Description of integrated pilots/demonstrations/field tests/existing practices

1. Name of the case

   Integral Resource Optimization Network - Study
   A robust, distributed control network for optimizing the resource “electrical energy”. Consumers, producers and storages network in a self-organized way and coordinate autonomously their usage of electrical energy. Load-shaping, transparent flow of information, system-wide increase in efficiency
   Integral Resource Optimisation Network - Concept
   An integral control network for optimizing the resource "electrical energy". Concept for new, innovative services for the power market based on the latest advances in the field of modern information- and communication technologies.

2. What is integrated with DSM

DG	☐
Energy storage	☐
Smart grid technologies	x

3. What is the level of commercialization

Research project	x
Demonstration	☐
Field test	☐
Existing practice	☐

4. Where to find more information?
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   - references
     http://www.ironstudy.org

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5. Objectives of the case

   IRON Study

   IRON (Integral Resource Optimization Network) Study is a research study about the coordination of decentralized energy resources (DERs). Recent developments, within our energy system, show a tendency towards more decentralization, which leads to a number of implications. On one hand, a decentralized infrastructure can offer more reliability and a better support for the integration of renewable energy sources. On the other hand, the distribution grid must handle a bi-directional flow of energy; grid features like power quality can be decreased but also increased by decentralized energy resources.

   What is needed is an appropriate coordination of the members of such a decentralized energy system. The IRON system will offer a platform that networks an arbitrary number of DERs. This IT network goes way beyond the traditional control networks of the energy system. Depending on whether it is economically reasonable one can integrate every aspect of the energy system, down to the individual end consuming device. Good scalability and low costs are the two key factors.

   IRON Concept

   With the aimed at infrastructure, every customer can take up a more active role than today. The diversified, great amount of controllable loads can help to reduce congestion in the distribution network by operating the grid in a concerted way. A great amount of so far only passive and statistically accounted users are becoming a plannable and strategically usable factor. Flexible loads can be coupled with decentral, stochastic generation and local synchronization can be achieved. Suppliers can reduce their purchases of expensive peak-load at whole sale markets and instead of this, offer their customers new energy products and services.

   The project transfers the IRON idea to a market compatible concept. Even if the underlying strategy is one for years to come, the IRON system shall be capable of optimizing parts of the energy system in a profitable way already now – and it shall be capable of growing without problems. This stage of the project also involves the first steps towards a field trial, which shall deliver valuable information and experience for the broad implementation of the system.

6. Business rationale/model

   Similar solutions available on the market do not satisfy these requirements which make it partly necessary to develop new technology in order to fill the white spots. New developments shall be largely based on open standards.
   The IRON system is conceptually neutral; it can be used for a multitude of emerging services, e.g. the synchronization of local energy generation and consumption, real-time pricing, global peak load management. The financial benefit generated by the distributed

optimization system can be shared between the provider of the system and the networked customers.

Within the first phase of the IRON project, the fundamental economical and technical requirements have been analyzed and the ideas of the project have been successfully installed in the relevant circles via intensive public relations activities. Cooperation partners for a follow-up project could be found easily

Scenarios for putting the system on the market

The study analyzes three scenarios concerning the question by which party the intended system should be initiated and operated:

- A private company which takes care for the installation, operation, maintenance and administration of the technical infrastructure and acts as an energy supplier with time-variable tariffs or prices.
- (Distribution) grid operators which use the load shedding mechanisms of the new infrastructure to actively manage the grid and to provide new services to their customers.
- The system will be embedded in national energy economic strategies (e.g. creation of a dedicated economic structure similar to the Austrian „Ökobilanzgruppe".)

Economic requirements for the new system

To get a detailed view of the current problems and trends of the (Austrian) power market several participants (customers of variable size, utility managers, energy suppliers, etc.) have been interviewed about their opinions concerning market tendencies in general and the IRON system in particular. Lurking problems have been discussed as well as short- and medium-term solutions for the energy system of the future.

A continuous increase in demand (more than the economic growth) and a reduction of available capacities is expected by all experts. Without taking counter measures, shortages in supply are unavoidable.

Efficient measures for shortage and emergency management are very important. So far, only the generation side and the grid are included into solutions, but not the demand side. Having to cope with increased levels of renewables and distributed generation, the management of the grid should become more flexible and active. The IRON system could make a valuable contribution to this goal, for example by introducing an infrastructure to automatically and locally match demand and supply. This would reduce the amount of reserve energy which is needed to compensate for stochastic suppliers like wind power stations.

Some suppliers are expecting relatively stable prices while others consider significantly higher price levels possible, especially when reaching the point where the life time of more and more existing utilities expires. Current prices correspond to short-term marginal costs which leave very little spare money for investments. For consumers, the relatively low and inflexible prices provide no incentive to think about their consumption behaviour. There is very little experience with demand response systems in Austria. Time-variable prices for flexible loads are mainly offered for big industries. Private homes are considered to be too small, although, put together, their influence of the load is significant. Ubiquitous demand side management systems like the IRON system have to be very simply installable (plug & work), unobtrusive and automated. As the expected savings per customer are relatively small, the optimization infrastructure has to be very low-cost, too.

However, there are not only costs, but also lots of benefits which can be achieved with the IRON System:

- Significantly more information and communication
- Automated load management down to the end users' appliances, peak load reduction
- Making use of demand side potentials for shortage and emergency management of the distribution grid, improved remote monitoring and diagnostics, new real-time markets, e-business systems and (ancillary) services
- Support of distributed resources – local demand/supply matching, higher levels of decentralized generation, increased use of combined heat and power (CHP) systems
- Increased capacity factors for utilities and the grid – higher productivity of existing structures, avoidance of investments in unprofitable new power stations, reduced capital costs
- A more efficient, clean, sustainable, diverse and therefore secure energy supply

Part of the benefits of the intended automation infrastructure originates in the fact that it creates an elastic demand curve. With elastic demand curves the customers have the possibility to react to price signals – and thus shortages in supply. This leads to a better balance of demand and supply which results in a more efficient system. This is getting more and more important concerning the lurking capacity shortages (Figure II) and their unpleasant influence on electricity prices (especially for peak load times).

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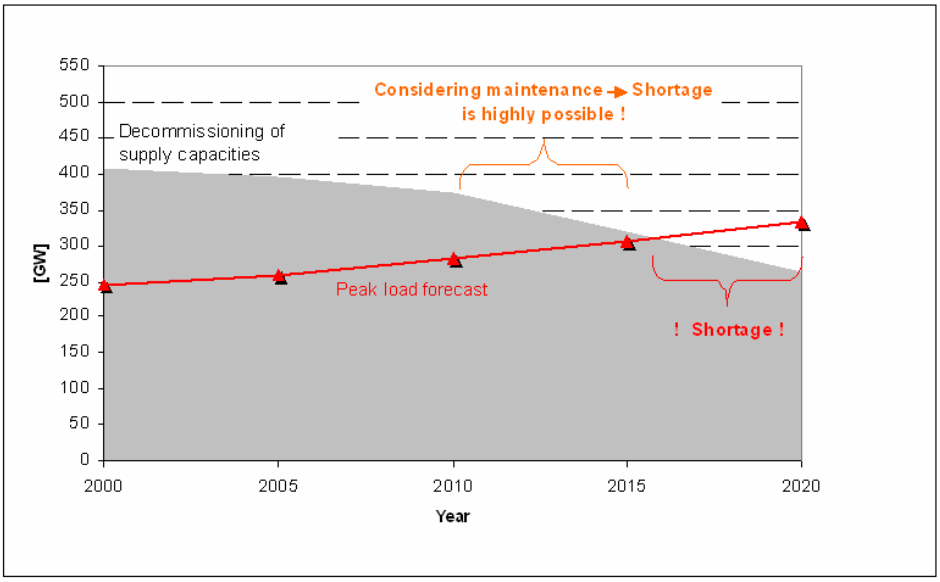

Figure 1: Decomissioning of capacitites and peak load forecast for the central European Energy market.

7. Technologies used

The basic tasks the new automation and optimization infrastructure will have to fulfill are:

- to acquire local data with embedded control modules (load data, supply data, grid status, weather conditions, etc.),
- to communicate relevant control information,
- to couple the new system to already existing control systems (interfaces to DSM systems, interruptible loads, grid management systems, etc.), and
- to provide algorithms and management tools (for optimization, cooperation, billing, etc.)

There are several technical requirements for the new IT infrastructure which are connected with IT-security, safety, robustness, scalability, flexibility, self-adaptation, fault tolerance, and network management. Concerning the fields of application for the IRON system, the following parties have been identified:

- small industries,
- big buildings,
- private homes,
- single-site stations (wind power stations, etc.).

The above mentioned entities represent the highest level of nodes in the IRON network (Figure III). Within these nodes (e.g. within a building) additional networks will be used to reach the sub-nodes (e.g. appliances) for communication purposes. Thus, the IRON network consists of a global and a local communication infrastructure (Figure 2: **Distribution of price signals to sub-nodes.**).

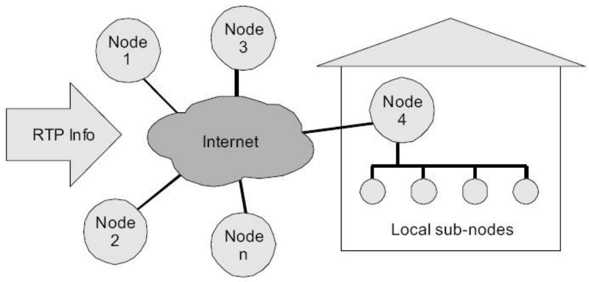

Figure 2: Distribution of price signals to sub-nodes.

For global communication the internet will be used. Other communication channels would be possible, but would, in general, lead to higher additional costs. The local network within the building or the plant, thus the communication infrastructure between the IRON nodes and sub-nodes like appliances or counters, is different for the various types of nodes (fields of application like small businesses or private homes).

Figure 3: IRON Box

The customers' appliances shall be locally equipped with an "IRON-Box", an embedded, intelligent control-module. Those modules collaborate with each other and with higher nodes, thereby exchanging information about available degrees of freedom concerning loads (local possibilities for shedding and storing loads). The exchanged information feeds optimization algorithms which coordinate the operation mode of the individual appliances. An intelligent, self-organizing "society" of loads and storages emerges. For the first time, so far unused optimization potential can be exploited. Incentives and goals for the optimization processes are taken from suppliers, distributors and energy markets.

Description of integrated pilots/demonstrations/field tests/existing practices

8. Short description of the case

   IRON Study

   For consumers, the relatively low and inflexible prices provide no incentive to think about their consumption behavior.

   The IRON system is a demand side management system with lots of benefits: significantly more information and communication, automated load management down to the end users' appliances, peak load reduction, making use of demand side potentials for shortage and emergency management of the distribution grid, improved remote monitoring and diagnostics, new real-time markets, e-business systems and (ancillary) services, support of distributed resources – local demand/supply matching, higher levels of decentralized generation, increased use of combined heat and power (CHP) systems, increased capacity factors for utilities and the grid – higher productivity of existing structures, avoidance of investments in unprofitable new power stations, reduced capital costs, a more efficient, clean, sustainable, diverse and therefore secure energy supply.

   IRON-Concept

   The goal of the project is the development of new services aimed at maximizing the efficiency of the usage of electrical energy. Those services are enabled by an information and communication platform based on the latest advances in network and information technology. Using components which are available – with the necessary performance at reasonable prices – for only a very short time, all relevant members of the energy system, like

   - energy sources (power plants, wind power stations, micro turbines, fuel cells, and similar)
   - consumers (machinery, devices, etc.)
   - and virtual energy storages (pumps, flexible loads, heating and cooling systems, etc.)
   -

   are networked. The focus hereby lies on the last two mentioned.

9. Achieved/expected results (operational savings, CO_2, efficiency enhancement)

   IRON Study

   The project partners hold that the suggested infrastructure will be basically valuable and useful. The direction of the development in the sector of energy and communication will go towards higher penetration of ICT.

   As target customers big office buildings, single-site plants (like wind power stations), private homes and small industries were identified. Large energy customers were not taken into account, since they often already have their own optimization system. The main technical requirements of the IRON system are as follows:

- different classes of end-nodes depending on the respective target customers (functional as well as in price – costs of less than EUR 100 are aimed at), short amortization times (2 years)
- easy – if possible automatic – installation, robust, zero-maintenance operation
- good scalability up to 100.000 nodes
- usage of Internet technology, field area networks and building automation technologies, coupling to existing control systems (DSM, interruptible loads, etc.)
- provision of add-on services like security, information or remote home

Similar solutions available on the market do not satisfy these requirements, which make it partly necessary to develop new technology in order to fill the white spots. New developments shall be largely based on open standards.

The IRON system is conceptually neutral; it can be used for a multitude of emerging services, e.g. the synchronization of local energy generation and consumption, real-time pricing, global peak load management. The financial benefit generated by the distributed optimization system can be shared between the provider of the system and the networked customers.

Within the first phase of the IRON project, the fundamental economical and technical requirements have been analyzed and the ideas of the project have been successfully installed in the relevant circles via intensive public relations activities. Cooperation partners for a follow-up project could be found easily.

IRON Concept

The results of the projects are:

- a service-portfolio
- a market model
- an infrastructure model,
- a first report concerning the necessary steps for a field trial.

Together, they form a concept which serves as a direct basis for the preparation of a field trial, which is planned for a follow-up project.

10. Lessons learnt