Latvian Project of Smart Grid and Renewables Technological Park

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Abstract: - To promote commercialization of science through modern technologies as well as to support technologically oriented companies technological parks are being developed world-wide. The paper provides a detailed overview and opportunities which are offered by Latvian Project of Smart Grid and Renewables Technological Park. Moreover, the publication discusses the importance of the experimental platform development, the Technological park structure and functions. Launching and development of such technology-based and innovative business activity will improve the recognition of Latvian research-dependent and market-oriented product as well as positively enhance economics and welfare development.

Key-Words: - science and technology parks, innovation, experimental infrastructure, economic development, synergy between universities and companies

1 Introduction

1.1 Renewable Energy Sources and Smart Grid Technologies

Over the course of the past years considerable amount of publications were devoted to the study of renewable energy sources (RES) as well as smart grid technologies, and it will surely be in the spotlight as these technologies continue to mature.

As it shown in [1], from the end of 2004 to the end of 2008, solar photovoltaic (PV) capacity increased sixfold to more than 16GW, wind power capacity increased 250% to 121GW, and world's total power capacity from new renewables increased 75% to 250GW. By-turn [2], renewable energy, which experienced no downturn in 2009, continued to grow strongly in all end-use sectors – power, heat and transport – and supplied an estimated 16% of global final energy consumption in 2010. Renewable energy accounted for approximately half of the estimated 194 gigawatts (GW) of new electric capacity added globally during the year. Renewables delivered close to 20% of global electricity supply in 2010, and by early 2011 they comprised one quarter of global power capacity from all sources [2]. Although these technologies are developing rapidly, they are still not at the technological and economical state to compete with conventional ones such as natural gas, coal thermal generation, or large hydro.

To facilitate large scale penetration of renewables and to reduce greenhouse emissions Europe has defined its 20-20-20 plan for 2020 [3]. It is generally expected that European electricity markets will have to reach a renewables share of 30-35% of all generation sources, mainly from wind and solar power, which are by their nature intermittent, unpredictable and unevenly geographically distributed [4], [5].

The 2004 Commission report on the use of renewable energy resources also emphasizes the need to diminish reliance on resource imports and increase the use of biomass [3]. Today biomass makes up 14% of the world's total biomass balance (50 EJ/year from the total 406 EJ/year) [2], [6]. As it is noted in [2], biomass supplies an increasing share of electricity and heat and continues to provide the majority of heating produced with renewable sources. An estimated 62 GW of biomass power capacity was in operation by the end of 2010. Biomass heat markets are expanding steadily, particularly in Europe but also in the United States, China, India, and elsewhere. Trends include increasing consumption of solid biomass pellets (for heat and power) and use of biomass in combined heat and power (CHP) plants and in centralized district heating systems. Extraction of biomass is mainly based on the usage of forestry, agricultural as well as scrap material. Recently there has been an intense work on the development of technology to create technically, ecologically

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and economically grounded solutions for the use of the bio fuels [7]. Directive 92/42/EEC is aimed at facilitating the installation and operation of electricity cogeneration plants, in order to save energy and deal with climate change. This Directive stipulates that one of the criteria for high-efficiency combined heat and power generation is the possibility of using renewable energy resources and such producers should be granted priority access to power transmission and distribution networks, as well as useful heat demand in the internal energy market should be promoted. Compared with hydro- and biomass generation, which are flexible and relatively controllable energy sources, wind and solar generation will be far more challenging to integrate into the system resulting in the significant and far-reaching effects on the electricity market and on transmission (also distribution) grid [8].

With the large scale penetration of renewable energy sources into European power grids, the transmission system faces more risk due to their intermittent nature and European Community has begun paying more attention to the development of electrical power grid (on the generation, transmission, distribution and consumption levels), making it on the one hand more intelligent (Smart grid) [9], [10], on the other hand more suitable for transmission of large energy quantities over far-away distances (Super grid or SuperSmart grid) [5], [11]-[13]. The vision of SmartGrid development by European commission is shown in Fig.1 [14].

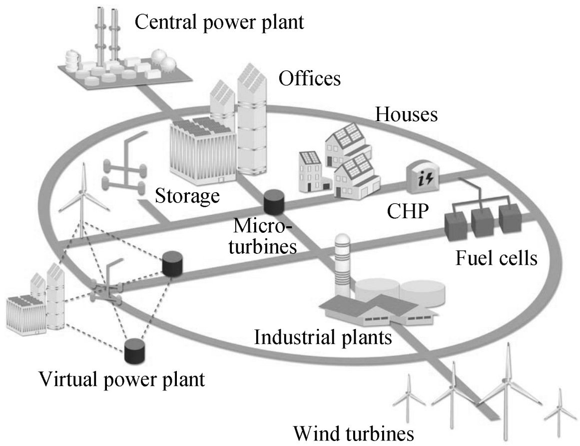

Fig.1. SmartGrid vision of EU [14]

One cannot but agree with the opinion given in [15] that many of needed improvements are not ready to be immediately implemented in the current system and there is a specific need for research on some key aspects of the smart transmission and distribution systems which are deemed essential for the full development and utilization of the future grid. Furthermore, as the authors state [15], a significant portion of the ongoing research seems to be out of touch with reality due to the fact that many theoretical approaches are not benchmarked in a lifelike simulation environment using realistic test systems.

1.2 Analysis of Latvian Situation

In order to avoid risks related to the import of electricity and primary energy resources, measures have to be taken to increase the extent of Latvia's self-supply with generating powers. The goal of the government policy is to achieve a balance between electric energy demand and the potential of energy supply from Latvia's power plants. The extent of self-supply has to reach 80% by 2012 and 100% by 2016. To achieve this goal, measures of efficient use of energy as well as supplies from power plants using local fuel and renewable energy resources within a high-efficiency combined heat and power (CHP) cycle will be promoted to maximum possible extent. In accordance with the national energy policy implemented in Latvia, there are a number of support instruments for the development of cogeneration using renewable energy resources.

The electricity market in Latvia as well as in the Baltic countries is open for all commercial consumers, yet for the time being, mostly only formally. The relatively small Baltic market is isolated from other EU markets. Thus, physically there is no possibility for trade transactions and energy exchange with the markets of the Nordic countries or with the Central European markets. Although the power transmission systems of the Baltic countries are included in the overall operating system of Russia and other countries of the Commonwealth of Independent States, it is possible for each of the Baltic countries to trade only with one market participant in Russia (InterRAO). After the construction of the Estonia-Finland connection in 2006, there is a possibility both for producers and consumers as well as other suppliers to engage in direct market transactions.

Due to new limitations for using some types of energy or/and due to increasing electrical grid congestion, favorable conditions are being created for penetration of new electricity suppliers (mainly using small CHP, solar and wind generation) in Latvian electricity market.

It should be noted that Latvia is one of the most wooded countries in Europe: on the average, there is 1.23 ha of wood per capita, which is 4.5 times more than the European average. According to research mentioned in [7] wood is the most popular local bio-energy source in Latvia, both in available volume and in practical use. Firewood is in stable position also in other country's energy balances and its proportion in energy production is increasing. This tendency can be observed locally and globally, as the proportion of wood and other bio-fuels in power supply has been increasing since the eighties of the previous century. The origination of the process was most probably initiated by the energy crisis of seventies. Apart from that, in the several last centuries, the ecological consciousness of the society and countries has been increasing. This has resulted in international treaties on utilization of bio-energy resources and reduction of the amount of fumes.

2 Problem Formulation

Summarizing the above mentioned RES and SmartGrid sectors as an important and fast-developing part of power engineering industry faces the essential economical and technological challenges. Solution of which has significant commercial value, especially, due to poor availability of infrastructure facilities for experimental and industrial research.

Practical usage and implementation of RES technologies are related to following problems:

1. Due to increased amount of RES power production becomes only partially controllable (depending on wind intermittence, solar radiation, needs of local cogeneration power plants etc.). On the other hand, power system operation is based on generated and consumed energy equilibrium at particular time moment. To ensure this balance controllable active power reserves have to be maintained. The realization of this requirement can be quite costly and bring to nothing all the usage merits of RES as well as distributed generation (DG). To achieve economic effectiveness and profitability smart technologies are needed in the fields of energy production control, power supply process monitoring and consumers' energy demand control, taking into consideration forecasting of consumption, generation and weather conditions. It can be claimed that this particular problem is one of the main reasons of SmartGrid implementation necessity.

2. Essential capital investment is required. In many countries (e.g. USA, China, Denmark, Germany) this problem is solved involving companies such as manufacturers of DG equipment or design and service providers. As a result work places for highly qualified staff have been created, unemployment has been reduced, and export services have been offered.

3. On the local (the Baltic States) level the insufficient financing in research infrastructure modernization in the previous years as well as minor availability of infrastructure, where it is possible to carry out experimental research and ensure commercialization of research results in the power engineering sector, is one of the main innovation' and industries' disincentive factors. Another complication is difficulties related to the voltage problems and connection to the bulk electrical grid in rural areas.

3 Problem Solution

To overcome the mentioned above difficulties and to provide new effective solutions industrial researches and pilot projects are launched world wide. Also Latvia has taken the first steps towards developing high quality research infrastructure and improving synergy between academia and industry (financial support available within activity programme „Entrepreneurship and Innovation", sub-activity „Development of Science Infrastructure") [17].

Firstly, the nine National research centers (NRC) have been established (one of them is NRC of Energy and natural resources sustainable use technologies, incl. the transport sector), primarily to carry out multi-disciplinary fundamental research and minimally the applied one. Secondly, innovative entrepreneurships, involving academia, have been supported with the aim to provide commercial introduction of research results. Within this activity the Smart Grid and Renewables Technological Park project has been promoted, primarily to carry out experimental and industrial research (taking into consideration local specifics of RES and DG sectors). The project involves leading research and commercial organizations in Latvia in the field of power engineering.

3.1 The Aim and Description of Smart Grid and Renewables Technological Park

The aim of the project is to set up infrastructural platform for experimental and industrial research focusing on knowledge, know-how and innovation transfer, creating high added-value products, market-oriented applications and technologies.

The main priority is development of renewable power sources, smart grids and the distributed generation technologies and support of their implementation in Latvia and abroad. Later it will be extended in the following research directions: electrical vehicles and their impact on electrical grid and consumption; carbon dioxide storage, its utilization using plants (greenhouses); stimulation of plant growth by emitting an electromagnetic spectrum appropriate for photosynthesis and so on.

A land plot with a total area of 30.65 ha is available for the project development. In the first stage for the project needs, a land plot with a total area of 5 ha (situated in Ogre region, Krape municipality, Latvia) has been rented for a period of 25 years.

The Technological Park is designed in such a way that it would be possible to connect experimental equipment in any technological phase, as well as to vary different operating modes.

The maintenance and development of the Technological Park project will be covered from the following anticipated incomes: multidisciplinary industrial and experimental research, commercialization of research results, attractions of EU and national science funds, selling by-pass products (e.g. heat and electricity).

3.2 The Technological Park Structure

The structure of the Smart grid and Renewables Technological Park is given in Fig.2.

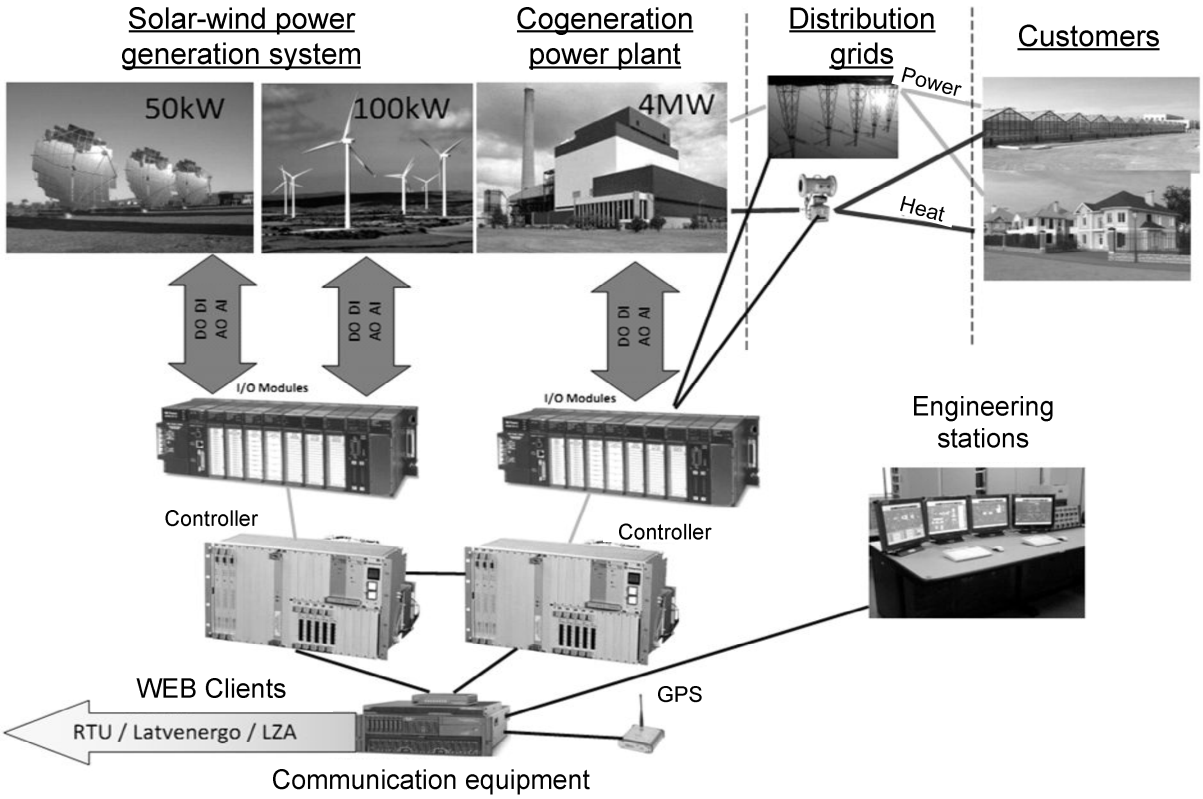

Fig.2. Basic diagram of the system

The main components of the Technological park are:

• Cogeneration plant (also trigeneration) with an electric power of 4MWe and a thermal power of 14 MWth.*

• Solar - wind power generation system with planned capacity of, respectively, 50 kW and 100 kW;

• Electrical and heat distribution smart grids, including consumers' provision with smart metering systems as well as installing information exchange systems among transmission system operator or/and Web clients.

The essential feature of the Technological park structure is configuration of automatic control system and automatics:

• Double system of automatic control which will allow adjusting control algorithms not interrupting technological equipment operation.

• Special connection places for relay protection and anti-emergency automatics for carrying out experimental research which will allow setting up, adjustment and verification of newly worked out equipments, technologies and applications.

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• Special remote access and connection features for other energy sources, control systems and smart metering units using Internet and ensuring their compatibility will allow enhancing of the Technological park in the future by connecting to other systems.

As it is seen on Fig.2, proportion of solar and wind sources in respect to cogeneration power plant capacity is relatively small. That choice of the energy sources structure is based on consideration that operation of the Technological park has to be economically justified. As economic estimation showed the proposed structure is able to guarantee not only experimental research but also to gain essential income covering the Technology park operation in self-repayment condition (procuring fuel, charging maintenance personnel and the like). Moreover the CHP plant is a controllable power source which ensures control over experiments on voltage regulation and power losses in distribution power grid.

The type of fuel for cogeneration power plant is biomass, mainly wood chips and peat. In order to evaluate the sufficiency of wood chip resources for the needs of the Technological Park, a study was carried out. As a result, it has been concluded that for the project, the resources of wood chips in the economically substantiated area are sufficient for a period of at least 20 years. Besides, the assessment does not include reserves located in the territory owned by the municipality, on the Latvenergo (Transmission system operator) forest corridors and along the state roads.

3.3 Tasks Solved by the Project

To reach the goal of the Technological Park project the following tasks and problems will be solved:

• To study, simulate and analyze advanced renewable energy sources integration and implementation into traditional power system;

• To investigate possibility of support micro grid “island mode” regime as well as its impact on electrical grid stability in a case of increasing penetration of RES;

• To develop standard guidelines related to sustainable use of alternative power sources (Wind farms, photovoltaic, Bio fuels CHP and so on) and smart grid technologies;

• To optimize woodchip (and other biomass products) extraction and manufacturing process, as well as its sustainable use;

• To develop, produce and check up power sources management elements: converters, automatics and protection devices, automatic operation and control elements;

• To develop the optimal methodology of consumers power supply (thermal and electrical);

• To carry out experimental check of developed algorithms and methods, protection and automation means, as well as new products and materials;

• To develop the business plans of smart grids, micro grids and alternative energy sources application;

• To investigate other actual issues in the field of renewables, distributed generation, smart grids

It is worthwhile mentioning that the Technological park is located remotely from high voltage electrical grid, which will allow finding out and estimating operation possibilities and impacts of small power source or group of them by connecting it to middle voltage distribution electrical grid.

These research directions comply with market identified issues and needs as well as are within the possible order range of potential clients.

Findings and research results can be processed, analyzed and used in the simulation laboratory of the mentioned NRC.

4 Synergy between Industry and Science

It’s well-known that the improvement of industry structure and the development of science and technology are mutually supplementing each other and positively impacting economics. To achieve better results and progress, establishment and development of such Technological parks are advisable and favorable. Within the bounds of the Technological park project the new collaboration forms will be formed and strengthened as it is pointed out in Fig.3.

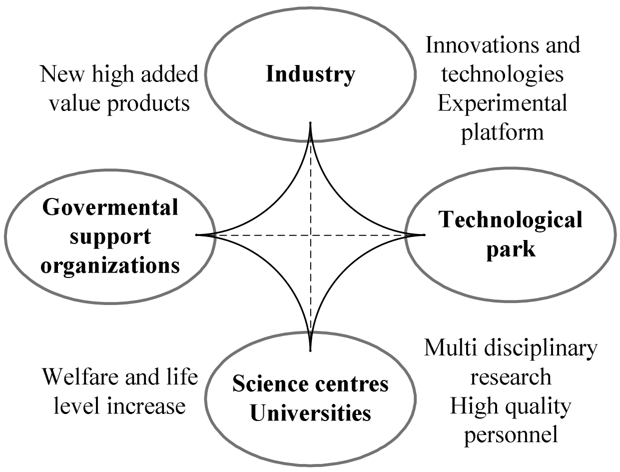

Fig.3. Synergy between industry and science

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The following mutual benefits of such kind of synergy will be anticipated in the future: strong collaboration with different academic and industry representatives; enhancement of multidisciplinary research; involvement and growth of highly qualified staff and young scientists; international funding and investments' attraction; development of state-of-art technologies and products; research result commercialization; yielding innovative solutions for industry problems; welfare and life level increase and so on.

It has to be emphasized that personal interests in development of the Smart grid and Renewables Technological Park are being expressed by many, e.g. Riga Technical University, Latvian Academy of Science, National Research Centres, biofuel and peat supplying companies, solar and wind power generation system components manufacturers and virtual power plant control system developers. Moreover, Latvian distribution system operator is genuinely interested in this project.

The fifteen working places for young scientists will be directly allocated in the Technological park.

5 Conclusion

Smart grid and renewables Technological park (total electrical power 4MW) provides solution facilities for a range of cutting-edge scientific tasks. The chosen structure will allow economically justified operation but electrical and thermal energy sales will ensure self-repayment and partial research funding conditions. Performing applied, experimental, industrial research and development the necessary data will be collected and summarized plus working hypotheses about future power system operation (based on RES sustainable usage and smart grid technologies) will be tested, elaborating new methods, algorithms, applications and technologies.

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