

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

1. End User Flexibility by Efficient Use of Information and Communication Technologies - Norway

2. What is integrated with DSM

DG

Energy storage

Smart grid technologies

3. What is the level of commercialization

Research project

Demonstration

Field test

Existing practice

4. Where to find more information?

IEA DSM, Task XV, Database

Project website at: www.energy.sintef.no/prosjekt/Forbrukerflex/engelsk/

Ericson, T. (2005). Time-differentiated Pricing and Direct Load Control of Residential Electricity Consumption. Trondheim, Department of Electrical Power Engineering, Norwegian University of Science and Technology.

Grande, O. (2002). Experience with Residential Market Based Direct Control. Demand Response Seminar, San Francisco, 4 February. PowerPoint presentation available at: http://drcc.lbl.gov/pubs/intDRseminar_grande

Grande, O.S. and Saele, H. (2005). Market Based Solutions for Increased Flexibility in Electricity Consumption. Presented at the Market Design Conference, Stockholm, June.

Kärkkäinen, S. (ed) (2004). Energy Efficiency and Load Curve Impacts of Commercial Development in Competitive Markets: Results from the EFFLOCOM Pilots. EU/SAVE 132/01 EFFLOCOM Report No 7. Available at: www.efflocom.com/pdf/EFFLOCOM%20report%20no.%207%20Pilot%20Results.pdf

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5. Objectives of the case

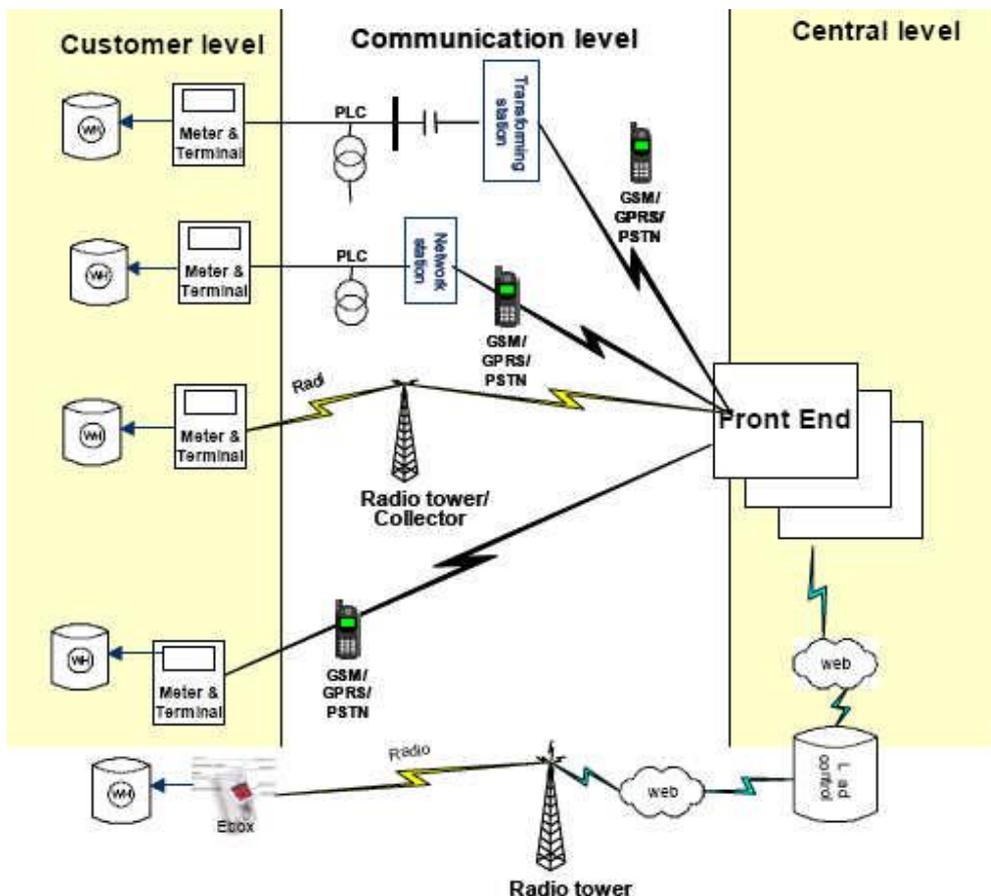
In the Nordic power market, the bid curves in the day ahead market (Elspot) are rather steep in the higher price ranges, which means that price elasticity is very low. The tight peak power balance, periods with shortage of energy, and very little investment in new production capacity has focused attention towards increased price elasticity on the demand side. The purpose of this pilot project was to investigate manual and automatic demand response to prices in the day ahead market.

6. Business rationale/model

7. Technologies used

This was a large scale pilot project involving two network operators and six technology vendors.

- two way communication to 10,984 mainly residential customers using radio, PLC, GSM, GPRS and PSTN;
- automated meter reading with hourly readings;
- a separate channel for direct load control of water heaters.



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8. Short description of the case

In Norway, the electricity industry has been unbundled with separate network service providers and energy retailers supplying end use customers. Customers therefore receive electricity bills containing four main components based on:

- a network tariff;
- a retail energy tariff;
- value added tax (VAT); and
- government charges.

The residential customers involved in the pilot project were offered a specially designed time of use (ToU) network tariff. This tariff consisted of three components:

- a fixed component;
- a component for network losses; and
- an energy-related component which was only activated during peak periods.

The TOU network tariff had a two-level rate structure. The rates were:

- a peak price of about NOK 0.88 (excluding VAT) during peak load periods (defined as 7 to 11 am and 4 to 8 pm on working days from November to April); and
- an off-peak price of NOK 0.02 (excluding VAT) in all other hours of working days, weekends and holidays.

The 44:1 differential between the peak and off-peak network tariff was very large. However, when the retail energy tariff, VAT and government charges components were added to the customers' electricity bills, this differential was reduced to about 3:1.

In addition, the energy retailers in the area offered customer contracts based on the spot prices in the electricity market on an hourly basis.

One of the retailers also offered an hourly spot price in combination with remote controlled automatic disconnection (load control) of water heaters in the periods from 9 to 11 am and 5 to 7 pm on week days. The energy spot price was expected to be high during these periods. Load control of water heaters was available to 50% of the customers in the pilot project.

Load control operated through a separate channel to automated meter reading and required an agreement with the network operator to carry out the remote load control in the specified periods. Load control was implemented for short test periods of between two and three days several weeks apart.

The two network operators offered slightly different load control options. Water heaters were switched off as follows:

- Buskerud Kraftnett AS: during the hour with the highest energy spot price plus the hour before or after;
- Skagerak Energi Nett AS: during two hours in the peak load periods when the energy spot price reached a predefined limit.

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In the case of Skagerak, the energy spot price limit was initially set at 0.0625 NOK/kWh. However, spot prices during the test period were low with little volatility. In the last months of the pilot project the spot price limit was removed and the water heaters were disconnected for two hours every morning and evening, when the spot prices were highest.

Therefore, there were five possible tariff options from which customers in the pilot project could choose:

- ToU network tariff and standard-offer energy tariff; or
- ToU network tariff and spot price energy tariff; or
- ToU network tariff, spot price energy tariff and direct load control of water heaters; or
- standard-offer network tariff and spot price energy tariff; or
- standard-offer network tariff, spot price energy tariff and direct load control of water heaters.

9. Achieved/expected results (operational savings, CO₂, efficiency enhancement)

The main test period was from November 2003 to March 2004. During this period, the average load reductions per household achieved through the various options were as follows:

Buskerud Kraftnett AS

ToU network tariff - approx 0.18 kWh/h

Hourly spot price for energy - approx 0.6 kWh/h

Direct load control of water heaters - approx 0.5 kWh/h

ToU network tariff plus hourly spot price for energy - approx 1 kWh/h

Skagerak Energi Nett AS

ToU network tariff - approx 0.18 kWh/h

Hourly spot price for energy - approx 0.4 kWh/h

Direct load control of water heaters - approx 0.57 kWh/h

ToU network tariff plus hourly spot price for energy - approx 0.3 kWh/h

The largest response was achieved for the households with both the ToU network tariff and the hourly energy spot price and no direct load control of water heaters. However, only a very small number of customers (6 out of 10,894) chose this option and it is possible that these were households with an interest in the issue and the willingness and ability to modify their energy-using behaviour.

For those customers who were offered remote controlled automatic disconnection of water heaters, the average load reduction from water heaters was estimated to be about 0.5 kWh/h during peak periods.

The load curves for the customers with direct load control showed some increases in load towards the end of peak periods. This increased load was probably caused by the

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simultaneous reconnection of the water heaters with a loss of diversity in the water heater load as a result.

In addition, the decision to disconnect the water heaters to coincide with the two most expensive hours for the energy spot price meant that the water heater reconnection took place when the TOU network price was still high and remained high for the first hour after reconnection.

10. Lessons learnt

A large experimental area with installed technology for automatic meter reading and remote load control was established in the pilot project. To improve the results from the project, the tests will be continued in a follow-up project (project period: 2005-2008). This will make it possible to perform different tests for at least one more winter.

In the pilot project, the average reduction in electrical consumption per household was 0.5 kWh/h. Taking network losses into account, this is equivalent to 0.6 kWh/h in reduced electricity generation.

Assuming there are 2 million household customers in Norway, and 50% of these install technology for remote load control, the estimated potential for peak load reduction through remote load control in the residential sector in Norway is 600 MW (an average of 0.3 kWh/h per customer).

The data from the pilot project enables an estimate of the average annual cost to achieve peak load reduction in the residential sector across Norway of NOK 680/customer/year ÷ 0.3 kWh/h/customer = NOK 2,260/kW.

This estimate is from a pilot project with many technological and organisational challenges. It is expected that lessons learned from the pilot project will make it possible to improve this figure considerably in future projects.