e-harbours

WP 3.5 Application of Smart Energy Networks

Technical and Economic Analysis
Summary results of showcase City of Malmö

Author(s) : City of Malmö,
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Photo: Your location

1.1 Introduction

Smart energy networks are intelligent and flexible solutions which combine flexible energy consumption, local generation of (renewable) energy and energy storage on different levels. In any smart energy network, the presence of both technical/economical and organisational/legislative conditions is crucial.

The e-harbours report 3.7 focuses on the *organizational and legislative aspects* of smart energy solutions. A long list of general barriers has already been composed (deliverable 3.3).
The report 3.7 addresses the analysis on a local basis (country/city/harbour), where the smart energy solutions are hampered.

This e-harbours report 3.5 focuses on the *technical and economical aspects* of smart energy solutions. The scope of WP3.5 is the translation of the 6 universal business cases (e-harbours report WP3.4) on the level of every showcase. It gives an overview of the potential for the exploitation within the existing local (national) rules and regulations.

This document summarizes the results for each of the showcases in ….*enter your text here*

Universal business cases: 6 possibilities defined

The final document of WP3.4, “Strategies and Business Cases for Smart Energy Networks “ [1], gives an overview of universal business cases for the exploitation of smart energy networks. Demand side flexibility is a term which is used for devices, installations and/or companies which are able to adapt the energy consumption to some extent without compromising their proper operation. Examples are installations which can shift non critical activities in the time or devices which can store energy for later use. The economical potential of the flexibility, offered by these devices, installations and/or companies is estimated in the WP3.4. WP3.4 summarizes the following cases:

1. Contract optimization: The present flexibility can be used in order to reduce the energy cost within the margins of the existing energy contract. Examples are shifting energy consumption to cheaper off-peak tariff hours or reduction of the peak power.

2. Trade on the wholesale market: Significant amounts of energy are traded on energy exchange markets. Due to the variable price on these energy markets, the presence of flexibility can be used for energy cost reduction.

3. Balancing group settlement: Balancing responsible parties (BRP’s) are responsible for balancing electricity production and consumption in their portfolio. Flexible consumers can help a BRP in order to maintain the balance of his portfolio.

4. Offer reserve capacity: In case BRP’s are not able to maintain the system balance, the transmission system operator (TSO) has reserve capacity in order to restore the balance. Customers can offer their flexibility directly to the TSO for balancing purposes of the total system control area.

5. Local system management: The local distribution grid has a limited capacity and some combinations of local power injection and consumption may result in congestion. Flexibility can be used to operate the local grid in an optimal way within its constraints.

6. Offer further grid stabilization services: Large scale producers and consumers can offer flexibility for reactive power balancing or preventing congestion of the transmission grid.

The scope of WP3.5 is the translation of the "theoretical" business cases of WP3.4 into realistic business cases in your context.

1.2 The strategy in showcase City of Malmö: Smart Homes

Identification

The strategy applicable to the show case is: *1. Contract optimization. The present flexibility can be used in order to reduce the energy cost within the margins of the existing energy contract. Examples are shifting energy consumption to cheaper off-peak tariff hours or reduction of the peak power.*

The flexibility consists in shifting energy consumption to cheaper off-peak tariff hours and using renewable energy directly connected to the apartments: solar collectors for heating and hot water, PVCs and wind mill for electricity.

Smart homes residents have the flexibility to adapt the energy use on a 24 hours basis. Each day, residents receive on their app the electricity price for each hour during the upcoming 24 hours period (via Nord Pool spot). Users can then choose which appliances to be run during that period using the app. They can for example choose to charge the electric car, run the dish washer or the tumble drier during off peak hours. The app gives a very clear picture of the energy use per each appliance at home: the dish washer, the tumble drier, the electric vehicle etc. The residents can make a prognosis of the energy invoice and elaborate on how their energy consumption pattern will affect the invoice. All data is generated via and can be withdrawn from the app.

The flexibility has been identified by collecting data from interviews with the energy company EON, one apartment owner and general statistics on energy use and energy rates. The quantification of the flexibility is only estimation, since real data will be available first later this year.

Quantification

The flexibility is estimated for one apartment and aggregated to all the seven apartments in Smart homes. It is based on the following assumptions:

- That dishwasher, tumble drier, washing machine and charging electric car are made during off peak hours.
- That all apartments would make use of the energy from wind, solar collectors and PVCs that are installed at the Smart homes, which will reduce the energy costs since the renewable energy goes straight into the apartments.
- That the household appliances in the apartments are the most energy efficient on the market.

Valorisation

The value of the flexibility in Smart homes consists in shifting certain energy use to off peak hours. A household may choose to run for example the washing machine or dish washer during the night, when the electricity rate is lower, instead of during the day.

Exploitation

For the exploitation, a presumption has been made that the flexibility can be scaled up to all the new build apartments in the City of Malmö.

1.3 Scope of the e-harbours showcase in Malmo

The deliverables of the showcase are:

- Smart system with 100 control points for energy use and temperature in each apartment.
- Software consisting of an app for monitoring and steering energy use.

2 RESULTS

2.1 Case study Smart Homes

2.1.1 Introduction

Smart homes consist of seven smartly designed rental apartments in the residence area Western Harbour in Malmö, owned and managed by the energy company E.ON.

Different energy systems for electricity, heating and hot water are tested in the apartments: district heating, air/water-heat pump, gas and solar collectors. A hundred measuring points are installed in each apartment and residents can follow and monitor the energy use via an app on a tablet or smart phone.

Part of the energy is produced locally: solar collectors produce heating and hot water, PVCs and windmill produce electricity. The grid electricity has a fully variable price connected to the Nord pool spot intraday market.

Each apartment also has a vehicle included in the contract. In total there are five electric cars, one gas driven car, one electric vespa, seven electric bikes.

Smart homes focus on the user perspective:

- Visualisation – all energy use is measured and visualized
- Monitoring – all energy use can be monitored by the user
- Price model – the price model should be easy to understand.

2.1.2 Investigation summary.

Available information

Up to date there is almost no information available on the Smart homes. The reason is that the installations of all meters and the system has been delayed. But, from the 17th of September the total measurement system is running. The first evaluation has will give some results by the end of October this year.

Data has therefor been based on estimations on the following.

- Standard household energy use for heating and electricity – kWh and costs
- PVCs – kWh and investment costs
- Solar collectors – kWh

- Windmill – kWh

Data has been made available from EON on the investment and running costs for the following:
- PVCs

Power consumption analysis
Interviews with Smart homes owner indicate that there is a shift of energy use from daytime to night time, when energy price is lower. The dish washer, tumble dryer, washing machine are run during night shift, and electric car is charged in the night.

Household electricity kWh/yr	
Dish washer	300
Tumble drier	180
Washing machine	155
Electric car	750
Total	**1385**

Our estimation on the electrical car is based on that it consumes 1 kWh per Swedish mile (10 km). The average car in Sweden drives 1218 Swedish miles per year, but we decided to use a slightly lower number in our calculations since the residents don't use the car on an everyday basis.

Quantification of flexibility
The shift of energy and use of renewable energy is estimated to generate a flexibility for all the seven apartments of around 44 462 kWh, which corresponds to 33 483 Euro. This calculation is based on the difference between a standard apartment and the minimum tariff during a day for the show case. If the maximum tariff during the day is used, the corresponding figure will be 31 663 Euro.

Upscaling scenarios region/country
Scaling up the above described flexibility could contribute to reaching the energy and climate targets of the City of Malmö: 100 % renewable energy in 2030, reduction of energy use by 20 % per person 2020 and another 20 % by 2030.

If the strategy is applied in all new built apartments in Malmö, with the assumption that 10 000 new apartments will be built till 2030, the energy (electricity and heating) reduction potential would be 63 MWh per year and the savings on their energy bill would be 5,7 million Euros per year.

3 Conclusions

3.2 General Overall Conclusions
The overall conclusions of the show case are the following:
- The flexibility results in potential of 82% savings on the annual total energy bill compared to normal tariff and exploiting flexibility.
- The up scaling consequences on a local, cluster and regional level could contribute to reaching the energy and climate targets of the City of Malmö.

4 Lessons learned

4.1 Technical issues

- A smart charging function, that made it possible to charge the electrical car during the night when the electricity price was lower and use that electricity during the day when the price was higher, was initially planned to be installed in one of the vehicles. This could have contributed to an annual saving of 6-7000 SEK. However, this smart charging function was not available on the market. For this reason, an electric power station with some smart charging functions will be installed instead.
- The software is developed for Apple's products, which has caused problems for Android users.
- Problems when integrating several sensors and computers in the apartments

4.2 Economic issues

The value of the flexibility for a household economy is not very high, since there's not a very big difference in the rates between peak and off peak hours. There is little incentive to use the function. This is since the flexibility mainly is a result from the usage of very energy efficient household appliances and the usage of renewable energy from wind, solar collectors and PVC.

4.3 Ideas for further investigation

The ideas for further investigation are connected to the technical and economic issues:

1) Keep searching for a smart charging function for electrical vehicles.
2) Develop software for Android in order to make the service available for Android users and not only the ones using iPhone/iPad.
3) Find other incentives for the managing system than the economic ones. The managing system could for example show the environmental benefits of controlling the electricity consumption in the home.

5 References

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[9] Per Rosén, EON, Telephone, meeting 130617, telephone 130923
[10] Nikolaj Shiskhov, resident in SmartHomes, telephone, 130927