

Energy Improvement District: case from Polytechnic University

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Abstract—The study addresses to harness the full energy savings potential of existing city's structures, to elaborate holistic strategies that integrate sector-based approaches, and to engage energy consumers in strategic energy planning for energy improvement district (EID). The article presents results of a case study of Peter the Great St. Petersburg Polytechnic University campus as an EID. SPbPU is considered as a typical object, possessing properties that are inherent in a large number of territorial entities of St. Petersburg, where there are real estate objects that are in private, state and regional ownership. Using the method of identifying stakeholders, the article analyzes the stakeholders of the EID at SPbPU. The EID special characteristics are highlighted which obstruct to motivate main users on resource saving. In combination with the SWOT analysis, this allows us to identify gaps and challenges in creation of a resource-saving motivation system for the main users. Results of the study form a background for development of strategic plan for EID with close interaction of main stakeholders. Invariant components of the case study that are of interest for other EID were selected and described.

Keywords—energy efficiency, stakeholders motivation, strategy energy planning

I. INTRODUCTION

"On average, every €1 invested in energy efficiency saves €3, over the lifespan of a technology" [1]. Various versions of similar statements can be found everywhere, ranging from advertising brochures to serious analytical studies. They reflect the unanimous expert opinion about the prospects of energy-saving technologies, and at the same time indicate the lack of tools that would allow to accurately calculate the economic effect from the energy-saving measures. The reason for this is not a lack of research in the area of energy production, transfer and use, but rather the complexity and versatility of the problems that form potential for energy saving. Energy consumption in the residential sector is implemented in the framework of complex systems that belong to the class of socio-technical systems, and have technical, economical and social subsystems.

The technical components of the system are equipment and technologies that ensure the supply and metering of energy consumption by end users. From the point of view of energy saving, the objective function of this subsystem is to minimize energy losses during its transfer from the power generator to the consumer. The necessary conditions are the requirement to ensure the transfer of energy in the mode of peak consumption and average loads.

The economic components of the system are financial and organizational mechanisms that stimulate (or vice versa, impede) the consumption of various types of energy resources in the context of consumption volumes, time and spatial frameworks of energy consumption by end users. From the point of view of energy saving, the objective function of this subsystem is to stimulate minimization of energy consumption. A necessary condition for the effective functioning of this subsystem is the compliance of the general level of financial burden on the energy consumer with the general level of economic development and financial condition of energy end users. Too high tariffs or financial restrictions on the use of resources can serve as a barrier to the development of the economy or worsen the quality of life of the consumer (the greatest energy savings will be achieved if you refuse to use any electrical appliances due to the high cost of electricity). On the contrary, a financial burden of 0,5-1% is unlikely to serve as an effective economic incentive to save energy consumption.

The social components of the system reflect the behavioral characteristics of the energy resources end-users. They are significantly affected by financial and economic mechanisms that regulate energy consumption. However, issues of end-user behavior cannot be reduced only to the issues of tariff optimization for consumed energy. Obviously, in order to optimize the activities of this subsystem, it is necessary to maximally activate non-economic energy stimulation mechanisms that could be considered as the objective function of this subsystem.

The above shows that to obtain the maximum effect from energy-saving measures, a systematic approach is needed based on a comprehensive analysis of all the components of the socio-technical system of energy saving.

II. LITERATURE REVIEW

Cities and urban areas with their vast building stock and infrastructure play a key role in reaching European energy efficiency targets. They represent crucial spaces with great energy efficiency potential. Nevertheless, transition towards high energy efficiency cities is often hampered by sectoral fragmentation and lack of cooperation between public authorities, energy utilities and property owners. Currently, a number of project initiatives aimed at a comprehensive solution to the problem of improving energy efficiency is implementing all over the world including Europe. Different aspects of energy saving problems including in housing and infrastructure sectors are studied in these projects.

A. Innovation technologies for energy saving in housing

The main content of researches devoted to technical aspects of energy saving is renewable energy and corresponding technologies. [2]. Progress that was made in recent years in the field of digitization, renewable energy and electrical energy storage provides an opportunity to increase energy and economic efficiency in all areas of activities. All experts point out that at the moment, renewable energy shows the highest growth rates among all energy carriers. While a general increase in energy demand is forecasted at the level of 47% by 2040, the consumption of renewable energy sources (RES) will increase by 93% at the same period [3]. The main trend in development of renewable energy technologies is reducing costs while increasing capacity and reliability of solar and wind generators [4]. According to BNEF there has been 28,5% drop in the price for crystalline – silicon PV modules for every doubling of cumulative capacity since 1976 [5].

The rapid growth in the number of RES innovative projects brings to the fore the tasks associated with the need for power redundancy and energy storage to ensure the flexibility of the power system at times of peak loads. In addition to the known problem of daily irregularity of electricity production at renewable energy facilities, it should be noted the seasonal component, which is manifested in connection with changes in the intensity of solar radiation and wind energy at different times of the year. Because of this, the average monthly power consumption may vary by several times. Since the system must be designed for stable operation at peak times, in fact this causes additional hidden investment costs, which are often not taken into account when comparing the costs of generating electricity from different sources. Batteries that are needed to replenish energy in dark or calm weather have become one of the limiting factors for increasing the efficiency of renewable energy. Their production and disposal can have a negative impact on the environment, and the limited service life and the need for replacement cause additional costs during the operation of renewable energy sources.

The efficiency of batteries increases, and the price decreases due to the development of technology and growing demand. Both renewable energy sources and electric vehicles have a significant impact on this process, where batteries are also one of the key elements. BNEF expects that sales of electric vehicles will increase from 1.1 million currently, to 30 million by 2030, which will lead to a decrease in the basic cost of batteries [6].

One of perspective innovations for increase of efficiency of RES is development of semiconductor devices with wide bandgap (WBG) technologies that is stimulated by the demand for highly efficient power electronics devices, which are most used in electric drives, connection of renewable energy sources (RES) and "smart home" energy devices [7].

Strictly speaking, the above technical tasks for improving the production technologies for RES are only indirectly related to the housing sector. Traditionally, in the centralized energy supply systems, energy production is a part of industrial sector. The housing and utilities sector consumes energy resources and it doesn't matter who and how produces energy. The main thing is the volume, price and reliability of supply. RES development changes the situation and energy

generators come to housing sector and become a part of housing infrastructure. Solar energy, wood and wind are the most widely used RES: wood is used as fuel for district heating, both centralized and local, and for the heating of individual buildings. All the most of the electricity generated by local communities and located in urban areas comes from renewable and environmentally friendly energy sources, whereas the remaining electricity is generated by combined heat and power plants working in cogeneration mode.

Transition to decentralized energy supply system provides a number of advantages but formulates additional questions for economical and social subsystems of the complex energy saving system.

B. Business support mechanisms for RES development

The economic attractiveness of renewable energy is in the analysis of many experts. While some experts state that "renewables are reaching price and performance parity on the grid and at the socket" [8], another underline that high rates of growth in production of renewable energy are largely due to significant state support [9].

Energy efficiency projects are not typical investments: they do not result in direct revenues but rather in non-expenses, i.e. through savings of energy, water and other resources. To transform the effect of energy saving projects from the material and technical to the financial sector, appropriate tools are necessary. Such tools are studied in the BSR INTERREG project EFFECT4buildings develops [10]. In collaboration with public property owners and managers, financial tools and methods that help improve profitability, facilitate the financing of energy investments and reduce risks are analyzed. As examples of such tools, financial calculation instruments, bundling and funding tools, energy service and green leasing contracts and economic models for both producing and consuming energy are studied. Financial tools and methods are developed along a number of real cases among institutions participating in the project.

C. Social aspects of energy saving measures

The importance of social aspects for the energy efficiency problem solving is confirmed by many publications. These questions are in the focus of a numerous of BSR INTERREG projects. Two Interreg projects, AREA 21 and LowTEMP, unlock energy efficiency potential by triggering public and private strategic partnerships for energy production and management and by offering low temperature district heating technology for more efficient heating systems [11].

The following aspects of social questions are studied [12].

1. Organizational structure of social innovations for energy saving. Main focus of these studies is related to consumer/producer associations and cooperatives for energy saving. A significant share of these cooperatives are organized in well-structured networks that bring together citizens towards joint ownership and participation in renewable energy or energy efficiency projects.

2. Measures to ensure comfortable living conditions in the context of energy shortages. Today, energy poverty still affects several million households in Europe, where residents are trying to provide adequate heating, live and pay utility bills in a timely manner in homes that are not protected from moisture and mold. This situation is significantly dependent

on the geographical location and social status of energy resources consumers, which leads to different levels of access to possible levels of energy supply and modern technologies.

3. Social aspects of financial schemes for energy involving citizen investment:

- shareholding participation in energy communities;
- crowdfunding initiatives in the sectors of renewable energy and energy efficiency;
- citizens which finance and implement innovation projects in the field of RES;
- allocation of public resources via vouchers or grants and
- donations of business-angels, i.e. citizens voluntarily providing financial support to an energy efficiency without expecting any return.

4. Educational aspects, referring to raising awareness and contributing to increasing the acceptance of renewable energy and energy efficiency measures and projects. This mode of social innovation can explore synergies with cultural and entertainment activities addressing general messages such as climate change mitigation and the environment protection. Additional possibility for involvement of the youth in energy saving measures provide ICT gaming technology.

III. METHODOLOGY

A systematic approach to analysis of the complex problem of strategic planning of energy saving measures at the level of the urban districts was proposed in the framework of the AREA 21 project [13]. The project is based on 2 keystones:

- the concept of an Energy Improvement District (EID) as a limited area where both consumers and producers or suppliers of energy resources consumed by the housing sector are compactly located and
- the comparative analysis of 7 pilot areas located in different countries Baltic Sea region.

The selection of EID is based on the set of criteria developed by the project Partners (figure1). The process of defining the EID starts from selection the pilot area which corresponds to these criteria. In order to provide comparable data for analysis of various EIDs, the project has developed a method for collecting and analyzing information, consisting of five steps as it is shown in Figure 2.

First step of the above method is aimed on analysis of external environment of the EID. It provides data on opportunities and threats for the SWOT analysis which will be done at the Step 3.

interreg
Baltic Sea Region

AREA 21

Selecting an Energy Improvement District Framework

AREA 21. Energy Improvement Districts (EID) should be characterized by existing urban areas, predominantly comprised of housing, with a presence of public buildings, which might also be combined with commercial and business uses.

When selecting the EID, we divided criteria on 3 groups and put them in descending order of importance:
 1. Conditions of necessity for analytical approach: criteria 7, 6.
 2. Types of objects for analysis: criteria 8, 2, 1.
 3. Conditions of efficiency for energy improvement measures: criteria 3,4,5
 The most significant criteria from each group are marked in the below table with the sign

<input type="checkbox"/>	Criteria 1: Housing areas with a preference of multi-family buildings; presence of cooperatives and associations with a reduced number of separate owners Aim: Fewer owners will assist with gaining authorization and participation.
<input type="checkbox"/>	Criteria 2: Existence of public buildings within the EID Aim: The integration of public buildings will serve as lighthouse projects for each city.
<input checked="" type="checkbox"/>	Criteria 3: Accessibility to data of the area including energy demand and consumption (current and future availability), age and refurbishment of buildings, etc. Aim: Data availability is key for analysis and selection of measures to be applied, to optimize and track the results of an EID.
<input type="checkbox"/>	Criteria 4: Strong interest and commitment of stakeholders in the area: <ul style="list-style-type: none"> • Public authorities responsible for energy planning, urban and sustainable planning, other related fields (experts, government officers and policy makers); • Cooperatives, associations or owners (willingness to participate in the strategic and decision making process to reduce the energy consumption through measures applied to the property or to permanent/fixed property appliances, and providing access to energy usage data); and • Energy utilities; It is also recommended to select districts with existing or concurrently run initiatives of cooperation formats, for example: business or housing improvement districts, previous redevelopement projects on energy or refurbishment related topics, previous redevelopement projects, etc. Aim: Early involvement of key public and private stakeholders is crucial for the success of an EID. It is recommended to secure the commitment of at least 15% of the involved property owners. As well, the assuredness of the largest property owners as early as possible will avoid a blocking minority. Selecting districts with existing initiatives will simplify the data availability and the stakeholders' involvement. This will add value to the EID by enabling knowledge sharing of existing data, and will build upon existing experiences, lessons learned and stakeholder partnerships.
<input type="checkbox"/>	Criteria 5: Integration in current or/and future redevelopment plans or strategic documents. Capacity of involved parties to influence the planning and implementation of EIDs Aim: Selecting districts, in which redevelopment plans are already under consideration, may facilitate the implementation of the EID. The same purpose may be achieved by involving parties with the capacity to influence the implementation process.
<input type="checkbox"/>	Criteria 6: Selection and identifying of EID through mapping areas with the highest energy losses and/or highest energy consumption, with distinct identifiable and unifying features such as similar building typology, spatial configuration of urban structures, common goals, etc. (See below) Aim: An analytical approach in the selection of an EID by identifying energy behavior mapping of the most critical districts within a city/urban area.
<input checked="" type="checkbox"/>	Criteria 7: Unifying features, common goal or need (ex. aging housing stock, high energy losses, functionality and attractiveness enhancement, living quality improvement, etc.), which considers buildings stock, the infrastructure and the people as one system Aim: Unifying features will help determine boundaries of the EID as well as the future approach for the selection of measures.
<input checked="" type="checkbox"/>	Criteria 8: Area with a manageable size that considers a unifying feature as listed above

Fig. 1. Criteria for the EID selection

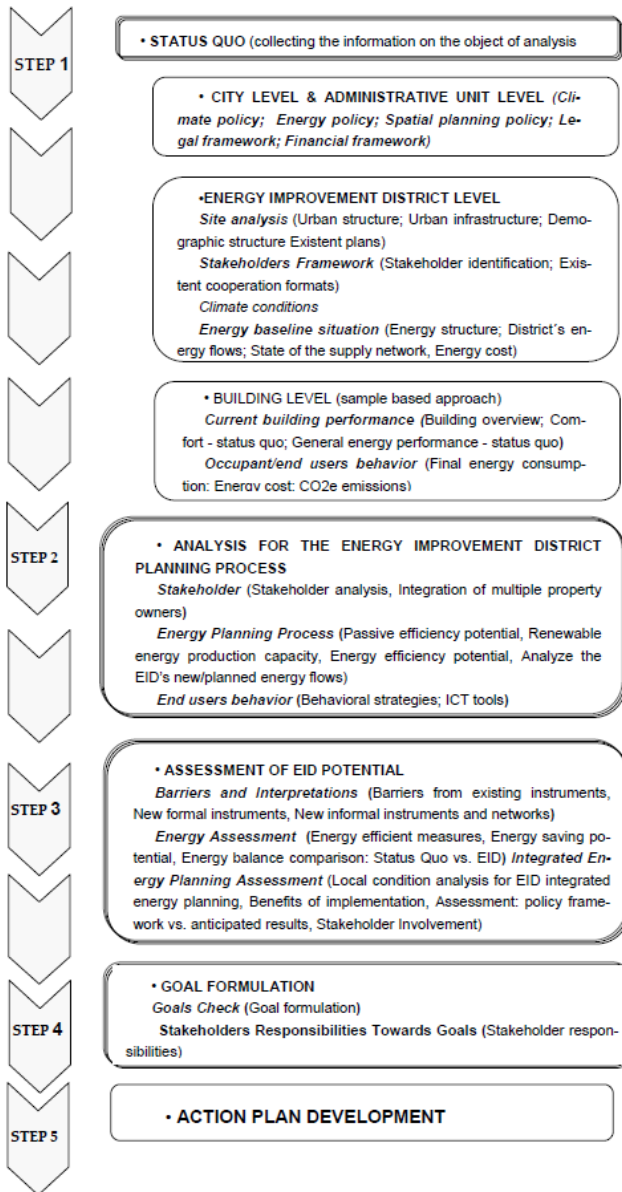


Fig.2 Steps for analyzing of Energy Improvement District

Second step provides necessary input to defining strengths and weakness of analyzed EID from the point of view of energy efficiency. Standard SWOT procedures realized at the Step 3 provide formulation of goals and development of action plan to achieve these goals (steps 4 and 5). Since the social aspects of energy saving are considered as one of the main focus area of AREA21 project, the analysis of stakeholders involved in strategy energy planning at the district level is one of key tasks. To solve this task, the Stakeholder Map as special instrument for visualization of stakeholders roles was developed according to their main intervention in the life cycle of an EID, as primary or secondary stakeholders [14].

The following Intervention Categories in the EID life cycle were selected as main elements of Stakeholder Map [15]:

Category 1: Strategic Policy Development

This category comprises energy sector policy making on environmental protection and spatial planning to promote EID

goals and development. It has a strategic focus by identifying needs of stakeholders and using stakeholder consultation to review, evaluate and monitor the policy to make further improvements.

Category 2: Regulation and Financing

This category comprises practical rules for everyday working in the fields of energy, environmental protection and spatial planning, as well as financing models for EID development. Financing includes private investments, incentives and other funding programs.

Category 3: Cooperative Energy Planning

This category includes the communications that will be undertaken with EID stakeholders including notification of project updates and cooperative formats such as round table discussions and online forums. The communication material will address all matters related to energy planning for the EID.

Category 4: Implementation

This category includes the necessary technology delivery and energy supply for the EID, as well as the people and organizations implementing the EID.

Category 5: End Use, Management & Maintenance

This category involves end users such as beneficiaries and users of the EID, as well as the groups responsible for management and maintenance of the EID.

IV. RESULTS AND DISCUSSION

A. EID selection

One of the AREA21 project pilot areas is the EID Polytechnic which is the main subject for further analysis on the base on the above methods [16].

EID Polytechnic is located at the north part of SaintPetersburg in Kalininskiy district, Academichesky municipality. Local territorial context of EID Polytechnic is shown at the figure 3.

The EID was selected as a result of analysis of different areas of Saint-Petersburg on the base of selection criteria presented at figure.1. The following criteria were considered as the most important for the selection (are marked by at the figure 1).

Criteria 7: Unifying features, common goal or need (ex. aging housing stock, high energy losses, functionality and attractiveness enhancement, living quality improvement, etc.), which considers buildings stock, the infrastructure and the people as one system.

The following technical subsystems play key role for the energy efficiency in Polytechnic.

Electricity supply subsystem

No electricity generators, electricity supply from the city, small solar and wind generators used only for testing and research. Centralized electricity supply: 24 electricity transformer substations, 42 transformers, 31 of them are more than 45 years old while life time is 20-25 years. Cable lines 6kV with the length around 25 km, 90% of which have average exploitation age more than 45 years. Cable lines

0,3kV with the length around 50 km, 90% of which have average exploitation age more than 45 years.

Energy Baseline Situation: heat and water supply subsystem

The length of external serviced heating networks is 20 km. The length of outdoor networks of drinking and fire water supply and sewerage systems is 30 km. The length of internal heat supply, water supply and sewerage systems more than 150 km. The number of heat nodes and water-measuring units more than 140. The number of sewer and water wells more than 800. 80% of all external and internal water and supply and sewerage systems have physical wear or exceeded service life. Combination of centralized and decentralized systems.



- 1. **Central campus**, total area more than 250 000 sq.m.: 16 educational buildings, 3 administrative buildings, 2 dormitories, 2 apartment houses, 4 manufacture buildings, 1 kinder-garden, 1 sports complex with swimming pool
- 2. **Khlopinskaya site**, total area more than 50 000 sq.m.: 4 dormitories, 1 apartment house, 4 educational buildings, 3 public buildings (kinder garden, outpatient hospital).
- 3. **Lesnaya site**, total area more than 62 000 sq.m.: 7 dormitories, 1 residential building, 6 manufacture buildings
- 4. **Gradgdansky site**, total area more than 30 000 sq.m.: 2 dormitories, 2 educational buildings, 6 manufacture buildings
- 5. **Obruchevykh site**, total area more than 10 000 sq.m.: 1 educational building, 1 manufacture building, garage

Fig. 3. EID Polytechnic: territorial aspects

The heat supply of buildings on the Central Campus is provided by the Central Boiler House with the thermal capacity 26 Gcal / h and the pressure of the coolant in the pipes at the output 4-4.5 bar.

Heat supply of buildings on the Lesnaya site is provided by the Campus Boiler with the thermal capacity 6.5 Gcal / h and the pressure of the coolant in the pipes at the output 4.5-5 bar.

Heat supply of buildings on the Khlopinskaya site is provided from urban networks. The pressure of the coolant in the pipes is 5.05.5 bar.

The responsibility on maintenance and use these energy supply subsystems lies on a single juridical person - Peter the Great Saint-Petersburg Polytechnic University (SPbPU) that make it natural to consider different technical elements of the infrastructure of supply energy resources in Polytechnic as subsystems of one energy resources supply system. The technical condition of this system elements creates the most dangerous threats for achievement of EID goals.

Criteria 3: Accessibility to data of the area including energy demand and consumption (current and future availability), age and refurbishment of buildings, etc.

The availability of data is one of prerequisite for analysis. Data of energy consumption refer to the category of personal, which in some cases creates additional barriers to their receipt. The centralized management system in the EID Polytechnic greatly simplifies the task of obtaining energy consumption data for EID analysis.

Criteria 5: Integration in current or/and future redevelopment plans or strategic documents. Capacity of involved parties to influence the planning and implementation of EIDs

Conducted analysis has showed the presence in St. Petersburg of a sufficiently developed regulatory framework of the federal and regional levels on energy efficiency and energy saving in housing. SPbPU develops and realizes own programs for renovation and development of outdoor infrastructure and indoor equipment for energy resources supply of buildings in the campus.

All of the above confirms that the SPbPU camp meets the selection criteria for EID developed under the AREA21 framework.

B. EID analysis

Following the methodology presented at figure 2, SWOT analysis of EID Polytechnic was conducted (see figure 4). Results of this analysis were discussed at 3 Local Stakeholders Workshops that were organized in SPbPU with methodical support of AREA21 Partners. One of the key factors for the success of these workshops was the informed choice of their participants. This choice was made using EID Polytechnic Stakeholder Map (see figure 5). Social aspects of energy saving measures were selected as priority topics for energy saving in SPbPU and the motivation in energy saving for different stakeholders was discussed. Summarized results of these discussions are given in the table 1. Since the most of stakeholders in EID Polytechnic do not have direct economical motivation in energy saving, to realize EID goals it is necessary to stress opinion at behavioral aspects and to provide measure which will develop the internal motivation of SPbPU students and employees in energy saving when they use SPbPU facilities and infrastructure.

The result of the analysis and discussion was an action plan that contains a list of tasks to be solved to achieve the goals of the EID (see figure 6). Since this action plan was developed in cooperation with all parties which will be involved in its realization, prospects for its implementation significantly increased.

INTERNAL ORIGIN (attributes of the area)	EXTERNAL ORIGIN (attributes of the environment)
<p>Strengths</p> <p>Identify characteristics of your EID, which support the initiation of a cooperative energy planning process</p> <ul style="list-style-type: none"> • Cooperation formats already exist within the district: regular working meetings and round tables in frame of local events • Availability of own scientific and service departments that conduct benchmarking of technical and organisational solutions that corresponds not used potential of energy saving • Centralized management system with high level of main stakeholders responsibility concentration. The EID territory is under the SPbPU management. SPbPU has direct motivation for reduce of payments for housing resources • Partial independence from external heat sources (combination of centralized and decentralized heat supply systems: 2 boiler stations and connection to the city grid) • Automated system of technical accounting of energy resources in EID. 	<p>Opportunities</p> <p>Identify favorable conditions in the environment that your project could exploit to its advantage</p> <ul style="list-style-type: none"> • Newly developed ICT: Tools and/or measurement technology for online control of energy use • Local energy policies focused on energy saving, SPbPU program for modernization of housing infrastructure (updated annually) • Pilot energy efficient building and wind electricity generator. • Motivation rise of end users in energy saving by different means: changes to internal regulations, changes to internal documents, promotion of green sustainable development ideas, ensuring the collection and processing of energy consumption data for each object in EID. • Big potential for implementation of energy- and resource-saving measures including rise of end users motivation in energy saving • Use of EID for improvement the quality of education in SPbPU and for appearance the new types of scientific and technical services provided by SPbPU
<p>Weaknesses</p> <p>Identify characteristics of your EID, which are disadvantageous in the initiation of a cooperative energy planning process</p> <ul style="list-style-type: none"> • Lack of effective financing instruments • No electricity generators in the EID. Electricity supply from the city grid to EID • Feed-in Tariffs for renewable energy do not apply • SPbPU departments responsible for maintenance of energy infrastructure have no direct motivation in energy saving (salary received does not depend to results of energy saving). • Most of end users have no motivation (and partly - technical possibility) on energy saving 	<p>Threats</p> <p>Identify unfavorable conditions in the environment that could endanger your project</p> <ul style="list-style-type: none"> • Energy suppliers have no interest in energy saving measures (economically harmful for them) • 80% of internal energy infrastructure (grids, substations etc.) have physical wear or exceeded service life (31 transformers are more than 45 years old while life time is 20-25 years). • Formal barriers for use of regional financing in EID which is federal property • Existing tender procedures are aimed at choosing cheap technical solutions with the limited possibilities of considering the best quality characteristics • Long and complex procedures for connecting new customers to existing power grids. Lack of procedures for connecting new electricity suppliers to existing networks, which hinders the use of renewable energy sources

Fig. 4. SWOT-analysis of EID Polytechnic

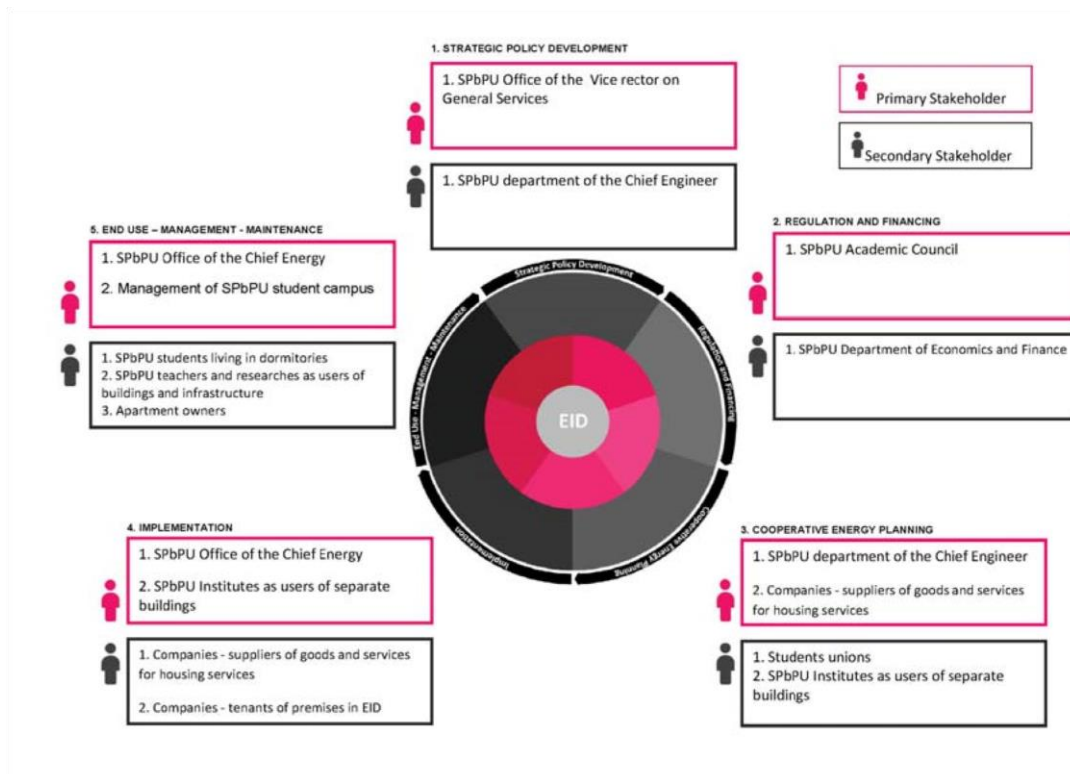


Fig. 5. Stakeholder Map of EID Polytechnic

TABLE I. ANALYSIS OF STAKEHOLDERS MOTIVATION

Stakeholder	Degree of interest in energy saving	Potential to increase the interest in energy saving	The possibilities of influencing the final result	Main problems within the framework of existing opportunities
1 Managers of the object	Direct interest in frame of the job responsibilities	Finalization of job descriptions, targets and their monitoring with bonuses based on the results in energy saving..	High (development of technical aspects, increase of the work efficiency)	Absence of direct links between salary and saved money thanks to energy saving measures. Insufficient capacity to analyze resources consumption in separate buildings
2 Apartment owners	Direct interest (costs saving, quality of life)	Additional information on existing opportunities	Relatively small (their number in the EAD Polytechnicheskyy is insignificant)	Lack of technical capacity to regulate heat consumption in the old apartments
3 SPbPU teachers and researches as users of buildings and infrastructure	Indirect interest, (practically absent, only quality of conditions for the work)	Stimulation of SPbPU units for saving of resources (water, heat, electricity)	Practically absent, although they are end users for most of consumed resources (more than 40 buildings)	Lack of technical capacity to regulate heat consumption in the old buildings. Inability to collect data on resources consumed by the unit
Stakeholder	Degree of interest in energy saving	Potential to increase the interest in energy saving	The possibilities of influencing the final result	Main problems within the framework of existing opportunities
4 SPbPU students as users of buildings and infrastructure	Indirect interest, (practically absent, only quality of conditions for the study)	Additional information, promotion, involvement in projects on energy saving	At the moment practically absent although they are end users for most of consumed resources (more than 20 buildings)	Absence of the information on SPbPU plans and actions for energy saving
5 SPbPU students living in dormitories	Indirect interest, (they pay on tariffs, but not for consumed resources)	Additional information, promotion, involvement in projects on energy saving	At the moment practically absent although they are end users of consumed resources in 13 dormitories	Absence of possibility to collect data on consumed resources
5 Companies - suppliers of goods and services	Direct interest (business)	Long-term partnership and projects	High (quality of products and services for energy saving)	Restrictions of contracting system

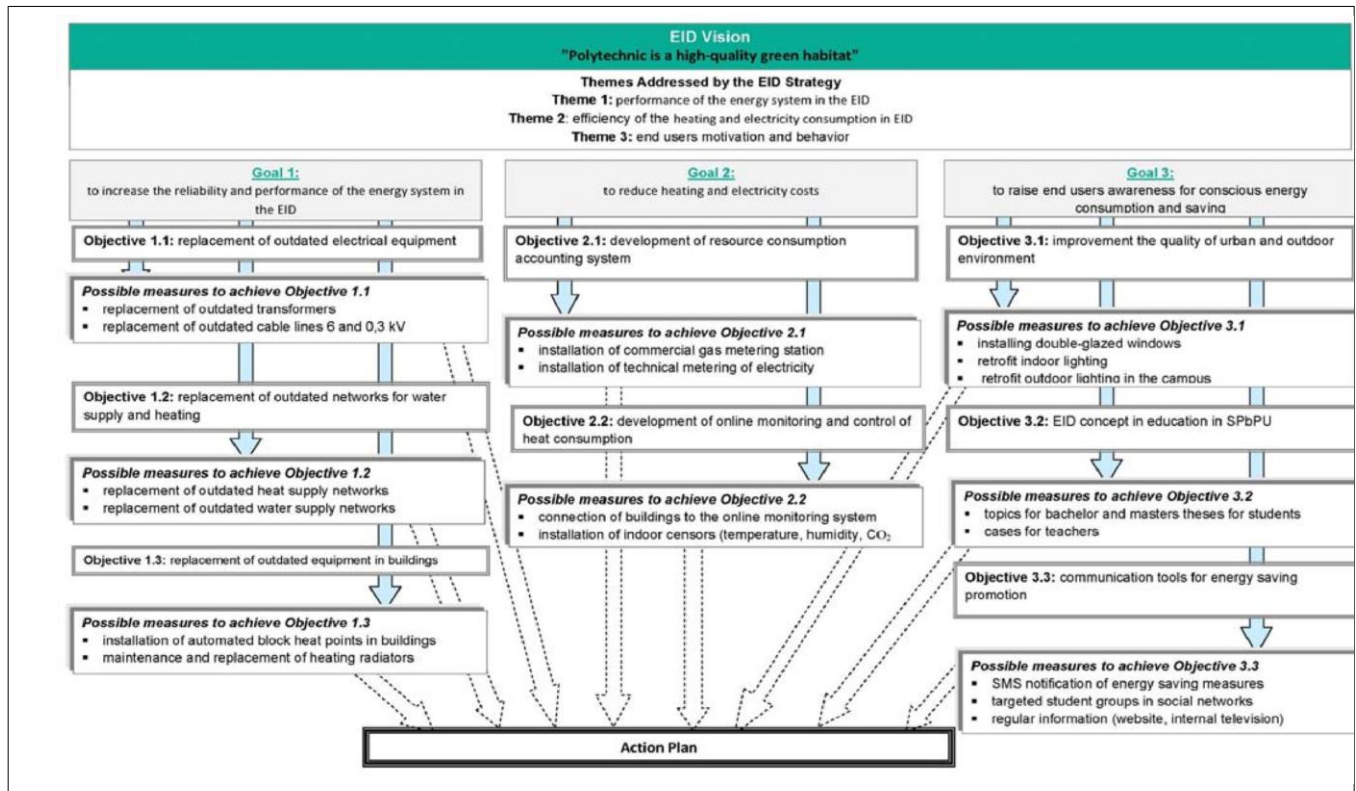


Fig. 6. EID Polytechnic: from vision to action

V. CONCLUSION

1. By their nature, energy saving is a complex problem, which requires the joint consideration of technical, organizational, economical, and socio-psychological problems. e

2. The EID concept developed in frame of AREA21 project provides systematic view on complex problems of energy saving in urban regions. This provides additional impetus for engaging all stakeholders in energy saving planning and realization.

2. Behavioral aspects of stakeholders are crucial for energy saving especially in cases where stakeholders have no direct economic motivation.

3. ICT and education should be considered as effective tools to promote and motivate energy saving measures.

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