Smart Grids Demo Snapshots 2013/2014

Collection of regional and national key projects as a starting point for the establishment of ERA-Net Smart Grids Plus

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Introduction & Acknowledgements

This brochure contains a collection of 34 snapshots of **important national, regional and transnational demonstration and demonstration-relevant projects** from 18 different countries and regions in Europe.

The goal of this brochure on one hand, is to give an overview of the most important information of these projects on one sight, i.e. on one page. This shall help national and regional program managers to distribute concise information to key players in research, politics and decision making.

On the other hand, on-going national and regional activities in the smart grid area shall be promoted – especially with regard to the preparation of an ERA-Net Plus proposal. Last but not least, this brochure shall facilitate the search for future partners for multi-national Smart Grids projects.

The major target group of the brochure is the consortium members of the existing ERA-Net Smart Grids project and the potential ERA-Net Plus project: Program managers, representatives from ministries and national as well as regional governments, but also representatives from research institutions and industry in the Smart Grids field aiming at sending in project proposal for potential ERA-Net Plus calls.

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National/ regional Demo Snapshots

Smart Grids Model Region Salzburg

Key facts

Project coordinator:	Salzburg AG
Duration:	01/2011 – 05/2015
Location:	Province of Salzburg, Austria
Website:	www.smartgridssalzburg.at
Contact:	Michael Strebl, michael.strebl@salzburg-ag.at
Further SG information of Austrian:	Energie der Zukunft

Project setting

- ✓ ‚Living lab' with 23 projects across a single region:
- ✓ Focus on 5 areas of application:
  - Integration of **renewable energy sources** in distribution grids (active distribution grids)
  - Intelligent system integration of **electromobility**
  - Intelligent integration of **residential customers** into the power grid
  - Automation of **buildings** to manage loads
  - **Load management** in commercial and industrial enterprises

Vision

The vision of the Model Region programme is the development of an integrated smart grid approach.

Based on comprehensive research, several smart grid applications are developed. In the next step these are aggregated and field-tested in flagship projects. Thereby smart grids become concrete and can be evaluated in real-life operation. Apart from the development and presentation of technical solutions, research in the field of customer acceptance and usability play a central role.

In applying the philosophy that “the whole is more than the sum of its parts”, SG Model Region Salzburg has endeavoured to combine the findings of the numerous individual projects into a systematic whole: Smart Infrastructure Salzburg.

Selected projects

PROJECT	KEY QUESTION
B2G – Building to Grid	How can buildings contribute to peak load reduction and enhanced energy efficiency in power grids by intelligent load management? **Field test with 10 real-life buildings.**
C2G – Copnsumer to Grid	Is it possible to encourage customers to reduce their energy consumption effectively by energy feedback (based on smart metering)? **Field test with 290 households.**
Smart Heat Net	Which intelligent operation and control strategies enable peak load reduction and thus minimize the use of oil/gas-fired peak load boilers in district heating networks?
Vehicle to Grid (V2G) -Interfaces	Which business models and interfaces are needed to integrate electric vehicles intelligently into the energy system?
DG DemoNet Validation	Active distribution grid operation using an innovative voltage control concept in the medium voltage grid of the Lungau region (regional approach). **Field test and comparison with the ZUQDE approach.**

Source: www.smartgridssalzburg.at

Major findings

There are three types of synergies stemming from an integrated view of the areas of application which facilitate the economic expansion of the requisite information and communication technology (ICT) infrastructure: synergies in the area of **communication and IT infrastructure** as well as in the **cooperative use of hardware**. A potential saving of over 30 % was identified when the ICT infrastructure was optimised in comparison to the worst case.

In order to benefit from the synergies between the applications, it will be necessary to **bundle the specifications of the individual technologies** rather than viewing them separately. This will enable the creation of an efficient, generic and easy-to-extend basic infrastructure. New challenges are, for example, the integration of residential customers, the processing of dramatically increasing data volumes and user-specific security. For all applications including smart metering, the transport protocol IP should be used as a convergence layer.

In order to ensure the trust and acceptance of both the consumer and the producer in ICT based applications, it is essential **to provide for security and privacy on a consistent basis**. A holistic view comprises the three pillars of technological security, data protection and trust.

There is also the question involving **the relationship between the cost and benefit of an application** and how this can be adequately evaluated. For example, different applications lead to a more efficient use of existing infrastructure and this, in turn, to deferred investments in the power grid. This benefit is however difficult to quantify. Using a cost rollup process, however, **ranges for evaluating load peaks** that have been successfully avoided on different network levels of the grid **can be calculated**. In the medium voltage network, there will be, for example, a benefit in the range of € 22-104 per kilowatt of successfully reduced demand.

Based on the areas of application and the findings across the applications, open questions concerning **further development of technologies, cost effectiveness, risk minimisation** and **development of a market model** will be analysed.

In bringing together all the applications within an integrated smart grid system, it will be helpful to use a **reference architecture**. The Smart Grid Architecture Model from the M/490 Mandate will serve as a model. This will provide answers as to how the different electricity market and grid interests can be taken into account and aligned when flexibilities are used.

DG DemoNet project chain

Key facts

Project coordinator: AIT Austrian Institute of Technology
Duration: 2006 – 2014
Budget: **EUR 5,2 million**
Location: Province of Salzburg (Lungau & Köstendorf), Province of Vorarlberg (Großes Walsertal), Province of Upper Austria (Eberstalzell) Austria
Website: www.ait.ac.at
Contact: Helfried Brunner, helfried.brunner@ait.ac.at
Further SG information of Austrian: Energie der Zukunft

The following sub-projects belong to the project chain:
DG DemoNet Concept, BAVIS, DG DemoNet Validation, DG DemoNet Smart LV Grid

Main innovation – medium voltage grid

In the sub-projects **DG DemoNet Concept** and **BAVIS** voltage control concepts were developed in numerical simulation environments and based on real network data (three different typical Austrian medium voltage networks). Moreover, the economic and technical efficiency has been evaluated and compared to a reference scenario. Based on this experience, **DG DemoNet Validation** analysed, if the promising results from the simulations are also valid and effective under real network conditions. The latter sub-project is divided into three phases:

- **Phase 1:** the data from DG DemoNet Concept and BAVIS was updated and measurements for validation planning and for the generation of parameters for the control concepts are performed.
- **Phase 2:** the platform for validating the voltage control concepts and the necessary communication solution is adapted and tested and is implemented in both grid areas.
- **Phase 3:** the voltage concepts and the communication platform is analysed and validated in both networks during field tests.

The validation and field test is already finalized. Finally, two different solutions for voltage control in medium voltage networks have been validated and successfully demonstrated (coordinated voltage control and distributed voltage control) on a **test platform in two different medium voltage networks** (**Lungau in Salzburg** and **Großes Walsertal in Vorarlberg**).

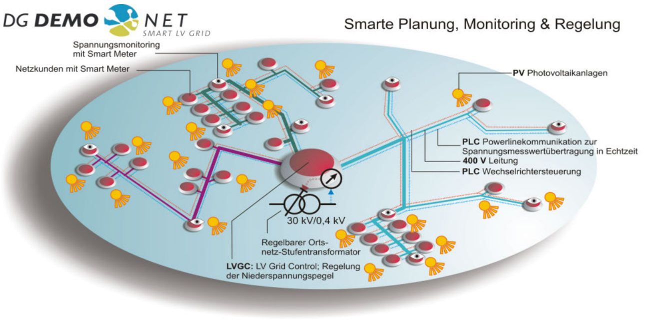
The solutions are based on enhanced network monitoring and algorithms for active control of OLTC at substation level as well as reactive power management at selected generation units based on the network monitoring. It was possible to increase the share of distributed generation about 50% with a cost reduction in a range of 55 – 80% compared to network reinforcement in order to integrate the same amount of distributed generation.

Two test sites – low voltage grid

Beside the definition and demonstration of new intelligent network planning approaches (probabilistic based network interconnection requirements) two main test cases have been implemented within **DG DemoNet Smart LV Grid:**

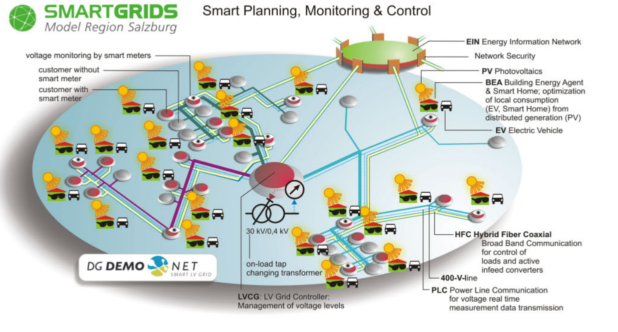
✓ Test Case 1: **Active network operation and voltage control with a high share of PV – installations (Eberstalzell):**

At the demosite in Eberstallzell increased hosting capacity for rooftop PV installations are enabled through local autonomous voltage level control at on-load tap changer in the secondary substation using real time measurement of voltage from smart meters transmitted by PLC. Reactive power from inverters additionally reduce the voltage spread coordinated by a control unit at the secondary substation. Thus PV-plants could develop from "Troublemakers" to "Troubleshooters" and an increased penetration of DG would be possible. In Eberstallzell and Littring every second house was equipped with PV unit (Eberstalzell: 30/0,4 kV – 630 kVA Transformer, 11 branches up to 600m, 165 Buildings/Customers - 173 customers, 1.3 GWh/a 450 kW maximum load, 60 PV-Systems roof top 330kWp; Littring: 30/0,4 kV – 250 kVA Transformer, 5 branches up to 1 km, 54 Buildings/Customers, 15 farmers, 8 households, 1 small saw mill, 1 fish farm, 0.35 GWh/a 120 kW maximum load, 15 PV-Systems roof top 140 kWp).



✓ Test Case 2: **Active network operation and voltage control with a high share of PV installations and e-mobilty (Köstendorf)**

In the Köstendorf test case, additionally a high penetration of e-mobility in LV networks is demonstrated. In practise each customer who installed a PV system within the project is also equipped with an electric car for at least one year. The customers are interconnected with broad band communication lines which are parallel in use for television and internet. The charging unit as well as upcoming further devices of customers are controlled by a Building Energy Agent unit. The real-time voltage measurements and the transfer of related data are done by smart meters. Main parts of the voltage-var-control are implemented to a central system and are interconnected via the Energy Information Network which also enables control of the reactive power of PV Inverters. Almost every second house was equipped with PV and e-mobility (191,4 kWp installed generation capacity by 43 PV-Systems, 36 e-cars with a maximum power consumption of about 133 kW, 95 buildings / 127 customers, 210 kW maximum load without e-mobility, Transformer station 30/0,4 kV in Köstendorf).



Next step: iGREENGrid FP7 Project

The next step is to further investigate the replicability and scalability of the developed solution in Austria as well as in Europe in order to identify networks where similar problems may occur and whether the developed solutions will be suitable. Therefore, the **project chain DG DemoNet**, in particular the demonstration sites in Salzburg and Upper Austria and the respective distribution system operators Salzburg Netz GmbH and Oberösterreich Netz GmbH, as well as the Austrian Institute, are partners within the **European FP7 Project iGREENGrid**, which started in early 2013. The project focuses on investigating replicability and scalability of the specific solutions by establishing a family of relevant national projects (6 European key demonstration projects) on the effective integration of variable distributed generation in power distribution grids.

Smart Grid Ulm in Baden-Württemberg

Key facts

Project coordinator:	SWU Netze GmbH, Ulm University of Applied Science
Duration:	since 2010
Location:	City of Ulm, Germany
Contact:	Florian Meier, florian.meier@swu.de Prof. Gerd Heilscher, heilscher@hs-ulm.de

Project setting

- ✓ Three test sites around Ulm
- ✓ Focus on 5 areas of application:
  - Enhance of **grid planning** strategies for distribution grids with a high amount of decentralized renewable sources,
  - **Smart aggregation** of grid data in the low voltage grid,
  - Improvement of the communication between the low voltage grid and the **grid control centre,**
  - **Forecast grid parameters** and status,
  - Development of a **pro-active grid operation.**

Vision

The vision of the project is the development of an pro-active smart grid approach.

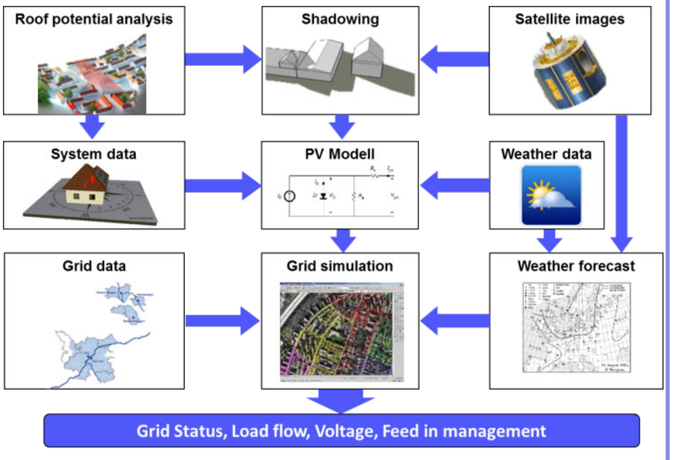
The distribution system operators (DSO) had planned their distribution grids historically only in view of the demand of their customers. The increased number of decentralized energy systems in the low voltage distribution force the DSOs to adapt their planning rules to an increasing influence of decentralized generators with a volatile feed-in characteristic.

The operation of the grid becomes more complex with the increasing number of decentralized energy systems and the DSO needs additional information from the low voltage grid. The main questions in this situation are the following: How can the DSO observe and protect the stability of the grid and how can this information be used for the management of the accounting grid?

This project supports the DSO in defining a strategic plan for securing the grid stability and future business model options.

Selected projects

PROJECT	OBJECTIVES
ENDORSE	Analysis of low voltage grids with a high amount of PV-systems. Development of remote monitoring system for grid parameters. www.endorse-fp7.eu
PVSYS-NS	Evaluation of different combinations of flexibility options for application in low voltage networks.
Smart Solar Grid	Development of a communication unit for the grid connection decentralized renewable energy systems.
OrPHEuS	Optimising hybrid energy grids for smart cities by evaluate coupling possibilities between electric, district heating and gas grids. www.orpheus-project.eu
NATHAN-PV	Advancement of grid planning approaches and integration into a pro-active grid operation.



Major findings

The increasing number of decentralized generators in the low voltage distribution grids turns the normative requested voltage band into a tight resource. The DSOs has now to adopt their gird operation for high load and high feed in times. The DSO reconsider the traditional approach for dividing the voltage band into parts for the different voltage levels and need more information about the influence of the volatile decentralized renewable energy to the voltage in the grids. In the meantime they have to adapt their planning rules to an increasing influence of decentralized generators with a volatile feed-in characteristic.

The necessary data could be measured directly by the power inverters of the installed decentralized energy systems. The systems have to communicate with the grid control centre by a secured communication protocol.

The grid measurements also could be measured indirectly by using remote sensing technologies e.g. solar irradiation derived for the weather satellites as the basis for power flow and voltage calculation without the need of specific information of the installed PV systems.

The combination of smart data aggregation with grid control technologies as well as meteorological and technical grid forecast systems allows the setup of a pro-active grid operation system for a cost effective integration of decentralized energy systems.

EcoGrid EU Project

Key facts

Project coordinator: Sintef Energi
Project initiator: Energinet.dk
Duration: 2011 – 2015
Budget: EUR 21 million, FP7 granted EUR 12 million
Location: Island of Bornholm, Denmark
Website: www.eu-ecogrid.net
Contact: Ove S. Grande
Ove.S.Grande@sintef.no

Project setting

- ✓ A large scale demonstration of a real-time marketplace for distributed energy resources (DER),
- ✓ ICT systems and innovative market solutions enable small-scale consumers to offer TSO´s additional and more efficient balancing services,
- ✓ A demonstration of a real power system with more than 50 % renewable energy,
- ✓ Preparation for a fast-track towards European real-time market operation of renewable energy sources and demand response.

Key objective

The key objective of the project is to demonstrate how smart grid technology and ordinary electric customers on the light of information on electricity price can contribute actively to balance a power system with a high share of varying environmentally-friendly electricity generation, especially wind power.

About one in every ten households on Bornholm as well as small and medium-sized companies will be involved in the project. Advanced meters and other smart appliances will be installed at the homes and companies of 2000 participants on Bornholm. These appliances will enable them to control their consumption more or less automatically down to a five-minute basis base on the principle: It must be smart, easy and convenient to be a price conscious and environmentally-friendly electricity customer in the future “smart grid-society”.

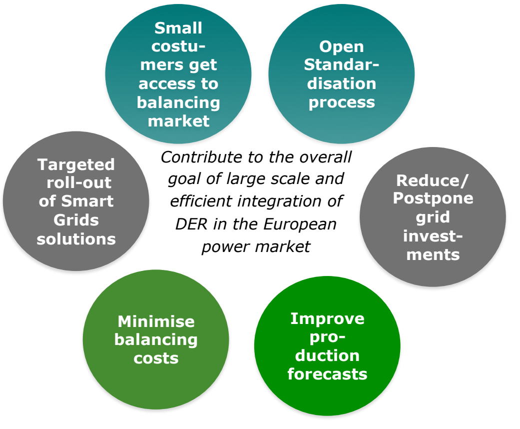
Win-win

EcoGrid EU can create “win-win” situations, enabling small and large electricity customers to save money on their electricity bill, while the power system is relieved. And in the long-term, this will reduce society’s investments in grid reinforcement and new grids.

The saving at a European level has not been estimated yet, but the Danish electricity sector and Energinet.dk have calculated a direct socio-economic saving of at least DKK 1.6 billion when using smart grid solutions in Denmark. Furthermore, an extra bonus is to be added in connection with the environmental benefit, which Denmark will achieve when improving the integration in environmentally-friendly electricity and power savings.

The future electricity customer will gain far more control of his electricity consumption and electricity bill. As society becomes more and more “electrified” by renewable energy generation, and as electric vehicles increasingly gain a foothold in the vehicle fleet, this can be of great importance to an ordinary household budget.

Overall Impact of EcoGrid EU



Source: www.eu-ecogrid.net/

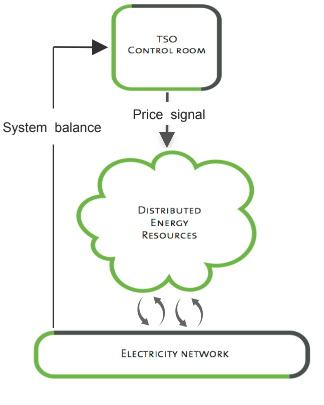
The market concept

Why a Real-time Market?

- ✓ An efficient way to meet the future challenge of balancing:
  - High(er) demand of flexible consumption/ production,
  - High(er) volatility,
  - High(er) balancing costs.
- ✓ An efficient instrument to wide spread adoption of small-scale end-users/ prosumers in the power market(s).
- ✓ Increasing competition on the power market(s):
  - Small scale end-users can attain economic benefits,
  - TSOs get access to alternative balancing resources.

The design of an EcoGrid prototype real-time market place is a realistic approach because it is “just” widening the scope of the current power market systems.

The EcoGrid real-time market will be an integrated part of the current power markets and supports the need of direct control options on a very short time scale.



THE MARKET CONCEPT ALLOWS REGULATION OF DER PRICE SIGNAL WITHOUT DIRECT MEASUREMENT OF THE INDIVIDUAL DER RESPONSE

Source: www.eu-ecogrid.net/

Smart City Kalundborg

Key facts

Project coordinator:	SEAS-NVE
Duration:	2012 – 2015
Budget:	DKK 100 million, 50% grant from EUDP
Location:	City of Kalundborg, Denmark
Website:	www.smartcitykalundborg.dk
Contact:	Ole Søgaard, OSD@seas-nve.dk

Project setting

The purpose of Smart City Kalundborg is to demonstrate the optimized use of renewable energy and decentralized energy production and energy management opportunities. The following steps are foreseen:

- ✓ Development and technical construction of the open platform (year 1);
- ✓ Platform will be put into operation, and feedback will be collected from the users (year 2);
- ✓ Market component will be added (year 3).

Additionally, test sites will be selected in the first half of 2013. The tests will be carried out in various parts of the municipality, primarily within Kalundborg city limits, where the energy consumption is sufficiently high and concentrated. There will be tests in public buildings as well as in private homes and businesses.

Why Kalundborg?

As The Green Industrial Municipality, Kalundborg Municipality aims to attract businesses and promote a sustainable development, and Smart City Kalundborg is considered to be an important aspect of these endeavours.

The area has the right size for a Smart City project, and the municipality has the right mix of residential properties, businesses and public buildings. In addition, Kalundborg Municipality has many years of experience from the work with the city's industrial cluster, Kalundborg Symbiosis.

With the budget, the partners behind Smart City Kalundborg will provide the framework over the next years for a number of projects, the purpose of which is to test technology and new business models which may result in tomorrow's energy efficient and sustainable society.

When the demonstration sites and buildings are selected, technical equipment will be installed that connects the demonstration sites with a technical platform - called a hub. Smart City Kalundborg Energy Hub is the name of the software that keeps track of the many data on energy production and consumption.

The main challenge and the solution

It is a **major challenge** to make society independent of fossil fuels. Renewable energy sources like solar and wind require a flexible and intelligent power system. The existing power grid was created based on a principle dating back 100 years that energy is produced centrally. That is the main challenge which Smart City Kalundborg will address, because it will not remain that way. An increasing number of power consumers have become power manufacturers by means of e.g. solar panels, and the power consumption of each residential unit is much more varied now than earlier. This development will accelerate further when, in the decades to come, Denmark will reduce its consumption of coal, oil and gas, and a greater part of the energy consumed will need to be covered by sustainable energy sources.

This development is presenting several challenges to our current utility grid, such as periodic overloads. Seen from a macroeconomic point-of-view, the solution is not to bury more cables, which is the method we have used for the last 100 years. Often the problem is limited to bottlenecks and peak loads of short duration. **The best solution** is to utilise the existing power grid with the assistance of software and efficient consumption patterns.

Source: www.smartcitykalundborg.dk

Project highlights

Open platform offering many advantages

- ✓ Smart City Kalundborg is to develop an open platform which offers user-friendly energy services to people and businesses while creating more flexibility in the grid.
- ✓ Furthermore, the platform will create a completely new method for trading in the flexibility of the grid in combination with flexible energy producers and consumption.
- ✓ The purpose of the open platform is to facilitate the development of user-friendly software applications – apps – which provide easy access to consumption data and energy production for people and businesses. For example, the apps could show your earnings as a result of your flexibility as a consumer or they could show the variations in the electricity rate over 24 hours. The open platform provides an unlimited number of opportunities.

Intelligent technology for automated adjustments in consumption

- ✓ Electricity customers are different and have very different needs. One business may be able to postpone their power purchase to the time of day when the price is low, whereas another business may have to pay a higher rate to obtain a guaranteed power supply around the clock.
- ✓ Likewise, some people may choose cheaper electricity against reducing their power consumption during certain periods. Intelligent technology will enable such adjustments to be carried out automatically and without any inconvenience to the electricity customer, who will receive the electricity needed at the agreed price.

Cases and tested technologies

- ✓ The purpose of Smart City Kalundborg is to demonstrate the optimized use of renewable energy and decentralized energy production and energy management opportunities.
- ✓ During the project, various technologies are tested, such as building security, efficient pump control, solar panels, electric cars and charging stations. The demonstration will not take place in a closed laboratory, but in existing neighbourhoods, buildings and facilities – in a vibrant city where citizens have a legitimate expectation that energy supply is functioning.
- ✓ What makes Smart City Kalundborg unique is that the demonstration carried out shall contribute to develop new markets for energy flexibility and test different business models in line with the Danish government's smart grid strategy.

SGEM – Smart Grids and Energy Markets

Key facts

Project coordinator:	CLEEN
Duration:	01/2009– 12/2014
Location:	Multiple, Finland
Website:	www.cleen.fi/en/sgem
Contact:	Jan Segerstam jan.segerstam@empower.fi
Further Finnish SG information:	www.cleen.fi

Project setting

✓ National Smart Grid Initiative of Finland:
- Create an interlinked smart market enabling smart grid,
- Consists of 7 interlinked work packages and spearhead demo projects. Industry 53% of the volume. 21 industry & 8 research partners. ICT companies contribute 25%,
- 5 year program, 55 M€ budget,
- Coordinated by CLEEN CSTI (Centre for Strategic Science, Technology and Innovation).

Vision

The SGEM Vision is to create a smart energy market platform by innovating and integrating smart grid technologies and creating smart processes for the future energy market.

The project brings together grid knowledge, market knowledge and emerging technologies in a unique environment propelled by CLEEN coordination.

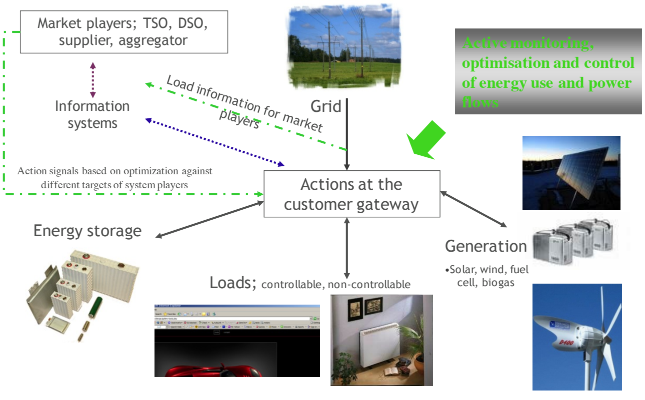
The vision incorporates the basic thought of giving power to the people, not only literally, but by making everyone a part of the smart ecosystem of energy. This means that everyone will be able to affect and control their contribution and needs as prosumers in the future marketplace.

The project

The project is divided into seven work packages, which form the backbone for creating the enablers of the SGEM vision:

WP1: Smart Grids Roadmap,
WP2: Active LVDC distribution system,
WP3: DR and DER in regional HV networks,
WP4: Demand Response, HEMS, Sustainable Urban Living,
WP5: LVAC Island grid,
WP6: Self-Healing networks, Smart Metering, MV Island grid,
WP7: Aggregator business models and new network tariffs.

The Smart Grids Roadmap is a mapping of the collective SGEM knowledge to understand the pace of innovation penetration in the market environment. By building LVDC demonstrators the project has investigated the feasibility of leveraging DSO infrastructure in challenging investment scenarios. By looking at the aggregate effects of DR and DER in the transmission network the project has established a basis for widening market tools to leverage TSO network abilities. Coming from the customer side towards the market and grid in modelling demand response functionalities in market environments, the project has established novel processes and information exchange. These enable aggregation and leverage the smart metering investments made. Transforming from control room lead to self healing networks and incorporating aggregation business models completes the scope of the SGEM project.



Source: www.cleen.fi/en/sgem

Major findings

The SGEM project continues in its final year and is generating a holistic picture of how smart grid technologies can work and leverage the liberalized energy market in ways that empower individuals and enterprises to make best use of smart grid resources.

The Smart Grid Roadmap from a Nordic perspective outlines the view of developers and market participants on how and when implementation will evolve.

Low Voltage DC distribution piloting has created stable pilot networks and lowered the number of outages in complex networks where LVDC has enabled better use of alternative resources. Prosumer connections have been enabled and are working as a stable part of the system.

Aggregate Demand Response potential for transmission networks has been established. Multiple market participant demand response process chains have been proven and new information exchange content structures have been created for implementation in market environments. This takes demand response to a whole new level from its traditional network peak balancing role.

Large scale AMR rollouts have provided ample opportunity to evaluate possibilities for aggregation. Use of smart meters as active endpoints in demand response chains has been proven in conjunction with novel information exchange. This enables ESCO and Market DR processes for parties responsible for the balance of the metering points included.

Simulation models have been created to understand both distributed production effects on grid and market scenarios. Control logic flows for island networks have been established.

Readiness for full scale testing of self healing networks has been established. New cost effective fault indicators have been developed for networks. Communication platforms for smart grids have been evaluated and connected to test environments.

New tariff structures and power based market models have been evaluated. The value of demand response at different penetration levels has been established. Consumer willingness and needs for demand response have been established.

Finland

Linear – Local Intelligent Networks and Energy Active Regions

Key facts

Project coordinator: EnergyVille
Duration: 05/2009 – 12/2014
Location: Flanders, Belgium
Budget 40 million, 9,5 million grant
Website: http://www.linear-smartgrid.be
Contact: Wim Cardinaels, wim.cardinaels@energyville.be

Project setting

- ✓ Large-scale pilot on technical solutions and business models for demand response in electricity grids.
- ✓ 240 households, spread over the whole of Flanders
- ✓ 25% get Time of Use pricing; 75% get smart domestic appliances that enable use of flexibility
- ✓ Goal is reaching commercial breakthroughs for current and forthcoming products.
- ✓ Tests with and without smart meters

Vision

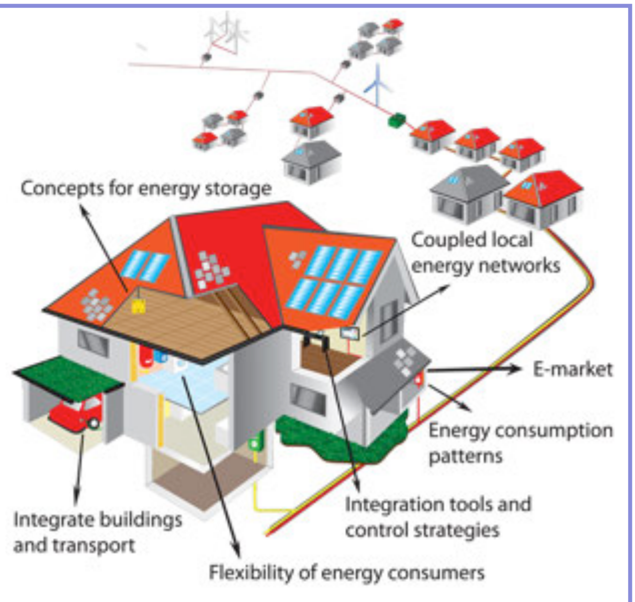
The vision of the project is to test and prove the commercial viability of products, solutions and models for residential demand response.

Demand response in residential settings is complex. Although there are products enabling it, they have not been tested at the large scale that is needed for serious conclusions. Moreover, the jury is still out on the economic models that make residential DR attractive for all parties involved.

Linear is a breakthrough step in that it offers both the large-scale integrated environment and a test of two different business cases. Because of its size and substantial duration, the project yields extremely valuable and statistically relevant results on technology readiness, economic models and user acceptance.

Main activities of the project

Activities	Description
1. Reference measurement	Feb 2011 – March 2012 Measurement with 70 randomly selected households in Flanders as a baseline for the Linear-setup
2. DR test without smart meter	Feb 2012 – April 2014 100 households, all over Flanders Business cases 'portfolio management' and 'wind balancing'
3. DR test with smart meter	Feb 2013 – July 2014 110 households, two selected areas Business cases 'Wind Balancing', 'Transformer load/aging' and 'Line voltage profile'



Major findings

- Globally speaking, consumers can be motivated to participate in demand response – as long as the appropriate models and incentives can be found. The current approach from within the energy sector is too much technology-driven and too little consumer-driven. Nonetheless it is this end-user perspective that determines success or failure.
- Customers/end users are not a homogeneous group. They fall into four distinct categories: adherents, proponents, doubters, recusants. Efforts should be focused on the first two and tailored to suit them.
- Involving (residential) end users in smart grids only works if they are offered plug and play solutions that will not interfere with their comfort.
- Even when a suitable business case has been developed, incentives have to be carefully designed. Linear uses a combination of (monetary) incentives to induce customers to take part in overarching energy management schemes.
- Setting up a complex and fully functioning system like smart grids/demand response, requires more time, effort and resources than the average project budget in this field allows for. A thorough incubation phase at the beginning of the project is needed to fully determine the requirements and the scope.

VENTEEA - Voir l'Energie Naturelle Transformer l'Exploitation de l'Electricité dans l'Aube

Key facts

Project coordinator: ERDF
Duration: 12/2012 – 12/2015
Location: Aube, France
Budget 20,5 million, 7,4 million grant
Contact: Didier Colin, didier.colin@erdf.fr

Project setting

- ✓ Dynamic voltage regulation to follow wind production
- ✓ Forecasting and management of wind power in grids
- ✓ Development of new equipment and switchgear
- ✓ Test of electricity storage in medium voltage grids

Vision

The VENTEEA project wants to be a technological, economic and regulatory test environment for the future high voltage grids (> 2OkV).

The goal of the project is to improve the efficiency of the network and to better integrate wind power into these networks. This requires tools that make the grid more readily observable and more manageable. In addition to integrating more wind power, those tools will let grid operators better manage line tension and detect errors. The project further looks into storage solutions as a means to help balance the grid and expand its hosting capacity.

The project results are a major step forward in terms of innovation, cost savings, sustainability and social acceptance of new energy technology.

Main activities of the project

Activities	Description
1. Equipment test	Test of switchgear on high-voltage grid in rural environments with high wind penetration.
2. Test of innovative tools	Tools for observing and managing electricity remotely. The goal is both to limit unintended deconnection of turbines and to smoothen output fluctuations.
3. Test of storage solutions near wind turbines	Storage/batteries at the level of the decentralised resource (i.e. the wind turbine) further help to stabilize the grid and allow it to reach a higher level of wind integration.

Expected results

Innovation:

- Increased grid stability in times of high wind production,
- Grid management based on real time monitoring of production,
- Established case for storage.

Economic and Financial:

- Optimised infrastructure investment cost,
- Reduced grid connection cost of wind turbines.

Sustainability:

- Measurement of global environmental impact of the solutions deployed in the project.

Social:

- Overall societal impact of the technologies being introduced. This included technology impact, end user acceptance and the level of service.

Smart Grid Vendée

Key facts

Project coordinator: SyDEV
Duration: 01/2013 – 12/2017
Location: Vendée, France
Budget 27,7 million, 9,5 million grant
Website: www.smartgridvendee.fr
Contact: Nicolas Gente
nicolas.gente@sydev-vendee.fr

Project setting

- ✓ Optimisation of local distribution grids,
- ✓ Involvement of all actors in the electricity system,
- ✓ Demonstration of viable business models,
- ✓ New systems and interfaces for reinforced coordination on day-ahead and in real-time.

Vision

The Smart Grid Vendée project tries to better manage and optimize a rural grid with wind parks and rooftop PV installations connected to low and medium voltage.

The growth of intermittent sources is putting pressure on existing electricity grids. Management at the local level is needed, in addition to the existing grid management at the transmission level.

The project focuses on the 6 most congested of the 35 injection points in the Vendée area. Together they represent about 60% of energy production in the region. The overall goal is to improve the observability of demand and supply, which will in turn reduce uncertainty and make balancing easier.

Main activities of the project

Activities	Description
1. Analysis	Y1 Local optimisation situation (ex ante and ex post analysis) + specification of local energy markets
2.Deployment	Y1 – Y4 Development of technology/tools needed for grid management and management of distributed resources. Deployment in the field.
3. Follow-up	Y4 – Y5 Study of end user behaviour (mostly in public buildings) and training of operators using the new tools and systems.

Expected results

Innovation:

- Technology and business models to allow a higher penetration of renewables on the grid at the lowest cost, while ensuring the quality of electricity supply.

Economic and Financial:

- An overall model for the management of a local distribution grid,
- A viable business case for all actors in this setting.

Sustainability:

- Integration of the energy system into the local environment and social fabric. Measure the impact of the local deployment on the overall electricity supply chain.

Social:

- Creation of a new line of study: 'Smart grids technician', in close collaboration with industry.

E-Energy, Smart Grids made in Germany

Key facts

Project coordinator:	1 coordinator for each of the six model-regions, and one coordinator for the accompanying research
Duration:	2008 – 2013
Website:	www.e-energy.de
Location:	6 model regions in Germany: Cuxhaven, Harz, Rhein-Ruhr, Aachen, Rhein Neckar and Baden-Württemberg Accompanying research: Munich,
Contact:	Ludwig Karg, l.karg@baumgroup.de

Project setting

6 German model regions and accompanying research, including urban and rural areas with focus on:

- Development and demonstration of standardized architectures and platforms needed for the restructuration of the electricity grids to cope with the renewable and decentralised energy sources. Including new integral system solutions, in which information and communication technologies (ICTs) play a key role.
- Creation of a market place suitable for a decentralised power system, dominated by fluctuating power generation.

Unique project features

- ✓ Creation of an E-Energy marketplace that facilitates electronic legal transactions and business dealings between all market participants.
- ✓ Digital interconnection and computerisation of the technical systems and components, and the process control and maintenance activities based on these systems and components, such that the largely independent monitoring, analysis, control and regulation of the overall technical system are ensured.
- ✓ Online linking of the electronic energy marketplace and overall technical system so that real-time digital interaction of business and technology operations is guaranteed.

Project topics

Region	Project name	Focus
Cuxhaven Coordinator: EWE AG	eTelligence	**ICT, liberalisation of markets, decentralised electricity production**, integration of renewables, smart metering.
Harz Coordinator: RegenerativKraftwerk Harz GmbH & Co KG	RegModHarz	**Decentralised electricity production, integration of renewables**, liberalisation of markets, storage, and security of electricity resources.
Rhein-Ruhr Coordinator: RWE Deutschland AG	E-DeMa	**Liberalisation of markets, ICT architecture, decentralised electricity production**, integration of renewables, smart metering
Aachen Coordinator: utilicount GmbH & Co. KG	Smart Watts	**Smart metering, liberalisation of markets, flexibility of loads, ICT security and data protection.**
Rhein-Neckar Coordinator: MVV Energie AG	Modellstadt Mannheim	**Energy efficiency, ICT architecture, security of electricity resources**, flexibility of loads, ICT security and data protection.
Baden-Württemberg Coordinator: EnBW Energie Baden-Würtemberg AG	MEREGIO	**Liberalisation of markets, security of electricity resources, flexibility of loads, ICT security and data protection**, storage, decentralised electricity production, energy efficiency.
Accompanying research Munich Coordinator: B.A.U.M. Consult GmbH		Quality control and support instrument for the e-energy programme.

Main findings

Generally:

- To handle the new challenges of decentralised power generation, the grid has to be reinforced and remodelled. Local analysis and provisions are necessary. Here, the tested ICT components, systematic solutions and market designs can be applied due to their high transferability.
- The key to an efficient integration of renewable energies is the flexibility of consumption and generation in companies as well as in private households. Proper ICT systems are necessary to ensure this flexibility. It is also necessary to provide the technical and legal requirements for a discrimination free energy information system.
- The energy requirements of private households were reduced due to the intelligent systems coupled with special legal contracts. Up to 10% (20% in industrial estates) of the consumed electricity could be shifted to times of low demands.

Specific results from

eTelligence:

The analyses of modelled scenarios underline the increasing benefit of flexibilities in the near future with higher amounts of renewables in the energy mixture.

RegModHarz:

Market analysis showed that new business models at whole scale and regional markets are not economical under the influence of the current renewable energy law (EEG). Future energy markets need to take decentralised producers into account.

SmartWatts:

An information and control model for the energy system, the so called internet of energy was developed. Informing the customers about price, quality and origin of the purchased energy was the essence of smart watts.

eDeMa:

The developed energy gateway runs reliably. Remote updates are possible at any time. The system was installed at 450 customer houses, including visualisation via tablet application. Sensible data remained in the houses. The general acceptance of the system from was large. However, some remaining challenges lie within special customer demands. A new way of inclusion for end-devices is necessary.

Modellstadt Mannheim:

Amortization of costs from the smart grid infrastructure can only be achieved if different business models come to a macroeconomic benefit.

MEREGIO:

A smart grid infrastructure was built up which allowed for real-time communication between energy consumers, multiple distributed energy resources and smart storage devices. A marketplace for energy connected the 1,000 private and commercial energy customers as well as centralized and decentralized energy providers.

Relevance

- The tested ICT components, systematic solutions and market designs have the potential of being implemented.
- The companies and universities involved in the E-Energy projects are planning further F&E activities, i.e. the interaction of the electricity grids with other grids such as for gas or heat.
- By decentralised integration of devices used for gaining, storing and distributing electric energy the cost effectiveness, security of energy supply and ecological compatibility can be enhanced. A profitable market for innovative services will develop based on an efficient energy information grid.

OGEMA 2.0 - Smart Grid meets Smart Home

Key facts

Project coordinator: Fraunhofer IWES, Fraunhofer IIS Fraunhofer ISE
Duration: 12/2011 – 12/2015
Website: www.ogema.org, www.openmuc.org
Contact: Patrick Selzam, Patrick.Selzam@iwes.fraunhofer.de

Project setting

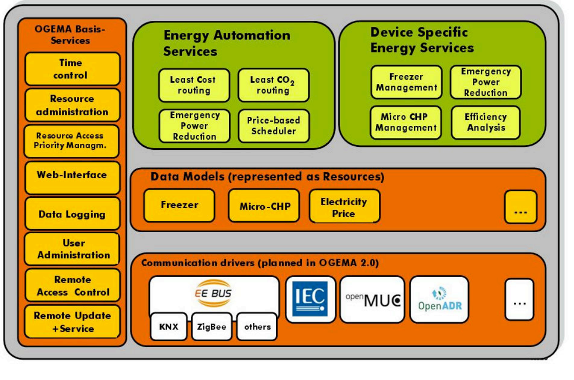
- ✓ OGEMA2.0 combines research results from OGEMA 1.0 and openMUC. It provides an open software platform for energy management. Here, it links the customer's loads and generators to the control stations of the power supply system, including a customer display for user interaction. Smart grids and smart homes are meant to be interlinked to profit from each other.
- ✓ The project "OGEMA 2.0" is based on the current OGEMA development as well as further previous developments of Fraunhofer IWES, Fraunhofer IIS and Fraunhofer ISE, comprising experiences from four major smart grid projects in the E-Energy framework in Germany.

Unique project features

OGEMA 2.0 is based on OGEMA. OGEMA allows energy flows within end customer premises to be optimized with high degree of modularity. Web based user interaction and other basic functions are provided by a framework architecture shown in the illustration below.

The alliance aims at developing a software standard and reference implementation. Participants are manufacturers and users/operators of standard conformant systems. All developers and involved parties can turn their ideas for more efficient energy usage by automation into software for the gateway platform.

Industrial partners from producers of meters, domestic appliances, heating technologies and inverted rectifiers, to companies from the telecommunication and energy utility sector are involved in the processes.

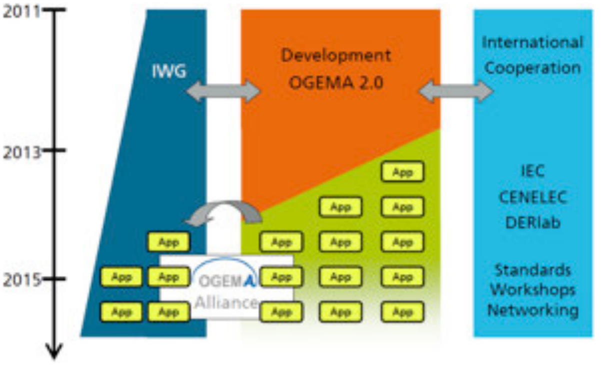


Framework architecture of OGEMA (source: http://www.ogema.org/, 2014.01.13)

Project topics

OGEMA stands for "Open Gateway Energy Management Alliance". It is an open software platform for energy management which links the customer's loads and generators to the control stations of the power supply system and includes a customer display for user interaction. In this way end customers are able to automatically observe the future variable price of electricity and shift energy consumption to times when the price is low. OGEMA includes the software itself as

- Linking the smart grid and the costumers by:
- automatized control
- variable prize for electricity
- communication connection
- intelligent gateway



Time table for OGEMA 2.0 (source: 11.10.2012, Kasseler Symposium für Energie-Systemtechnik 2012, David Nestle)

Relevance

With an increasing amount of renewable energy the grids have to get smarter. Making houses smarter adds to the positive effect of minimizing the costs for new grids on the one hand and reduce C02 production on the other hand. Combining both, the smart grid and the smart house provides huge potentials in these fields. As it is a cheap, standardised open source device, it can make intelligent energy management economical, even for private households.

Besides of the development of the software and technology, OGEMA 2.0 aims at a standardisation in its field which will have a positive effect for energy management systems as a whole.

Main findings

The atomized energy management should help the costumers to use the incentive offers provided by the smart grid. Furthermore, it supports the effective usage of energy by managing of controllable household devices (washing machine, dishwasher, refrigerators etc.). The project is still in an early phase. Notable results are yet to come.

Agios Efstratios – Green Island – Microgrid

Key facts

Project coordinator: CRES
Duration: 01/2013 – 12/2015
Location: Agios Efstratios Island, Prefecture of Lesvos, Northern Aegean region, Greece
Contact: Stathis Tselepis, stselep@cres.gr

Source: CRES

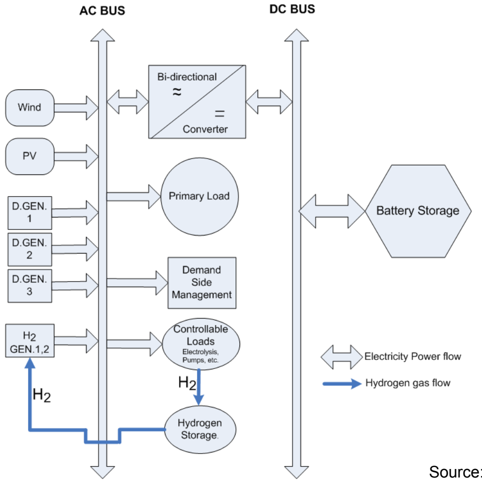
Project setting

- ✓ Autonomous Power System 'Living lab' in an island:
- ✓ Focus on 6 areas of application:
  - Integration of **renewable energy sources (PV and Wind)** in distribution grid (active distribution grid) with contribution not less than 85% of the annual electricity demand
  - Island **grid formed by inverters** with smart central supervisory control
  - **Load management** in public buildings, Electrolysis for Hydrogen production, pumping systems, etc.
  - Integration of central **electrochemical and Hydrogen storage systems**
  - Installation of **smart meters** in most buildings
  - Introduction of **electromobility**.

Vision

The project deals mainly with the integration and operational control of variable renewable energy generation and storage considering also the appropriate management of the resources and of certain non-critical loads. **The project is aiming for at least 85% RES contribution of the annual electricity demand. The proposed system shall substitute power production of the existing thermal power plant where expensive and polluting diesel fuel is being used through the development of a smart grid approach.**

The model autonomous island microgrid of Agios Efstratios could be an example and a real life "laboratory" for high penetration of renewables with central or distributed main components and a **test bed for the implementation of control and communication functions, introduction of new RES generators and storage units in smart electricity grids**. Furthermore, the microgrid operation should be transparent to the Hellenic island system operator who plans to install advanced energy management systems in the non-interconnected islands.



Source: CRES

Major goals

The project "Agios Efstratios – Green Island", is an autonomous island **grid formed by inverters with integrated renewable energy sources** (PV and Wind) contribution not less than 85% of the annual electricity demand. Furthermore, the introduction of electric vehicles, heating and cooling in public buildings using renewable energy technologies and energy saving measures in buildings aim to reduce dependence on fossil fuels and establish environmentally friendly technologies. All these measures are expected to reduce the peak demand and the total energy consumption, in the long term.

The backbone for the operation of the microgrid is the **smart central supervisory control (SCSC)** which monitors RES production, demand, weather forecast, state of charge of storage systems and through an algorithm determines and implements the operation mode, signaling the inclusion, limitation or shut down of the existing diesel generator sets, decides to integrate, limit or disconnect controllable loads and manages the production of RES units, storage strategy as required. The communication and control of generation, storage and controllable loads will be made through a **communication bus sending set points to the units or by applying a droop mode function**.

The integration of an **electrolysis unit for hydrogen production, pressurized hydrogen storage and two hydrogen-fed gensets** will make use of the excess electricity and further reduce the use of diesel fuel and increase accordingly the renewable fraction, while the electrification system will be able to cope with even higher renewable energy generation if the energy consumption increases further in the future.

The design of the new island electrification RES based system takes into account the **reliability issues** of the most important components in order to avoid lengthy disruption in the main mode of RES operation of the microgrid and avoid the use of diesel fuel.

Historic electricity production cost data of the diesel powered station in Agios Efstratios compared with simulation results of the HOMER software indicate that the drastic reduction of the diesel gensets operation time and the automation of the new RES based power station will decrease significantly the fixed cost, as defined for conventional power stations.

The calculated total electricity cost per year by HOMER for the new RES based system represents mainly the fixed cost, as the variable cost reflects the cost of the diesel fuel used, maintenance and operation, which are minimal in the RES system. Over a system lifetime of 25 years, the RES based microgrid is expected to have a total **levelized electricity cost ranging between 200 and 235 €/MWh.** This is about half of the current conventional diesel fuel powered system.

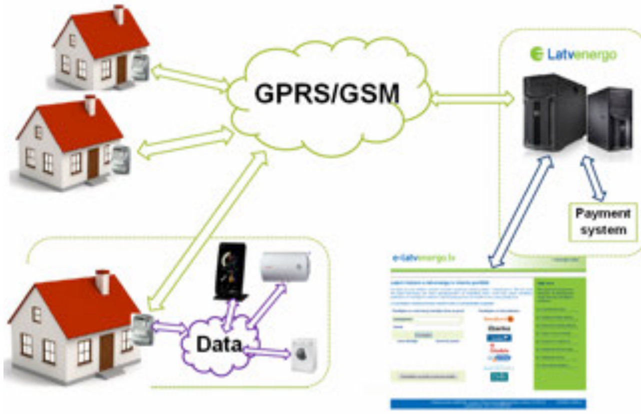
Promotion of Energy Efficiency in Households with Smart Technologies

Key facts

Project coordinator: JSC Latvenergo
Duration: 06/2012 – 04/2013
Location: Riga, Latvia
Website:
http://www.latvenergo.lv/lat/viedie_skaititaji/viedie_skaititaji/
Contact: Aris Dandens,
Aris.Dandens@latvenergo.lv

Project setting

- ✓ 500 households, 5 groups according to the annual electricity consumption, private houses and flats in 2 multi-storey buildings.
- ✓ Location of households – mainly in Riga district.
- ✓ Main tasks of the project:
  - Provide households with information about actual electricity consumption and CO2 emissions,
  - Involve households to take active measures for improvement of energy efficiency and environmental protection,
  - Assess options for improvement of energy efficiency in households using smart technologies.



Vision

The vision of the project is the improvement of energy efficiency and decrease of electricity consumption in households.

To increase understanding about efficient use of electricity, smart meters and other smart technologies are developed and installed in the household sector. The implementation of smart technologies will raise awareness of electricity end-users about the benefits that are based on efficient management of electricity consumption. The project will show how informing consumers about measures for improvement of energy efficiency effects the behaviour of consumers.

The motivation of consumers to take measures to ensure optimal use of resources is an important step to successful implementation of smart grid policy in Latvia.

Main activities of the project

Activities	Description
1. Smart metering	Installation of smart meters in households and implementation of data registration system.
2. Data analysis	Development of web-based information system and smart phone application with tools for analysis of consumption data.
3. Other smart techno-logies	Installation of different additional measurement equipment for monitoring of electricity consumption.

Major findings

Consumers who were involved in the project were asked to participate in interview with experts in the field of smart technologies. During the interview, consumers provided information about main electrical devices in the household and the behaviour of users. Once the information about the household was available, experts could give more detailed and specific advice about solutions for improvement of energy efficiency. Interview is a useful measure to reach different consumer groups.

The main challenge of the project is obtaining 10% savings in electricity consumption of households. The project has been implemented successfully, and there will be reports on the impact of the project activities for 3 years after the end of the project. First monitoring report will be prepared until February 2014.

Project activities included seminars and other dissemination activities. The communication with the target audience of the project provided a joint platform for discussions and exchange of experience on practical ways how to achieve more efficient use of energy by consumers.

The installation of smart meters brings precise information about the electricity consumption in the household. The information about the consumption of electricity is stored in data system, and the consumer is able to analyse the total consumption of the household in different periods of time. The information system provides option for consumers to compare the data of a particular household with other households with similar annual consumption.

Additional measurement equipment for monitoring of electricity consumption is beneficial for consumers because it brings information about the amount of electricity that is consumed by different specific electric devices in the household. The measurement data is stored in online energy management system, and the home energy monitoring system has remote viewing and control option. Analysis of each electric device brings more opportunities to create more efficient consumption of electricity in the household.

DREAM - Dynamic real-time control of energy streams in buildings

Key facts

Project coordinator: University of Twente
Duration: 2011 – 2014
Funding: NWO Physical Sciences and STW
Website: www.utwente.nl/ctit/energy/projects/dream.html
Contact: Hermen Toersche, h.a.toersche@utwente.nl

Goals

The main goal of this project is to study, develop, prototype and test real-time control systems for the energy management of buildings connected in a micro-grid to 1) reduce the energy related CO_2 footprint of buildings without loss of comfort for the owners or inhabitants and 2) to efficiently integrate new distributed micro-generation techniques based on renewable sources.

This project is focused on ICT technologies that can be employed in buildings that are interconnected in a small electricity micro-grid of approx. 150 buildings, which is the typical size of the low-voltage electricity grid behind a local transformer.

Step 1

Prediction of energy patterns

In the first step of the three-step optimization method a prediction of the energy demand and the electricity production potential is made for each building individually. This is done for every building separately, because every building has a different power profile due to different local generators, different appliances used in the building and different behaviour of people working or living in these buildings.

Next to the energy profiles of individual buildings in the micro-grid, the energy profile of generators not directly connected to buildings like local wind-mills and local biogas installations within the micro-grid are predicted in step 1.

Step 2

Global scheduling of energy streams

In the second step the local production and consumption potential is used to compute an integral planning of the micro-grid. This planning specifies the preferred power profile of all individual buildings. It is calculated 24 hours ahead, based on local (building specific) and global objectives (e.g. APX electricity wholesale prices), and is based on the information the global controller receives from step 1.

The main idea of the proposed planning method is to organize the buildings of the grid in a hierarchical way. Each node in this hierarchical structure represents a subset of the grid (e.g. a building, a neighbourhood or a complete city) and the planner within a node only communicates with the planners in the nodes above and below him. Within this method, the planners can steer their sub-grid by sending (artificial) cost prices of electricity to the planners below. These prices are adapted based on signals the planner gets from the planner from the level above.

On the leaf level, the local (house) controllers schedule their building such that energy consumption is shifted to periods with low prices and energy production to periods with high prices. By iteratively sending different prices (based on deviation from the target value of the fleet), the controllers in the houses reschedule their buildings, resulting in an aggregated planning of the whole grid which matches better the global objective.

Step 3

Local Control

In step 3 the control system has to control the supply and demand within a building such that the total energy consumption of the building is close to the preferred power profile. This last step is performed by a local real-time controller which decides when to switch on/off appliances, when to charge batteries, or when to store heat in the heat buffer, etc. Whereas the first two steps can be done off-line, the devices need to be (on-line) controlled in real-time.

On-line decisions have to be made to switch devices on or off. These decisions should not only be based on the preferred planning but should also take into account the current situation in the building (e.g. new devices may (request to) start, the temperature in the fridge may change after filling it with new goods). In this way, the controller has to take into account local constraints resulting from the concrete situation in the current time period, but should also estimate the influence of the made decisions for future time periods.

We propose to base the real-time control on cost functions for every device (generators, consumers, storage) and to take as goal to minimize total costs. Using these cost functions not only the preferred plan but also the priorities of the residents and the possible incentive based on which they allow some discomfort, can be taken into account. In this way, the local controller has to find a balance between these possibly conflicting objectives, resulting in schedules deviating from the preferred planning.

Essential in the sketched approach is that we propose to make schedules for the complete planning horizon of one day (24 hours) and not only for the current time period. This is quite different from smart agent approaches that react in real-time on signal from other agents. In our approach extreme behaviour of the system, for example all agents reacting at the same time in the same way on pricing signals, can be avoided. We expect that this approach works smoother, even in highly dynamic and extreme situations, and can give more guaranties for the performance of the overall system. Therefore, our approach is much more transparent than agent based approaches.

For realizing a short-term planning, concepts like Model Predictive Control (MPC) or a rolling horizon approach may be developed. Besides the concrete methods and algorithms for calculating the concrete schedules in each iteration of such a method also questions like the re-planning frequency or the length of the time horizon taken into account in the local plannings have to be answered. Furthermore, when the MPC or rolling horizon approach conclude that the short-term planning differs too much from the planning which formed the base of the global planning, the local controller can request a re-planning on a higher level. To control somehow the extra effort resulting from such re-planning steps, good communication and decision protocols between the planners on the different levels of the hierarchical structure have to be developed. Furthermore, since a re-planning should not shuffle the existing plans too much and has to be executed faster than the global planning a day ahead, new methods and algorithms for the re-planning have to be developed. These methods should take into account the hierarchical structure and the should decide on which of the different levels the re-planning should be done. Some deviations may be corrected by only re-planning houses in the neighbourhood, whereas in other cases a re-planning over the whole grid is needed.

Kostredin - Cost reduction MV/LV Instrumentation

Key facts

Project coordinator: Enexis
Duration: 01/2013 – 09/2014
Funding: TKI Switch2SmartGrids and partners
Website: www.enexis.nl
Contact: Han Slootweg, Han.Slootweg@Enexis.nl

Vision

Costs of MV/LV instrumentation are too high:

The large-scale incorporation of decentralised electricity generation results in issues for the energy infrastructure. Smart Grids, with which the supply and demand of electricity can be much better matched at local level, offer a solution. **KOSTREDIN wants to develop inexpensive MV/LV instrumentation to promote the use of Smart Grids.**

Energy distribution at medium voltage and low voltage (MV/LV) installations is easy to measure and control. MV/LV installations are therefore ideal for the incorporation of instrumentation to facilitate Smart Grids on the electricity grid. The costs of current MV/LV instrumentation are, however, higher than the added value obtained through the implementation of Smart Grids.

Goals

Curbing the costs of MV/LV instrumentation:

The higher costs than benefits are a barrier to the wide (necessary) roll-out of Smart Grids. How the present electricity grid is utilised and how the energy flows are distributed must be changed to be able to facilitate Smart Grids. To facilitate the large-scale roll-out of Smart Grids, MV/LV instrumentation will ultimately have to be so inexpensive that grid operators will benefit from investing in it. This would in turn result in the large-scale application of these technologies and fast growth in this market.

KOSTREDIN wants to ensure significantly cheaper instrumentation. The solution is sought in the development of an open platform that enables the utilisation of shared components for diverse functionality in one and the same MV/LV installation. One requirement is that this platform is interoperable and supplier-independent. Then the functionality of various suppliers can be combined and flexibility and modularity can be guaranteed.

Results

Cheaper MV/LV instrumentation resulting in the use of Smart Grids:

The project is to result in cheaper MV/LV instrumentation, so the use of Smart Grids becomes attractive and grid operators want to invest in it

Partners

- ✓ Enexis,
- ✓ Alliander,
- ✓ Cogas,
- ✓ Westland Infra,
- ✓ Endinet,
- ✓ Rendo,
- ✓ Alfen,
- ✓ Eaton Industries,
- ✓ Locamation,
- ✓ Datawatt, f
- ✓ orTop automation & energycontrol,
- ✓ Reewoud Energietechniek,
- ✓ Flexicontrol,
- ✓ ELEQ Steenwijk and
- ✓ Avans Hogeschool.

PowerMatching City II

Key facts

Project coordinator:	DNV KEMA
Duration:	2012 – 2015
Program:	Innovatieprogramma Intelligente Netten (IPIN)
Location:	Hoogkerk, The Netherlands
Website:	www.powermatchingcity.nl
Contact:	Albert van den Noort, albert.vandennoort@dnvkema.com

Project setting

PowerMatching City is a living lab demonstration of the future energy system, located in Hoogkerk near Groningen in The Netherlands. In PowerMatching City the connected households have smart appliances that match their energy use in real time, depending on the available (renewable) generation. With the field trial it demonstrates the energy system of the future.

It is a folllow-up smart grid pilot project of the project PowerMatching City I, focused on the larger scale application of a total package of smart energy services. Involved are:

- ✓ 40 households,
- ✓ 10 electric vehicles,
- ✓ 2 distribution transformers.

Hoogkerk gains practical experience with, amongst other things, new energy services and feeding in of renewable energy to the grid.

New products and services will be tested in the pilot project, which were developed in co-creation with residents. Soon, residents will be able to collectively use their energy in the most sustainable manner possible, or as cost-effectively as possible.

Purposes of Phase 2

Whereas PowerMatching City first paid attention to technical conditions, during the second phase the main focus points are market mechanisms under a smart grid regime. How does your new bill and cost price calculation of energy looks like? How you could tap into electricity resources from your aunt in the south when you are living in the north of the Netherlands? And what will be the cumulative effects of a dozen full-electric vehicles that are charging, now virtually, later real-time, in front of your door at night?

As in the first phase, households play a pivotal role in the second: behaviour of members of the household is paramount for all kinds of IT systems that are operating behind charging points and electric vehicles. For stability of the public grid, it doesn't matter when two or three of electric cars are parked in front of your door. This alters when a dozen or more households simultaneously want to plug in and re-charge their electric vehicles at the same grid. Then a reliable, safe and payable IT infrastructure becomes necessary. The question is: how flexible tariffs will look like in those market circumstances?

Impressive changes aren't limited to this new interaction. Also the residences itself are involved. Looking at their dashboard in the living room, households can see online and real-time the energy production and consumption of all their appliances. Those appliances will be fitted into forthcoming industrial standards while manufacturers will also test new market models. To which degree household participants also get insight into the ROI rates (return on investment) of smart electric appliances, is yet another question.

Consequently, the second phase of PowerMatching City will have to lead to the first business models that calculate flexible prices for both heat and electricity for each situation during the day. In the course of time, start-up companies will blossom, having the right knowledge of smart grids on the one hand, and/or expertise to use, operate and maintain appliances and related IT systems on the other.

Results of Phase 1

Connecting energy-flows turns out to work well in practice. By using electric cars, microCHPs and heat pumps, grid administrators can reduce peaks in the grid. Moreover, the consumption curve is flatter, which enables a reduction in the imbalance for energy suppliers.

Some lessons learned are that collaboration is crucial for smart grids, not only now, but also in the second stage and later. The collaboration not only applies to the participating parties, linking the various systems must also be done properly. Sometimes this means small adjustments, sometimes however a new design to make equipment suitable for the system. But this takes time. The learning curve will therefore come to a conclusion during the second stage (such as the introduction of the new portal).

This makes PowerMatching City the perfect example for a smart grid where the digital highway allows and promotes free movement of all energy flows, of both gas and electricity. This will result in flexible rates, new ways of invoicing and other innovative market mechanisms. What is more, rates for electricity and transportation in a smart grid increasingly tend towards each other.

Concepts

PowerMatching City demonstrates a number of (future) technologies that will be deployed in the energy system of the future.

http://powermatchingcity.nl

DeVID

Key facts

Project coordinator:	NTE Nett AS SINTEF Energy Research
Duration:	01/2012 – 12/2014
Location:	Steinkjer (Mid-Norway) and Hvaler (East-Norway), Norway
Website:	www.sintef.no
Contact:	Hanne Sæle, Hanne.Saele@sintef.no
Budget:	Approx. 5 MEuro (38. Mill NOK) funded by the Research Council and more than 30 national partners.

Project setting

Development and demonstrations of technologies and decision support methods are central in the work. The project is performed in close cooperation with two demonstration sites; Demo Steinkjer og Smart Energi Hvaler.

Focus on:

- Smart grid reference architecture and use cases (WP1),
- Smarter network operation (WP2),
- Smarter planning, maintenance and renewal (WP3),
- Information security and right to privacy (WP4),
- Exploitation of regional end-user flexibility (WP5),
- Empirical/use case data base (WP6).

Project topics

The Norwegian electric energy sector faces substantial challenges in the coming years related to the implementation of AMI and other Smart grids technologies.

There is a need to:

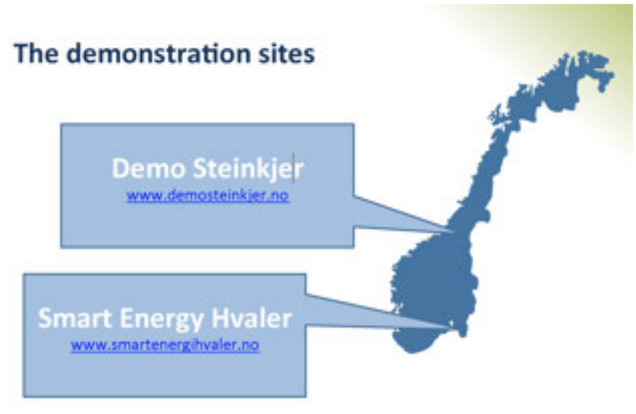
- ✓ Test and verify Smart grid methods and technologies,
- ✓ Reduce risk related to large investments to come,
- ✓ Increase energy industry competence regarding Smart grids issues.

To face (parts of!) this challenge, the DeVID-project was established on initiative from central actors in the Norwegian Smart grids community. The main idea of the project is to provide a novel and better knowledge basis for decision makers who shall purchase, deploy and/or develop Smart grids technologies. Development and demonstration of technologies and decision support methods is central in the work.

Unique project features

The main contribution of the DeVID-project is to contribute to the expected challenges for the Norwegian electric energy sector in the coming years related to smart meters and other smart grids technologies, by testing and verifying smart grid methods and technologies, reducing risk related to the expected large investments to come and increasing energy industry competence regarding smart grid issues.

Based on demonstration and verification the DeVID project will improve the knowledge base and strengthen competencies regarding smart grids technologies and their use.



Source: www.ieadsm.org/Files/Content/10.Trondheim_Nordgard.pdf

Demo site settings

Smart Energi Hvaler

1. Four «main islands» and 16 small ones
2. 6.800 load points with AMS
3. 4.300 cottages
4. 50 kV radial supply
5. 1 primary substation, 30 MW
6. 18 kV HV network (110 km OHLs)
7. 206 secondary substations (MV/LV)

Demo Steinkjer

8. City area, all located under the same transformer
9. 700 Domestic customers (11.140.000 kWh/year)
10. 1 Cottage (7.000 kWh/year)
11. 1 Farm (73.900 kWh/year)
12. 50 Small business (1.250.000 kWh/year)
13. 16 Larger business (7.629.200 kWh/year)
14. 3 Electrical boilers (1.250.000 kWh/year)
15. 1 Small hydro
16. 772 customers in total (21.350.100 kWh/year)

Preliminary findings

As the project is not finished yet, final conclusions on the main research questions are not available yet. There are however a number of lessons that have already been learnt.

Some barriers identified within the DeVID/project are:

- Lack of interoperability between different software systems.
- Technology for demand response. What should be installed at the customers? How should different loads be controlled?

Some drivers identified within the DeVID/project are:

- Customers are interested in demand response, but they need information and incentives.
- Smart meters and smart grid technologies are important pieces for a more efficient operation and management of the distribution grid. This will be demonstrated and verified in the DeVID-project with use of use case methodology.

The DeVID-project will therefore contribute with added value through development, demonstration and verification, through cost-efficient solutions and increased productivity for customers, DSOs and vendor industry. The plan is that in the end of the project this will result in:

- Smarter operation and maintenance of the grid,
- Support for performing risk analysis related to smart meter technology,
- Regional demand response, realised through incentives and technology.

North Sea Offshore Networks

Key facts

Project coordinator: SINTEF Energi
Duration: 2010 – 2015
Location: Trondheim, Norway
Website: www.sintef.no
Contact: Magnus Korpås
Magnus.korpas@sintef.no
Budget: 0,75 Meuro + 0,5 Meuro funded by the Norwegian Research Council and industry partners (2 projects)

Project settings

- **Initial project: Role of North Sea power transmission in realizing the 2020 renewable energy targets**

The project aims at describing and analysing a plausible stadium 2020 situation for the role of the North Sea which respect to utilization of offshore wind resources and increased subsea power exchange for realization of the 2020 renewable targets. The base case of the stadium 2020 situation to be drawn will only constitute point-to-point interconnectors and radial connections of offshore wind farms. Additional cases with the inclusions of T-connections to offshore wind farms and oil/gas rigs, and moderately meshed grids will be analyzed with respect to:

- ✓ Socio-economic benefits and costs of offshore grids,
- ✓ Impacts on power system control and market operation,
- ✓ Political, regulatory and institutional challenges of investing in T-connections and meshed offshore grid structures.

- **Follow-up project: North Sea Offshore and Storage Network (NSON)**

The main objective of the project is to build the knowledge required to establish a Strategic Research Agenda (SRA) for offshore grid development in the North Sea. The SRA will also identify knowledge gaps to be filled within technology, market development, system planning and policy. This will be done in a collaborative way between key energy research partners from NO, DE and UK. It is foreseen that the pre-project will be followed by an initiative from the same partners towards a full-scale North Sea RD&D programme, also involving key industries and stakeholders as well as more countries. This also to ensure the participating countries a global industrial lead on offshore component technology, system solutions and planning methodology, with the North Sea as a first mover towards integrated onshore /offshore HVDC and HVAC transmission networks.

Secondary objectives of the project are:

- ✓ Provide sufficient framework of methods and tools for offshore grid investment decision for alternative cost-benefit sharing models, reflecting the trade-off between the risks of stranded investments vs. the risk of building parallel infrastructure.
- ✓ Enhance international research cooperation and network between SINTEF, Fraunhofer IWES and University of Strathclyde within research related to offshore grids.

Level	NO	DE	UK
Technology	Harmonized	Harmonized	Harmonized
Cost-benefit sharing			
Politics			
	Not harmonised		

Regulatory barriers to offshore grid development

Unique project features

- In-depth analysis on how to optimize possible future offshore grid designs, taking into account offshore wind developments and cross-border exchange,
- Recommendations on the development and use of decision aid tools for optimizing offshore grid designs,
- In-depth energy market simulations on how extensive offshore power transmission impacts the onshore power system,
- Providing a robust knowledge and modelling platform for international collaboration (The follow-up project briefly described above is one example).

Main findings

- Scalability and replicability of the project solution:

A key point for the build-up of offshore power transmission is to avoid sub-optimal solutions consisting of only non-flexible point-to-point connections. A successful development of a North Sea offshore grid, which the project aims to contribute to, will lead to better dispatch of hydro power, more MW of offshore wind and more efficient cross-border power exchange. Benefits of offshore grids are expected for power plant owners (onshore and offshore), consumers (onshore and at oil/gas platforms) and society in general due to stronger market integration that facilitates a higher share of renewables in the power system.

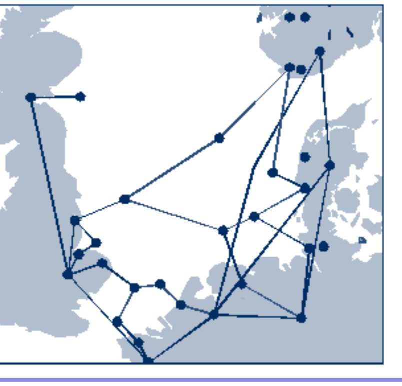
- Generic barriers and drivers identified:

A main barrier for the development of meshed offshore grids is the sharing of costs and benefits between different countries and the different users of the grid, as well as harmonization of grid rules and technology standards.

- Implications for further developments:

Cost-benefit sharing is a key issue for the development of offshore grids. The initial studies, as well as NSCOGI give clear indications that common offshore network in the north sea is likely to be worthwhile from a global socio-economic viewpoint, even taking account for technology uncertainties. However, the cost/benefit analyses of North Sea grids conducted so far does not address to a high enough degree how these costs and benefits should be shared among the stakeholders (between countries and between different users). Adding to the complexity is the risks for stranded investments if it is decided to e.g. build a larger converter station than needed today to prepare for future uses that still are uncertain.

An example of an optimized grid in the North Sea using the NET-OP Tool (Trötscher&Korpås, Wind Energy 2011)



Power Networks Demonstration Centre

Key Facts

Project coordinator:	Power Networks Demonstration Centre
Location:	Cumbernauld, North Lanarkshire, Scotland
Website:	www.strath.ac.uk/pndc/
Contact:	Graeme Burt, graeme.burt@strath.ac.uk

Project setting

- ✓ The Power Networks Demonstration Centre is an innovative development and demonstration facility founded by the University of Strathclyde, Scottish Enterprise, Scottish Funding Council and founding members Scottish Power Energy Networks and Scottish and Southern Energy Distribution.
- ✓ The 13,000 sq. ft. facility is comprised of a unique 11kV and LV network environment representative of UK networks, secure test bays, MW-scale MG Set, dedicated SCADA control room and real-time simulation suite. This affords the pre-commercial testing of HV and LV equipment and secondary control, protection and measurement systems.
- ✓ The Centre membership is growing and now includes S&C Electric, Omicron and Locamation.

Vision

The PNDC vision is to undertake a range of innovative projects that will accelerate the proving and adoption of new 'smart' technologies, from advanced power grids incorporating renewable generation to electric vehicles and household appliances.

PNDC is committed to developing and testing new low carbon technologies by providing a realistic environment to trial them more quickly and effectively under a range of challenging power system scenarios. The Centre aims to set new standards in electrical distribution with a focus on a range of technology streams.

Core Research Themes

THEME	OVERVIEW
Power Electronics & Distributed Energy Resources	Integrating new power electronics based systems and distributed energy resources into the power network. Applications include Electric Vehicles (EVs) and off-grid power supplies.
Protection & Control	Ensuring that the protection of future networks is fit for purpose to enable the vision of a secure and reliable smart grid.
Sensors & Measurement	Developing novel sensors and characterising emerging sensor technologies to give greater system and plant observability.
Asset Management	Realising methodologies for the management of asset condition and maintenance practices and risk and cost analysis to support effective decision-making.
Communications & Systems Integration	Investigating existing, emerging and novel communications technologies to support the better integration of smart grid sub systems.
Network & Demand-Side Management	Creating systems and schemes for the real-time operational management of distribution networks that meet emerging commercial and technical objectives.

Selected Projects

The current portfolio of projects being undertaken at the PNDC include:

- **Hybrid Generator Testing** - Hybrid generator technology is offered as a solution for off-grid power supply requirements in remote locations, and the performance of various unit sizes are being evaluated.
- **On-Route Rechargeable Hybrid Bus** – Vehicle and charger testing is undertaken. Such systems support the realisation of low emission zones within city boundaries.
- **Tablet Application for Managing Protection Relays** – This provides access to individual relays' information, including live voltage, current, and frequency measurements, and trip and alarm status.
- **Investigation of Sensitive Earth Fault (SEF) Mal-operation** – Hardware-in-the-loop simulation supports the investigation of a number of factors which may impact on SEF protection and the identification of remedial measures.
- **Condition Monitoring for On-Load Tap Changers** - Available options for improved monitoring of on-load tap changers are investigated through an acoustic monitoring system.
- **Distribution and Transmission Cables Failure Prognosis** – An analysis of the factors affecting the health of cables and development of models that help identify risk factors and prevent future failures.
- **HVDC Technologies and Facilities** – Supporting the specification of state-of-the-art real-time testing facilities for the validation of HVDC technologies.
- **MVDC Demonstration Project** – Designing DC infrastructure to provide for AC/DC hybrid network technology evaluation.

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PRICE Project

Key Facts

Project coordinator: Iberdrola; Gas Natural Fenosa
Location: Madrid, Spain
Website: www.priceproject.es/en
Contact: Mariano Gaudó Navarro, mgaudo@gasnatural.com, González Sainz-Maza, rgonzalezsm@iberdrola.es

Project setting

This initiative covers different areas to meet the needs identified for the development of a smart grid within a framework of efficiency, security and sustainability. In order to develop it, the PRICE project is based on the following sub-projects:

- PRICE-RED: Monitoring and Automation,
- PRICE-GEN: Energy Management,
- PRICE-GDI: Distributed Generation,
- PRICE-GDE: Demand Management.

Vision

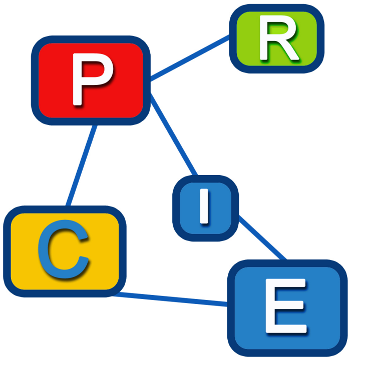
PRICE (Joint Project of Intelligent Networks in the Henares Corridor) an initiative aiming to give an answer to the technological challenges worldwide in the next generation of electrical systems.

Some of the most important challenges to be faced in the forthcoming years are the aging of systems and electrical infrastructure, the growth in demand for energy supply, the increasing presence of renewable energy sources, the integration of electric vehicles (EV) in the network and the need to improve the security of energy supply and reduce dependence on non-renewable energy sources.

In addition, PRICE will be an important milestone not only for the energy sector regarding national and European level, but also will be an opportunity for internationalization, as is clear from market growth experienced in recent years in USA, China, Australia, and emerging countries. Overall worldwide market growth is expected to reach 171,4 billion $ at the end of this project, compared with 69.3 billion $ in 2009.

Consortium

The PRICE project will be carried out by 21 partners, among which there are suppliers of industrial and information technology, research centres and universities, as well as Red Eléctrica Española (REE), the TSO (Transmission System Operator) of the Spanish electricity system.



Project Areas

This initiative covers several areas in order to meet the needs identified for the development of a smart grid within a framework of efficiency, security and sustainability. In order to develop it, the PRICE project is based on the following sub-projects:

PRICE-RED: Monitoring and Automation, aims to create an international reference in the development of a unique solution for monitoring and automation of transformation centers since there are related systems only at the substation level but not in medium voltage. PRICE RED will develop an interoperable platform to promote synergies between electric utilities and manufacturers so as to be easily exportable and adaptable to international energy networks.

PRICE-GEN: Energy Management, will focus on topics related to smart grid energy management through the development of an optimal and interoperable network architecture, taking into account the changing needs of the intelligent network and the implementation of the architecture by developing new smart metering equipment to provide accurate information of the consumption and generation of customers, as well as information of the energy grid.

PRICE-GDI: Distributed Generation, will focus on finding solutions that enable successful integration into the electricity network of distributed energy resources. Distributed generation is increasingly present in the distribution network. Moreover, the distributed renewable generation is growing because of the initiatives for combating climate change and sustainability promoted by the actual energy policies. Due to the design of the actual power grids, the system is not ready for an electric scenario with an large presence of renewable generation due to the characteristics of this kind of electric generation that would not allow a proper operation of the network.

PRICE-GDE: Demand Management, aims to develop a consumption monitoring system for customer use to enable the implementation of the Intelligent Management of the electric demand. The main objective is to obtain a more responsible and efficient use by end users. Therefore, proper communication between the system operator, distributors and retailers for intelligent action on end consumer demand is one of the main challenges of this project.

SMART GRID Gotland

Key facts

Project coordinator:	Vattenfall
Duration:	2013 – 2016
Location:	Gotland, Sweden
Website:	www.smartgridgotland.com
Contact:	Håkan Gustavsson, hakan.gustavsson@vattenfall.com
Budget:	25 Meuro approx. 4.5 MEUR funded by the Swedish Energy Agency

Project setting

One of the smartest electricity network in the world is currently under development on the island of Gotland in Sweden by the local energy company GEAB, together with Vattenfall, ABB, Swedish Energy Agency, Swedish national grid, Schneider Electric and KTH. By using modern technology, large quantities of renewable energy sources can be integrated in the grid. This is being done with improved cost efficiency and preserved quality compared to conventional grid technology.

Project topics

The project Smart Grid Gotland has three overall objectives:

- Cost efficiently increase the hosting capacity for wind power in an existing distribution system.
- Show that novel technology can improve the power quality in a rural grid with large quantities of installed wind power.
- Create possibilities for demand side participation in the electricity market, in order to shift load from peak load hours to peak production hours.

The three objectives have been translated to five measurable objectives:

- Increase the hosting capacity of wind power from 195MW with 5 MW by use of load shift.
- 20% reduction of SAIDI (System Average Interruption Duration Index), in the grid between substations in Källunge and Bäcks.
- Active participation of 30 industrial companies.
- Attract 2000 households to participate in a market test under market driven conditions.
- Active customer will contribute to a load shift of +/- 10%.

A reference group has been put together for the Smart Grid Gotland project; the reference group consists of representatives from a number of governmental agencies and interest groups. The idea with the reference group is twofold: it ensures that the business community and society in general is kept informed about project activities, and it also acts in an advisory role so that the project can benefit from the reference group's knowledge and experience.

Source: http://www.smartgridgotland.com/eng/about.pab

Project results

In order to improve and concretize the private customer offer sub project market test has performed meetings with customer target groups in Gotland. In the middle of February almost a thousand persons had expressed their interest of participating in the market test which is planned to start in October 2013.

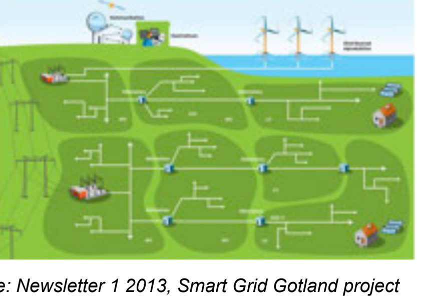
The market test is also carrying out around twenty energy audits in different companies in Gotland. The audits are performed in order to analyze the companies and identify energy efficiency potential and companies that have possibility to control their processes and shift load.

The smart meters have been ordered but due to delivery delays the installation of the meters have been postponed. Almost 3000 meters will be installed in the area between Källunge and Bäcks in Gotland and the installation is planned to start in May with approximate 200 meters. The remaining meters will be installed after the summer. The smart meters will measure electricity consumption but will also be used for surveillance of the grid and provide GEAB with power quality information.

In sub project Smart substations and rural grid an installation of a photo voltaic test bed is included. The test bed will for instance be used to study:

- Photo voltaic (PV) production in the existing rural grid.
- Different power capacity for the PV system.
- Combination of single and three phase PV.

At the moment negotiations regarding the technical solution are taking place and building permits for the test bed is planned to be submitted beginning of April 2013.



Source: Newsletter 1 2013, Smart Grid Gotland project

SMART GRID HYLLIE

Key facts

Project coordinator: Malmö stad
Duration: 01/2012 – 12/2015
Location: Malmö, Sweden
Website: www.hyllie.com
Contact: Per-Arne Nilsson, per-arne.nilsson@malmo.se

Budget: 21 MEuro, approx. 5.6 MEuro funded by the Swedish Energy Agency

Project setting

Malmö's largest development area, Hyllie, will be used as an international reference project for future sustainable solutions with the application of smart technologies where a number of technologies and solutions will be applied first. The project will show the way to Malmö's future as a sustainable city based on recycling, self-sufficiency, energy conservation and the use of renewable energy. The design of a sustainable energy supply will look beyond the boundaries of Hyllie and consider all types of energy needed at the consumer side, including industrial processes, electricity supply, heating and cooling of buildings, infrastructure services (water supply, lighting, etc.) and energy for mobility.

Project topics

Hyllie is a new, sustainable city district in the city of Malmö. The project involves the whole energy system: electricity, heating, cooling and transport. Different infrastructures will be coordinated, such as waste, water and waste water. The energy that is being used will come from renewable resources, or from recycling such as biogas for transportation. There will be local microproduction. The end user will be very active as balancing power for electricity and district heating, as producer of heating and electricity, and for energy efficiency.

Source: *www.hyllie.com/artikelarkiv/hyllie-testing-ground-for-new-technology.aspx*

SMART GRID Stockholm Royal Seaport

Key facts

Project coordinator	Fortum
Duration:	Started in 2012
Website:	www.stockholmroyalseaport.com/en/srs
Location:	Stockholm, Sweden
Website:	www.stockholmroyalseaport.com/en/srs
Contact:	Johan, Ander, johan.ander@fortum.com
Budget:	20 MEUR, approx. 3.5 MEUR funded by the Swedish Energy Agency

Project setting

Stockholm Royal Seaport is a large-scale smart grid project where a former brownfield industrial site is being transformed into a state-of-the art waterfront area with a high-tech smart grid component for the new urban district includes development of 10 000 new apartments and 30 000 new work spaces. Smart grid functions to be implemented and tested from 2012 onwards include, for instance, demand response, grid automation, integrations of small-scale renewables and distributed storage. The demonstration project will increase knowledge about optimisation, control, maintenance, market concepts and regulation of future smart grids in urban areas and the project will implement a smart grid supporting and demonstrating climate mitigation in city areas.

Project topics

Key objectives:

- Develop a world class sustainable city district,
- Reduce CO_2 emissions to a level below 1.5 tonnes per inhabitant by 2020,
- Become fossil fuel free by 2030,
- Adapt to climate change.

Focus areas:

- Efficient energy use,
- Environmentally efficient transports,
- Local ecocycles,
- Environmental life styles,
- Regulatory framework.

Smart Grid scope:

- Automated intelligent urban distribution grid,
- Demand Response Management,
- Integration of renewable energy,
- Integration of electric vehicles,
- Energy storage,
- Electrification of harbour – Ship to shore,
- House and building automation.

Source: http://new.abb.com/smartgrids/projects/stockholm-royal-seaport

Project goals

Among others, residents of Stockholm Royal Seaport will be able to:

- ✓ Produce their own electricity from solar panels installed on the rooftops. The smart grid also makes it possible to store electricity in local storage units, or feed it back into the grid – for either own consumption or sale. The goal is for the properties to produce 30 percent of their electricity locally using solar power, wind power or by utilizing surplus energy in various ways.
- ✓ Influence how they use electricity and adapt their energy consumption (e.g. use of washing machines and dishwashers) to times of day when there is an ample supply of less expensive, green electricity.
- ✓ Charge electric cars at their own charging stations. The smart grid adapts charging to periods during the day when the price of electricity is low and there is low environmental impact. Furthermore, it could be possible in the future for electric car batteries to provide an effective power reserve for the city district in the same manner as permanent energy storage units.

The FlexLast Project

Key facts

Project coordinator: IBM Schweiz Ltd
Duration: 05/2012 – 12/2013
Location: Neuendorf, Switzerland
Website: www.zurich.ibm.com/flexlast/
Contact: Norbert Ender, norbert.ender@ch.ibm.com

Project setting

How can energy from renewable sources be integrated in large quantities into the power supply without overwhelming the grid?

A collaboration between BKW, the electric utility in the Canton of Bern, IBM, Migros, Switzerland's largest retailer and supermarket chain, and Swissgrid, the national grid operator created a unique solution that applies advanced algorithms to data on the state of the grid and large freezer warehouses to optimize and manage the consumption of power for cooling to help balance the grid.

Project approach

The question for the network operator and energy provider is twofold. First, how can demand for electricity be met when power from renewable sources is unavailable or scarce? Second, what can be done with excess power from these sources when they supply more than is needed? One solution is to create a buffer between power suppliers and consumers to help keep power flowing when supply is low and absorb power when it is high. Many possible solutions exist for achieving this, including Storage, Flexible production and Demand Response.

One especially promising form of industrial demand response is to use the significant energy storage available in industrial refrigeration warehouses as a buffer for renewable energy production. Advanced algorithms use logistics planning information and warehouse temperature-sensor data, along with near-real-time energy data from the grid operator, to help optimize the balance between energy production and consumption for cooling. Simply put, when the sun shines and the wind blows, renewable energy powers the cooling units in the warehouse. When renewable energy is not available, the units will run less or shut down until cooling is required. Optimization benefits both the warehouse owner, who maintains the required temperature range while profiting from participating in the demand response scheme, and the grid operator and energy producers through improved balancing.

Within the project, an IT-prototype to control and optimize the cooling equipment has been realized, the potential and constraints to achieve secondary control power has been analysed in a field trial; in a complementary study the transfer of these results to the Swiss energy market has been evaluated.

Conclusions

It has been shown, that secondary control power with industrial loads can be principally achieved, yet not with the studied cooling equipment alone. Barriers to entry are relatively high, yet can be overcome by pooling industrial loads with different characteristics and additional supporting measures. The project report states related recommendations.

From a business case point of view pooling industrial loads in order to participate in balancing power markets can be beneficial compared to investing in new power plants. However this will only be successful if balancing pools of sufficient size can be achieved. Pools of 50 MW and above have the best chance to gain a bigger market share in balancing power markets since TSOs have an intrinsic interest in filling up their balancing power requirements from a small number of sources. Therefore, even if the winning bids are assigned in order of merit, it is unlikely that the complete balancing power need can be filled by minimum bids of 5 MW. Larger pools, therefore, have the chance to be accepted at higher prices than minimum pools.

Swiss2Grid: Algorithm based load management

Key facts

Project coordinator:	SUPSI
Duration:	01/2010 – 05/2014
Location:	Mendrisio, Switzerland
Website:	www.s2g.ch
Contact:	Roman Rudel, roman.rudel@supsi.ch
Further Swiss SG information:	Smart Grids

Project setting

✓ Focus on 5 areas of application:

- household appliance controllers with decentralized intelligence;
- simulation of different communication and tariff scenarios;
- mobile and stationary storage systems;
- load shifting on the principle household appliances;
- grid measurements and simulation on different levels (up-scaling).

Vision

The future electrical grid has to integrate more and more decentralized energy generation and accumulation such as photovoltaics, wind and electrical cars with batteries. The increase of intermitting energy generation arises new challenges to the grid management. This project develops an innovative approach to the decentralized management of a smart grid, exploiting the capabilities of swarm intelligence in smart meters in a pilot study.

The project aims to demonstrate the balance between an increasing amount of intermitting energy form renewables and demand, while shifting peak loads, and reducing future investments in grid infrastructures.

The project

The overall goal of the project is to investigate in a pilot project the technical feasibility of decentralized electric energy production, storage and consumption by combining available and new technologies in an intelligent and self-organizing system.

The project analyzes the practical use of small energy production units in about 20 smart private households, main loads in a household, plug-ins for storage and environmentally friendly mobility linked to the grid. This is the basic (infra-) structure of the project. This infrastructure allows to define the system parameters and to simulate the behaviour of the users and their impact on the grid on different scales of the technology diffusion.

The basic idea of the project is to optimize the control of the grid by an algorithm based on decentralized decision making with limited knowledge in an environment with selected information in the single nodes and to understand their impact on the grid, simulated by a conventional approach. The present project wants to show, to which extend the need of two-way communication systems capable to manage the smart grids can be reduced and the problems related to the elaboration of huge quantities of information overcome.

This represents an innovative approach of the grid management based on intelligent devices with self – optimization capabilities at the level of each node (household). This leads to a decentralization of the decision processes on when to consume, store or produce energy and represents a promising option to the common management approaches for smart grids.

Source: www.s2g.ch

Major findings

The intelligent measuring devices developed by SUPSI host the S2G algorithm and are distributed on the grid.

Decentralized decision making algorithms, only exploiting information available locally, can shift household loads in order to optimize multiple objectives at once, namely energy costs for the user, and flattening of aggregate loads at the transformer.

Results of the grid measurements show a significant correlation between local voltage values at household plugs and electrical loads at LV transformers. The impact of photovoltaic generation on the local voltages was also measured. This represent s an useful piece of information for optimizing loads, which limits the need for an explicit two-way communication infrastructure.

The voltage measurement can be achieved with very simple electronic circuits allowing the realization of cost-effective solutions.

Algorithms can be configured by the system designer in order to handle in a meaningful and predictable way the cases in which such objectives are conflicting.

Moreover, even when explicit coordination through communication is desired, very limited communication infrastructures are sufficient.

Results of the grid simulation with the S2G algorithm based voltage values are promising and show increasing grid stability with the growing penetration of households and intelligent measuring devices equipped with the S2G algorithms.

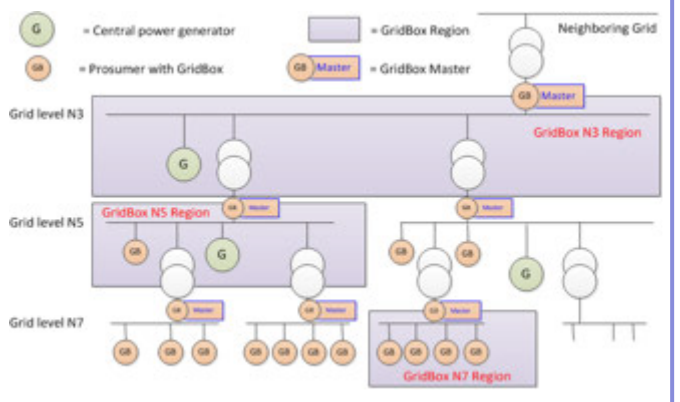
Additional simulation results warn against the risks of very volatile energy pricing schemes, in case cost-optimizing algorithms are controlling a large fraction of the total load enhancing instead of shaving peaks.

Work is ongoing on the investigation of the effect of the algorithm to higher grid levels, the evaluation of impact on present grid control processes and strategies and the development of tariffs scenarios suitable for a decentralized algorithm.

GridBox – Open real-time distribution grid control system

Key facts

Project coordinator: Supercomputing Systems AG
Duration: 09/2011 – 03/2016
Demonstration Location: City of Zürich and rural part of canton Bern, Switzerland
Contact: Stephan Moser, stephan.moser@scs.ch



Project setting

- ✓ Holistic smart grid concept
- ✓ One city and one rural demonstration region on MV / LV grid levels
- ✓ Focus on the following aspects:
  - Grid stability by high accuracy measurement and real-time control
  - Secure real-time integration of renewable energy infeeds, battery and prosumer household storage connected to distribution grids
  - Flexible management of energy storage devices
  - Business cases in future energy grids

Vision

The future massive infeed of distributed generation mainly through renewable electricity production puts new demands on the distribution grids. Specifically, the highly volatile electricity supply by local photovoltaic power plants can adversely affect the voltage quality and the flows in the grid. To meet the new challenges requires innovative solutions.

GridBox proposes a novel grid management system which provides solutions to the new energy system requirements for handling the growing infeed of distributed electricity generators (PV, wind, CHP, biomass), the increased flexibility of active electricity consumption and the use of distributed storage. The distribution grids will be exposed to different power loading levels and daily usage patterns, voltages will vary a lot and will not decrease towards the end of the radial segments as in the past. GridBox provides a strongly coordinated, distributed, low cost solution for guaranteeing a secure operation of the distribution grid while at the same time allowing (local) market participation also for prosumers, i.e. consumers with their own electricity generation and storage. GridBox is adaptable and open to new grid technology and business models.

At the core of the GridBox concept is a highly distributed network of real-time measurement devices. All nodes within this network communicate real-time grid status information in a hierarchical manner. The grid state is continuously measured and modeled, so that appropriate control of relevant parameters is possible. The GridBox platform aims at integration any type of power generation, consumer, storage and intelligent building technology and offers a flexible framework for grid optimizing algorithms.

Key elements

Distributed communicating sensor-/actor nodes connected to the distribution grid

The GridBox as the basic element of the concept is the measuring point for the network status as well as to influence the interface for the operation and the stability of relevant actors and parameters. Thus the GridBox as the local physical presence of the grid management system is implemented both at strategic points in the distribution network (grid levels MV - LV) as well as directly with the electricity producers and consumers. A communication network between the individual nodes (grid boxes) allows the expansion of a limited local view towards a complete system picture and an integrated, strongly coordinated approach to the regulation and control of the grid state.

Real-time measurement and model-based detection of grid state

The information gathered from the distributed grid is imported into a model of the physical power system to determine the complete system state of a grid section. This enables the detection of erroneous measurements and allows the determination of critical grid model parameters at non-measurable locations.

Monitoring and control of power producers and consumers

On the basis of stability criteria and the computed model state, grid bottlenecks and hot spots are determined in real time. Based on these insights, flexible grid users are controlled in such a way that a secure grid state can be maintained at any time.

Robustness due to principle of locality

The calculation of the system state and the rationale needed for effective controls are contained in the grid boxes connected to the grid. This basic functionality is therefore not dependent on a central monitoring and control infrastructure. This allows for maximum autonomy and independence of each power supply and keeps the communication reaction times short.

By monitoring and controlling local information the controllability of data security is increased and the complexity and processing of data is decreased. In particular, the localization of the prosumer control (Demand Response) reduces the overall optimization problem to a region as a manageable sub-problem.

Open Platform for SmartGrids applications

The GridBox system provides a vendor-independent standard. The grid operators can use the open design and specification documents and the reference implementation to develop either own devices or integrate GridBox functionality into existing (software) products. GridBox conformance tests gurarantee compatibility and interoperability. Open interfaces allow extensions and an easy integration of third-party systems.

TÜDOSİS Project – Feeder Automation System

Key facts

Project coordinator: TÜBİTAK Marmara Research Center Energy Institute

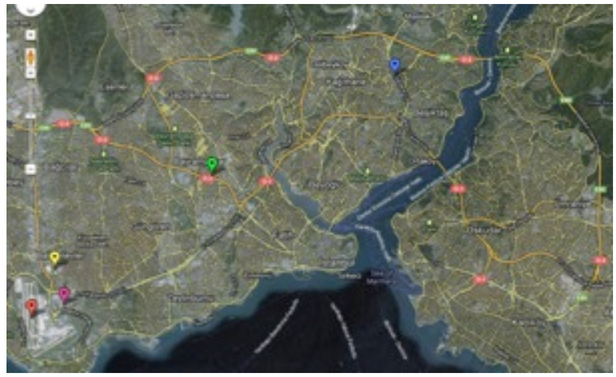
Duration: 1996 - 2006

Location: İstanbul

Project Client: Bogazici Electricity Distribution Company (BEDAS)

Contact: Abdullah Nadar, abdullah.nadar@tubitak.gov.tr

Pilot Implementation Regions



Project setting

Feeder Automation for Istanbul European Side MV Distribution System - Background:

Uprating to the single MV (34.5 kV) level in big cities:

- ✓ Less MV/MV transformer substations,
- ✓ Less MV feeders,
- ✓ Easy and practical operation of the network,
- ✓ Requires a Distribution Automation System (DAS) for substations and MV feeders.

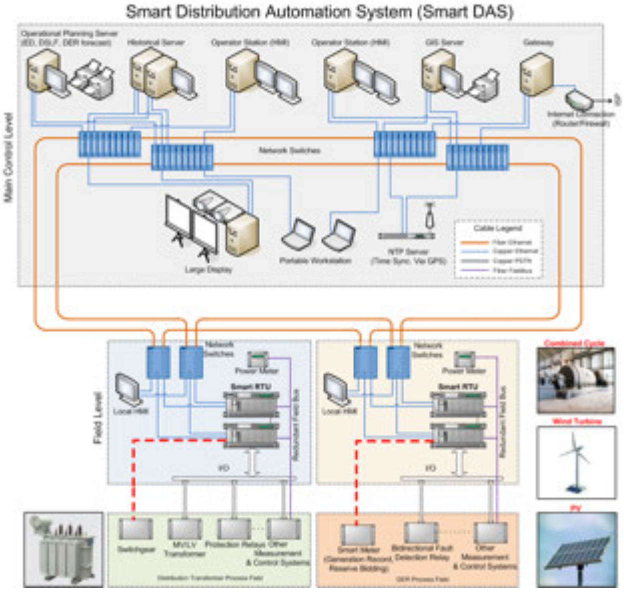
Major achievements

Functions of TÜDOSİS

- Monitoring and Data Acquisition,
- Remote Control,
- Automatic Fault Detection, Isolation and Service Restoration.

Deliverables

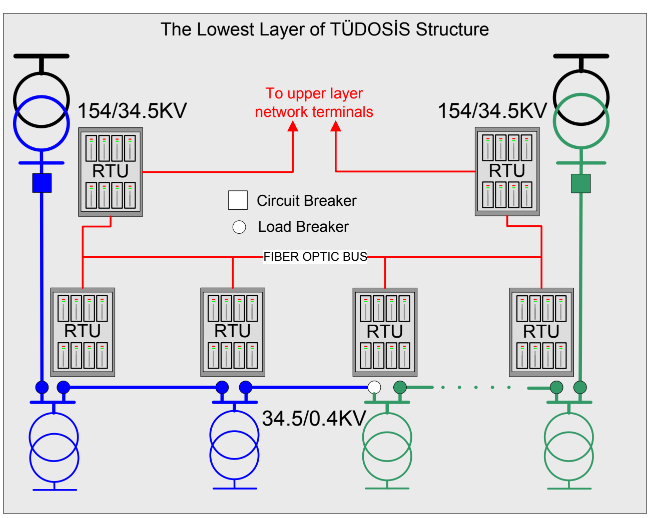
- A MV Transformer Center Equipped with TUDOSIS,
- Remote Terminal Units (RTU) of TÜDOSİS:
  - ✓ DTTU (Distribution Transformer Terminal Unit): used in Distribution Stations,
  - ✓ LETU (Line End Terminal Unit): used in Switching Stations,
  - ✓ STU (Substation Terminal Unit): Substation's remote terminal units,
  - ✓ CCTU (Control Centre Terminal Unit): used in Control Centre.



Goals

- ✓ Minimize the duration of electricity cut off due to problems in MV feeders,
- ✓ Improve operational performance through centralized monitoring and control,
- ✓ Prevent equipment breakdown and prolong system lifetime.

Structure of the TÜDOSİS



Wind Power Monitoring and Forecasting System of Turkey

Key facts

Project coordinator: TUBITAK Marmara Research Center Energy Institute
Duration: 2010 – 2013
Location: Turkey
Website: http://www.ritm.gov.tr/
Contact: Erman Terciyanlı
erman.terciyanli@tubitak.gov.tr

About

Monitoring and Forecasting System Development for Wind Generated Electrical Power in Turkey

Purpose:

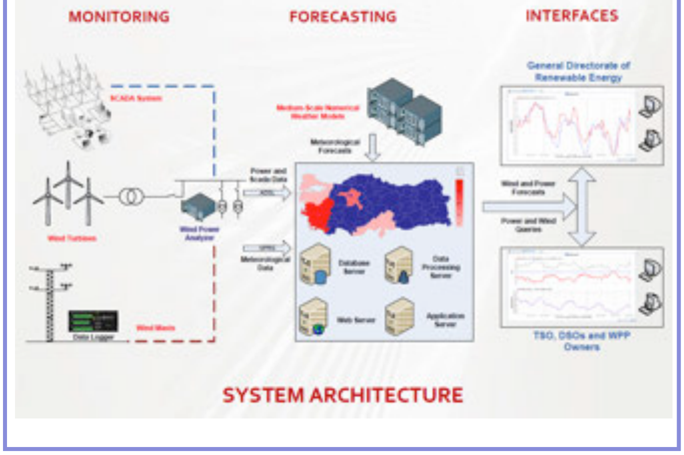
With this project, it is aimed to provide large-scale integration of Wind Power Plants(WPPs) to Turkey Electricity System.
In this context, a wind power system monitoring and forecasting system will be developed and disseminated throughout Turkey.

Activities

Technical Content and Components : In the project,which is designed for the generation of a large-scale electricity from wind resource and determination of the necessary measures for the integration of wind power plants (WPPs) with electrical systems, monitoring and forecasting system basically consists of five sub-system.

- ✓ WPP Measurement Sub-System,
- ✓ Wind Forecast Sub-System,
- ✓ Forecast Subsystem of Electrical Power That Will Be Produced, From The Wind,
- ✓ Monitoring and Prediction Center Sub-System,
- ✓ User Sub-System.

Structure of the RITM



Major achievements

- ✓ A secure and reliable system located at General Directorate of Renewable Energy under The Ministry of Energy and Natural Resources.
- ✓ Data Storage
  - Wind data from wind masts,
  - Power data from monitoring equipment,
  - Turbine status data from SCADA,
  - Mesoscale forecasts.
- ✓ Data processing and forecasting.
- ✓ Providing requested data through the client softwares.

WPPs which are included in the Monitoring and Prediction System in the first stage:

	Plant Name	Location	Installed Capacity (MW)
1	Aliağa RES	İzmir Aliağa	90
2	Ayyıldız RES	Balıkesir Bandırma	15
3	Bandırma RES	Balıkesir Bandırma	60
4	Bandırma 2 RES	Balıkesir Bandırma	30
5	Belen RES	Belen Hatay	36
6	Bores	Çanakkale Bozcaada	10,2
7	Burgaz RES	Çanakkale Gelibolu	14,9
8	Mare Manastır	İzmir Çeşme	39,2
9	Rotor RES	Osmaniye Bahçe	135
10	Soma RES	Manisa Soma	116,1
			TOTAL: 546.4 MW

GREDOR

Key facts

Project coordinator:	University of Liège
Duration:	01/2013 – 012/2016
Location:	Wallonia, Belgium
Website:	http://gredor.be/
Contact:	Prof Damien Ernst, dernst@ulg.ac.be
Further info:	http://energie.wallonie.be/

Project setting

- ✓ 1 Engineering company (Tractebel Engineering), 1 TSO (Elia), 2 DSO (ORES and Tecteo RESA), 2 Universities (Mons and Liège), 1 Producer (EDF Luminus),
- ✓ Partially financed by "Service Public de Wallonie".

Vision

In Wallonia, Belgium, the political willingness to increase the capacity of renewable generation, the evolution of the consumption pattern (for example electrical vehicles), and the changes in the electricity markets sector will raise several challenges in distribution systems in a near future. Without re-thinking the system, issues such as congestion, under and over voltage, and renewable power curtailment are likely to appear more often than today. In addition to investing in costly physical devices, one of the key aspects is to accommodate the variability of the renewable energy sources by some demand flexibility or by some storage, which are both currently almost inexistent. The GREDOR project will aim at addressing those challenges.

Some other projects in Wallonia

PROJECT	KEY QUESTION
FLEXIPAC	Using the weather forecast, managing the use of the heat pumps and using the storage of heat or cold in order to increase flexibility.
PREMASOL	Using the monitoring of many already installed PV pannels to help managing the low voltage grids.

Major tasks

Task 1: Build models

Define the relationships between the stakeholders of the holistic electric ecosystem – and how they should interact technically and financially to achieve the societal objectives, fostering demand and decentralized generation flexibility on one hand and ensuring compatibility with scenarios to be considered for the evolution of the electric ecosystem from now until 2050, on the other hand.

Task 2: Improve the network

Long-term planning of distribution grids will be significantly impacted by the increased development of decentralized renewable generation and possible new electricity uses. The classical fit-and-forget investment approach may proof not to be the economic optimum as compared to new planning strategies considering new control and flexibility sources (demand side management, automatic network control,...). Task 2 aims at providing a tool for supporting investment decisions in this context in order to derive new optimum planning strategies. The link with the control approach developed for the operational planning (Task 3) will be considered. Scenarios defined in Task 1 will be used as input.

Task 3: Predict and plan

Planning the operation of a distribution network one day or a few days ahead is mandatory if one wants to hedge against uncertain events in the network at the lowest cost. Planning means deciding in advance when and how to use the flexibility and storage means, so that it is always possible to balance consumption and generation. Furthermore, operational planning must be coordinated with Task 4.

Task 4: Real Time control

Task 4 deals with the real-time operation of distribution systems hosting a significant amount of renewable energy sources. Real-time monitoring and control is the last resort to protect the system against unscheduled events. This involves:

- estimating the current operating conditions from the available real-time measurements, complemented by pseudo-measurements. This, in turn, will lead to identifying the optimal reinforcement of the measurement configuration;
- anticipating the near-future (short-term) evolution of the system, with due attention paid to variable renewable energy input;
- controlling distributed generation units, flexible loads, load tap changers, energy storage, or shunt capacitors in a smooth and coordinated manner in order to automatically correct (thermal) congestions and voltages outside limits.

Task 5: Tools testing

A sufficiently rich set of test systems is needed to assess the aforementioned developments. A DSO will collect technical data regarding distribution network material as well as provide the detailed layout of MV network structure. Besides information related to MV energy flows will be gathered and processed by statistic analysis. Finally, two DSO will point out consistent test networks in order to assess the tools developed in the other tasks.

Task 6: Continuous evaluation

The validation of the full process will be done by applying scenarios built in task 1 to the overall decision system elaborated in tasks 2, 3 and 4. The results will be compared with nowadays solutions. This task is a continuous process performed all along the project, beginning with qualitative aspect and evolving step by step to a quantitative evaluation.

Transnational Demo Snapshots

INFRA-PLAN

Infrastructure planning and hybrid energy networks in urban model quarters

Key facts

Project coordinator: ENERGY RESEARCH AUSTRIA
Duration: 05/2013 – 04/2015
Locations: Berlin, Graz, Hamburg (Austria, Germany)
Website: www.infra-plan.eu

Contact: Robert Hinterberger
Robert.Hinterberger@energyresearch.at

Project setting

- ✓ BERLIN Adlershof, GRAZ Mitte and HAMBURG Wilhelmsburg are amongst the most innovative urban quarter energy projects in Europe.
- ✓ Strategic planning processes for energy infrastructures have been set up in the context of the optimization of city-wide infrastructures.
- ✓ A transnational exchange of experiences regarding hybrid energy networks and systems have been initiated and innovative R&D- and demonstration projects prepared.

Vision

The vision of the transnational project INFRA-PLAN is the development of an integrated hybrid smart grid approach in urban model quarters.

Conflicting interests between model quarter and city-wide infrastructure planning are constantly occurring. The same happens between the operators of the different infrastructures (power, natural gas, district heating, municipal systems).

Thus, one main focus of INFRA-PLAN is to identify such **conflicting interest** as well as **possible synergies**, in particular in the context of future hybrid networks and systems.

The project results will be directly used for strategic decision making regarding the implementation of smart grid solutions and for **avoiding "stranded costs"** related to capital-intensive investments.

Furthermore, this transnational project establishes the basis for a consortium with strategic potential to enable the participation in the European SET-Plan Initiative and other future European support mechanisms.

Selected projects

PROJECT	CONTENT AND CHALLENGES
INFRA-PLAN	Identifying synergies and conflicting interests between different infrastructures (power, heat, gas, municipal systems) and planning levels (city quarter, whole city, regional) as well as developing further demonstration projects.
High Tech-Low Ex	Bundle of projects and measures in Berlin Adlershof for reducing the use of primary energy by minus 30% till 2020. Technologies employed including smart power and heating networks, electricity storage and innovative ICT systems.
Smart City Graz	Smart City lighthouse project in the 2nd biggest city in Austria. Technologies employed including innovative building technologies, interactions between different energy supply grids and mobility services.
IBA Hamburg	Bundle of more than 50 energy-related projects. One example is the energy bunker. With an solar casting and a CHP plant and 2000 m3 heat storage inside, this local power plant is supplying the whole neighbourhood with electricity and heat.

Source: Wista Management, Marcus Pernthaler, IBA Hamburg/Martin Kunze

Demonstration sites

Berlin Adlershof is the biggest and most successful high-tech park in the city of Berlin (450 hectares with 16 scientific institutes, around 1000 businesses and 21.000 people working, living or studying). www.adlershof.de

Graz Mitte is a large-scale demonstration project and currently the only Smart Cities lighthouse project in Austria. A consortium of 14 partners is working to realize a completely new urban quarter. The whole project area is 400 ha. http://www.stadtentwicklung.graz.at/cms/beitrag/10191841/4631044/

In **Hamburg Wilhelmsburg** more than 50 energy-related projects have been developed in the framework of the IBA Hamburg Building Exhibition. Nearly 40 private investors have invested more than 700 Mio. € at several demonstration sites. www.iba-hamburg.de

Conclusions

Smart Grid concepts are applicable not only to the electrical power system, but also to **natural gas** and **district heating networks**.

Nevertheless, as main difference to electrical power, natural gas or heat can be **stored easily** at **moderate costs**. At the long run, huge amounts of excess renewable electricity could be stored in underground gas storage even for months or years by using Power-To-Gas technologies.

In a short-term perspective, **Power-To-Heat** could be even much more important by using the surplus of electricity from renewable energy sources in district heat networks. From the technical side, the necessary technologies are simple (e.g. electrode boilers). Thus, the integration of P2H technologies would be a quick and **cost effective solution** for the **integration of the surplus of renewable electricity** that cannot be used otherwise.

Apart from this **functional storage of electricity**, there is a multitude of other possibilities for connecting electricity, natural gas and heating networks to generate technical and **economic synergies** and added value. In particular, synergies could be achieved by linking these networks with municipal infrastructure. Thus, water and wastewater infrastructures, transport systems and other municipal infrastructures could be integrated in future hybrid networks, in addition to electricity, natural gas and heating networks.

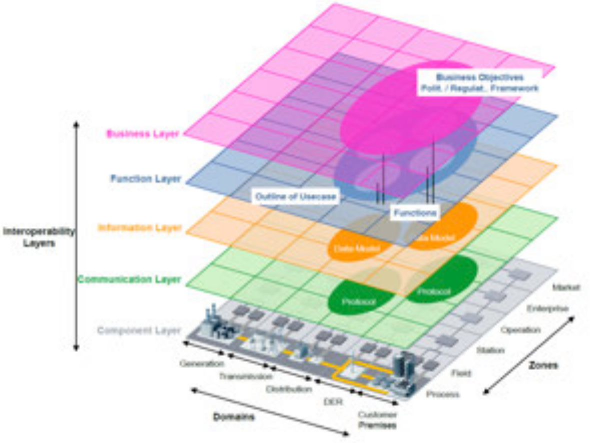
INTEGRA

Key facts

Project coordinator: Salzburg AG
Duration: 2013 – 2015
Location: Province of Salzburg, Austria
Website: www.smartgridssalzburg.at
Contact: Robert Priewasser
robert.priewasser@salzburgnetz.at
Austrian SG programme: e!MISSION

Project setting

- ✓ INTEGRA explores how influential a safe and stable system operation in the presence of a large number of mutually interdependent and smart grid services can be organized taking into account the European energy markets. Against the background of different frameworks of policy and regulation it is necessary to reconcile the requirements of various markets with local network conditions.
- ✓ Results will be available as a largely standardized Smart Grid Reference Architecture and a "unifying" instance, the "Flexibility operator". Thus, a concrete basis for the necessary discussions and next steps set up and strengthened the strategic positioning of Austria at the European level.



Source: Smart Grid Architecture Model (SGAM) M/490

Project topics

- ✓ INTEGRA addresses a central issue in the implementation of smart grid approaches: How safe and can stable operation of intelligent medium and low voltage networks be organized, taking into account a variety influencing of mutual and interdependent smart grid services and at least the actual regulations of European Energy markets?
- ✓ Objective is to prepare the target system of the Smart Grid Model Region Salzburg (SGMS), and to guarantee a homogeneous and efficient operation of the power system (market AND network requirements) on the basis of a single Smart Grid Reference Architecture. INTEGRA develops an internationally visible Smart Grid Reference Architecture, which allows us to bring the requirements of the common European market and the nationally authorized, individual schemes in the market system in line, considering a special focus security and privacy policies by design. To ensure a transnational cooperation (cooperation D-A-CH), a German sister project (In2VPP) is planned.
- ✓ Another goal of INTEGRA is the "missing link" in the form of a toolbox (eg, interfaces, soft-ware modules, ...), to develop the relationships between the different smart grid applications and to provide them for market. With it the integrated application of smart grid functionality will be enabled, as soon as the relevant applications are feasible from an economic perspective. Technically, the project will define and develop among other things a Flexibility Operator (FO) which also will be tested as a proof of concept in SGMS. Thus, organizational and technical interaction of the grid and market-specific processes of the smart grid is made possible.
- ✓ The findings of this project and the transnational cooperation will strengthen the strategic position of Austria in standardization bodies and in the debate at European level in the treated subjects. Clear recommendations for policy and regulation as well as for the standardiza-tion work are derived

Expected results

As the project is not finished yet, final conclusions on the main research questions are not available yet. There are however a number of expected results which are as follows:

- Smart Grid reference architecture for the Smart Grid Model Region of Salzburg,
- Proof of concept for active and coordinate distribution grid operation in low and medium voltage grid areas,
- Proof of concepts of a Virtual Power Plant consisting of Smart Buildings and E-Mobility,
- Proof of concept of a Flexibility Operator,
- Basis for Austrian energy and infrastructure related policies.

Flexible Electric Vehicle Charging Infrastructure

Key facts

Project coordinator:	Bernt A. Bremdal
Duration:	02/2014 – 02/2016
Location:	Aalborg University, Denmark University of Zagreb, Croatia Narvik University, Norway
Contact:	Bernt A. Bremdal, bernt@xalience.com

Project setting

- ✓ International project with 3 main partners (Aalborg University, University of Zagreb and Narvik University):
- ✓ Focus on 6 areas of research:
  - Integration of **energy storage system** in distribution grids as a vital part of smart charging station (CS),
  - Finding **optimal storage technology and capacity,**
  - Control design of charging stations to allow wide usage of **electric vehicles,**
  - Mitigating the impact on power system and **providing reserve** to the system operator,
  - Assembly of **reduced scale experimental test bench** to verify the simultaneous operation,
  - **Coordination concept** for the proposed flexible electric vehicle charging infrastructure.

Vision

The vision of the Flexible Electric Vehicle Charging Infrastructure project is the development of an integrated concept of smart charging stations.

In this project, a new concept for flexible electric vehicles charging stations will be developed using emerging technologies and control methods deployed in distributed generation systems and microgrids.

To that end, a novel distributed coordination strategy between the grid and dedicated energy storage systems converters will be implemented, providing seamless expandability and robustness of the system.

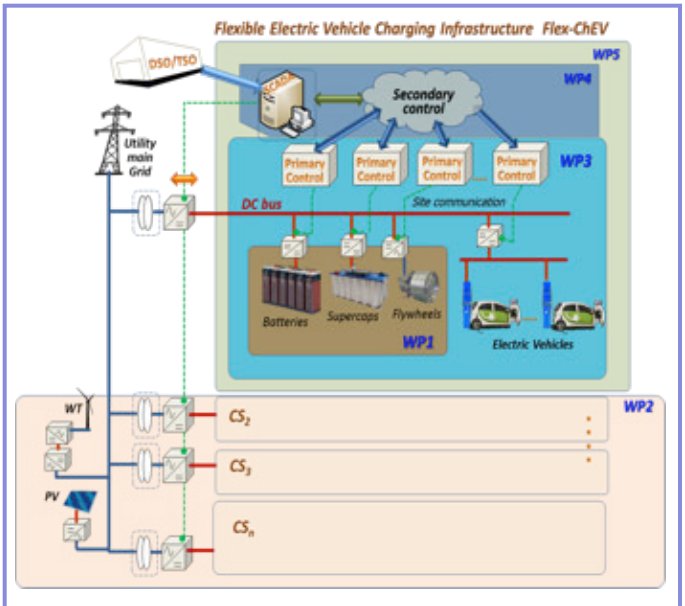
Theoretical analysis of grid performance indicators in the case of high HEV penetration will be conducted. Dynamic system model of fast hybrid electric vehicles charging station based on different energy storage systems technologies will be developed.

Real time simulation study and assessment of operation will be conducted on a laboratory experimental rig on reduced scale model located in Denmark, Aalborg University.

Finally, conceptualization of ancillary management service to balance charging needs with grid/market demands will be done.

Project elements and key concepts

KEYWORD	KEY QUESTION
CS2G – Charging Station to Grid	It will explore the possibility of using a dedicated energy storage system (ESS) within the charging station (SC) to alleviate grid and market conditions but not compromise the electric vehicles's (EV) battery charging algorithms or change daily routine of the EV owner.
Flex-ChEV	What are the key components of the efficient control algorithm of a flexible electric vehicle charging infrastrucutre? **Field test on a small scale laboratory concept.**



Project summary

Hybrod electric vehicles chargers are expected to play a significant role in the total consumption of developed countries across the world. Besides, there is a global tendency to make power systems independent of fossil fuels by **additional increase in the shares of renewable energy resources**.

Both of these effects tend to push the future power systems more and more towards the **boundaries of safe operation**. Today's commercially available HEV chargers are not flexible and present significant disturbance sources for the grid. On the other hand, flexible chargers proposed in academic literature introduce several drawbacks mostly concerned with compromising the comfort level of vehicle owners and rapid degradation of HEV's batteries. Therefore, preservation of power systems secure operation will require new interventions to increase the flexibility of HEV chargers in a cost-effective way.

Proposed project is focused on theoretical development and experimental verification of a new generation of fast **HEV charging stations (CSs)**. Its principal functionality is to use **dedicated energy storage system** within the station to compensate the adverse effects caused by charging, as seen from the grid. Flexible fast CS will be an essential part of the future intelligent power systems as projected by the smart grid concept.

There is also the question involving **the relationship between the cost and benefit of an application** of different energy storage technologies. Therefore, ageing models and assesment of various technologies baesd on rain-flow approach will be done.

Based on the areas of application and the findings across the applications, open questions concerning **further development of energy storage technologies, control methods for charging stations infrastructure** and **development of a business model** will be analysed.

The international consortium brings together leading research institutions and industrial companies from native countries of involved partners. Final experimental tests for developed control strategies will be carried after the results from the partners are consolidated into a system oriented integral platform. Verifications will be done in the intelligent **MicroGrid laboratory**, a world-class experimental facility at Aalborg University.

IN2VPP

Key facts

Project coordinator:	Siemens AG
Duration:	05/2013 – 04/2016
Location:	Fürth, Germany
Website:	www.in2vpp.de
Contact:	Dr.-Ing. Jörg Heuer Embedded Networks www.siemens.com
Budget:	3,2 MEuro, approx. 2 MEuro funded by the German Federal Environment Ministry (BMU)

Project setting

- Project partners are Siemens AG, Office e.V., infra Fürth GmbH and the technical university of Munich.
- R&D project focussing on the interaction between Virtual Power Plants (VPP) and grid operation. Includes field tests and verification by associated member in Austria (INTEGRA).

Project topics

- ✓ In2VPP addresses the question of how a VPP based on renewables can work economically, as well as sustainable on the technical side, while using the regional grid infrastructure.
- ✓ Field tests are planned with three different steps:
  - Independent operation of VPP and grid.
  - Operation of VPP and grid as a regional microgrid.
  - Managed operation of inter-regional VPPs and regional grid distributers.

Unique project features

The focus of In2VPP lies in the interaction between VPP and grid operation. In2VPP is based on results gained by previous projects, i.e. NetzQ, RegModHarz and OpenNode.

Generalised solutions are going to be verified by an associated partner in Austria within the project INTEGRA.

Relevance

Technology and software developed, as well as knowledge gained by this project will help the industry partners to strengthen their market share. Within the university, publications, lectures and probably future jobs can be expected.

Furthermore, international standardisations will be beneficial for the general public, as the number of VPPs is going to increase with the increasing amount of renewables in the energy mixture.

Main findings

- New and generalised systematic solutions in the interaction between VPP and grids.
- Development of an action toolbox for coupling of regional operating distribution grids and interregional VPPs.
- The project is still in an early phase. Notable results are yet to come.

Smart transmission grid operation and control

Key facts

Project coordinator: NTNU, Norway
Duration: 2011 – 2015
Location: Nordic countries
Project size: 24 mill NOK (3 M€), Nordic funding 17 M NOK (2,1 M€)
Website: http://www.nordicenergy.org/project/smart-transmission-grid-operation-and-control/
Project leader: Professor Kjetil Uhlen, kjetil.uhlen@ntnu.no

Project goals

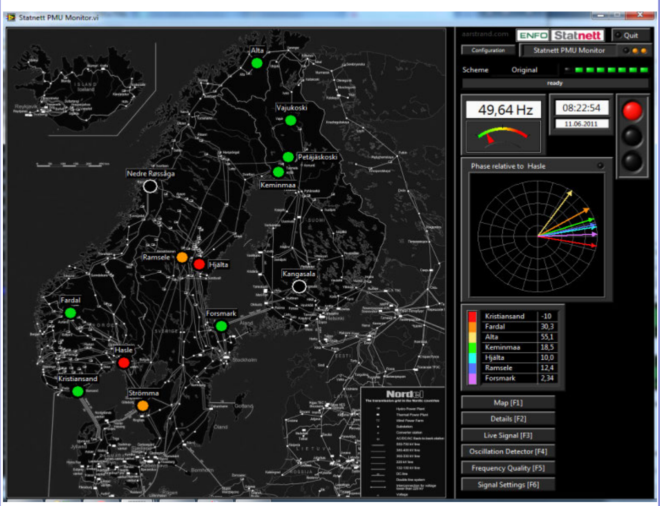
Address the challenges that the secure and reliable operation of the power grids will face in the future.

Develop a solid interdisciplinary theoretical foundation supporting development of better tools for planning, operation and control of power grids interconnected across traditional national boundaries and at various voltage levels.

Establish Nordic leadership in this area.

Innovate in power distribution monitoring and control, addressing the challenges and requirements brought forward by Smartgrid developments.

Provide Nordic added value by developing a common technical platform that fully utilises the different competences in power engineering and ICT engineering, and addresses common operation and control challenges in power transmission.



STRONgrid

Smart Transmission Grids Operation and Control

KTH - NTNU - AALTO - DTU - UI

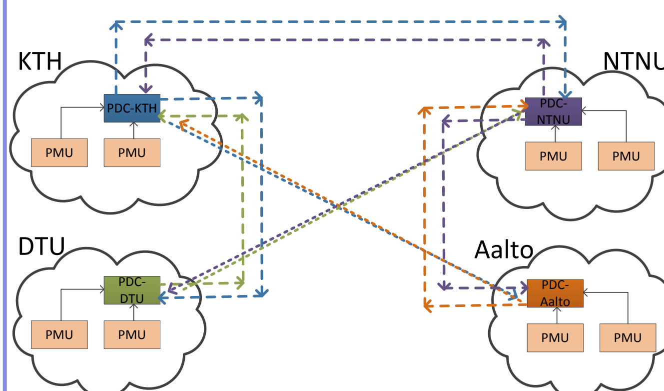
Vision

This project seeks to develop better tools for addressing the increasing need to move electricity across national borders. More interconnected electricity grids in both the Nordic region and Europe are seen as an important facilitator of more sustainable energy systems, and international cooperation is critical in achieving this vision.

Results

In addition to scientific work and publishing, the project has developed a common research platform comprised by a power systems emulator (software and hardware labs), PMUs, PDCs and specialized software interfaces allowing PMU-data application development, and implementation.

This is used to develop innovative applications that will enable operation and control of the Nordic power grid more reliably and with better information about security margins. One example is an app for ipad og phone: wide-area visualization tool based on the LabView environment, which is shown on the picure below.



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