# SMART CUSTOMER GOTLAND

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## ABSTRACT

*This paper is about a demand side management pilot on the island of Gotland the largest island in Sweden. The paper describes the strategy for recruitment, the technology used in the customers houses and the results so far collected. The test is ongoing and therefore only preliminary results can be presented.*

## INTRODUCTION

### Gotland

Gotland is an island in the Baltic Sea with almost 60.000 inhabitants. Due to favourable weather conditions, Gotland has a large and growing production from renewable energy sources (especially wind power but recently also from photo voltaic). In situations of strong winds and low consumption on the island, electricity is distributed from Gotland to mainland Sweden by use of a high voltage direct current link.

In addition to all the usual challenges connected to volatile production adjacent to consumption, reversed polarity of the power link means especially vulnerable operation conditions. The current situation is that the distribution system operator, despite a very large interest to establish new wind power production on the island, has been forced to limit the installed capacity on the island in order to ensure the power quality. The limit is based on a risk analysis based on maximum production a minimum consumption and set to 195MW. The conventional solution to the problem, a new high voltage link to Gotland, a huge investment, is already planned.

The ambition of Smart Grid Gotland is to achieve a, small but not insignificant, increase in the hosting capacity by use of, especially, available information technology and an, in comparison, limited budget.

### Smart Grid Gotland

Smart Grid Gotland is a research- and development-, project with the ambition to upgrade an existing rural distribution system, on a deregulated market, to a modern smart grid. The overall goals of the project are to:

1. Increase the hosting capacity for renewable power in the distribution grid by use of load shift from active customers and a battery based energy storage
2. Improve the power quality for the customers by a decrease of the number and duration of power outages with 20%
3. Attract up to 2000 residential and up to 30 business customers to become active on the electricity market

Where the first and, especially, the third project objective are handled by two (of nine) subproject to Smart Grid Gotland and carried out as a market test called Smart Customer Gotland.

Smart Grid Gotland and its subprojects are conducted as a consortium between GEAB, Vattenfall, ABB, Schneider Electric, Svenska Kraftnät, and the Royal Institute of Technology. The project is co-funded by Swedish Energy Authority

### Smart Customer Gotland

The initial idea behind the market test was to move consumption from periods of high load to periods of lower load by use of price signals to active customers. Periods of vulnerable operation would thus be shorter and fewer, which would justify an increase of the hosting capacity.

In the project pre-study it was concluded that approximately 8600 electricity customers on Gotland had the potential (large enough consumption, controllable load etc.) to participate in the test. If a rough quarter of these customers (2000 households and 30 small and medium sized enterprises) were to be able to shift +/- 10% of their consumption, it would correspond to approximately 5MW, i.e. the overall goal of the project. The battery based energy storage would thus be used to cover for small, short term, balancing, such as intra-day prognosis errors.

In addition to the overall project goal, the objectives of Smart Customer Gotland are to:

- Conduct a market test under market driven conditions
- Achieve better understanding of customers' behaviour, interest and acceptance of active participation
- Lower electricity costs for active customers

In the tests, enterprises was kept separated from household customers both due to a larger overall consumption, thus higher expectations on the outcome, and since industrial processes was believed to demand extra attention. However, only private customers in detached houses and electrical heating in particular, will be discussed in this article.

## METHOD

The initial phase of the market test was characterized by two general activities, customer communication and technical development, which will be discussed separately in following sections.

## Communication Strategy

Although both enterprises and household customers were introduced to participate in Smart Customer Gotland, the target group was customers with a consumption exceeding 8000 kWh/year with the possibility to control the residential heating and/or water boiler.

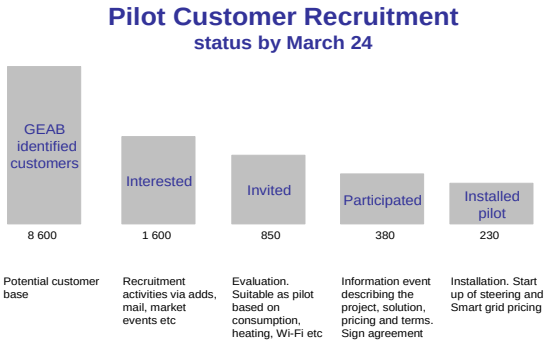
In order to create an awareness and curiosity for the test and, thus attract people to participate, information about the test was distributed to customers, by use of:

- Advertisement in local media
- Attachments to their monthly invoice
- Presence at various exhibitions on the island
- An priority channel for dialogue with private customers at www.gotlandenergi.se

Additional information was distributed to members of the target group by use of direct mail.

The overall strategy was to attract customers to participate in the test in terms of contribution to a sustainable society, awareness of energy consumption and efficiency as well as a possibility to lower their expenses. The strategy also included hopes that a few, very positive customers would act like local ambassadors on the island.

After the initial set in information, approximately 1600 customers applied for participation through the designated webpage. About half of these customers were, unfortunately, unable to participate in the test due to, for example, missing technical prerequisites or due to long term fixed price agreements. The other half was identified as potential test pilots and invited to an open house event were the project informed the customers about price models, technical equipment and the project agreement. At the event the customers was introduced to, and had the possibility to sign, the project agreement. An EnergyWatch and a time for installation of the automatic control of heating devices (see Technical Platform), was offered to each signing customer.




## Technical Platform

### Control and Visualization

The fact that Smart Customer Gotland involves real customers, real installations and, not least, customers real electric bill must be reflected and respected. This especially concerns the choice of technical platform.

Besides obvious fact such as safe and reliable operation the control and visualization system should be able to handle a huge variety of different systems for residential electric heating (direct electric heat, electric heaters, water boilers and heat pumps, as well as combinations thereof). Additional requirements such as:

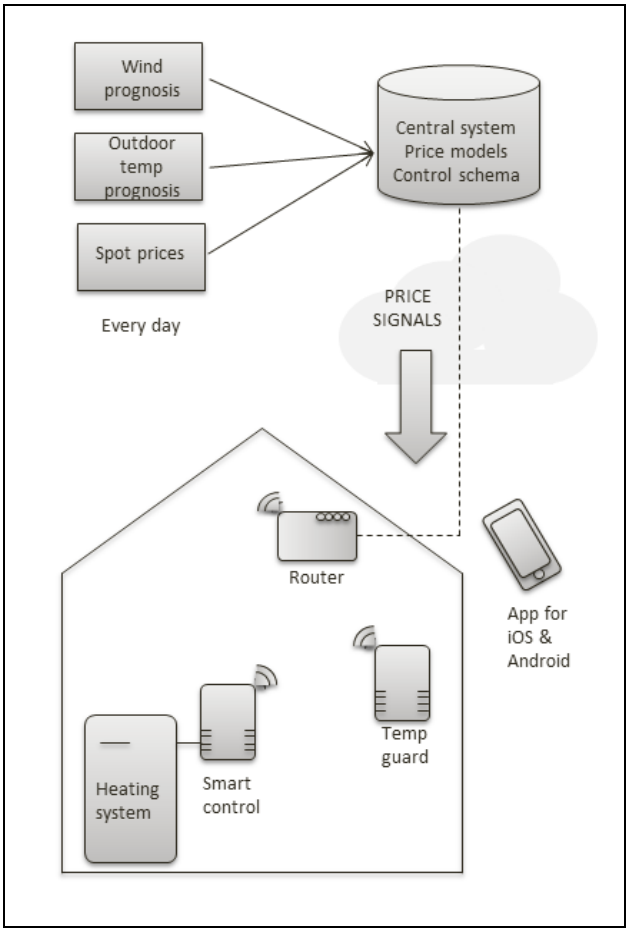
- Reasonable priced
- Use of proven technology
- Easy to access and to understand
- Possible to control manually

meant that three commercial products, Energy Watch, Smart Temp and Smart Plug, offered by project partner Vattenfall, with Swedish manual, was chosen for the tests.

Although the system was commercial and ready to use (including apps for iOS and Android) it needed certain adjustment in order to include

- Automatic (remote) control of heating devices, based on algorithms optimizing the total heating cost for the customer.
- Easy to understand visualization of price and control signals
- Indoor temperature guard (with override functionality – for customer safety)
- Control of various electrical heating types (including a soft control for heat pumps, electrical heaters and electrical floor heating)

Overview technical platform




The installations of the control and visualisation in households were carried out by a small team of electricians. Besides additional cabling and an occasional Wi-Fi amplification the project also provided low budget smart phones for those customers who lacked one. This meant that prerequisites such as Wi-Fi and smart phones usually were met, although, each installation turned out to be more or less unique. Especially the fact the customer needs to be at home during the installation and lived on different places on Gotland proved to slowed down the installation rate to a maximum of three installations per day for each electrician.

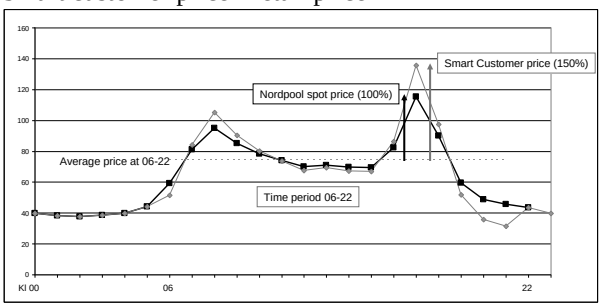
**Smart Customer Price**

In order to simulate a future situation when a large production from volatile energy sources give rise to larger variations in the electricity price, a special retail price (called smart customer price) was designed and offered to customers in the market test. The smart customer price comprises three components:

1. Enhanced hourly spot price based on the Nord Pool Spot exchange for electric power
2. Grid Tariff - Time of use tariff, i.e. higher tariff between November and March on workdays between 6am and 22pm. All other times low tariff is applicable
3. A wind component, unique for Smart Customer Gotland

The wind component means that the customer will have a special discount in situations of strong wind (during max 30 days when there, according to the forecast, will be strong wind also the following day).

Smart customer price - retail price




**Control Schemes**

Customers can choose to have their control equipment on remote control with three pre-set levels:

- Comfort (lowest level of control in order to maintain comfort)
- Normal
- Economy (toughest level of control in order to save money)

A customer, who, for some reason, wants to discontinue their participation, temporarily or completely, can simply disconnect the technical equipment.

## **ANALYSES** plan

The evaluation period spans from winter 2013 to spring 2015 so that every customer will be followed during at least a year.

The analysis will mainly focus on:

Consumption

- Change in consumption patterns over time
- Potential load shift to reduce peaks

Cost/Price

- Impact from steering
- Impact from Price model, wind component
- Energy saving

Customer behavior

- Surveys during and after test

Steering schemes will be monitored.

- Actual outcome
- Customer overrides

**Control and Reference**
Each participating customer's behaviour will be compared with recorded consumption data from prior to the test.

A reference group of households on Gotland that are as similar as the test group as possible will be identified and analyzed

The final conclusions from Smart customer Gotland will be published in December 2015.

## RESULTS

A total of 230 customers (2014-03-24) are installed and remotely controlled.
Main steering objects are:

- Heating pumps (water medium)
- Water boilers
- Direct heating system

Combination of these steering objects might occur in some cases.
Consumption is targeted to above 8000 KWh but the majority is in the threshold of 12.000 -30.000 KWh.

**Results from the first survey**

The first survey to customers with installation approx. one month ago has been completed. The survey covers questions regarding participants project experience in general, project communication, web page, customer service, installation, technical functionality and comfort.

In addition the customers are asked to add general ideas and future development proposals. The survey result showed that:

- > 70% of target group responded.
- Overall very positive feedback. Avg. rating > 7 on a scale 1-10.
- Indicates interested and motivated participants
- Challenges regarding communication and connectivity between the installed components for measurement and steering, identified in some cases
- The active participants are interested in continuing after the test period and proposes several ideas for future development.

## General findings so far regarding the project

Some overall findings can be identified from the project so far.
Challenge to recruit pilot customers mainly due to:

- Customer have signed up for long term fixed price agreement – expensive to change for SCP
- Low energy prices in general – low motivation for participation

By studying participating customers daily load chart we can identify impact from the remote steering. Usage has decreased during morning peak price hours. Meanwhile the remote control activates the steering after the peak and we can identify increased load, now at a lower price.