SMART GRIDS STRATEGY FOR SALZBURG, AUSTRIA

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ABSTRACT

Utilisation of synergies is a key approach the transition of today's energy systems into future Smart Grids. Climate and energy targets both on European (e.g. EC Climate and Energy Package) and national level (Austrian Energy Strategy) can only be realized, by using all available resources and options. Smart Grids will play an important role here, especially regarding the integration of increasing shares of distributed generation from renewable sources into the electricity grids and balancing generation and demand.The Smart Grid Model Region Salzburg (SGMS) has the goal of aggregating different smart grid applications in an integrated system and to implement flagship projects in the real environment, considering problems of daily business and addressing specific customer needs. This strategy is founded on a portfolio of RD&D projects (research development and demonstration) consisting of seven completed and nine ongoing projects plus three RD&D proposals, which were accepted for funding recently. The expected results until 2013 include integration of buildings into Smart Grids, the ability to massively use renewable energy sources, reduction of greenhouse gas emissions, increased comfort and flexibility in infrastructure with a focus on customer needs and finally the innovation leadership for Austria in the field of Smart Grids.

INTRODUCTION

Smart Grids will play an important role in fulfilling national and European climate and energy targets, especially regarding the integration of increasing shares of distributed generation from renewable sources into the electricity grids and balancing generation and demand.

Salzburg AG[1] agreed to assume social responsibility and contribute towards these goals in all of their projects, which focus on smart grids, smart meters, electro mobility and grid integration, to satisfy future requirements of the energy sector. In October 2009 Salzburg AG together with other partners successfully submitted a bundle of projects in the third tender of "New Energies 2020" (see Fig. 1), funded by the Austrian Climate and Energy Fund (KLI.EN), for the research, development and demonstration of intelligent networks and the integrated concept with the vision of a comfortable and intelligent "Smart Infrastructure" that could preserve resources. The first Smart Grid model region of Austria was established.

The Smart Grid Model Region Salzburg (SGMS) is supported by an interdisciplinary team of energy industry (Salzburg AG), housing industry (Salzburg Wohnbau), industry (Siemens AG, Fichtner) and top-class research partners (Austrian Institute of Technology, TU Vienna, CURE). The aim of the SGMS is to aggregate different smart grid applications in an integrated system and to implement flagship projects in the real environment, considering problems of daily business and addressing specific customer needs.

The ongoing and planned RD&D projects are targeted towards the vision of a comfortable, intelligent and integrated "Smart Infrastructure" in Salzburg using sustainable resources. In order to show the feasibility of various Smart Grid approaches, a flagship project will start beginning of 2011, which will equip a building complex with all necessary infrastructures to determine the optimal Smart Grid friendliness.

The holistic approach (see Fig. 2) chosen in Salzburg is noteworthy, because system integration is done at all levels. Apart from the main goals – enabling a massive increase of renewables, increasing the energy efficiency and reducing CO_2 emissions – the focus is on improving the consumer benefit by offering energy information and new, more comfortable energy services. Therefore the focus of the RD&D-projects is both the development and system integration of technical smart grid solutions and also research and investigation of customer integration, acceptance and needs.

STRATEGY FOR A MODEL REGION

The following section briefly explains the main focus and core areas of the Smart Grid Model Region Salzburg and its projects. Different approaches for **Active Distribution Grids** in medium [1] and low voltage level will be integrated, tested and compared. As part of project *ZUQDE* (which is an abbreviation for central voltage and reactive power control for distributed generators) and *DG-DemoNet Validation*, central and regional concept for intelligent control of medium-voltage power grids are developed and evaluated (see e.g. [2]). The next step is *DG DemoNet Smart Low Voltage Grid*, focusing on development of concepts for Smart Grid system integration in low voltage power grids and was recently approved.

Load- and Demand-Side-Management [3, 4] are covered in the projects *Consumer to Grid (C2G)* and *Building to*

[1] Salzburg AG is the multi-utility (electricity, natural gas, district heating, water, transportation and telecommunications) for the province and city of Salzburg, Austria.

Grid (B2G), which deal with the role of end customers ("human in the loop") and buildings (as active components) in Smart Grids. To optimize energy efficiency and affect customer behavior in a positive way the following questions need to be answered: How should consumption data be processed and presented to the customer? Which technologies should be used in buildings in order to achieve maximum Smart Grid friendliness? In the next step (also approved recently) a Smart Grid demonstration building is to be planned and constructed as a flagship project, in order to investigate the possibilities and benefits of Smart Grids in connection with buildings, which should then be brought to the attention of a broader public to make this topic visible, feel- and touchable.

Integration of E-Mobility: The projects *Vehicle to Grid (V2G) Interfaces* and *V2G Strategies* are based on experience from the ElectroDrive-Initiative (which offers E-Mobility as a complete package in Salzburg since April 2009). The *V2G Interfaces* project focuses on concepts for interaction portals for E-Mobility customers in the Smart Grid Model Region Salzburg and offers a concrete implementation plan. In addition, Salzburg Netz GmbH (DSO for electricity and natural gas grid in the province of Salzburg) is involved as a partner and helps with the basic research in *V2G Strategies*. This study targets E-Mobility strategies for political decision makers and market participants to transfer them to the whole of Austria, thus moving beyond the scope of the Salzburg region. However, Salzburg Netz GmbH provides basic grid data from the Smart Grid Model Region Salzburg, which can be seen as an enabler of this study.

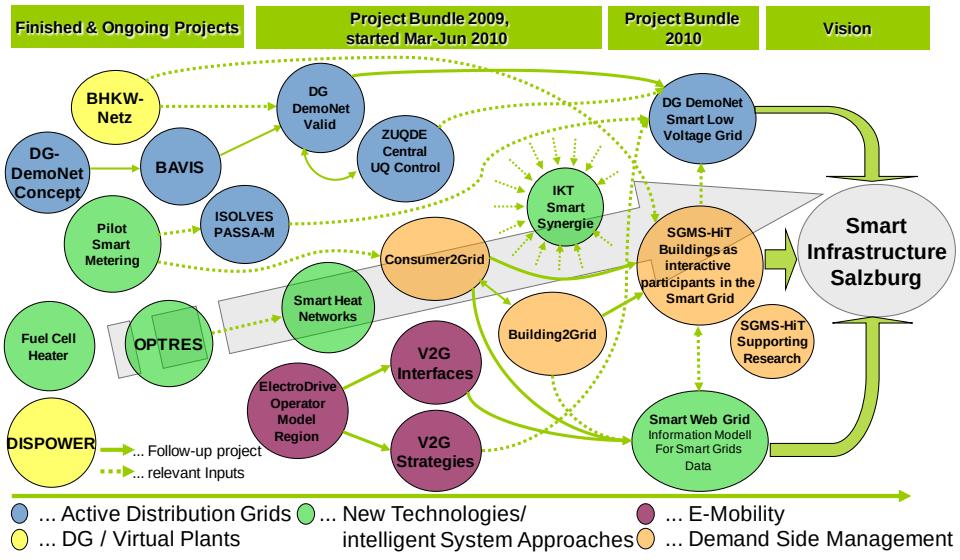

Figure 1: Roadmap of the Smart Grids Model Region Salzburg

Intelligent network management in district heating networks: The focus of the *Smart Heat Networks* project are intelligent operational- and control strategies for district heating networks, concentrating on the reduction of peak loads and increasing the number of full load hours of feeding systems. As a result, through adapted dimensioning, investments can be reduced, overall efficiency of district heating can be increased, the adoption of fossil fired peak load boiler reduced to save on CO_2.

Information and Communication Technology (ICT): For different Smart Grid- and E-Mobility applications different data and information need to be captured and distributed nationwide. Each application has different technical requirements (e.g. regarding amount of data, real time capability, data security, etc.), which have a significant effect on technical specifications and therefore on costs of the ICT infrastructure. In the *SmartSynergy* project, concepts are developed that allow the creation of cost efficient ICT infrastructures. Realizing these concepts, synergies across multiple applications need to be identified and evaluated.

Future Smart Grids will rely on data exchange between different applications and market participants. The *SmartWebGrid* project (starting 2011) analyzes user interaction, technology, cost effectiveness and data security of such a data exchange by means of three concrete examples in the Model Region Salzburg. The goal is the conceptual design of an information model for Web service based access to Smart Grids data sources.
By combining the different issues from the various Smart Grid topics in the Smart Grid Model Region Salzburg it is possible to transfer knowledge directly, to overlay effects of individual applications, to investigate mutual dependencies and interactions and to identify potential synergies.

Flagship-Projects: The *SGMS-HiT* project (Buildings as interactive participants in the Smart Grid) will start in 2011and will investigate the possibilities and benefits of Smart Grids in connection with buildings. In the HiT housing estate different Smart Grid technologies and features will be realised, including distributed generation in photovoltaic systems and micro-CHP (combined heat and power plant), demand side management and controlled charging of electro vehicles (EV), e-car sharing, energy feedback and interaction for inhabitants. The demonstration building is a residential complex of several buildings to house different generations (from young living to senior-friendly living with technical assistance). The results are brought to the attention of the broad public (customers, stakeholders from politics and economy, journalists etc.) to

make Smart Grids visible, touchable and concrete. Furthermore, this establishes a tangible relationship to the topic Smart Grids as the central step on the way to reach the climate and energy goals – and thus to the future of energy systems.

The project *DG DemoNet Smart LV Grid* aims to enable an efficient and cost effective use of existing grid infrastructures based on a three-step concept: 1. intelligent planning, 2. on-line monitoring, 3. active low voltage (LV) grid management. Communication-based systems for automatic control concepts for low voltage grids will be developed and evaluated by putting them into practice. This project shall meet the upcoming challenges for LV grids, which include a high penetration of distributed energy resources (especially photovoltaic) and electric vehicles. The validation of the project is done in field tests, inter alia in Salzburg: In a dedicated low voltage grid branch in Salzburg

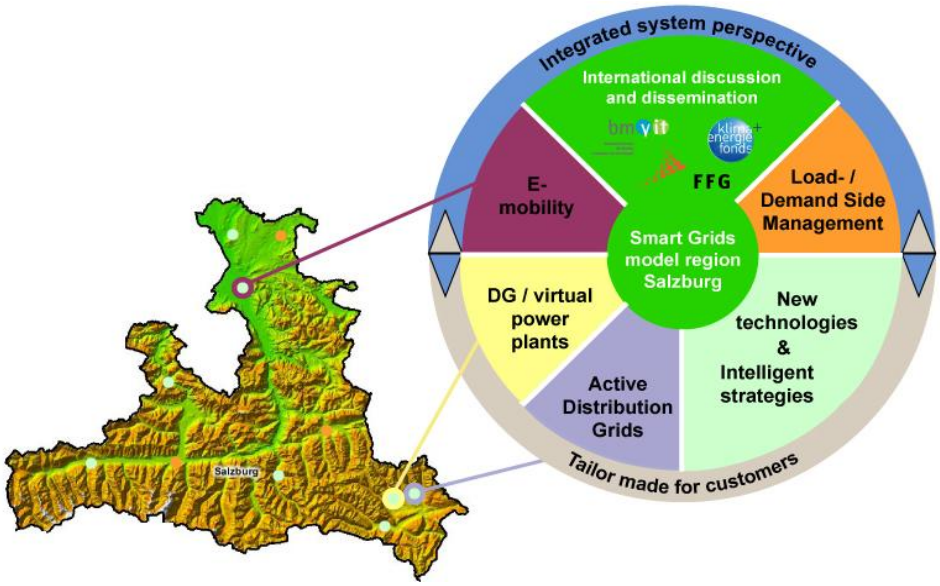

Figure 2 Overall Concept of the Smart Grids Model Region Salzburg

(rural area) a very high penetration of photovoltaic systems (approx. at every second roof) and e-cars (approx. in every second garage) is installed. By intentionally creating such a scenario that puts additional pressure on the grid we intend to show that new, intelligent solutions are needed to guarantee security and quality of supply in the near future. The future shall be anticipated in a real network section in the demo area to verify possible solutions for challenges that will become reality everywhere in the next decades – if the ambitious targets for renewable energy and e-mobility are met.

These flagship projects ensure that the smart grid concepts developed in R&D projects are tested, evaluated and advanced into real grids, plants and buildings – so to speak in "living labs".

R&D-METHODOLOGY

In order to give an insight into the high level research done in the projects we briefly describe the methodology of project *Building to Grid* (B2G) [5, 6].

One third of the world-wide energy use and its respective emissions are linked to commercial and residential buildings. Despite this prominent position, buildings are still a passive player in modern energy networks. The industrial and transportation sector are increasingly embedded in an active manner, while buildings still act as unidirectional endpoints and are treated as "black boxes" that cannot be influenced from the outside. Active members of smart grids can contribute to the overall optimization of the energy system by being operated flexibly and by sharing information with the grid.

Buildings host a number of significant energy-consuming processes, like heating, ventilation, air-conditioning (HVAC) and lighting. Many processes have operational bandwidths in terms of set-points and scheduling which can be used if needed. Aggregating a number of buildings leads to even larger flexibility and larger loads that can be dispatched. Strategies like "demand response" (DR; loads, reacting on events in the energy grid) are in its infancy because two key factors are still unsolved:

The Smart Grid does not know the current state of the load processes (e. g. is the air condition turned on or off), and even if it does, there is no standard way to communicate the status. Both are needed for intelligent algorithms that harmonize loads with grid operations. This is the reason why DR is still open-loop control, where DR-events are broadcast to the loads without knowing the potential consequences. No planning and anticipative reactions are possible in such a system. An intelligent system would take the process state of the customer facilities into account, and would get feedback about the reactions. A traditional DR system can neither estimate the magnitude of a reaction to a DR-event, nor how long this reaction may last, because the loads do not expose information on their current state.

It is the goal of the project to close that gap and to investigate in a series of experiments where the limits of intelligent buildings in a Smart Grid are. To do so a number of generic load models for buildings must be developed and embedded into an interoperable communication infrastructure.

Particular insight is expected by putting building control and grid control into relation. Currently these two systems are optimized separately. A building management system that is able to control the building's energy systems is extended by an online simulation of the building, thus allowing predictions about the behavior of the building in future and the implications of control actions that are taken. One

service that the simulation can provide is to make an estimation how long a building can be suspended from energy supply before the indoor comfort for the inhabitants is violated. This includes the temperature as well as climate and CO_2 levels when switching off ventilation systems. As a first step this helps the grid to reduce power peaks by reducing load from HVAC systems. The next service is a predictive control strategy for the building automation system. Assuming that the Smart Grid announces its upcoming peak load times (which are usually well known) in advance (e.g. the day before, the building management system can shed more electric load during these times by preparing the building. This is done by loading available thermal storage and increasing the air exchange rate up to the point of the expected peak load, thus allowing longer switch-off times. Thermal storages mainly addresses the building itself (i. e. walls, floors, furnishings and the indoor air volume), but also heat buffers like hot water storage tanks.
The results of project *B2G* will be implemented during a field trial in a set of commercial and residential buildings. First the building management systems are equipped with all necessary communication and computation technology so that the field trial can be operated semi-automatically. The data collected during the trial is permanently analyzed; conclusions and measures are taken at the end of the trial.

EXPECTED RESULTS

In terms of reaching goals of the overall concept, it is important to consider the development paths of individual projects and the relationships between the projects. The overall objective in the quality identified in the SGMS thus only can be achieved through the interaction of the components described above. The individual projects partly build on each other and utilize the results of other projects. The coordination and utilization of synergies between the projects is encouraged by an overall program management including project controlling and reporting as well as periodic meetings of the project leaders. The program management furthermore ensures pooling of the results at the level of the Model Region and their applicability to other model regions. The project content is tailored to the international work in the Smart Grids community and in particular coordinated with the D-A-CH countries (Germany, Austria and Switzerland).

The following results are expected in particular within the duration from 2009 to 2013:

- Intelligent algorithms for optimizing building behavior towards Smart Grids
- Comfortable, flexible infrastructure with a focus on customer needs and acceptance as well as substantiated field experience
- Ability for the massive use of renewable energies and reduction of peak loads
- Innovation leadership for Austria and accordingly export opportunities (for industrial partners)
- Reduction of greenhouse gas emissions and resource consumption

OUTLOOK

The projects of the Smart Grid Model Region Salzburg and especially the projects that are to start 2011 with their broadly accessible demonstration and flagship character will constitute a significant contribution to the Smart Grid initiatives of the Federal Ministry of Technology and Innovation (Smart Grid Pioneers in Austria, Austria's positioning in the context of the EU SET Plan – Strategic Energy Technology Plan and the EU industry initiative EEGI - European Electricity Grid Initiative). The industrial partners provide significant contributions on their own account to make flagship projects viable in this form.

Acknowledgments

Smart Grids Model Region Salzburg (SGMS) is supported and the individual RD&D projects are co-funded by the Austrian Climate and Energy Fund under the program "New Energies 2020".

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