Smart grids

Network "Communities of a sustainable Europe" (CoSE)

International network of RURAL villages and URBAN neighborhoods for bottom-up approach

For more information, see: http://communities-of-sustainable.eu/

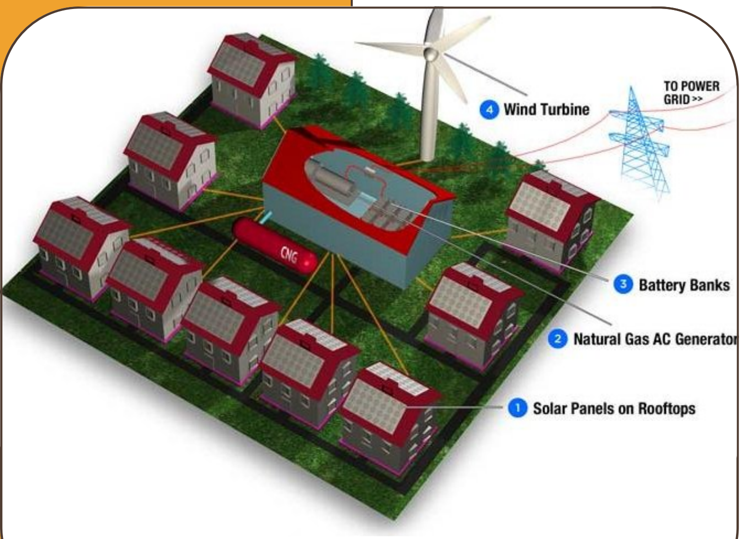
Smart grids

- True communal energy network
- Connecting all local energy initiatives
- Opportunities for transparency in energy usage
- High tech system that will require specific knowledge

Smart grids, what is it?

Traditionally, energy is generated at centralised production facilities and distributed through a network, called the grid, towards consumers who use the energy. In other words, energy flows in just one direction. Currently, this traditional vision on energy production and consumption is shifting since conventional consumers of energy are starting to generate and consume their own energy. In practice owners of a local (renewable) energy production installation will not always directly consume their generated energy. Surpluses are transported to the grid, which means that energy has to flow into two directions. This is often referred to as bidirectional energy flows. A smart grid differs from a regular grid through its ability to monitor, manage and predict these (bidirectional) energy flows. A smart grid collects information on the behaviour and actions of the various connected parties to ensure that energy demand and supply are well balanced and energy is efficiently used.

It should be noticed that there is no common definition of a smart grid. Where some advocate that a smart grid should encompasses only those activities related with the grid operations and the supporting communication infrastructure, others support a more inclusive view in which additional valuable services such as smart meters or renewable energy installations are included as well.



Smart grid lay out

Technical aspects (preconditions / opportunities)

Smart grids have some distinct features and opportunities that set them apart from the conventional grid.

An important characteristic of a smart grid is its ability to communicate with all connected parties. Besides handling bidirectional flows of energy, a smart grid should also handle bidirectional flows of information among appliances. In terms of energy flows, the production and consumption of energy is not always evenly balanced. Therefore, during peak times when energy demand is exceeding energy supply, smart grids can reduce demand through communicating and informing appliances in households and business to turn off or delay their activities. Alternatively, smart grids can inform appliances to turn on when supply is exceeding demand. As a consequence of its communicative capability:

- Smart grids assist in alleviating high peaks of energy demand near-instantaneously balancing supply and demand.
- Smart grids also assists in preventing systems overloads since utility companies can control consumption by communicating directly to household or business appliances.
- Smart grids can also significantly increase energy efficiency. In terms of demand side management, the overall effect is greater utilisation of generated energy.

Compared to the conventional grid, smart grids are more flexible since they are able to handle bidirectional energy and information flows. This is an important precondition that allows the large-scale deployment of decentralised generation, which includes various renewable energy technologies as well as the charging to and from the batteries of electric cars.

Fluctuations in energy production are inherent to several mainstream renewable energy technologies, due to changing conditions such as cloudy weather or inconsistent wind speeds. These fluctuations cause difficulties regarding secure and stable power levels within conventional grids. Fluctuations also remain a challenge for smart grids, however it has the ability to predict, manage and ultimately handle fluctuations related to renewable sources and therefore constitutes a necessary condition for large-scale deployment of renewable energy technologies.

Due to the possibility to integrate various smart grid applications such as renewable resources, demand side management and electric storage, increases the reliability of the grid. In light of this it is emphasized that an ideal mix of diverse smart grid applications will lead to a flatter net demand.

Scale

No relevant data or information on European level available.

Benefits for the community

Costs

Costs associated with the implementation of smart grids are hard to estimate and can differ widely. The following aspects make it difficult to estimate the costs:

- Information and communication technology rapidly becomes obsolete. Increasingly complex technologies enhance the chance of smart grid components to become obsolete well before the end of their life span. Therefore, reasonable replacement costs should be estimated.
- The investment cost for smart grid components has the potential to decrease rapidly as soon as the technology matures and production volumes increase.

- Despite the many advantages of smart grid technologies, they are relatively new and unproven. In case their performance is marginal or degrades unexpectedly over time, the entire business plan for the technology could be undermined.

Revenues (economic and ecological)

The presence of a smart grid will provide various benefits. However, not all stakeholders will equally gain from a smart grid, but for a smart grid to be successful and accepted, all stakeholders should benefit to varying degrees.

- End users might benefit through more reliable service, the ability to access real-time information on energy production and consumption with the option to control their energy use and thus their energy bill.
- Utilities can provide more reliable energy, particularly during challenging emergency conditions, while managing their costs more effectively through improvements in efficiency.
- Society at large will benefit in the first place by the improved ease of implementing renewable energy technologies in their homes, business or community buildings. This indirectly effects our dependency on fossil fuels and reduces emissions, which in turn positively affects the environment and public health. Furthermore, society gains from more reliable energy delivery, greater energy efficiency and the opportunity to create an industry that requires new jobs necessary for the design, construction, operation and maintenance of smart grids.

Social aspects (cohesion)

It is clear that smart grids provide several benefits for end-users, utilities and society at large. Nevertheless, these benefits might come at the cost of exposing the parties connected to the grid to new challenges, in particular in the field of security of communication networks and information systems. Where on the one hand information and communication technologies are the backbone of a smart grid, an increasing dependency on information technologies that collect and communicate data on our behaviour is more vulnerable to be exploited for financial or political motivations on the other hand. Furthermore there is a great deal of concern that as the grid becomes smarter and more interactive, disruptions that challenge the reliability of energy supply will become easier.

Where has it been implemented?

Examples CoSE communities

In the communities of Strem, Austria, and Beckerich, Luxemburg, a heat grid is in place for certain areas.

Success and Fail Factors for implementation

Several important aspects should be considered in order to guarantee a more successful implementation of the smart grid:

- Stakeholders should have a common definition of the smart grid concept and its applications.
- Improving end-user awareness of the concept and possibilities of a smart grid, which will enhance acceptance.
- The roll-out of smart meters for which end-user acceptance is vital
- Guaranteeing privacy of the connected parties. Especially in terms of cyber security regarding data on personal behaviour.

How to get started?

European legislation

The European Commission (EC) sets a target of 20 per cent renewables within the EU by 2020. Renewables include wind, solar, hydroelectric and tidal power as well as geothermal energy and biomass. Increasing the share of renewables in the EU will contribute in cutting down greenhouse emissions and make it less dependent on imported energy. To reach this ambitious goal the EC has presented the 2009 Renewable Energy Directive.

Besides setting a target, the Directive also improves the legal framework for promoting renewable electricity, requires national action plans that establish pathways for the development of renewable energy sources including bioenergy, creates cooperation mechanisms to help achieve the targets cost effectively and establishes the sustainability criteria for biofuels.

Each Member State has a national target, which differs between them. Annex I of the 2009 Renewable Energy Directive shows the various national targets. An annual report on the progress of each Member State is presented on the website of the EC. These reports include various aspects such as the current share of renewables, updates on national legislation, all support measures taken, system of guarantees of origin, administrative procedures and many other relevant national measures. Under further reading a link to the national reports can be found.

Aside from general European legislation, the EC provides recommendations concerning data protection and security issues and addresses common minimum functionalities of smart metering systems since smart meters collect and exchange data regarding the production and consumption of end users. Furthermore, the 2009 Directive on the internal markets encourages Member States to deploy smart grids and smart metering systems.

Local knowledge (CoSE partners)

None of the CoSE partner communities has a smart grid yet. The community of Ashton Hayes (United Kingdom) has a midterm goal to develop a smart grid.

Finding partners (co-funding)

The community of Ashton Hayes, United Kingdom, is working on a plan to develop a smart grid based on its current and planned renewable energy sources. The grid will probably be developed based on private investment.

Building a strategy and plan

During the transition a smart grid, numerous challenges will appear. When engaging in this process it is advocated to consider the following challenges:

- The transition towards a smart grid will take time. Consequentially, the transition should be gradual and support long coexistence of conventional and smart technologies. However, during this transition unnecessary expenses and decreases in reliability, safety, or cyber security should be avoided.
- Although not every person or business will participate directly in the development of a smart grid, all stakeholders need to invest significant efforts to understand and address the requirements and benefits related to a smart grid.
- Smart grids are complex systems in which some aspects are sensitive to human response and interaction, while others need instantaneous, intelligent and automated responses. Moreover, diverse forces ranging from financial pressures to environmental requirements drive their development.

- Since communication and information technologies that exchange and store data on individual behaviour is a crucial aspect of a smart grid, every aspect of it must be secure. Besides cyber security technologies and compliance with standards policies, this also requires on-going risk assessment and training.
- The information and communication technologies must be robust in order to handle future applications without being replaced and accommodate future media while preserving a secure system.

Further reading

- European legislation
  - Homepage: http://ec.europa.eu/energy/renewables/targets_en.htm
  - Progress reports: http://ec.europa.eu/energy/renewables/electricity_en.htm
  - 2009 Renewable Energy Directive: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:01:EN:HTML
  - 2009 Directive concerning common rules for the internal market in electricity: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0055:0093:EN:PDF
  - Summary of legislations: http://europa.eu/legislation_summaries/energy/index_en.htm
  - European recommendations on smart grids: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:073:0009:0022:EN:PDF
  - European recommendations on smart meter functionalities: http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/2011_10_smart_meter_funtionalities_report_full.pdf
- Several initiatives in Europe focus on the dissemination and sharing of results, lessons learned and best practices concerning smart grids:
  - JCR Smart Grid project repository: http://ses.jrc.ec.europa.eu and http://ses.jrc.ec.europa.eu/sites/ses/files/documents/guidelines_for_conducting_a_cost-benefit_analysis_of_smart_grid_projects.pdf
  - Smart Grid dissemination platform: http://www.smartgridsprojects.eu
- Enisa – European Network and Information Security Agency:
  - http://www.enisa.europa.eu
  - http://www.enisa.europa.eu/activities/Resilience-and-CIIP/critical-infrastructure-and-services/smart-grids-and-smart-metering/ENISA-smart-grid-security-recommendations
- IEEE – Smart grids:
  - http://smartgrid.ieee.org
  - http://smartgrid.ieee.org/ieee-smart-grid/smart-grid-conceptual-model
- Electrical Power Research Institute (EPRI)
  - http://ipu.msu.edu/programs/MIGrid2011/presentations/pdfs/Reference%20Material%20-%20Estimating%20the%20Costs%20and%20Benefits%20of%20the%20Smart%20Grid.pdf

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An initiative of the communities of:
Ashton Hayes (village in Cheshire-West, United Kingdom)
Beckerich (municipality-village in Luxemburg
Betlejem (quarter of Reda, near Gdansk, in Poland
Böcs and Bükkaranyos (municipality-villages in Bükk-Mak-Miskolc-Region, Hungary)
De Stoere Houtman (quarter of Arnhem, the Netherlands)
Measolle (village in France)
Ommerkanaal (village of Overijssel, the Netherlands)
Strem (municipality-village in Öko-Energie-Bürgerland, Austria)

Other communities invited into the network:
Blacon (quarter of Chester, United Kingdom
Feldheim (invited, village of Treuenbrietzen, Germany)
Frankenwald (invited, village near Hof, Germany)
Jühnde (invited, independent village in Germany)
Schönau (Schwarzwald, Germany)
Vauban (quarter of Freiburg, Germany)

For more information, see: http://communities-of-sustainable.eu/

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