saving issue. The Russian authorities find it embarrassing that they are wasting resources, especially as international attention is drawn to the problem (Haugland and Sammut, personal communication). The Russian government and their *Russian Energy Strategy for the period until 2030* adopted on 13 November 2009 shows signs of increased attention to environmental and energy efficiency issues, but the oil companies, the engines of the oil driven Russian economy, still have a strong hold on what kind of regulations are made in their industry (Bobylev 2010).

4.3 Step 3: Mapping out the functional pattern of the TIS

The third step of the TIS analysis is the most comprehensive one. It entails studying how the TIS is behaving with regards to seven key processes (Bergek et al 2008). After having analyzed this, the fourth step moves on to assess how well these processes function.

4.3.1 Knowledge development and diffusion

This process relates to the knowledge base of the TIS, and is thus of great importance (Bergek et al 2008). There are numerous different sources (R&D, learning from new applications, imitations etc) and types of knowledge (scientific, technological, market, logistic, production etc) which in various ways is important to the development of the TIS. It is however not only the quality or quantity of knowledge that will be most important, but also the organization of that knowledge.

Generally, knowledge about different options for utilizing gas is widespread, both globally and in Russia. This knowledge originates in academia as well as private companies, and both the public and private sector is well informed (Kryukov, personal communication). The oil companies hold substantial in-house knowledge on the first phases of APG treatment, and some oil companies aim at expanding this knowledge base by establishing their own R&D facilities, such as Russneft and Surgutneftegaz (Surgutneftegaz 2010b, Russneft 2010b). Others already operate their own gas turbines for power generation (Surgutneftegas and GazpromNeft) (Poussenkova, personal communication). According to Torleif Haugland and Francois Sammut (personal communication) however, the oil companies also buy services and know-how from engineering companies and consultancies. This is very common in the oil industries both globally and in Russia. Joint Ventures between oil companies and technical and processing companies is also a common means of benefiting from the knowledge of others.

As discussed previously, the oil and gas sectors in Russia have traditionally operated independently of each other. APG falls between these two sources of expertise, as it involves both oil extraction and separation of APG from oil, and gas treatment. Valery Kryukov (personal communication) points out that this leads to a situation where there is substantial knowledge on the matter, but it is not integrated. This is one of the aspects of the APG utilization system that most relate to innovation, or more specifically, organizational and industry innovation in Schumpeterian terms (Fagerberg 2005); knowledge contained in one field, namely knowledge of gas processing held by gas companies, is needed and used in the oil industry, and APG utilization technologies necessitate a restructuring of the hydrocarbon industries.

Generally speaking, no unique technology is needed for APG utilization. The technology is already there, either in the oil or gas industry, and any lack of knowledge is caused by the non-integration between the two. However, a certain level of knowledge needed for APG utilization – approximately 10-15% – is APG specific and does not exist in either the oil or gas industry. This APG specific knowledge is incremental; it's an extension of the knowledge already found in the oil and gas industries (Kryukov, personal communication). Companies such as Globotek and Metaprocess have specialized in this field, and offer small scale gas processing facilities and GTL (gas to liquids) technology, respectively, to the oil industry (Kryukov, personal communication, Globotek 2010, Metaprocess 2010). These companies also contribute to APG specific knowledge generation through innovation and development (Poussenkova, personal communication).

The knowledge needed is very different for the various utilization options. If the gas is to be sold as dry gas, the gas companies hold the expertise in processing. If the gas is to be reinjected, the expertise is generally held by the oil companies, but in cases of power generation and petrochemical production, a different segment of the energy sector enters the arena. Companies such as Sibur and Kazanorgsintez produces petrochemicals, and Iskra-Energetika, Aviadvigatel and BPC Energy Systems are examples of companies with expertise on power generation.

Looking beyond the technical knowledge needed for APG utilization, knowledge of the current state of the TIS is also needed, particularly on APG production and flaring levels. However, this type of knowledge is not easily accessible, if it exists at all. Of particular importance in this regard is the lack of metering equipment in Russian oil fields. The lack of specific information on flaring not only makes it necessary to rely on inaccurate estimates which may be politicised one way or the other, it also contributes to the non-management of the flaring. This is because the oil companies cannot make explicit assessments of costs and benefits of APG utilization, and because it is difficult for the authorities to accurately control what is done with the APG (Clearstone Engineering 2008). The metering equipment in itself is widespread globally and available also for Russian producers, and has been made a mandatory part of the government decree to reduce flaring.

4.3.2 Influence on the direction of search

For a TIS to develop, companies and actors have to enter it. The combined force of the incentives and/or pressures to enter the TIS is what the 'influence on the direction of search' function covers. In addition, this function relates to how different technologies, applications, business models etc. compete to influence the direction of the development within the TIS (Bergek et al 2008). A major component of this function is the expectations of the actors involved in the growth potential of the TIS. Other factors that may influence the direction of search relate to product prices and taxes, regulatory pressures, and articulation of interest by leading customers.

Belief in the growth potential of the APG utilization TIS is present in Russia, but with limitations. The geological realities of Western Siberia previously discussed contribute to an optimistic view by the oil industry, as they are well aware that future oil fields contain even more APG than their current fields (Kryukov, personal communication). However, as APG utilization is costly, the oil companies are only interested in increasing utilization if they can make revenues of the utilized APG. If the gas can be sold for a sufficiently high price, this economic disincentive is reversed. As previously mentioned, APG and gas has been on the list of products who's prices have traditionally been decided upon by the authorities, often influenced by Sibur (Kristalinskaya 2010). After 2008, APG was removed from that list, but the natural gas prices are still centrally regulated by the Federal Tariff Service.

Other product prices which may have an effect on the belief in growth potential are oil, electricity, flaring and metering equipment, processing facilities, power generators, etc. The price of oil is important to include as continued oil extraction, as well as financial security in the oil companies, is a prerequisite for APG utilization. If the APG is to be processed and used for power generation, the overall electricity price can be either an incentive or a non-factor. If the electricity price is high, on site power generation for local use may save the oil company costs, or generating power for the regional grid may be a profitable business. If the electricity price is low, the oil company will not have the same incentive to generate electric power.

Other factors that influence the direction of search are related to taxes. Particularly for the small engineering companies that specialize in APG utilization, expenses and taxes are of major importance to their survival. Their mere existence bears witness of belief in the growth potential of the APG utilization TIS, but without assistance in terms of tax breaks, venture capital etc, they may subside. Many of these companies are currently struggling due to the financial crisis, most notably the largest of them, Metaprocess (Poussenkova, personal communication).

The financial crisis has also affected larger companies. The oil companies keep their focus on keeping oil production up rather than spending money on what they see as a non-urgent issue. The crisis also affected the gas and oil markets, making them less predictable than before. In the current economic state, it is more difficult for the oil and gas companies to do anything out of the ordinary (Poussenkova, personal communication).

Besides expectations and price levels, regulations may also play a major role in the direction in which the TIS evolves (Bergek et al 2008). The Decree of January 2009 requiring 95% utilization of APG by 2012 sets an important standard for the industry to follow, thus encouraging the continued growth of the APG utilization TIS. The previously mentioned regulations obliging Gazprom to grant third parties access to their gas pipelines will also contribute to the continued development of the TIS, especially in the direction of utilizing the APG as processed dry gas.

A final factor that may have an influence on the direction of search is the articulated demand of leading customers (Bergek et al 2008). As all the products that APG may be processed into are already marketed goods, there is surely some demand for it. However, demand for gas or electric power may change, affecting the direction in which the TIS evolves.

4.3.3 Entrepreneurial experimentation

In the establishment of a TIS, there is generally some uncertainty regarding whether the TIS will indeed develop into a strong market, or wither away (Bergek et al 2008). This uncertainty is best reduced when there is a high level of entrepreneurial experimentation 'which implies a probing into new technologies and applications, where many will fail [and] some will succeed' (Bergek et al 2008:415-416). As the APG utilization TIS is already in its later stages of diffusion and application, the uncertainty is fairly low. It is also clear that the success of a number of technologies has already been established, and the need for entrepreneurial experimentation is thus not as big as in the early stages of a TISs evolution.

As previously mentioned the numerous oil companies already have established knowledge of and technologies for APG utilization. Companies with technological knowledge in all fields relating to APG utilization are not experimenting much, but they represent a broad and solid technological basis because much of the technology needed for APG utilization has been in use for some time already. APG utilization is just one of many fields they work with, and APG expertise is not very different from expertise about other types of gas. There are certain chemical differences which affects how easily the gas can be liquefied. This requires somewhat different technological solutions than natural gas does, but that aside the separation process is fairly straightforward; this have always been a part of the daily processes for oil companies.

However, there is still experimentation and development of new integrated solutions for APG utilization, primarily in small engineering companies (Poussenkova, personal communication). For instance, the two newcomers Globotek and Metaprocess have developed new APG-specific technological solutions. Globotek has developed technology for unified solutions, bridging the gap between the oil and gas knowledge bases. This solution is based on a number of building blocks which may be assembled and combined in various ways to cover the needs of a given company. However, this solution is not applicable for large fields, only on a small scale. Metaprocess specializes in LPG technology, but the company is currently struggling economically (Kryukov, personal communication). Other companies are experimenting on LNG and GTL conversion. Normally, large quantities of gas are required to process APG into LNG or GTL. However, new technology is currently being developed which may make it profitable to process gas into LNG and GTL also when the quantities are small (Haugland and Sammut, personal communication).

4.3.4 Market formation

For a TIS to develop, there must be a market for the product or technology. Markets are generally formed in three stages, beginning as a 'nursing market', moving on to 'bridging market' and finally becoming a full-fledged mature market (Bergek et al 2008). In the APG utilization TIS, there is a demand for various gas- or power products, the technology to produce it exists and firms are ready to offer their services, but still there is only limited APG utilization. This indicates that the APG utilization market is a late bridging market – ready to move on to the next step, without yet having done so.

This inability to finalize the market formation has its roots in geography and non-market mechanisms. Geographically, most of the major Russian oil fields are situated in Western Siberia, an extremely scarcely populated region. There is in other words barely potential for any market there, either for gas, electricity, or petrochemical products (Haugland and Sammut, personal communication). As a consequence, the APG, processed gas, electricity or in other ways processed APG must be brought to areas where there is a market. As Gazprom holds a monopoly on gas pipelines, any transportation of dry gas must be dealt with by them. As Gazprom offers are unacceptable to the oil companies, Gazprom sets a de facto stop to the possibility of oil companies to enter the regular gas markets (Haguland and Sammut, personal communication). To avoid this problem the gas may be converted to GTL or LNG, or used for power generation, but then the additional problems of production cost and transportation feasibility arise.

There are attempts of government intervention to circumvent this obstacle to market formation, e.g. through the third party access laws. However, there is no intermediary body controlling whether there is indeed spare capacity in the pipelines or not, thus the attempts only has limited potential for affecting change (Kryukov, personal communication).

Another issue complicating an APG market is one of the distinctive features of APG compared to natural gas; as APG is contingent on oil production, supply of APG cannot simply be stopped or increased (Kryukov , personal communication).

The option of gas reinjection circumvents the issue of market formation, as the gas would never enter a market. That in itself is also one of the reasons why this option is not seen as viable; there is no economic gain and hence no incentive to pay the extra costs of the necessary technology. The only case in which reinjection may be of interest is if it can contribute to enhanced oil recovery, but the costs are still expected to exceed the revenues, and when potential problems linked to leakages are added to the equation, it is generally not a viable option (Haugland and Sammut, personal communication).

4.3.5 Legitimation

A TIS needs to be considered appropriate by the actors involved and comply with existing institutions if it is to develop. Without this legitimacy, resources cannot be mobilized, expectations and motivation diminish (ref. 'influence on the direction of search'), demand is not formed and the actors cannot acquire political strength (Bergek et al 2008). To obtain legitimacy, stakeholders must actively pursue such a course; either institutional alignment (manipulating the relevant institutions), compliance with the established standards, or creation of a new institutional framework. The latter is rare, as technologies seldom emerge in a vacuum (Bergek et al 2008). In order to assess the legitimacy of the TIS, we need to not only look at the TIS in relation to existing institutions and value bases in industry and society, we also need to study how the legitimacy may affect demand, legislation and firm behaviour, and lastly what or who influences legitimacy, and how (Bergek et al 2008).

The alignment with current legislation and the value base in industry and society is at the core of the legitimacy of the TIS. In the case of APG utilization there is legislation related to the issue, and for the most part it works *for* the TIS, not against it. The 2009 decree on flaring reduction is an institutional advancement for the APG utilization TIS. However, the monitoring and enforcement of the regulations that exist is meager, and the institutional support for the APG utilization TIS is thus a technical alignment rather than bona fide one.

That the law is not adhered to by the industry itself indicates that the acceptance of the APG utilization TIS is low here. The oil industry accepts the TIS, but only insofar as it does not come at an extra cost. In the oil industry, APG utilization is a growing concern. The oil industry has previously held a clear focus on oil production, regarding APG as a by-product with no use. This has changed rapidly over the years, but many oil companies are still showing little effort to utilize more APG. This is primarily due to the potential economic costs related to APG utilization.

The gas industry represented by Gazprom has a similar approach, only accepting the APG utilization TIS if it does not compromize their own interests. Gazprom belongs to an existing TIS where they control the gas market, and is ready to defend that position. Not only is Gazprom an opponent of the APG utilization TIS, it is also in a unique position to halt its development.

As for the value base in society, the former is quite compatible with the TIS. As APG utilization is a rather technical issue dealt with by the industry, society has little direct interest. They have, as mentioned under the 'market formation' function, already accepted the products that may be produced from APG. The public realm seems to have aligned themselves increasingly to APG utilization in recent years, putting more and more focus on and efforts into increasing APG utilization, by aligning the institutional (legal) framework. Russian attitudes to environmental issues are reflected in Russian environmental and climate policies. Russian authorities were long debating whether to commit to greenhouse gas reductions at all, but signed the Kyoto protocol in 2004. In 2009, Russian authorities announced in that they by 2020 would reduce their greenhouse gas emissions by 25% compared to 1990-levels (Kremlin 2009). Russian arguments against climate commitments have related to a wish not to halt economic growth. The current Russian environmental policy regime focuses on adaptation rather than mitigation, but encourages increased use of renewable energy and increased energy efficiency (EurActive 2009).

Following up on the strength of the legitimacy of the TIS, we need to assess ‘how [that] legitimacy influences demand, legislation and firm behaviour’ (Berkeg et al 2008:417). The demand is not affected much by legitimacy, as the end-products (gas, LPG, electric power etc) are already accepted and integrated products in the Russian markets.

The legitimacy (or lack thereof) may have an impact on legislation, but this depends on the relationship between the state, the oil industry, and Gazprom. In Russia, there are in certain cases very close ties between government and companies, and if the oil industry were strongly opposed to the APG utilization TIS, the government may not be as accepting of the TIS either. In the current situation, the government has close ties to both the oil industry, which accepts the TIS, and Gazprom, which is the main adversary of the TIS. How this dual relationship may affect the policy and legislation passed by the government is unclear, and may perhaps be better addressed within the Advocacy Coalition Framework. As Bergek et al (2008) points out, new entrants to the TIS may strengthen the TIS advocacy coalition. As there are already a number of entrants acting within the TIS, this may prove the TIS advocacy coalition stronger than Gazprom.

With regards to legitimacy, the last issue to address relates to who influences the legitimacy, and how. APG utilization is already a common practice in a number of oil producing countries, and this global TIS may influence the legitimacy of the emerging Russian TIS (Bergek et al 2008). Closely related to this is the direct influence of single international actors. Knizhnikov and Poussenkova (2009) states that the flaring issue entered the Russian political agenda because new satellite images, broadcasted internationally, revealed high levels of flaring in Russia. This waste of resources was somewhat of an embarrassment to the Russian government, who introduced the issue on the political agenda (Haugland and Sammut, personal communication). This international focus brought attention to the issue, but it would not have been allowed on the agenda if it was not accepted as relevant and at least not unimportant. Other ways in which foreign actors try to influence the acceptance and legitimacy of APG utilization are through private initiatives such as the Equatorial Principles. These are a set of principles of corporate social and environmental responsibilities voluntarily agreed to by a number of international banks. By signing on to these principles, the banks agree to assess all projects they finance worldwide in terms of environmental and social impacts. None of the banks are Russian, but international banks also finance projects in Russia, and WWF is currently working with Russian banks to have them sign the principles (Poussenkova, personal communication).

4.3.6 Resource mobilization

Resources, (human, financial, and complementary assets) need to be mobilized for a TIS to develop. As many of the companies involved in the TIS were already actors in the oil or gas industries, there is a sound human resource base for the APG utilization TIS. As the financial crisis of 2008 left a number of engineers unemployed, this created a pool of available labor to tap into the APG utilization TIS. These have been of particular importance with regards to the new innovative small firms that specialize in developing APG utilization technologies (Poussenkova, personal communication).

Financially, the strong oil industry provides a sound basis for APG utilization. The financial crisis has put its toll on the Russian industries, and this has a particular impact on how the oil industry prioritizes APG utilization (Poussenkova, personal communication). The crisis made the companies economically unable to invest in non-essential projects such as APG utilization (Poussenkova, personal communication). The smaller companies established specifically for APG utilization have less financial leeway than the oil companies, and are more dependent on external support (Poussenkova, personal communication). Venture capital could have been a source of finance for such companies and their projects, but this type of financing is not common in Russia. For these small companies, government support, e.g. in the form of tax breaks, could be of vital importance (Poussenkova, personal communication).

Despite the lack of a Russian venture capital system, there are other possibilities for financing APG utilization projects. The European Bank for Reconstruction and Development have for instance assisted Irkutsk Oil Company with financial support to increase their APG utilization (European Bank for Reconstruction and Development 2009). Another potential source of finance is through the Kyoto mechanisms, and more specifically Joint Implementation (JI's does not have to be approved by the UN like Clean Development Mechanism (CDM)-projects have to, but only need approval from the Russian government. The Russian process is slow and non-transparent, and despite the rather large number of such projects being proposed, none have yet been approved. One of the reasons why this process is slow in Russia, is that the potential financial flow JI projects may provide is small related to the flow of investments in the Russian economy, and the projects thus fail to catch the attention and hence priority of decision makers (Korppoo and Moe 2009). Another less direct reason may be that certain actors in the Russian authorities do not want Russia to commit to greenhouse gas emission reductions (Haugland and Sammut, personal communication). There is no technical or legal reason why this mechanism should not work, as projects for reducing flaring have been approved for Nigeria and others. The reason why the process is lengthy is that the project managers must be able to prove 1) that the effort will indeed reduce emissions, and 2) that the effort would not otherwise have been done (Haugland and Sammut, personal communication). It is difficult to prove the second point, but through this process it is revealed that projects in remote areas tend to be more in need of this type of financing to be implemented (Haugland and Sammut, personal communication).

With regards to resources, complementary assets such as infrastructure, pipelines etc. are also of great relevance. In the APG utilization TIS, most of the APG utilization options somehow depend on complementary assets, most notably gas pipelines and electric grids. Technologies from the oil and gas industries may be considered complementary assets, but are so integrated into the APG utilization TIS that they themselves, at least to a certain extent, are the (somewhat modified) technological innovations. Complementary assets may either be generic, specialized or cospecialized, depending on the degree of dependence between the innovation and the complementary asset (Teece 1986). The APG technologies are technically generic – they are assets with a general purpose much wider than just APG utilization. But the Gazprom monopoly makes the complementary asset of gas pipelines a specialized one, where the oil industry is unilaterally depending on Gazprom.

The issue of gas pipeline access has been discussed previously, but is important to mention as one of the most crucial complementary assets. As discussed the existence of the pipelines is not the problem, but rather the access to them. As for the power generation option, the complementary asset of an electric grid is necessary. For remote oil fields there may not be a regional grid to use for disposal of excess electricity, but in many areas there is some sort of grid available, and access is rarely a problem. The oil companies have to pay a fee to reserve space for their power on the grid, regardless of whether they end up using that space or not. This may be a disincentive for power production, but the costs are generally minor (Kryukov, personal communication).

Owners of complementary assets may prove unintended beneficiaries of the TIS (Teece 1986). This is the case if Gazprom, power production companies or others attain buying gas at a low price from the oil companies, and making larger revenues by selling the gas or electricity produced by the gas.

4.3.7 Development of positive externalities

The final function is, rather than being independent, working through strengthening the other six functions. This is because the externalities that may arise in a TIS are positive in that they contribute to the other functions. External economies may be found in the form of political power, legitimacy, combinatorial opportunities, resolution of uncertainties and pooled labor markets, specialized intermediate goods and service providers and information flows and knowledge spill-overs, and may strengthen the functions of legitimation, resource mobilization, market formation, influence on the direction of search and entrepreneurial experimentation.

One of the major positive externalities in the APG utilization TIS is the entry of new firms. As the small engineering companies entered the TIS, it both increased the legitimacy and strengthened the advocacy coalition on the side of increased APG utilization, it also lowered uncertainty, influenced the direction of search and function as a bridge of knowledge between the oil and gas industries. The entry of new firms also becomes a challenge to the established institutional and traditional preference for giant units and enterprises, which in turn may affect institutional preferences, thus empowering small companies and strengthening the position of oil companies vis-à-vis Gazprom.

4.4 Step 4: Assessing the functional pattern of the TIS and setting process goals

In assessing the functional pattern, one can either identify the phase of development or compare the TIS to another similar TIS. As none of these are entirely accurate, a combination of the two is recommended (Bergek et al 2008).

The main phases of development of a TIS are the formative and the growth phase, although Bergek et al (2008) emphasize that there is no 'one size fits all' when it comes to development patterns. The APG utilization TIS has long been formed, and have also had some time to grow, but it seems it now has reached some constraints related to particularly market formation and legitimation. This rather peculiar stage of development is not a perfect fit in the TIS framework, but as Bergek et al (2008) points out, more research is needed concerning the classification of these phases, and the Russian case may thus shed some light on development patterns.

Comparisons between TISs also aid in identifying the phase of development of the TIS. Taking the scope of this paper into consideration, only preliminary comparisons can be made here. As Russia tops the list of flaring nations along with Nigeria, the APG utilization TIS (or lack thereof) in Nigeria is an interesting comparison. By also comparing with the APG utilization frontrunner Canada, which has similar geographic constraints as Russia, we get a comprehensive image of the state of the Russian APG utilization TIS compared to those of other countries'.

According to GGFR (2010b) Nigeria flared 14.9 bcm of APG in 2008. This is a much lower estimate than the Russian 40 bcm, but still constitute close to 40% of the APG production in Nigeria (Walker 2010). The flaring problem is much more urgent in Nigeria than in Russia, as the APG is flared in populated areas, directly affecting humans and nature. The issue has received considerable attention, but the oil companies and government blame each other for inaction. Also in Nigeria, the oil companies need pipeline access, but in Nigeria the pipelines are yet to be built (Walker 2010). One of the reasons the oil companies hesitate in this matter is cost, another is fear of militias controlling the area, and that they will attack workers constructing such a pipeline (Mason 2010). The need for energy in Nigeria is large, and if processed or used for power generation, there is a considerable market in which the processed APG may be sold (Walker 2010). Shell, the largest oil producer in Russia, has recently declared a major effort to reduce their flaring (Mason 2010).

As for Canada, 1.8 bcm APG was flared in 2008 (GGFR 2010b), and the bulk of flaring is done in the region of Alberta (Environment Canada 2010). In Canada, the regional authorities play a vital role in regulating flaring and venting (GGFR 2004). In 2007, Canadian oil companies utilized 93.6% of the 23.5 bcm produced (Canadian Regulatory

Authorities 2008). From 1996 to 2002, the flaring levels in the region of Alberta were reduced by 62% thanks to the setting of industrial targets (GGFR 2004). The instruments used to reach the goal were government regulations, close cooperation between regulatory authorities and oil companies, and close monitoring (ibid.). Both Nigeria and Canada are members of the GGFR, Russia is not (GGFR 2010d).

Comparing Russia, Nigeria and Canada, their large differences are striking. Russia and Nigeria have similar utilization levels, but very different reasons behind it. In Nigeria, the presence of foreign oil companies is also a major influence, Shell having been under considerable pressure in their home country the Netherlands to reduce flaring. The location of the flares and the presence of militant groups also contribute to the image of two highly different APG utilization systems. As for Canada, strong motivation in government and regional authorities seems to have been the driver of APG utilization efforts. By closely monitoring the oil companies in their strategizing, planning and implementation phases, APG utilization is at a world high. In terms of market, the Russian TIS is closer to the Canadian than the Nigerian. Russia has both pipelines and consumers; ‘all’ the oil companies need here is access. In terms of motivation and government efforts, the Russian TIS lies closer to the Nigerian. In conclusion, it seems the Russian APG TIS, while poorly developed in terms of motivation (both from industry and public bodies), has a solid base on which to build the final steps towards a fully developed and established TIS. This is in line with the preliminary discussion of development phases, where the Russian TIS was placed in the final stages of the growth phase.

Having identified which phase the TIS is in, thus having an indication of what is to be expected from the TIS, the process goals of the TIS should be set. These are expectations of how the TIS can and should develop on order to increase the functionality. A major goal, or a function to be improved, is market access. As seen in the comparison with Nigeria and Canada, Russia *has* a market; access to it is the pressing issue. A second goal concerns the structure of the hydrocarbon industries. In the further development of the TIS, some sort of restructuring is needed, either as an integration of the oil and gas industries, or, perhaps more likely, strengthening of the small firms that have entered the TIS, contributing to its technology innovation and alignment of institutional and structural factors, as well as bypassing the market-related problems. A third process goal, something that can and needs to be attained within the TIS, relates to resource mobilization, and in particular financial resources.

5 Answering the research question

Having described and assessed the APG utilization TIS in the previous chapter, we will now move on to the two final steps of the TIS analysis, which are the most relevant to the research question of this study: *which factors are the main hindrances to a radical increase in APG utilization in Russia, and can these be addressed by policy?* Step five of the TIS analysis involves identifying the inducement and blocking mechanisms, thus informing us on the first half of the research question. Step six entails specifying key policy issues. Through this step a base for further discussion of policy issues and instruments is formed, hence answering the second half of the research question.

5.1 Step 5: Identifying inducement and blocking mechanisms

As a TIS evolves 'under the influence of outside pushes and pulls and the momentum of its own internal processes' (Myrdal 1957, cited in Bergek et al 2008:421), the mechanisms inducing or blocking development in the TIS are found both within and outside the TIS. In the early stages of a TISs development, external forces are more influential than in later stages when the TIS has numerous and strong enough functions to withstand external pressure (Bergek et al 2008). The APG utilization TIS has proven to be in its later stages, as the technology is well developed, entrepreneurial experimentation is ongoing, numerous actors have entered the TIS, institutions are in the process of being aligned to the TIS, and political attention is given to the problem. This not only implies that many blocking mechanisms are already traversed, but also that many factors that are prerequisites for a TIS to develop fully have long been established. With a system as developed and well founded as this, preliminary expectations would be that APG utilization in Russia is a well-established, self-sustained TIS. But this is not the case; there are still substantial factors hindering the full development of the APG utilization TIS. It is both interesting and important to identify these blocking mechanisms which, taken into consideration that they are able to stop the further development of a well founded TIS, must be quite substantial.

5.1.1 Inducement mechanisms

Identifying the inducement mechanisms are important because of the key role they can play in policy making when attempting to further the development of the TIS and counter the blocking mechanisms. The inducement mechanisms that affect the development of the TIS may have an impact on one single function, or they may influence several functions at once. When trying to strengthen inducement mechanisms through policy, the latter type of mechanisms should be prioritized (Bergek et al 2008).

That the TIS is so developed in certain realms proves that there must be strong forces working for the establishment and strengthening of the TIS. Most considerable is the economic factor. As the newly developed oil fields contain higher volumes of APG than older fields, the oil companies face larger potential revenues from APG products. In addition, flaring fines constitute an unnecessary expense for the oil companies, and as these fines are planned to increase, the effect of this mechanism will grow stronger. The economic gains/saving mechanism has an influence on several of the functions of the TIS. It may influence the direction of search, the entrepreneurial experimentation, market formation, legitimation process and resource mobilization. On the other hand, economic considerations may be a blocking mechanism if the net costs of utilizing (and selling) the gas exceeds the cost of paying flaring fines. This will be disucussed under blocking mechanisms.

One inducement mechanism which is much weaker than the economic, but which holds great potential, is public attention. This mechanism is potentially strong, because it shapes policy and thus can work to strengthen the other inducement mechanism – economic concerns. The public attention mechanism is mostly influenced by external attention to environmental and climate concerns in general, and flaring in particular. This mechanism is currently in a crucial stage, as federal policies are being developed in the Federation Council.

There are few other inducement mechanisms. In other oil producing countries factors such as environmental protection and energy efficiency may be motivations to increase APG utilization volumes, but as we have seen these issues are, due to historic, geographic and institutional reasons, not of primary concern in Russia.

5.1.2 Blocking mechanisms

As mentioned for inducement mechanisms, those mechanisms that influence several functions should be prioritized in policy making. The overarching issue of path-dependency is one such blocking mechanism. The way in which the Russian hydrocarbon industries are organized and relate to each other is the main problem hindering increased APG utilization. Knowledge on APG options is not shared, and lack of cooperation creates a situation where competition and tension is the norm and none of the parts of the conflict are willing to make economic sacrifices. The monopolies of Gazprom and Sibur are at the core of this blocking mechanism. As the sole actors offering their type of services, the oil companies are depending on their cooperation. These monopolies are obstacles to the demand for APG; there is no end-user demand for APG-specific products (as they after processing are integrated in the end-user sale of other petroleum products) and the prices offered by processing and transportation companies such as Sibur and Gazprom are unacceptably low to the oil companies. In other words, there is effectively little or no real demand for APG. These path-dependency related blocking mechanisms have an immense impact on the development of the TIS, as they affect knowledge diffusion, influence the direction of search, entrepreneurial experimentation, resource mobilization, market formation, and legitimation.

As mentioned under the inducement mechanisms heading, economic concerns may be another strong blocking mechanism. This finds its explanation in the highly pragmatic attitudes of Russian oil companies. If there are few inducement mechanisms and APG utilization would constitute an economic loss for the company, the APG is rather flared than utilized. The same attitude is seen in the gas companies, where Gazprom has no interest in making sacrifices to increase APG utilization. With no real market and limited means of financing projects, economic considerations influence the direction of search, entrepreneurial experimentation, market formation, and resource mobilization.

A final blocking mechanism is not a 'function' as such, but is necessary to mention due to its high influence on the development of the TIS. It is related to geography. The remote location of the oil fields in Western Siberia has made APG utilization much more costly and poses a number of challenges which oil companies operating in other regions do not face. Through their work with numerous oil companies searching finance for APG utilization projects, Haugland and Sammut (personal communication) have experienced that geography is a prime reason why some oil companies simply deem it uneconomic to utilize their APG. The geographic issue influences the direction of search, the resource mobilization and in particular the market formation functions.

5.1.3 Main hindrances to a radical increase in APG utilization in Russia

Returning to the first part of the research question '*which factors are the main hindrances to a radical increase in APG utilization in Russia?',* the above discussion of inducement and blocking mechanisms have not only shown us that economic and geographic issues as well as path-dependency are important hindrances to further development of the APG utilization TIS. The absence of one important factor is in itself noteworthy. This study set out to use the TIS framework to identify whether the main factors influencing the non-utilization of APG were technological, economic, societal or other. What the above discussion has shown is that technologically, the TIS is rather well developed. There are numerous technologies available, and they are well established within at least one of the hydrocarbon industries. The issue lies more in the effective use of these technologies, as the infrastructure and institutional context surrounding them represent a number of problems for increased APG utilization, mainly affecting the economic attractiveness of APG utilization.

5.2 Step 6: Specifying key policy issues

Having previously identified process goals as well as inducement and blocking mechanisms, we are now in a position to address the issue of how policies on certain key issues can strengthen the inducement mechanisms and weaken the blocking mechanisms. This reliance on policy instruments is in line with the TIS focus on systems rather than markets alone.

As the mapping out of the functionality of the TIS showed us, there are already numerous policies and regulations on APG flaring in Russia. However, compliance with the regulations is not sufficiently monitored and non-compliance only to a limited extent penalized. As Lindblom (1959, cited in Bergek et al 2008) points out, policy is best made through a process of successive incremental changes. The partial failure of previous policies should thus be seen as a learning experience on which new policies may be based. In knowing how former policies and regulations did not work, the same mistakes can be avoided in new policy making. As monitoring and enforcement have been the major issues with existing policies and regulations, this should be a point of concern to Russian policy makers.

Key issues that should be addressed by policies relate to the actors involved and to the context or framework within which the APG utilization TIS exists. The two first policy issues relate to the traditional and current structure of the oil and gas industries and the numerous blocking mechanisms caused by this. By using policy to alter the structure, many mechanisms currently blocking the further development of the APG utilization TIS could be diminished. As the single most prominent actor in these industries, Gazprom has a great power base and a strong influence on government policy making. Pressuring the giant oil and gas companies to alter their relations and organizational structure within and between them may thus not hold great potential. An important policy issue would still be to ensure third party access for APG in the Gazprom pipelines. It is evident that the function that would be most strengthened by this policy issue is market formation, but legitimation and direction of search would also be influenced. Third party access is difficult to monitor and enforce, and policy options that may help the oil companies work around this particular problem, avoiding the troublesome contact with Gazprom, are thus welcome. Such options may in themselves contribute to stronger competition, thus pressuring Gazprom into compromises with the oil industry.

One such alternative way of making changes in the industrial structure is to strengthen the new entrants in the APG field. This is the second policy issue. As the large actors currently dominating the APG utilization TIS only show interest in APG utilization when it is economically beneficial and generally consider APG utilization as a nuisance, smaller new entrants regarding APG utilization as their niche may have immense impact. They provide the oil companies with alternatives to dealing with Gazprom, potentially making it more economically interesting for the oil companies to utilize rather than flare the APG. The alternative small scale solutions provided by many such companies may even be more suitable for remote locations, potentially saving money for the oil companies which they would otherwise spend on buying for instance externally produced electricity. As these small companies are in their establishing phase and vulnerable, policies assisting these companies and making it easier for them to get through the first stages of development could be paramount. These companies can have an impact on legitimation, knowledge diffusion, entrepreneurial experimentation and market formation functions of the TIS, as well as weakening the blocking mechanism of path dependency, as it challenges the rigid block structure of separated oil and gas industries.

The second set of key policy issues relates to the framework or context of the APG utilization TIS, and entails incentives for the oil industry to increase APG utilization and strengthening the market mechanisms of the TIS. In the current state of the APG utilization TIS, there are few incentives for the oil industry to increase the utilization of their APG. It is costly, and there are only limited real options that may generate revenues. In addition, flaring fines are low, and consequently do not constitute a real incentive to reduce flaring. By using policy to incentivize increased APG utilization in the oil industry, flaring may be substantially reduced. Such incentives may be subsidized or tax free metering and/or utilization equipment, government guarantees that the final product will be sold at a given price, or tax breaks for coops between oil companies in e.g. power generators. This is particularly the case if these incentives are combined with policies that influence the other blocking mechanisms. Incentivizing the oil companies is only worthwhile (and possible) if they have real options to sell the APG or APG products, which can be affected by the two policy issues mentioned above.

To conclude on a more specific note, the key policy issues as discussed above boils down to the following:

- Ensuring third party access to pipelines
- Nurture small engineering companies specialized in APG utilization
- Providing the oil industry with incentives to increase APG utilization

5.2.1 Addressing the main hindrances through policy

Through the above discussion of key policy issues and the previous identification of the main hindrances to a radical increase in APG utilization in Russia, we are now prepared to discuss the second half of the research question, namely whether the '*main hindrances can be addressed by policy'*.

The analysis of this paper suggest that a number of issues *need* to be dealt with by policy, as the independent actors and mechanisms of the system have not proven able to reduce flaring beyond a certain level. The current situation is not sufficiently dynamic and open to change to the extent necessary to substantially increase the utilization volumes of APG. The question remains however, if policies are *able* to address these issues. Until now, the policies and regulations on APG flaring and utilization have not been sufficiently strong, or not sufficiently monitored or enforced to have the intended effect. The Russian authorities are showing increased interest in making a real effort to increase APG utilization, but the influence of key actors such as Gazprom is still strong. The advocacy coalition working for increased flaring levels is in its current state not strong enough to outweigh the coalition who opposes them. Despite some government attention to the flaring and utilization issues in recent times, it remains unclear how strict a new APG flaring regime can become under the current level of governmental motivation and effort. The key to sufficiently strong government motivation for policy making, monitoring and enforcement, may thus be to strengthen the APG advocacy coalition. However, as the development of the TIS has halted for reasons described at length in this study, a natural assumption is that it has evolved as far as it can independently and now depends on government intervention. The paradox is clear; for the TIS to evolve, key actors (the small engineering companies) must be strengthened through policy. But for such policies to be made, the authorities must be put under more pressure by that same set of actors – who are in the current situation not in a position to do this. This, in a nutshell, is the reason why the development of the TIS now has been impeded, and a potential argument for the inability of the Russian authorities to make policies that does increase APG utilization.

But can this lock-in be overcome? As seen previously in this study, one of the reasons why the government has given APG flaring and utilization more attention is international focus on the matter and the 'embarrassment' the Russian authorities face when allowing such a wasteful practice as flaring. Russian authorities may thus find increased international attention to be an incentive for stronger APG policies. The potential influence of international attention should however not be overemphasized, not only because the non-attitudes towards environment and energy efficiency in Russia are well established, but also because Russian authorities seldom tend to allow themselves to be pressured from the outside. However, even a slight change in policy may be enough to alter the current lock-in.

An important aspect in this regard is the different qualities and implications of the key policy issues. Opposing coalitions are only problematic under certain policy courses. Third party access has until now had the primary focus in discussions on APG utilization, and as the coalition led by Gazprom strongly opposes this, Gazprom has been seen as the key hindrance to increased APG utilization. However, the other key policy issues may be more readily addressed by policies, as they are less prone to strong opposition, and have less far-reaching ramifications than third party access policies. By using policy to ensure third party access, the whole system of gas monopoly will seemingly be altered, and Gazprom consequentially feel threatened and strongly oppose any such policy. Nurturing and supporting the small engineering companies on the other hand, is a much less invasive policy option. It is not as commonly referred to as third party access, but thanks to its small-scale, neutral stance, such policies would likely be more readily successful than a full-blown alteration of the entire monopolistic Russian gas production and transportation system. Policies to establish and strengthen small engineering companies will have less invasive consequences and its consequences will be more isolated – as opposed to ending the monopolistic gas system in Russia – and hence have more potential for success with regards to increased APG utilization. Oil industry incentives are also less invasive and 'softer' policies which may be more readily acceptable to the opposing coalition, and hence hold larger potential.

6 Discussion: The applicability of the ACF and TIS frameworks

Having applied the TIS framework to assess the situation with regards to APG utilization in Russia, it is clear that it is not only a technology innovation issue, it is also a process innovation issue. The systemic overview that the TIS framework offered revealed that the technology needed for APG utilization indeed is in place, and that there are institutional and economic reasons why the APG utilization TIS has not fully developed. The TIS framework did not only point out where the hindrances to increased APG utilization lie, it also proved a valuable reminder of how developed the TIS actually already is. This aspect should not be disregarded, despite the lock-in of the current situation.

These main reasons for low APG utilization, related to actor conflicts and path dependency, were addressed in the TIS framework, but their importance necessitated additional aspects from the ACF. By applying this approach, we got a more complete understanding of the dynamics at hand. Despite the usefulness of this approach, it was not utilized to its full potential in this study, as the scope of the paper made it necessary to make a choice between breadth and depth. A more in-depth study of the aspects revealed in the ACF approach may be a valuable topic for further research.

The relevance of the broad TIS study, however, should not be disregarded. The comprehensive model included a number of factors that were of obvious relevance to the APG issue, and also contributed to revealing patterns of path-dependency. By using this innovation approach, it was possible to specify both the potential of the APG utilization technologies, and which factors block their further development. It was illustrated that a radical increase in APG utilization is technologically close, but economic interests and institutionalized perceptions halt the development into the final stages of full-scale utilization. By applying this framework to a case that is not so decisively an innovation case, the potential of the framework was investigated. It proved useful also in addressing this case of a rather developed innovation system, and its structured and systemic approach allowed us to clearly identify some less evident issues.

However, despite being a framework for *technology* innovation systems, the focus on technology specific considerations is low, as the context is the prime concern. In this particular case however, more focus on technical issues would be valuable, as these form the basis of many of the problems linked to increased APG utilization. The availability of the different utilization options varies from one oil field to the next due to technical, geological and geographical reasons. The institutional and economic consequences of these technical issues were treated in the TIS framework, but the technical basis of the issues could with advantage have been dealt with more explicitly within the framework.

An advantage of the TIS framework is that it is a structured scheme of analysis that lends itself easily to comparative studies. This study has only briefly mentioned the APG utilization cases of Canada and Nigeria, but full studies of both these cases and those of other oil producing countries within the TIS framework could call for some interesting comparisons. Another suggestion for further research is a more detailed study of the policy instruments; which options are available to Russian authorities, how could they influence APG utilization, and how could their effectiveness be ensured.

7 Conclusion

APG has, to some extent, been utilized in Russia since the beginning of oil extraction. The technology is there, and there is also political attention to the problem. Despite this, a considerable volume of APG is still flared in Russia. The goal of this study was to identify the reasons why APG utilization rates remain so low in Russia despite the technological knowledge and political attention. The picture was complex, but certain issues stood out. Traditionally, a main hindrance to APG utilization has been the Gazprom pipeline monopoly. Ensuring third party access has been seen as an important means of achieving increased APG utilization, but policies aiming at this have huge political and economical ramifications, and it will alter the entire structure of the now monopolistic Russian gas system. Consequently, the opposition against such policies is strong.

Another, but closely related issue, the traditional structuring of the oil and gas industries in Russia of the APG system, holds both a problem and a potential solution to the APG utilization problem. As APG is a part of oil production, but requires gas processing, it falls between the (in Russia) clearly separated industries of oil and gas. This entails that no-one sees APG as either interesting or their responsibility. In the past few years however, this has changed somewhat as newly established small engineering companies specializing in the APG niche entered the field. These play an important role both in creating a market for APG outside of the Gazprom monopoly, as well as offering cross-sectional expertise to the oil companies. Despite the emergence of these companies, their continued existence and growth (which is necessary if APG utilization is to increase) is not a given, and requires some sort of government intervention such as tax breaks.

A final major hindrance to APG utilization is the perception of the oil companies of utilization being economically unattractive. This is particularly the case because of the Gazprom pipeline monopoly and the costs associated with transportation of gas which comes in addition to the initial cost of compressing the APG, borne by the oil company. However, even this problem may be at least partially overcome by strengthening the small companies mentioned above both in size and number. By so doing, available utilization technologies may be provided to the oil companies cheaper, and experimentation on the part of these new companies may potentially lead to new and even more economically beneficial options.

All in all, the various and complex issues hindering the increased utilization of APG in Russia cannot be solved by one silver bullet, and certainly not by third party access policies. A viable and relatively simple way to both make utilization more economically attractive *and* bypass the Gazprom monopoly issues however, is to strengthen the small companies.

Notes

[1] Estimations of level of flaring vary greatly, ranging from 75% (EurActiv 2010) to 27% (Ministry of Natural Resources, quoted in Knizhnikov and Poussenkova 2009).

[2] According to ACF, only secondary opinions on instrumental choices alter relatively easily. Core beliefs are fundamental to the advocacy coalition and their ontological perceptions, and are highly resistant to change. Near core beliefs, which comprise ideals and policy choices on how to achieve the core beliefs, are somewhat more prone to change under pressure (Hisschemöller et al 2009).

[3] Another option for disposing of excess APG is burning it in an incinerator, which is slightly less polluting than flaring and venting, but equally wasteful (Bott 2007).

[4] It should be noted that by 'utilization' of APG, it is meant any treatment of the gas that is not venting or flaring.

[5] See appendix 1 for a list of these.

[6] Until 2008, the APG price was regulated by the Federal Tariff Service, which was under high influence from Sibur. This price was low, and proved little incentive for the oil industry to sell their gas to e.g. Sibur. When the APG prices were deregulated, Sibur offered even lower prices to the oil companies for their APG (Kristalinskaya 2010).

[7] The regions of the Russian Federation are defined along different levels of autonomy, a *republic* being most autonomous, *oblasts* and *krais* least. An *autonomous okrug* is situated within another entity (i.e. a territory), but is treated as constituent member of the federation (Remington 2008).

Appendix 1: Oil Companies in Russia

Table A.1.1. Russian Oil Companies

Name	Main operating region in Russia	Annual crude oil production volume (in Russia) (2008)	Ownership	APG utilization rate (2006)[a]
OAO Rosneft[b]	Western and Eastern Siberia, Southern and Central Russia, Far East	106.3 mln tonnes	75.16% state owned, 15% 'free float'	59%
OAO LUKOIL	Western Siberia	95.2 mln tonnes	OAO – share capital dominated by minority stakeholders	75%
OAO TNK-BP	Western Siberia (Khanty-Mansiysk and Yamalo-Nenets Autonomous Districts, Tyumen Region), East Siberia (Irkutsk Region), Volga-Urals (Orenburg Region)	82.5 mln tonnes	Joint venture (owned 50/50 by BP and Alfa Group). Owns 50% of Slavneft.	78.4% (80% in 2008 according to TNK-BP).
OAO Surgutneftegaz	Western and Eastern Siberia	61.7 mln tonnes	OAO - share capital dominated by minority stakeholders	93.5% (96.9% in 2009 according to Surgutneftegas)
OAO Gazprom Neft	Primarily Western Siberia (Khanty-Mansiysk and Yamalo-Nenets Autonomous Districts, Tomsk and Omsk Regions), but also in far North East (Chukotka Autonomous District)	46.8 mln tonnes	Over 80% of shares owned by Gazprom, which is 50%+1 state owned. Formerly named Sibneft. Important subsidiaries: Slavneft and Tomskneft (49.9% and 50% ownership, respectively).	55%
OAO Tatneft	Primarily in Tatarstan	26.06 mln tonnes	OAO, major stakeholders are Republic of Tatarstan (33.6%), ING Bank Eurasia (26.7%), and 26.7% ordinary shares.	98% (94.6% in 2008 according to Tatneft)
OAO Russneft	Western Siberia, West/Central Russia	14.2 mln tonnes	OAO – 49% of shares owned by Joint Financial Stock Company (JFSC) Sistema.	78%
OAO Bashneft	Bashkortostan, Russian Republic	11.74 mln tonnes	OAO – Controlling share owned by JFSC Sistema.	80%

Subsidiaries of these companies are not mentioned separately, but treated as part of the company they are owned by.

Sources: All information about the oil companies is retrieved from their respective home pages, and, where possible, verified by independent sources. Bashneft (2010a, b), Enery Intelligence (2010), Gazprom Neft (2010a, b, c), Knizhnikov and Poussenkova (2009), LUKOIL (2009a), Rossneft (2009), Russia info-centre (2007), Russneft (2009, 2010), Surgutneftegas (2010a), Tatneft (2009, 2010a, b), TNK-BP (2009, 2010), and Webb (2009).

a. The flaring data is subject to a high level of uncertainty – I here refer to the discussion in the main text on this subject. The newest available data for all oil companies is from Knizhnikov and Poussenkova (2009) for 2006, but some oil companies have themselves published more recent information. In those cases, this is mentioned in the table.

b. OAO: Otkrytoe aktsionernoye obschestvo (Open Joint Stock Company)

Appendix 2: Map of Russia

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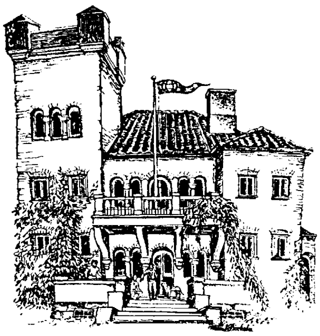

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Fridtjof Nansens vei 17, P.O. Box 326, NO-1326 Lysaker, Norway
Phone: (47) 67 11 19 00 – Fax: (47) 67 11 19 10 – E-mail: post@fni.no
Website: www.fni.no