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National Case Study (Russian Federation):

"Realization of Energy Efficiency Lighting Systems in Moscow, Moscow region and Nizhniy Novgorod region"

Project "Financing Energy Efficiency Investments for Climate Change Mitigation"

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Acronyms

AdCom: Advisory Committee
CFL: Compact Fluorescent Lamp
CIE: International Commission on Illumination
CIS: Commonwealth of Independent States
DSM: Demand Side Management
EBRD: European Bank for Restructuration and Development
EE: Energy-Efficient
EEL: Energy-Efficient Lighting
EuP: Energy Using Products
ESCO: Energy Service Company
FEELC: Federal Energy Efficient Lighting Council
FSU: Former Soviet Union
GDP: Gross Domestic Product
GEF: Global Environment Facility
GHG: Greenhouse Gas
GLS: General Lighting System (incandescent lamp)
IEA: International Energy Agency
IFC: International Finance Corporation
JSC: Joint Stock Companies
LED: Light Emitting Diode
M&E: Monitoring and Evaluation
NPL: National Platform for Lighting
OECD: Organization for Economic Cooperation and Development
RTD: Research and Technological Development
SE: Software Engineering
SC: Steering Committee
SSL: Solid State Lighting
TT: Technical Task
UNFCCC: United Nations Framework Convention on Climate Change
UNDP: United Nations Development Program
UNEP: United Nations Environmental Program

Part 1. A. SECTOR CHARACTERISTICS BEFORE THE POLICY REFORMS: Current Status of Energy Efficient Lighting in the Russian Federation

The current development status of Russia's light engineering industry is determined by the fact that at the beginning of the 90s the state completely gave up the issues of regulation of domestic lighting equipment market, granting it all the rights, including those related to engineering policy, energy efficiency and, as a matter of fact, to all aspects of security, which led to the total lack of control, permissiveness and irresponsibility for manufacture, purchase and sales of poor quality products. The country is lacking programs of scientific, industrial and market development on the national, regional and municipal level. The existing Law on Technical Regulation in Russia was adopted in December 2002. This Law provides for consideration of legitimate interests of all organizations concerned in the process of standards development and will undoubtfully have an impact on new standards developed in the area of light engineering. Under the priority area 'Energy and Energy Saving' of the Federal Target Program 'R&D in Priority Fields of Russia's Science and Technological Complex Development for 2007-2012', several research projects focused on the development of state-of-the-art high performance lighting equipment are underway. In selected Russian regions (Moscow city, Moscow region, Nizhniy Novgorod region) the energy saving programs contain sections dealing with the improvement of exterior and architectural lighting of the regions' cities. The issues of exterior lighting in major cities are dealt with by special municipal 'Gorsvet' enterprises and in small and medium-sized towns — by utility companies responsible for all municipal issues, including water supply, heating, urban waste collection, etc.

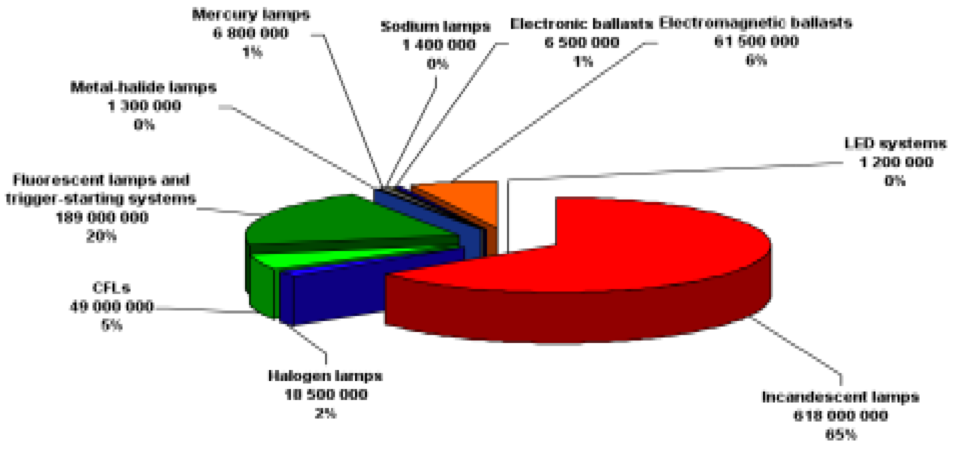
In 2007, annual power demand for lighting 57.5 TW, corresponding to electricity consumption of 137.5 TWh, or 14% of national electricity consumption, and to annual CO_2 emission of 69 Mtn. Table 1 shows energy consumption for lighting by economic sector as well as estimation for energy saving potential. The total lighting energy savings potential in Russia is enormous: 57 TWh per annum which is equivalent to approximatly 28.5 Mtn CO_2 per annum. Commercial and industrial buildings account for more than 50% of lighting energy consumption.

Table 1: Russian lighting consumption and technical potential for energy savings, by sector

Group of lighting equipment	Established capacity, (GW)	Electric energy consumption, (GWh/year)	Potential energy saving, GW*h per year	Released capacity, GW
Industry and commercial buildings	28	85 000	30 000	10
Public, educational and state buildings	8	12 000	5 000	3
Street lighting	1.5	4 500	2 000	0.7
Residential sector (private sector)	15	20 000	13 000	10
Agricultural sector, including population.	5	16 000	7 000	2.5
Total	**57.5**	**137 500**	**57 000**	**26.2**

Today, the Russian Federation has an estimated 1-1.2 billion lighting points. The light source technology used breakdown as shown in Figure 1.

Figure 1: Light sources technologies used in Russia (in number of units)



The breakdown by sector is as follows:

- Residential sector: about 97% incandescent lamps (GLS, with an 75W average power); 2.7% linear fluorescent lamps (mainly T12) and 0.3% compact fluorescent lamps CFL;[1]
- Administrative, educational and commercial buildings: 96.2% linear fluorescent lamps (T12 and T8)[2], 3.3 % incandescent lamps.
- Industrial buildings: 45-50% linear fluorescent lamps (T12 and T8) with electromagnetic ballasts; 10-20% incandescent lamps; 35% other discharge lamps (mainly mercury HID
- Street lighting in urban environment: 30% mercury HID lamps and 60% high-pressure sodium. Metal halide lamps are used in well-developed regions. However, incandescent lamps are still used in economically weak regions.
- Agriculture (including house lighting in remote areas): 67% high pressure HID lamps (mainly mercury); 12% Linear Fluorescent lamps (T12) and 10% incandescent lamps (mainly for homes)

It could be further qualified the installed lighting base as follows:

- The share of lighting from incandescent lamps is in the order of 35%, whereas in the Western countries it does not exceed 20%;
- The generation of 1 Mlm h of light flux requires 36 kWh in Russia whereas this value is as low as 25-26 kWh in Western countries;
- In the residential sector the penetration rate (0.3%) of energy efficient light sources (CFLs) is very low compared to any other western country.
- In the tertiary sector the penetration of T5 technology is almost negligible (it seams that there is a severe procurement problem with T5 lamps in the Russian market: there are present in product lists but almost impossible to supply[3]). The T8 (and older T12) lamps used are still first or second generation products, whereas in western countries third and fourth generations are used;
- In public buildings the level of power for lighting is in the order of 7 W/m^2 per 100 lux in the working space, when in western countries this amount is about 2.5 W/m^2/100 lx;
- Lighting control systems that are today widely used in western countries are almost absent from the market.
- Electronic ballasts for linear fluorescent lamps are almost absent from the market.

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[1] As example: there is about 3 700 000 flats in Moscow, each flat is usually equipped with 15 incandescent lamps. The average luminous efficacy of the sector is less than 15 lm/W.

[2] The ballasts used impose an additional 20% energy loss and high-pressure sodium);

[3] For the moment it was not possible to identify the real causes of this procurement problem.

1. B. Situation of Russian Lighting Market

In 2008 the Russian market for lighting is estimated to be in the order of 1.6 billion Euros: 1.1 billion for lighting systems and fixtures and 0.5 billion Euros for light sources. Expenditure par capita and per annum for purchasing lamps in Russia is in the order of 2.28 €, while in Europe this figure is in the order of 7.5 € and 15.6€ in Japan.

The national lighting industry is declining. All in all, in 2007 the national production volume was estimated at 639 million lamps. Today, the national lighting industry produces in large majority incandescent lamps, some linear fluorescent lamps (T12, T10 and T8) and high-pressure mercury lamps. In parallel with the decline of national production, there has been a constant influx of imported products. The value of imports of electrical lamps in Russia is increasing. In 2003 lighting imports were valued at US$ 30.8 million in 2006 this grew to US$ 87 million, and was over US$ 154 million in 2008. This represents a five-fold increase in five years.

Supply of Energy-Efficient Lighting technologies is currently limited in Russia. Only two factories in Russia produce fluorescent bulbs: LISMA Lighting and Smolensk-Svet. Although all technologies are available in principle, there is virtually no domestic production of the most efficient technologies and supply is inadequate if market demand increases to the levels envisaged with this project. Manufacturers have indicated an interest in supplying more efficient lighting, but are yet to decide whether this supply should come from domestic production, international joint-ventures, or imports.

1. C. Project Goal and Objective

A project has been selected and formulated on the basis of the results that have been achieved after realization of three local projects in the Nizhniy Novgorod region to be described in the Part III of the study. The objective of the selected project is to transform the national market for efficient lighting and to phase-out inefficient lighting, and reducing national GHG emissions. All lighting sectors are concerned: household, health and education buildings, and street lighting.

The main project goal is to promote efficient lighting technologies (CFLs, T5 & T8 linear Fluorescent lamps with electronic ballasts, Ceramic Metal Halide lamps, centralized control systems, efficient fixtures and LED) and to modernizing state regulations, standards and their respective enforcement mechanisms in order to transform the national lighting market. The project will contribute also to phasing-out inefficient lighting technologies (bulbs, fixtures and ballasts).

The main advantage of regulation compared with other measures is its higher certainty of outcome. With adequate monitoring and enforcement, regulations can ensure that lower-efficiency products are excluded from the market, thereby guaranteeing an energy-efficiency improvement. This certainty of outcome leads to an advantage in terms of cost-effectiveness because regulations are generally cheap to establish and maintain compared to the value of the energy savings they induce.

To achieve this ambitious goal, the project will promote high quality efficient Lighting systems based on widely accessible arguments, training, socio-economic knowledge, standardization, extra legislation and incisive. The following “fishbone” graphics illustrates all the above issues.

While it is not realistic to assume that a single project can transform the market of a large, complex country like Russia, the project will make sure that:

- at the federal level, instruments and policy frameworks are introduced to initiate and facilitate a market transformation;
- efforts are made to support the private sector to increase supply of EE equipment. This support will consider different options including international joint ventures and improved domestic production.

On the top of this, the project will communicate the benefits of lighting energy efficiency programs nationwide.

The selected project co-funded by GEF, the government, private sector and international partners. Obtaining co-funding support from non-traditional sources is also a key to the project's future effectiveness and so pilot sites were chosen in part based upon the level of promise or success to date in sourcing this kind of funding or support.

The total cost of the projects: 72,750,000$; GEF as co-financing has provided 7,020,000$; the central government-20,000,000$; regional governments: Moscow-11,950,000$, Nizhniy Novgorod-12,800,000$; private sector and international investors-20,980,000$

1. D. Barrier analysis

In Russia, the legacy of the old central planning system on the country's emerging market economy is particularly evident in its use of energy. This leads to a number of barriers to the uptake of energy-efficient lighting, including:

Barriers linked to regulation and its enforcement

- Regulation: In Russia the design of indoor lighting systems is carried out according to the requirements of SNIP (Construction Norms and Regulations). SNiP 23-05-95 (7.5.1: lighting of public, residential and service buildings) imposes 7 to 10 $W/m^2/100lx$ for energy consumption for lighting. Incandescent lamps are allowed for architectural lighting and in locations with explosion hazard. Beyond SNIP no other text imposes limits for luminous efficacy of lighting systems. The existing technical standards for energy efficiency for buildings are very poor compared to any other western country and this creates no incentives for production or sales of highly efficient lighting products. For example, in the European Union the new EuP directive imposes minimum efficacy levels for lighting systems following a distinction between "clear" and "frost" lamps. EuP is a directive and thus compulsory. In US Energy Star label limits the luminous efficacy as function of the total luminous flux. Energy Star is a voluntary label. In France the directive RT2005 (under revision now) imposes a maximum energy use for lighting in non-residential buildings (e.g. for office spaces, schools, hospitals, hotels the lighting consumption should be less than 12 W/m^2 or 2.5-4 W/m^2/100lx). RT2005 is compulsory in France and is a pre-conditions for the delivery of building permit;

- Enforcement: Russia currently has no enforcement regarding energy efficiency of lighting systems. The only lighting characteristic that can be verified by law in non-residential buildings is the level of illumination in the workplace as imposed by CIE recommendations (this test can be carried-out by health authorities).
- Certification: There are no mandatory tests for energy efficacy and lighting system quality. Russia has no system of mandatory energy efficiency labeling for lighting equipment that would facilitate the enforcement and compliance check[4].
- Coordination: Unlike other countries, Russia does not have an institutional body to coordinate lighting activities. Lack of coordination is an important barrier for implementing any EEL scheme in a large country like Russia. Usually, these bodies play a role for normalization and serve as advisors for other executive institutions. These organisms are either autonomous or attached to national energy agencies and/or ministries.

Barriers linked to education and awareness

Domestic lighting

- Consumers are typically not aware of energy saving potential of CFLs. This makes it difficult to convince individuals that replace an incandescent bulb by an equivalent good quality CFL has a payback time of 20-22 months[5].
- Payback time in Russia is rather long. This is due to the fact that kWh price in Russia is in the order of 3 rubbles (7 eurocents) when in other western countries this ranges from 10 to 15 eurocents/kWh[6]. In addition good quality EELs are very expensive compared to existing GLS.
- End-users typically cannot distinguish low and high quality CFLs. To our knowledge there is no specific study in Russia on that subject, but systematic inquiries in other countries (e.g. EnERLIn project in 14 EU countries[7]) shown that without the benefit of a public education campaign, consumers were unaware of CFL quality issues.
- Many Russians are still unaware of the environmental and economic benefits of efficient lighting. A recent poll[8] based on a large Moscow population sample found that 46.1% of people consider that lighting energy savings are unimportant. In addition, the same poll showed that only 12.8% of the participating population recognize the problem and have installed energy saving lamps at home. The following graphic illustrates the situation:

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[4] For example Europe and many other countries worldwide use the Energy Label with classes ranging from A to G (compulsory in EU), and the US adopted the voluntary “Energy Star” label. Some countries adapted the “GreenLight” label to lighting (in all cases on voluntary basis)

[5] According to the product installed, its price, and electricity retail price in Russia

[6] On 05 May, 2008 Federal Tariffs Service (FTS) approved marginal levels of the increase of energy tariffs for the year 2009. Overall in Russia the increase will come to 19%, as it was indicated in the forecast of social and economic development of the country. In the regions the increase will vary from 10% to 26%. It’s planned that in 2010 and 2011 the tariffs will increase too (the growth of tariffs will be higher than inflation rate).

[7] European project EnERLIn EIE-05-0176 http://www.enerlin.enea.it

[8] Conducted by Moscow State Institute of Economics, Statistics and Informatics

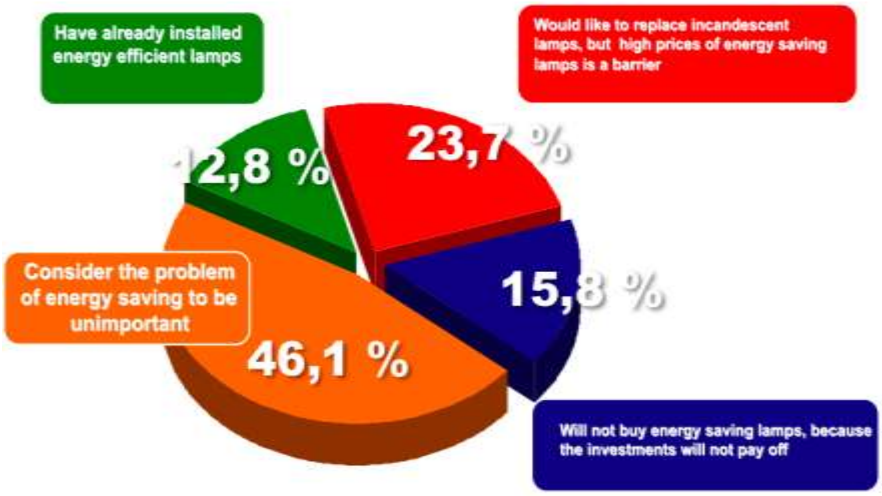

Figure 3: Answers of residential end-users concerning the reasons that aren't using CFLs at home. Source: Moscow state institute of economics, statistics and informatics, 2008

Non-domestic lighting

- Lack of energy management expertise and practices, especially in the national industries and municipal sector (this includes administrations, education, health buildings), in the private tertiary sector (commercial buildings, stores, etc.) the situation is better;
- Lack of prioritization of energy saving investments, especially in the corporate sector. Businesses typically seek to improve profits by raising production rather than cutting costs;
- Ineffective interaction of top management and technical specialists. Decisions concerning energy efficiency are not applied because technical staff lacks knowledge on new technologies. Proposals that do come from technical services may be completely ignored by decision makers because they are not aware about energy saving needs.
- The majority of designers and architects plan lighting without taking into consideration quality parameters of the system, and the existing SNiP[9] (7-10 $W/m^2/100lx$) levels are very often ignored. At present it isn't possible to quantify the compliance rate with certitude. This is because there is not mandatory verification of energy efficacy of lighting. As has been mentioned above, authorities can only audit the illumination level of the work spaces.

Barriers linked to price, quality and other technical issues

- Energy efficient solutions are expensive in Russia and more especially for individual end-users. Today Russian consumers can find CFLs at prices ranging from 100 up to 400 rubles[10]. This is still high when the average price for an incandescent lamp is 15-20 rubles. Low-cost energy saving lamps can be found in the Russian markets. These low-cost lamps mainly come from the black market and while it is hard to know the exact quantities, it is clear that the quality is generally quite low. Customers buying these lamps due to the attractive price are rapidly disappointed due to reduced lifetime, poor lumen output due to wrong information from manufactures about how to replace incandescent, and bad lumen maintenance of these lamps.
- The quality of CFL products is not constant. The "quality" is measured here by the lifetime (a good CFL typically has a rated lifetime of 6000 h life, a low quality lamp has a shorter lifetime and limited reliability), color stability with ageing, power factor (a good CFL has a power factor in the order of 0.9, in comparison to 0.4-0.6 for a low quality lamp), mercury dose (a good CFL has less than 5mg of Hg, whereas a low quality lamps has more than 20 mg).

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[9] Building Code SNiP 23-05-95 with amendment 'Natural and artificial lighting' approved by the Resolution of Gosstroy (the RF State Construction Committee) of May 29, 2003, No 44.
[10] 100 roubles correspond to imported brands from Asiatic countries that can be got from internet sale whereas high-end prices correspond to higher wattages (e.g. 20 W) got from specialised stores. Average value is around 250 rubbles (IKEA).

- Lack of technical supervision of import commodities led to flooding of the domestic market with lighting products of dubious quality, coming from both legal imports and an important shadow market.
- CFL lamps are very sensitive to voltage variation. In principle in large Russian cities the mains voltage is very well regulated (less than ±10%), but the situation is completely different in rural areas.

Part II. POLICY REFORMS

2. A. POLICY REFORMS TO ATTRACT INVESTMENTS: Institutional, sectoral and policy context

There is currently strong national momentum for increasing energy efficiency. Early in his presidency, in June 4, 2008, President Medvedev signed the Decree № 889 “On Certain Measures for Increasing Energy and Ecological Efficiency of Russia's Economy”. To implement the Decree, Ministries are in the process of drafting a Federal Law on amendments to the technical regulation legislation. The law would improve the energy and ecological efficiency of industrial sectors, and would require energy efficiency indicators of certain types of facilities. The Federal Government has identified lighting as an important sector for energy saving in all economic sectors in the country. As follow-up to the decree, the Ministry of Energy organized in September 2008 a high-level meeting of regional governors and heads of companies, to talk about ways to improve Russian energy-efficiency.

Today the only text in force dealing with energy efficient lighting is paragraph 7.21 of building Code SNiP 23-05-95 with amendment 'Natural and artificial lighting' approved by the Resolution of Gosstroy (the RF State Construction Committee) of May 29, 2003. Paragraph 44, stipulates that 'For the purpose of general lighting of premises, the most efficient electric-discharge lamps with the minimum luminous flux of 55 lm/W shall be used'. And further: 'Use of incandescent lamps for general-purpose lighting is allowed only to meet architectural highlighting requirements and in premises with explosion hazards.' However, there is no enforcement process to audit implementation these measures.

As governments across the OECD have become more convinced of the existence of market barriers in this sector, there is increasing willingness to contemplate regulatory approaches, which have become common over the last decade. Regulatory measures may be characterized as those that apply horizontally at the system level (such as building codes that specify a minimum level of system energy performance) and those that apply vertically at the component level (such as by specifying a minimum energy performance level for a given type of lamp).

The new Federal Law on Energy Efficiency, which is under preparation, covers Energy Efficient Lighting. The proposed text includes a gradual incandescent lamp phase-out starting with high wattage lamps (starting with 100W).

The present project will support the federal government to undertake the following actions:

- Set standards for energy efficient lighting technologies.
- Update existing regulations for the energy performance and quality of lighting systems installed in major applications like commercial buildings, new residential construction, street lighting, and industrial lighting.
- Develop efficient enforcement processes and associated indicators.
- Provide information and training to lighting specifiers, designers and installers; educate the public at large about the benefits of efficient lighting.
- Ensure that the energy costs and performance of lighting are visible in the market by labeling the energy performance of equipment and certifying the performance of entire light-using systems such as buildings and outdoor lighting.
- Encourage better building design with more effective use of daylight.
- Lead by example through pioneering efficient-lighting technologies and practices in their own buildings and by setting appropriately ambitious targets.

In order to lead to a real market transformation, all these measures need careful design and targeting. Taken as a whole, the rapid adoption of such measures will produce a brighter future and help prevent light's labor from being lost.

2. B. STAKEHOLDERS INVOLVED: Stakeholder analysis

The following institutional and governmental stakeholders are being involved in the program:

- Ministry of Energy of Russian Federation. Its primary task is the development and implementation of the Federal energy strategy, including provision for improving energy efficiency from the production to the end-use. The Ministry is developing a document entitled "Concept of energy efficiency improvement in Russia by 2020". This is a framework law that implicitly includes lighting. After its endorsement, the Ministry of Energy will prepare a program of "Energy consumption energy efficiency improvement in the field of final consumption in Russian Federation". Lighting will be explicitly included, with specific targets to be achieved. The Ministry of Energy has already approved the inclusion of the UNDP/GEF project of "Market transformation for energy efficient lighting promotion" into the above stated Federal Program. Proposals for EEL policies and their enforcement mechanisms defined in the present UNDP/GEF will be included in the new federal decree.
- The Joint Stock Company (JSC) "Energosbyt" and its multiple regional branches are electricity distributors. This stakeholder should play a very important role in this project: JSC is also responsible for installing electricity meters at the end-user level. Current Russian metering practices make it difficult to identify consumption of an individual home. JSC is harmonizing electricity metering by installing standard multi-rate meters in all across the country. Given their wide reach, JSC and its regional subsidiaries can play a role in the promotion of EEL technologies to their clients. This will be explored in the early stages of implementation.
- Government Agencies in Federal and Regional levels (table below gives a more detailed analysis of this stakeholder category), as well as Unitary and JSC companies are responsible for administrative building maintenance, housing, transport and similar activities. Departments, prefectures and town councils are both customers and contractors for building electrical system maintenance, housing buildings and urban lighting. Very often installation and maintenance is bid out to private contractors. Contractors are selected on the basis of tenders organized by prefectures, departments and town councils. All institutional stakeholders will be required by Federal law to save energy, but in many cases private contractor awareness on the subject is limited and follow-up control is scant. In its demonstration regions, the Project will support municipal entities in using and monitoring EEL criteria in lighting retrofit projects.

The following table shows the main stakeholders who are being involved in the project (beyond institutional stakeholders identified in the above paragraphs).

Domain	Stakeholder	Capacity assessment	Role in the project
Private	International Lighting industry e.g. Philips, Osram and General Electric Lighting.	These three major international actors have subsidiaries in Russia. They control more than 70% of the lighting market in the country. These companies have developed many activities linked to EEL promotion for professionals and end-consumers	Implication in EEL promotional campaigns, in Moscow and Nizhniy Novgorod demonstration projects. They will be invited to join the Federal EEL Council (FEECL, see more below).
Private	Lighting system component importers	60% of the lighting system components are imported, mostly by	Training and awareness seminars will be organized in order to increase

		small/medium size companies. Some large companies (namely KOSMOS) also exist. In many cases they have very limited awareness about energy savings and lighting quality. Russia has a large "shadow" market of very low quality lighting system components.	awareness about energy savings and product quality. KOSMOS will be involved in promotional campaigns and quality specifications. One representative of the sector will be invited to join FEELC.
JSC	Energy utilities, energy distribution companies	In Russia this type of company has not yet paid attention to EEL.	In early implementation, the program will explore opportunities for their participation in promotional and/or education campaigns for residential users
Private and JSC	Lighting systems installers and maintenance service companies	Usually, some companies in this branch are subcontractors to public authorities for housing and city electrical networks. These actors have a very low awareness about EEL technologies and standards.	Training on EEL systems use, quality issues and new standards. Call for Tenders for implementation of demonstration project.
Public	Rostest	As the official body for certification, Rostest carries out state control and supervision of legal entities and individual entrepreneurs. Lighting products in Russia have to be certified by Rostest. Today, lighting system certification laboratories need upgrades.	Two metrology laboratories will be upgraded t and will serve the main standard testing units in Russia. Rostest will be included in FEELC.
Public	Local housing maintenance offices (DEZy), Housing cooperatives (TSZh). The Department of Major Repairs administers the residential sector. The Department of Health and the Department of Education	These Departments are responsible for lighting in residential buildings, schools. They have limited awareness about energy savings and lighting quality.	Targeted for training on EEL systems use, quality issues and new standards and new enforcement process. Will participate in residential campaign in Moscow region, and in education and health building demonstration project in Moscow region
Regional & local authorities	Regional governments and local authorities	They control street lighting systems and are responsible for their	Targeted for training on EEL systems technology. Involved actively in the

		maintenance. Often pass contracts with private companies for the installation and maintenance of the lighting network. These actors are aware of energy savings potential but in many cases they don't have enough technical knowledge.	Nizhny Novgorod demonstration project: They will publish a call for tenders and they will be involved with the support of FEELC in the selection of candidates. At the end of the installation they will undertake with FEELC a system performance check.
Private	National Lighting Industry	Has been in decline for several years. Proposed product range is obsolescent and production plants are very old.	One company, selected on a "call for tenders" basis by FEELC, will receive support in modernizing one production line for high quality EEL components production.

Academic institution stakeholders

The Former Soviet Union had an excellent record in the science of lighting. Organized in 1990, the (Russian) Lighting Engineering Society had 26 sections and committees. However, government sponsorship of lighting research has almost stopped and the lack of competitive forces hampers in-house innovation by the producers. Today several high quality research teams in the domain still exist but their resources are limited.

Basic lighting research, development, and product testing have been based at the All-Union Research Lighting Institutes in Moscow (VNISI), and in Saransk (VNIIIS). More fundamental research on the science of light sources exists in Optics Department of St Petersburg University and in Moscow Power Engineering Institute. The National Academy of Science and the Academy of Medicine address certain lighting and associated vision issues. The State Committee on Architecture and various trade union organizations also work with lighting issues.

Lighting engineering is included in many higher education curricula across the country; however, in many cases, EEL is not part of the syllabus.

2. C. IMPLEMENTATION OF THE POLICY REFORM: Regional Task Program

In 2008, by order of the regional government, experts of the Nizhniy Novgorod Energy Efficiency Investments Centre, in cooperation with experts of core ministries of the region, developed a program of energy efficient street lighting modernization in the Nizhniy Novgorod region. The program provides for renovating the available lighting systems and construction of new street light lines. It is expected to use modern energy saving technologies and equipment as technical solutions.

The program was adopted by the regional government regulation in October 2008.

To monitor realized projects, within the above mentioned program, and their efficiency evaluation appropriate standardized specifications were developed and they were also adopted by the regional government regulation.

2. D. BENEFITS OF THE POLICY REFORM:

Modernization of street lighting in settlements of the territorial district of Dzerzhinsk town.

Project objective: population life quality improvement, electric energy use efficiency improvement and local budget street lighting costs reduction.

Project area – settlements: Igumnovo, Petriyaevka, Yuryevets, Babino, Kolodkino.

The administrative-territorial unit comprises five settlements: Igumnovo, Petryayevka, Yuryevets, Babino, Kolodkino. Total population of five settlements is 2800 people.

Before modernization, the street lighting system was in emergency condition. Inefficient illuminating equipment was used in the system. Before realization of project (2007) the system was operated with 448 streetlights including 314 mercury lamps and 134 incandescent lamps.

Project definition phase

A project feasibility study and a project business plan were elaborated at the project definition phase. The present project document was considered and approved by regional project selection commission. The project approval enabled settlements' administration to plan the use of forthcoming electric energy and operational savings for the following modernization of street lighting.

The project was to be implemented in two phases:

- first phase in 2007 - replacement of 283 streetlights, electric net rehabilitation and installation of about 100 streetlights in the unlit plot of the settlements;
- second phase in 2008 - replacement of 294 streetlights, electric net rehabilitation;

The total project costs (1st and 2nd phases) – 160 000 USD, including:

- administration own means – 88000 USD;
- international grant of Global Development Alliance – 25000 USD (for the first phase of the project);
- Electric energy and operational savings of the local budget after the first phase – 47 000 USD.

Pay back period is 30 months.

Project realization

In 2007 during the first phase 383 streetlights and 32 poles were replaced and installed with repairing electric circuit in Igumnovo and Petryayevka settlements. This project phase was funded from the grant and local budget. The grant was allocated by the United States Agency for International Development through the program of Global Development Alliance – 25000 USD. The share of the local budget was 45000 USD.

In 2008 at the second phase of the project 294 streetlights and 4 pylons were replaced and installed with repairing electric net and control cabinets in Yuryevets, Babino and Kolodkino settlements. It was funded with an amount of 43000 USD from the budget and those financial means with an amount of 47000 USD that were accumulated as a result of the first project implementation phase savings in accordance with reconstruction program. The savings consisted of two elements – electric energy savings and technical service savings after the first phase of project in Igumnovo and Petryayevka.

On the basis of the project positive practice in 2007-2008 administration of Dzerzhinsk town (administrative centre of the district) decided to extend realization of the project for street lighting modernization in other settlements of the district applying the saved means.

At present they have developed project documentation (project feasibility study and business plans) for modernization of street lighting system in three settlements: Gavrilovka, Gorbatovka and Zhelnino. The settlements population is 5000 people. To accelerate realization and minimization of costs the project is planned to be funded from two sources: the town investment program, and electric energy and operational costs savings after the project in Igumnovo, Petryayevka, Yuryevets, Babino, Kolodkino is completed. The total project cost about 180000 USD.

The similar activity is undertaking now in other district centers and towns of the Nizhniy Novgorod region. In particular, along with the mentioned above scheme of funding (grants, budget and saved means) they apply the scheme of attracting the credit resources.

Financial mechanism is using now for project implementation in the Nizhniy Novgorod region:

Special credit program for energy efficient projects in the budget area.

Regional administration on the basis of the regulation acts (Nizhniy Novgorod government regulations №82 and №27) repays the interest of credit, provided by a commercial bank to municipal administration for the project realization, from the regional budget. The regional budget provides for the required means with annual increase in proportion to the planned project's number enlargement and scope. Projects are funded under condition of observing criteria of payback period and limited risks.

Algorithm of funding procedure and credit return (step by step):

- Elaboration of a feasibility study and a business plan;
- Project approval at the meeting of the working group for project selection in the regional administration (technical approval of project solutions and project costs);
- If it is necessary to complete the feasibility study;
- Project justification at the meeting of "Commission for Energy and Resources Saving Project Selection" under the government of region;
- On the basis of positive decision the commission authorizes the special credit program for the project;
- Consideration of business plan and feasibility study by the bank;
- Signing the credit contract;
- Funding project by the bank (according to the time schedule);
- Municipal administration does step-by-step repayment of the main credit to the bank and partial repayment of the credit interest;
- Simultaneously with municipal administration Regional Ministry of Finance repays to the commercial bank a part of interest (usually 50% of the credit interest)

After justification of the project a municipal administration is authorized to manage the savings resulted from the project realization during the pay back period (according to the feasibility study and a business plan)

Part III. Implementation of the projects: Modernization of Street Lighting Systems in the Nizhniy Novgorod Region

Two projects of different size have been implemented in the Nizhniy Novgorod Region.

Project 1. 3. A. TECHNICAL DESCRIPTION OF THE PROJECTS: Modernization of street lighting system in a small town Lyskovo

The town's resident population is 22,000 people.

The street lighting system rehabilitation project for Lyskovo includes:

- installation of 848 energy saving luminaries in the streets
- replacement of 10-15% of street light pole brackets
- installation of a power consumption control system at the power supply points
- installation of additional 46 outdoor luminaries with poles and a lighting network
- replacement of poles in poor condition.

Main results of the project:

- reduction of electricity consumption by 49%
- reduction of operational costs by 50%
- 1.5 times improvement of street illumination in Lyskovo

Table 1. Technical characteristics of the outdoor lighting system in Lyskovo before and after rehabilitation

Technical characteristics	Before rehabilitation	After rehabilitation
Installed capacity, *kW*	172.15	95.35
Power consumption, *kWh per year*	463,255	256,586
Number of light sources	848	894

Technical characteristics	Before rehabilitation	After rehabilitation
Luminous efficiency of lamps, lm/W	50	110
Optical efficiency of luminaries, *%*	45	75

Table 2. Project economic performance

Total project value, *million RUB*	4.99
Annual savings, *million RUB*	1.76
Energy savings, *million kWh / year*	228,569
Payback period, years	2.8

The state-of-the-art energy-efficient equipment used to implement this project will help utilize the industrial and resource potential of the town more efficiently, as well as the municipal facilities and improve the quality of life for citizens by creating a safe and supportive environment.

1. The street lighting system in Lyskovo

The central streets of Lyskovo feature an outdoor lighting system employing 848 light sources. Lyskovo Commune Service OAO ("Lyskovo Commune Service") performs system maintenance. The equipment installed in the 1970s and 1980s has become obsolete and shows signs of a high degree of wear and tear and fails to provide the rated illumination. The wear and tear of most luminaries is 100%. The equipment used in the outdoor lighting system is described in Table 3.
The actual efficiency of installed luminaries (about 45% of the design efficiency) is low due to:
- high wear and tear due to a long service life
- lack of protection of reflectors against moisture and dust.

The actual life of lamps (4 times shorter than the standard life) is short due to the worn electrical parts of luminaries, voltage fluctuation during the night-time hours and the low quality of mercury arc lamps used.
Total installed capacity of the operated system is R_{inst} = 172.15 kW. Calculation of annual electricity consumed by the outdoor lighting system is shown in Table 3.

Table 3

Capacity, ***kW***	Utilization ratio	Ballast losses	Duration of system operation ***'000 hours***	Annual electricity consumption before rehabilitation ***kWh per year***
172.15	0.9	1.15	2,600	463,255

The cost of maintenance of 1 light source per year is about 1,000 rubles (mobile service tower operation, work of lineman and costs of materials).

Rehabilitation the street lighting system in Lyskovo

Rehabilitation involves the installation of energy efficient lighting ZhKU-01 (S-01) street lights with DNaT high-pressure sodium lamps. Installation of an electric metering and luminary's power control system in the town centre streets.
Capital costs for the rehabilitation of street lighting will be about 4.99 million rubbles.
After rehabilitation, the installed capacity of the lighting system will decrease by 76.8 kW (from 172.15 kW to 95.35 kW). The power of the town lighting system was estimated based on the operational and photometric characteristics of S-01 luminaries, which have a high degree of protection against moisture and dust (IP65) and effective light distribution.
System energy consumption per year after the project implementation is presented in Table 6

Table 6.

Capacity, *kW*	Utilization ratio	Ballast losses	Average duration of system operation, hours	Electricity consumption per year after rehabilitation, ***kWh per year***
95.35	0.9	1.15	2,600	**256,586**

Additional energy savings resulting from the installation of an automated street lighting control system (reducing the system power consumption in the evening and night hours) is about 21,900 kWh / year.

The project implementation will reduce electricity consumption by 228,569 kWh / year.
The maintenance cost of luminaries will be reduced by 40% to 600 roubles because the lamp replacement interval will be doubled. New luminaries with low power consumption (100-150W) and high cos φ (0.8-0.85) will significantly (3 times) lower the current in the lighting system and considerably reduce the accident rate in lines and systems.|
The additional light lines (46 light sources) will lower annual operating costs from 847,000 rubbles to 535,800 roubles. Thus, operating savings will be 311,200 RUB/year.
The comprehensive rehabilitation involving installation of new equipment will reduce the annual major repair costs of the lighting system.
Savings are itemized in Table 7.
Table 7

No	Description of savings	Savings per year, '000 RUB
1.	Reduction in energy consumption by reducing the installed capacity of the lighting system: (228,569 kWh/year × 1.96 RUB/kWh)	448
2	Lower costs of major repairs (replacement of poles, lines, luminaries) and construction of new light lines	1,000
3	Lower operating costs	311
TOTAL		**1,759**

**-Electricity tariff for state-financed organisations for 2008 is projected at 2.25 roubles / kWh (including an increase of 15% on the 2007 base rate).*

Investments in the project totalled 4.99 million roubles and comprised 0.59 million rubbles of own funds and 4.4 million roubles of a bank loan.
The bank loan was to cover the cost of equipment and installation. The loan is being repaid from project savings. The region budget compensates part of the interest rate on the loan (50% of the CBR refinancing rate, or about 5%).
The region and district budgets will apply the existing limits set on power consumption until the project has been paid back and the loan repaid in full.
Taking into account the above compensation, the bank's rate for the municipality is 11.25% per annum.

3. A. TECHNICAL DESCRIPTION OF THE PROJECTS: Modernization of street lighting in the town of the middle size Kstovo

The town's resident population is 68,900 people.

The street lighting system rehabilitation project for Kstovo includes:

- installation of 2,600 outdoor energy-efficient luminaries;
- replacement of 10-15% of outdoor lighting pole brackets
- installation of electric power metering systems at delivery points

- installation of a variable power control system for luminaries in the city centre (5 control cabinets).

Main results of the project:

- electricity consumption reduction by 55 %
- reduction of operational costs by 40-50 %
- improvement of street illumination in Kstovo

Table 1. Technical characteristics of the outdoor lighting system in Kstovo before and after rehabilitation

Technical characteristics	Before rehabilitation	After rehabilitation
Installed capacity, kW	651.0	317.5
Power consumption, *million kWh / year*	2.7	1.2
Number of light sources	2,549	2,591
Luminous efficiency of lamps, lm//W	50	110
Optical efficiency of luminaries, %	45	75

Table 2. Project economic performance

Total project value, million RUB	10,613
Annual savings, ***million RUB***	4.06
Energy savings, ***million kWh / year***	1.48
Payback period, years	2.6

Basic data

1. The street lighting system in Kstovo

The central streets of Kstovo feature an outdoor lighting system employing 2,549 light sources. Energia Municipal Unitary Enterprise (MUE "Energia") performs system maintenance.

The equipment installed in the 1970s is obsolete showing a high degree of wear and tear and fails to provide the rated illumination. The wear and tear of most luminaries is 100%.

The actual efficiency of the installed luminaries (about 45% of the design efficiency) is low due to:

- high wear and tear due to a long service life
- lack of protection of reflectors against moisture and dust

The actual life of lamps (4 times shorter than the standard life) is short due to the worn electrical parts of luminaries, voltage fluctuation during the night-time hours and the low quality of mercury arc lamps used.

Total installed capacity of the current system is R_{inst} = 651.0 kW. Calculation of annual electricity consumed by the outdoor lighting system is shown in Table 3.

Table 3

Capacity,	Utilization ratio	Ballast losses	Duration of system operation	Annual electricity consumption before rehabilitation

kW			*'000 hours*	***million kWh / year***
651.0	0.9	1.15	4	2.695

The municipal budget spends 3,189,000 rubbles a year to maintain street lighting (apart from covering the costs of electricity, lamps and consumables).

The cost of maintenance of 1 light source per year is 1,230.9 rubbles that includes the use of a mobile service tower and services of a lineman–twice a year.

In addition, annually about 2 million roubles are spent on spare parts and consumables (lights, ballasts, lamp sockets, lamps, wire, brackets, etc.)

2. Main technical solutions for rehabilitation the street lighting system in Kstovo

Installation of new energy saving ZhKU-01 (S-01) street lights with DNaT high-pressure sodium lamps

Quality materials and state-of-the-art technologies have been used to manufacture energy saving ZhKU-01 (S-01) street lights that maintain their high lighting characteristics throughout their life. The average service life of the luminaries is 15 years.

The lighting system rehabilitation also involves the replacement of worn away brackets, as well as the brackets, the tilt angle of which is not optimal for the luminous flux from luminaries.

After rehabilitation, the installed capacity of the lighting system will decrease by 333.5 kW, from 651.078 kW to 317.54 kW. ZhKU-01 lights have a high degree of protection against moisture and dust (IP65) that guarantees the preservation of reflection properties over their entire service life and reduce the safety factor to 1.3 when designing the system capacity. The luminaries design and the materials used provide high lighting performance and reduce the installed capacity (efficiency = 75%, I_{max} = 420 cd / klm).

System energy consumption per year after the project implementation is presented in Table 4

Capacity, *kW*	Utilization ratio	Ballast losses	Duration of system operation, hours	Electricity consumption per year after rehabilitation, *kWh per year*
317.54	0.9	1.15	4,000	1,314,616

Installation of lighting control cabinets (Appendix 4) will help save energy in 5 major areas of the lighting system with total installed capacity of 120 kW. Reduced power will be used 2,190 hours / year, while power consumption will be 60% of the installed capacity. Night-time lighting control will additionally save 108,799 kWh per year.

So, the lighting system after rehabilitation is estimated to consume 1.205 million kWh per year (saving 1.489 million kWh per year).

The servicing of luminaries due to failures would be required only once every 2 to 3 years; the new installed luminaries will ensure high performance and the current in the network will significantly (3 times) decrease reducing the accident rate across the lines and systems. Expenses on spare parts and consumables will be reduced, and the overall system maintenance costs will be cut by 50% to 1,594,000 rubbles a year (without the cost of lamps).

Savings are itemized in Table 5.

Table 5

No.	Description of savings	Savings per year, '000 RUB

No.	Description of savings	Savings per year, '000 RUB
1.	Reduction in energy consumption by reducing the installed capacity of the lighting system: (1,489,646 kWh per year × 1.66 RUB/kW)	2,472
2.	Lower operating costs as lamp life triples (due to DNaT lamps); lesser equipment (lifting tower trucks) and support staff by 50% (3,189 * 500 rubles)	1,594
	TOTAL	**4,066**

According to the Tariff Department of the Regional Energy Commission (REC), the electricity tariff for state-financed organisations from 01.01.2006 is 1.66 RUB, incl. VAT.

3. Operations and facilities om MUE "ENERGIA"

Core activities of MUE "Energia" include:

- electricity transmission and distribution under a contract with Nizhny Novgorod Retail Company OAO

- maintenance of consumer electrical networks in Kstovo

- maintenance of municipal electric networks, including outdoor lighting networks

Lighting networks in Kstovo are serviced on a contractual basis with the Kstovo District administration. The electricity consumed by street lighting and maintenance and repair of the lighting system and municipal consumer electric networks account for most of the network maintenance costs.

MUE "Energia" operates 105 transformer and 5 distribution substations with total capacity of 54 MVA. Total electricity consumption across the MUP Energia system is 70 million kWh/year.

4. Enterprise resource management

Staff comprises 76 people. The technical fleet of MUE "Energia" comprises 2 hydraulic lift trucks to service lighting networks and technical facilities to carry out network repair and installation operations. The vehicle fleet comprises:

- 3 cars;
- 2 trucks;
- excavator.

The enterprise also features a GAZ-53-mounted electrotechnical laboratory to conduct various electrical measurements.

5. Environmental protection and environmental impact

The application of state-of-the-art outdoor lighting systems will help abandon mercury lamps and reduce fuel consumption thus reducing greenhouse gases emitted from power plants.

The rehabilitation of the outdoor lighting system will result in energy saving through reducing electricity consumption and will decrease the fuel amount needed to generate electricity to power the outdoor lighting system. As a result, less fuel consumed at power plants will reduce noxious atmospheric emissions.

The rehabilitation of outdoor lighting system will include replacing mercury arc lamps with DNaT high-pressure sodium lamps that reduces the quantity of mercury-containing lamps requiring special recycling.

It is estimated that lesser electricity consumption will reduce atmospheric emissions of greenhouse gases by 1,000 tons / year (in the Nizhny Novgorod region average carbon dioxide emissions are 670-680 grams / kWh).

Replacing one mercury arc lamp by DNaT lamp on average reduces mercury emissions by 0.2 g. Under the Energy Saving Street Lighting Project implemented in Kstovo 2,591 high pressure sodium lamps will replace 2,549 mercury lamps. That will reduce mercury emissions by 500 grams per year.

6. Industrial safety

At present, some streets and squares of Kstovo poorly illuminated during night-time hours and failing to comply with SNiP 23-05-95 illumination standard can increase the risk of accidents.

The analysis suggests that street lighting in Kstovo after rehabilitation will meet the required illumination standards, or even exceed them, and thereby will have a positive impact on road safety. The improved outdoor lighting during night-time hours will also help improve the general crime situation.

All equipment involved in the lighting system rehabilitation fully complies with GOST and is safe for installation and operation.

7. Investment efficiency

The most efficient project has been identified by comparing the following parameters:
Capital investment size
Annual energy savings
Operational costs savings
Cumulative economic effect
Project payback period.

Investment efficiency estimates are summarized in Table 6
Table 6

Indicator	Option
Capital investment, million RUB	10.613
Energy savings, million RUB per year	2.47
Operational cost savings, million RUB per year	1.59
Cumulative economic effect, million RUB per year	4.06
Payback period, years	2.6

Project investment totalled 10.613 million rubbles
The project was financed from the municipal budget.
Project monitoring conducted in 2007 and 2008 confirmed design performance indicators.

Part 4. Conclusions and Recommendations:

4. A. Results to be achieved after implementation of the selected project

After implementing the above mentioned projects and received positive outcomes especially in elaboration of different financial mechanisms and utilization of local secondary legislation a selected project has been started. Three pilots have been determined. They are undertaken in three major regions: Moscow city and region and Nizhny Novgorod region, and for three major end-uses: homes (Moscow region, pilot), hospitals and schools (Moscow city, pilot), and street lighting (Nizhny Novgorod region, pilot).

The major results to be achieved by the end of the project are the following:
Improvement in the efficient lighting standards and policy framework
Improved standards and policy framework will bring about systemic improvement in the energy efficiency of lighting use in Russia. GEF support is required for the technical assistance in updating of the product standards, and the national testing lab, and for the initial establishment of the groups that will support the development and implementation of the policy framework.

In order to strengthen links between government and private sector energy-efficient lighting specialists, the project will establish the Federal Energy Efficient Lighting Council (FEELC). This council is expected to be placed under the auspices of the Ministry of Energy.

Work on development of energy efficiency standards and regulations are being carried out based on existing norms and standards for lighting and electric equipment. The very first action in the frame of this Project is to collect, critically compile and then adapt to the Russian context international (or selected national) lighting efficiency standards and recommendations (e.g. European EuP directive, French RT2005 degree, US Energy star requirements for lighting, European directives on Energy Efficiency of Buildings etc.).

In the case of building codes, these are divided into (a) those that explicitly specify lighting energy limits as either maximum lighting power density limits or maximum lighting power density per unit of luminance, and (b) those that specify whole building energy-performance requirements for which attention to lighting is just one of many potential routes to compliance. Combination codes are also possible by which both whole-building energy limits and lighting energy performance limits are set. This approach is relatively new but is likely to be effective, because while it allows efficient lighting measures to contribute to whole-building performance targets. It also sets a minimum lighting performance benchmark that focuses attention on the lighting installation and informs building developers or installers of the degree to which the lighting is contributing to the overall performance target.

The project proposes revisions to SNiP (Construction Norms and Regulations), MGSN (Moscow City Construction Regulations), SanPiN (Sanitary Regulations and Standards) as follows:

- Introduce maximum permissible specific energy consumption for lighting installations in buildings as well as for street lighting. For example, lighting consumption for buildings will pass from the actual 7-10 W/m^2/100lx limit to an average value of 2.5-4 W/m^2/100lx (according to the building destination), luminous efficacy for street lighting will pass from 55 lm/W to at least 70 lm/W;
- Introduce restrictions on the use of lighting fixtures and lamps with a low lighting efficiency depending on the rated illumination level, the annual operating time of the lighting installation and requirements to the quality of lighting. Lamps with light output of less than 50 lm/W, color rendering index of less than 80, service life of less than 4,000 hours, $\cos\varphi < 0.9$, and payback period of more than 3 years would not be used;
- Limit the use of lamps with a large decrease of light flux in order to ensure a sharp reduction in the rated maintenance factor, to lower the installed capacity of lighting installations.
- Limit the use of lighting fixtures with electromagnetic ballasts;
- Introduce stringent requirements for maintenance of lighting installations (cleaning of lighting fixtures and replacement of lamps) to ensure an additional possibility of reducing the maintenance factor and improving the quality of lighting;
- Introduce stringent requirements to the quality of full lighting systems not only from the viewpoint of safety of their use as is stipulated in the IEC documents but also with regard to the efficiency factor of lighting systems, the light output ratio of lamps, $\cos\varphi$, power consumption.
- Introduce mandatory use of automatic daylight and occupancy sensors

Once adopted and implemented these proposals are likely to make a considerable impact in lighting energy consumption in Russia and will give the country one of the most comprehensive lighting policy portfolios. However, enforcement mechanisms, which are missing today, will also need to be designed, adopted, and implemented. FEELC will develop an enforcement protocol to strengthen testing and compliance arrangements for lighting products.

The enforcement mechanism would require building energy performance to be measured, certified and displayed to end-users. It is necessary having a subsection explicitly displaying the lighting energy performance as either metered or audited values, because this allows users to ascertain how readily they can economize through retrofitting the lighting. It also puts the work of lighting electrical contractors more firmly in the spotlight. In addition, if there is no practical sanction for non-compliance, regulations will have no greater impact than the issuance of guidelines; that is to say that they may well produce some positive results, but that their impacts will be far less than the intention. Thus, there is a need to set regulatory requirements that oblige reasonable system and component performance, ensure common and reliable metrics are used to establish this, ensure energy performance and benchmarking is communicated to the market and are adequately enforced.

The project will also establish a National Platform for Lighting (NPL). The platform will be a body that can undertake or facilitate work requested by the FEELC. It will benefit from synergies and dialogue between high-level scientists and/or technology developers, institutional and industrial stakeholders. The NPL's objectives will be as follows:

- Constituting an expert pool that can be used by FEELC for project evaluation and monitoring actions.
- Guaranteeing high levels of international visibility and scientific and/or industrial connectivity. NPL will also establish systematic international contacts with leading energy efficiency centers in other countries (e.g., European Union, China). The GEF Global Umbrella EEL project will be helpful in this regard.
- Establishing EEL roadmaps for the next decades. This imposes a serious and continuous monitoring analysis of technological developments in the domain;
- Gathering annual market monitoring data. Manufacturers consulted so far have agreed to provide data in the context of the project.
- Creating a documentation centre that will allow storing knowledge and experience issue from any EEL projects.
- Disseminating results from EEL projects so that professionals in other agencies can benefit from the experience.
- Undertaking consumer surveys in order to identify barriers and negative perceptions that consumers may have about EEL.

This Project will develop the plan of modernization of national metrology laboratories and upgrade one or two key laboratories, selected by FEELC, so that they can serve as a main qualification authority to certify testing laboratories across the country. Once this step has been accomplished, FEELC will suggest to Federal Government to develop:

- Tight controls of the quality of locally-manufactured EE-lamps (introduction of penalties for products of low quality can be desirable).
- Tight customs control of the availability of certificates on imported products (which would be obtained only at specialized certification centers) as well as use of certified components (lamp holders, collector blocks, etc.).

Support the supply chain for EE lighting

Under the auspices of FEELC a national EE lighting action plan will be developed to allow for the gradual phase-out of inefficient lighting devices though such measures as phase-out of electromagnetic ballasts for fluorescent lamps (in new construction and rehabilitation). Then within the next two years, a phase-out of frosted incandescent lamps, mercury HID and T12 fluorescent lamps should begin. An overall phase-out of inefficient technologies should be planned within a 7 to 8 year period.

The following table shows the proposed scheme for the phasing-out process.

Stage	Year	Quota allocation for incandescent lamps (manufacture and import)	Development and introduction of technical regulations on energy efficiency (state regulations)	Quota allocation for electromagnetic ballasts (manufactured and import)	Estimated direct Energy saving / CO_2 emission reduction
1	2009 - 2011	90%	Phase-out of incandescent lamps. Energy efficiency standards for lighting systems in state-financed	90%	2 TWh/yr or 1 Mtn CO_2/yr

			organizations (public sector)		
2	2012 - 2014	50 %	Standards of energy efficiency for fluorescent lamps and lighting devices Standards of energy efficiency for lighting systems in industrial and commercial buildings	50%	9 TWh/yr or 4.5 Mtn CO_2/yr
3	2015 - 2017	30 %	Standards on efficiency for the systems of lighting in residential sector. Standards of efficiency for LED and related devices	10%	6 TWh/yr or 3 Mtn CO_2/yr

To help start the transition, new federal legislation have been proposed that will oblige all public institutions to switch to using CFL and FL T5 with electronic ballast within three to five years.

Imposing new quality standards and phasing out the least efficient lighting devices may have a strong negative impact on the national lighting industry, which still employs more than 14 000 people; these social impacts cannot just be ignored. It is possible to strengthen the national industry by setting-up strong R&D projects for the development of new EEL products. This type of action will be initiated and monitored by the FEELC. The activities that will be undertaken to achieve this result have been designed to assist manufacturers who currently produce GLS (General Lighting Service, i.e., Incandescent lamps) to convert such production lines to more efficient alternatives.

The activities that will be carried out to realize this result include: (a) conduct of more thorough research to fully understand the risks to the Russian lighting sector and overall economy of the phase-out of GLS; (b) development of appropriate strategies for mitigating the risks; (c) development of tools to support manufacturer business plans for conversion to EEL production; (d) provision of technical assistance to selected GLS manufacturers in developing specific business plans for the GLS manufacturing conversion; (e) implementation of GLS manufacturing conversion plans in selected manufacturers (this selection will be done by FEELC after a call for proposals); (f) training and capacity building for other GLS manufacturers in Russia to share the experience in GLS manufacturing conversion.

In order to demonstrate the capacity of the national industry to evolve, the design of some EEL products (for instance LEDs) can be validated and partially supported by this project and financed by national and private investments.

Penetration of energy-efficient lighting increases in Moscow homes and buildings, and the initiatives are replicated elsewhere

Given that a large part of Russians are not aware of energy saving opportunities from lighting, the best method to transform their opinion is to clearly demonstrate the benefits of EEL. To do this, a key part of the project is to demonstrate improved practices related to overcoming barriers in three pilot sites: (1) Schools and hospitals in the Moscow; (2) residential areas in the Moscow region; (3) street lighting in Nizhniy Novgorod oblast. These demonstration projects will complement governmental efforts to expand EELs system use and durably transform the national market. The criteria used to select the three pilot sites are summarized below:

- In the Moscow region the energy-saving program “Energy savings in Moscow” is active in 2009-2011. While the education, health and residential sectors aren’t considered as first priorities for that program, it can nevertheless offer co-funding for these activities.

- In Nizhny Novgorod region there is a program of reconstruction of street lighting for the period 2008-2012. In the absence of project financing municipalities will reconstruct lighting systems but will use old (and less expensive) technology. The project will support the implantation of modern technology that will allow larger energy savings.

The following table summarizes demonstration activities that will be undertaken in the frame of this project.

Pilot Site	Expected impact (energy savings and GHG reduction)	Barriers addressed	Significance within the project	Potential for co-funding & partnerships.
Schools and hospitals in Moscow region (40 buildings)	4.6 GWh/yr or 2.3 ktn CO_2 less per year	• Lack of energy management expertise and practices, especially in the national industries and municipal sector (this includes administrations, education, health buildings). • End-users are not really educated to distinguish between low and high quality CFLs. • Low awareness of population about EELs	• Targeting schools for this pilot should be considered as a high impact promotional mechanism because children (the citizens of the future) who are used to living in a high quality energy saving lighting environment will more probably reproduce the same behavior later as consumers and decision makers. • Targeting hospitals will offer a better environment to patients and hospital staff. This will demonstrate that with EELs we can obtain a very healthy and pleasant lighting	• In Moscow region there is an energy-saving program "Energy savings in Moscow". Education and Health buildings aren't priorities in that program. In the frame of a partnership co-funding is possible. • Potential sponsoring from large lighting companies that will profit from the publicity around these actions.
Residential sector in Moscow region (10% of total number of flats is concerned)	48.8 GWh/yr or 24.4 ktn CO_2 less per year	• Low awareness of population about EELs • End-users are not really educated to distinguish between low and high quality CFLs. • Very often the consumer can't correctly evaluate the energy gains engendered by EELs.	• CFLs use about one quarter as much energy an incandescent lamps and therefore offer significant potential for energy savings. In order to increase end-user awareness demonstration projects coupled with intensive promotional campaigns, especially in indoor lighting applications, are necessary.	• Potential sponsoring from large lighting companies that will profit from the publicity around these actions. • Potential sponsoring from electricity providers • Potential co-funding from regional housing authorities in the context of the "Energy savings in Moscow" program

Pilot Site	Expected impact (energy savings and GHG reduction)	Barriers addressed	Significance within the project	Potential for co-funding & partnerships.
Street lighting in Nizhny Novgorod oblast (20000 lighting points)	16 GWh/yr or 8 ktn CO_2 less per year	• Ineffective interaction of top management and technical specialists of energy services. Decisions concerning energy efficiency are not applied because there is lack of knowledge of new technologies by technical staff. Proposals coming from technical services may be completely ignored by decision makers because they are not aware about energy saving needs. • Low awareness of population about EELs	• Street lighting represents a major expense for cities. Proposing high quality EELs will help cities to gain money and offer to their citizens a pleasant and safe living environment. Street lighting is also directly linked to security aspects in the city (both traffic and criminality are addressed). Good light offer also an additional attractively of the urban space and allows development of commercial and touristic activities.	• Potential sponsoring from large lighting companies that will profit from the publicity around these actions. • Potential co-funding from oblast authorities that will support the civil engineering work necessary for the demonstrator installation.

There are approximately about 1000 fixtures in a typical 5000 m^2 school or hospital. A typical building of this type consumes 200 MWh for lighting (assuming 2000 h of operation per year this leads to 20 W/m^2) Lighting consumption in this type of buildings accounts for between 40 and 60% of their total electricity use.
The demonstration project will cover the modernization of 40 buildings in the Moscow Region. Modernization will include retrofitting of fixtures with T5 lamps and electronic ballasts, replacement of incandescent lamps by CFL and installation of control systems.
The following table shows the expected direct savings from the demonstration project

Base line	Assumptions	Energy savings at the end of the project	Assumptions for pay back calculation	Payback period
In each building ($5000m^2$) has in average 1000 fixtures. This breakdown to 200 fixtures with 100W GLS and 800 fixtures with 2x40W T12 FLs that leads to a total power of 100W due to ballast losses. In conclusion the average power per fixture is Pav = 100 W and the total installed power 100 kW. The number of	Demonstrator size: 40 buildings. After modernization, for each building 200 GLS lamps will replaced by 20 W CFLs, and 800 fixtures with 2xT12 FLs will be replaced by fixtures with T5 lamps (54W total) and electronic ballasts. This leads to an average power per fixture is 52 W of. This corresponds to	40 buildings x 1 000 fixtures/building x (200-83.6) kWh/yr/fixture = 4.6 GWh/yr or 2.3 ktn CO_2 less per year	The pay back is calculated considering that retrofitting additional cost will be in the order of 80 Euros per lighting point. This leads to an initial investment of 3.2 MEuros (this include all installation from scratch) for an average power gain of 116 kWh per fixture.	Gains from electricity: 40 buildings x 1 000 fixtures/building x 116 kWh/yr/fixture x 0.07 Euros/kWh = 325 kEuros/yr

operating hours per annum is estimated in the order of 2000 h that leads to 200 kWh/year/fixture. All in all each building of this type uses 200 MWh/yr for lighting (100 ktn of CO_2)	104 kWh/yr/fixture, minus 20% due to electronic control system leads to a final consumption per fixture of 83.2 kWh/yr.		Electricity price is taken equal to 0.07 Euros/kWh.	

Monitoring of pilot projects will allow identification of the most viable solutions (organizational and technical); these will then be presented to the government and regional authorities for distribution and replication by means of state programs.

A residential CFL promotional campaign has been designed. The goal of this activity is to increase population awareness about EEL technologies. The main difference between this project and previous Russian initiatives is that free CFLs will be not distributed in this project. Instead, the current project uses a market transformation strategy to increase individual consumers awareness about CFLs. A communication and promotion strategy will be designed in order to overcome barriers listed in the previous paragraphs. Mass media (TV, radio, national, regional and local press…) will be used as needed. As Russian Internet use is rapidly increasing, a web based “Energy Conservation Performance Catalogue” may also be developed, with information on energy efficiency, and on product quality and its impact on customer satisfaction. This catalogue should also include a number of good practice examples.

The pilot will include a study of CFL installation and use in 200 flats in several residential buildings. In 5-10 typical flats a special system will monitor lighting energy consumption, this monitoring will contribute new knowledge about Russian residential lighting energy use. The following table shows the expected direct savings from the above-mentioned activities.

Base line	Assumptions	Energy savings at the end of the project
In residential sector 97% are GLS (75W average power) 2.7% linear fluorescent lamps (mainly T12) 0.3% compact fluorescent lamps CFL. In Moscow the average number of lamps in a flat is in the order of 20-25.	Expected CFLs penetration: 370 000 flats (10% of Moscow number of flats) In each flat 2 GLS (75 W in average) will replaced by 20 W CFL (in order to get equivalent quantity of light) Installed power reduction: 55 W/retrofitting = 275 W/flat; Operating per year in each flat: 1 200 h/yr	370 000 flats x 2 retrofits/flat x 55 W/retrofit x 1 200 h/yr = 48.8 GWh/yr or 24.4 ktn CO_2 less per year

In addition, the FEELC will explore means of organizing CFL collection and disposal.

All activities targeting residential consumers will be done together with manufacturers/distributors. GEF support is needed for the development of EEL promotion schemes, the design and facilitation of pilot financial assistance programs for low-income consumers.

The monitoring of pilot project will allow choosing the most viable solutions (organizational and technical) that will be offered to the government and regional authorities for distribution and replication by means of state programs.

This approach will be scaled up within Moscow, and replicated in five other regions. To this end, a replication plan will be prepared. The plan will include means of disseminating the experience and results of the pilot.

Energy-efficient street lighting is adopted in Nizhny Novgorod region and local EEL initiatives are replicated elsewhere

The pilot in the Nizhniy Novgorod oblast involves modernization of street lighting including the replacement of incandescent lamps (50 lm/W) and high-pressure mercury lamps (50 lm/W) with lighting fixtures (IP 65 class) with metal halide lamps (90 lm/W) and other new energy efficient technologies.

The following table shows the expected savings

Base line	Assumptions	Energy savings at the end of the project
Existing light sources in Nizhniy Novgorod oblast street lighting: GLS – 15 lm/W Hg-HID (50 lm/W) Average installed power/lighting point: 350 W Installed power for 20 000 points: 7 MW	Demonstration project size: 20 000 lighting points retrofitted. Installed lamp types: Ceramic Metal Halide lamps 150 W each with electronic ballast and centralized control. Installed power for 20 000 points: 3 MW Operating per year in each flat: 4 000 h/yr	20 000 lamps x 200 W/retrofit x 4000 h/yr = 16 GWh/yr or 8 ktn CO_2 less per year

Furthermore, specific power of street lighting will be reduced from $10W/m^2/100lx$ to $4W/m^2/100lux$. Globally 20 000 lighting points will be replaced, leading to a reduction in installed power of 4 MW.

Monitoring of pilot project will allow identification of the most viable solutions (organizational and technical). These will be submitted to the government and regional authorities for distribution and replication by means of state programs.

In order to ensure the replication of the pilot within Nizhny Novgorod and in five other oblasts, a replication plan will be prepared. The plan will include means of disseminating the experience and results of the pilot.

The project is being implemented at an excellent time: while there is strong government will to increase energy-efficiency, there is no specific effort dedicated to increasing the efficiency of lighting. The project has brought together the human and financial resources necessary to draft laws and regulations supporting energy-efficient lighting that can then slot into the wider national action on energy-efficiency, and to implement pilot projects to demonstrate the benefits of energy-efficient lighting.

Experts assessment indicates that total energy demand for lighting in Russia amounts to approx. 137.5 TWh/annum, and that potential savings from the use of commercially available more efficient lighting technologies amount to 57 TWh/annum which is equivalent to approx. 28.5 Mt CO_2 per annum. The evaluation of energy savings from this market transformation is based to the following assumptions:

- In residential sector compact fluorescent lamps CFL represent only about 0.3% of the installed lamps in households, the western counties average is in the order of 12%. A CFL is 4 to 5 times more efficient than an incandescent bulb;
- In public and commercial buildings – fluorescent lamps T12 or T8 with electromagnetic ballasts are dominant incandescent lamps. Changing T12/T8 by new T5 technology will lead to an average economy of 30%, using electronic ballasts and more efficient fixtures will add at 10 to 15% additional savings;
- Introducing occupancy sensors and intelligent lighting system management for tertiary sector can save more than 30% of energy;
- In street lighting replacing obsolete Hg High Intensity Discharge lamps by modern

technologies like Sodium and ceramic metal halide lamps can save up to 15%. Introducing new efficient IP65 class fixtures will save 10% and will decrease the light pollution of the skies. Then introducing electronic ballasts and dimming systems the additional savings can be in the order of 40%.

- Using more electronic ballasts and CFL with power factor higher than 0.9 will lead to a very important reduction of “reactive” power injected to the national electrical network.
- Furthermore, we can use for our estimations the following “standard upgrade” situations as given from European Lighting Companies Association:

Sector	Proposed upgrade	Energy Savings (%)	GHG reduction (kg per lamp and per year)
Street lighting	From: Hg High Intensity Discharge lamp with electromagnetic ballast To: Ceramic metal Halide lamps with electronic gear	57	109
Commercial	From: Low power halogen reflector lamps To: low power ceramic metal halide reflector lamps with electronic gear	80	115
Public & industrial buildings	From: T8 fluorescent lamps with electromagnetic ballast To: T5 fluorescent lamps with electronic gear	61	77
Residential	From: Incandescent lamps To: CFLs	75	30

Under these assumptions we assume that the ten-year market potential captured due to the present GEF project has represents 55% of the technical potential; by experience in other countries, this is a rather conservative value. The factor chosen reflects general national momentum on energy efficiency, as a consequence of a recent presidential decree to this effect, and global momentum on EEL due to several projects (GEF Umbrella project, World Bank EEL toolkit, etc). This leads to a ten-year saving of 34 TWh/yr or 17 Mtn of GHG saved per year.
This calculation is justified indirectly by the comparison of the Russia situation with other countries. For example the residential sector in Russia uses 10 W/m^2 per 100 lx whereas Japan uses 4 W/m^2/100lx, Europe and USA are at around 6 W/m^2/100lx; tertiary and public building sector in Russia consumes 7-10 W/m^2/100lx, whereas Japan is using 2.5 W/m^2/100lx, Europe and USA 4 W/m^2/100lx. Furthermore, the generation of 1 Mlm h of luminous flux requires 36 kWh in Russia whereas in leading foreign countries this ranges from 25 to 26 kWh.
Beyond the direct energy savings accrued by the demonstration projects and detailed in the above sections of this document we can expect also indirect savings due to market transformation that can be evaluated ate the end of the project. The following table shows these indirect savings (at the end of the project) sector by sector.

Sector	Baseline & Assumptions	Energy Savings	GHG reduction
Residential (in urban environment):	There is 170 million lamps in households with an average power per lamp of 77 W. 97% of that is GLS (incandescence with average power of 80 W), 2.7% is Fluorescent (T12 - 36 W) and 0.3% is CFL. Assuming that the annual growth of the number of lamps is in the order of 3% (this comparable to that from eastern countries after passing to market economy) at the project end we expect to find 190 million	650 GWh/yr	325 ktn/yr

	lamps in dwellings. Assuming now that people will buy more CFL due to promotions etc. we can expect that that 10 million CFL (20W) will be installed in homes (this is a conservative estimate, representing only 5% of the global number of lamps in a home), 180 (75W) GLS will remain in use. From that we can calculate the overall gains from the sector (assuming 1200 h of operation per year).		
Schools, hospitals & public buildings	This sector is easy to control because the decision depend directly from government and regional authorities. Today 97% of lamps are T12 and T8 fluorescent with classic ballast (average luminous efficacy 55 lm/W and 440 Glm of light). Assume now that the number of fixtures stays the same during the project execution. Then T12 will be retrofitted by T8 (no need to change the fixture...) and the number of T5 will increase. Then taking a final distribution of 10% T12 (36W), 80% T8 (with or without electronic ballast) and 10% of T5 we obtain an average luminous efficacy of 66 lm/W.	2 TWh/yr	1 Mtn/yr
Street lighting	This is much more expensive to replace and the average lifespan of a street lighting system is 20-30 years. Assuming that Hg HID lamps will be retrofitted by Sodium High pressure and Metal Halide lamps, and that some controls will be added to some parts of the network, we expect that at the end of the project we can capture 5% of the global saving potential given	100 GWh/yr	50 ktn/yr
Commercial buildings	Very complex sector because is driven by turnover and profit. Assume that the easiest way (and cheapest) to achieve energy saving is just retrofit T12 by T8 and that only 1% of the global potential is captured at the end of the project (no specific action is undertaken in that direction in the project but the enabled market transformation will profit also in this sector).	600 GWh/yr	300 ktn/yr
Agriculture and rural population:	The sector has today 67% Hg HID lamps, 23% T12 and 10% GLS (the last one mainly in dwellings). Offer CFL for home lighting, replace T12 by T8 and introduce Metal Halide instead of Hg HID we can expect that 5% of the global potential can be captured.	350 GWh/yr	175 ktn/yr
TOTAL		**3.7 TWh/yr**	**1.85 Mtn/yr**

4. B. Recommendations for the replication and large-scale promotion:
Replication

The project is designed to have a balanced mix of capacity building and enabling environment activities tailor-made to Russia’s specific conditions, markets and regulatory environment. The project’s support to legislation and to industry will strengthen the likelihood that the replication will take place as planned. Such balanced mix of activities is expected to promote the application of EE lighting systems and technologies. Replication is an integral component of the project design as the expected energy savings from the application of EE lighting technologies in education and health buildings, residential sector and street lighting (and the corresponding GHG emissions reduction from the reduced electricity demand) rely on the replication of the relevant project activities.

Project legacy will live on in three ways:

- First, the project activities are designed to closely involve market stakeholders. This will empower many different market actors to promote efficient lighting in their own special interests;
- Second, the project will contribute to implement the institutional and professional decision-makers in the country to support ongoing growth of efficient lighting markets well into the future;
- Third, the project will leave behind a self-sustaining certification process to support market development for an expanded range of efficient lighting technology in Russia.

The pilots in Moscow and in Nizhny Novgorod region are being realized within the project and then will be replicated in five other regions. In addition, replicability of the proposed project components will be ensured through the documentation of the package of activities that went into each pilot.

Total benefits from the project

National benefits will be two-fold. First, thanks to energy savings from the project, projected to be about 4 TWh annually by project close, the Russian Federation will be able to avoid building approximately eight to nine 900 MW-power plants. Then, the project is expected to increase the quality of and demand for energy-efficient lighting products manufactured in Russia. This will stimulate the local economy. On the other hand, as actual average level of light (in lux) in the public and tertiary sector is very low and the introduction of new standards similar to western countries will imply an increase of the light level, and of course moderate energy consumption increase[11].

Local benefits will come in the form of reduction of emissions of acid rain precursors and other by–products of fossil fuel combustion. In the case of mercury, mercury emissions caused by fossil fuel combustion for lighting will be reduced; the project will also put in place a recycling protocol to limit mercury pollution from discarded CFLs. Local benefits will accrue in the pilots. It is expected that the Moscow pilot will concentrate on areas facing constraints on the electricity distribution systems. The pilot should avoid the investment in and construction of additional distribution networks.

Local benefits will also take the form of reduced energy bills for program participants, and an improvement in the quality of life for individuals who, thanks to the project, experience improved quality and quantity of light in their homes, streets, or workplaces.

[11] The growth will be moderate only if EEL are implemented otherwise the energy consumption increase will be proportional to the light quantity increase.