



E.ON Energy Research Center

FCN | Institute for Future Energy  
Consumer Needs and Behavior

FCN Working Paper No. 6/2012

# **Russia's Emerging ESCO Market: Prospects and Barriers for Energy Efficiency Investments**

Maria Garbuzova and Reinhard Madlener

July 2012

Revised September 2012

**Institute for Future Energy Consumer  
Needs and Behavior (FCN)**

School of Business and Economics / E.ON ERC

**RWTH**AACHEN  
UNIVERSITY

FCN Working Paper No. 6/2012

**Russia's Emerging ESCO Market: Prospects and Barriers for Energy Efficiency Investments**

July 2012

Revised September 2012

Authors' addresses:

Maria Garbuzova, Reinhard Madlener  
Institute for Future Energy Consumer Needs and Behavior (FCN)  
School of Business and Economics / E.ON Energy Research Center  
RWTH Aachen University  
Mathieustrasse 10  
52074 Aachen, Germany  
E-Mail: mgarbuzova@eonerc.rwth-aachen.de, RMadlener@eonerc.rwth-aachen.de

Publisher: Prof. Dr. Reinhard Madlener  
Chair of Energy Economics and Management  
Director, Institute for Future Energy Consumer Needs and Behavior (FCN)  
E.ON Energy Research Center (E.ON ERC)  
RWTH Aachen University  
Mathieustrasse 10, 52074 Aachen, Germany  
Phone: +49 (0) 241-80 49820  
Fax: +49 (0) 241-80 49829  
Web: [www.eonerc.rwth-aachen.de/fcn](http://www.eonerc.rwth-aachen.de/fcn)  
E-mail: [post\\_fcn@eonerc.rwth-aachen.de](mailto:post_fcn@eonerc.rwth-aachen.de)

# Russia's Emerging ESCO Market: Prospects and Barriers for Energy Efficiency Investments

Maria Garbuzova-Schlifter and Reinhard Madlener\*

*Institute for Future Energy Consumer Needs and Behavior (FCN),  
School of Business and Economics / E.ON Energy Research Center, RWTH Aachen University,  
Mathieustrasse 10, 52074 Aachen, Germany*

September 2012

**Abstract:** The Russian Energy Service Company (ESCO) market emerges rapidly due to the new energy efficiency legislation that has been implemented since 2009. However, a clear identification of the Russian ESCOs, comparable to those operating in the Western markets, remains rather difficult. Hence, aside from the independent ESCOs identified, further energy service-providing companies were within the scope of this survey. This paper delivers, to the best of our knowledge, the first systematic empirical investigation of the Russian ESCO industry, taking into account experiences from the international ESCO markets. Building on the insights gained from reviewing the existing international and Russian academic and non-academic literature on the ESCO concept, an explorative, questionnaire-based survey among 161 Russian energy companies and organizations was conducted. Twenty eight usable responses were returned, corresponding to a response rate of 17%. Our findings show that the new energy efficiency legislation addresses and supports the state sector. There are almost no state measures supporting the commercial ESCO sector. Most of the projects are financed either through ESCOs' own funds and direct loans to customers, or by the customers themselves. In contrast, Russian banks rarely provide direct loan financing for energy efficiency projects of ESCOs, but rather offer financial leasing contracts. The contractual form "guaranteed savings", which is generally more applicable in mature ESCO markets, is gaining in importance, while "shared savings" is barely used.

*Keywords:* Energy Efficiency, Financing, Energy Service Company, ESCO, Energy Performance Contracting, EPC, Energy Service Providing Company, ESPC

---

\* Corresponding author. Tel. +49 241 80 49721 Fax: +49 241 80 49829; e-mail addresses: MGarbuzova@eonerc.rwth-aachen.de (M. Garbuzova-Schlifter), RMadlener@eonerc.rwth-aachen.de (R. Madlener).

# 1 Introduction

Russia is the fourth-largest energy consumer and the fifth-largest CO<sub>2</sub> emitter in the world (EIA, 2012). Its technical potential for energy savings was 45% of the country's total primary energy consumption in 2005 (The World Bank, 2008). Given that the Russian economy strongly depends on energy production and energy exports, there is a need to address these issues systematically. Meanwhile, energy efficiency and energy saving issues have received a high priority by the Russian government (RG). A policy and regulatory framework to support energy efficiency and energy savings has rapidly taken effect since 2009 and, hence, the development of a new energy service market in Russia has been boosted. In this context, Energy Service Companies (ESCOs) can take a significant role to promote energy efficiency and savings, as well as to address the environmental issues of the country. In Russia, an ESCO industry is rather a new subject matter, and only about 30 ESCOs have been in operation there by the end of the year 2011. During the last few years, there were some attempts to promote ESCO pilot projects, mostly initiated by foreign organizations and financial institutions. However, to date there is no information available about results of the energy performance-based projects and no comprehensive research and review on the Russian ESCOs market has been done before.

In order to identify the current stage of the ESCO industry development<sup>1</sup> in Russia, some primary questions need to be raised, such as whether the Russian ESCOs are representing a discrete business model by building up a separate industry, and if yes, how Russian ESCOs differ from companies that provide merely energy services, such as Energy Service Providing Companies (ESPCs)<sup>2</sup>. In this context, Energy Performance Contracting (EPC) is considered as a core characteristic of the ESCO business model by distinguishing it from an ESPC. Based on the information gained from the review on the international academic literature on ESCO business models, as well as the Russian ESCO market conditions, this paper aims at exploring the Russian ESCO industry empirically by means of a questionnaire-based survey and considering Russian expert opinions. In order to provide focused answers to the above mentioned research questions specifically for the Russian ESCO market, five research hypotheses have been formulated for this study:

---

<sup>1</sup> In this study, for simplicity and "visualization" reasons, the U.S. and other "successful" ESCO markets that apply the "Western-ESCO" business model are considered as a benchmark for the Russian ESCO market.

<sup>2</sup> ESPC can be, for instance, a consulting engineer specialized in efficiency improvements, an equipment manufacturer, an energy supplier, or a utility. An ESPC provides services for a fixed fee or as added value to the supply of equipment or energy. An ESPC is not paid on the basis of the guaranteed performance achieved through delivered services and, hence, does not bear any performance risk (WEEA, 1999).

***Hypothesis 1:** There are no differences in the types of contract agreements applied by ESCOs and ESPCs.*

***Hypothesis 2:** There are no differences in the project financing options applied by ESCOs and ESPCs.*

***Hypothesis 3:** The factors of the ESCOs' competitive strategy do not differ from those of the ESPCs.*

***Hypothesis 4:** There are no major differences in barriers that affect the development of ESCOs and ESPCs in the Russian energy service industry.*

***Hypothesis 5:** There are no major differences in the factors that are decisive for the growth of ESCOs and ESPCs in the Russian energy service industry.*

The remainder of this paper is organized as follows. Section 2 defines an ESCO business model and provides a short overview of the evolution of the ESCO industry in the U.S., as well as outlines the academic literature on the ESCOs all over the world. This analysis provides the possibility to derive some parallels to the Russian ESCO business model, if there are any, and some necessary adjustments for its successful operation under the given Russian market conditions and legislation. In section 3, the Russian market context with its current legislation base for energy service contracting is discussed in some detail. Section 4 describes the methods and procedures applied, as well as the population of this study that includes Russian companies providing energy efficiency services in a broader sense and those that can be classified as ESCOs. The detailed analysis and discussion of the results of the hypotheses testing, as well as further insights gained, are provided in section 5. Section 6 concludes.

## **2 Definition and history of the ESCO business model**

The Russian ESCO industry is still in its early stage of development. Hence, up to now there is only very little academic and non-academic literature on ESCOs operating under Russian market conditions. In order to provide the best evidence we have of the context of an ESCO business model for further discussion in this paper, it is reasonable to investigate the prevalent features and history of the ESCO concept first, as well as to consider some of the experiences from other countries. Furthermore, parts of the questionnaire for the survey of the Russian ESCO market were derived from existing international survey studies on ESCOs worldwide.

## 2.1 Definition of the ESCO business model

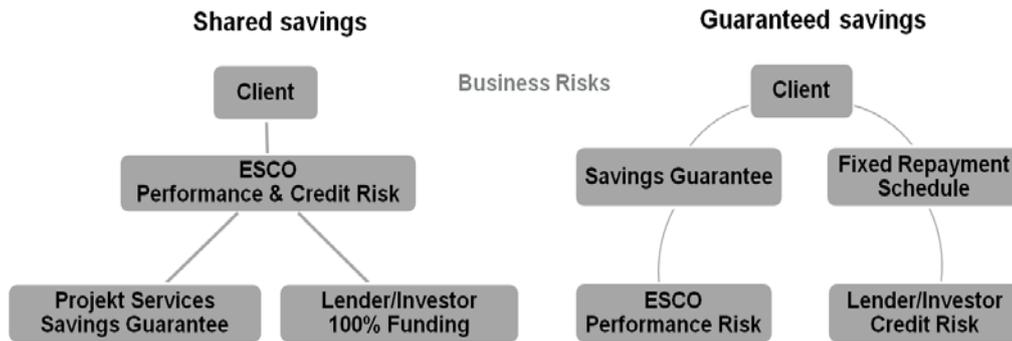
In the international academic and non-academic<sup>3</sup> literature there is no consensus yet regarding the exact definition of an ESCO business model. Nevertheless, most of the authors agree that an ESCO is a private or a public company that develops, installs, and provides integrated service-based projects with a typical duration of 5 to 10 years. The main aim of such ESCO projects is to enhance energy efficiency and savings and, consequently, to reduce greenhouse gas (GHG) emissions. An ESCO may provide further value-added services, such as energy auditing, energy management, comprehensive engineering, project design, and specifications and implementation, but also procurement and installation of equipment, facility and equipment operation and maintenance (O&M) for the contract period, monitoring and verification (M&V) of the savings results etc. (see e.g. Bertoldi et al., 2003; Bertoldi et al., 2006; Bertoldi and Rezessy, 2005; Dayton et al., 1998; Garbuzova and Madlener, 2012; Hopper et al., 2007; Painuly et al., 2003; Satchwell et al., 2010; Singer and Lockhart, 2002; Vine, 2005; Vine et al., 1999).

EPC is widely seen as a core characteristic of the ESCO business model (Bertoldi et al., 2003; Bertoldi and Rezessy, 2005). EPC typically encompasses the financing, planning, implementation and supervision of energy savings measures, where an ESCO provides energy and/or monetary savings guarantees through two main types of contracts (Fig. 1; see also Bertoldi et al., 2006; Lamers et al., 2008):

- **Guaranteed Savings** – An ESCO guarantees a certain level of energy savings and, hence, assumes the energy savings risk (performance risk). A client provides financing and takes on the credit risk. In case of higher savings than the guaranteed level, the surplus is to be divided between an ESCO and a client in an agreed manner. Due to the high level of trust needed for this type of contract (trust relation ESCO – client, client – lender), it is more applicable in a mature market;
- **Shared Savings** – An ESCO finances the project by covering the project-relevant costs and, hence, assumes the performance (energy saving guarantee) and the credit risk. The generated energy cost savings have to be split between an ESCO and a client in an agreed way. This type of EPC requires financially strong ESCOs.

---

<sup>3</sup> In the Directive 2006/32/EC of the European Parliament and of the Council of April 5, 2006, for instance, an ESCO is defined as “a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user’s facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria” (CEC, 2006, p.68) (additionally, see the “Commission staff working paper (annexes to the impact assessment) accompanying Draft Directive of the European Parliament and of the Council on energy efficiency and amending and subsequently repealing Directives 2004/8/EC and 2006/32/EC” of June 22, 2011 (CEC, 2011).



**Fig. 1:** Business risks of “Shared savings” and “Guaranteed savings” contracts

Source: Dreessen (2003)

Generally speaking, EPC distinguishes between ESCOs and other ESPCs. In this study, therefore, the ESCO business model based on EPC is considered as a “Western-ESCO”, i.e. something like an “ideal” type of business model used in the mature ESCO industry. Indeed, in accordance with Goldman et al. (2005), we assume that the “definition of ESCO market activity must reflect industry evolution and changes in ESCO products and services” (Goldman et al., 2005, p.389). On account of this, in section 2.2 we present a review of the international academic and non-academic literature on the development of ESCO business models for application in the U.S and some other countries.

## 2.2 Development of the ESCO business model worldwide

Historically, the first ESCO business models emerged in the U.S. in the late 1970s, after marked oil prices increases (NAESCO, 2011). Nowadays, the U.S. ESCO industry is “widely seen as a successful model for the private sector delivery of energy efficiency technologies and services, primarily to large institutional customers” (Goldman et al., 2005, p.387). The successful development of the U.S. ESCO industry, among others in the institutional markets, occurred not only due to growing energy prices, but also due to measures that have been encouraging the self-sustaining ESCO industry, such as the government policy support and market development programs (e.g. Integrated Resource Planning (IRP) and utility Demand Side Management (DSM) programs); well-established contract laws; access to local, long-term funds at reasonable rates etc. (Lin et al., 2004; Üрге-Vorsatz et al., 2007). Singer and Lockhart (2002) divide the U.S. ESCO industry development in several development phases. A short overview of these phases, enriched with some additional information from further studies on the U.S. ESCO market, is presented in Appendix 1.

Since the late 1980s, the U.S. ESCO concept has been spreading to highly industrialized countries (e.g. Germany, Austria<sup>4</sup>, UK, Japan), some of the largest developing countries (e.g. Brazil, India), and numerous countries in transition (e.g. the Czech Republic, Slovak Republic). The ESCO industry, however, has been developing from country to country, with varying degrees of success. Thus, the focus of the academic literature of the 1980s and 1990s by and large has been put on ESCO's market development strategies as well as opportunities and barriers the ESCO industry is facing internationally.

Adnot et al. (2002) highlight the history of energy services in France and describe a French ESCO approach, which is markedly different to the one adopted in the U.S. or Germany. The main differences of a French ESCO are: services provided are unbundled and an ESCO is "...judged (and paid) on each of the unbundled components: the economic efficiency in purchasing energy, the technical efficiency in continuous audit and maintenance, the financial efficiency in planning works on time..." (Adnot et al., 2002, p.2). Painuly et al. (2003) consider an ESCO as an important financing mechanism for energy efficiency in developing countries. Furthermore, the authors discuss the market barriers that impede formation of an ESCO industry in the developing countries. Among these barriers are: a lack of government support and competition; scarcity of capital; a lack of a credit history for energy efficiency projects, and awareness of energy efficiency potential, skill and technical competence. Vine (2005) assesses the development of the ESCO industry internationally (i.e. outside of the U.S.)<sup>5</sup>. Several generally accepted actions to foster the development of an ESCO industry are provided in this study: increase of information about the ESCO business model, energy efficiency projects in general and given financial options; quality insurance of services provided by ESCOs; development of funding sources; standardization of contracts; and others. Bertoldi et al. (2006) provide a comprehensive review of the ESCO industry focusing on the European countries. The study was conducted by means of a questionnaire-based survey in 2003-2004 that was mainly addressing energy efficiency experts, national authorities, and ESCO professionals<sup>6</sup>. Based on the insights gained from their survey, the authors conclude, in conformity with Vine (2005), that

---

<sup>4</sup> In the EU, a development of an ESCO industry is boosted, among other factors, by the ambitious climate and energy policy targets for 2020: decrease of GHG emissions by at least 20% compared to 1990 levels; increase of usage of renewable energy sources up to 20% of the total energy production; and a reduction of energy consumption by 20% of the projected 2020 levels through energy efficiency improvements (EC, 2010).

<sup>5</sup> Vine (2005) interviews numerous participants from 38 selected countries in order to identify the following: a number of ESCOs in each country; economic sectors where the identified ESCOs operate; the four most important barriers for the ESCO business development; and the value of ESCO projects accomplished in 2001. The estimated total value of ESCO projects in 38 countries surveyed in this study is approximately \$560-620 million (2001), amounting to about one-fourth of the U.S. ESCO industry size in 2000 (about two billion dollars) (Goldman et al., 2005; Vine, 2005).

<sup>6</sup> The questionnaire was addressed to EU-25 (to that point in time) and, additionally, to Bulgaria and Romania.

the development of the ESCO industry in Europe is quite heterogeneous<sup>7</sup>. Furthermore, the majority of ESCOs in Europe are either funded by large companies or established as subsidiaries of companies, and mostly active in the public sector. In contrast to the U.S. ESCO industry, where the guaranteed savings concept is primarily used, in the European countries the shared savings concept became the most adopted contractual form (Fig. 1).

Meanwhile, the focus of the academic research on the ESCO business is increasingly shifting to the African and Asian countries, in which ESCO business models were introduced with reference to the U.S. ESCO model. Vine et al. (1999) discuss several ESCO market development strategies for the Japanese market by focusing on opportunities and barriers of joint ventures between the U.S. and Japanese ESCOs. Lee et al. (2003), by referring to the article of Painuly et al. (2003), produce a case study on experiences from the Korean ESCO industry, which shows the particularly successful evolution in comparison to other developing countries. This is attributed to the fact that the South Korean government became one of the biggest customers for ESCO services and has actively supported the ESCO programs (likewise the U.S. and Canada<sup>8</sup>). However, in Korea, ESCOs formed as joint ventures have difficulties to overcome cultural barriers and the issue of high initial investment cost. In order to solve these issues in the Korean market and in further developing countries, the authors suggest utilities or energy efficiency equipment manufacturers to focus on the implementation of “simple and easy projects” (Lee et al., 2003, p.656) arranged by ESCOs.

Murakoshi and Nakagami (2009) examine the development of the ESCO industry in Asia and ESCO development programs to that point of time in elected countries (Japan, China, Thailand, India). Likewise, in Europe the Asian ESCO market development varies from country to country<sup>9</sup>. Da-Li (2009) considers ESCOs as an important instrument for energy efficiency improvements and carbon mitigation improvements in China. Still, several barriers, related to market, finance, technology, information, poor energy pricing policies etc., considerably affect the development of the Chinese ESCO industry. In this context, the author provides a series of

---

<sup>7</sup> The authors rank the surveyed countries according to their degree of intensity of ESCO activities (e.g Germany, Austria, the UK, and to a lesser extent Spain and Hungary in the group of the leading countries; and Sweden, France, the Czech Republic as the middle range countries).

<sup>8</sup> The ESCO industry is developing successfully in Canada. However, in contrast to the U.S., the financing of the projects is based on the strength of a project and not of the balance sheet of an ESCO or a customer (Painuly et al., 2003).

<sup>9</sup> ESCO markets have formed to some degree in Japan, China, India and Thailand. In other countries, such as Malaysia and the Philippines, the government has introduced an ESCO concept, but markets have not yet been developed. Initial measures for promoting ESCO concepts are assumed to be responsible for such differences in the development of an ESCO industry. For instance, the successful development of the Japanese ESCO industry is owed to a strong governmental support, clear regulation for energy efficiency measures, and the establishment of the Japan Association of Energy Services Companies (JAECOS) etc. In China and other emerging markets, the pilot ESCOs were, in contrast, initiated and financed by international organizations (Murakoshi and Nakagami, 2009).

corresponding countermeasures in order to boost the development of the country's ESCO industry. Among them are the dissemination of the Kyoto Protocol and its flexible mechanisms; rationalization of energy prices and reduction of subsidies; and strong governmental support by the promotion of EPC.

Van Rensburg et al. (2008) explore an ESCO business model from an application-oriented point of view specifically for the telecommunication industry in South Africa. The authors develop and implement a new ESCO procedure in performing ESCO analysis for the telecommunications facilities by using different kinds of software, such as data for gathering, simulation modeling, retrofit and saving intervention analysis, as well as financial analysis.

Based on the review of the worldwide ESCO business development provided, one may conclude that there are two main forms of boosting the formation of an ESCO industry in any country: joint venturing between international ESCOs and domestic ESCOs or ESPCs, and active measures and programs for energy efficiency and services of the domestic government. However, most ESCOs in their infant stage face two common barriers: lack of funding for the projects and lack of a strong legislation base.

### **3 Development of the ESCO industry in Russia**

#### **3.1 The Russian energy market context**

Despite of the average decrease of Russia's primary energy intensity by 3.9% and its CO<sub>2</sub> intensity by 4.3% annually between 1995 and 2009 (Enerdata, 2011)<sup>10</sup>, Russia remains the fourth-largest energy consumer<sup>11</sup> and the fifth-largest CO<sub>2</sub> emitter in the world. According to the Government of Russia (2010), these changes in energy- and CO<sub>2</sub> intensity are not attributed to the improvements in the efficiency of energy use, but rather to the sharp economic downturn, caused by the transition from the centrally planned economy of the Soviet Union to a market economy during the 1990s, followed by the financial crises of 1998 and 2008-2009. According to the Federal State Statistics Service (Rosstat), the average level of the fixed assets' depreciation in Russia has reached 47.1% in 2010.<sup>12</sup>

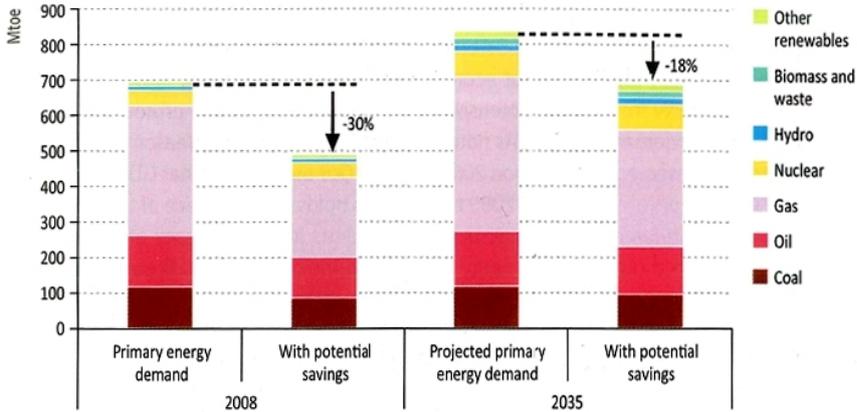
---

<sup>10</sup> Primary energy intensity is calculated as total primary energy consumption divided by gross domestic product (GDP) (expressed in purchasing power parity (PPP) terms). CO<sub>2</sub> intensity is calculated as CO<sub>2</sub> emissions per unit of GDP, also expressed in terms of PPP.

<sup>11</sup> Such a high level of energy intensity in Russia can be explained, among other reasons, by a high energy-intensive industrial structure due to the predominance of the heavy industry and a high population density in areas with considerable heating requirements (IEA, 2011).

<sup>12</sup> On average, the producing equipment of the industrial sector is with a probability of 26% between 11 and 15 years old and with a probability of 14% about 20 years old (Rosstat, 2010).

These numbers suggest a huge scope for energy efficiency improvements. According to some estimates, Russia could have saved 30% of its energy consumption<sup>13</sup> in 2008 in each sector of the economy by using energy as efficiently as comparable OECD countries<sup>14</sup> (Fig. 2). If the comparable OECD countries achieved their projected energy efficiency levels by 2035, Russia could still save about 18% of its projected primary energy consumption (about 150 Mtoe) in 2035 according to an IEA efficiency sectoral analysis of the Russian economy (IEA, 2011, p.262). The technical potential for energy savings<sup>15</sup> in Russia, calculated by The World Bank (2008), was estimated at 45% of the country's total primary energy consumption in 2005.



**Fig.2:** Primary energy savings potential in Russia, based on comparable OECD efficiencies in the New Policy Scenario, 2008 and 2035

Source: IEA<sup>16</sup> (2011, p.263)

A modernization of the Russian economy, in order to realize the given technical potential for energy savings, requires substantial investments. To date, the level of energy efficiency investments in Russia is, however, low due to several factors: an uncertain rate of return, lack of reliable data on energy consumption patterns over time, lack of communication of the investment opportunities in energy efficiency, lack of energy efficiency expertise, and an emerging

<sup>13</sup> It accounts for more than 200 Mtoe of the Russia's primary energy demand in 2008 (approximate amount of the total primary energy used by the UK in 2008). The savings potential of gas is almost 180 billion cubic metres (bcm), of oil and oil products 600 thousand barrels of oil per day (kb/d), and of coal more than 50 Mtce. The saved primary energy resources would have an international market value of about \$70 billion in 2011, which equals to 46% of Russian domestic spending on energy in 2008 (IEA, 2011).

<sup>14</sup> The estimation of the energy efficiency potential of the Russian economy by the 2011 World Energy Outlook emerges from a detailed and disaggregated analysis of Russia's energy consumption in 2008 relative to OECD benchmarks in all sectors and sub-sectors except those affected by climate (e.g. due to higher heating needs), for which Finland and Canada were used for comparison.

<sup>15</sup> The technical potential of energy savings in Russia is estimated by comparing the energy efficiency of technologies used in the Russian economy with all the most energy-efficient technologies commercially available over the world for each particular sector (The World Bank, 2008).

<sup>16</sup> In this paper, we consider results calculated in the New Policies Scenario by the 2011 World Energy Outlook. The Scenario takes into account the existing Russian policies and policy intentions, and includes (where available) targets for the energy sector and environment that are set out in national strategy documents, even where the relevant measures or instruments for their implementation are not yet available (IEA, 2011).

legislative base for energy efficiency projects (IEA, 2011, pp.257,259). In this context, an ESCO business model can partly address issues concerning the lack of investments, underdeveloped technology in use, and ineffective energy systems by bearing business risks.

### **3.2 Development of an ESCO business model in Russia**

Since the RG as part of its governmental program (hereafter GP) set a target to reduce the energy intensity of the Russian economy by 40%<sup>17</sup> by the year 2020 compared to 2007, stipulated in the Decree No. 889 “Concerning some measures for improving the energy and ecological efficiency of the Russian economy” (June 4, 2008), the issue of energy efficiency has gained considerably in importance. Furthermore, the “Energy Strategy of the Russian Federation up to the year 2030”, approved and adopted on November 13, 2009, defines energy efficiency as one of the key priority areas for the Russian energy policy and economy.

In order to support the achievement of the federal target of an at least 40% decrease in energy intensity of the Russian economy by 2020, the RG approved by the Decree No. 2446-p a new national program “On Energy Conservation and Improving Energy Efficiency up to 2020” on December 27, 2010 (Minenergo, 2010). The key targets of the program are a reduction in energy intensity of the Russian economy of at least 7.4% during the first program period (2011-2015) and, overall, by 13.5% during the whole program period (2011-2020). These targets are expected to be achieved through certain federal measures aiming at the modernization as well as a rational and environmentally compatible use of energy resources in the main sectors of the Russian economy<sup>18</sup> and its social sphere (Minenergo, 2010)<sup>19</sup>. The remainder of the 40% target is expected to be achieved through some structural changes, such as the implementation of energy-efficient equipment, development of energy efficiency industries, and a reduction of energy consumption due to higher energy tariffs.

---

<sup>17</sup> According to the New Policies Scenario of the 2011 World Energy Outlook, the 40% reduction of energy intensity target of the RG is quite ambitious and could be achieved, however, only by 2028 due to the still quite ineffective regulatory framework, a lack of market-driven reforms and measures, and little structural change in the economy away from energy-intensive industries.

<sup>18</sup> The GP introduces subprograms for improving energy savings and energy efficiency in electricity, heating, industry, agricultural, transport, housing sectors, in state service organizations and federal subjects of the Russian Federation (Minenergo, 2010).

<sup>19</sup> These measures include enhancement and coordination of the federal, regional and municipal energy efficiency and energy saving programs; dispersion of information to increase public awareness; co-financing of the program from the governmental budget; promotion of efficient use of energy and heat resources; modernization of the energy infrastructure; and an increase of the renewable energy resources share in the total energy consumption balance of up to 4.5% by 2020 (Minenergo, 2010).

From the year 2010, all state-financed organizations are required to reduce their energy consumption by 3% of the 2009 level on an annual basis for a 5-year duration. According to Art. 16 of the Federal Law No. 261-FZ “On Saving Energy and Increasing Energy Efficiency, and on Amendments to Certain Legislative Acts of the Russian Federation” (hereafter “FL 261-FZ”), adopted in November 23, 2009, state and local governmental bodies; organizations with state or municipality interest; organizations with regulation functions; water, fuel and energy (producing and/or transporting) enterprises; industrial enterprises whose annual energy costs exceed 10 million RUB<sup>20</sup>; and organizations that implement energy efficiency- and energy-savings measures that are partly or fully financed through the governmental or municipal budgets of the Russian Federation, are required to undergo the energy audit by the end of the year 2012 and, thereafter, at least once every five years. The remaining organizations may undergo the energy audit voluntarily (FL 261-FZ, Art. 15.5). Such an energy audit has to be carried out by a specialized Energy Audit Company (EAC)<sup>21</sup> as an approved member of one of the (non-commercial) Self-Regulated Organizations (SROs)<sup>22</sup> that unite EACs (FL 261-FZ, Art. 15.4) (Minenergo, 2011).

In the context of the high energy intensity of the Russian economy and ambitious energy efficiency targets set by the RG, an ESCO business model is becoming one of the key market elements. In line with the FL 261-FZ, the Federal State Unitary Enterprise “Federal Energy Service Company” (FESCO) was established in July 2011 under the supervision of the Ministry of Energy of the Russian Federation (in accordance with Decree No. 274). The main goals of FESCO are the development of the energy services market in Russia by expert and informational support through technical solutions for ESCOs; technical expertise and monitoring of energy efficiency project implementation; unification and type-design of engineering solutions; establishing centers of competence; activity-planning at regional and municipal levels; bringing energy service activities to international standards; integration of energy service agreements into the federal budget system; advancement of international cooperation; promotion of domestic production of energy efficiency- and energy saving technologies and technological development in the field of alternative energy sources etc. Most energy service contracts are planned to be accomplished under the supervision of FESCO in the public and industrial sectors (FESCO, 2012).

---

<sup>20</sup> There are around 150 000 such organizations in Russia (IEA, 2011). 1 RUB = 0.0252 EUR, as of July 23, 2012.

<sup>21</sup> The audit company provides a customer with an energy passport in accordance with the results of the energy audit (FL 261-FZ, Art. 15.6) (Minenergo, 2011).

<sup>22</sup> Since August 2010, Minenergo has maintained a database of the SRO in line with the regulation, stipulated in FL 261-FZ (for more information see FL 261-FZ, Art. 18 and FL 315-FZ “On self-regulated organizations” (December 1, 2007).

Hence, the RG has taken a number of steps to foster the development of an ESCO industry. The recent main documents on the existing legislative and regulatory framework for energy service contracting (ESC) and ESCOs are summarized in Table 1.

**Table 1:** The Basic legislation related to ESC and ESCO operations in Russia.

Law/Decree	Main issues concerning ESC
<p><b>FL 261-FZ “On Saving Energy and Increasing Energy Efficiency, and on Amendments to Certain Legislative Acts of the Russian Federation”<sup>23</sup></b> (November 23, 2009) (followed by several additional decrees and special federal programs of action to make the law work) (Minenergo, 2011)</p>	<ul style="list-style-type: none"> <li>• <b>Aim:</b> Creation of legislative, economic and organizational incentives for energy savings and energy efficiency</li> <li>• <b>Art. 19.1: Energy service contract (ESC)</b> - a new type of civil law contract, under which a contractor undertakes steps aiming at energy savings and increasing the efficiency of energy resource consumption of customers</li> <li>• <b>Art. 19.2:</b> ESC has to include:               <ol style="list-style-type: none"> <li>(1) <b>Quantity of energy savings</b> to be achieved by the contractor</li> <li>(2) <b>Term of the contract</b> that is larger than the term necessary to achieve the volume of energy resource savings agreed to in the contract</li> <li>(3) Further obligatory conditions existing in line with Russian contractual legislation</li> </ol> </li> <li>• <b>Art. 19.3:</b> ESC may include a clause:               <ol style="list-style-type: none"> <li>(1) With regard to the customer’s obligation to deliver the energy resource usage pattern during the energy service contact period</li> <li>(2) On obliged installation and putting into operation of energy resource meters by the contractor</li> <li>(3) On setting a price of the contract that is based on the attained or planned targets of the implementation of an energy service contract etc.</li> </ol> </li> <li>• <b>Art. 20.1:</b> The fulfilled clauses of ESC (Art. 19) may be included in contracts of sale and purchase, supply or transmission of energy resources (apart from natural gas)</li> <li>• <b>Art. 21.1-2:</b> ESCs may be concluded by state and municipal customers in congruence with the Public Budget Law and the Law on Placement of Orders</li> <li>• <b>Art. 27.1.2:</b> The RG commits itself to support the promotion of regional energy efficiency programs and ESC</li> </ul>
<p><b>FL 94-FZ of July 21, 2005 “On Placement of Orders to Supply Goods, Carry out Works and Render Services for Meeting State and Municipal Needs“</b> (amended in 2011) (FAS, 2011)</p>	<ul style="list-style-type: none"> <li>• <b>Aim:</b> Regulation of relations associated with the procurement of goods, works and services for state and municipal needs, and needs of budget-funded organizations</li> <li>• <b>Amendment 2011:</b> new Chapter 7.1 “On procurement of energy services for the state and municipal needs” (hereafter “customer needs”)</li> <li>• <b>Art. 56.1</b> “Procurement of energy services for the customers’ needs”:               <ol style="list-style-type: none"> <li>(1) State and municipalities may conclude an ESC in order to implement energy-saving and energy-efficiency measures</li> <li>(2) ESC is to be separated from (resources) supply contracts</li> <li>(3) The initial (maximum) price of the ESC is based on the customer’s actual energy costs in the previous year (price setting order is defined in more detail in Art. 56.3-5)</li> <li>(4) The payment for energy services by customers should be financed through state budgetary funding</li> <li>(5) Procurement of energy services occurs through a tender, (open) auction in electronic format or a similar mechanism</li> </ol> </li> </ul>
<p><b>Decree No. 636 "On the Requirements for Energy Service Contract Terms and the Particularities of Determining the Starting Price (Lot Price) for Energy Services"</b> (August 18, 2010)</p>	<ul style="list-style-type: none"> <li>• <b>Aim:</b> Introduction of requirements for an energy service contract concluded by state or municipality</li> <li>• <b>Point 1:</b> Specification of energy-saving and efficiency measures formulated by the customer (e.g. based on the energy passport issued after energy audit)</li> <li>• <b>Point 3:</b> A defined amount of energy savings to be provided by a contractor after the execution of an EPC</li> <li>• <b>Point 6:</b> Instructions on setting a baseline for energy consumption patterns before energy-saving measures are implemented</li> <li>• <b>Point 11:</b> Duration of EPC has to be defined</li> </ul>

Source: Own compilation

<sup>23</sup> FL 261-FZ replaces FL 28-FZ “On energy saving” dated April 3, 1996.

The current legislation on ESC was expected to intensify the formation of the ESCO industry in Russia in the past few years. However, the necessary terms of the ESC, such as the rights of the contracting partners and crediting procedures; public procurement; the term “measures aiming at energy savings and increasing the efficiency of energy resources” and quality standards for energy audits are not defined in the new legislation. Furthermore, no mechanisms for the cooperation between an ESCO and a bank and no guarantee mechanisms for ESCOs for invested funds have been provided so far. Also, the mechanism for the return on private investments from budget funds remains unclear. The latter, on which ESCOs may rely on, has to be carried out in accordance with FL 261-FZ, has likewise not been defined and regulated properly. Furthermore, the focus of the current legislation has been primarily put on setting norms for an ESC in the public sector (state/municipalities) by means of e.g. involving budgetary funds for energy saving- and energy efficiency measures, and less so on setting norms and incentives for the development of a commercial ESCO market.

Nevertheless, there were several attempts to implement ESCO pilot projects in Russia, mostly through international programs of the European Bank for Reconstruction and Development (EBRD) and The World Bank’s International Financial Corporation (IFC), even before the new legislation came into force. Efremov et al. (2004) provide a short overview of the considered or initiated projects related to ESCO operations in Russia. One of them represents the Collaboration Agreement on Energy Efficiency, which was signed between Norway and Russia in April 1999. The Norwegian Energy Efficiency Group (NEEG) was commissioned to prepare and implement various activities under the bilateral project “Energy Efficiency in Northwest Russia”. The authors discuss a setting-up procedure of an ESCO business in Russia, in accordance with the legislation base valid in 2004, and identify three types of the ESCO business model for the Russian market: (1) energy consultant; (2) energy consultant and supplier of energy-saving equipment (including equipment lease<sup>24</sup>); and (3) an ESCO, established by an energy company that provides a full range of energy-saving services (e.g. energy auditing, financing, deployment of new equipment). The authors state that the guaranteed savings would be the most applicable agreement form in Russia due to the low financial history of the emerging ESCOs. Honkanen (2005) describes an attempt to promote a Finnish ESCO business also in Northwest Russia, in line with the EU project “FRESCO” (10/2003-12/2005) administrated by the Finnish Lappeenranta University of Technology. The study considers the ESCO business model as a financial tool for energy savings through short/mid-term projects mainly in the energy

---

<sup>24</sup> The authors emphasize that emerging ESCOs would primary offer leasing agreements for the delivery and installation of metering equipment due to the existence of well-framed Russian lease legislation.

production and distribution sectors, as well as through energy utilization from waste (Honkanen, 2005). Furthermore, the IFC, the private sector investment arm of The World Bank Group, proposed a pilot program “Financing Energy Efficiency in Russia”. This program builds upon IFC’s expertise and experience in Central Europe and cooperation with the Russian institutions and Russian energy efficiency project developers. The program aims at a better understanding of what energy projects can be considered as viable investments; examine industry-related loans and leases from energy efficiency perspectives; actively build a portfolio of energy efficiency projects<sup>25</sup>; and develop specialized financial products, which target niche markets for energy efficiency finance in Russia (Osokina, 2004). However, there is no follow-up information provided on the realization progress of these pilot projects and energy efficiency programs.

Additionally, the given gaps in the current legislation on ESCOs and EPC lead to the assumption that most of the contracts are still closed between a contractor and a customer in line with the Civil Code for general provisions on contractual agreements (e.g. consultancy/services agreements, vendor and/or leasing contracts). Evidence suggests that the issue of the development of the Russian ESCO industry has been broadly broached in line with the energy efficiency politics and corresponding measures. However, it remains unclear how the Russian ESCO business model has been developing in comparison to the performance-based “Western-ESCO” model. In the following, we aim to shed some light on the Russian ESCO market by means of a questionnaire-based empirical analysis.

## **4. Empirical analysis and methods used**

### **4.1 Research design**

This paper also aims at exploring the emerging Russian ESCO market empirically. In order to obtain structured information for this purpose, a quantitative approach was chosen for conducting a questionnaire survey. The questionnaire method was applied for the following reasons:

- Main practices of the exploratory studies on the ESCO industries worldwide can be taken as prime guidelines for the development of the questionnaire for the Russian ESCO market;
- A questionnaire can employ a mixture of open-ended and closed-ended items and, hence, delivers more accurate conclusions and recommendations. The closed-ended questionnaire

---

<sup>25</sup> In this context, the perceived credit risks and lack of familiarity with lending for energy efficiency projects is addressed by partial risk guarantees, which are applied to a portfolio of projects and not to individual transactions (Osokina, 2004).

items allow, through quantification, a systematic analysis by using certain statistical procedures. The open-ended questions reveal additional information that might have been missed by using only closed-ended questions (Johnson and Christensen, 2012);

- Due to sensitive data provided, confidentiality of the survey participants can be safeguarded through a special coding scheme to anticipate the identification of any specific individual or company;
- Due to the substantial effort required to survey 161 Russian companies targeted, which are located in different geographical parts of the country, the questionnaire method turned out to be less resource-intensive (time, funds etc.) than personal or telephone interviews.

Furthermore, some valuable practice-oriented insights into the Russian ESCO market development gained during a telephone interview of the authors with Mr. Wolfgang Skribot, Managing Director of the department “Energy & Infrastructure” of Gazprombank, on April 5, 2012, were applied in the survey data analysis.

## **4.2 Questionnaire development**

Some parts of the questionnaire in its initial form (list of questions/constructs and corresponding items, measuring these constructs) were derived from international academic studies on the ESCO business model, its opportunities and barriers, and strategic management (especially Army, 1996; Bertoldi and Rezessy, 2005; Dayton et al., 1998; Goldman et al., 2002; ICF, 2007; Lew, 2005; Lin et al., 2004; Okay and Akman, 2010; Painuly et al., 2003; Porter, 1998; Vine et al., 1998; Vine, 2005). For the purpose of this study, these items were adapted and extracted to the Russian energy efficiency market conditions. In addition, the formulated items were evaluated by an internal group of experts from the FCN institute. In order to ensure the technical appropriateness of the formulated items, the questions to technical aspects of ESCO activities were discussed with researchers from the corresponding areas of the FCN sister institute “Energy Efficient Buildings and Indoor Climate” (EBC). The final version of the questionnaire was adjusted according to the comments received with regard to data contents, structural equivalence/laid out, logical flow of the questions, placement of directions<sup>26</sup>, and wording.

The logical flow of the questionnaire was advanced by grouping the questions in 11 thematic blocks, covering the following topics: (1) general characteristics of the surveyed companies; (2)

---

<sup>26</sup> An appropriate placement of directions in a questionnaire can reduce the participants’ uncertainty about what they are supposed to do, and allow them to focus on providing the information needed for the survey (Babbie, 1973).

identification of the business type of the surveyed companies<sup>27</sup>; (3) targeted market sectors; (4) services provided by the company (5) specialization areas; (6) types of contract agreements; (7) project financing; (8) characteristics of the projects; (9) competitive strategy; (10) barriers for energy services; and (11) growth factors for the energy service industry in Russia.

After the source questionnaire had been finalized in wording and design, it was translated from English into Russian as the share of the English-speaking population in Russia of just 4.8% is rather low (Nationmaster, 2011). The fact that the principal researcher of the research project (M.G.) is Russian in origin was beneficial not only for the translation process, but also for the adoption of the terms<sup>28</sup>. In addition, the translated questionnaire was checked by a professional English-Russian translator.

Each questionnaire was accompanied by a motivation letter (also translated into Russian) with the short introduction of the survey-conducting institute and the purpose of the study. Besides, a summary of the study's main conclusions was promised after finishing the analysis<sup>29</sup>. The surveyed companies had a choice to send back the completed questionnaire either by using the enclosed stamped envelope (if a company had a wish to receive a questionnaire by ordinary mail), or via fax or e-mail. These measures as a whole were expected to facilitate the completion of the questionnaire and, in turn, improve the response rate and reduce measurement errors (e.g. a respondent is more likely to follow the flow of the survey, and less likely to misread or overlook questions (Bradburn et al., 2004; Dillman, 2000)).

### **4.3 Measuring instruments**

In line with the defined systematic question blocks, two types of questions were used: closed-ended ones with multiple choices, and open-ended ones. Some of the closed-ended questions have dichotomies (yes/no) and use nominal scale that has no natural rank order for all answers. Other closed-ended questions (question blocks 9 to 11) use the ordinal scale<sup>30</sup> represented by a

---

<sup>27</sup> Question block 2 has been inserted as a filter question in the study. It distinguishes several companies' business models in accordance with provided definitions to each of them (e.g. "ESCO" was defined as a "company that provides energy-efficiency-related and other value-added services based on performance contracting as a core part of its business").

<sup>28</sup> The advantages of the multinational teams in cross-national studies are discussed by Bullinger (1995), Presser et al. (2004), and Harkness (2003) in detail. Furthermore, the translation of the questionnaire is considered by various authors as a central part of the scientific process of designing valid cross-national questions (Grunet and Muller, 1996; Pasick et al., 1996; Smith, 1998).

<sup>29</sup> Dillman (2000) states that people's motivation to respond to surveys is vested in the Social Exchange Theory: by responding to the survey, the respondents should be compensated in return in a way that meets some of their needs.

<sup>30</sup> Some authors state that it is possible to treat the Likert scale as an interval scale to allow application of the parametric tests (Bowling, 1997, Ferguson and Cox, 1993, among others).

Likert scale. In this case, the answer categories show a natural and unambiguous rank order, as the participants were directed to make their item judgments in accordance with their stance to this particular item. The rating scale produces numerical data, where each point is labeled with a corresponding descriptor. In order to assess the importance of different items, suggested in line with the question block 9 on the competitive strategy of the companies, a 5-point Likert scale (ranging from 1 = fully irrelevant to 5 = very important) was provided. For the assessment of the effect of different barriers on the ESCO industry in Russia, block 10 also provides a 5-point Likert scale, where 1 is attributed with “no effect” and 5 with “major effect”. In question block 11, the importance of the listed factors for the growth of the energy service industry in Russia is assessed by a 3-point Likert scale: 1 = not important; 2 = important; 3 = very important. In accordance with Dillman (2000), only odd numbers of points were used in the Likert scale in order not to force participants to set one or two centermost numbers as a center or neutral point by an even number of ranking points.

The participants were given the opportunity to add each question with a further item, if it is not listed among the items provided. Besides, several open-ended questions provided specification of some issues described in the closed-ended questions.

Most of the terms used in the questionnaire were supplied with a clear definition in order to avoid misunderstandings or misinterpretation errors. The numerical item categories used in the survey do not overlap and, hence, are mutually exclusive (Johnson and Christensen, 2012).

#### **4.4 Target population**

The study sample of 161 companies is based in the Russian Federation and was primarily categorized as follows: 15% (or 24) are independent ESCOs, 9% (or 15) are ESCOs as a subsidiary or a department of large companies, 5% (or 8) are energy efficiency consulting or outsourcing companies, 11% (or 17) are regional energy efficiency centers, and 60% (or 97) are SROs<sup>31</sup>. The attempt of this study was to cover all the operating ESCOs in any form to date, which explains the large diversity of the target population. Furthermore, it was difficult to cluster Russian ESCOs into one category, because there is no clear-cut definition of an ESCO business model for the Russian market. The lack of a database of companies that operate in the energy service industry, as well as almost no official (and very little unofficial, speculation-based) information on the ESCO industry in Russia, forced us to include all identified companies in this

---

<sup>31</sup> SROs were included in the database after the pretest phase.

survey, which referenced their business activities to energy efficiency- and energy-saving projects (see footnote 27 on the issue of filtering questions).

#### **4.5 Approach**

The target companies were identified by screening the companies' web pages, available companies' reports, several energy efficiency conference participants' lists, governmental web pages and programs, news articles, and descriptions of the energy efficiency- and energy-saving projects mostly through Internet search engines in Russian and English.

In order to find out whether the final version of the translated questionnaire works properly before using it in the research study, it was pretested<sup>32</sup> in September, 2011. We contacted by phone five companies, each of which represented<sup>33</sup> a specific type of the target companies, and was randomly chosen. Two filled out questionnaires were returned, and the pretest resulted in only minor modifications for some items and variables.

All target companies were contacted by phone<sup>34</sup> (October, 2011) before the final version of the questionnaire was sent out to an identified contact person (October-November, 2011). Two weeks later, the reminders were e-mailed to all non-responding companies to once more encourage them to participate in the survey, followed by a reminder by phone. Overall, the survey procedure took about four months<sup>35</sup> (September – December, 2011).

#### **4.6 Statistical methods**

The descriptive statistics<sup>36</sup> for all items depending on their scale (nominal, ordinal, or metric) were carried out. The multiple response questions were defined as the Multiple Response Sets before the descriptive statistics were applied. For each item of every data type, frequencies were calculated and the corresponding diagrams generated. This procedure allows to inspect the data

---

<sup>32</sup> Especially in the cross-national studies the role of pretesting of a translated questionnaire increases due to the need to examine whether items and scales meet acceptable standards of comprehension, reliability, and validity in the targeted country (Krebs and Schuessler, 1986; Presser et al., 2004). This helps to identify potential problems in intent, clarity, and navigation (Bradburn et al., 2004; Dillman, 2000).

<sup>33</sup> Tull and Hawkins (1976) and Zaltman and Burger (1975) state that a pretest subject should be "typical" or "representative" for the target population of a survey.

<sup>34</sup> The identification of a contact person among the companies, which could provide information needed for this survey, was one of the biggest hurdles in this survey. In some cases, during the first telephone calls, there was unwillingness of the addresses to participate in the survey or to forward it to a corresponding person either because of a fear of an "industrial spionage", or of general company's restrictions to participate in the survey.

<sup>35</sup> The questionnaire preparation phase (4 months) is not included here.

<sup>36</sup> All statistical analyses in this paper were performed using the Statistical Package for the Social Sciences (SPSS) 19.0 for Windows. All tables and graphs were generated and modified using Microsoft Excel.

for errors that might have occurred either during the transcription of the data or due to inconsistency in the respondent's answer and, hence, to improve the plausibility of the data (Baur and Fromm, 2008).

The comparison of the discrete characteristics was assessed with Fischer's Exact Test<sup>37</sup> (Hypotheses 1 and 2). The continuous characteristics were compared between two groups (ESCOs and ESPCs) by means of the two-tailed Exact Wilcoxon Mann-Whitney Rank Sum Test<sup>38</sup> (Hypotheses 3-5). All *p*-values are reported for two-tailed statistical tests, and an error level of 5% was used.

In order to estimate reliability of the ordinal multi-item scale for each construct (questions 9 to 11), Cronbach's<sup>39</sup> alpha was calculated. The scale on which the competitive strategy dimensions (question 9) and barriers for the energy service industry (question 10) were estimated revealed a Cronbach's alpha of .923 and .793, respectively. Such high values of Cronbach's alpha indicate a high level of internal consistency for these scales. For the scale that measures growth factors (question 11) for the Russian energy service industry, the Cronbach's alpha is .605. This value is quite low; however, for the exploratory research it shows sufficient internal consistency (Garson, 2008).

## 5. Results and discussion

This section provides a detailed discussion of each of the hypotheses formulated and further insights gained by utilizing information from the questionnaire analysis of the 28 surveyed companies in Russia.

### 5.1 Sample profile

Out of the 161 target companies, there are 28 (17%) that have returned filled-out and usable questionnaires. During the first telephone call, 26 (16%) of the companies decided not to

---

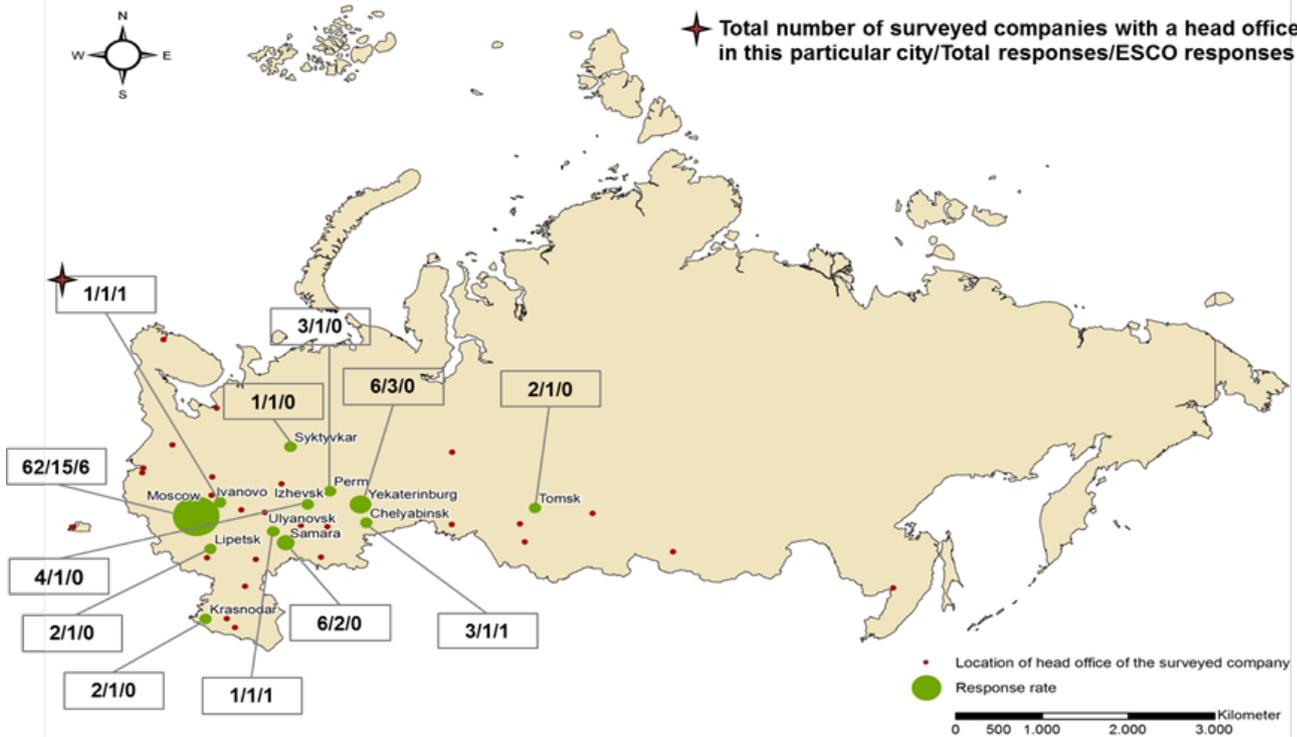
<sup>37</sup> For the calculation of the contingency tables and execution of the non-parametric tests, SPSS normally uses asymptotic methods to estimate *p*-values. This implies a sufficiently large sample size that conforms to a certain distribution. However, in the current study, the sample size is relatively small ( $N < 30$ ), sparse and unbalanced. In this case, the asymptotic method is not expected to produce reliable results (Mehta and Patel, 1996). Thus, in order to solve this shortcoming, the calculations in this study are based on the exact distribution of the test statistics by calculating an exact *p*-value using Fischer's Exact Test for the 2 x 2-contingency tables.

<sup>38</sup> The Mann-Whitney Test determines whether a significant association exists between the mean responses of the two groups (ESCOs and ESPCs).

<sup>39</sup> Reliability is the "extent to which a variable or set of variables is consistent in what it is intended to measure" (Hair et al., 1998, p.90). Cronbach's alpha is widely used for reliability testing of the measurement set. It ranges from 0 to 1, the value of 1 indicating perfect reliability (e.g. 0.7 is considered to be at the lower level of acceptability of the reliability) (Hair et al., 1998).

participate in the survey and 16 (10%) could not be reached. 91 (57%) of the companies received reminders (e-mail and telephone call), but still chose not to participate in the survey. 13 (46%) of the respondents were directors of the companies; 5 (18%) were vice directors, managing/technical directors, or senior consultants/managers.

The head offices of 14 (50%) of the companies are located in Moscow; 3 (11%) in Yekaterinburg; and 2 (7%) in Samara. The head offices of the remaining 9 companies are predominantly located in the central part of Russia (Fig. 3).



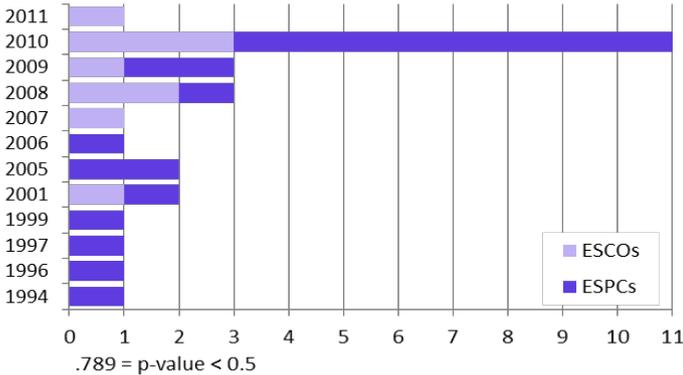
**Fig. 3:** Response rate by head office location  
 Source: Own compilation using Geographic Information System

The responding companies were founded between 1994 and 2011. Most of the companies, 11 (40%) were founded in 2010, 3 (10%) in 2008 and 2009, respectively (Fig. 4). This can be attributed to the fact that due to the new legislation on energy efficiency since 2009, the corresponding business segment has created an interest by numerous entrepreneurs in Russia (see section 2.2).

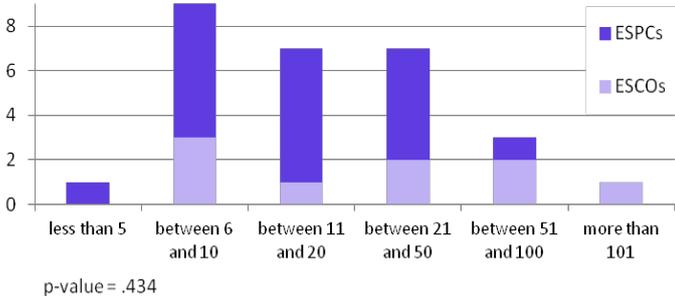
15 (54%) of the companies mentioned that they are active at the national level; 13 (47%) at the regional; 2 (8%) at the international, and 1 (4%) at the local level (multiple responses were allowed). Such a low international activity of the surveyed companies may, in contrast to some

Asian countries like Japan and China, indicate that there is no or very little cooperation in the form of joint ventures between the foreign and domestic companies on energy services.

Most of the companies ( $n = 26$ ), 18 (64%), operate as both Business-to-Consumer (B2C) and Business-to-Business (B2B); 7 (25%) as B2B businesses; and 1 (4%) as B2C enterprises. The magnitude of the total number of employees involved in the energy efficiency business area of the surveyed companies ranges intensively between 6 and 50 employees (Fig. 5).



**Fig. 4:** Years of the foundation of the surveyed companies



**Fig. 5:** Total number of employees involved in the energy efficiency business areas

In line with question block 2, the surveyed companies were asked to choose one or several definitions of business models best describing their own company (Table 2). Based on the results achieved, companies were arranged in two groups: ESCOs and other energy services-providing companies (hereafter ESPCs). Four companies did not choose any of the given options, but provided in the option “others” two business models that distinguish their companies: two companies are EACs and two are consulting companies in energy services. These companies were arranged into the group “ESPCs”. All conducted statistical tests in this study were based on this 2-group classification of the companies.

**Table 2: Business model definition (multiple responses)**

	<i>n</i> = 24	Percentage
ESCO	9	25.7%
Architectural & engineering firm (A/E)	3	8.6%
Outsourcing energy management company	9	25.7%
Equipment supplier	1	2.9%
Equipment leasing company	1	2.9%
Service company	1	2.9%
Public sector energy agency	8	22.9%
Public-private Joint Venture	3	8.6%
Total	35	100.0%

## 5.2 Hypotheses testing

*Hypothesis 1: There are no differences in the types of contract agreements applied by ESCOs and ESPCs.*

In order to determine whether there are significant differences in the types of contract agreement applied by ESCOs and ESPCs, the two-tailed Fisher’s Exact Test was used (Table 3). As can be seen, only three types of contract agreement occur: first-out/fast pay-out ( $p = .063$ ), shared savings ( $p = .608$ ), and fixed price ( $p = 1.000$ ), indicate support for Hypothesis 1, as there are no statistically significant differences between ESCOs and ESPCs. In contrast, the other 4 items, design-build ( $p = .002$ ), asset ownership ( $p = .002$ ), pay-from-savings ( $p = .029$ ), and guaranteed savings ( $p = .030$ ), differ significantly<sup>40</sup> at the 5% significance level. This indicates no support for Hypothesis 1 and, hence, it can be rejected. For a contract agreement “fee-for-service”, the  $p$ -value could not be calculated by SPSS as the cells have an expected frequency of less than 5.

Indeed, especially in one of the contractual types of EPC, “shared savings” (core characteristics of a “Western-ESCO” business model that distinguishes it from other ESPCs), a significant difference was expected to be found. It appears that “shared savings” is also applied by companies that could not be identified as ESCOs in this study. In contrast, a significant difference could be identified in the contractual type “guaranteed savings”, thus, it is also applied by ESPCs. Apparently two types of contractual agreement – “fixed price” and “fee-for-service” – are mostly used in the projects by ESCOs and ESPCs.

<sup>40</sup> No statement on a specific form of the differences between ESCOs and ESPCs can be clearly defined.

**Table 3:** Most applicable types of contract agreement

	Yes		Planned		Total $n^{41}$		$p$ -value
	ESPCs	ESCOs	ESPCs	ESCOs	ESPCs	ESCOs	
Design-Build	1	2	0	4	10	7	.002
Asset Ownership	0	0	0	5	9	6	.002
Pay-from-Savings	0	2	1	4	9	8	.029
Guaranteed Savings	1	5	4	4	10	9	.030
First-Out/Fast Pay-Out	0	1	1	4	9	8	.063
Shared Savings	2	2	3	4	10	8	.608
Fixed Price	11	7	0	0	12	7	1.000
Fee-for-Service	16	9	0	0	16	9	N/A

**Hypothesis 2:** *There are no differences in the project financing options applied by ESCOs and ESPCs.*

The findings from testing Hypothesis 2 (two-tailed Fisher’s Exact Test) show no statistically significant difference between ESCOs and ESPCs in the following project financing options: financial lease ( $p = .053$ ), direct loan ( $p = .120$ ), cooperation between company and the local banks ( $p = .254$ ), and participation in the governmental funding programs ( $p = 1.000$ ) (Table 4)<sup>42</sup>. For these items Hypothesis 2 cannot be rejected. As for certain financing options, such as operating lease ( $p = .005$ ), internal financing arranged by the company ( $p = .010$ ), and participation in the international funding programs ( $p = .047$ ), ESCOs and ESPCs significantly differ Hypothesis 2 can be safely rejected. For the option “Internal financing arranged by the customer”, no  $p$ -value could be calculated.

A supposition that due to favorable legislation, the two options “operating lease” and “financial lease” are currently the most applicable ones for the financing of the projects in the area of energy efficiency and energy saving, was not much supported by the results provided in Table 4. Nevertheless, Skribot (2012) emphasized the importance of “financial lease” for energy efficiency projects in the Russian market. In contrast, nowadays, the option “internal financing arranged by the customer” seems to be widely adopted as a project-financing option. The majority of ESCOs finance or plan to finance the projects through their own funds. A certain coherence could then be identified for the option “direct loan” (used or planned) as a source for such project financing. The results, furthermore, do not show any affiliation of current or planned participation in any of the governmental or international funding programs. The companies that do participate in such programs have not specified this in an included text field for this purpose.

<sup>41</sup> An answer option “no” is not shown in the table due to scarcity of space. The number of responses “no” provided by ESPCs and ESCOs can be calculated as the difference between “total  $n$ ” and “yes”/“planned” respectively. This procedure is also applied to Table 4.

<sup>42</sup> A further financial option, “membership fees”, was mentioned by three SROs in addition to the list provided in Table 4.

**Table 4:** Most applicable financing options for the projects

	Yes		Planned		Total <i>n</i>		<i>p</i> -value
	ESPCs	ESCOs	ESPCs	ESCOs	ESPCs	ESCOs	
Operating lease	0	0	0	5	9	7	.005
Internal financing arranged by the company	5	6	0	2	11	8	.010
Participation in the international funding programs	0	0	1	4	11	7	.047
Financial lease	0	1	1	4	9	7	.053
Direct loan	2	4	4	4	13	9	.120
Cooperation between company and the local banks	2	2	2	5	9	9	.254
Participation in the governmental funding programs	2	0	1	1	10	4	1.000
Internal financing arranged by the customer	13	9	0	0	13	9	N/A

**Hypothesis 3:** *The factors of the ESCOs competitive strategy do not differ from those of the ESPCs.*

A two-tailed Exact Wilcoxon Mann-Whitney Rank Sum Test was used to compare Likert scale scores between ESCOs and ESPCs (Table 5). The test indicates that significant differences are found between ESCOs and ESPCs in six factors of the competitive strategy, for which Hypothesis 3 can be rejected: risk management by the “performance guarantee” concept (ESCOs *mean* = 4.63, ESPCs *mean* = 2.83, *U* = 3.0, *Z* = -3.606, *p* = .0, *r* = .806 ); vertical integration (ESCOs *mean* = 4.00, ESPCs *mean* = 2.79, *U* = 20.0, *Z* = -2.650, *p* = 0.008, *r* = .565); attractive project financial opportunities (ESCOs *mean* = 4.78, ESPCs *mean* = 3.60, *U* = 28.0, *Z* = -2.53, *p* = .011, *r* = .516); cost position (ESCOs *mean* = 4.00, ESPCs *mean* = 2.69, *U* = 21.0, *Z* = -2.361, *p* = .18, *r* = .515); adjustment to consumer needs (ESCOs *mean* = 4.67, ESPCs *mean* = 3.93, *U* = 33.0, *Z* = -2.315, *p* = 0.21, *r* = .473); distribution channel selection (ESCOs *mean* = 3.75, ESPCs *mean* = 2.38, *U* = 26.0, *Z* = -1.966, *p* = .49, *r* = .429). Furthermore, the mean scores indicate that these factors of the competitive strategy were graded by ESCOs as being more important.

No significant differences at the significance level of 5% between ESCOs and ESPCs are indicated for the remaining factors, such as product and service variety, product and service quality, price policy technological leadership, operational excellence, specialization, relationship to the mother company, and relationship to the mother company (Table 5). This implies that Hypothesis 3 for these factors cannot be rejected at the 5% significance level.

These results show a noticeable inclination of ESCOs to the importance of performance contracting and of attractive financial options for their competitive strategy. In this context,

Skrivot (2012) emphasized that especially in the case of an ESCO being established as a subsidiary of a bank, it becomes, self-evidently, easier to access the financial resources needed for the energy efficiency projects. Particularly in this case, the option “attractive project financial opportunities” becomes the most important feature of the competitive strategy of an ESCO in an emerging ESCO market.

**Table 5:** Strategic dimensions of the competitive strategy

	ESPCs		ESCOs		Total Mean	Mann-Whitney U	Wilcoxon W	Z	r	p-value
	Mean	n	Mean	n						
Risk management by “Performance guarantee“ concept	2.83	12	4.63	8	3.55	3.0	81.0	-3.606	.806	.000
Vertical integration	2.79	14	4.00	8	3.23	20.0	125.0	-2.650	.565	.008
Attractive project financial opportunities	3.60	15	4.78	9	4.04	28.0	148.0	-2.530	.516	.011
Cost position	2.69	13	4.00	8	3.19	21.0	112.0	-2.361	.515	.018
Adjustment to consumer needs	3.93	15	4.67	9	4.21	33.0	153.0	-2.315	.473	.021
Distribution channel selection	2.38	13	3.75	8	2.90	26.0	117.0	-1.966	.429	.049
Product and service variety	3.31	13	4.00	9	3.59	36.5	127.5	-1.528	.326	.127
Product and service quality	4.12	17	4.78	9	4.35	54.5	207.5	-1.371	.269	.170
Price policy	4.00	17	4.44	9	4.15	54.0	207.0	-1.353	.265	.176
Technological leadership	3.60	15	4.22	9	3.83	51.5	171.5	-1.001	.204	.317
Operational excellence	3.71	14	4.11	9	3.87	50.5	155.5	-.838	.175	.402
Specialization	4.59	17	4.33	9	4.50	65.5	110.5	-.686	.135	.493
Relationship to the mother company	2.50	10	2.83	6	2.63	27.5	82.5	-.280	.070	.779
Relationship to the home government	4.31	16	4.43	7	4.35	52.5	188.5	-.260	.054	.795

**Hypothesis 4:** *There are no differences in the barriers that affect the development of ESCOs and ESPCs in the Russian energy service industry.*

By means of the two-tailed Exact Wilcoxon Mann-Whitney Rank Sum Test, a significant difference between ESCOs and ESPCs was found in one barrier, for which Hypothesis 4 can be rejected: the electricity bill non-payment problem (ESCOs *mean* = 4.00, ESPCs *mean* = 2.94,  $U = 33.0$ ,  $Z = -2.253$ ,  $p = .027$ ,  $r = .442$ ) (Table 6).

The mean scores provided in Table 6 indicate that the problem of electricity bill non-payment has more effect on ESCOs than on ESPCs. This problem roots in the Former Soviet Union (FSU), where energy supply was a guaranteed public service and the Russian energy companies were required to supply customers even though they had not paid their bills<sup>43</sup> (IEA, 1995). In turn, this has led to a huge share of non-cash transactions and affected the ability of energy companies to invest in their modernization. It explains to some extent the

<sup>43</sup> In 2000, the RG prohibited such non-cash transactions at all levels.

absence of an investment culture regarding the reduction of the high energy and carbon intensity of the Russian industry.

No significant differences between ESCOs and ESPCs could be detected for further barriers, which is why Hypothesis 4 cannot be rejected at the 5% significance level. In accordance to Skribot (2012), many ESCOs face the problem that the ESCO business model is either still unknown to most of the banks or many ESCO-newcomers are not in a position to provide a strong balance sheet from already realized energy efficiency projects as a sufficient proof of the reliability of such long-term investments under the Russian market conditions.

**Table 6:** Barriers for the energy service industry in Russia

	ESPCs		ESCOs		Total Mean	Mann- Whitney U	Wilcoxon			
	Mean	n	Mean	n			W	Z	r	p-value
Electricity bill non-payment problem	2.94	18	4.00	8	3.27	33.0	204.0	-2.253	.442	.027
Lack of awareness/experience of local banks for financing EE projects	3.89	19	4.33	9	4.04	77.5	122.5	-1.249	.086	.225
Lack of managerial competence and interest	4.17	18	3.89	9	4.07	62.5	107.5	-1.108	.213	.300
Lack of competition	2.93	15	2.50	8	2.78	47.0	83.0	-.931	.194	.393
Lack of government support	4.53	19	4.44	9	4.50	72.5	117.5	-.737	.139	.416
Lending on strong balance sheet	3.59	17	3.89	9	3.69	61.5	214.5	-.869	.170	.430
High credit risk of energy efficiency projects	4.63	19	4.33	9	4.54	72.0	117.0	-.770	.146	.438
Low price of electricity	3.53	17	4.00	7	3.67	47.0	200.0	-.826	.169	.477
Unfamiliarity with energy efficiency technologies	3.84	19	3.78	9	3.82	73.5	118.5	-.659	.124	.546
ESCO concept unknown	4.06	18	3.88	8	4.00	64.0	100.0	-.472	.093	.647
Environmental issues (e.g. CO <sub>2</sub> ) are not a priority	3.33	18	3.11	9	3.26	73.0	118.0	-.423	.081	.694
Lack of time and focus to initiate/carry the project	3.56	18	3.44	9	3.52	74.0	119.0	-.392	.076	.737
Lack of awareness of the EE potential	4.58	19	4.44	9	4.54	62.5	252.5	-.456	.086	.742
Banks focus mostly on revenue stream not on energy saving stream	4.22	18	4.00	9	4.15	74.5	119.5	-.362	.070	.766
Lack of skills and technical competence	4.00	18	3.78	9	3.93	75.5	120.5	-.301	.058	.787
Low investing in non-core business project	3.81	16	3.89	9	3.84	67.5	203.5	-.267	.053	.809
Weak legal and contract enforcement framework	4.63	19	4.78	9	4.68	80.0	270.0	-.357	.068	.815
Lack of aggressive marketing of EE projects	3.94	18	4.00	8	3.96	68.5	239.5	-.219	.043	.855
Bureaucracy	4.29	17	4.22	9	4.27	72.0	117.0	-.264	.052	.894
Shorten of resource capacity to develop projects	3.84	19	4.11	9	3.93	83.5	273.5	-.104	.000	.911
„Performance contracting“ unknown	4.17	18	4.25	8	4.19	71.0	107.0	-.061	.012	1.000
High transactions costs for project financing on small projects	3.88	17	3.63	8	3.80	67.0	220.0	-.063	.013	1.000
Lack of baseline annual energy consumption	3.79	19	3.89	9	3.82	85.5	130.5	.000	.020	1.000

**Hypothesis 5:** *There are no differences in the factors that are decisive for the growth of ESCOs and ESPCs in the Russian energy service industry.*

By means of the two-tailed Exact Wilcoxon Mann-Whitney Rank Sum Test, a significant difference in only one factor “attractive investment opportunities in an infant industry” (ESCOs *mean* = 2.67, ESPCs *mean* = 2.16,  $U = 45.0$ ,  $Z = -2.329$ ,  $p = .030$ ,  $r = .030$ ), could be found between ESCOs and ESPCs. For this factor Hypothesis 5 must be rejected. The mean score, thus, indicates that ESCOs consider this factor slightly more importantly for the growth of the energy service industry than ESPCs did.

No significant differences could be indicated between ESCOs and ESPCs in further factors of growth of the energy service industry in Russia (Table 7). Hence, Hypothesis 5 cannot be rejected for those factors.

Government support, qualification and skills, guaranteed return on investments in projects, as well as the legislation base for and standardization of EPC are obviously the most important factors for the growth of the energy service industry, measured by nine ESCOs.

**Table 7:** Growth factors for the energy service industry in Russia

	ESPCs		ESCOs		Total Mean	Mann- Whitney <i>U</i>	Wilcoxon <i>W</i>	<i>Z</i>	<i>r</i>	<i>p</i> - value
	Mean	<i>n</i>	Mean	<i>n</i>						
Attractive investment opportunities in an infant industry	2.16	19	2.67	9	2.32	45.0	235.0	-2.329	.440	.030
Awareness of banks of earnings possibilities from EE and carbon mitigation	2.11	19	2.56	9	2.25	57.0	247.0	-1.532	.290	.151
Partnerships with public sector	2.42	19	2.11	9	2.32	62.5	107.5	-1.276	.241	.289
Government support	2.63	19	2.89	9	2.71	67.5	257.5	-1.174	.222	.342
Favorable regulatory environment for domestic and foreign long-term investments	2.79	19	2.56	9	2.71	65.5	110.5	-1.257	.237	.371
Qualifications/Skills	2.58	19	2.78	9	2.64	68.5	258.5	-1.007	.190	.417
Stable business environment	2.53	19	2.33	9	2.46	69.0	114.0	-.939	.177	.435
Rising energy prices	2.44	18	2.56	9	2.48	70.5	241.5	-.612	.118	.599
Tax incentives	2.58	19	2.44	9	2.54	72.0	117.0	-.765	.145	.623
Growing public awareness of energy scarcity and climate change	1.79	19	1.89	9	1.82	77.5	267.5	-.437	.083	.663
Flexibility in meeting customers' needs	2.32	19	2.44	9	2.36	76.5	266.5	-.510	.096	.722
Reliable customers with strong balance sheet	2.58	19	2.56	9	2.57	81.0	126.0	-.259	.049	.919
Demonstration projects	2.16	19	2.22	9	2.18	80.5	270.5	-.284	.054	.920
Guaranteed ROI in whole project payback period	2.74	19	2.78	9	2.75	82.0	272.0	-.229	.043	1.000
Legislation base for and standardization of EPC	2.58	19	2.67	9	2.61	84.0	274.0	-.090	.017	1.000

### 5.3 Further results

The questionnaire addresses further aspects of the surveyed companies in order to provide the complete picture of the energy services market development in Russia. Based on the results from the analysis of the market sectors, targeted by projects of the companies, one may conclude that the surveyed companies operate in all main sectors of the economy. No significant difference was found between ESCOs and ESPCs in the targeted sectors (Table 8).

It should be noted that the surveyed companies are less active in the transport, recycling and agricultural sectors, which show high energy efficiency potentials. Such a result is contradictive to the fact that e.g. energy demand in the transport has been growing faster than in other sectors (3.4% per year in the period of 2000-2009), accounting for 21% of final energy consumption in 2010 (IEA, 2011).

In the five types of services provided by the surveyed companies, such as equipment installation, equipment supply, design-build projects, project research and development, getting technical requirements and development of the scope statements, significant differences were identified between ESPCs and ESCOs (Table 9). “Energy audits” are carried out by all ESCOs and the majority of ESPCs. In line with the new legislation (discussed in section 2.2), all “state-related” companies have to undergo an energy audit till the end of 2012. Thus, in recent years, many EACs were established. In this context, a question about the future of these EACs after the end of 2012 remains open. Including the ESCO-typical services, e.g. EPC, into the scope of the services provided by EACs, could help those companies to maintain their market positions in the longer term. The advantages of such structural change from EACs to ESCOs are that EACs in line with provided energy audits already know the majority of their potential clients, and hence, their energy consumption pattern.

**Table 8:** Market sectors targeted by the projects of the company

	ESPCs ( <i>n</i> = 18)	ESCOs ( <i>n</i> = 9)	<i>p</i> -value Fisher's Exact Test
Transport	4	4	.375
Industrial	15	9	.529
Recycling	2	2	.582
Commercial	13	8	.582
Public	14	8	.582
Agricultural	6	4	.582
Residential	16	8	.582

“Energy consulting” and “getting technical requirements and development of scope statements” are also frequently mentioned services by ESCOs and ESPCs. Some of the respondents provided several additional services to those listed in Table 9, such as the development of the energy-savings programs for companies; modernization of the municipal infrastructure; and teaching activities in energy audit and energy-savings topics.

**Table 9:** Services provided by the companies

	ESPCs ( <i>n</i> = 17)	ESCOs ( <i>n</i> = 9)	<i>p</i> -value (Fisher's Exact Test)
Equipment installation	1	7	.000
Equipment supply	0	5	.002
Design-build projects	1	6	.002
Project research and development	1	5	.010
Getting technical requirements and development of scope statements	7	8	.036
Project feasibility study	9	8	.098
Equipment maintenance and operations (M&V)	1	3	.104
Project management	7	7	.110
Energy Audit	12	9	.129
Project finance	2	4	.138
Guarantee of performance	2	3	.302
Energy Consulting	11	8	.357
Non-energy facility improvements	10	3	.411
Solutions to environmental issues	2	1	1.000
Equipment manufacturing	1	1	1.000

Equipment used in the companies’ projects mostly comes from Russia (*n* = 9) and has been imported from the following producing countries: Germany (*n* = 10); China (*n* = 4); U.S. (*n* = 4); Great Britain (*n* = 3); France, Sweden, Spain (each *n* = 2), and others (*n* = 4). The project specialization areas of the companies are presented in Table 10. In addition to this, at least seven companies mentioned “metering of energy consumption” as one of the most important core business directions nowadays that is based on the new legislation requirements since 2009.

**Table 10:** Specialization project areas of the companies

	ESPCs ( <i>n</i> = 11)	ESCOs ( <i>n</i> = 9)	<i>p</i> -value (Fisher's Exact Test)
Combined heat and power	2	6	.065
Lighting	8	9	.218
Cooling	4	1	.319
Modernization	7	8	.319
Gas based power	1	2	.566
Heat/cold storage	3	1	.591
Energy from waste	4	2	.642
Fuel switching	4	4	1.000
Water management	2	1	1.000
Industrial processes modernization	4	4	1.000
Air conditioning	5	5	1.000
Heating	10	8	1.000

There were very few responses to the question block 8 on the characteristics of the realized and planned projects. Hence, almost no statistical tests could be conducted for these questions. Nevertheless, there are some results worth mentioning. Two options were considered as criteria to agree a contract with a client: an average amount of a client's minimum energy bill of 172500 € (6.7 million RUB) ( $n = 3$ ) and/or average maximum contract duration of  $2\frac{1}{2}$  years ( $n = 4$ ). The projects of ESPCs ( $n = 12$ ) last on average between one and two years, and of ESCOs ( $n = 8$ ) between three and five years ( $p = .022$ ). The average project payback time of such projects is less than 4 years (ESPCs  $mean = 6$ , ESCOs  $mean = 5$ ,  $p = .740$ ) and the expected average project payback time for the future projects increases up to 6 years (ESPCs  $mean = 8$ , ESCOs  $mean = 5$ ,  $p = .622$ ). Further characteristics of the projects are summarized in Table 11. No significant differences in all options could be identified between ESPCs and ESCOs.

**Table 11:** Projects' characteristics and forecasts

	2010		2011		2012		2013	
	ESPCs	ESCOs	ESPCs	ESCOs	ESPCs	ESCOs	ESPCs	ESCOs
Estimated value of the conducted and planned projects (mean) (million €)	<b>3.2</b> $n = 6$	<b>0.35</b> $n = 3$	<b>7</b> $n = 6$	<b>1.7</b> $n = 6$	<b>1.1</b> $n = 5$	<b>5</b> $n = 6$	<b>10</b> $n = 3$	<b>9.8</b> $n = 4$
Estimated achieved and expected energy savings through the projects	8% $n = 2$	32% $n = 3$	8% $n = 2$	33% $n = 6$	8% $n = 2$	37% $n = 6$	8% $n = 2$	34% $n = 4$
Estimated achieved and forecasted project growth in revenue	17% $n = 3$	15% $n = 3$	17% $n = 3$	18% $n = 5$	17% $n = 3$	15% $n = 5$	17% $n = 3$	15% $n = 4$

However, a significant difference between ESPCs and ESCOs in the assessment of the annual growth rate of the Russian energy services market in the next five years were found: ESPCs assume an average growth rate of 6 to 10% and ESCOs of 11 to 20% per annum (ESPCs  $mean = 14$ , ESCOs  $mean = 8$ ,  $p = .011$ ). The market potential of energy efficiency projects over the next five years was assessed only by two respondents with a mean value of 125 GWh/year.

In accordance to Skribot (2012), it is quite difficult to estimate the Russian ESCO market development growth rate in the first 5 to 10 years. Skribot (2012) emphasizes that some parallels to the emerging Russian ESCO market could be derived from the development of the U.S. or Chinese ESCO industry, where it took a decade until the proper legal and business environment needed for the well-functioning ESCO market was established.

## 6. Conclusion

Our present explorative study reveals that there is an emerging ESCO market in Russia with an average estimated (by ESCOs and ESPCs) growth rate of 15-17% for the next three years. Likewise, in the U.S. ESCO industry, in the early 1990s (see Appendix 1), there were numerous market newcomers, such as ESPCs and several independent ESCOs. These Russian companies have been carrying out the project financing mostly in the form of the “fixed price” and “fee-for-services”. The study results show that the contractual form “guaranteed savings” is gaining in importance in the Russian ESCO market, while “shared savings”, presumably due to risk-sharing with a client, does not seem to be an attractive option for the emerging market. Most of the projects are financed either from ESCO’s own funds, direct loans, or by the customers. Even though the Russian banks offer financial leasing contracts for energy efficiency projects, financing through EPC seems to be rarely implemented.

The RG has been establishing a new regulatory framework and setting ambitious targets aiming at improving energy efficiency in all sectors of the economy. However, this legislation is far from being comprehensive for the well-functioning ESCO market, as there are substantial gaps in terms of rights of the contractual partners as well as funding and contractual procedures. Furthermore, as our study indicates, the new regulatory framework and political programs on energy efficiency issues tackle the “state-related” sector, and barely the commercial/private one, which may become the driving force of the Russian ESCO business. Incentives provided by funding programs or tax credits would help to attract commercial companies to enter the energy efficiency market.

Due to the requirement to conduct an energy audit until the end of 2012, numerous energy audit companies have been established over the last few years. Most likely, some of these companies will be converted into ESCOs in the aftermath of the mature legislation by adding performance-based contracting to their core business. In accordance to Skribov (2012), most of the energy audit companies would not be able to sustain their business unless they adapt their business model according to the requirements of the Russian legislation consistently. Apart from the comprehensive regulatory framework, there is a need to further increase the awareness of the banking sector of the energy efficiency projects and to introduce hedging instruments for risks and uncertainties of ESCO businesses. Like any other business, this could be partly achieved through the aggressive marketing of an ESCO business. Furthermore, as for instance, in China and Japan, the Russian ESCO market could extremely

benefit from joint venturing with foreign partners – by securing know-how, financing, risk management, and technology transfer.

Even though our research provides some deep new insights into the Russian ESCO market development but it also reveals some of its limitations. First, some ESCOs may have been missed because the authors were not aware of all ESCOs operating in the Russian market. Second, obtaining reliable numbers is challenging in the Russian market and due to a lack of scientific literature on the Russian ESCO industry, there is no possibility to exposure, if the results of this study are plausible at the national level. This constrains the validity of our study and, hence, generalization of results should be made only with caution.

Future research should address the economic theories and applications of the ESCO business model under transition economies' market conditions, which implies high economic and political uncertainty. A detailed analysis of the generation of White Certificates, implementation of Green Investment Schemes (GIS) and Joint Implementation (JI) projects, in line with an ESCO business model in the Russian market, would generate valuable new market opportunities and reveal future research needs. Finally, financial organizations and governmental programs that provide loans and funds for energy efficiency, as well as the ESCO projects implemented in the budget sector, should also be taken into consideration for the next Russian ESCO market survey.

## **Acknowledgements**

We gratefully acknowledge the support of all Russian companies, which participated in our survey in 2011. We are also indebted to Wolfgang Skribot, Managing Director Energy & Infrastructure of Gazprombank in Moscow, for the valuable insights into the Russian ESCO market provided in the course of personal communication. Moreover, we are grateful for the helpful comments on an earlier version of the questionnaire provided by Carl Christian Michelsen, Research Associate at FCN, and Davide Cali, Research Associate at the Institute for Energy Efficient Buildings and Indoor Climate (EBC). Finally, financial research support from the E.ON ERC foundation (E.ON ERC gGmbH project grant no. 04-029) is gratefully acknowledged.

## Abbreviations Used

B2C	Business-to-Consumer
bcm	billion cubic meters
CEC	Commission of the European Communities
CO <sub>2</sub>	Carbon dioxide
CRS	Congressional Research Service
DSM	Demand-Side Management
EAC	Energy Audit Company
EBC	Energy Efficient Buildings and Indoor Climate (= E.ON ERC Institute)
EBRD	European Bank for Reconstruction and Development
EE	Energy efficiency
EPC	Energy Performance Contracting
ESC	Energy service contracting
ESCO	Energy Service Company
ESPC	Energy Providing Service Company
EU	European Union
FAS	Federal Antimonopoly Service
FCN	Institute for Future Energy Consumer Needs and Behavior (= E.ON ERC Institute)
FESCO	Federal Energy Service Company
FL	Federal Law
FRESCO	project “The promotion of the Finnish energy business in North-West Russia”
FSU	Former Soviet Union
FZ	Federal Law (in Russian) - Федеральный (F) закон (Z)
GHG	Greenhouse gases
GIS	Green Investment Scheme
GP	Governmental program

GWh/year	Gigawatt-hours per year
IEA	International Energy Agency
IEECB	Improving Electricity Efficiency in Commercial Buildings
IFC	International Financial Corporation
IRP	Integrated Resource Planning
JAESCO	Japan Association of Energy Service Companies
JI	Joint Implementation
kb/d	thousand barrels per day
M&V	Monitoring and verification
Mtoe	million tons of oil equivalent
NAESCO	National Association of Energy Service Companies
N/A	not available
NEEG	Norwegian Energy Efficiency Group
O&M	Operation and maintenance
OECD	Organization for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PPP	Purchasing power parity
RG	Russian government
ROI	Return on Investment
RUB	Russian Ruble
RWTH	Rheinisch-Westfaelische Technische Hochschule
SPSS	Statistical Package for the Social Sciences
SRO	Self-Regulated (non-commercial) Organization
UK	United Kingdom
U.S.	United States of America

## References

- Adnot, J., Guerre, F., and Jamet, B. (2002). A short history of energy services in France. Available at: <http://www.cenerg.ensmp.fr/english/themes/mde/bas>. (accessed 2 February, 2012).
- Andrews, A. (2004). Energy Savings Performance Contracts: Reauthorization Issues. Available at: <http://www.environmentors.org/NLE/CRSreports/04Sep/RL32543.pdf> (accessed 4 January, 2012).
- Arny, M. (1996). The retail energy services company model for restructuring the electric utility industry. *The Electricity Journal*, 9(1), 80-88.
- Babbie, E.R. (1973). *Survey Research Methods*. Belmont, California: Wadsworth Publishing Company.
- Baur, N., and Fromm, S. (2008). *Datenanalyse mit SPSS für Fortgeschrittene, Ein Arbeitsbuch, 2. überarbeitete und erweiterte Auflage*. Wiesbaden: VS Verlag Sozialwissenschaften.
- Bertoldi, P., Berrutto, V., Renzio, M., Adnot, J., and Vine, E. (2003). How are EU ESCOs behaving and how to create a real ESCO Market. *Proceedings of the 2003 ECEEE Summer Study, European Council for an Energy-Efficient Economy* (pp. 909-916). Paris.
- Bertoldi, P., Hinnells, M., and Rezessy, S. (2006). Liberating the power of Energy Services and ESCOs in a liberalized energy market. Paper presented at the Energy Efficiency and Domestic Appliances and Lighting Conference, 21-23 June, London. Available at: <http://www.eci.ox.ac.uk/research/energy/downloads/bmt-report3.pdf> (accessed 19 June, 2012).
- Bertoldi, P., and Rezessy, S. (2005). Energy Service Companies in Europe. Status Report 2005 (pp. 1-72). Ispra, Italy, European Commission Directorate-General Joint Research Center (DG JRC).
- Bertoldi, P., Rezessy, S., and Vine, E. (2006). Energy Service Companies in European Countries: Current status and a strategy to foster their development. *Energy Policy*, 34(14), 1818-1832.
- Bowling, A. (1997). *Research Methods in Health: Investigating Health and Health Services*. Buckingham: Open University Press.
- Bradburn, N.M., Sudman, S., and Wansink, B. (2004). *Asking Questions: The Definitive Guide to Questionnaire Design*. San Francisco: Jossey-Bass.

- Bullinger, M. (1995). German translation and psychometric testing of the SF-36 Health Survey: Preliminary results from the IQOLA Project. *Social Science Medicine*, 41(10), 1359-1366.
- CEC - Commission of the European Communities. (2006). *Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on Energy End-Use Efficiency and Energy Services and Repealing Council Directive 93/76/EEC*, (Text with EEA relevance). *Official Journal of the European Union*, L 114, 65-85.
- CEC - Commission of the European Communities. (2011). *Proposal for a Directive of the European Parliament and of the Council on Energy Efficiency and Repealing Directives 2004/8/EC and 2006/32/EC, SEC(2011) 779 final*. 22 June 2011, Brussels.
- Da-Li, G. (2009). Energy Service Companies to improve energy efficiency in China: Barriers and removal measures. *Procedia Earth and Planetary Science*, 1(1), 1695-1704.
- Dayton, D.S., Goldman, C., and Pickle, S. (1998). The Energy Service Company (ESCO) Industry: Analysis of industry and market trends. *Proceedings of the 1998 ACEEE Summer Study, American Council for an Energy-Efficient Economy*. Washington, DC: Berkeley Lab.
- Dillman, D. (2000). *Constructing the Questionnaire. Mail and Internet Surveys*. New York: John Wiley&Sons.
- Dreessen, T. (2003). Advantages and disadvantages of the two dominant world ESCO models: Shared Savings and Guaranteed Savings. In: *Proceedings of the First Pan-European Conference on Energy Service Companies*. Editor: P. Bertoldi.
- EC - European Commission. (2010). The EU Climate and Energy Package. The "20-20-20" Targets. Available at: [http://ec.europa.eu/clima/policies/package/index\\_en.htm](http://ec.europa.eu/clima/policies/package/index_en.htm) (accessed 10 December, 2011).
- Efremov, D., Smirnyagin, D., Valerianova, O., and Hernesniemi, H. (2004). ESCO Companies in Northwest Russia: Legal Issues and Organizational Schemes. Report as part of the Interreg III A Project "The Promotion of Finnish Energy Business in North-West Russia, FRESCO". Helsinki: Elinkeinoelämän Tutkimuslaitos (ETLA) - the Research Institute of the Finish Economy ETLA.
- EIA – U.S. Energy Information Administration. (2012). International Energy Statistics. Available at: <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8> (accessed 3 May, 2012).

- Enerdata (2011). Trends in Global Energy Efficiency 2011, Country reports, Russia. Available at: [http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/5fe3ef5f71dab20cc1257864005185df/\\$file/russia.pdf](http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/5fe3ef5f71dab20cc1257864005185df/$file/russia.pdf) (accessed 21 December, 2011).
- FAS - Federal Antimonopoly Service. (2011). Federal Law of the Russian Federation "On State and Municipal Procurement of Goods, Works and Services" (as amended in 2011) (non-official translation). Available at: [http://en.fas.gov.ru/legislation/legislation\\_50755.html](http://en.fas.gov.ru/legislation/legislation_50755.html) (accessed 1 December, 2011).
- Ferguson, E., and Cox, T. (1993). Exploratory Factor Analysis: a user's guide. *International Journal of Selection and Assessment*, 1, 84-94.
- FESCO - Federal Energy Service Company. (2012). [Home page]. Available at: <http://www.fes-com.ru/> (accessed 29 Mai, 2012).
- Garbuzova, M., and Madlener, R. (2012). Towards an Efficient and Low Carbon Economy Post-2012: Opportunities and Barriers for Foreign Companies in the Russian Energy Market. *Mitigation and Adaptation Strategies for Global Change*, 17(4), 387-413.
- Garson, G.D. (2008). Reliability Analysis Statnotes: Topics in Multivariate Analysis. Available at: <http://faculty.chass.ncsu.edu/garson/PA765/reliab.htm> (accessed 4 January, 2011).
- Gilligan, D. (2011). U.S. Energy Service Company Industry: History and Business Models. Paper Presented at the Second U.S.-China Energy Efficiency Forum, May 5-6. Berkeley, California: Lawrence Berkeley National Laboratory.
- Goldman, A.C., Osborn, J.G., Hopper, N.C., and Singer, T.E. (2002). Market Trends in the U.S. ESCO Industry: Results from the NAESCO Database Project. Berkeley, California: Energy Analysis Department, Environmental Energy Technologies Division, Ernest Orlando Lawrence Berkeley National Laboratory.
- Goldman, C., Hopper, N. and Osborn, J. (2005). Review of UE ESCO Industry Market Trends: an Empirical Analysis of Project Data, *Energy Policy*, 33(3), 387-405.
- Grunet, S., and Muller, T. (1996). Measuring Values in International Settings: Are Respondents Thinking "Real" Life or "Ideal" Life. *Journal of International Consumer Marketing*, 8, 169-185.
- Hair, J.F., Anderson, R.E., Tatham, R.L., and Black, W.C. (1998). *Multivariate Analysis* (5th ed.). Prentice Hall International, Englewood Cliffs, HJ.
- Harkness, J. (2003). Questionnaire Translation. In: Harkness, J., van de Vijver, F. and Mohler, P. (Eds.). *Cross-Cultural Survey Methods* (pp. 35-56). New Jersey: Wiley, Hoboken.

- Honkanen, H. (2005). Applying the international ESCO Concept to energy saving projects in the energy production sector in Northwest Russia. Kalmar ECO-TECH'05 and The Second Baltic Symposium on Environmental Chemistry, 28-29 November, Kalmar, Sweden.
- Hopper, N., Goldman, C., Gilligan, D., Singer, T., and Birr, D. (2007). A Survey of the U.S. ESCO Industry: Market Growth and Development from 2000 to 2006. Berkeley, California: Lawrence Berkeley National Laboratory.
- IEA - International Energy Agency. (1995). Energy Policies of the Russian Federation: 1995 Survey Review. Paris: OECD/IEA.
- IEA - International Energy Agency. (2011). World Energy Outlook 2011. Paris: OECD/IEA.
- ICF - International and National Association of Energy Services Companies. (2007). Introduction to Energy Performance Contracting. Prepared for U.S. Environmental Protection Agency ENERGY STAR, Prepared by ICF International and Buildings National Association of Energy Services Companies.
- Johnson, B., and Christensen, L. (2012). *Educational Research: Quantitative, Qualitative, and Mixed Approaches* (4th ed.). California: Sage Thousand Oaks.
- Krebs, D., and Schuessler, K. (1986). Zur Konstruktion von Einstellungsskalen im internationalen Vergleich. ZUMA-Arbeitsbericht 86/01. Mannheim, Germany.
- Lamers, P., Kuhn, V., and Kreching, A. (2008). International Experience with the Development of ESCO Market. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, In Line with the Program for Environmental Management and Sustainable Use of Natural Resources Component Promotion of Renewable Energies.
- Lee, M.-K., Park, H., Noh, J., and Painuly, J. P. (2003). Promoting energy efficiency financing and ESCOs in developing countries: Experiences from Korean ESCO business. *Journal of Cleaner Production*, 11(6), 651–657.
- Lew, V. (2005). Summary of Energy Service Companies. Summary of Responses, California Energy Commission.
- Lin, J., Goldman, C., Levine, M., and Hopper, N. (2004). Developing an Energy Efficiency Service industry in Shanghai. Berkeley, California: Lawrence Berkeley National Laboratory.
- Mehta, C.R., and Patel, N.R. (1996). *SPSS Exact Test*, Marketing Department. Chicago, IL: SPSS Inc.
- Minenergo - Ministry of Energy of the Russian Federation. (2010). Государственная программа Российской Федерации “Энергосбережение и повышение энергетической

- эффективности на период до 2020 года” (Federal Program of the Russian Federation “On Energy Conservation and Improving Energy Efficiency up to 2020”). Russian Energy Agency (REA). Available at: <http://rosenergo.gov.ru/info/docs/> (accessed 5 November, 2011).
- Minenergo - Ministry of Energy of the Russian Federation. (2011). Федеральный закон №261 от 23.11.2009г. "Об энергосбережении и о повышении энергетической эффективности и о внесении изменений в отдельные законодательные акты Российской Федерации" (Federal Law No. 261-FZ “On Saving Energy and Increasing Energy Efficiency, and on Amendments to Certain Legislative Acts of the Russian Federation”). Available at: <http://minenergo.gov.ru/activity/energoeffektivnost/documents/> (accessed 10 December, 2011).
- Murakoshi, C., and Nakagami, H. (2009). Current State of ESCO Activities in Asia: ESCO Industry Development Programs and Future Tasks in Asian Countries. ECEE 2009 Summer Study – Act! Innovate! Deliver! Reducing Energy Demand Sustainably, 311-322.
- NAESCO - National Association of Energy Service Companies. (2011). What is an ESCO? Available at: <http://www.naesco.org/resources/esco.htm> (accessed 8 December, 2011).
- Nationmaster. (2011). English-speaking population. Available at: [http://www.nationmaster.com/graph/lan\\_eng\\_pop\\_tot-language-english-speaking-population-total](http://www.nationmaster.com/graph/lan_eng_pop_tot-language-english-speaking-population-total) (accessed 2 December, 2011).
- Okay, N., and Akman, U. (2010). Analysis of ESCO Activities Using Country Indicators. *Renewable & Sustainable Energy Reviews*, 14(9), 2760-2771.
- Osokina, I.V. (2004). Financing Energy Efficiency in the Russian Federation (FEER). Project Executive Summary, GEF International Work Program Submission, GEF Focal Point and Ministry of National Resources, March 19.
- Painuli, J.P., Park, H., Lee, M.-K., and Noh, J. (2003). Promoting Energy Efficiency Financing and ESCOs on Developing Countries: Mechanisms and Barriers. *Journal of Clean Production*, 11, 659-665.
- Pasick, R., Sabogal, F, Bird, J., D’Onofrio, C., Jenkins, C., Lee, M., Engelstad, L., and Hiatt, R. (1996). Problems and Progress in Translation of Health Survey Questions: the Pathways Experience. *Health Education Quarterly*, 23, 28-40.
- Porter, M.E. (1998). *Competitive Strategy*. Techniques for Analyzing Industries and Competitors. New York: The Free Press.

- Presser, S., Rothgeb, J.M., Couper, M.P., Lessler, J.T., Martin, E., Martin, J., and Singer, S. (2004). *Methods for Testing and Evaluating Survey Questionnaires (Wiley Series in Survey Methodology)*. New Jersey: A John Wiley & Sons, Inc., Publication, Hoboken.
- Rosstat - The Federal State Statistics Service. (2010). Степень износа основных фондов на конец года, (Level of the fixed assets' depreciation). Available at: [http://www.gks.ru/wps/wcm/connect/rosstat\\_main/rosstat/ru/statistics/enterprise/fund/](http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/enterprise/fund/) (accessed 1 November, 2011).
- Satchwell, A., Goldman, C., Larsen, P., Gilligan, D., and Singer, T. (2010). A Survey of the U.S. ESCO Industry: Market Growth and Development form 2008-2011. Berkeley, California: Lawrence Berkeley National Laboratory.
- Singer, T., and Lockhart, N. (2002). IEA DSM Task X – Performance Contracting. National Association of Energy Service Companies, *U.S. Country Report*, September, 1-50.
- Skribot, W. (2012). Personal communication, Managing director Energy & Infrastructure. Gazprombank, 5<sup>th</sup> April, 2012.
- Smith, T. (1988). The Ups and Downs of Cross-National Research Survey. *GSS Cross-National Report 8*. Chicago: National Opinion Research Center.
- Tull, D.S., and Hawkins, D.I. (1976). *Marketing Research: Measurement and Method*. New York: Macmillan.
- Ürge-Vorsatz, D., Köppel, S., Liang, C., Kiss, B., Nair, G.G., and Celikyilmaz, G. (2007). An Assessment of Energy Service Companies Worldwide. WEC ADEME Project on Energy Efficiency Policies, London: World Energy Council. Available at: [http://www.worldenergy.org/documents/esco\\_synthesis.pdf](http://www.worldenergy.org/documents/esco_synthesis.pdf) (accessed 5 November, 2011).
- Van Rensburg, J.F., Geysler, M.F., Kleingeld, M., and Mathews, E.H. (2008). Developing ESCO Procedures for Large Telecommunication Facilities Using Novel Simulation Techniques. *Journal of Energy in South Africa*, 19(1), 43-54.
- Vine, E. (2005). An International Survey of the Energy Service Company (ESCO) Industry. *Energy Policy*, 33(5), 691-704.
- Vine, E., Nakagami, H., and Murakoshi, C. (1999). The Evolution of the U.S. ESCO Industry: From ESCO to Super ESCO. *Energy*, 24(6), 479-492.
- Vine, E.L., Murakoshi, C., and Nakagami, H. (1998). International ESCO Business Opportunities and Challenges: A Japanese Case Study. *Energy*, 23(6), 439-447.
- WEEA - World Energy Efficiency Association (1999). Briefing Paper on Energy Services Companies with Directory of Active Companies (Revised Edition). Washington: World Energy Efficiency Association.

(The) World Bank. (2008). Energy Efficiency in Russia, Untapped Reserves. World Bank working paper No. 46936. The World Bank in Cooperation with International Finance Corporation (IFC).

Zaltman, G., and Burger, P.C. (1975). *Marketing Research: Fundamental and Dynamic*. Illinois: Dryden Press, Hinsdale.

## **Further reading**

Cudahy, R.D., Dressen, T.K. (1996). A Review of the Energy Service Company (ESCO) Industry in the United States. March 1996, The World Bank.

Evans, M. (2000). Tapping the Potential for Energy Efficiency: The Role of ESCOs in the Czech Republic, Ukraine and Russia. In: *Proceedings of the 2000 ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, DC: The American Council for an Energy-Efficient Economy, August.

Hunt, S.D., Sparkman, R.D., Wilcox, J.B. (1982). The Pretest in Survey Research: Issues and Preliminary Findings. *Journal of Marketing Research*, XIX(2), 269-273.

Jensen, J.O., Oesten, P., and Nielsen, S.B. (2010). ESCO as Innovative Facilities Management in Danish Municipalities. 9<sup>th</sup> EuroFM Research Symposium, EFMC, 1-2 June, Madrid, Spain, 1-12. Available at: [http://vbn.aau.dk/files/52279920/ESCO\\_Jensen\\_et\\_al.pdf](http://vbn.aau.dk/files/52279920/ESCO_Jensen_et_al.pdf) (accessed 10 February, 2012).

Kiss, B., Bertoldi, P., and Rezessy, S. (2007). Latest Development of the ESCO Industry Across Europe, European Council for an Energy Efficient Economy (ECEEE). Summer Study "Saving Energy – Just Do It!", 333-344.

Kostka, G., and Shin, K. (2011). Energy Service Companies in China: The Role of Social Networks and Trust. Working paper, Frankfurt School of Finance & Management, Frankfurt, 68, 1-38.

Naval Facilities Engineering Command (1998). A Guide for A/E Firms Performing Services for: Engineering Field Activity Chesapeake. Naval Facilities Engineering Command, Revised: October 1998, Washington, D.C.

Olivier, J.G.J, Janssens-Maenhout, G., Peters, J.A.H.W., and Wilson, J. (2011). Long-Term Trend in Global CO<sub>2</sub> Emissions. 2011 Report, The Hague: PBL/JRC. Available at: [http://edgar.jrc.ec.europa.eu/news\\_docs/C02%20Mondiaal\\_%20webdef\\_19sept.pdf](http://edgar.jrc.ec.europa.eu/news_docs/C02%20Mondiaal_%20webdef_19sept.pdf) (accessed 10 December, 2011).

Solanko, L. (2011). Why Energy Efficiency is Vitally Important for Russia. In International Association for Energy Economics (IAEE) Energy Forum, first quarter 2011, 19-22.

Tranfield, D., Denyer, D., and Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management*, 14, 207-222.

## Appendix

### Appendix 1: The U.S. ESCO industry evolution phases

Evolution phase	Main characteristics of the ESCO concept development in the U.S.
<b>I. Beginning of large-scale energy efficiency (EE)</b> (pre-1985)	<ul style="list-style-type: none"> <li>• Demand-side management (DSM) programs and increase of energy prices intensified utilities to implement EE technologies (Painuly et al., 2003)</li> <li>• <b>ESCO customers:</b> Utilities (utility program execution on the residential and institutional customers side) (Singer and Lockhart, 2002)</li> <li>• <b>Business model:</b> ESPCs as pre-ESCOs - subcontractors to utilities that provide auditing, program management, but rarely comprehensive services (Singer and Lockhart, 2002)</li> <li>• <b>Financial model:</b> Fee-for-services (Gilligan, 2011)</li> <li>• <b>M&amp;V model:</b> Providing services, not energy savings</li> </ul>
<b>II. Early ESCO experience</b> (1985-1995)	<ul style="list-style-type: none"> <li>• Industry size – \$1 billion in 1995, average growth rate of 26% in 90s (Goldman et al., 2005)</li> <li>• Authorization<sup>44</sup> of Energy Savings Performance Contracts<sup>45</sup></li> <li>• <b>ESCO customers:</b> Industrial sector, and later public sector</li> <li>• <b>Business model:</b> Service packages (comprehensive audit, design, implementation, maintenance, and financing) → first <b>EPC</b> (Singer and Lockhart, 2002)</li> <li>• <b>Financial model:</b> <ul style="list-style-type: none"> <li>- Utilities pay ESCOs 80-100% of EE project costs (&lt; building a new power plants)</li> <li>- Shared savings, introduction of guaranteed savings</li> <li>- Increased interest of banks and specialized financial companies</li> </ul> </li> <li>• <b>M&amp;V model:</b> Emulation of utility metering, ESCO-proprietary spreadsheets, National Association of Energy Service Companies (NAESCO), US Department of Energy (DOE)</li> </ul>

<sup>44</sup> Federal agencies were authorized to enter into Energy Service Performance Contracts with ESCOs (amendment to the National Energy Conservation Policy Act, 1992). ESCOs were paid with a defined share of any resulting energy cost savings from privately financed and installed energy conservation measures in federal buildings and facilities (Andrews, 2004).

<sup>45</sup> In this research paper, no abbreviation for Energy Service Performance Contracts (ESPCs) is used in order to avoid confusion with the abbreviation of Energy Service Providing Companies (ESPCs).

<b>III. Consolidation and growth</b> (1995-2000)	<ul style="list-style-type: none"> <li>• Industry size - \$2 billion in 2000<sup>46</sup>, the average growth rate is 9% (Goldman et al., 2005)</li> <li>• Consolidation of independent ESCOs by utilities and other companies</li> <li>• <b>Business model:</b> formation of SuperESCOs<sup>47</sup>; EPC has been declining in its market share<sup>48</sup></li> <li>• <b>Financial model:</b> Guaranteed savings dominate<sup>49</sup></li> </ul>
<b>IV. Setbacks</b> (2000-2004)	<ul style="list-style-type: none"> <li>• Industry size – \$2 billion in 2004, the average growth rate is 3%<sup>50</sup> (Hopper et al., 2007)</li> <li>• <b>Problems</b> (Hopper et al., 2007): <ul style="list-style-type: none"> <li>- Deregulation of the electricity market → stalled retail competition → utility-owned ESCOs or in-house ESCOs are negatively affected</li> <li>- Enron collapse → debt classification in EPC (off-balance-sheet financing) is questioned</li> <li>- Industry consolidation (buyouts and mergers of ESCOs)</li> </ul> </li> </ul>
<b>V. Growth and new services</b> (2004-present)	<ul style="list-style-type: none"> <li>• Industry size - \$5 billion in 2011<sup>51</sup>, average growth rate of 20% in 2004-2006 (Hopper et al., 2007)</li> <li>• Expenditures on energy efficiency by utilities are kept growing</li> <li>• Aggressive EE goals of the U.S. Congress in 2005</li> <li>• <b>ESCO's new customers:</b> public buildings (energy savings mandates, pay for capital improvements with energy savings; long payback horizons)</li> <li>• <b>Business model:</b> <ul style="list-style-type: none"> <li>- New services (e.g. distributed generation, renewable energy, build-own operate generation facilities, street lighting, water meters combining commodity procurement with energy price risk and energy efficiency management in a bundled product</li> <li>- ESCOs are increasingly moving away from EPC (Goldman et al., 2005)</li> </ul> </li> <li>• <b>Technologies used by ESCOs (e.g.):</b> <ul style="list-style-type: none"> <li>- EE technologies - 75% of ESCO industry revenues 2008 (\$3.0 billion per year)</li> <li>- Onsite renewable generation - 14% of ESCO industry revenues in 2008 (\$570 million)</li> </ul> </li> <li>• <b>Problems affecting ESCO industry:</b> <ul style="list-style-type: none"> <li>- Finance industry instability and number of reforms in accounting treatment of leases</li> <li>- Continued education is required</li> </ul> </li> </ul>

Sources: Own representation based on Andrews (2004), Gilligan (2011), Goldman et al. (2005), Hopper et al. (2007), Painuly et al. (2003), Satchwell et al. (2010), and Singer and Lockhart (2002)

<sup>46</sup> Goldman et al. (2005) identify 63 regional and national companies that offer EPC, most of which are registered in NAESCO's voluntary accreditation program's database. In order to estimate ESCO market activity, the authors consider revenues from energy efficiency and other value-added services and exclude revenues from electric or gas commodity procurement. The estimated market size for EPC services was \$0.9-1.2 billion in 2000.

<sup>47</sup> A SuperESCO is a fully integrated ESCO that provides energy efficiency services and delivers fuels (e.g. gas, electricity) (Painuly et al., 2003; Vine et al., 1999).

<sup>48</sup> According to Goldman et al. (2005), the U.S. ESCO business model has been undergoing structural changes, such as: declining market share of EPC projects (even though, the performance-contracting projects has been getting larger in their size) by switching to a design/build, fee-for-service bases, and offering additionally consulting or information services; enlarging scope of activities by entering "...restructured electricity and natural gas markets, combining commodity procurement with energy price risk management and energy-efficiency services as a single, bundled product" (Goldman et al., 2005, p.389); decreasing duration of projects.

<sup>49</sup> Guaranteed savings are the dominant contractual form in the U.S. for the following reasons: generally, higher qualification of a third party financier than of an ESCO; a project debt is not denoted on the balance sheet of a customer, which, however, is intensified to resolve the on-going project issues as it bears the on-going debt service obligations.

<sup>50</sup> Hopper et al. (2007) estimate the size of the U.S. ESCO industry by means of the "top-down" approach: identification of active ESCOs followed by evaluation of the corresponding project details.

<sup>51</sup> Satchwell et al. (2010) estimate the U.S. ESCO industry revenues in 2008 at about \$4.1 billion (lower than the projected revenues of \$5.2-5.5 billion by Hopper et al., 2007). The projected annual growth rate of the U.S. ESCO industry revenues was 26% in 2009-2011 (Satchwell et al., 2010, p.6), and 7% in 2006-2008 (Satchwell et al., 2010, p.5).



E.ON Energy Research Center



## List of FCN Working Papers

### 2012

- Ghosh G., Shortle J. (2012). Managing Pollution Risk through Emissions Trading, FCN Working Paper No. 1/2012, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, January.
- Palzer A., Westner G., Madlener M. (2012). Evaluation of Different Hedging Strategies for Commodity Price Risks of Industrial Cogeneration Plants, FCN Working Paper No. 2/2012, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, March.
- Sunak Y., Madlener R. (2012). The Impact of Wind Farms on Property Values: A Geographically Weighted Hedonic Pricing Model, FCN Working Paper No. 3/2012, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, May.
- Achtnicht M., Madlener R. (2012). Factors Influencing German House Owners' Preferences on Energy Retrofits, FCN Working Paper No. 4/2012, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, June.
- Schabram J., Madlener R. (2012). The German Market Premium for Renewable Electricity: Profitability and Risk of Self-Marketing, FCN Working Paper No. 5/2012, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, July.
- Garbuzova M., Madlener R. (2012). Russia's Emerging ESCO Market: Prospects and Barriers for Energy Efficiency Investments, FCN Working Paper No. 6/2012, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, July (revised September 2012).

### 2011

- Sorda G., Sunak Y., Madlener R. (2011). A Spatial MAS Simulation to Evaluate the Promotion of Electricity from Agricultural Biogas Plants in Germany, FCN Working Paper No. 1/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, January.
- Madlener R., Hauertmann M. (2011). Rebound Effects in German Residential Heating: Do Ownership and Income Matter?, FCN Working Paper No. 2/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, February.
- Garbuzova M., Madlener R. (2011). Towards an Efficient and Low-Carbon Economy Post-2012: Opportunities and Barriers for Foreign Companies in the Russian Market, FCN Working Paper No. 3/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, February (revised July 2011).
- Westner G., Madlener R. (2011). The Impact of Modified EU ETS Allocation Principles on the Economics of CHP-Based District Heating Networks. FCN Working Paper No. 4/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, February.
- Madlener R., Ruschhaupt J. (2011). Modeling the Influence of Network Externalities and Quality on Market Shares of Plug-in Hybrid Vehicles, FCN Working Paper No. 5/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, March.
- Juckenack S., Madlener R. (2011). Optimal Time to Start Serial Production: The Case of the Direct Drive Wind Turbine of Siemens Wind Power A/S, FCN Working Paper No. 6/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, March.
- Madlener R., Sicking S. (2011). Assessing the Economic Potential of Microdrilling in Geothermal Exploration, FCN Working Paper No. 7/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, April.

- Bernstein R., Madlener R. (2011). Responsiveness of Residential Electricity Demand in OECD Countries: A Panel Cointegration and Causality Analysis, FCN Working Paper No. 8/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, April.
- Michelsen C.C., Madlener R. (2011). Homeowners' Preferences for Adopting Residential Heating Systems: A Discrete Choice Analysis for Germany, FCN Working Paper No. 9/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, May (revised January 2012).
- Madlener R., Glensk B., Weber V. (2011). Fuzzy Portfolio Optimization of Onshore Wind Power Plants. FCN Working Paper No. 10/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, May.
- Glensk B., Madlener R. (2011). Portfolio Selection Methods and their Empirical Applicability to Real Assets in Energy Markets. FCN Working Paper No. 11/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, May.
- Kraas B., Schroedter-Homscheidt M., Pulvermüller B., Madlener R. (2011). Economic Assessment of a Concentrating Solar Power Forecasting System for Participation in the Spanish Electricity Market, FCN Working Paper No. 12/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, May.
- Stocker A., Großmann A., Madlener R., Wolter M.I., (2011). Sustainable Energy Development in Austria Until 2020: Insights from Applying the Integrated Model "e3.at", FCN Working Paper No. 13/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, July.
- Kumbaroğlu G., Madlener R. (2011). Evaluation of Economically Optimal Retrofit Investment Options for Energy Savings in Buildings. FCN Working Paper No. 14/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, September.
- Bernstein R., Madlener R. (2011). Residential Natural Gas Demand Elasticities in OECD Countries: An ARDL Bounds Testing Approach, FCN Working Paper No. 15/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, October.
- Glensk B., Madlener R. (2011). Dynamic Portfolio Selection Methods for Power Generation Assets, FCN Working Paper No. 16/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Michelsen C.C., Madlener R. (2011). Homeowners' Motivation to Adopt a Residential Heating System: A Principal-Component Analysis, FCN Working Paper No. 17/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Razlaf J., Madlener R. (2011). Performance Measurement of CCS Power Plants Using the Capital Asset Pricing Model, FCN Working Paper No. 18/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Himpler S., Madlener R. (2011). Repowering of Wind Turbines: Economics and Optimal Timing, FCN Working Paper No. 19/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Hackbarth A., Madlener R. (2011). Consumer Preferences for Alternative Fuel Vehicles: A Discrete Choice Analysis, FCN Working Paper No. 20/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December.
- Heuser B., Madlener R. (2011). Geothermal Heat and Power Generation with Binary Plants: A Two-Factor Real Options Analysis, FCN Working Paper No. 21/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December.
- Rohlf W., Madlener R. (2011). Multi-Commodity Real Options Analysis of Power Plant Investments: Discounting Endogenous Risk Structures, FCN Working Paper No. 22/2011, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December (revised July 2012).

## 2010

- Lang J., Madlener R. (2010). Relevance of Risk Capital and Margining for the Valuation of Power Plants: Cash Requirements for Credit Risk Mitigation, FCN Working Paper No. 1/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, February.
- Michelsen C.C., Madlener R. (2010). Integrated Theoretical Framework for a Homeowner's Decision in Favor of an Innovative Residential Heating System, FCN Working Paper No. 2/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, February.
- Harmsen - van Hout M.J.W., Herings P.J.-J., Dellaert B.G.C. (2010). The Structure of Online Consumer Communication Networks, FCN Working Paper No. 3/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, March.
- Madlener R., Neustadt I. (2010). Renewable Energy Policy in the Presence of Innovation: Does Government Pre-Commitment Matter?, FCN Working Paper No. 4/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, April (revised June 2010 and December 2011).
- Harmsen-van Hout M.J.W., Dellaert B.G.C., Herings, P.J.-J. (2010). Behavioral Effects in Individual Decisions of Network Formation: Complexity Reduces Payoff Orientation and Social Preferences, FCN Working Paper No. 5/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, May.
- Lohwasser R., Madlener R. (2010). Relating R&D and Investment Policies to CCS Market Diffusion Through Two-Factor Learning, FCN Working Paper No. 6/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, June.
- Rohlf W., Madlener R. (2010). Valuation of CCS-Ready Coal-Fired Power Plants: A Multi-Dimensional Real Options Approach, FCN Working Paper No. 7/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, July.
- Rohlf W., Madlener R. (2010). Cost Effectiveness of Carbon Capture-Ready Coal Power Plants with Delayed Retrofit, FCN Working Paper No. 8/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, August (revised December 2010).
- Gampert M., Madlener R. (2010). Pan-European Management of Electricity Portfolios: Risks and Opportunities of Contract Bundling, FCN Working Paper No. 9/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, August.
- Glensk B., Madlener R. (2010). Fuzzy Portfolio Optimization for Power Generation Assets, FCN Working Paper No. 10/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, August.
- Lang J., Madlener R. (2010). Portfolio Optimization for Power Plants: The Impact of Credit Risk Mitigation and Margining, FCN Working Paper No. 11/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, September.
- Westner G., Madlener R. (2010). Investment in New Power Generation Under Uncertainty: Benefits of CHP vs. Condensing Plants in a Copula-Based Analysis, FCN Working Paper No. 12/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, September.
- Bellmann E., Lang J., Madlener R. (2010). Cost Evaluation of Credit Risk Securitization in the Electricity Industry: Credit Default Acceptance vs. Margining Costs, FCN Working Paper No. 13/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, September (revised May 2011).
- Ernst C.-S., Lunz B., Hackbarth A., Madlener R., Sauer D.-U., Eckstein L. (2010). Optimal Battery Size for Serial Plug-in Hybrid Vehicles: A Model-Based Economic Analysis for Germany, FCN Working Paper No. 14/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, October (revised June 2011).
- Harmsen - van Hout M.J.W., Herings P.J.-J., Dellaert B.G.C. (2010). Communication Network Formation with Link Specificity and Value Transferability, FCN Working Paper No. 15/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Paulun T., Feess E., Madlener R. (2010). Why Higher Price Sensitivity of Consumers May Increase Average Prices: An Analysis of the European Electricity Market, FCN Working Paper No. 16/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.

- Madlener R., Glensk B. (2010). Portfolio Impact of New Power Generation Investments of E.ON in Germany, Sweden and the UK, FCN Working Paper No. 17/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Ghosh G., Kwasnica A., Shortle J. (2010). A Laboratory Experiment to Compare Two Market Institutions for Emissions Trading, FCN Working Paper No. 18/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Bernstein R., Madlener R. (2010). Short- and Long-Run Electricity Demand Elasticities at the Subsectoral Level: A Cointegration Analysis for German Manufacturing Industries, FCN Working Paper No. 19/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Mazur C., Madlener R. (2010). Impact of Plug-in Hybrid Electric Vehicles and Charging Regimes on Power Generation Costs and Emissions in Germany, FCN Working Paper No. 20/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Madlener R., Stoverink S. (2010). Power Plant Investments in the Turkish Electricity Sector: A Real Options Approach Taking into Account Market Liberalization, FCN Working Paper No. 21/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December (revised July 2011).
- Melchior T., Madlener R. (2010). Economic Evaluation of IGCC Plants with Hot Gas Cleaning, FCN Working Paper No. 22/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December.
- Lüschen A., Madlener R. (2010). Economics of Biomass Co-Firing in New Hard Coal Power Plants in Germany, FCN Working Paper No. 23/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December (revised July 2012).
- Madlener R., Tomm V. (2010). Electricity Consumption of an Ageing Society: Empirical Evidence from a Swiss Household Survey, FCN Working Paper No. 24/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December.
- Tomm V., Madlener R. (2010). Appliance Endowment and User Behaviour by Age Group: Insights from a Swiss Micro-Survey on Residential Electricity Demand, FCN Working Paper No. 25/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December.
- Hinrichs H., Madlener R., Pearson P. (2010). Liberalisation of Germany's Electricity System and the Ways Forward of the Unbundling Process: A Historical Perspective and an Outlook, FCN Working Paper No. 26/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December.
- Achtnicht M. (2010). Do Environmental Benefits Matter? A Choice Experiment Among House Owners in Germany, FCN Working Paper No. 27/2010, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December.

## 2009

- Madlener R., Mathar T. (2009). Development Trends and Economics of Concentrating Solar Power Generation Technologies: A Comparative Analysis, FCN Working Paper No. 1/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November (revised September 2010).
- Madlener R., Latz J. (2009). Centralized and Integrated Decentralized Compressed Air Energy Storage for Enhanced Grid Integration of Wind Power, FCN Working Paper No. 2/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November (revised September 2010).
- Kraemer C., Madlener R. (2009). Using Fuzzy Real Options Valuation for Assessing Investments in NGCC and CCS Energy Conversion Technology, FCN Working Paper No. 3/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Westner G., Madlener R. (2009). Development of Cogeneration in Germany: A Dynamic Portfolio Analysis Based on the New Regulatory Framework, FCN Working Paper No. 4/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November (revised March 2010).
- Westner G., Madlener R. (2009). The Benefit of Regional Diversification of Cogeneration Investments in Europe: A Mean-Variance Portfolio Analysis, FCN Working Paper No. 5/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November (revised March 2010).

- Lohwasser R., Madlener R. (2009). Simulation of the European Electricity Market and CCS Development with the HECTOR Model, FCN Working Paper No. 6/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Lohwasser R., Madlener R. (2009). Impact of CCS on the Economics of Coal-Fired Power Plants – Why Investment Costs Do and Efficiency Doesn't Matter, FCN Working Paper No. 7/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Holtermann T., Madlener R. (2009). Assessment of the Technological Development and Economic Potential of Photobioreactors, FCN Working Paper No. 8/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Ghosh G., Carriazo F. (2009). A Comparison of Three Methods of Estimation in the Context of Spatial Modeling, FCN Working Paper No. 9/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Ghosh G., Shortle J. (2009). Water Quality Trading when Nonpoint Pollution Loads are Stochastic, FCN Working Paper No. 10/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Ghosh G., Ribaudo M., Shortle J. (2009). Do Baseline Requirements hinder Trades in Water Quality Trading Programs?, FCN Working Paper No. 11/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.
- Madlener R., Glensk B., Raymond P. (2009). Investigation of E.ON's Power Generation Assets by Using Mean-Variance Portfolio Analysis, FCN Working Paper No. 12/2009, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, November.

## 2008

- Madlener R., Neustadt I., Zweifel P. (2008). Promoting Renewable Electricity Generation in Imperfect Markets: Price vs. Quantity Policies, FCN Working Paper No. 1/2008, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, July (revised November 2011).
- Madlener R., Wenk C. (2008). Efficient Investment Portfolios for the Swiss Electricity Supply Sector, FCN Working Paper No. 2/2008, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, August.
- Omann I., Kowalski K., Bohunovsky L., Madlener R., Stagl S. (2008). The Influence of Social Preferences on Multi-Criteria Evaluation of Energy Scenarios, FCN Working Paper No. 3/2008, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, August.
- Bernstein R., Madlener R. (2008). The Impact of Disaggregated ICT Capital on Electricity Intensity of Production: Econometric Analysis of Major European Industries, FCN Working Paper No. 4/2008, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, September.
- Erber G., Madlener R. (2008). Impact of ICT and Human Skills on the European Financial Intermediation Sector, FCN Working Paper No. 5/2008, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, September.

FCN Working Papers are free of charge. They can mostly be downloaded in pdf format from the FCN / E.ON ERC Website ([www.eonerc.rwth-aachen.de/fcn](http://www.eonerc.rwth-aachen.de/fcn)) and the SSRN Website ([www.ssrn.com](http://www.ssrn.com)), respectively. Alternatively, they may also be ordered as hardcopies from Ms Sabine Schill (Phone: +49 (0) 241-80 49820, E-mail: [post\\_fcn@eonerc.rwth-aachen.de](mailto:post_fcn@eonerc.rwth-aachen.de)), RWTH Aachen University, Institute for Future Energy Consumer Needs and Behavior (FCN), Chair of Energy Economics and Management (Prof. Dr. Reinhard Madlener), Mathieustrasse 10, 52074 Aachen, Germany.