DR Technologies in Denmark

1. EFFLOCOM pilot: DR offered by households with direct electric heating

A. Brief Overview

The Danish pilot project, Demand Response offered by households with direct electric heating, sponsored by the Danish TSO Elkraft System and ELTRA is a part of the EU SAVE project EFFLOCOM. The utility SEAS helped with contact to and selection of customers plus contact an installation company. Results and conclusions from the pilot project are described below.
The main objective of this project was to find a segment of households where the relation between cost and benefits is attractive and develop, test and evaluate a product, which stimulates flexibility in consumption, with basis in an economical bonus (to be a part of a power price tariff) and implementation of IT in order to facilitate the customers acting and knowledge on their consumption. In this project we tried to follow the guide lines described in "Peak Load Management Alliance, Demand Response: Principles for regulatory guidance, Feb. 2002" with compensation based on price and actual reactions, to allow for individual preferences and possibility for the customer to override.

The pilot project was established in 2003 including 25 domestic homes with direct electrical heating with a consumption of more than 16.000 kWh/year in order to reach a successful economy (the average consumption for houses with electric heating is 11.000 kWh/year). 125,000 houses are heated by direct electric heating in Denmark. If one third of these were offering demand response it is estimated to give a demand response potential of around 200 MW.

Hourly metering and the potential of load control in peak hours give opportunity for new products from the supplier of electricity. Customer dynamics might reduce the risk of the supplier connected to periods with huge fluctuations in spot price. Hourly remote reading gives new possibility in the work of the grid companies.

B. Description of the DR technology

As shown in figure 1, enabling technologies include extra customer installations with control and remote reading by GRPS communication and customer services provided at the Internet.

An extra small electronic meter record and store the heating electricity consumption every quarter of an hour. The Amplight unit provides individual control of five zones/appliances with a relays for each zone.

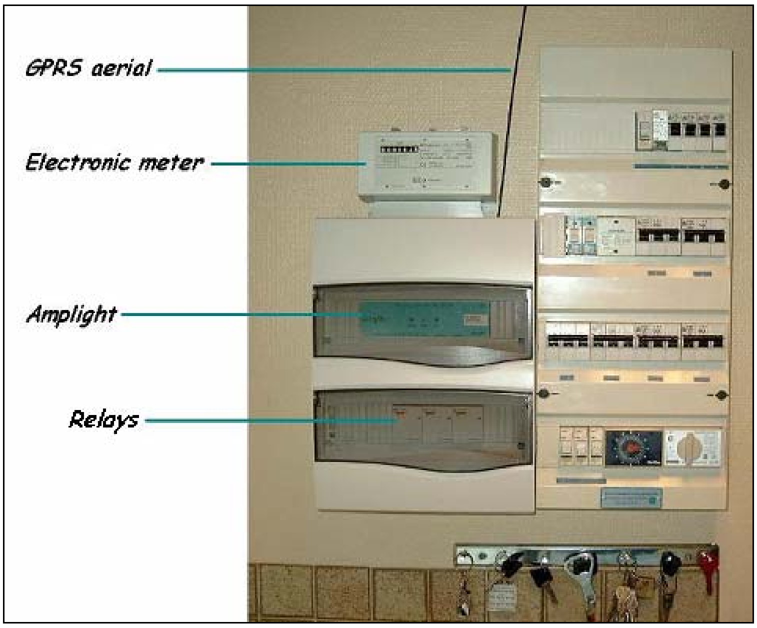

Figure 1 Household installation

The customer Web site includes:

- Access to setting the limits for the maximum duration of interruption for up to five different control zones for different time periods of the day.
- Access to stop an actual interruption for some of or all the control zones.
- A report on the daily, weekly and monthly use of electricity and the saved bonus by demand response control.

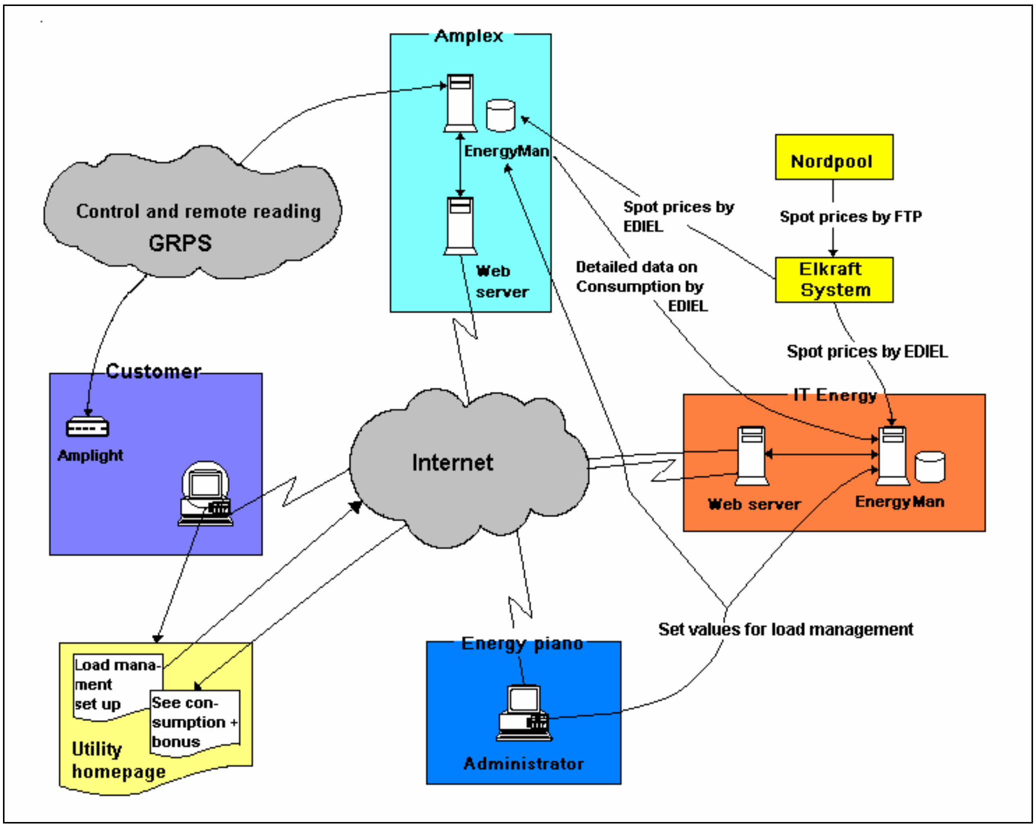

Figure 2 IT configuration in the Danish pilot project

The communication by the high-speed mobile phone net GPRS is wireless and nation-wide and does not assume any investments in infrastructure. The system might control groups of loads and include remote meter reading at different voltage levels in order to follow the influence of the demand response control and avoid return load higher than the grid and/or system can supply.

C Demand Response methodology

The Nordic Power Exchange Nord Pool settle the day before the hourly Elspot prices are settled based on power offers and expected demands given in by all producers and suppliers at the market. The EFFLOCOM system is designed for activation when the Nord Pool hourly Elspot prices exceed some specified price levels. Currently, a year contains around 10 hours with very high spot prices. In the pilot project is simulated a probable near future situation with an extended potential for demand response including 100 hours per year.

The highest 100 spot prices appear typically on working days and in the two time periods: 06-11 and 16-19 hours. This is thus the time when the interruptions have been made in the pilot project.

The communication by the high-speed mobile phone net GPRS is wireless and nation-wide and does not assume any investments in infrastructure. As shown in Figure 4, the system might control groups of loads and include remote meter reading at different voltage levels in order to follow the influence of the demand response control and avoid return load higher than the grid and/or system can supply.

In the project, the economical incentives for DR were higher than the actual level. This simulates a possible scenario within a few years. The customer load curves without control as well as the load just before interruption are used as reference to find the influence of demand response.

The bonus in the 100 hours of control varied between 0.13, 0.27 and 0.40 € /kWh (equal to 1, 2 and 3 DKK/kWh) for the electricity consumption interrupted in order to find the customer response depending on the size of the bonus.

Customer bonus by DR in the winter 2003/04 were in average 80 € /customer. The data analysis showed that only 41% of the interrupted consumption is used afterwards to bring the temperature back to the required level which gave the customer an average saving of 40 € /customer. The economical benefit were thus in total 80+40 = 120 € /year.

C. Cost of the system

The cost of equipment, software and installation is evaluated to be around 800 € for an installation in around 1000 houses. Assuming that 5 kW/house can be interrupted at cold days this is equal to an investment of 160 € /kW which is equal to 31 €/kW per year (10 years, 7%). If the interval meter and meter communication is already installed, the extra cost for relays, control system and installation might be reduced to around 25 € /kW per year.

As a comparison, the investment for gas turbines is around 80 € /kW, year (10 years, 7%). Customer saving/benefits are found to be around 120 € per year (see part 2.3).

D. Development of technology

Testing of the system has resulted in including more security in the system by:

- Start and stop of an interruption are communicated in the same message to all the controllable units.
- Repetition of sending messages.
- Automatic control every late evening that every controllable is switch on.
- Ensuring that the time of interruption and recording 15 min consumption is synchronized.

The next generation of the technology is intended to give access to management of every single heating unit and appliance which gives more customer flexibility and integration.

The system can also be developed to include more services:

- including the pilot as regulation power with a facility to see the real time load at an aggregated level for the houses
- customer possibilities for interruption and thereby lowering the temperature in the night and/or the middle of the day in order to save electricity. This will increase the customer value of the system and the customer may be willing to pay for this service.

E. Further Information

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2. NESA's Smart Read metering system

A. Brief Overview

The Danish Electric Utility NESA (550,000 customers) has developed a metering system called Smart Read, built on the dual band mobile phone technologies SMS/GPRS. The metering system is able to perform hourly or daily reading of electricity consumption and is the platform for development of new and better customer service.

Two hundred Smart Read meters are currently deployed for field test. During 2005 will be installed 20,000 units: 14,000 units for commercial customers, 5,000 residential customers with integrated alarm, and 1,000 selected customers. From 2006 and five years ahead, the plan is to install 110,000 metering systems annually, leading to a total of 550,000 installations during the next 5-6 years.

The vision for the direct improved service is to send a bill every month to every customer based on actual reading and thus avoiding future consumption estimation, automatic metering when the owner of a house is changing, visualising energy consumption for the customers and increased pay rate in order to increase the long-term income.

The Smart Read system will be able to provide other attractive services to the customers such as alarm systems, buying of electricity at spot prises, reduction of stand-by loads and load control for demand response. NESA sees the possibility of using the system for DR by installation of automatic DR at the 30,000 homes with direct electric heating in NESA's grid area.

B. Description of the DR technology

The goal is to include the following added services to the customers:

- Silent and simple alarms
- Remote control
- wireless local meters
- operated via customer cell phones
- DR cut off of load when the price is high

Figure 1 shows the wireless communication in the system.

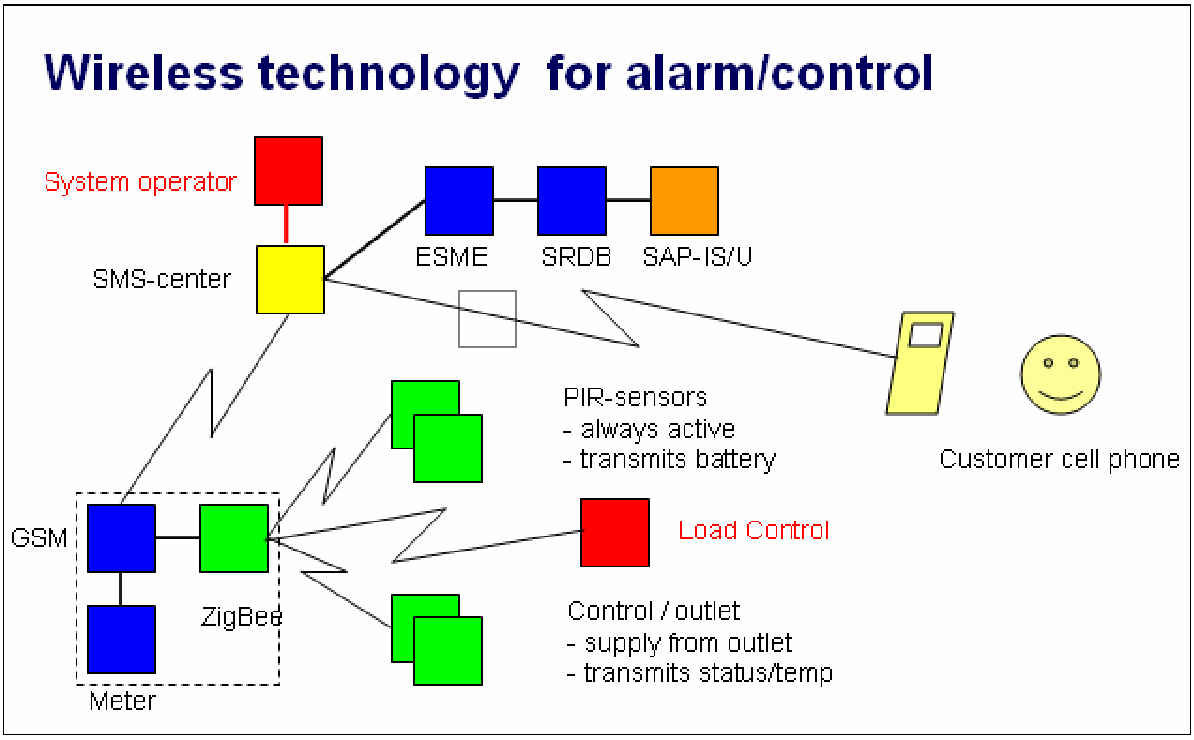

Figure 1 Wireless communication in the Smart Read System

Automatic meter reading will include metering of the consumption per day. This might be extended to consumption per hour when necessary.

DR control may take form by broadcast to all customers or individual control.

Control of loads (direct electric heating zones or radiator, water heater, dishwasher,) will be done by units in front of each appliance including a relay.

Customer set up of maximum duration of interruptions may be included in future versions of the system but is not available in the present version of the system.

The customer is able to block for interruption. All blockings will be logged and taking into consideration in the payment for DR.

The reduction in consumption during an interruption will be calculated based on meter readings at the start and stop of each interruption along with reference consumption at days without interruption.

The customer can be able to monitor and analyse real-time and historical usage on the condition secondary meters are installed to meter the DR consumptions of interest.

Concerning DR by electric heating, the reconnection of the load per consumption is intended to be executed on an individual basis by SMS communication at different time within a relatively large period in order to avoid new peaks at the time of reconnection.

C. Cost of the system

The installation cost of the metering system (without DR) is estimated to be about 270 €. Installation of a meter system that can accommodate the simplest form of DR costs around 400 €. The extra cost includes one contractor and use of software for control of one group/zone of appliances.

Running costs are estimated to be about 15 € per year including cost for communication and administration.

D Further information

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3. AMR system at Sydvest Energi

A. Brief Overview

4. RCOM - Use of Back-up Generation as Regulating Power

A. Brief Overview

In Denmark the use of backup generation (BUG) has been introduced as a part of a major DR activity. BUGs are a niche within DR, which holds a significant potential for power generation. The TSO in East Denmark Elkraft System has launched a project to utilise power from back-up generators. In one tender in 2004 Elkraft System received offers for 50 MW.

Elkraft System has signed 18 contracts covering 40 units and 32 MW including 29.7 MW back-up power (13 contracts) and 2.3 MW interruptible power (5 contracts). The typical owners of BUGs are hospitals, airports, computer centres, medical factories, phone companies and electric utilities. The typical size of the BUG is 0.5 MW.

In 2005 Elkraft System and Eltra merge to be one national TSO covering all Denmark.

B. Description of the DR technology

The project has resulted in the development of software solutions that aggregate the individual bids from the BUGs to a common bid. This bid is put into the Nordic market for regulation power (NOIS).

Through the software the BUGs can be activated using by two communication channels:

- voice mail
- GPRS-relay

If GPRS-relays are used, the BUG will start automatically on site when they are triggered from the control room at the TSO.

C Demand Response methodology

The preliminary results show that the use of BUGs as regulation power has advantages for both the owners of the units and the TSO. The owner experiences that the local security system can be maintained or even improved. At the same time the owner get an income payment of generally 27,000€ per MW per year in reservation costs and 0.15 €/kWh produced.

For the TSO new capacity is introduced to the market, thus improving competition and security of supply. It is expected that the typical operation time is 10 to 30 hours per year. The project revealed high introduction costs up to 27,000 € per unit because of the need of extra meters and synchronisation units.

D. Development

Emergency power is a fast resource with typical start up time from 10 seconds to 1 minute. At the same time the reservation cost is low compared to other investments, for example in gas turbines. Furthermore, it is a reliable resource because many independent units are activated.

Since the last tendering round, many other companies have shown a marked interest in participating in the project and Elkraft System states that a realistic goal is 75 MW regulating power from BUGs in 2010.

D. Further Information

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5. Aggregator offering back-up generation as Regulating Power

A. Brief Overview

In June 2004, the Western Danish TSO, Eltra entered a contract with the Norwegian company EffektPartner who offered to make contracts with customers with backup generation power to be used as operating reserve. Effektpartner offer through to Eltra's monthly tender for regulatory power.

In 2005 Elkraft System and Eltra merge to be one national TSO covering all Denmark.

B. Description of the DR technology and methodology

EffektPartner enter an agreement with the owners of the backup generation units and establish the communication infrastructure and offer the backup generation units into the market for regulatory power, where the resource through/via Eltra will be available to all the Nordic TSOs. The backup generation units will be activated, when the energy price in the market for regulatory power exceeds their operating costs (bids). The system will be automatic.

The infrastructure of communication by MPLS and/or GRPS will follows the standard conditions for suppliers of regulatory power. This includes a maximum reaction time of 15 minutes from the TSO's order till full delivery is realized. Eltra only has to contact EffektPartner, who are responsible for activating the ordered quantity of regulatory power within the given time frame.

In the market for regulatory power, the settlements are usually based on the ordering plan for delivery and will be paid directly from Eltra to EffektPartner, who distributes the payment among the owners of the backup generation units. Eltra will require measuring arrangements to document the delivery.

D. Development

The contract is formed as a pilot project for a period of one year, from the time of first delivery. After the pilot period, EffektPartner is expected to offer the backup generation power in Eltra's monthly tender.

The pilot project contract is signed for minimum 5 MW and for maximum 30 MW. The payment in the pilot period is agreed to approx. 4,000 €/MW per month. EffektPartner must pay all project costs.

D. Further Information

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