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EcoGrad

A concept for ecological city planning for St. Petersburg, Russia

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Abstract

The objective of the EcoGrad project was to develop a design concept of eco-efficient districts in the city of St. Petersburg. The important principles of the creation of this concept included the so-called GOLD principle (GOLD – Globally Optimized, Locally Designed). This meant that local conditions had to be taken into account while applying globally optimized solutions.

The EcoGrad concept includes dense city development, a minimal need for travel, a maximum use of public transportation and light vehicles, minimum power consumption, the maximum use of renewable energy sources and ecologically stable solutions concerning waste disposal and sewerage. Social and cultural aspects must also be taken into account.

In Russia, the creation of energy efficient sites is still in its early stages. Power supply systems based on renewable energy sources are also hardly known. On the other hand, the Russians are well skilled in placing offices and consumer services next to residencies. Regulations dictate the maximum allowable distances between residential buildings and such services as infant-care groups, kindergartens, schools, ambulatory clinics and stores, fully conforming to the principles of designing eco-efficient city districts.

While the project was being implemented, residents were polled. The polls revealed that the absolute majority of them (92%) did not consider the use of renewable energy sources important. Most of them (80%) had not heard of mechanical ventilation. Fresh air is considered important yet less than half of al respondents (40%) are prepared to pay for it. Involving residents in the development process, that is, the so-called LivingLab action is an important component of designing eco-efficient residential areas. In Russia, the participation of residents should be further extended and made a part of the design work.

The project concerned three pilot territories for which residential designs were made. The designs included estimates of power consumption and a study of the distribution of emissions when using various energy supply systems suitable for local conditions. Besides, a design providing for better ecology without any greater investment was made for one of the pilot sites. The PPP (Public-Private-Partnership) pilot project involved the development of practical models of project implementation.

While this work continued, seven meetings with representatives of St. Petersburg administration were held. During these meetings, a presentation of the components of this concept was made and opinions heard as to how its various sections would suit local conditions. These opinions were put in the basis of the list of the criteria of designing environmentally clean areas presented in this report. Local designers may use this list while searching for answers as to requirements to city designs which need to be met in order to make residential areas eco-effective.

Preface

Lately, in Finland, the planning of city districts with consideration of their environmental impact has been increasingly publicly accepted. The development of complex projects wherein all the various characteristics of a territory are considered at the very initial stages of planning has been accepted as an efficient approach. Developmental planning involves a large number of various aspects and its success greatly depends on local conditions.

At this time, in Finland, many projects aiming at making city development more eco-efficient are underway. The hard part here is developing approaches and methods that, while being universally applicable, allow for the specifics of particular territories. This is the essence of the so-called GOLD principle, GOLD standing for Globally optimized, locally designed.

The GOLD principle is used in the EcoGrad concept of eco-efficient development under the conditions existing in the city of St. Petersburg. It is worth noting that, where city development is concerned, St. Petersburg may show many things that have been worked out considerably better than their Finnish analogues. In St. Petersburg, construction is dense, while regulations require that services be placed close to residencies. Where technologies, economics and administration are concerned, Russia has a lot to improve. Bringing good, energy-efficient solutions to a greater market gives Finnish companies good opportunities. Yet for this to become possible rather large changes in the traditional managerial and maintenance models and procedures are required.

The EcoGrad project has attracted a lot of attention in both St. Petersburg and Finland. This means that there is demand in St. Petersburg for the skillful planning of environmentally clean city areas, while, on the other hand, there is interest in Finland for finding out what stages of development the neighboring country is going through and for commercial opportunities it presents.

The financing of the EcoGrad project comes from Finland’s Foreign Ministry. Once the project has been completed, the implementation of the technological solutions, the development of approaches to planning and the establishing of contacts will continue.

Contents

Terms and definitions

District servicing company: earlier, in Finland, such companies specialized in the maintenance and small repairs of buildings and sites. At this time, such companies also own public territories and premises and are responsible, among other things, for the creation of parking lots for motor vehicles. Maintenance and repair services may be subcontracted to outside parties. Servicing companies may be owned, for instance, by landlords, construction companies or municipalities.

APM: this abbreviation stands for Automated People Mover, an intelligent transit system.

Sun collector: these collectors accumulate solar energy used for heating homes. Collectors may be integrated into roofs and into the facades.

Solar panels: convert solar energy into electricity. The panels may be integrated into roofs and into the facades. Solar panels may power indoor circuitry or be connected to accumulator batteries.

Bio fuels: these are obtained from renewable sources of energy such as wood (often chips or pellets), biological gas that results from the bacterial decomposition of organic substances, straw, etc.

CHP: stands for Combined Heat and Power production. Heat and power plants may be fuelled, among other things, with biological fuels, natural gas or solid fuels. CHP plants are mainly connected to the district heating network and are mainly run based on the heat demand. The efficiency of such combined energy production is better than that of utilities producing heat and electricity separately.

COP or coefficient of performance: the heat coefficient or coefficient of conversion reflecting the efficiency of heat pumps. For instance, a heat pump whose COP equals 3 produces 3 kilowatts of heat energy using 1 kilowatt of electricity.

CO_2 equivalent shows the effect on global warming of a given type and amount of greenhouse gases, comparing it with the functionally equivalent amount or concentration of carbon dioxide (CO_2). The reference. **GWP**, that is, global warming potential is calculated with the use of coefficients.

EcoGrad concept: ecologically sustainable concept using the latest technologies for the construction of new residential areas in Russia.

Electronic commerce (eCommerce) is a service that enables shopping in the internet and having goods delivered to the clients' homes.

Environmental performance index is calculated as follows: the living standard index is divided by the harmful environmental effect index, multiplied by the use of natural resources index and by the cost index. Practically, the maximization of environmental performance means that, while pursuing higher living standard, a community may try and minimize the environmentally harmful effects of it and the use of natural resources. The cost of it is also taken into account.

Energy efficiency means the maximally efficient use of energy, that is, the minimum possible amount of energy is used with the maximum possible effect.

GEMIS (Global Emission model for Integrated Systems) is a computer program allowing to model life-time emissions of technological processes, including construction transportation, etc. The program uses a large database containing various technological parameters and amounts of emissions related thereto.

The GOLD (Globally Optimized, Locally Designed) **principle** means the principle of planning with the use of globally optimized solutions adjusted to local conditions.

Decentralized energy supply means that energy is produced locally, at a place situated near its users. Energy production units are sometimes rather small. Examples of decentralized energy supply are solar panels or collectors built into building roofs or fronts, geothermal units, wind-driven generators or heaters using wooden chips or pellets.

Air tightness is a property of a house or a building affecting the amount of energy needed to heat it. The better air tightness a building has the smaller air leakage factor it has and the less heating energy is needed. Air leakage of n50 shows how many times in an hour the air inside that building is replaced after it escapes through doors, windows, etc. when either rarefaction or overpressure equals 50 Pascal.

Waste disposal may be understood only as trucking the waste out. However, nowadays it may also mean the sorting and secondary processing of waste as well as the planned reduction of waste generation. Waste disposal, in full or in part, may be the responsibility of municipalities or private subcontractors.

Centralized heating and cooling is a system where heat or refrigerated medium is produced centrally at larger facilities and then transported to users through pipes.

City district or district: in Russia, it is the basic administrative unit approximately the same as a municipal in Finland.

Committees are, in St. Petersburg, administrative bodies responsible for various activities. Executive agencies cooperate with committees, while being subordinate to them.

Block/quarter is, in Russia, among the basic planning and accounting units used for planning services. When amounts of calculation are large, a block is good to use as the basic reference unit.

User-owner is, in Finland, a shareholder of a housing company or a Real Estate company who either himself uses or rents out the premises he (she) owns.

Ground/rock/water heating system collects heat using a system of pipes and a heat pump. Is used for heating buildings. Besides ground or rock, heat may be collected from a body of water, over 2 meters deep, such as a sea or a lake or a layer of sediments at its bottom. Heat consumption per heat pump depends on a pump's COP coefficient.

Low energy house consumes 50% less heat than buildings (houses) conforming to Finland's 2008 construction code. Heat consumption is reduced by, among other things, the use of enhanced insulation materials, increased air-tightness and more efficient heat recuperation. Such buildings (houses) must be designed by professionals cooperating with architects and by professional designers of engineering communications and structures.

Off-grid is an autonomous solution unconnected to other networks. For instance, in the production of electricity, this term means that all the electricity, heat and or cooling energy used in an area is produced locally, independently from other networks such as the national grid or central heating or centralized air conditioning systems.

The ownership, use and maintenance of Real Estate include a number of Real Estate management measures that may be taken as needed. Such activities may be performed by a single party or divided and subcontracted to outside parties.

A passive building (house) uses 75% less heat than buildings (houses) conforming to Finland's 2008 construction code. This is achieved, among other things, by the use of enhanced heat isolating materials, better air-tightness and more efficient heat recuperation. Such buildings (houses) must be designed by professionals cooperating with architects and by professional designers of engineering communications and structures. There are also other definitions of a passive building (house), such as the European passive building (house) [Nieminen & Lylykangas, 2009].

Wood chip plants are plants producing heat by burning wood chips. Often they are connected to the district heating network.

Financing means allocating and managing money needed for the functioning of a company or a person. Financing may come from an outside financing organization, or seller, or the seller's financing institution.

The construction of social housing, that is, most often, the provision, under the law, of housing to certain social groups with the use of incentives or grants that may be subject to norms regulating certain methods and levels of construction and the distribution of ownership.

SO_2 equivalent describes the quantities or concentrations of emissions causing acidulation. This is based on the relative acidity of SO_2 and is referred to SO_2, NOx, HCl, HF, NH_3 and H_2S emissions.

Client is the in-house or outside buyer of a product or service. Client is not always the same as a managing company or end-user.

Layout is the division of land, based on a map, a chart or an agreement, into units of use or ownership. This is a somewhat inevitable procedure if, in a market economy, a group of Real Estate objects is used as a circulating unit or a collateral.

TOPP equivalent (tropospheric ozone precursor potential) is referred to the mass equivalent of ozone generated from its prophase. TOPP reflects the generation in the troposphere of O^3 ozone that, in summertime, may, for instance, cause smog. The equivalent is calculated according to the relative degree of ozone generation due to CO-, NMVOC-, NOx- и CH_4 -emissions. The higher the TOPP equivalent, the greater the probability of summer smog). [GEMIS Manual].

Townhouse is a two or three-storey building, built within city limits on a separate plot of land, where adjacent units, each with its own entrance and of separate ownership, share common walls. Each unit may have its own fore and back yards. [Manninen & Holopainen, 2006]

Wind power is electricity produced by a wind turbine. Such turbines may be of various types and sizes. Small ones may be installed, for instance, on roofs. Turbines may have vertical or horizontal axes and may be used on land or sea. One should make sure that the frequency of occurrence and intensity of winds, in the area where a wind turbine is to be installed, is sufficient.

U-value is the heat conductivity coefficient characterizing the capacity of various parts of a building, materials or structures for conducting heat. The smaller the U-value, the better is the heat insulation and the less heat escapes from the structure.

Contractor is someone doing the construction of an object or its part. A contractor may be a company or a person hired by the client to independently complete the construction of that object or its part for him**.**

Collateral is a basic element of financing and ownership of a property, presupposing the sufficient level and effectiveness of a real estate system.

WinEtana is a computer program developed by the VTT for calculating electricity and heat consumption.

1. A description of EcoGrad concept

1.1 The EcoGrad project: general information

The EcoGrad project aims at adapting the new internationally tested EcoCity concept to residential construction and development in Russia. Formerly, exports were based on dealing with raw materials and ready products, yet now is the time for exporting integrated concepts, which are increasingly in demand.

An initial starting point was the continued exploration of the possibilities offered by traditional exports of projects. However, special consideration was given to the models of creating energy-efficient environments. Where conditions existing in Russia were concerned, the most important were the similarity of climates, the possibility of using renewable sources in the production of construction materials and, partially, the necessity of concentrating residential construction in large metropolitan centers, remote under-populated territories going deserted.

While implementing new residential area concepts and new production concepts intended for countries with transitional economies, one may use and further develop forms of ownership and Real Estate management. The creation of new forms of management, use and maintenance is not just necessary from the viewpoint of financing and financial guarantees but also from the viewpoint of the participation of residents in the costs. The introduction of the partial responsibility of residents for the costs, is also important because the implementation of various modes of energy efficiency always requires the motivation of end users in addition to purely constructive solutions. On the other hand, cooperation on the part of end users and owners is also needed where the making of basic investments is concerned. If, instead of normative regulations and client companies, residential construction relies on demand on the part of users-owners to be, the chain of ownership and maintenance must be functional.

The objective of the EcoGrad project was integrating innovational technologies that could be used in St. Petersburg into solutions implemented on the level of districts. Special attention was paid to enhancing the energy efficiency of territories and buildings and to designing, at the conceptual level, an optimal energy production system. This was done by analyzing pilot projects.

Besides, while the EcoGrad project was being implemented, contacts with administrative committees, such as the Committee for City Construction, and with St. Petersburg’s Chief Architect's office were established. Also, business contacts were established preliminarily. Entrepreneurs used their chance to comment on certain solutions used in the project.

The EcoGrad project was implemented in a rather short time, from January through November 2010. The project was financed by the Foreign Ministry of Finland. Locally, while the Coordination Centre for International Science and Technology and Education Programmes was a local partner in the project.

While working on the project, VTT researchers repeatedly met with representatives of the city administration. There were seven roundtable meetings in St. Petersburg and two in Finland. In August, a three-day tour of Finland was organized for Russian officials who were given a chance to have a better look at what energy saving technologies are being developed within the construction business in Finland. Besides, a presentation of the project was given in Russia during the ProEstate event, at the roundtable organized by the Russian innovational forum, at a lecture given at the St. Petersburg Institute of Finance and Economy and at the HVAC exhibition in Moscow. In Finland, the project was presented at an FRTP seminar and at the “Sustainable Building 2010” international conference.

1.2 The structural settlement models in the EcoGrad project

The EcoGrad concept is based on a territorial analysis, wherein, as one of its factors, we find an approach to city arrangement described herein, based on vast Finnish and international experience and know-how. One of the starting points of the concept is an analysis, on the level of designing pilot districts, that often enhances the applicability of theoretical models to practical investments.

Within the EcoGrad project, portions of and certain buildings to be placed on selected pilot sites, as per the general plan and wider city construction principles, were considered. Even though the applied concept was based on territorial thinking and on the advantages of large ranges, models were formed as per the outcome of studying certain individual objects. Results obtained at a single object may be replicated and “multiplied” within larger zones. Under the conditions existing in Russia, a study of objects creates an excellent foundation also because the rules and norms related to the ownership, maintenance and use of Real Estate are better understood if considered at the level of small projects. One of the principal reasons for that is, as a rule, in that, in countries with transitional economies, the skill of handling various infrastructural solutions is still underdeveloped.

Applying the EcoGrad concept to Russian environment, one must consider the local principles of doing technical calculations and designs. Besides, the new model of development and methods of management must sufficiently well answer the basic questions and conform to the ends of local organizations within the industry. In the case of St. Petersburg and Russia, the basic problem is residential construction in new territories meant to accommodate a certain known number of residents there. Even though, from the integral viewpoint, the objective is the enhancement of living conditions within a larger area, the basic principle is the number of residents to become the users and/or owners of the newly built housing. Under the conditions existing in Russia, the principal content of such a concept as EcoGrad is not just energy efficiency but also the new solutions it offers that will help enhance the living conditions.

1.2.1 General notes on the current situation in Russia

In October 2010, in St. Petersburg, a seminar on EcoGrad was held. Among other officials, the concept was presented to Victor Polischuk, the city's Chief Architect. He offered certain comments on the project and recounted the current situation and practices currently prevalent in Russia. Also, Anna Yegorova, head of the Economic Development Committee and Olga Madison, director, the For Eco-Baltic Region public foundation were in attendance.

Three million new apartment square meters are built annually in St. Petersburg alone. Most often, developers opt for 16, 20 or even 30-storey residential buildings. For instance, the NCC company builds very large residential projects in the north of the city. The Chief Architect wanted to know if this practice was still environmentally safe and if it had a future. As they say, some Russian developers maintain that such buildings are environmentally sound. In the Northern Valley residential project, the construction of 25-storey buildings is underway. The buildings are so tall that domestic hot water does not reach higher floors and needs to be additionally pumped. There is also a greater need for parking facilities, each family owning two cars on the average. Another current practice is demolishing smaller buildings in order to make room for high-rises. The Russian attendees also noted the importance of a balance between financial advantages and environmental safety and quality.

During the October seminar, it was also mentioned that new construction regulations were being developed in Russia and that, once introduced into practice, they would become law in St. Petersburg. Developers have been given an objective of reaching up to the construction standards of Europe. Changes are introduced little by little, being, at first, made rules and then laws. It was decided that the Architectural and Construction Committee of St. Petersburg would organize an expert examination of the engineering design, including that of parking zones, forest preserves and social facilities.

The volume of construction to be done in Russia is gigantic. In St. Petersburg alone, about 400 hectares of land should be developed to accommodate residential projects. Because there are lots of areas where construction is supposed to be done, the efficiency of developing projects is important. For instance, 15 kilometers of sewers must be built between the north to the south of the city. All these projects are being implemented simultaneously, making their coordination and control far from easy.

St. Petersburg's planning objectives include the development of new territories along the metro train lines. This should make transportation more efficient.

Supplying electricity here is a function of the state and other suppliers are not welcome. On the other hand, during the second meeting with Galina Polyakova from the Economic Development Committee of the Administration of the Moscow district, she said that Russia already had a law on energy, legitimizing small electricity suppliers mostly using renewable energy sources. She also noted that the costs and rates were important.

During the second PPP (public-private partnership) roundtable meeting held in St. Petersburg, the importance of land usage and layout matters came to attention. This was of special relevance to St. Petersburg. Land costs made a considerable portion of the overall construction costs.

1.2.2 The results of polling Russia's residents

The EcoGrad project included polling Russia's residents jointly with Finec (the State University of Economics and Finance) students. The person to contact was Maria Apresian, a lecturer. Thirty Finec graduate school students polled people over the period from October 20, 2010 through November 15, 2010. The questionnaires had been prepared by the VTT. The total number of respondents was 750. Of these, 600 responded over e-mail or telephones and 150 gave extended interviews. The purpose was finding out the opinions of the projects' residents concerning their living conditions and the housing.

Of the respondents, 62% were women and 38% were men. The average family size was between 3 and 5 persons. Their ages, education, and monthly incomes are shown in Table 1.

Table 1. The ages, education, incomes and housing statuses of respondents.

Age groups	15–20	21–30	31–40	41–50	51–60	>60
	9%	52%	12%	14%	8%	5%
Educational levels	Secondary education	Uncompleted higher education	Higher education			
	4%	20%	76%			
Monthly incomes per one family member	€100–€300	€300–€500	€500–€1000	> €1000		
	8%	28%	44%	20%		
Housing statuses	Home owners: 84%	Home renters: 16%				

Table 2. Polls summaries.

Questions	**Yes**	**No**
Have you had any temperature-related discomfort?	8%	92%
Is access to temperature controls important to you?	80%	20%
Is the inflow of fresh air important to you?	80%	20%
Are you prepared to pay for fresh air supply?	40%	60%
Do you know about mechanical ventilation?	20%	80%
Would you appreciate your building being heated by energy from renewable sources?	8%	92%
Is having your own vegetable garden or flower beds important to you?	36%	64%

1.3 A general description of the EcoGrad concept

The purpose of the EcoGrad concept is designing an eco-efficient residential city district, with Russia's local conditions in mind. The resulting residential project is a maximally environmentally efficient, successfully functioning comfortable living space. One of the significant components of the concept is integrated design. While various sections are designed, the involved professional designers of various specializations cooperate continuously. This helps to find the most optimal, where the complete result is concerned, solutions as concerns environmental impact, construction costs and the functioning of the whole. The EcoGrad concept follows the GOLD principle, GOLD meaning Globally Optimized Locally Designed. This means that the concept involves globally optimized EcoCity solutions adapted to Russia's, especially St. Petersburg's conditions and prerequisites. Once assigned to certain sites, more detailed designs based on the EcoGrad concept will be developed by local people having the particulars of the locations in mind.

When designing environmentally clean city areas, all the following components must be taken into account: the structure of the city, local conditions and starting points, buildings, energy supply, transportation, water supply, sewerage, water treatment, waste disposal and social and domestic matters. The matters related to the ownership, use and maintenance of the future Real Estate must be sufficiently decided at design time and relevant legislation and norms must be passed. Traditionally, various professionals consider these matters separately, each in his or her own way. Yet the EcoGrad concept demands a joint effort.

The basic components of the EcoGrad concept are shown in Figure 1. They include energy-efficient buildings, dense construction, the close proximity of offices and consumer services, functioning well transportation, a well-designed network of transportation routes, centralized parking facilities, an energy supply system using renewable sources and environmentally safe water supply, sewerage, water treatment and waste disposal. These solutions will be detailed hereinafter.

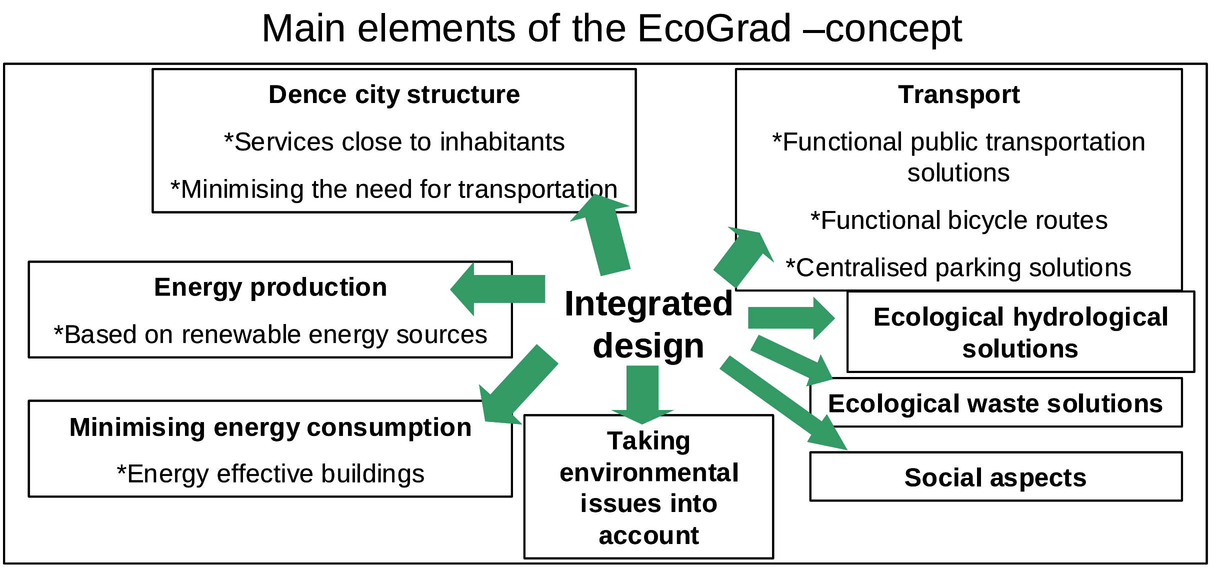

Figure 1. The basic components of the EcoGrad concept.

1.3.1 Dense construction

The EcoGrad concept welcomes dense city planning and construction. In this case, the construction of the same number of homes will require less land and community services may be located nearby. Besides, dense construction is the best way to decrease the need for travel, shorter distances inspiring residents to walk or ride bicycles rather than drive. According to Russia's current norms, organizations and service companies must be placed in a close proximity to residencies, so Russia has already taken care of this aspect of environmental safety. The norms limit the maximum distances to organizations and consumer service companies and determine their required capacities, which depend on the number of residents. The documentation on the 2nd and 3rd pilot projects contains information about these norms and a table that contains it is found in Appendix A.

Dense city layout involves a more careful planning of land and residential. For instance, Finnish experience, illustrated by housing fairs, shows that correct planning means the easier use of residential areas in the future. Excessive narrowness will cause difficulties in maintenance and repairs, which is especially true for northern latitudes. In Finland, there were problems with the current maintenance and repairs of Real Estates where there were no clear-cut division between the rights and duties of home owners and local servicing companies. This is why it is important take into account in the EcoGrad concept the traditional methods of land and buildings maintenance and repair, while also making use of the advantages of new small-scaled home ownership.

New residential projects should be placed near existing residential areas where public transportation and other basic services already work fine. This will allow to save on the construction of such city infrastructural elements as roads, transportation lines, power lines, district heating pipes, power substations, water supply, sewerage, etc.

Park zones and green corridors also serve as attractive pedestrian and bicycle routes. Besides, they enhance the environmental qualities of districts. On the other hand, they emphasize the aforementioned importance of the more clear division between the rights and duties of those expected to maintain Real Estates. In Finland, there have been negative occurrences when large client organizations and municipalities managed green zones while owners or end users had no say over what was going on there. Among other things, the EcoGrad concept is expected to preclude the occurrence of so-called no one's areas. When the concept is adapted to conditions which are very different from what the Finns are used to, adhering to local norms becomes very important. The ownership, use and maintenance of sites may conform to either regular rules or laws, although often there are handshake agreements and other local ways to deal with it.

Having fruit or vegetable gardens is gaining increased popularity in cities. The resident poll shows that about one third (36%) of all residents of Russia consider having gardens important. Suburban garden areas are environmentally significant, being a way of using local resources and of producing so-called slow food with no great environmental impact. It is good when suburban garden areas are located not far from residential districts enabling residents to walk or bike there and have less trouble taking care of their land. Garden plots may be either owned or rented by their users. Having a garden or a summer house is an old Russian tradition and it should be respected. If such land plots become part of construction designs or if they are supposed to be used in totally different ways, the possibility of changing their statuses should be considered and precisely found out, also considering that construction sites are becoming more expensive.

The poll also revealed respondents' living conditions and their attitudes towards various issues related thereto. Of all respondents, 96% live in apartments and only 4% live in private houses. Most of them (84%) own their apartments while 16% rent them. Most respondents would like to live in three to five-room apartments whose areas are in excess of 100 square meters. Most of them consider having balconies important. Most balconies are used as smoking or storage areas. Yet far from all respondents are prepared to pay for having balconies.

When a Russian buys or rents an apartment or a house, location is the chief consideration. The next most important things are layouts and prices. People want parks or gardens, stores, bus stops, ponds and such to be nearby. About three quarters (72%) of all respondents would like their windows to look onto parks, green zones, green courtyards or bodies of water. Just about one quarter of respondents do not care what they see out of their windows.

When developing a city construction design, one must consider local particulars and habits. The pilot project of the Pöyry company, detailed in section 3.1, makes a good example of that.

1.3.2 Energy-efficient buildings

An important aspect of the EcoGrad concept is the minimization of the energy consumption of a site. This must be especially taken into account when designing residential buildings because they consume the most power distributed to a district. The most significant requirement is the minimization of buildings' heat consumption. This may be achieved by building either low-consumption or passive buildings. The former use 50% less heat than buildings built according to Finnish construction norms of 2008. Passive buildings consume 75% less heat. The cost of the construction of low energy consumption buildings is 3% to 5% higher and the cost of the construction of passive buildings is 5% to 10% higher than that of regular buildings. In Finland, the technologies of the construction of low consumption buildings are generally accessible.

Beside other things, the heat insulation and air-tightness of those buildings are better than those of regular modern ones. They are equipped with mechanical ventilation systems effectively recuperating heat. Passive solutions using solar energy also make sense. When designing buildings, it is important to try and minimize, the need for cooling them in summertime. Otherwise air conditioners will drastically increase power consumption. For this purpose, for instance, various solar control systems are used. Windows can be equipped with jalousies, etc. Energy consumption is harder to control when heating water because it depends on tenants' behavior. Yet they may be informed of the need for controlling their use of hot water, so they don't let it run when they do not need it. Apartments may be equipped with water-saving showers, faucets, etc.

Minimizing the consumption of household electricity also seems hard, most of it depending on tenants' behavior. The Smart Meter technology helps to cope with that. It allows tenants to directly watch their electricity consumption in real time and start to pay attention to the consumption. This measure may be supplemented with an automatic (light/darkness controlled) notification devices informing tenants of higher rates periods. The system could inform tenants of when electricity price is lower and when it's higher because of consumption peaks. Research shows that very soon this technology starts compelling tenants to change their wasteful habits. Saving electricity results in lower overall energy consumption and, consequently, smaller energy bills. As to how much energy consumption drops, research results fluctuate between 2% and 18% savings, the average figures being between 6% and 12% [Neenan & Hemphill, 2008]. In addition to this, tenants may be persuaded to save electricity by, for instance, using more economical appliances, those of the A class or like them.

The introduction of energy efficient HVAC technologies is helped by the possibility of centralized purchases in an early stage, at lower prices. For that purpose, future users and owners should be given sufficient information about their future spending. For this system to work, the concept must sufficiently define the ownership and maintenance of apartments and the whole building in order to substantiate and correctly distribute investments. The new type of investments and building construction solutions require the calculation of the prices of completed units and the extent of added costs related to the use of new technological solutions. Construction and financing may no longer be based and, in most cases, are no longer based on mass solutions and traditional systems of ownership. Users-owners, renters and investors, with their differing variations and combined schemes, must be sufficiently accounted for if energy saving incentives are to bring results.

In Finland, varieties of passive buildings and houses are generally available. The issue has been studied again and again. For instance, the VTT had a project aiming at promoting passive houses, entitled The Promotion of European Passive Houses. The project literature included passive houses architectural, heat engineering, and constructive design and layout manuals now available on the project website [PEP].

The poll also revealed what the Russians thought about the energy consumption of buildings. Most of respondents (92%) were comfortable with temperatures in their homes. They believe comfortable temperatures important but not many of them are prepared to pay for them. Four out of every five respondents believe that their ability to control temperatures in their apartments and having an inflow of fresh air are important yet less then half (40%) of them would agree to pay for fresher air in their homes. About 80% of all respondents have never heard about mechanical ventilation. When adapting the technology of low consumption buildings to the Russian conditions, accounting for these circumstances and these attitudes is important. Adjustments must be made for difference in mentality and the basic knowledge of mechanical influx and extract ventilation.

All respondents believed that having electricity meters and comfortable temperatures in apartments was important and that monitoring helped preserve natural resources and save on energy bills. This should be also taken into account and used in future projects. It is important that residents be informed about why energy-efficient building should be built and why energy should be saved. Smaller bills are an effective motivation.

One of St. Petersburg's construction companies expressed its suspicion that officials may create obstacles when licensing the construction of passive buildings (houses). They say that, when applying for a construction permit, one is supposed to prove that the declared power and water consumption is realistic. People worried about ways to explain to officials that passive buildings (houses) use less energy and that is why the declared lower than usual figures are realistic. The company thought that explaining this to officials would be a problem.

1.3.3 Real Estate ownership, maintenance and repairs

The ownership and maintenance of uncompleted and completed apartments, buildings and sites is different in different countries. It all depends on the basic system of ownership. While planning EcoCity projects, the plans often begins with “Greenfield” projects, that is, construction would be done on totally undeveloped land. In reality it is seldom the case that the land plot hasn’t been earlier reserved or used for some other purpose. Very often, in countries with transitive economies, there are no problems caused by official discrepancies concerning land ownership, the system of ownership being just formed or non-existent. However, this also makes such projects risky. When it seems that the project uses no one's land, problems may arise with construction already underway or done, unless the issue of land ownership, management and maintenance is sufficiently clarified from the start.

Once the construction is completed, it is important to know, from the viewpoint of the future use of the buildings, who is going to maintain the site, who is going to profit from it and who is going to bear the risks that always exist. This goes not just for buildings but also for the land and the infrastructure. While EcoCity projects are relatively large, their implementation also takes a long time. The ownership, management, maintenance and logistics issues must be sufficiently clarified while the implementation of projects continues.

1.3.4 Energy supply

The EcoGrad concept provides for the use of energy supplies based on renewable sources, such as heat pumps when heat comes from the ground, rock or a body of water. There also may be boilers using wood chips or pellets or biological gas and combined facilities (CHP) producing both heat and electricity. There may be wind turbines or solar panels and collectors. In the future, fuel cells may also become an option. Various versions of power supply have been analyzed in paragraphs 1.3.3, 3.2.2.3 and 3.3.2.3.

Energy supply solutions may also use ICT technologies helping to forecast changes in networks and better prepare for the changes. The intelligent technologies used by power grids allow multi-lateral exchange of data between power producers, grid management and consumers, which allow to regulate electricity rates depending on the levels of consumption, allowing consumers to use advantageous rates and save on their bills.

Energy costs depend on local factors so completing a precise cost analysis would require a more precise research of all circumstances. The technologies provided for in the EcoGrad concept and used in pilot projects are so new for Russia that true costs are very hard to determine at this time. The costs of implementing new solutions are, as a rule, high at first but go down as experience is gained.

As to the use of wind power and solar energy, the profitability of such investments considerably depends on local climatic conditions. This is especially true where wind power is concerned. Special weather studies are necessary in order to make sure that the use of wind power in the area is advisable. The results of the use of solar energy mostly depend on geographical latitude and are not quite as uncertain as in the case of wind power. The practical use and economy of many energy supply technologies using renewable sources depend on various auxiliary and support systems. In many places in Europe, feed-in tariffs for electricity produced with the use of winds and sun are now in effect. In some European countries, investment subsidies are available. In Russia, similar support systems should be considered in order to give energy production from renewable sources and energy-efficient technologies a powerful push forward.

The price of electricity and heat also has a considerable effect on the financial advisability of the use of renewable energy. While energy at this time is not very expensive in Russia, the growth of the renewable sources of energy may be difficult. This also affects the profitability of energy-saving technological solutions.

Another substantial part of energy spending is related to connecting to the national electric grid and centralized district heat supply. According to the committees of the Administration of St. Petersburg, there may be parties in Russia interested in off-grid solutions affecting residential areas. The idea of paying nothing for energy transmission is rather attractive. Interest for off-grid solutions is reinforced by that, in this case, they make it easier to control deadlines, especially where energy supply is concerned.

Further on, while using the results of the research and applying them to particular issues, one should, once again, take a look at the people's attitudes. Most respondents (92%) see no added advantage in that their homes may be heated with the use of renewable sources, that is, "green energy". In the future, getting residents interested in renewable energy sources may be given more thought.

1.3.5 Transportation

Where transportation is concerned, EcoGrad's first priority is minimizing the need of travel. On the other hand, what's left of that need must be treated in the most energy-efficient way possible. The solution of this kind must rely largely on public transportation and light vehicles. The solution of the territory's transportation problem is, for instance, in metro trains, busses and bus lanes forbidden to other vehicles. Transportation must be designed jointly by passenger carriers and city planners together doing whatever possible to minimize the need for any personal motor vehicles. There are three ways to achieve that. They are as follows: the use of centralized parking areas located at the edges of the district, the possibility of parking near train stations and bus stops and the creation of advantages for pedestrian and bicycles. Importantly, the safety of pedestrians and cyclists must be assured. Bicycle routes must be available and must terminate at sufficiently reliable bicycle storage areas located near train stations.

Transportation solutions may be computerized so as to suggest, in real time, optimal ways to travel. Information may include optimal routes, bus route numbers, and waiting times.

In countries with transitional economies, transportation solutions depend on how advanced city planning is and on landownership. For both environmental and financial reasons, the construction of transportation infrastructures is better financed by governments (municipalities). In such situations, solutions based on market mechanisms do not necessarily work because the decisive factor is the use of city space. In many countries, Real Estate structures expanded uncontrollably forcing transportation underground or above the ground. The only thing else that is left are expropriations or buy-outs of land. In the EcoGrad concept, the important thing is that vast unused lands shown on cities' old plans be used by transportation infrastructures, yet, on the other hand, small proprietors' rights must be protected during both construction and use. International experiences prove that when large projects, while they are being implemented, ignore the current use of land and its residents, they considerably suffer image and time-wise and even more than that. From the viewpoint of international financing, finding out about the initial statuses of projects and their standing as concerns properties is even more important.

The poll also revealed the standing practices concerning the organization of transportation and the Russians' attitudes towards them. More than one half of all respondents (56%) own cars because they like being comfortable. Others either can not afford cars or (4%) they are afraid of driving them. Normally, car owners use their vehicles on a daily basis finding them more convenient than public transportation. In the meantime, three quarters of all respondents live in buildings situated next to public transportation routes. Most respondents find public transportation too expensive (€12, €80, €30, €24, €13, €60 to €70, etc.). Their estimates of the cost of transportation are very different. Just a few of the respondents said they were riding bicycles because most of them lived too far from their places of work or study. As a rule, Russia's residents use either their own cars or public transportation.

Environmentally safe transportation solutions are considered in detail in the description of the Pöyry pilot project in paragraph 3.3.6.

1.3.6 Environment-oriented solutions concerning water supply sewerage and water treatment

At this time, on the average, a resident of Russia uses 250 liters of water daily. In St. Petersburg, the organization named Vodokanal, with its five water supply stations, is in charge of water supply. Most water comes from the Neva river. Just 75% of it meets the quality standards for drinking water. The aging of pipes is among the greatest problems. [GES].

The systems of water supply and sewerage may be made more efficient and safer environmentally if they are decentralized and additionally cleaned. Computers, computer sensors and water-saving equipment will cut down consumption. Water consumption should be reduced to about 120 liters per person daily, which will help save energy used for water heating. There is also the objective of cutting the volume of biogenic outflow into the Gulf of Finland. [GES].

EcoGrad areas will receive water through pipes from local water supply companies. In St. Petersburg it is Vodokanal. Added purity of water will be achieved by the use of activated charcoal filters. Water will also be disinfected for safety. The water supply system should better use intelligent water networks capable of sensing leaks and using smart water meters. Besides, the domestic consumption of water should be reduced by installing water-saving appliances and low-pressure toilets. On the other hand, green water treatment technologies, where black waste waters are separated from gray waste waters, should be used. Those waste waters may be processed by decentralized biological water treatment facilities. Rain and snow-melt water should also be processed, which is done by environmentally stable urban hydrology using finer filtering, while diverting some rain water for irrigation purposes. Excess rain water may also be treated. [GES].

Water supply and sewer systems must meet the needs of consumers. water consumption should be closely looked at. It may be cut by the use of water-saving equipment and faucets. Water consumption should be metered unit-by-unit and water bills must reflect actual physical consumption. Sewer slit and other decomposing waste may be used for producing bio-gas that, in turn, may be used for producing added energy.

When designing street infrastructure, rain water must be managed and rain drains arranged in order to prevent flooding and make cityscapes more attractive and environmentally more diverse. EcoGrad areas must be equipped for managing rain and snow-melting water. Systems serving that purpose must be built at the time the rest of the infrastructure is built. As noted previously, in northern regions, construction planning must be more careful and landownership and land maintenance taken into consideration. This becomes especially important in wintertime, modern climatic conditions being such that raining and freezing are intermittent. Level marks must be paid attention to because excessive local water level differences even now cause water supply problems and, in Finnish cities, cause disagreements between neighbors.

Storm-water parks are among the principal zones of recreation. At the same time, rain water could be treated so that it later may be used for irrigating parks and gardens or the golf field provided for in the Pöyry project. Systems for collecting and treating rain and surface waters allow to preserve the environmental balance in the nearby bodies of water.

1.3.7 Environmentally sound waste disposal solutions

At this time, 232 kg of garbage is generated per each St. Petersburg resident, while in Finland 488 kg of garbage per person is generated. In St. Petersburg, over 70% of all garbage goes to landfills. The city has two compost plants using mechanical metal detection and separation. However, their output is of so low quality that it also goes to landfills. Plans are made for the reconstruction of one of the garbage-processing plants, so that more garbage may be reused. [GES].

The poll show that Russia’s residents do not collect or sort garbage for the purpose of its reprocessing, there being no equipment or system for garbage reprocessing. Residents of St. Petersburg find the problem of garbage very important. Representatives from the city’s committees say that this is a complicated matter and that the construction of garbage-processing plants in the state sector is too expensive while private investments in this business will hardly bring sufficient return.

In the EcoGrad concept, the solution of waste disposal includes sorting, reprocessing and transporting, while minimizing the amount of garbage that may drop into streets. The objective is 1) reducing or even preventing the growth of the amounts of waste, 2) preventing the loss of waste into the environment while transporting it, 3) reducing the amounts of garbage in landfills and the loss of it into the environment from landfills, reducing garbage pollution through waste reprocessing. The EcoGrad concept provides for the reprocessing of 70% of all garbage, sorting it at the places where it is generated. [GES].

The easiest way is sorting garbage where it is generated. This will require additionally educating tenants. There are various groups of waste that must be separated: organic and reusable (glass, metals, cardboard, paper and plastics). Also garbage that may be incinerated, hazardous waste and electronics must be separated. Garbage may be transported for further processing through, for instance, an underground automatic system. A system like that will save space, make outdoors better looking (no garbage cans) and reduce the loss of garbage into the environment. A system like that will be more hygienic and will make sorting easier. [GES].

For waste to be reused, an efficient system is needed, recirculation of materials being among the most important ways of keeping our environment clean. This will save materials as much as money and energy. Whole items and then paper should be the first to be reused, glass, cardboard, plastics, etc. must be utilized. If certain garbage may not be reused as such, it should then be used for producing energy. Dumping waste on landfills must be the last among possible things to do. The most rational way to reduce amounts of waste is buying and using less.

When looking for solutions of the problem of garbage, one must consider local conditions, such as the composition and location of waste and the ways of collecting it. The combination of waste disposal technologies will produce a solution for a particular area. If a collective system of garbage collection will be used, it should be created simultaneously with the rest of the infrastructure. The problem of waste should be combined with the problem of sewers. The so-called "green cleaning" technologies [GES] mean that sewerage silt and other organic waste may be used in the production of biological gas.

As mentioned above, garbage may be used for the production of energy. The biological gas may be burned to produce electricity and heat or may be used as motor fuel. Of course, the amount of energy contained in garbage produced in an area will not cover all its energy needs. So either garbage collected in other areas or other energy sources may also be used.

In Russia, the disposal and transportation of garbage are regulated by No. 155 governmental directive dated 10.02.1997, entitled "On the approval of the rules of the provision of services concerning the removal of solid and liquid domestic waste". However, there is no universal procedure of collecting garbage from residential buildings and no one is named responsible for it. There have been problems with garbage removal, especially in areas with small residential buildings. When the removal of garbage is the responsibility of local authorities while small areas have not enough money to do it, the owners of buildings or land may be made responsible for it.

In Finland, the responsibility for the removal and processing of garbage rests with building or lot owners. They must enter into agreements with waste disposal companies for the removal of garbage and the use of garbage cans – before their buildings or lots of land may be used. However, this guarantees only the removal of waste, while the responsibility for sorting and processing garbage still rests with tenants and garbage-processing companies. This is why EcoGrad projects must include provisions concerning the collection and processing of garbage at territorial levels. Measures taken and norms enacted at the level of buildings, houses and city blocks will make this effective.

1.3.8 Social aspects

The social aspects, like those concerning cultural and historical objects that may be found in sites, must also be taken into account at the design time. Residents must be afforded public places where they may socialize. Involving local residents in designing their living space is wise. This is usually called Living Lab methods that are under development also in Finland. Involving residents in city planning is a good way to meet their requirements. When planning areas and buildings, designers must assure normal transportation and make sure that the handicapped are taken care of. This means new requirements that projects must meet. Area security considerations are also important. According to the poll, 72% of all respondents do not feel safe where they live. According to the poll conducted in Finland in 2009, 81% of city dwellers believe their districts to be fairly or very safe. In small towns and villages, this figure is 90%. [Suominen, 2009]. However, when planning to move to another place of residence, the Finns think about security. When buying homes, people want to live in secure places that have alarm systems, surveillance cameras. They would live next to expensive restaurants or hotels that try to make their areas secure. Neighbors being nearby and the close proximity of police also seem good.

Demographic studies are important also because the functionalities of various zones of residential areas must be analyzed far ahead of time. The lack of demographic variety will cause problems when, further on, new residents arrive requiring new kinds of services. This is especially significant when the previously existing services must be discontinued. Finland has certain experience managing areas in need of special measures following rapid changes. Of course, most often, the need is known but those who can responsibly meet it are lacking. The EcoGrad concept may help to know ahead of time that the locations of offices and consumer service companies may need to be changed sooner than in ten years if the need for certain services diminishes rapidly. Housing management may also be re-planned with the natural replacement of population altering the distribution of categories of residents.

Also, the rules of housing planning, housing financing schemes and the overall attractiveness of areas to potential clients must be given consideration.

1.3.9 Information management in districts

Concerning the management of information, local cultures must be considered. Different people have different attitudes towards collecting, accounting and saving data. The already existing pools of Real Estate dictate their specific demands. Collections and analyses of data may not be very effective if there is no sufficient initial database concerning the objects and sources of data. The EcoGrad concept helps to resolve this important issue also.

EcoGrad projects must meet requirements and provide solutions related to computer technologies and communications. Among other things, they may affect the identity of the area. Yet there is a need for basic information related, for instance, to the consumption of electricity and heat by tenants and buildings. At this time, in Russia, the GreenCities EE 30 project is being implemented by VTT, its financing provided by the Foreign Ministry of Finland. The objective of the project is accounting and analyzing energy consumption in buildings.

The EcoGrad concept offers the possibility of continuously documenting the total pool of Real Estate and infrastructures, beginning from the initial design, so as to make possible area and building management and such related actions as accounting the consumption of, measuring and collecting other data. This will allow to bring the analysis of the existing pool of data to the level, which is normal for Finland, the data being reliable and recorded in uniform measurement units.

1.4 The EcoGrad certification procedure

Russia has a widespread tradition of regulating construction industry and certifying construction materials. Because flexible and continuous construction is among the significant elements of the EcoGrad concept, there must be sufficient preparedness at the conceptual level as well as at the levels of production and financing. On the other hand, the adaptation of the new type of method to the very large construction market requires, at least to a certain degree, careful regulation. Beside affecting production management, this principle also concerns the new forms of Real Estate ownership and maintenance emerging in response to the significant increase of the number of participants, that is, owners, users and tenants. This is to say that certification is not just the established way of completing documents by officials but also the way of bringing products to the level of end-users.

The EcoGrad certification procedure is supposed to give a steady life-supporting impulse to the system of ecological classification. The basic idea of EcoGrad is about, on the one hand, avoiding the creation of so-called elite areas, especially because, even if they may be excellent, their numbers will still be too small for any significant environmental impact. On the other hand, there is the need to increase the attractiveness of the areas and this is why regular solutions used in mass residential construction are rejected.

Under the conditions of Russia, it is important to give consideration to such circumstances, image-related issues being central to commercial activities when new solutions are commercialized. In Russia, avoiding the reiteration of errors typical for the mass construction of the Soviet time is very important.

One of the principally important aspects of the EcoGrad concept is the forming of the system of certification or a similar classification based on international norms and the already tested EcoCity concepts. At this time, in a number of countries, ongoing developments are mostly based on Western European or American systems.

Because the development of the EcoGrad concept is still mostly in the stage of making definitions, the introduction of more complicated procedures does not seem possible. At this time, the following points may be isolated:

1. The energy management of buildings
2. The environment-oriented communal infrastructure
3. The user / owner-oriented structure of Real Estate.

The first of these items is directly related to searching for right materials and identifying premises and equipment at design and construction time, now entering the practical phase. The second item will be considered during the first phase, that is when substantiating the planning. However, the infrastructure-related issues will remain important during all the stages of the concept implementation. Its cost is a large part of the cost of transportation and other inevitable costs. The third item is important from the viewpoint of practically dealing with investments because no new city may be created for undefined users under either EcoGrad or EcoCity model. The creation of a so-called “no man’s land”, especially within a small area, is a very bad idea as concerns both the costs and quality.

Where EcoGrad is concerned, certification means the application of international norms that have positively proved themselves in other countries being applied to their environments. Dealing with Russia, one should consider a large number of local regulations and rules and their specific requirements. During the further development of EcoGrad, it should be still possible to focus on energy supply issues so as for them, on the one hand, to conform to local norms and, on the other hand, to meet the requirements of owners and users. Many certification instruments and methods used today are mostly used at industrial companies and are suitable for large settings. As the development of the EcoGrad concept continues, certification may be found useful to end users also because the energy consumption of buildings and settlements is, in the end, the consequence of decisions made by actual owners and users/owners. This means that, from the viewpoint of certification, it is important that the profiles of Real Estate users were sufficiently under control.

1.5 Export partner groups

According to its initial objective, the EcoGrad concept aims at supporting Finnish companies in their export activities. This means that it is advisable to bring the usual Finnish practices into the model adapted to local conditions. That would give potential exporters competitive advantages on the international market, Russia being a part of it. The typical objects and features include the methods of industrial construction, which, however, should be treated with care so as not to promote the methods of low quality mass construction. While implementing this research project, the wide scale of considered issues prevented the namely export partner groups from being launched. Traditionally, the organization of work according to the export partner group aims at promoting companies' foreign dealings through developing models of solutions that pick out appropriate channels and technologies out of the vast field of activities. The objective of this project is finding out certain basic points that may become problems for business, trade, and exports.

Typical examples, especially in the sphere of services, are fields where, because of local cultural or other particulars, outsiders have problems finding out for sure about the true organization of services. On the Russian market, such is the example of communal services. When newcomers cannot understand the mechanisms of ownership and maintenance then the identities of recipients of services and relations between clients and suppliers may cause problems. The typical examples are home security systems. They are too dependant on clients and users and there are lots of other services provided in addition to technical solutions. If the future mode of property and maintenance is unknown, solutions concerning purchasing services may be quite different than those designed into the scheme.

1.6 The criteria of the EcoGrad concept

The objectives of the EcoGrad project included finding out the criteria that should be met by an eco-efficient area in Russia. Beside the general list of criteria, there are more detailed directions and notes especially concerning St. Petersburg. All these are presented in Table 3. The list of criteria was formed with the use of both international systems like LEED and BREEAM and national sources like HEKO, etc. in their parts applicable to the conditions of St. Petersburg. The list is divided into the following sections: city planning and the functional construction in the area, environment and terrain, buildings and transportation, waste disposal and energy supply.

Table 3. The criteria of the EcoGrad concept.

Overall criteria		**Details / directions**	**Special notes concerning St. Petersburg**
Planning structures / functional planning	Dense city planning	Area efficiency factor (the total area of floors divided by the area of the district) must be sufficiently high to assure there being a sufficient client base to make services profitable.	St. Petersburg's city planning is already dense, yet eco-efficient type "low and dense" is not there.
	Short distances to places visited daily, such as offices and service companies	Distances to places visited daily should be under 500 m.	This requirement is present in the current regulations.

	Green zones, and other recreational areas	Safe and attractive pedestrian and bicycle routes.	Growing passenger car traffic will require taking special measures.
	Public places in buildings and city blocks	Such as clubs, public saunas etc.	New types of saunas resembling aqua parks in common use areas.
	The locations of buildings	At the early design phases, to pay attention to the creation of microclimates: sunny courtyards protected from winds, optimized infrastructures, etc.	The joint efforts of power and water supply, sewer and transportation companies.
	Contaminated soil treatment	The closer to the place of used contaminated soil it is treated, the shorter its transportation routes are. However, the treatment may be hazardous, which must also be considered.	
Surrounding terrain	Surrounding terrain must be taken into account	For instance topography, nature types, etc.	
	Waste, rain, surface and subterranean waters	Sufficient absorption areas, coatings and the use of rain and gray water must be included in the territorial general plan.	
	Floods	The detection and analyses of risks, construction restrictions, protective measures, etc.	Local residents remember the history of the Neva River floods very well. They are the consequence of the "bathtub" effect of the Baltic Sea.
	People may grow fruits and vegetables in their courtyards, in nearby courtyards, on balconies, roofs, etc.		In very densely planned districts, such as St. Petersburg's high-rise-building areas, this may not be readily available. Because the air is badly polluted, certain areas (like those along large highways) should not have this criteria included.
	The ability of growing and purchasing food just steps away and closeness to nature create natural dependency on clean food produced right outside one's door		
Buildings	The enhancement of the energy efficiency of buildings through buildings'- and blocks' architectural planning	Clear-cut forms of the buildings and deep frames result in smaller amount of exterior walls and less heat loss. Living rooms could be on the southern sides of buildings; solar shading.	The minimization of exterior walls cuts down on construction costs but influences the architectural design, apartment planning, the natural illumination of rooms, ventilation, etc. Good end results require good designs. If the energy efficiency stays well below passive house standards this has an impact. If St. Petersburg wants to reach European energy efficiency, this becomes irrelevant.

1. A description of EcoGrad concept

	The use of ecological and safe construction materials.	The classification of materials according to their emission classification: Good (M1).	
	Efficient ventilation with efficient heat recuperation	Mechanical ventilation. Turnover factor of air > 0.5 1/h. Heat recuperation: at least 60% of heat contained in the air in a room must be recuperated.	Mechanical ventilation is unknown to many. People feel uncomfortable by very technological solutions. Maintenance and repairs must be accounted for and the importance of ventilation explained.
	Structures must be highly insulated and air-tight	The coefficient of the heat conductivity of a wall must be less than 0,12, that of a roof < 0,08; the coefficient of air leakage must be < 0,04.	Emphasize the inseparability of air-tightness and good ventilation.
	Energy-saving windows and doors	The coefficient of the heat conductivity of a window < 0,8, that of doors < 0,4.	
	The availability of building maintenance and safety services in the area must be assured	Technological solutions, such as mechanical ventilation, require well organized maintenance.	In Russia, this seems to be a problem. The organization of Real Estate maintenance is aggravated by the vagueness of the system of ownership and management and the unavailability of data as to the condition of indoor systems. In St. Petersburg, security is an important consideration.
	Flexible multi-functionality of public places	The use of public places as, for instance, clubs reduces the need for travelling outside the district; it also gives people a team feeling and enhances security. These places may also be used as information centers.	
	Account for embedded energy in construction materials and greenhouse gasses related to the materials	For instance, wood is often safer environmentally than concrete. [Lahti *et al.,* 2008]	There will be a need for more precise instructions, a list of materials and energy loss related to them. These figures must be possibly locally adjusted to reflect local conditions.
Transportation solutions	Safe and high quality transportation routes	Bicycle routes must be separated from pedestrian and motor vehicle routes (except for blind streets, courtyards and buildings' driveways). There must be safe bicycle keeping areas in courtyards and at rail stations.	Because of intense car traffic and safety hazards, bicycles are not very popular in St. Petersburg.
	Centralized parking facilities	Exclude parking in front of every building and entrance. Create electric cars charging facilities.	Norms dictate 80 square meters per car space, plus 50% of the number of car spaces.
	Easier to use public transportation	Bus stops next to residencies, parking lots for cars and bikes near rail stations. Locks for bicycles.	
Waste disposal	The territory has waste collection points and near residencies	What should be sorted depends on what may be processed nearby. Coordinate with neighbors or the city.	The poll shows that St. Petersburg's residents do not sort their garbage for the lack of technical means.

	Underground disposal systems	Allows to sort garbage right where it is generated. There must be a minimum number of residents for the system to be viable. Reduces territorial transportation problems.	In St. Petersburg, underground construction is difficult because of technical properties of the soil. Will there be a solvent demand?
Energy supply	The maximization of the use of renewable energy sources for heating	Technical solutions for buildings, such as boilers using woodchips or pellets, solar heaters or heat pumps.	As to bio-energy, find out if the energy source is available. In the case of heat pumps, find out the composition of ground or rock.
	The maximization of the use of renewable energy sources for electricity	Renewable sources for electricity: solar panels, wind power, shares in large wind generators, CHP plants using bio energy sources. Heat and electricity storage solutions.	As to wind power, study local winds situation. As to bio-energy, find out if the energy source is available.
	Energy saving solution for street and other outdoor lighting	LED technologies. Rational lighting designs.	

2. The factors affecting the implementation of the project

2.1 The difficulties of the implementation of the project

The starting points of the EcoGrad project included the launching of traditional exports and measures it required, such as various export partner groups and similar complexes of marketing measures assuring end results. While analyzing this concept, such spheres of design and development were paid attention to where selection criteria might appear advancing the efforts of or precluding various companies from taking part in its implementation.

On Russia's market of Real Estate and construction, local norms and rules are among the central factors. This project does not include an in-depth study of norms because the field is large, while the ways of obtaining construction permits are learned in practice. Formerly, during the early stages of transitional economy, the focus was put on tracing various new regulations, knowing norms and rules and understanding foreign influences, related to the above. Once things stabilized, such studies of legislation and norms were done by third parties hired for the purpose. However, the central moments, like the matter of the ownership and use of Real Estate or concluding agreements must be studied in detail by companies involved. New concepts require that people be careful, especially in Russia, so as not to try and sell services that have not been finely tuned.

The most typical selection objects are as follows:

1. Construction sites and whether or not large developers are welcome. In Russia, this should be found out from tender conditions.
2. Financing: whether or not to try and sell at top price or consider the quality of environment as the first objective. The EcoGrad concept offers a good chance to do truly social residential construction.

2.1.1 Completion timetables

The EcoGrad and EcoCity concepts rely on international, especially European experiences and models. Additionally, in Finland, various projects of the type Ecological Village were implemented and measures are taken to promote the conceptual model to territorial objects. Besides, it is important to note that the sizes of the objects that have reached the Finnish market are ten times smaller than the sizes of the objects to be constructed in Russia.

Considering that the sizes of objects considerably fluctuate from are to area and from environment to environment, and that the conditions are often very different, the timetables also significantly differ country to country. Lately, in Russia a number of projects, especially infrastructural ones, were completed fast, so the traditional ideas of long-time construction are no longer actual. Construction length is very much affected by the basic preparation for implementation, that is how well defined are land ownership, financing, and future use. As the result of the implementation of the EcoGrad concept we may see progressively fewer unfinished objects or even fully completed buildings and city blocks where the issues of ownership and management are so undecided that they preclude any use of such buildings.

2.2 The particulars of demand

In Russia, when polling residents, one must take into account the particulars of local traditional public culture where, in building management, significance is given to the human factor, the accessibility of data concerning Real Estate, and the individuality of environmental choices. The practice of dividing responsibility that works well in Finland may not be simply transplanted into a different economy.

In the EcoGrad project, when selecting pilot objects, attention was paid to their conformance to the requirements of the concept and, on the other hand, to its being interesting to the city and companies that will take part in the implementation. Now, there is a problem concerning such conceptual projects. When the objective is simultaneously constructing a large object and doing something about long-term maintenance costs, one must consider the future user. The first thing to pay attention to is land ownership rights and construction planning.

One of the starting points for the concept was the development of new models for the maintenance of the apartments, the whole area, different social services, and the energy supply systems. This does not directly result from the implementation of the project and there is no intention of exporting any Finnish or international models of financing and management into Russia. Since the ways of administering and the form of ownership are expressly local and since the new solutions have just recently been tested in Finland, analyzing local methods as applied to EcoGrad makes sense.

In Russia, even since the Soviet times, there has been a cooperative form of apartment ownership that, early in the 1990s, covered between 7% and 8% of the total number of residencies. The system was popular and purchasing a cooperative apartment was very difficult because demand was high while administrative obstacles were considerable. People still remember the positive aspects of this system and it was a good basis for transiting to new forms of ownership and management.

At this time, in St. Petersburg, there are three forms of apartment ownership and building management:

1. The direct building management by apartment owners
2. A cooperative of apartment owners
3. Management by an outside company hired for the purpose.

According to the law, apartment owners must select one of the three forms of management. There is no way for so called "dark buildings” to continue to exist. The law defines precise time constraints for operations, allowing for no dragging one’s feet as before.

From the viewpoint of the EcoGrad concept, every management version allowed by law has its positive aspects. This, for instance, concerns energy supplies, technical maintenance and repairs. Version 2 is being boisterously discussed in St. Petersburg. It is fraught with various practical problems, which means that it is not the number one choice from the viewpoint of the concept.

If one of the objectives of the concept is motivating residents for environmentally safe practices, then version 1 is the right way to go. It makes a lot of demands on its participants and is considered the right way for so-called active citizens. If, simultaneously, local small business is to be supported, this version is the best of them all.

On the other hand, assuming that also in Russia, residents have an increasing tendency towards purchasing outside services, version 3 becomes a comprehensive solution for residential areas, offering a better quality of service and more services that in the case of the first two versions. Even though, no in-depth analysis of the use of Real Estate and of maintenance spending was done within this project, correct solutions were found while it was being implemented.

As was previously established, work on the personal level is important in the culture of technical services. This is a significant component of services in general. It is also interesting because the rapid transition from the Soviet economy to the new one also changed the sphere of services in many ways.

Traditionally, in Russia, all activities were divided into individual and organizational. After the end of the Soviet period, there were just very small amounts of medium-sized businesses. What is important where the organization of the technical maintenance and use of buildings is concerned is that there are very small scaled, one-person-companies on the one hand, and, on the other hand, big energy companies where the price to costs ratio is not very important.

2.3 The viability of the Public-Private or Private-Private Partnership

The infrastructural solutions of the EcoGrad concept (energy, waste, water, sewers, transportation, etc.) are based on new technologies and new business models, to which public-private-partnership schemes are naturally applicable. Some EcoGrad solutions are so multifaceted that there is a need of private companies to design, service and maintain them. Without private players, these technological solutions do not guarantee the fulfillment of environmental objectives and that they will work as planned. The reason is that very often systems require special skills and, beyond the stage of construction, technical maintenance.

Local situations on Real Estate markets considerably affect the forms and ways of the implementation of public-private-partnership projects. What is typical for the St. Petersburg’s market is that, over the recent twenty years, city projects would go through many cycles of development and deal with many local and international companies.

The explanation of Russian ways of calculating service volumes came from local developers. However, the public-private-partnership models often require different solutions from case to case.

Up to the latest years, In Russia, construction companies used various financing schemes, depending on sales. The principal problem was in that very often, because of the backwardness of the banking system, developers did both sales and financing. At the earliest stages, buyers supplied the money, making their down-payments and then becoming shareholders of projects. Now, standard loans and mortgages becoming common, developers may concentrate on what is their principal function.

In Russia, one of the Real Estate financial solutions was the scheme, in which the General Contractor paid subcontractors with a pre-agreed number of completed apartments. Sometimes, this caused problems when apartments were sold and caused uncertainty among buyers.

Agreement schemes must be better worked out within the project. The procedures related to the participation in it of official agencies must be also analyzed in more detail. In this report, this is no more than just mentioned. However, later, it should be looked at more closely in connection with creating new technologies and procedures, such as the approval of planning and allocating plots of land.

Public-private-partnership schemes were also used in various infrastructural projects, such as the creation of water treatment plants, roads, airports and hospitals.

2.3.1 An overall description of the public-private partnership (PPP)

Public-private-partnership may help to cut costs during both the period of investing and, later, during use, if an efficient private company is brought into the schemes of governmental or combined financing.

The use of public-private-partnership schemes may help to cut the costs during either period if the use of an efficient private company is combined with the advantages of combined financing. The use of public-private-partnership schemes brings many advantages. The results are made better by the use of innovations. Environmental protection also becomes more efficient. The most widespread schemes are shown in Figure 2.

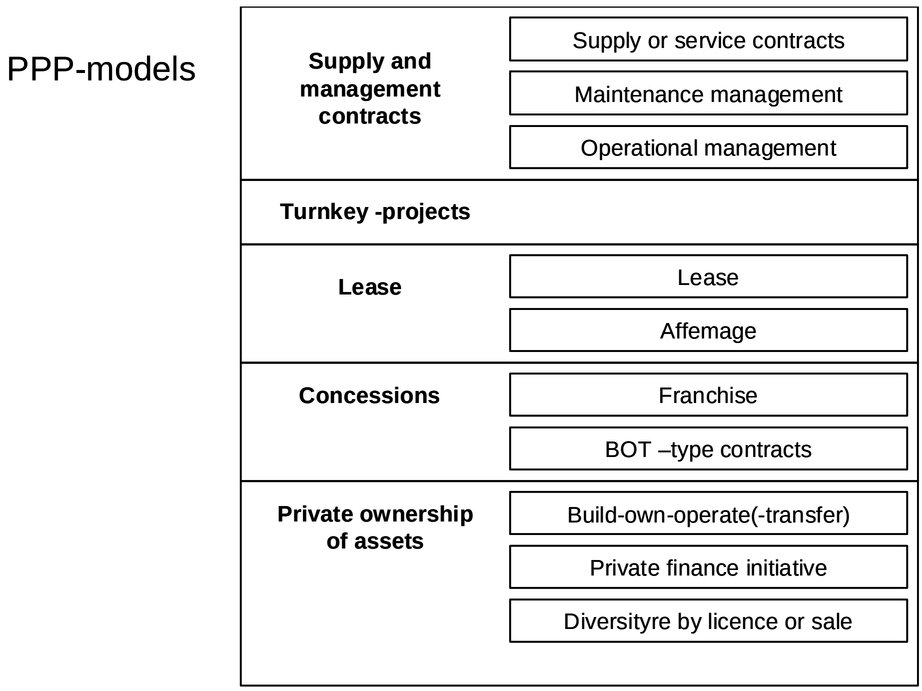

Figure 2. Public-private-partnership schemes of various types.

Management agreements may be useful, for instance when a new company is founded or local resources limited. For instance, in a city, transportation services may be provided by private companies under agreements. In the simplest case, a private company is paid a fixed fee for maintenance services it provides under an agreement. There may be more complicated agreements, providing for higher incentives. They may define objectives and planned results, the fee being commensurate with success.

In public-private-partnership schemes, leasing means that a company undertakes the use and maintenance of certain infrastructural systems and provides certain services yet, as a rule, does not make any commitments to make larger basic investments. The difference between leasing and outsourcing is in that a lessee collects rent from clients and users and makes lease payments provided for in his agreement with a state agency, while a hired company and its employer, a state agency, share the money paid by users in a pre-agreed proportion.

In case of a concession, state agencies define and afford to private companies the rights to build and maintain certain systems or to provide certain services over certain periods of time provided for in their agreements. Normally the lengths of such periods fluctuate between five and fifty years. State agencies remain the owners of the systems or the rights they afford to concessionaires. In this form of public-private-partnership, payments may be made on as-needed basis. A concessionaire pays concession fee to the state while, in case of a hired company, the state pays the company for doing something under an agreement.

The concession models fall into two subtypes: franchise and BOT (Build-Operate-Transfer). The difference is in that a state agency, franchise grantor defines the amount of service and is prepared to pay, while BOT means that the state sets certain quality requirements and is not necessarily financially responsible.

A franchise holder provides services defined by the franchise grantor. A private company runs the involved commercial risks and makes investments. This is a typical business scheme used, for instance, by passenger and cargo carriers.

Under the BOT model, the licensee (concessionaire) undertakes to make investments, use and maintain the subject of concession over a pre-agreed term and then deliver it back to the concession grantor. A private company undertakes to design, build and use buildings and/or infrastructures. There are also other alternative models: BTO, that is, Build-Transfer-Operate; BROT – Build-Rehabilitate-Operate-Transfer or BLT – Build-Lease-Transfer. There are also such schemes as BOO – Build-Own-Operate or Design-Build-Finance-Operate. They all define how a private company goes about handling facilities or providing services. A typical scheme of the BOO type is for a state-owned entity, such as an electricity supplier and distributor, to enter into a long-term agreement (an off-take agreement) for purchasing power from the operator at a certain price.

2.3.2 The use of PPP schemes in Russia and St. Petersburg

Russia’s laws and norms must be taken into account when planning public-private-partnership schemes. Russia has a law on concession agreements and the city of St. Petersburg has its own regional law concerning participation in public-private-partnerships. In the city, at the committee on investments and strategic projects, there is the public-private-partnerships and legal coverage agency responsible for supporting and managing the current and future public-private-partnership projects. Its objective is assuring that the city receives the maximum added value for its use of public-private-partnership schemes.

The city appoints a certain organization to every public-private-partnership project, thus assuring that preparation and implementation are taken care of. The principal participants, whose activities are assessed and compensated for are answerable to the administration. As a rule, most employees are well informed of the technical and financial details of projects, especially where public-private-partnerships are concerned.

A public-private partnership may receive a financial support. The support may come from the investment fund of the Russian Federation or the Vnesheconom bank, the development bank of Russia.

2.3.3 PPP schemes at pilot sites

The public-private-partnership models are considered from two starting points. The first point is the Morskoi Fasad (Seafront) pilot project, considered in detail in section 3.3. Solutions used in this project are subdivided into five sections: energy supply, waste disposal, water supply and sewers, transportation and ICT. Acceptable public-private-partnership schemes are outlined for each of these sections. The Global EcoSolutions, Ltd. company prepared the public-private-partnership schemes shown in Appendix C.

Energy supply to an pilot PPP project is based on decentralized energy production using renewable sources. A good scheme for this is FBOOT – Finance, Build, Own, Operate, Transfer. A private operator designs, brings in the money, builds, owns and operates the energy supply system for a certain number of years, normally 20 to 25. Investment and operational costs are covered by subscription fees. The private operator undertakes the production of energy and its transfer to end users, buying deficient amounts of it from a state-owned company (SOC-1), tuning and servicing the grid and maintaining the necessary infrastructure. The holder of the network undertakes purchasing excessively produced electricity, heat and chilling energy and affording the necessary reserve facilities for a certain period of time. After the expiration of the term, the holder of the grid becomes the owner of the whole system. The structure of the FBOOT model and the distribution of functions, as concerns electricity supply, are shown in Figure 3.

Applying PPP models to energy supply, one must take into account the particulars of the local economy. When introducing new PPP schemes, there was a problem. The problem was the Russian legislation that, in the opinion of local professionals, does little to allow to directly introduce new methods into practice, at least for now. Secondly, when planning the layout of the area, the layouts of the whole area adjacent to the seafront and the possibility of tapping into the networks of the neighboring districts should be considered. Finally, one should look at who owns the grid. The local professionals believe that energy supply, if the FBOOT scheme is used, may be possible only if the interests of the state-owned company are guaranteed.

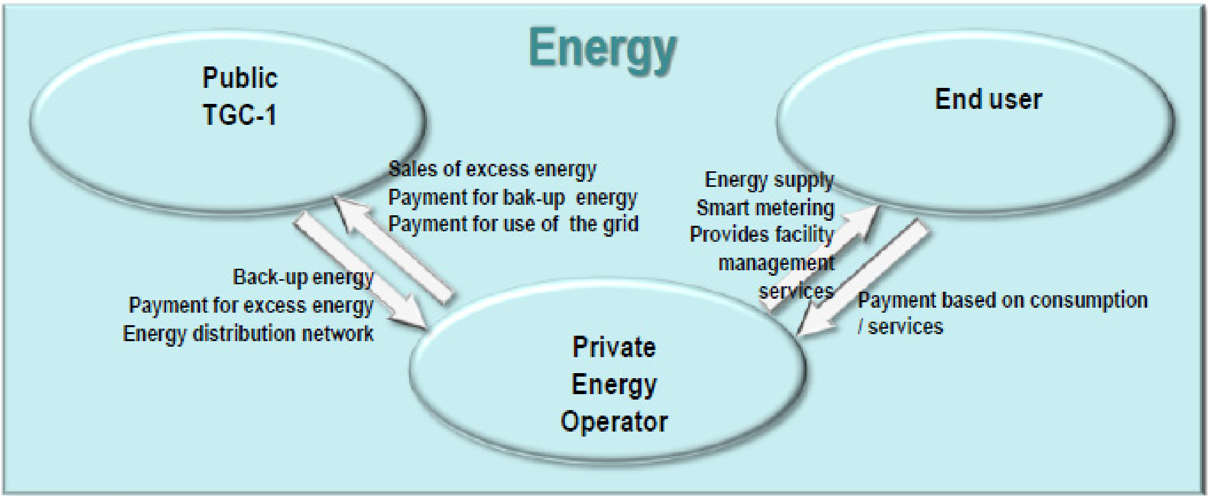

Figure 3. The structure of the PPP model and the distribution of functions under the FBOOT scheme.

The environmentally safe solution concerning waste disposal at the pilot PPP project is based on decentralized and automated operation under the FBOOT scheme. Private FBOOT operator designs, brings in money, builds owns and operates the waste disposal system for a certain number of years, normally 20 to 25. Investment and operational costs are covered by subscription fees and payments on the part of the state-owned operator. The private PPP operator undertakes the collection, sorting and removal of waste, its delivery to waste processing plants, servicing, billing and the maintenance of the necessary infrastructure. Besides, the state-owned operator undertakes the further processing of solid waste.

However, the FBOOT model is not entirely applicable to waste disposal. The decision making powers of the private operator must be limited, the whole system being of the municipal nature. The operational aspect of the system is limited by, for instance, the conditions of a concession, leaving it to the municipal agencies to define service rates, etc. In this case, the private waste disposal operator does exactly that, disposal, including the collection, sorting and removal of solid waste. In the meanwhile, after a certain period of time, the waste disposal infrastructure becomes municipal property. Figure 4 shows the distribution of waste disposal functions under the PPP model.

As concerns waste disposal under PPP scheme, local conditions, such as the availability of utilization plants, their specializations (metals, glass, paper, plastics and organics) and locations must be taken into account. Also legislation concerning waste disposal monopoly and the construction of biological gas facilities must be considered. Also, one must take a look at how these issues are handled in the adjacent districts.

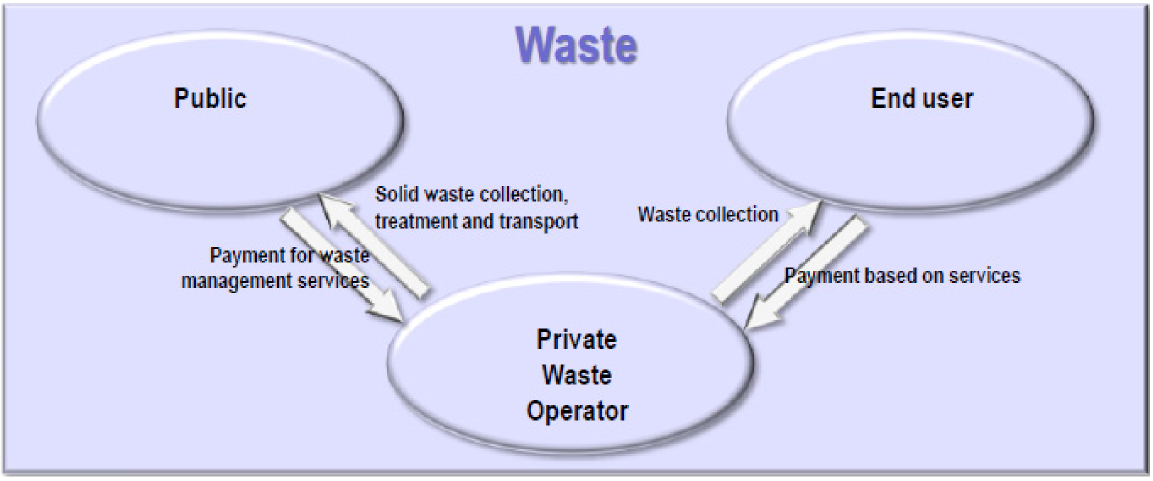

Figure 4. The structure of and the distribution of functions under the PPP model of waste disposal.

The environmentally safe solution concerning water supply and sewerage at the pilot PPP project may be included in a management agreement under the PPP model of the BTO (Build-Transfer-Operate) type. In this case, a private operator will first build an infrastructure that will then become municipal property. After that, the private company will operate the system under, for instance, a leasing agreement.

The private operator, that is, water supplier will undertake the distribution of technical and household water, the collection of gray drainage, its treatment and that of rain water, tuning up and maintaining the system, billing and maintaining the necessary infrastructure. According to the federal law, the organization of water supply, sewers and their modernizations are the functions of local administrations.

The suitable PPP model in this case is a leasing agreement. The private operator then undertakes the distribution of technical and household water the collection of gray drainage, its treatment and that of rain water, tuning up and maintaining the system, billing and maintaining the necessary infrastructure. At the same time, the municipal water supplier (Vodokanal in St. Petersburg) owns water supply and sewer systems and the infrastructure and supplies water to the private operator participating in the PPP scheme. The structure of the PPP model in this case is shown in Figure 5.

When designing water supply and sewer systems, one must consider local conditions. This especially concerns the monopoly of Vodokanal and the decentralization of waste water treatment. One must analyze the ways of using the available technological solutions over the whole seafront area. Besides, issues like water payments and taxes must be considered so as to avoid overcharging.

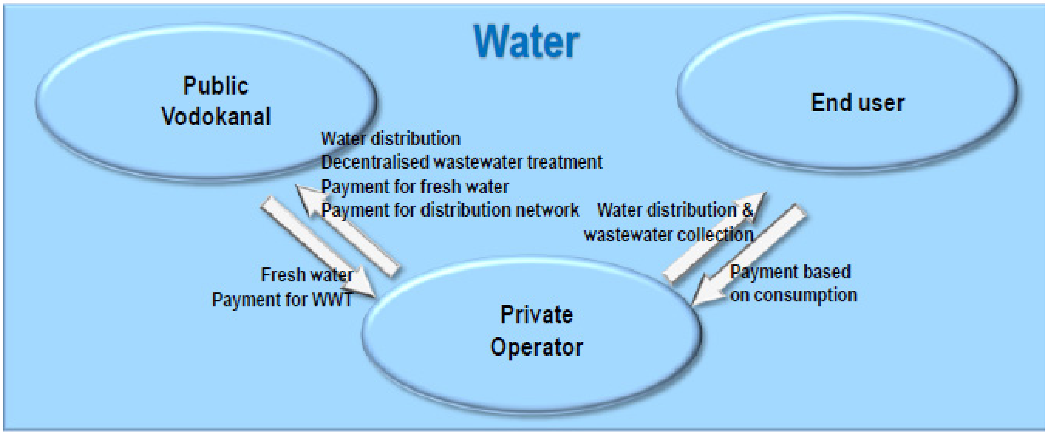

Figure 5. The structure of and the distribution of functions under the PPP model of water supply and sewerage under leasing agreements.

The environmentally safe solution concerning transportation at the PPP pilot project may be implemented either under management agreement scheme or under BTO (Build-Transfer-Operate scheme. Under the BTO model, a private operator builds an infrastructure, which is then purchased by the state. If the private company continues operating the infrastructure, it must be done under an agreement, such as leasing.

In this case, the functions of the private operator include transportation (operating electric cars and running parking facilities), motel services (outside the grounds), logistics (such as Internet commerce), data services and management.

For transportation, the PPP model may be concession or leasing. In this case, the private company provides local transportation services, parking services and city logistics. The municipal operator, in his turn, functions as a passenger carrier and operates public transportation, while maintains roads, streets and railroads as their owner, while maintaining a fleet of electric cars. The structure of the PPP model in this case is shown in Figure 6.

One also must look into the possibility of uniting the transportation systems along the whole sea-front.

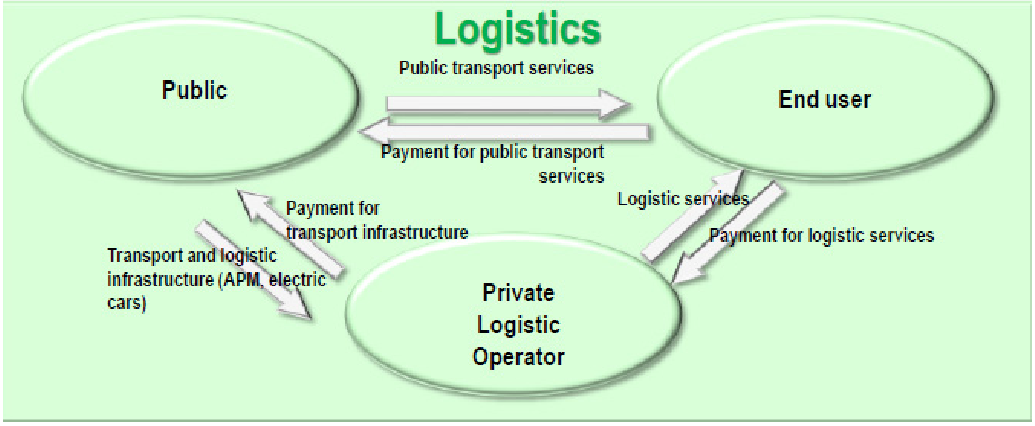

Figure 6. The structure of and the distribution of functions under the PPP model of transportation under a concession or a lease agreement.

Environmentally safe solutions concerning informational and computer systems at the PPP pilot project may be implemented under the BTO (Build-Transfer-Operate PPP model. In this case, the private operator, that is, a computer company provides informational services and maintains a computer system with a dedicated Internet line. It also builds a computer infrastructure and delivers it to the municipal partner. The municipal (state-owned) company owns that infrastructure and purchases public computer services. The structure of PPP model concerning computer technologies and the distribution of functions are shown in Figure 7.

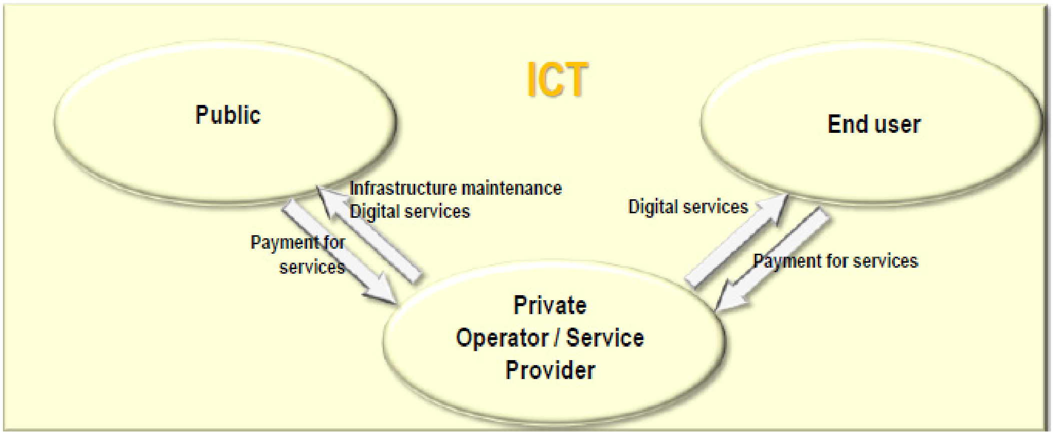

Figure 7. The structure of PPP model concerning computer technologies and the distribution of functions.

As the project progressed, it was found out that the obstacle to the wider proliferation of PPP models was the lack of sufficient interest, for the time being, on the part of decision makers. However, projects covering single areas and those implemented at small local objects are not completely rejected as an option. On the whole, on the basis of the completed basic analysis of PPP models, it looks that they have good future prospects, especially if administrations and legislation accept this way of development.

3. Pilot studies

The project covered three pilot sites: Pöyry, a densely built-up residential district and the so-called PPP site. These sites are located in three different districts of St. Petersburg. Pöyry completed a layout for its site and determined the overall arrangement of the area. At the second pilot site, the densely built-up block, the assistance of a local Russian partner was used when determining initial parameters. Besides high-rise buildings, there are premises suitable for offices and service companies, conforming to the Russian norms. The areas of the office and service buildings were calculated on the basis of the number of residents. At this pilot site, designers tried to minimize investments, that is, find cheaper ways to improve local ecology. The third pilot site is the PPP model, that is, public-private commercial partnership. This model was developed by the Global EcoSolutions Oy company. The PPP site includes two city blocks, which makes it the smallest of the pilot sites.

On the bases of the initial data, an environmentally clean city development design was created for each of these pilot sites. Each design contains a layout, showing the locations of residential, office and service buildings and transportation solutions. Also, models have been created as to the energy supplies of the sites, showing comparisons of energy consumption and supply. Finally, a calculation of atmospheric emissions has been prepared for every energy production scenario.

The layout structure based on the number of residents planned for each site was used for an analysis of the basic energy supply solution. The existing general plan was also considered. The structure of development was determined considering the buildings distribution used, in St. Petersburg, by single developers. Besides residential buildings, the models define the number of office and consumer servicing buildings needed in the area. These basic data were used for determining the areas of office and consumer servicing buildings and their types.

The types of buildings placed in a completely new area always vary. Design solutions have to be reconciled with local norms. The starting point of the EcoGrad concept was the adaptation of the Common principles of EcoCity and the reconciliation of the planned number of residents with other calculations with assumed parameters. In the end, the quality of buildings is always determined by local demand.

The environmental quality of construction materials should also be considered. VTT has been studying this issue for a long time and there are publications concerning this. In 1997, Häkkinen *et al.* published a report entitled “Rakennusmateriaalien ja -tuotteiden ympäristövaikutukset ja niiden arviointiperusteet”, which can be translated to “The Effects of construction Materials and Items on the Environment and the Principles of their Assessment”. An instrument could be created for designers to quickly model various construction solutions at various sites, where the results should be hints as to the selection of environmentally safe construction materials for the whole territory and single buildings. Among others, VTT has experience of creating such tools.

While working on the project, obtaining information about the current energy consumption of buildings that could be used as a starting point for St. Petersburg, proved hard. Finally, it was agreed to consider the local initial energy consumption as that of Finland in 2008. This was, possibly, rather optimistic. In reality, buildings in St. Petersburg most probably consume more than that. A method of monitoring power consumption of existing buildings is being developed under the GreenCities EE-30 project financed by the Foreign Ministry of Finland. Possibly, this project will produce a lot of energy consumption data. As to the optimistic nature of the assessment, additional info was provided during the Signal session on Russian Housing, organized by Tekes and Finpro on 25.11.2010. Daria Ivanova from Finpro's St. Petersburg office said that the Russians consumed annually 74 conditional units of fuel per each square meter of a building area, while in Scandinavia the figure was 18. However, it should be noted that that is primary energy and not the actual kWh consumption. The partners say that natural ventilation is the most widespread in Russia, so this is accepted as initial level for the building models.

At the Pöyry pilot site, the energy consumption of every type of building is modeled with the WinEtana computer program developed by VTT. There are three versions modeled: one is working according to Finland's construction code of 2008, one using the parameters of a low energy building and one for a passive building. Similar calculations were done for the PPP pilot site. A model for a densely built-up area and another one for passive houses were made for the densely built-up city district, the initial data for this site being somewhat different from those for the other two. The heat conductivity, the annual efficiency of the system of heat recuperation and the air leakage coefficients are shown in Table 4. The data concerning the electricity consumption of apartments came from the results of the research done, in 2008, by the Adato Energia Oy company, entitled "Kotitalouksien sähkönkäyttö Suomessa 2008" which can be translated to "The Domestic Consumption of Electricity in Finland". The business as usual parameters for 2007 was used to assess the current consumption. Data used for low consumption buildings and passive buildings came from "The Best Available Technology" for the year 2007. [Adato Oy]

Table 4. The heat conductivity, annual efficiency of the system and heat recuperation and air circulation coefficients.

	Heat conductivity coefficients, U-values (W/m^{2}K):				**Heat recuperation efficiency**	**Air leakage factor (1/h)**
	Outside wall	**Roof**	**Ground floor (on natural ground)**	**Windows**		
Norm (RM08)	0.24	0.15	0.24	1.4	30	0.1
A low consumption multi-apartment high-rise	0.17	0.09	0.16	1	50	0.08
A low consumption detached house	0.12	0.08	0.12	0.08	80	0.04
A passive multi-apartment high-rise	0.12	0.08	0.12	0.8	80	0.04
A passive detached house	0.08	0.07	0.08	0.7	85	0.02

According to IEA in Russia, transmission line loss amounts to 10.3% and heat losses in the district heating network are 7%. According to the data afforded by the RAO UES of Russia, and the “Energy Saving while Transporting Heat”, the losses of St. Petersburg’s central heating system amount to 30%, 10% or 11% of which is lost through heat pipes, 1% is lost due to breaches and leaks and 18% is lost through clients’ equipment. This is why, in new buildings, special attention should be paid to the interfaces between pipelines and buildings’ internal heating systems.

3.1 Pilot area 1: Pöyry

3.1.1 Presentation of the site

The first pilot site was set up on the basis of Pöyry’s design of an area development. Its location is shown in Figure 8. There is a railway next to the site and its western limit is a golf course.

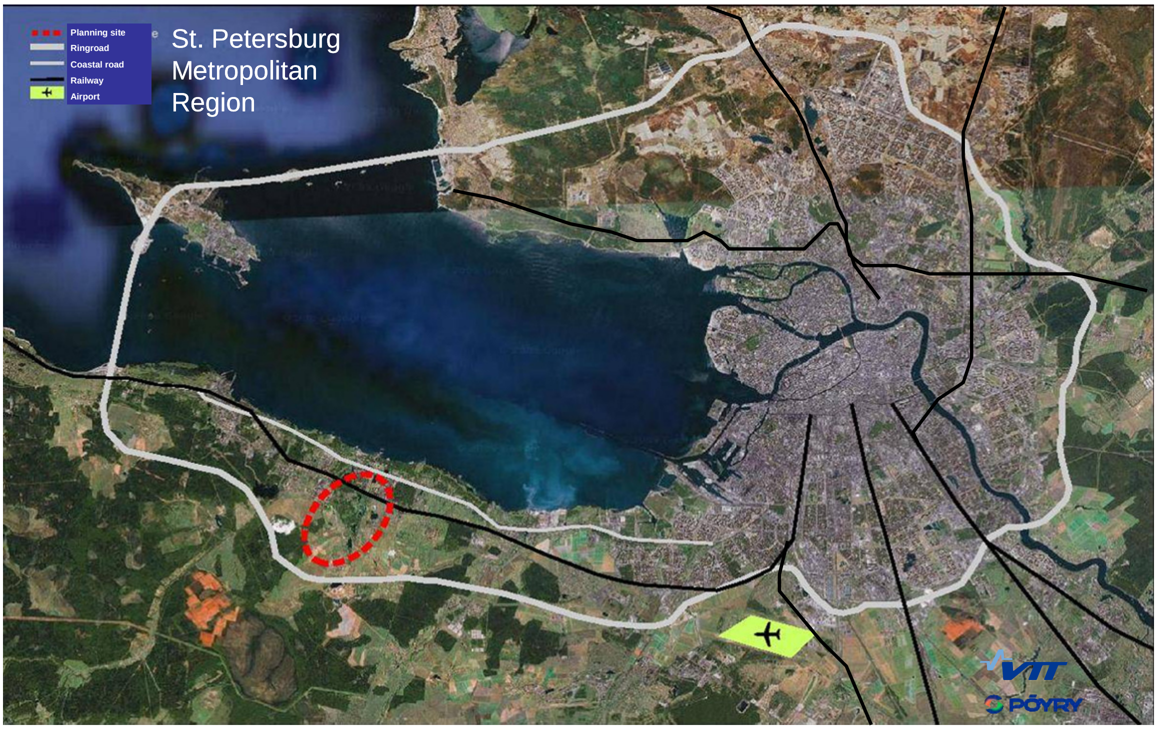

Figure 8. The location of the Pöyry pilot site is within the red stroke line [Pöyry and VTT].

3.1.2 An eco-effective city plan

Pöyry and VTT completed a preliminary design of the layout of the Pöyry site. The basic principles of the use of land are shown in Figure 9.

Firstly, the new site is situated on the verge of Peterhoff, an existing city area. This makes the pilot residential area more valuable in the eyes of local residents who now may just as easily use its offices and consumer service companies. Secondly, the new site is located near the train station, making easier commuting between the area and other districts, including downtown St. Petersburg. Thirdly, offices and consumer service companies, as well as a sufficient number of car parking and bike storing spaces are located near the train station, that is, people will use trains and the need for travel will be diminished, the offices and consumer service companies being located along the way from and to homes. Finally, the area closest to the train station (red in Figuare 9) is built-up more densely than the others, the density dropping as the distance to trains grows. The purpose here was to accommodate most people next to the train station, so they will have less trouble using public transportation and always be next to offices and services. This all aims at minimizing people's need to ride vehicles, while making the area planning as attractive as possible.

Figure 9. The overall general layout [Pöyry ja VTT].

The layout design provides for separate zones for different types of buildings, as shown in Figure 10. The area is to have about 20 000 residents, each occupying 30 square meters of living space. The total living area is 600 000 square meters, which includes kitchens and common use utilities. Figure 10 gives more information about the number of residents and living area they occupy. No. 1 shows the locations of offices and services, that is, municipal objects, stores and commercial premises and a parking facility for cars and bikes. No. 2 is the zone of dense construction and No. 3 is the location of low residential buildings and townhouses. Zone 4 is also low buildings and block townhouses. Zone 5 is allocated for one family houses, while Zone 6 is the place for large one family villas. Zone 7 is parks and gardens and Zone 8 is a very densely planned area. Figure 11 shows various types of buildings and houses planned for various zones.

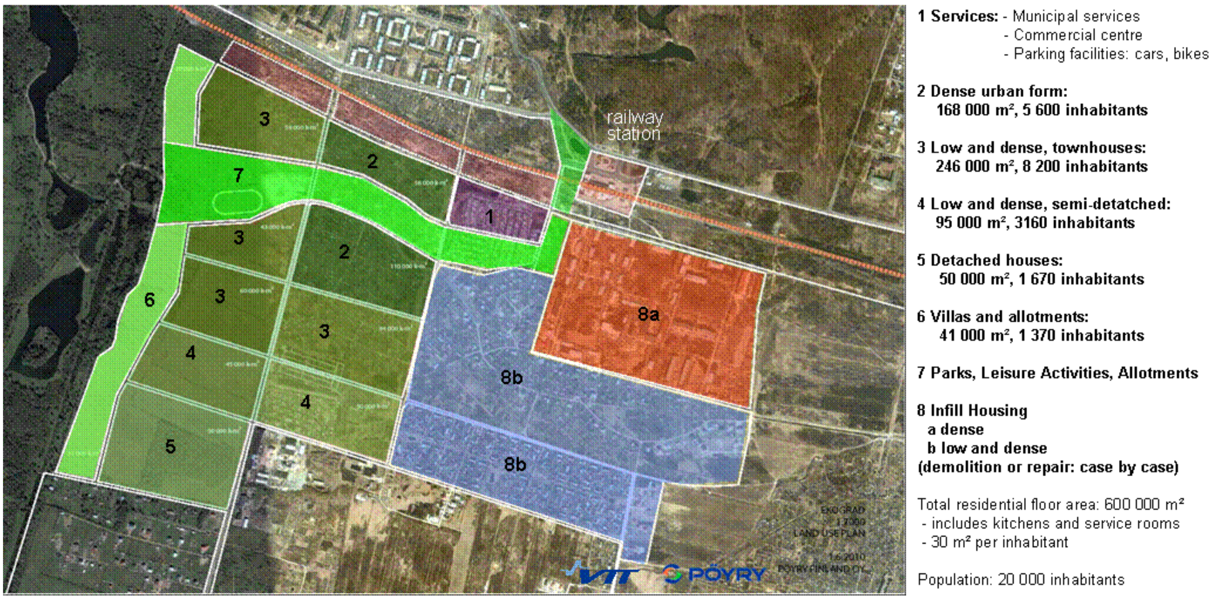

Figure 10. Layout design for separate zone [Pöyry and VTT].

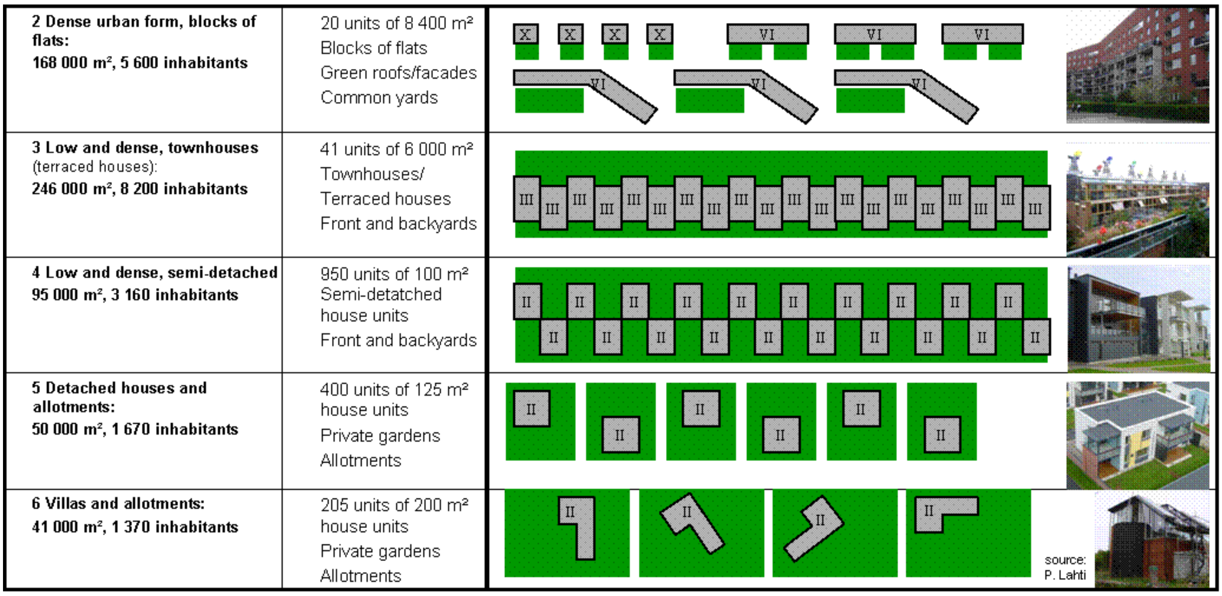

Figure 11. Examples of various types of buildings and houses planned for the area [VTT, Pekka Lahti].

3.1.3 The eco-efficient district solutions

3.1.3.1 Buildings

Pöyry preliminarily determined the types and sizes of buildings and houses to be built in the pilot district, their numbers, and the numbers of residents, all shown in Table 5. The area of a residence is 30 square meters per one resident, storey height 2.7 meters.

Table 5. Data as to various types of buildings [Pöyry].

Types of buildings	Building size	Number	Total area, m^2	Residents
High multistory building	8400	20	168 000	5600
Low and dense multistory building	6 000	41	246 000	8200
Townhouse or terraced house	100	950	95 000	3 160
Detached house	125	400	50 000	1 670
Bigger villa	200	205	41 000	1 370
Total:		1616	600 000	20 000

3.1.3.2 The buildings' energy consumption models

The energy consumption of every type of building was modeled by the WinEtana computer program. That was done in three different versions: complying with the 2008 construction code of Finland, with the parameters of a low energy building and the parameters of a passive building. The 2008 construction code of Finland was taken for a starting point, more precise information being unavailable. The basic data of the modeling are shown in Table 6.

Table 6. The basic data of the models obtained through the use of the WinEtana program.

Building types	Numbers of floors	Building shapes: X-Y	Residents in a building	Numbers of apartments	Notes
Dense high multi-story buildings	9	0.5	280	93.3	3 people per 90 square meter apartment
Low and dense multistory buildings	5	0.5	200	66.7	3 people per 90 square meter apartment
Townhouse or terraced houses	2	0.3	3	cottage: 5 townhouse: 1	May be cottages or villas
Detached houses	2	0.5	4	1	
Bigger villas	2	0.5	7	1	

The rated energy consumption of different types of buildings is shown in Table 7 and that of the whole district in Table 8. Both tables also show the relative reduction of energy consumption in low consumption and passive buildings. The models assumed that the townhouses were connected to each other. Besides, in the calculations of energy consumption for the whole district, it was assumed that basic level buildings had natural ventilation, which, in Russia, is the most widespread. Yet mechanical ventilation was assumed to be used in low-consumption and passive buildings.

Table 7. The energy consumption of different types of buildings.

	Scenarios				
	Basic level	Low consumption – natural ventilation	Low consumption – mechanical ventilation	Passive – natural ventilation	Passive – mechanical ventilation
Annual heat consumption, MWh/year of different building types					
Dense	14.334	13.080	11321	11.967	9.260
Low and dense	21.127	19.206	16.628	17.587	13.599
Townhouse or terraced house	7.842	5.065	2.753	4.392	2.122
Detached house	5.244	3.264	1.905	2.719	1.378
Bigger villas	4.068	2.613	1.501	2.235	1.093
Total MWh/year/district	52.614	43.228	34.107	38.900	27.452
Percent of basic level	100%	82%	65%	74%	52%
Annual electricity consumption, MWh/year of different building types					
Dense	6.895	6.058	6.554	6.058	6.554
Low and dense	10.176	8.940	9.667	8.940	9.667
Townhouses or terraced houses	3.726	2.926	3.207	2.926	3.207
Detached houses	1.808	1.672	1.968	1.672	1.968
Bigger villas	1.138	834	1.023	834	1.173
Total MWh/year/district	23.743	20.430	22.419	20.430	22.569
Percent of basic level	100%	86%	94%	86%	95%

Table 8. The total annual energy consumption of the different consumption scenarios.

Energy consumption scenarios			
	Initial level	**Low energy buildings**	**Passive buildings**
Annual heat consumption, [MWh/y]	52.614	34.107	27.452
% of initial level	100%	65%	52%
Annual electricity consumption, [MWh/y]	23.743	22.419	22.569
% of initial level	100%	94%	95%

The total energy consumption shown in Table 8 does not include cooling energy. The assumption was made for this pilot site that cooling would be achieved through passive means, such as various jalousies and good designs.

The above energy consumption models were calculated as based on the assumption that townhouses shared walls. While designing, there was a version when townhouses are placed closely together but do not share walls. So energy consumption was modeled for both these types of townhouses. The results are shown in Figure 12. It was found out that a five-unit townhouse consumed 14% to 25% less energy depending on whether they were basic level, low energy level or passive level. Townhouses sharing walls were therefore used as a basis for calculating the model.

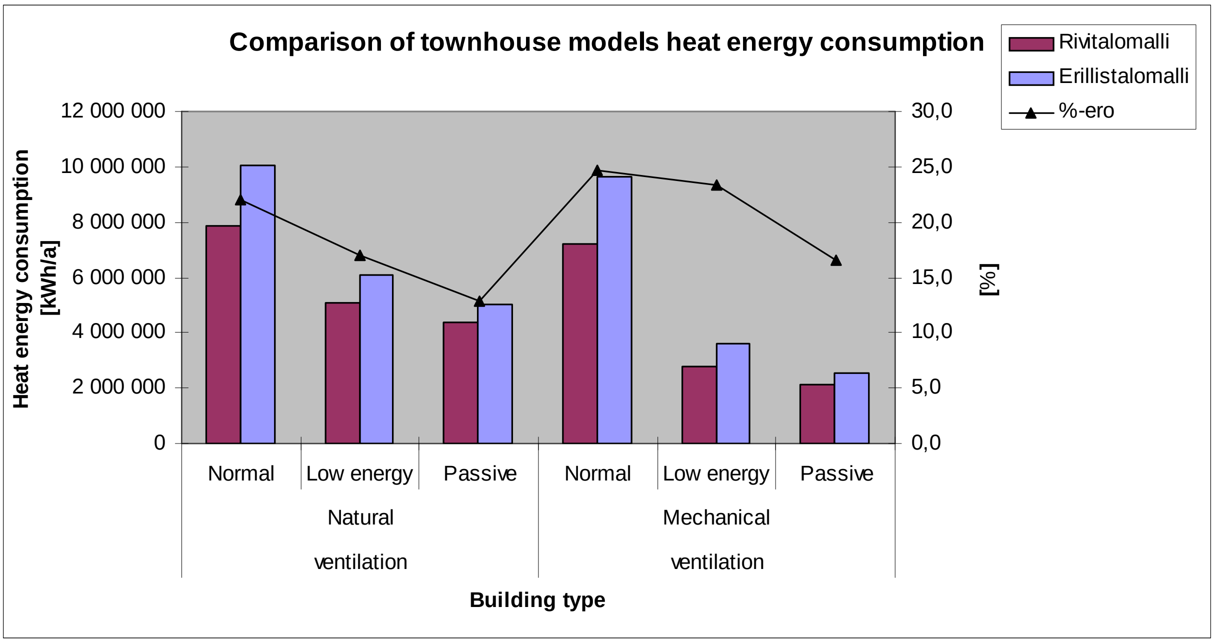

Figure 12. A comparison of the energy consumption of townhouses of differing types.

3.1.3.3 Energy supply scenarios

Where the use of renewable energy sources is concerned, those planning the Pöyry pilot site have been concentrating on the following: 1) ground heat, built-in solar panels and wind power 2) CHP plants burning wood chips or 3) biogas plants utilizing gas from waste (utilized garbage).

For the heating system using ground heat, horizontal pipes were used because they may be laid within the nearby golf course. This solution was used in all the energy consumption models, as shown in Table 9. In these models, the annual coefficient of efficiency of heat pumps was accepted as equaling 3 and heat collectors laid in clay soil, collecting, annually, 35 kWh per 1 square meter [Sulpu]. This estimate conforms to the norms of the United Heat Pump Industry of Finland. As Table 9 shows, if this solution is applied to regular buildings, a rather large area must be covered by heat pipes (as compared with the 60 hectare golf course [the Golf Association].

Table 9. The energy supply system using ground heat pumps – in various models of energy consumption (the pumps efficiency coefficient = 3, the soil is clay).

	Regular buildings (the basic level)	Low energy consumption	Passive buildings
Ground heat [MWh/year]	37 014	23 995	19 313
Pipe's length [km]	1 058	686	552
The area covered by pipes [hectares]	159	103	83
Annual energy consumption [MWh/year]	18 415	11 983	9 608

The modeled solution using solar panels is based on their combined areas equaling the areas of roofs. The total rated area of roofs is 160 867 square meters. According to estimates, in St. Petersburg, solar panels are capable of producing as much electricity as in Finland. That is, according to Naps, it amounts to 110 kWh/m^2/year [Naps Systems]. This means that the total electricity produced annually in the district will amount to 17 695 MWh.

There would be a need for a lot wind turbines, if ground heat, solar panels and windpower were the only sources of energy the area could use. It was chosen as objective to use heat pumps as heating source. Yet the pumps also need electricity, as Table 9 shows, and that electricity demand needs to be taken into account in calculations. Solar panels will produce electricity to the limit of their capacity, leaving the rest to wind turbines. This would mean wind energy production of 28 804 MWh (14,4 MW power capacity) with base level buildings, 20 200 MWh (10,1 MW power capacity) with low energy buildings and 17 796 MWh (8,9 MW power capacity) with passive energy buildings. Calculations are based on maximum production time of the wind turbines of 2 000 hours annually.

In other words, the scenario assumes that renewable sources provide as much energy as the area consumes. The timely difference between production and consumption is covered by connecting the area to the national grid.

CHP plants may burn wood chips or biogas. Calculation of the heat production is preferably done by assuming that the production follows the heat consumption, which is the most common way. For instance, a CHP plant may be adjusted to produce 80% of annually consumed heat. Heat production during top consumption hours may be supplemented with the output of a boiler burning natural gas. Energy production by CHP plants burning wood chips and producing 2 MWh of heat for every MWh of electricity was included in the model in order to calculate the atmospheric emissions. These plants, functioning with maximum capacity for 6 000 hours annually, will produce electricity with an annual efficiency rate of 27.5%. The calculated production figures based on these assumptions are showed in Table 10. Also in order to cut emissions, there may be a CHP plant burning biological gas and producing 1.5 MWh of heat for every MWh of electricity. Its efficiency and maximum usage hours per year are the same as that of a plant burning wood chips. Volumes of production based on such parameters are illustrated in Table 11.

Table 10. The annual energy production of the wood chips CHP plant and the back up plant.

	Basic level	**Low energy buildings**	**Passive buildings**
CHP plants: 80% of annual heat production, MWh	44 200	28 650	23 000
Back up heat production (natural gas), MWh annually	11 050	7 160	5 770
Electricity production by CHP plants, MWh annually	22 100	14 330	11 530
Back up electricity production (natural gas), MWh annually	4 090	10 440	13 360

Table 11. The annual output of the biogas CHP plant and of the back up plant.

	Basic level	**Low energy buildings**	**Passive buildings**
CHP plants: 70% to 80% of annually heat production MWh/year	38 670	28 650	23 060
Back up heat production (natural gas), MWh/year	16 570	7 160	5 770
Electricity production by CHP plants, MWh/year	25 780	19 100	15 370
Back up electricity production (natural gas), MWh/year	410	5 630	9 520

3.1.3.4 Life-cycle emissions from the energy production

In the GEMIS program, annual energy production-related harmful emissions are calculated for the whole life-time cycle. The various versions of CO_2 equivalent emissions are illustrated in Figure 13.

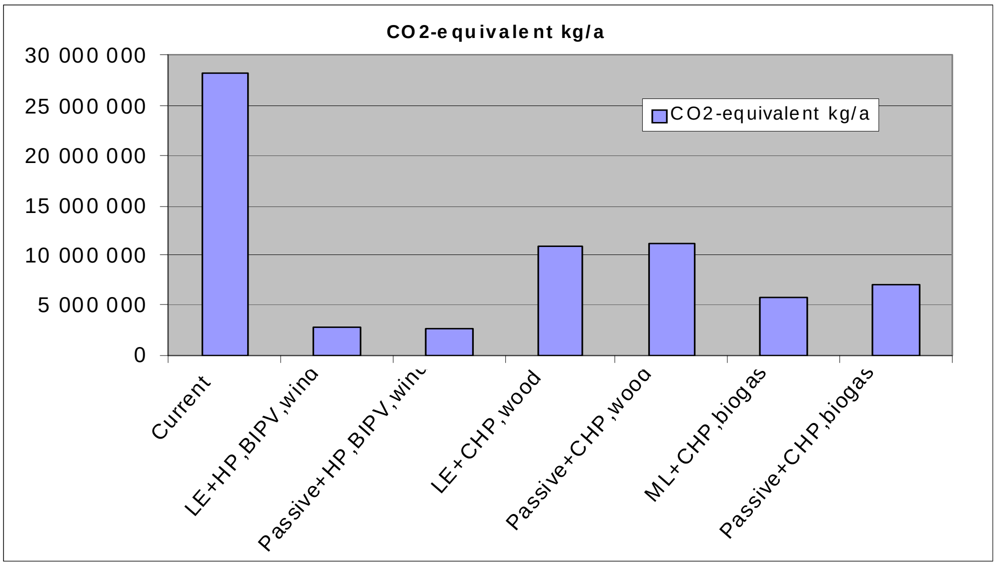

Figure 13. Life-time CO_2 equivalent emissions under various versions of energy production. Legend: LE = the power consumption of low energy buildings, Passive = passive buildings, HP = heat pump, BIPV = built-in solar panels, wind = wind turbines, CHP, wood = wood chips-burning heat and power plants.

SO_2 and TOPP equivalent emissions are shown in Figure 14. Fine particles emissions are illustrated in Figure 15. Current = the amounts of emissions from typical residential areas in St. Petersburg, that is, from centralized heating using natural gas and electricity from city grids. Current data are provided by IEA[IEA].

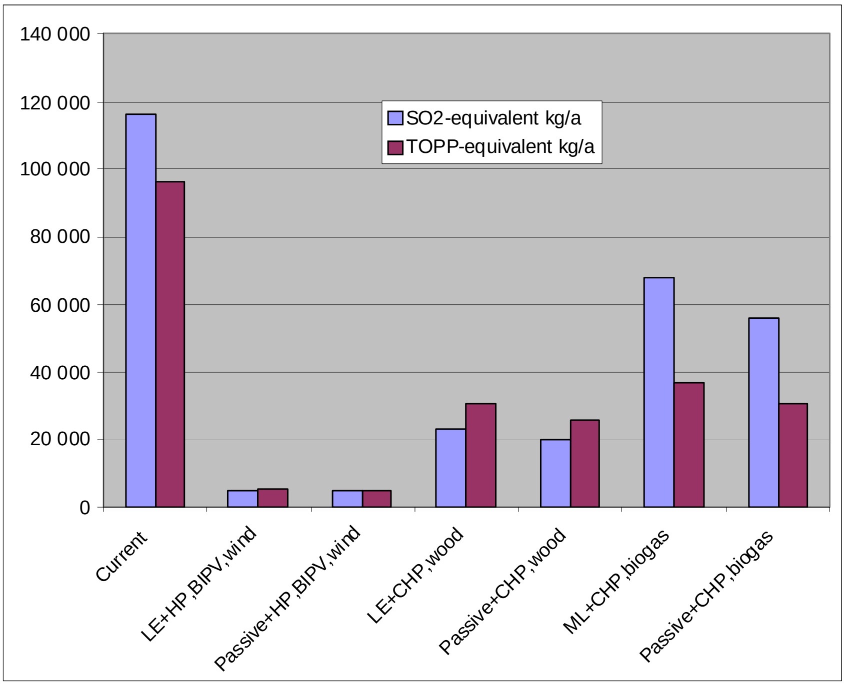

Figure 14. The annual emissions of SO_2 and TOPP equivalent, over the life-time cycle, under various versions of energy production.

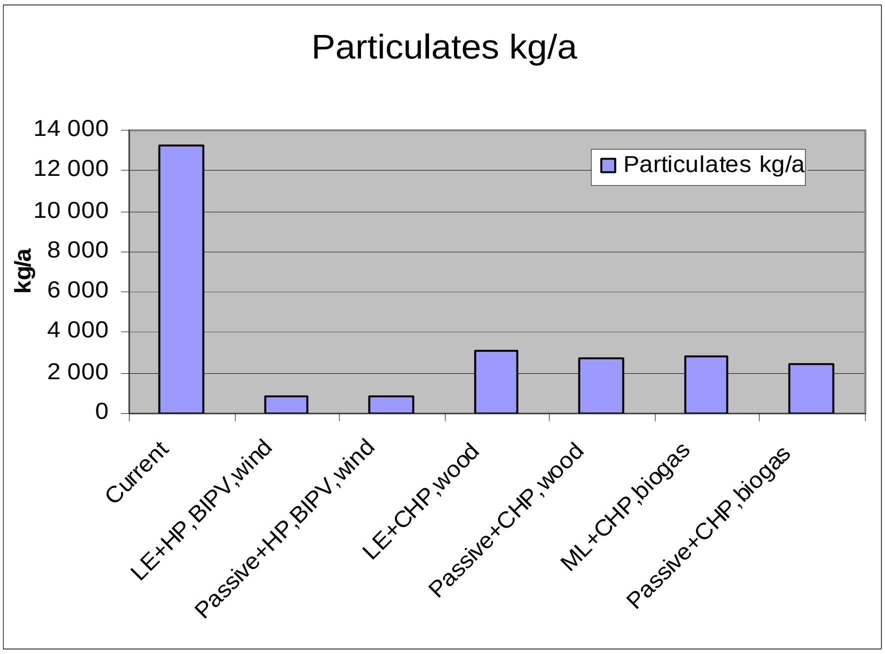

Figure 15. Life-cycle fine particles emissions under various versions of energy production.

3.1.3.5 Transportation solutions

Figure 16 illustrates the planned transportation solutions for the district. Blue stroke lines reflect distances to the train station. The radius of the smallest one represents the walking distance of 0.5 km, the radius of the next one = 1 km and the radius of the largest one = 2 km represents the biking distance.

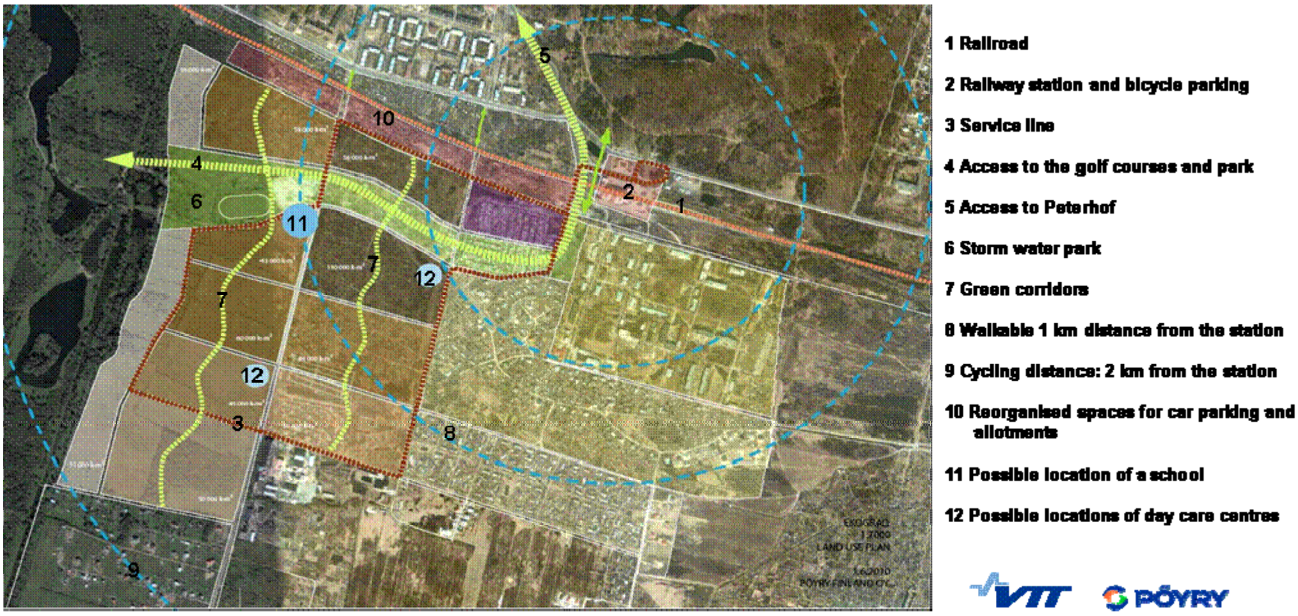

Figure 16. The most important elements of the principle functional layout of the area.

When designing a district, one should try and minimize the need for travel and shorten distances. This is achieved by larger population density near train stations, that decreases as the distance to trains increases. (see Figure 10).

The objectives here include the minimization of the use of cars in the district. The district is designed so as to promote walking and bicycling. This is achieved by a well thought-out organization of light traffic. On the other hand, a district should have efficient, attractive and easy to use public transportation.

Public transportation must be fast, comfortable, safe, efficient and deliver one from door to door. From the start, designing public transportation must be a part of designing a whole district. For instance, in Figure 16, the brown line shows the possible public transportation route, from remote passenger car parking areas to residencies. This will help minimize car traffic in the area.

Bicycling must be made attractive, fast and easy. This includes having reliable bike storage areas and safe biking routes as shown in Figure 17. The most important is having safe bicycle parking lots near the train station. All roads must have clear-cut striping separating bike routes from the other traffic and from pedestrians. Bike routes must be maintained and repaired around the year so as to make biking always safe, fast and easy.

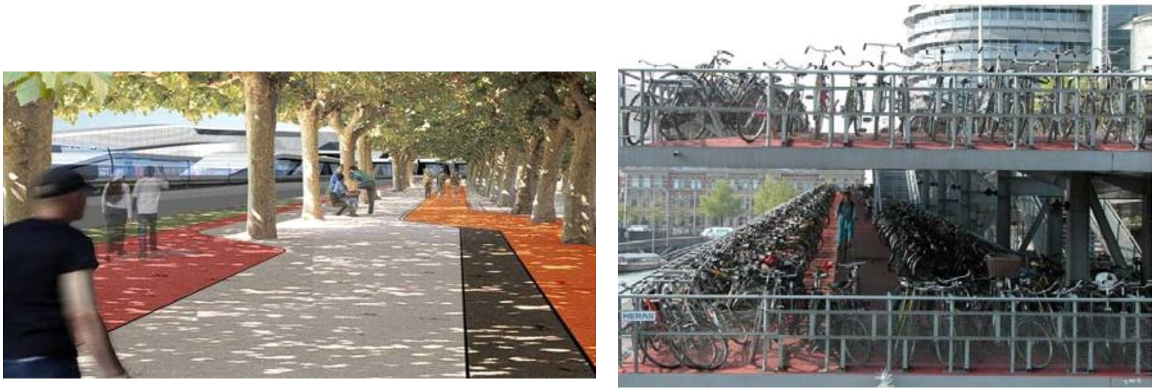

Figure 17. Safe and convenient bicycling as one of the basic ways of commuting [Pöyry].

3.2 Pilot area 2: a densely populated residential district

3.2.1 Presentation of the site

The pilot area 2 is supposed to be located to the southeast of downtown St. Petersburg. Two different models have been developed for it, the first aiming at the creation of the environmentally safest possible district, while the second meaning to make sure that the increase of the environmental efficiency of the district does not cost more than the construction of modern regular residential and commercial buildings. The designs are based on the actual basic data, that is the data meant for a design being actually implemented.

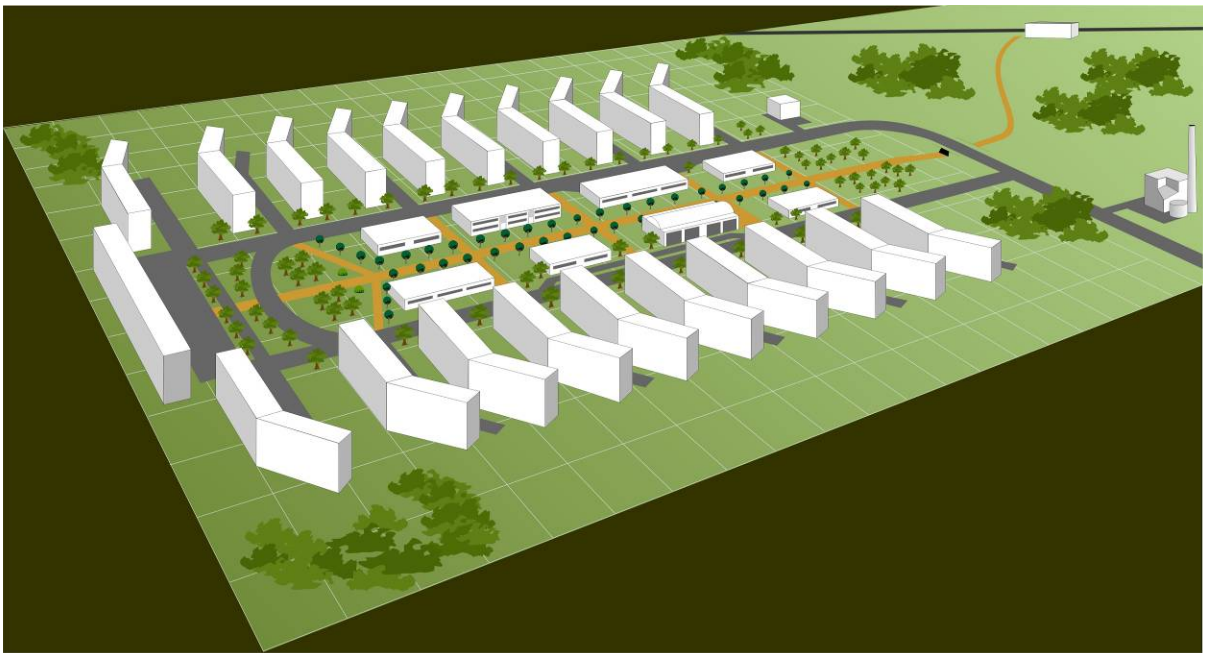

Figure 18. A layout of pilot area 2.

The total floor area of residencies in the district amounts to 350 000 square meters, the number of residents being 11 513, that is, 30.4 square meters of living space per person. Beside residential buildings, the area has a school, kindergartens, an ambulatory clinic for children and another one for adults, various consumer services and a fire brigade quarters. The numbers of offices and consumer services comply with Russian norms (more precise data is available in Appendix A).

3.2.2 The eco-efficient district solutions

3.2.2.1 Buildings

The district has residential high-rises accommodating 11 513 people and offices and consumer services in the numbers complying with Russian norms. The buildings of the district are shown in Table 12. Figures 18 and 19 illustrate the layout of the district. In the illustration, unnumbered buildings are high-rise residencies.

Table 12. The basic data as to various types of buildings.

Building types	**Building's floor areas, m^2**	**The number of buildings**	**The combined floor areas of the given type of buildings throughout the district**	**The total numbers of residents or visitors**
High-rise residencies	16 667	21	350 000	11 513
School	3 972	1	3 972	1 324
Kindergarten	1 179	4	4 715	403
Ambulatory clinic	1 648	1	1 648	55
Children's ambulatory clinic	1 648	1	1 648	55
Fire brigade quarters	600	1	600	
Household and other services	3 105	1	3 105	
Total in the district		30	365 688	13 350

The availability of social and household services conforms to Russian norms where information concerning such norms was available. The norms regulate the minimal floor areas such places may have and their maximum remoteness from residential buildings. The floor areas of certain offices and companies servicing residents are determined through comparing them with Finnish practices. The offices and consumer services of the pilot district, their necessary floor areas and their distances from residencies are shown in Table 13.

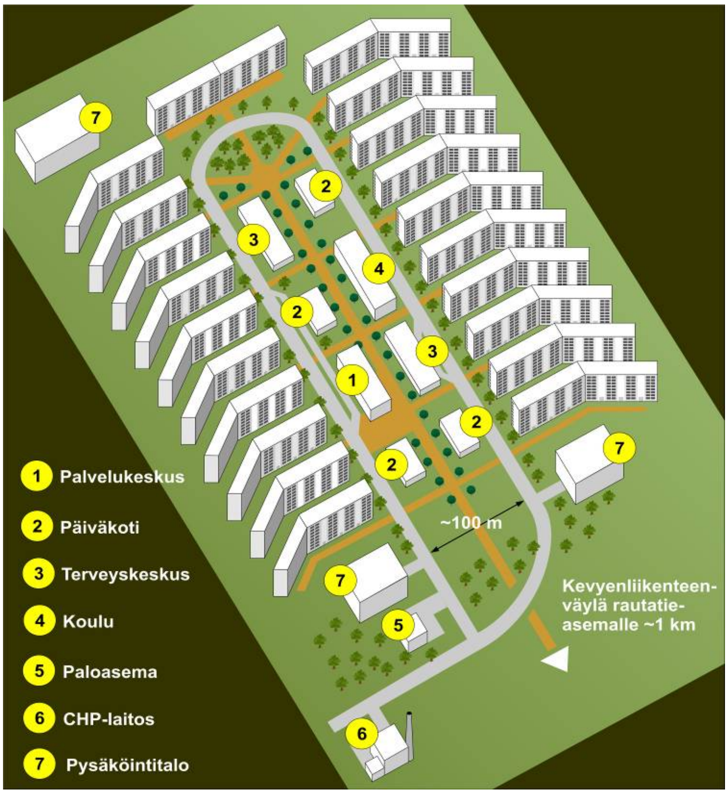

Figure 19. A layout showing the locations of high-rise residencies, offices and consumer services. 1:service center, 2: day care, 3: health care center, 4: school, 5: fire station, 6: CHP plant, 7:parking house.

Table 13. Offices and consumer service companies.

Objects	**Areas, m^2**	**Maximum distances, m**
Drugstores	100 (estimation)	750
Recreational places	576	750
Sports facilities	345	
Food stores	345	500
Non-food stores	345	500
Restaurants	405 (estimation)	500
Household services (barber shops, small repairs, tailor shops)	240 (estimation)	500
Ready milk foods	34	500
Postal services	100 (estimation)	750
Banks	400 (estimation)	750
Building maintenance offices	100 (estimation)	
Security services	115	

3.2.2.2 The buildings' energy consumption models

The two different versions of the buildings designed for the district are modeled by the WinEtana computer program. One version includes typical buildings conforming to current norms (low costs), while the other includes passive buildings (the innovational version). The model providing for the construction of regular buildings with the use of Russia's today's methods follows Finland's construction code of 2008. This is because no precise data concerning Russia's typical characteristics were available. When modeling energy consumption, it was accepted that typical buildings conforming to current norms had natural ventilation while offices and consumer service buildings had mechanical ventilation. Passive buildings always have mechanical ventilation. Ceiling heights are 3 meters in residential buildings and 4 meters elsewhere. The basic data concerning building sizes and shapes and the numbers of apartments and residents, used for modeling, are shown in Table 14. Rated energy consumption figures for the types of buildings are reflected in Table 15.

The annual heat consumption of districts built-up with regular and passive buildings is shown in Figure 20. The diagrams clearly show that passive buildings have much lower heat consumption than regular buildings. This also makes technical calculations and the creation of heating systems considerably easier.

Table 14. The basic data as to various types of buildings.

Building types	**Numbers of floors**	**Width / length**	**The numbers of residents in a building**	**The number of residents**
Residential high-rise	8	0.10	548	183
School	2	0.29	1324	
Kindergarten	1	0.49	101	
Ambulatory clinic	1	0.35	55	
Children's ambulatory clinic	1	0.35	55	
Fire brigade building	2	0.50	10	
Household and other services	2	0.37		

Table 15. The energy consumption of buildings of various types.

Annual heat consumption, MWh per building type		
Building types	**Basic**	**Passive**
Residential high-rise	25 886	12 512
School	354	157
Kindergarten	614	337
Ambulatory clinic	376	345
Fire brigade building	83	45
Household service building	270	82
Total, MWh per year for the district	27 583	13 478
% of reference level	100%	49%

Annual electricity consumption, MWh per building type		
Building types	**Basic**	**Passive**
Residential high-rise	15 618	13 767
School	114	114
Kindergarten	136	136
Ambulatory clinic	158	158
Fire brigade building	23	23
Household service building	206	206
Total, MWh per year for the district	16 255	14 420
% of reference level	100%	89%

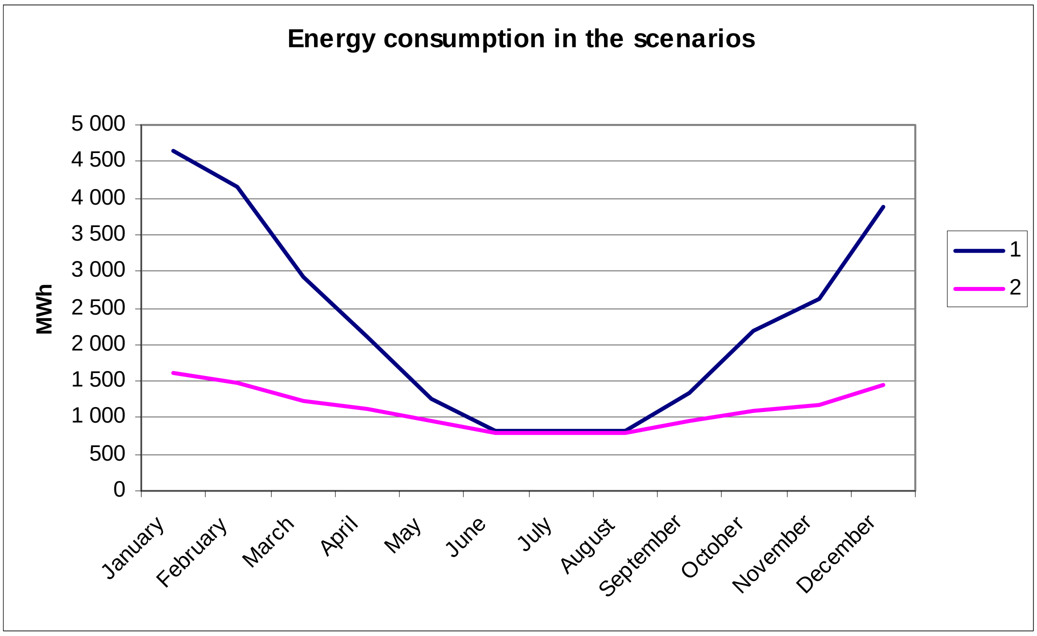

Figure 20. The annual energy consumption of regular (1) and passive (2) buildings.

While working on this pilot site, the dependence of the cost of construction and heat consumption on building size was researched. The cost of construction was considered evaluating the difference between outside and inside walls of a building, the construction of the outside wall being more costly.

It was assumed that the sizes of buildings affected the combined areas of all the outside walls in the district. The changes were studied on the models of two residential high-rises of different sizes. In addition to the large (16 667m^2) high-rise building, 144 meters long and 14.5 meters wide, used for modeling the district, a model of a smaller building (3 352 m^2), 29 meters long and 14.5 meters wide was created. For the total buildings' area to remain the same, 104 smaller buildings or just 21 larger ones would be needed. The combined areas of the outside walls of the larger high-rise equaled 5 671 square meters, that of the smaller building equaling 1 694 square meters. If all the residential buildings in the district were of the larger type, the combined areas of their outside walls would amount to 119 091 square meters, while if all the residential buildings in the district were of the smaller type, the combined areas of the outside walls would amount to 176 218 square meters. This means that if buildings are made larger, the combined areas of their outside walls are smaller, in this case smaller by 57 127 square meters. This difference is shown in Figure 21.

If the combined areas of the outside walls are smaller, the total construction is cheaper, the construction of inside walls being less costly. Money saved this way may pay for better energy efficiency, like, for instance, better thermal insulation or ventilation systems equipped with heat recuperation.

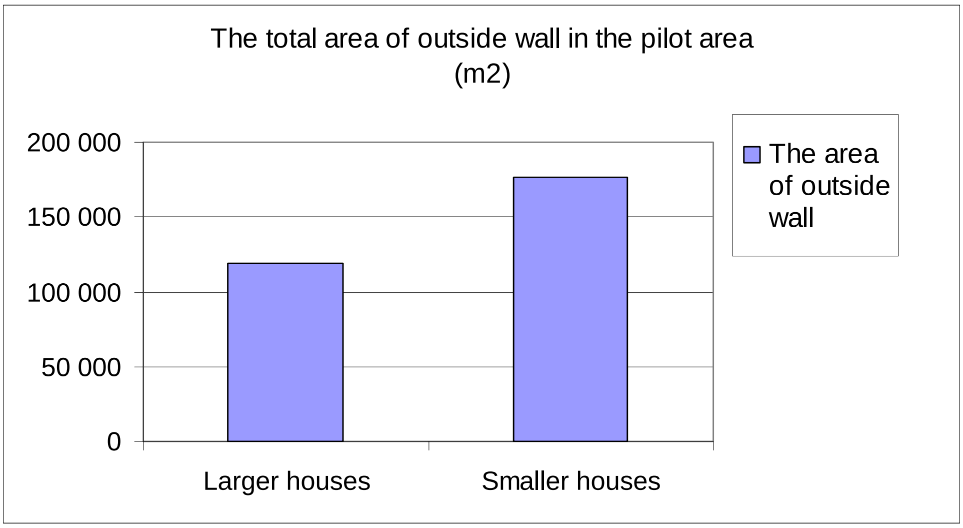

Figure 21. The reduction of the combined area of outside walls when building sizes increase. The dimensions of large buildings are 144 m x 14.5 m and those of small buildings are 29 m x 14.5 m.

When large and small residential high-rises were compared, it was noted that energy consumption somewhat decreases as building sizes increase. The difference is illustrated in Figure 22.

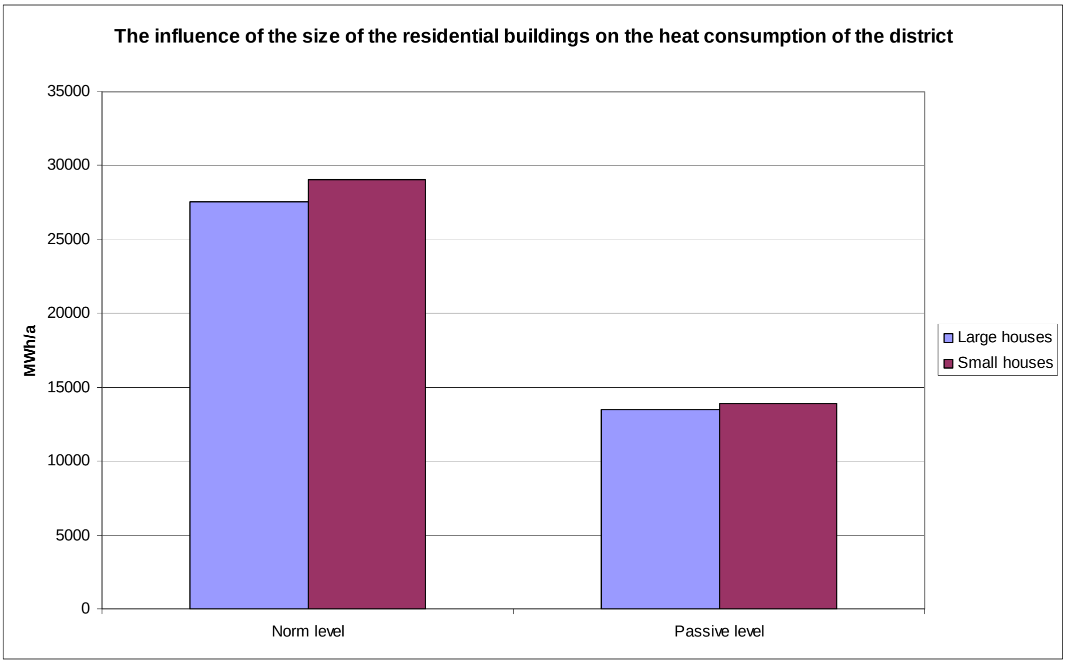

Figure 22. A comparison of the heat consumption of high-rise buildings of different sizes. The dimensions of large buildings are 144 m x 14.5 m and those of small buildings are 29 m x 14.5 m. The difference is 5% for regular buildings and 3% for passive ones.

The inevitable conclusion is that where cost increases are unacceptable, the energy efficiency of a district may be enhanced by either choosing well the locations of buildings and/or increasing their sizes. As building sizes become larger, heat consumption decreases because the combined areas of outside walls decrease, letting out less heat. When the area of outside walls decreases, the cost of construction also decreases, which allows to spend more money on better energy efficiency.

3.2.2.3 Energy supply scenarios

Energy supply was also set up in both innovational and low–cost ways and then compared with the base case level. The base case level means that electricity is purchased from the national grid while the heating system is the most typical: centralized, fuelled with natural gas. This is just like the previously presented various versions of energy consumption plus transmission losses. According to IEA, in Russia, 10.3% of transmitted electricity and 7% of heat is lost [IEA].

In the first version, all heat is produced by heat pumps. Heat collector pipes may be either laid horizontally or lowered into drilled wells. The efficiency coefficient of the heat pumps is considered to be 3. The ground is sand [Wikipedia, St. Petersburg]. Annually, the ground yields 35 kWh hours per 1 meter of pipes. Table 16 illustrates the calculation of the systems using horizontal pipes laid in sand. Similar calculations were made for clay soil, yielding 55 kWh per 1 meter of pipes annually (see Table 17). Another version was used for comparison. There, heat collector pipes are lowered into drilled wells (see Table 18). The calculation of it was based on Finland's directive concerning heat pumps in dry wells [Finnish Heat Pump Industry Association/2].

Table 16. The system of heat pumps: efficiency=3, ground=sand, horizontal collector pipes.

	Basic buildings	**Passive buildings, mechanical ventilation**	
Amount of collected heat	19 975	9 662	MWh/y
The length of pipes	570 714	276 068	m
The area needed	856 071	414 102	square m
The area needed	86	41	hectares
Electricity used annually by heat pumps	9 938	4 807	MWh/y

Table 17. The system of heat pumps: efficiency=3, ground=clay, horizontal collector pipes.

	Basic buildings	**Passive buildings, mechanical ventilation**	
Amount of collected heat	19 975	9 662	MWh/y
The length of pipes	363 182	175 680	m
The necessary area	544 772	263 519	square m
The necessary area	54	26	hectares
Electricity used annually by heat pumps	9 938	4 807	MWh/y

Table 18. The system of heat pumps: efficiency = 3, pipes lowered into a presumably dry well: 50 kWh per 1 m per year.

	Basic buildings	**Passive buildings, mechanical ventilation**	
Amount of collected heat	19 975	9 662	
The depth of the well	199 750	96 624	m
The approximate number of wells	999	483	square m
The necessary area	5.62	2.72	hectares

In the first version, electricity is supplied by built-in solar panels placed on the roof and the rest by wind turbines. The amount of electricity used by heat pipes (see Table 18) is added to the total electricity consumption. The annual output of the solar battery is considered as equal to 110 kWh per square meter, which equals the average annual figure for Finland [Naps Systems]. In this case, the total annual output of the solar panels amounts to 6 116 kWh. The rest of energy consumption being covered by wind power, the total annual electricity consumption of regular buildings amounts to 22 774 kWh and that of passive buildings to 15 091 kWh.

In the second case, analyses were performed of the use of power and heat plants burning wood chips and those burning biological gas. The output of CHP plants is adjusted to power consumption. The CHP plant produces 80% of the necessary heat, the rest being provided by a back up source, such as a boiler burning natural gas. A CHP plant burning wood chips produces 2 MWh of heat per each MWh of electricity. The difference between electricity consumption and CHP plant output will; be covered by another source, such as a generator ran by a natural gas-driven turbine.

Table 19 shows data for CHP plant burning wood chips. The other option being studied was a CHP plant burning biological gas, producing 1.5 MWh of heat per each MWh of electricity [the GEMIS database]. The biological gas is produced from garbage or other organic waste. This system is illustrated in Table 20.

Table 19. A CHP plant burning wood chips and the back up production.

	Basic	Passive	
The CHP plant produces 80% of required heat	23 850,7	11 537,2	MWh/y
The back up production of heat, such as a boiler burning natural gas	5 962,7	2 884,3	MWh/y
The production of electricity by a CHP plant	11 925,4	5 768,6	MWh/y
Another source of electricity, such as a generator powered by natural gas	6 003,7	10 136,6	MWh/y

Table 20. A CHP plant burning biological gas and the back up production.

	Basic	Passive	
The CHP plant produces 80% of required heat (75% at the reference level)	22 360.1	11 537.2	MWh/y
The reserve production of heat, such as a boiler burning natural gas	7 453.4	2 884.3	MWh/y
The production of electricity by a CHP plant	14 906.7	7 961.4	MWh/y
Another source of electricity, such as a generator powered by natural gas	3 022.4	8 213.8	MWh/y

The rated output of both systems using different CHP plants sufficiently covers the needs of the pilot site for electricity, but not at any moment in time. This is why the lacking amounts of power are purchased from the city mains. The use of CHP plant burning biological gas requires the development of more advanced ways to gather and process waste generated by the pilot district. The waste produced by the pilot site alone will not be sufficient to cover the need of the CHP plant. This means that certain amounts of waste must come from greater St. Petersburg.

In case of a low cost model, heat is produced by a boiler burning wood chips**.** In this case, the district will not produce its own electricity and that will have to be purchased from the city mains. Presumably the boiler burning wood chips will cover 80% of the annual need for heat. This system is illustrated by Table 21.

Table 21. Wood chip boiler.

Energy demand	Basic	Passive
Heat MWh/y	29 813	14 421
The annual production of heat with wood chip boiler, MWh	23 850.7	11 537.2
The rest produced with natural gas boiler	5 962.7	2 884.3

3.2.2.4 Life-cycle emissions from the energy production

Life-time annual atmospheric emissions from energy production have been calculated with the use of the GEMIS computer program. The emissions of CO_2 equivalent when different options of power supply are used are shown in Figure 23. Emissions of SO_2 and TOPP equivalents are shown in Figure 24. Fine particle emissions are illustrated by Figure 25.

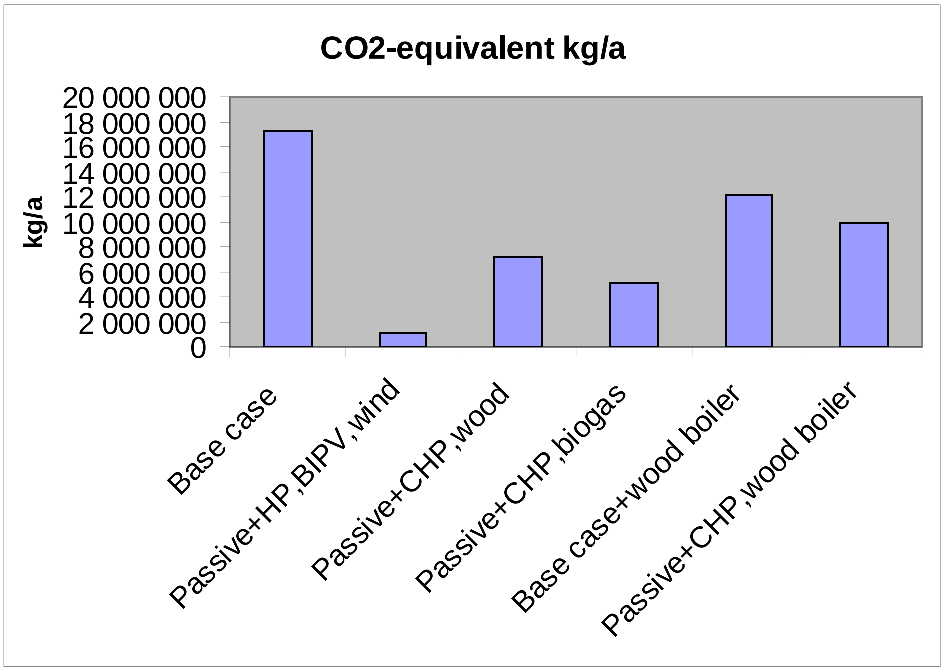

Figure 23. Annual CO_2 equivalent emissions over the life-time cycle when different energy production options are used. Legend: LE the energy consumption of low-energy buildings, Passive that of passive buildings, HP = heat pump, BIPV = built-in solar panels, wind = wind turbines, CHP, wood = heat and power plant burning wood chips.

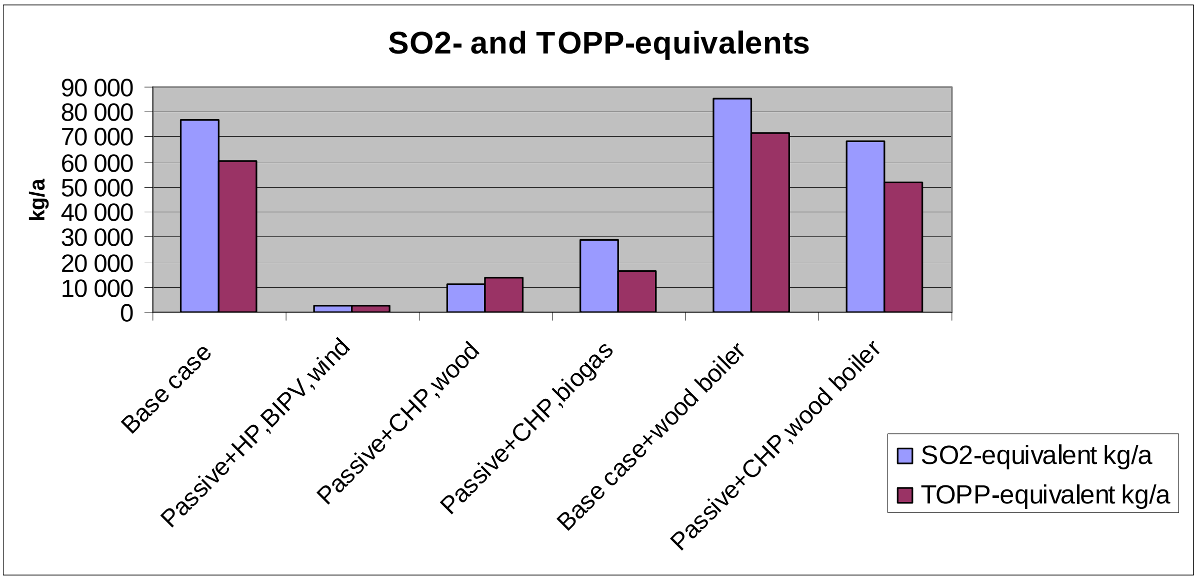

Figure 24. Annual SO_2 and TOPP equivalent emissions over the life-time cycle when different energy production options are used.

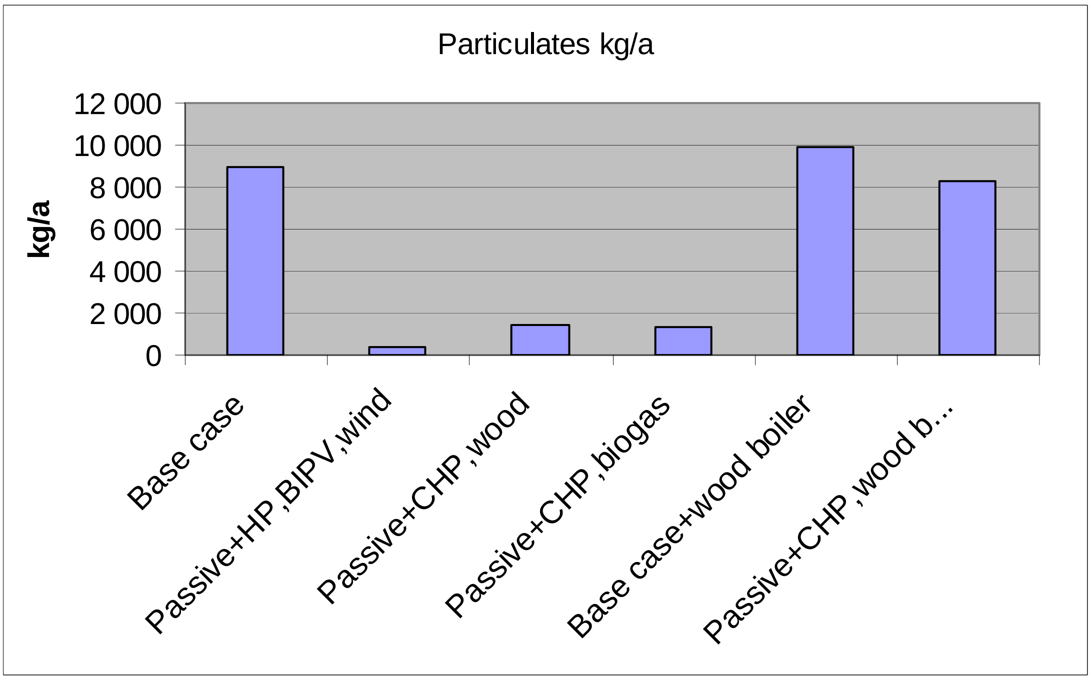

Figure 25. Annual fine particle emissions over the life-time cycle when different energy production options are used.

3.2.2.5 Transportation solutions

In this case, eco-efficiency was improved by placing buildings densely. Offices and consumer service companies are located in close proximity to the majority of residents, which will reduce the need for driving motor vehicles. By choosing good ways to place the buildings, the coziness of the district is improved. Because of the large building complexes coziness could otherwise suffer.

The need to drive cars inside the district should be minimized and a lot of attention needs to be paid to the organization of light traffic. There is a comfortable pedestrian area in the center of the district lined up with office and domestic services buildings The purpose of this was to enable residents to get to those places comfortably safely and fast walking or biking. There must be enough simple to use and reliable bicycle storage places.

Besides, when designing the organization of transportation, designers must try and minimize residents' need to travel outside the district, especially driving motor vehicles. The purpose is served by there being a train station one kilometer away. The train station must be connected to the district by light traffic routes encouraging walking or biking. There must be simple to use and reliable bicycle storage places near the train station. All this means that people may live in the city without traffic jams and polluted air.

Transportation and functional layout solutions should give people enough reasons to use public transportation and light vehicles. This also means that there will be no car parking places in court yards. Car parking areas are supposed to be removed to the limits of the district and be arranged in garage buildings. Of course, one may easily drive to offices or service companies in case of emergencies.

3.3 Pilot area 3: PPP

3.3.1 Presentation of the site

The PPP pilot site is situated on the Vasiliyevsky Island, looking onto the Gulf of Finland. The residential area is being built on a raised waterfront. This makes the construction of underground facilities difficult. As shown in Figure 26, the pilot district shall include two city blocks. The block closest to the waterfront consists of two low multi-apartment buildings or two blocks of city cottages, a two-storey one closer to the shore and a four-storey one a bit farther away. The block farthest away from the waterfront will consist of 16-storey high-rises, their ground floors occupied by offices and such consumer service companies as stores, restaurants, medical offices, kindergartens, administrative offices, etc. The location of the future pilot site is shown on the map found in Appendix C.

Figure 26. The mockup of the PPP pilot district.

The residential district will accommodate 1 752 residents, 40 square meters of living space to each person. The total floor area of each one of the eight 16-storey high-rises will be 7 680 square meters. The total floor areas of the two low residential buildings will be 3 840 and 8 680 square meters. Each apartment is supposed to accommodate three persons, the overall floor area of each being 120 square meters.

The pilot PPP site may be positioned as a modern residential district in the European style, intended for an international community, and may be advertised among St. Petersburg's resident foreigners and their families. This idea may be reflected in the architecture, supposedly mid-European, residential buildings lining streets, courtyards remaining behind them as autonomous territories. The waterfront proper should be used for a common green zone and a recreational zone.

The design may also allow for possibly more raised ground in the future, protruding further into the gulf. However, this does not agree with the already completed design. For instance, the built-in wind power plant will lose a lot of wind if blocked by more high-rises built on the waterfront. Also the system of water heat pumps, supposed to become the principle source of heat for the district, will not be functional anymore.

3.3.2 The eco-efficient district solutions

3.3.2.1 Buildings

One of the city blocks of the PPP pilot site consists of residential high-rises six of which house offices and service companies on their ground floors. The residential area also has another city block consisting of two-storey and 4-storey multi-apartment buildings. The characteristics of the buildings to be built in the area are shown in Table 22.

Table 22. The basic parameters of the buildings of different types.

Building types	**The floor areas, m^2**	**The number of buildings**	**The combined floor area of the buildings of this type in the site, m^2**	**The number of residents in a building**
A high-rise building, housing offices and service companies on its ground floor	7 200 + 480	6	43 200 + 2 880	180
A high-rise residential building	7 680	2	15 360	192
A two-storey multi-apartment residential building	3 840	1	3 840	96
A four-storey multi-apartment residential building	7 680	1	7 680	192
Total	21 120	10	72 960	1 752

The floor areas of the offices and consumer service companies are calculated according to Russian norms, as based on the number of residents, the same way as at the No. 2 pilot site. Table 23 shows the dictated by the norms kinds of services to be housed in the non-residential premises at the PPP pilot site. Besides, there will be offices with total floor area 2 131 square meters in the district.

Table 23. Offices and consumer service companies.

Kinds of companies	Floor area, m2
Drugstores	15.22
Recreational premises	87.65
Sports facilities	52.20
Food stores	52.20
Other stores	52.20
Restaurants	61.60
Household services (barbers', small repair, tailor shops)	36.52
Milk food kitchens	5.17
Post office	15.22
Bank	60.87
Building administration	15.22
Security services	17.50
Total	1 988.3

3.3.2.2 The buildings' energy consumption models

The energy consumption of the buildings was modeled with the WinEtana computer program. This was done for typical buildings conforming to current norms, low energy buildings and passive buildings. As concerns regular buildings, the norms of the Finnish Construction Code of 2008 were used, there being no better information of the current Russian construction parameters available. When modeling, offices and consumer service companies were treated as separate buildings, even though they will be located on the ground floors of some residential high-rises. The model presumes the use of natural ventilation in regular buildings, except the offices and service companies, and mechanical ventilation in other buildings. Ceiling heights are 3 meters in residential apartments and 4 meters in offices and consumer service companies. The basic modeling data, including buildings' shapes and sizes and the numbers of residents, are shown in Table 24.

Table 24. The basic modeling data.

Building types	Number of floors	The shapes, lengths / widths of the buildings	The number of residents in a building
A residential high-rise + offices and service companies	15 +1	0.5	180
A residential high-rise	16	0.5	192
A low multi-apartment residential building	2	0.1	96
A low multi-apartment residential building	4	0.1	192

The energy consumption of buildings of various types is shown in Table 25. The model for the actual 2-storey and 4-storey buildings was done as if for 2 3-storey buildings, which is the same where the energy consumption is concerned.

Table 25. The energy consumption of the city blocks of the PPP pilot site.

	Base case building	**Low energy consumption buildings with mechanical ventilation**	**Passive buildings with mechanical ventilation**
The annual heat consumption, MWh			
A 15+1-storey residential building with offices and services on the ground floor	996	769	539
A 16-storey residential building	824	631	487
A low residential building	631.124	478.13	369.414
Total for the area	7 774	5 942	4 538
% of the reference level	100%	76%	58%
The annual electricity consump-tion, MWh			
A 15+1-storey residential building with offices and services on the ground floor	392.24	388.83	388.83
A 16-storey residential building	196.82	193.18	193
A low residential building	147.62	145	144.89
Total for the area	2 004	1 971	1 971
% of the reference level	100%	98%	98%

The energy consumption figures shown in Table 25 do not account for cooling energy. At the PPP pilot site, air conditioning is supposed to be installed only on the ground floors housing offices and consumer service companies. The total annual cooling energy consumption of all those premises amounts to about 27 MWh.

3.3.2.3 Energy supply scenarios

The versions of energy supply are compared with the base case condition. In the base case, electricity is purchased from the national grid. The most typical heat supply solution is arranging a centralized network for distributing heat generated by burning natural gas. The presented figures are corrected by accounting for transmission loss. According to IEA, Russia's loss of electricity in transmission amounts to 10.3% and the loss of heat to 7 [IEA].

The pilot district is supposed to receive heat from water heat pumps. The efficiency coefficient of heat pumps is considered as equal 3. According to the Finnish Heat Pump Industry Association water annually yields 70 kWh of heat per 1 meter of collector pipes [Sulpu]. The heat pump model for various consumption levels is illustrated by Table 26. The maximum length of one pipe loop is 400 m.

Table 26. An illustration of heat supply using water heat pumps for various consumption levels (LE – low energy buildings).

	Regular	LE with mechanical ventilation	Passive	
Annual heat consumption, including transmission loss	8 318	6 358	4 855	MWh
Annual heat collection from the ground	5 573	4 260	3 253	MWh
The necessary length of pipes	79 619	60 859	46 472	m
The necessary number o pipe loops	199	152	116	
The annual consumption of electricity by heat pumps	2 771.81	2 119.48	1 618.44	MWh

Electricity will be produced by solar panels built into the roofs and by small wind turbines. The amount of electricity annually consumed by heat pumps will be added to the overall annual consumption of various levels. This way, the total annual consumption of electricity will amount to 5 270 MWh in the base level, 4 511 MWh for low energy buildings or 3 960 MWh for passive buildings. Solar panels are supposed to be placed on the roofs of all 16-storey buildings, covering total roof area and half roof area in the low residential buildings. This will make the total of 5 760 square meters of solar panels' area, producing, annually 110 kWh per each square meter [Naps Systems]. This means that the total annual output of the solar panels will amount to an average of 633.6 MWh.

Small wind turbines may also be mounted on the roofs. The calculation of the annual output of electricity by wind turbines is difficult to do for the lack of basic data. When making calculations for wind turbines, designers must account for local wind conditions. The estimation model includes rows of 6 meters high wind turbines installed on the roofs of the high-rises facing the gulf. The Windsiden VS-12 wind turbine was used as a sample and the source of technical data. It weighs 3 500 kg, its functional area equals 12 square meters. According to estimates, 48 such turbines may be installed on the roofs at 2 meter intervals. According to the manufacturer, the average annual output of one Windsiden turbine is 700 kWh per 1 square meter, that is, about 8 400 kWh annually per turbine. The Mylly trade center in the town of Raisio has two such turbines, their rated output being the same as above. This gives us an annual output of 403.2 MWh from the 48 such turbines. The efficiency of turbines greatly depends on local wind conditions. This makes finding out these conditions very important for completing the design.

However, the output of both the solar panels and wind turbines will not completely cover the needs of the district regarding electricity. Some electricity will still have to be purchased from the national grid in the amount of 4 232 MWh annually in the case of base case buildings, 3 474 MWh in the case of low energy buildings and 2 922 MWh in the case of passive buildings.

In the summertime, heat may also be produced by solar collectors. Presumably, the functional area of such collectors may be the same as has been calculated for the solar panels, that is, 5 760 square meters altogether. In this case, their annual output may be assessed as equaling 325 kWh per 1 square meter [Solpros], which gives us a total annual collection of 1 872 MWh. For instance, the practical experience of Viikki, Finland, shows that the output of solar collectors may considerably vary year to year. During good years, the output reached 400 kWh per square meter while during other years it just reached 300 kWh per square meter [Solpros].

3.3.2.4 Life-cycle emissions from the energy production

The annual amount of atmospheric emissions over the life-time of the energy supply system was calculated using the GEMIS computer program. CO_2 equivalent emissions are shown in Figure 27, SO_2 equivalent emissions in Figure 28 and TOPP emissions in Figure 29. Fine particle emissions are illustrated by Figure 30.

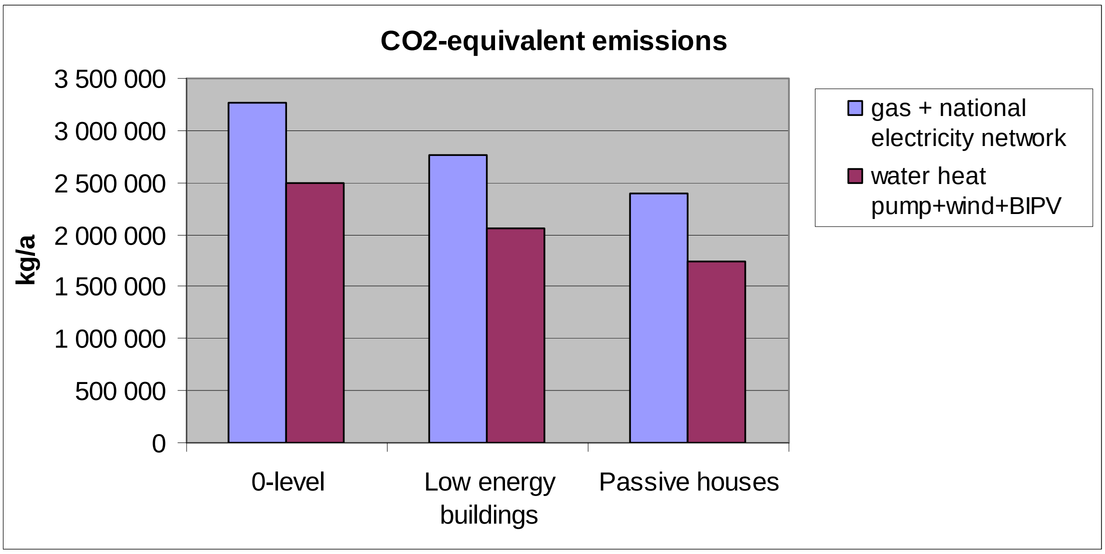

Figure 27.The annual amount of CO_2 equivalent emissions, depending on the versions of energy supply.

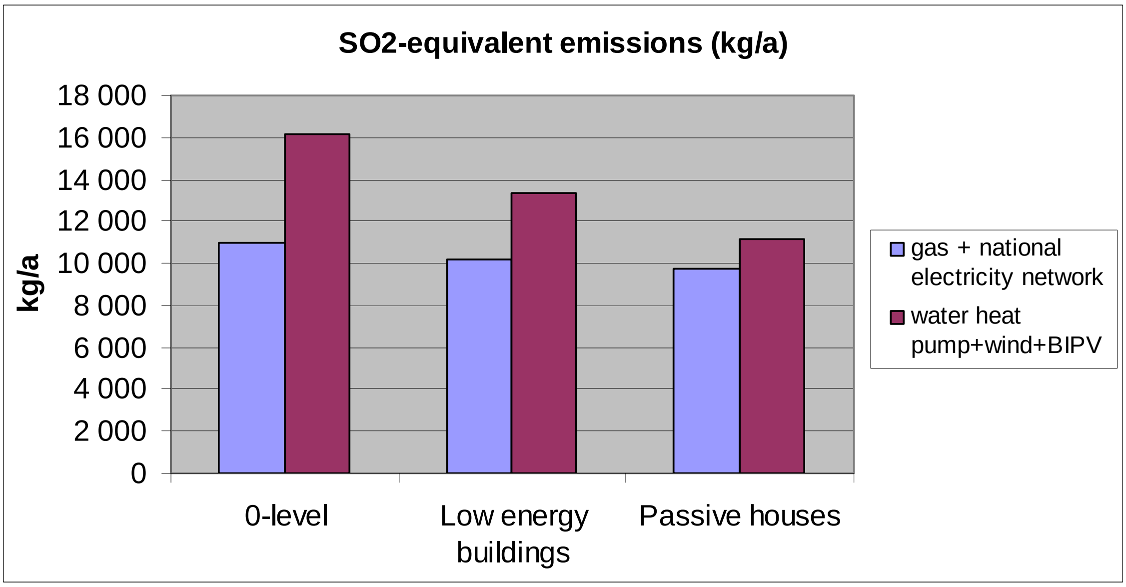

Figure 28. The annual amount of SO_2 equivalent emissions, depending on the versions of energy supply.

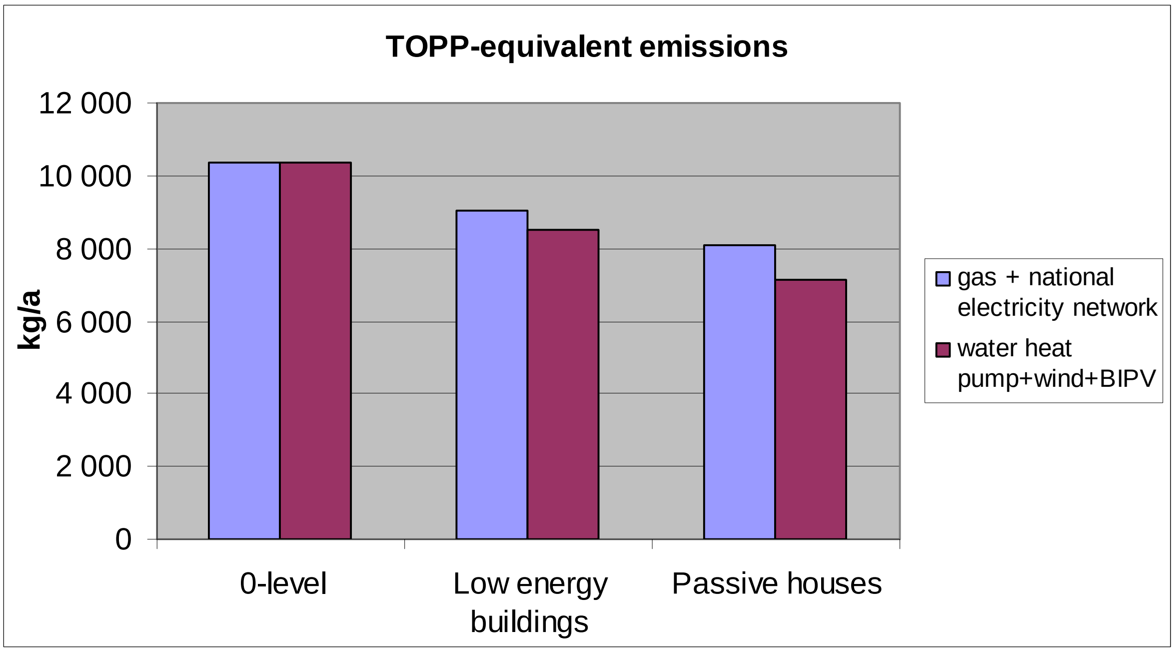

Figure 29. The life-time amount of TOPP equivalent emissions, depending on the versions of energy supply.

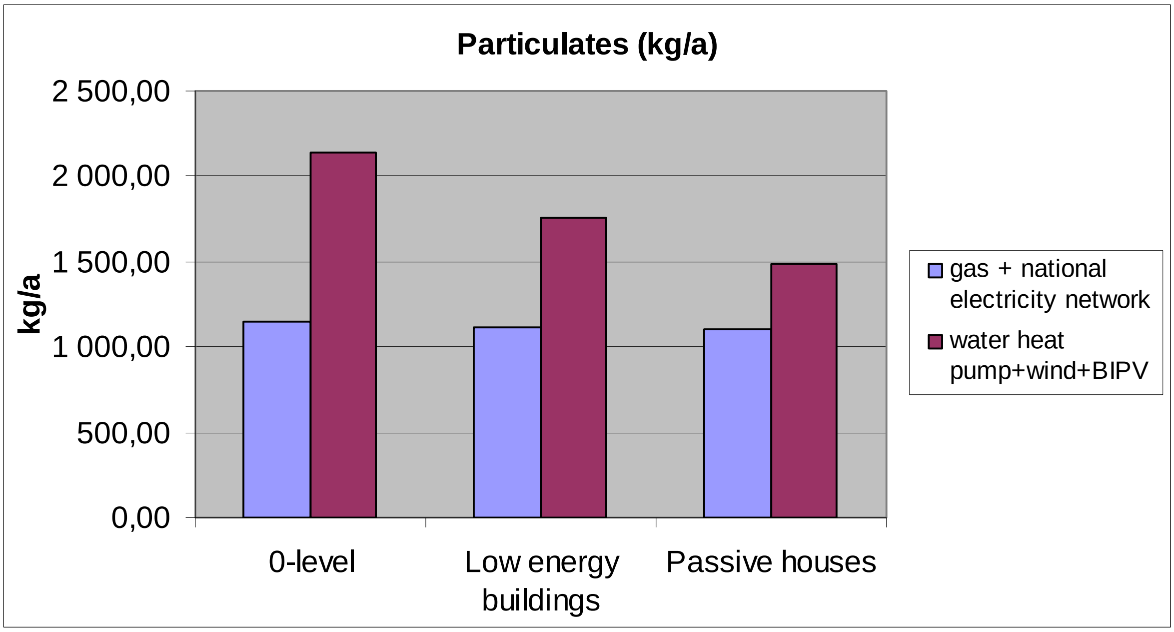

Figure 30. The life-time amount of fine particles emissions, depending on the versions of energy supply.

3.3.2.5 The organization of transportation

Residents are supposed to travel inside the pilot PPP site mostly on foot or bicycling. There is a metro train station not far from the district, assuring easy traveling over longer distances. Passenger car parking facilities, open or roofed, will be arranged at the limits of the area.

As to traveling outside the district, the ring road, now under construction, will pass to the east of the site. The construction of the highway, that is, its timetable, considerably affects the connection of the pilot site with the rest of the city. The future prices of the apartments will also depend on the availability of the ring road.

4. Future development

The EcoGrad project helped to find out the meaning of environmentally safe construction design in St. Petersburg and what demands should be made on such projects. The next logical step is to make the experience of EcoGrad part of city planning processes. It needs to be made clear what various committees must do to practically use the principles of eco-efficiency and whether or not better manuals and instruments should be developed for city designers. The existing regulations may need to be changed. Professionals may join their efforts assisting in this work. On the other hand, transparent procedures of filing commercial offers and making purchases should be developed.

The development of the pilot cases have in this project deliberately been kept at a preliminary design phase. The continuation of the pilot projects is another logical step. It will realize specific energy-efficient solutions adjusted to the local conditions. During the presentation of the EcoGrad concept in October 2010, attendees from the city administration noted that the big work should begin at small pilot sites and, further on, be expanded territorially. The city believes that what is important in these projects are financial efficiency and the growth of value. On the other hand, the people representing a construction company asked right away what exactly would make these projects profitable and who exactly would benefit from the savings.

In the future, the networks need to be expanded to local companies. The principal objectives of this project included establishing connections with officials and the committees. The next step is including local design and production companies in the network of contacts. A very good way of working together with them would be the creation of an innovational platform that may include technical and maintenance solutions as well as methods of financing. Administrations, professionals and entrepreneurs should be involved in the creation of such a platform.

Using LivingLab methods in St. Petersburg is another important area of development. Future residents should be more involved in the development and design processes. This will constitute an added value and guarantee arriving at decisions likely to be brought into life. The poll conducted among residents of the city as part of the project revealed what exactly Russia's city dwellers thought of the conditions they live in, transportation they use and energy supplies. However, such polls must be extended considerably and the method made part of normal design work.

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Appendix A: Pilot project 2: the Russian norms concerning the design and layout of the site and the locations and capacities of the offices and consumer service companies

KERROSTALOALUEEN RAKENNUTTAMISEN SUURIMMAT SALLITUT PARAMETRIT					
	normi	yks.	m2	ha	normi
asuinpinta-ala m2			**350 000**	35,00	
asukkaita	30,40	m²/asukas	**11 513**		markkinointiosasto
lapsia/koulu	115,00	opiskelijoita/1000 asuk.	**1 324**		TCH 30-305-2002
lapsia/päiväkoti	35,00	laps./1000asuk.	**403**		TCH 30-305-2002
kouluja varten tarkoitettujen tonttien pinta-ala	33,00	m²/asukas	43 692	4,37	TCH 30-305-2002
päiväkoteja varten tarkoitettujen tonttien pinta-ala	40,00	m²/asukas	16 118	1,61	TCH 30-305-2002
keskimääräinen kerrosluku	alle 9 krs				
rakennuttamisen kerroin	1,60				ПЗиЗ
autopaikkoja	1/80	autop./ asuinneliö	4 375		ПЗиЗ
autopaikkojen pinta-ala (max)	25,00	m²/autopaik.	109 375	10,94	ПЗиЗ
viheralueen pinta-ala (yhteinen)	23	m² /100 asuinneliö	80 500	8,05	ПЗиЗ
lasten leikkikentät	700,00	m² /tuh. asukasta	8 059	0,81	TCH 30-305-2002
aikuisten lepoalueet	100,00	m² /tuh. asukasta	1 151	0,12	TCH 30-305-2002
lenkkikentät	2000,00	m² /tuh. asukasta	23 026	2,30	TCH 30-305-2002
talouskentät ja koirien jaloittelukentät	300	m² /tuh. asukasta	3 454	0,35	TCH 30-305-2002

riippuvuus asuntoneliömetreistä

riippuvuus asukasluvusta

Appendix A: Pilot project 2: the Russian norms concerning the design and layout of the site and the locations and capacities of the offices and consumer service companies

Nimi /Наименование	Palvelun katesade metreina tai minuutteina /радиус обслуживания в метрах или минутах	Mittayksikko /Ед. изм.	Tilavuusnormi (kayttajia) per 100 asukasta /Норма вместимости на 1 тыс жителей	Normien edellyttama pinta-ala per mittayksikko, m2 /нормируемая площадь на единицу измерения, кв.м.	Laskennallinen arvo suunnitteltavalle korttelille arvolla 30.4 m2 varauksella /Расчетное значение для проектируемого квартала при обеспеченности 30.4 кв.м.	Tontin koko, ha /Размер участка в Га
1	2	3	4	5	6	8
Neliota/Метров		m?			350000,00	
Asukkaita/Население		hlo			11513,16	
Paivakodit /Детские дошкольные учреждения	300м	paikkaa /мест	35,00	40,00	402,96	1,61
Yleiset sivistyslaitokset /Общеобразовательные учреждения	500м	paikkaa /мест	115,00	33,00	1324,01	4,37
MERKITYS KAUPUNGINOSALLE / ОБЪЕКТ РАЙОННОГО ЗНАЧЕНИЯ Aikuisten terveyskeskukset ERILLINEN RAKENNUS/Поликлиники для взрослых ***ОТДЕЛЬНО СТОЯЩИЙ ОБЪЕКТ***	1000м	potilasta per tyovuoro /посещений/смену	12,00	3000,00	55,26	0,3
MERKITYS KAUPUNGINOSALLE / ОБЪЕКТ РАЙОННОГО ЗНАЧЕНИЯ Lapsien terveyskeskus ERILLINEN RAKENNUS/Поликлиники для детей ***ОТДЕЛЬНО СТОЯЩИЙ ОБЪЕКТ***	1000м	potilasta per tyovuoro /посещений/смену	4,80	3000,00	55,26	0,3
MERKITYS KAUPUNGINOSALLE / ОБЪЕКТ РАЙОННОГО ЗНАЧЕНИЯ PALOKUNTA ERILLINEN RAKENNUS /ПОЖАРНЫЕ ДЕПО ОТДЕЛЬНО СТОЯЩИЙ ОБЪЕКТ	3км/6 минут					
Apteekit/Аптеки	750м	kohde	0,05	2000,00	0,58	0,2
Harrastus- ja virkistystilat /Помещения для досуга и любительской деятельности	750м	m?	50,00		575,66	
Urheilu- ja liikuntatilat /Помещения для физкульт урно-оздоровительных занятий населения		lattiapinta-ala м?/м? пл. пола	30,00		345,39	
Elintarvikekaupat /Магазины продовольственных товаров	500м	kauppatilan pinta-ala м?/м?торг. площ.	30,00	4,00	345,39	
Taloustarvikekaupat /Магазины непродовольственных товаров	500м	kauppatilan pinta-ala m?/м?торг. площ.	30,00	4,00	345,39	
Ravintopaikat, ravintolat /Предприятия общественного питания	500м	istumapaikka /пос. мест	8,00	10,00	92,11	
Julkiset palvelut: korjaamot, ompelimot, parturi-kampaamot /Предприятия бытового обслуживания	500м	tyopaikkaa /раб. Мест	1,40		16,12	
Aidinmaitokeskukset /Раздаточные пункты молочной кухни	500м	kokonaispinta-ala m? /м? общей площади	3,00		34,54	
Posti- ja teleleitokset /Отделения связи	750м	1 kohde per 20...25 tuh. hlo / 1 объект на 20-25 тыс. человек	0,05		0,58	
Pankkiosastot Отделения банка	750м	1per 3 tuh.hlo /1 на 3 тыс. чел.	0,33		3,84	
Kiinteiston hoito- ja huoltopalvelun toimistotilat /Административные помещения служб эксплуатации		kohde per 12 tuh.hlo /обект на 12 тыс. чел.	0,08		0,96	
Vartiointi- ja turvallisuuspiste /Опорный пункт охраны порядка		kokonaispinta-ala m? /м? общей площади	10,00	1,00	115,13	

Appendix B: Models of public-private partnership designed by Global EcoSolutions, Ltd.

Global EcoSolutions

PPP models for St. Petersburg Marine Facade / Little Europe

Reijo Kohonen

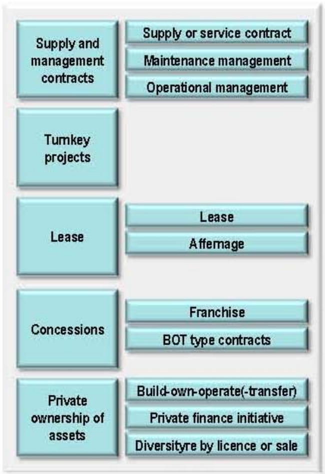
Malin Meinander

Finnish High-Tech ECOCITY | Member of CLEANTECH FINLAND | 3.11.2010 |

Global EcoSolutions

PPP models in general

- **Rationale:** Combining efficient private operation with public or hybrid financing - both investment and operating costs are reduced
- Often mentioned impacts of introducing PPP:
  - improved efficiency and performance by employing innovative operation and maintenance methods
  - improved service quality
  - improved financial efficiency
  - improved environmental protection by dedicating highly skilled personnel to ensure efficient operation and compliance with environmental requirements
- PPP models enable access to private capital for infrastructure investment by broadening and deepening the supply of domestic and international capital



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Appendix B. Models of public private partnership designet by Global EcoSolutions, Ltd.

Global EcoSolutions

Alternative PPP models in short

Operational management

- Management contracts may be useful when local manpower or expertise in running the facility is limited or when inaugurating a new operation.
- Operational management of urban transport services can also be contracted out to the private sector.
- In the simplest type of contract, the private operator is paid a fixed fee for perfoming managerial tasks.
- More complex contracts may offer greater incentives for efficiency improvement by defining performance targets and the fee is based in part on their fulfillment.

Affermage/Lease

- In this category of arrangement an operator (the leaseholder) is responsible for operating and maintaining the infrastructure facility and services, but generally the operator is not required to make any large investment.
- The arrangements in an affermage and a lease are very similar. The difference between them is technical.
  - Under a lease, the operator retains revenue collected from customers/users of the facility and makes a specified lease fee payment to the contracting authority.
  - Under an affermage, the operator and the contracting authority share revenue from customers/users.

Franchise

- Under a franchise arrangement the concessionaire provide services that are fully specified by the franchising authority.
- The private sector carries commercial risks and may be required to make investments.
- This form of private sector participation is historically popular in providing urban bus or rail services. Franchise can be used for routes or groups of routes over a contiguous area.

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Global EcoSolutions

Alternative PPP models in short

Concessions

- In this form of PPP, the Government defines and grants specific rights to a private company to build and operate a facility or provide utility services for a fixed period of time. Typical concession periods range between 5 to 50 years.
- The Government may retain the ultimate ownership of the facility and/or right to supply the services.
- Payments can take place both ways: concessionaire pays to government for the concession rights and the government may also pay the concessionaire, which it provides under the agreement to meet certain specific conditions.
- A key distinction between a franchise and BOT type of concession is that, in a franchise the authority is in the lead in specifying the level of service and is prepared to make payments for doing so, whilst in the BOT type the authority imposes a few basic requirements and may have no direct financial responsibility.

Private ownership of assets – variants of BOT

- In a Build-Operate-Transfer or BOT (and its other variants namely Build-Transfer- Operate (BTO), Build-Rehabilitate-Operate-Transfer (BROT), Build-Lease-Transfer (BLT)) type of arrangement, the concessionaire undertakes investments and operates the facility for a fixed period of time after which the ownership reverts back to the public sector.
- In this form of participation, the private sector remains responsible for design, construction and operation of an infrastructure facility and in some cases the public sector may relinquish the right of ownership of assets to the private sector.
- In the Build-Own-Operate (BOO) type and its other variants such as Design-Build- Finance-Operate, the private sector builds, owns and operates a facility, and sells the product/service to its users or beneficiaries.
- For a BOO project, the Government (e.g. a power distribution company) may or may not have a long-term power purchase agreement (commonly known as off-take agreement) at an agreed price from the project operator.

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Appendix B. Models of public private partnership designet by Global EcoSolutions, Ltd.

Global EcoSolutions

PPP practices in Russia & St. Petersburg

- The federal law on Concession Agreements while St. Petersburg has its own regional law on Participation in Public Private Partnerships
- St. Petersburg has a PPP unit organized under the Committee for Investments and Strategic Projects
  - Responsible for supporting and managing ongoing and future PPP projects to ensure the best possible value for money to the City of St. Petersburg
- A specific organization is established by the city for every PPP project managing the preparation and implementation of the project
  - The head representatives of the organization are responsible for managerial tasks and are assessed and rewarded for attaining them
  - As a rule, most of the employees are well acquainted with the technical aspects of the project, with the issue of financing projects, and specifically with the sphere of the PPP concept.
- Financial support
  - Investment Fund of the Russian Federation
  - The Russian Development Bank - Vnesheconombank (VEB)

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Global EcoSolutions

PPP model for Energy management

- For the proposed decentralised energy system the FBOOT model *) provides a reasonable PPP option
  - The FBOOT company is required to design, finance, construct, own and operate the energy supply system for an agreed number of years (commonly 20-25)
  - Investment and operating costs covered by charges to users
  - The grid company agrees to purchase the excess / provide back up to electricity, heat and cooling generated from the energy decentralized system during this period
- Responsibilities of Private PPP energy operator as service provider
  - Energy production
  - Energy distribution
  - Network control system
  - Services and billing
  - Infrastructure maintenance

***) FBOOT stands for Finance, Build, Own, Operate, Transfer**

Issues
Legislation related to the monopoly of TGC-1 and the construction of a decentralized energy network.
Possibility of implementing the system in the whole Marine Facade area.
Ownership of the distribution grid and network

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Appendix B. Models of public private partnership designet by Global EcoSolutions, Ltd.

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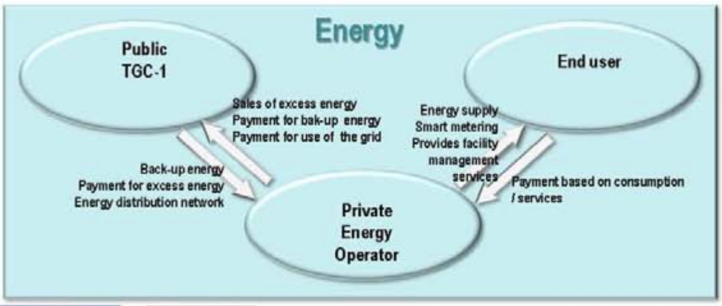
Energy PPP Model (FBOOT)

- Private = energy operator company (LE/MF energy company)
  - Provides the energy to end users
  - Produces the renewable energy and buys the rest of energy needed from TCG-1
  - Provides facility management services
- Public = TGC-1 (public energy company)
  - Provides distribution grid to LE/MF energy company
  - Provides back-up energy to LE/MF energy company
- Transfer of the ownership to TCG-1 after XX years



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Global EcoSolutions

Waste management PPP model

- For the proposed decentralised / automatic waste management FBOOT model provides a reasonable PPP option
  - The FBOOT company is required to design, finance, construct, own and operate the automatic waste management system for an agreed number of years (commonly 20-25)
  - Investments and operating costs covered by charges to users
- Responsibilities of Private PPP operator as service provider
  - Automatic waste collection and sorting
  - Logistics control system
  - Transport to treatment facilities
  - Services and billing
  - Infrastructure maintenance

Issues

- Recycling facilities (where are the closest for metal, glas, paper, plastic, biowaste)
- What is the situation of Yanino waste treatment plant
- Legislation related to the monopoly waste services and the construction of a biogas plant.
- Possibility of implementing the system in the whole Marine Facade area.

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Appendix B. Models of public private partnership designet by Global EcoSolutions, Ltd.

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Waste Management PPP model (Concession)

- Private = waste company (LE/MF waste company)
  - Operates the local automatic SWM system
  - Collects , sorts, transfer of solid wastes
- Public
  - Treatment of solid wastes
- Transfer ownership of the automatic waste collection system after XX years

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Water management PPP model

- For the proposed decentralized water management the Operational management model or BTO model provides a reasonable PPP option
- The organization, maintenance, and development of municipal water supply and sanitation are responsibilities of local governments [Stipulated in the federal law on local government]
  - The central government retains ownership of the systems in St. Petersburg
  - Tariffs are set by municipalities
- Responsibilities of Private PPP operator as service provider
  - Sanitary waste collection
  - Grey water collection
  - Grey and storm water treatment
  - Network control system
  - Services and billing
  - Infrastructure maintenance

<u>Issues</u>
Legislation related to the monopoly of Vodokanal and the construction of a decentralised waste water treatment system.
Possibility of implementing the system in the whole Marine Facade area.
Water fees
Taxation - provides subsidies to prevent the general level of charges from being too high

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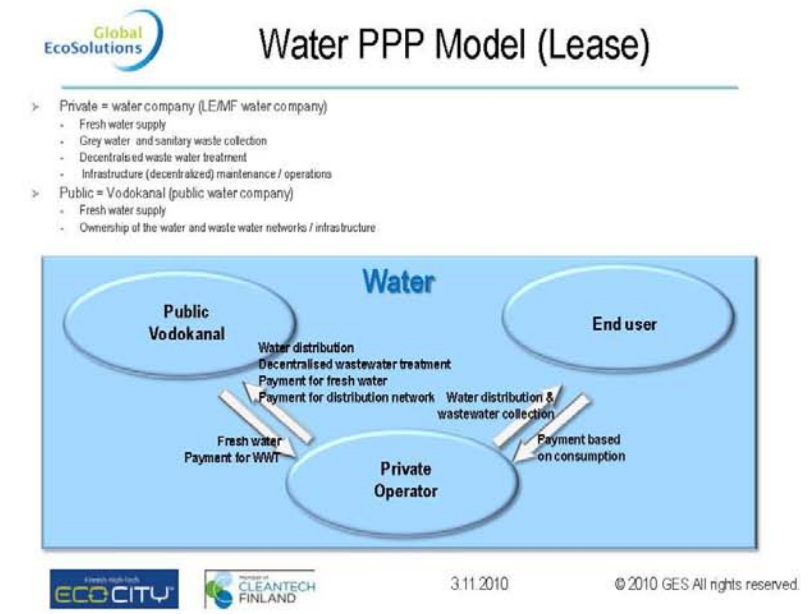
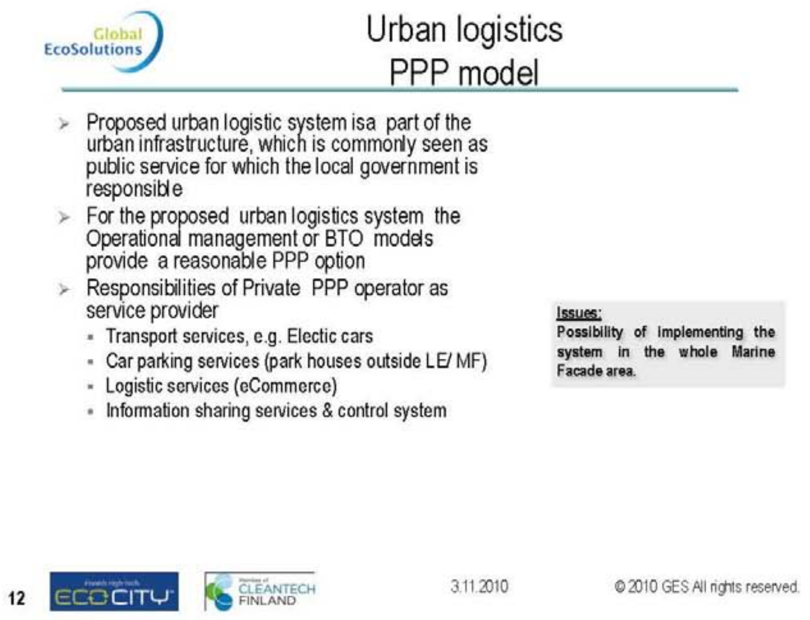
Appendix B. Models of public private partnership designet by Global EcoSolutions, Ltd.





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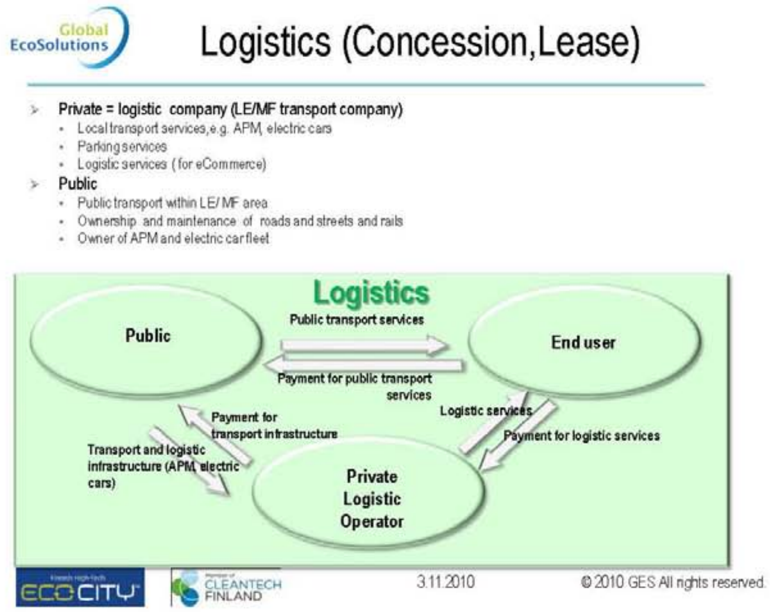

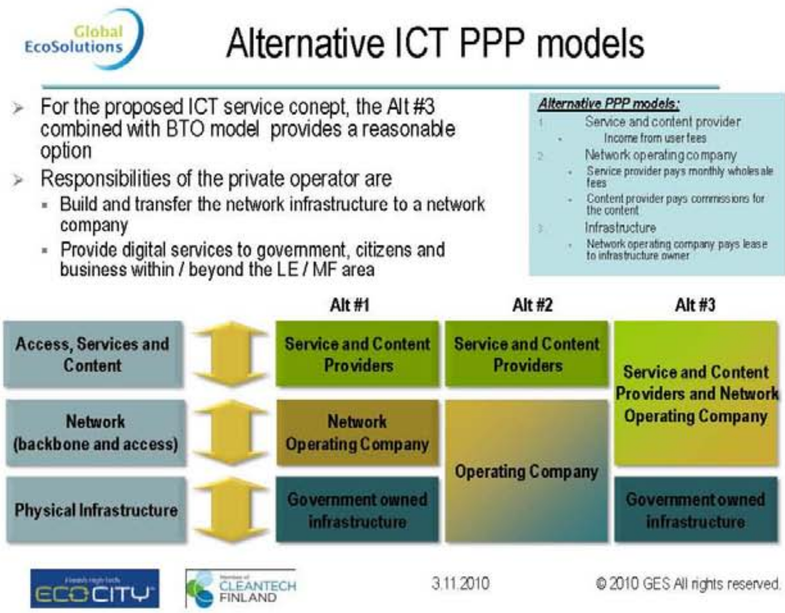

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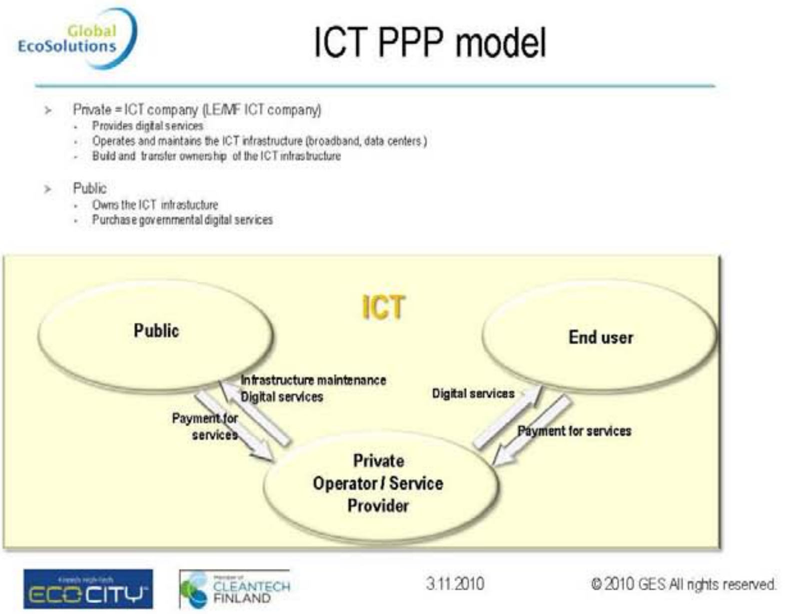

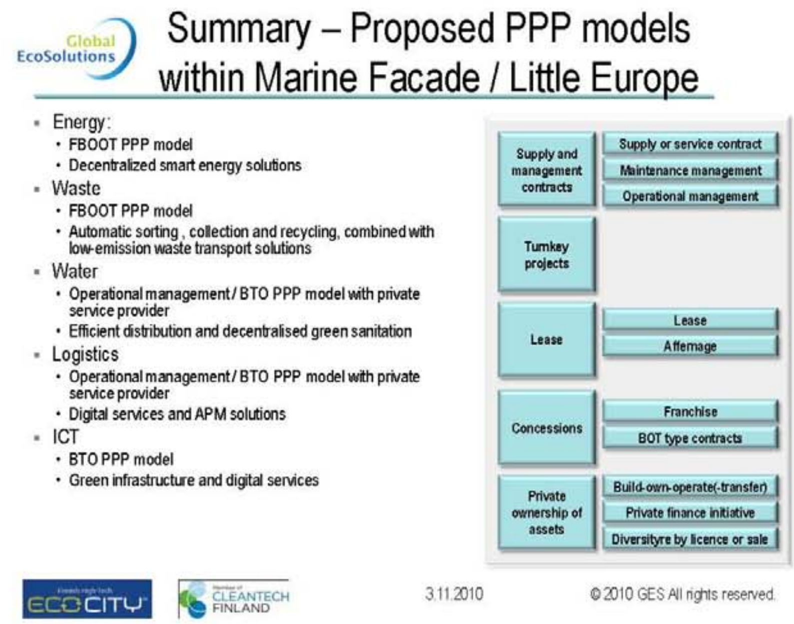

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Summary

Alternative PPP approaches

1. Little Europe only:
   - Scope #1 of PPP approach: One PPP project integrating utility technologies into all covering utility service concept (i.e. Facility management+ Energy+ Waste+Water+Logistics+ ICT)
2. Marine Facade
   - Scope # 2 of PPP approach : Several PPP projects, each of them providing one utility service (e.g. Energy) covering the whole Marine Facade area

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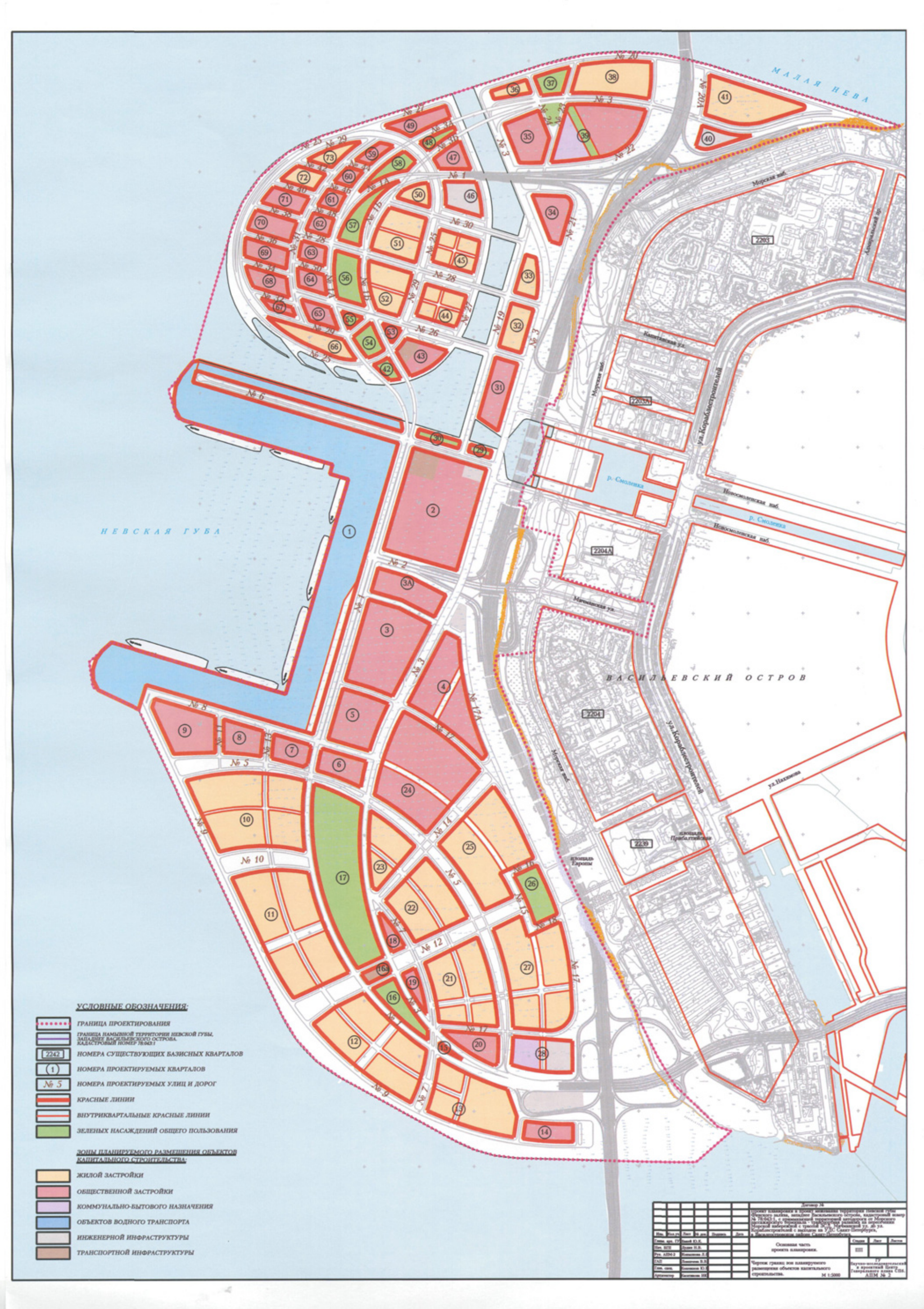
Appendix C: The location of the PPP pilot site in St. Petersburg



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Title

EcoGrad

A concept for ecological city planning for St. Petersburg, Russia

Abstract

The objective of the EcoGrad project was to develop an ecological city planning concept suitable for St. Petersburg. One important principle in the development process was the GOLD principle (Globally Optimised, Locally Designed). Local conditions were taken into account while implementing globally optimised solutions.

A dense city structure, minimisation of transport need and buildings energy consumption, maximisation of public transportation and bicycle routs, maximisation of renewable energy systems,sustainable waste and water management systems and taking social and cultural aspects into account, are parts of an ecological concept.

In Russia, energy efficient building technologies are still much undeveloped. Also renewable energy systems are quite unknown. On the other hand the Russian norms require very short distances to daily services as day-care, schools, health care stations, and shops. This is an aspect that supports ecological city planning very well.

A questionnaire among inhabitants was done within the project. It revealed among other things that it is not a value for inhabitants (92%) that their houses are heated with renewable energy. Mechanical ventilation is unknown for most of the respondents (80%), fresh air was anyhow considered important (80%), but less than half of the respondents (40%) were willing to pay for it. Taking the inhabitants into the development process, in other words Living Lab activities, are an important part of ecological planning and should be implemented into the planning process.

Plans for three pilots were developed within the project. The areas energy consumption was assessed and emissions were calculated for different types of renewable energy systems. In one of the pilots an ecological plan was made with the boundary that no extra investment costs were allowed. In the ppp-pilot focus was put on different business models based on public-private partnership models.

During the project seven meetings were held with representatives for St. Petersburg. Elements of the concept were presented, and feedback was received about how the concept would be suitable in local conditions. Based on this feedback the concept was revised and a criteria list was developed. The criteria list helps the local city planning with requiring the right things in order to develop an ecological housing area.

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The objective of the EcoGrad project was developing a concept of designing environmentally clean residential areas for St. Petersburg. This report defines the theses and criteria of the EcoGrad concept. The results of a poll conducted among Russia's residents have been used in this work.

The work included designing three pilot sites located in St. Petersburg. Energy supply versions and their atmospheric emissions were modeled for them. Besides, the work also included having a closer look at public-private partnership schemes that may be applicable to this concept.

Looking into the EcoGrad concept included exploring dense residential planning, the minimization of the need for travel, the maximization of the use of public transportation and light vehicles, the minimization of energy consumption, the maximally efficient use of renewable energy sources and environmentally stable ways of waste disposal, sewerage and water treatment. Accounting for social and cultural aspects is also important.

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