Creating a Smart City – Supporting Management of Regional Project Initiatives

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Abstract. Smart cities are developing fast and introducing new practices and services that have a strong impact on policy making and planning, while also interacting with urban facilities. It is now needed to understand the smart city’s contribution in the overall urban planning and vice versa, to recognize urban planning offers in the context of an intelligent city. The article is an attempt to preliminary analysis of the forms of innovation in small urban models for sustainable development, which can be used in an smart city. The structure of the review has been developed on the basis of conceptual framework of off-grid complex that unite selected regional specialties, the strategy of sustainable development and the process of connections, which has been chosen as a method of identifying paths of research in defined area. The result show that innovative projects for sustainable development strategy can be implemented using selected elements of data cloud computing, which would allow in the future strategy building in the cities based on selected categories of technologies and taking coherent actions in the area of innovative projects. The concept combines a variety of innovative technologies, where the outputs of one system are inputs of another. Further research is also required to develop appropriate measurement criteria for determining the effectiveness of strategies. The concept defined its main components, and outlines future directions to improve it.

1. Introduction
1.1. Background and purposes
Research on the transformations of the spatial and economic structure of cities more and more often indicate new development factors, which include advanced technologies that save time and energy, as well as human capital, social capital, which are extremely important in the development of cities. The contemporary city is not only its physical structure, but also a huge network of cyber connections, striving to optimize the use of city resources and processes to prevent negative externalities resulting from the city's functioning in accordance with the principle of sustainable development.

Growing populations, number of homes and a lot of new appliances have caused the growth of energy demand. Increasing share of renewable energy sources in energy balance contributes to the improvement of the efficiency of using and saving energy resources, improvement of the environment by reducing emission of pollution to the atmosphere, soil and water. The fast-paced development of power systems necessitates smart grids to facilitate real-time control and monitoring. Future smart grids are expected to have reliable, efficient, secured, and cost-effective.
1.2. Scope and focus of this work

The article focuses on innovations that provide value to the city while minimizing the negative impact on the environment and residents of the city. The paper discusses important, selected issues that form the methodological framework of prospective regional and regional strategic programming.

The concept is to develop an off-grid capable neighborhoods where the resources will be used in a closed loop. Starting with planning stages and the formation of buildings, through exploitation, maintenance and final demolition and recycling. The units will use the technology and sensors to monitor living patterns, energy use and efficiency, and send that data to the cloud to similar villages to learn from each other. Already existing technologies will be applied into an integrated system of information management.

2. Programming future regional specialties

2.1. The path of creating regional specialties

In the methodological path, regional specialties became the central category. It is assumed that the emergence of the regional economy specialties is a complex, multi-phase process. It is a process reflecting the essence of internal development, in which various components of the region's internal potential in interaction with regional stakeholders and regional leadership initiatives result in the emergence of a new urban model.

The development of the region is based on the process of creating ideas and developing them for projects. The rank and strength of regional scene stakeholders allows for the expectation of various types of project initiatives that generate study-conceptual-creation-development projects. It is about you to be able to select regional packages of projects due to their impact effects at national and international level [1].

![Diagram](image)

**Figure 1.** Generation of the creative specialty of the region [2].

2.2. Description of the off-grid complex

The eco-efficient solutions are improvements in conventional design, but still have negative impact to environment. Regenerative design is a part of sustainable development, but it is not the same as sustainable design. Sustainability it’s a process that endures without degradation, but it does not
regenerate itself. It is like plastic bottle – sustains; a plant – regenerates. Sustainable design has to task to provide elementary human needs without environmental degradation [3]. Regenerative design goes further. The concept combines a variety of innovative technologies, such as energy positive homes, renewable energy, energy storage, food production, water management and waste to reduce systems.

![Regenerative system](image)

**Figure 2.** Regenerative system [4].

Household waste is restored into different categories for recycling. The not compostable waste is used in the biogas facility. Compost becomes food for livestock and fields. The seasonal gardens produce fruit and vegetables for the home consumption. Livestock is also provided food source.

The roofs of houses are collecting the rainwater and stores it in water storage. The water production from the biogas facility is also added to the water storage. Grey water is separated and used to irrigate the fields. Clean water is distributed to the households.

The solar cells on house roofs provides energy for the homes and distributes to the smart grids. The biogas plant energy is also added to the smart grid. The smart grid distributes energy to the settlements and to electric car spots.
Figure 3. Off-grid complex – design concept [4].

Straw – bale construction is a building method that uses bales of straw as structural elements, building insulation, or both. Advantages of this system include the renewable natural straw, low cost, easy availability, naturally fire-retardant, and high insulation value [5]. Straw – bale technology is characterized by zero carbon footprint, possibility of composting, $\lambda = 0.052$ to $0.080$ W / mK [6]. The applied technology allows to reduce the construction costs of building a fully functional home, while also meeting functional and aesthetic expectations of modern society [7].

Figure 4. Thermal transmittance depending on the thickness of the straw layer and the arrangement of the stems. Own elaboration based on German technical approval 23.II-1595 (2014).
3. Optimization – coordination components
Specialized M2M (Machine To Machine) solutions are seen as driving enabler for future smart cities. It is essential to develop service platforms to achieve the vision of artificial intelligence of buildings [8].

Coordination is the system by which distributed control elements are made to cooperate to solve a problem (in this case, off-grid capable neighborhoods). Exploring methods for measuring and potentially predicting system interia associated with effectiveness of units may provide key information useful in researches of system reliability. In addition, such methods would be useful in the development of joint planning tools for purposes of enhancing understanding of infrastructure interdependencies (U.S. Department of Energy 2014). Therefore, there is a need to integrate a common platform with dispersed units and smart grid. Proper energy management will allow to optimal balancing of energy demand and supply. The most important targets of system are:

- energy security,
- safety,
- minimum environmental footprint,
- robustness (resilience and reliability),
- finance ability,
- flexibility (optionality and extensibility).

3.1. Elements of service platforms
To manage of smart grid, in secure, reliable and scalable way, utilities must be equipped in communication network management system to a distributed data center. Cloud computing is an emerging technology advocated for energy management. That applications are one of the most useful techniques for the future smart grid development [9].

Table below illustrates set of elements useful to compare, and to formulate and to solve various optimization problems, based on objectives and constrains [10].

Table 1. Selected elements of data cloud computing.

| COMPONENTS AND STRUCTURES | PROPERTIES | SYSTEM QUALITIES (TARGETS) |
|--------------------------|------------|----------------------------|
| - synchronized energy demand and supply sensing | - controllability | - closed system economy |
| - real-time monitoring | - observability | - minimum environmental footprint |
| - early warning system | - tolerance of load | - affordability |
| - energy obtain and storage | - scalability | - energy security |
| - integrated planning of development | - local optimization | - safety |
| - synchronized units | - data/system/device interpretation | - robustness |
| - advanced optimizing controls | - fault tolerance | - flexibility |
| - grid integration | - efficiency of energy and network resources | - finance ability |
| - data management | - emissivity | - |
3.2. Future development of local context factors
Virtualization is one of the most efficient techniques for resource optimization and cost reduction. Cloud computing can be implemented in the form of different strategies of development off-grid complexes. Requires a supporting communication infrastructure and protocols to maximize benefits.

The overriding goal, which is the basis for building an intelligent city is closed system economy. Table 2 shows some of basic mappings use in analysis and optimization of off-grid complex. It illustrates tracing impact of selected components and on an closed system economy. It is possible to do for any set of elements.

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| - synchronized units | - data/system/device interpretation | - robustness |
| - advanced optimizing controls | - fault tolerance | - flexibility |
| - grid integration | - efficiency of energy and network resources | - finance ability |
| - micro grids | - emissivity | |
| - coordination (central and dispersed) | - ability to regenerate | |
| - regulatory | | |
| - financial resources | | |
| - type of consumers | | |
| - technology of buildings (e.g. straw-bale) | | |
| - climatic conditions | | |
| - modern methods of processing raw materials | | |

4. Conclusions
This paper explores the diffusion of smart regional initiatives through a study aimed at investigating the ratio of components and theirs properties covered by a city’s best practices to a total potential domain of smart initiatives and at understanding the role that various economic, urban, environmental variables might have in influencing the planning approach to create a smarter city.

Results reveal that the evolution patterns of a smart city highly depend on its local context factors. An attempt to achieve a balance between the continuity of urbanization processes and the environment are the following actions:
- carry out activities directed at diversifying sources of energy in a maximum use of renewable sources,
- create favorable conditions for the emergence of Smart Grid,
- develop infrastructure to generate energy from renewable sources,
- introduce an energy management system, in particular the implementation plans for heat and electricity from the renewable sources.

This work presents findings from an investigation into directions of development of single-family housing, focused on energy self-sufficiency. The findings highlight the significance of information management in off-grid units. They also indicate areas in which further research is required. The article presents a preliminary tool to analysis and optimization of integrated infrastructure. The model takes into account set of elements of data cloud computing. It provides useful guidelines to define and drive a smart city strategy and planning actions towards the most appropriate domains of implementation.

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