EcoGrid EU
A Prototype for European Smart Grids

Presentation at: TU/Eindhoven
Presentation by: Per Lund

February 13rd 2014
Content

- The Challenges of Tomorrow
- What is EcoGrid EU?
- The Real-time Market Design
- ICT Implementation
- Bornholm Field Test-site
- Recruitment and Involvement
- “My EcoGrid” User Portal
- First Results
- Deployment and Impacts
Content

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The Wind Power Challenge
The Danish case

Today (Nov-Dec 2011)
28 % wind

Tomorrow (2020)
50 % wind power

Wind power already covers the entire demand of electricity in Denmark in many hours

In the future wind power will exceed the entire demand of electricity in Denmark > 1,000 hours
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EcoGrid EU in Brief

- EU funded FP7-Energy project (total budget: 21 million €)
- Project period 1st March 2011 – 31st August 2015
- A large scale demonstration of a real-time marketplace for distributed energy resources (DER)
- ICT systems and innovative market solutions enable small-scale consumers to offer TSO’s additional and more efficient balancing services
- A demonstration of a real power system with more than 50 % renewable energy
- Preparation for a fast-track towards European real-time market operation of renewable energy sources and demand response
EcoGrid EU Partners

DENMARK
- ØSTKRAFT
- SIEMENS
- ENERGINET/DK

NETHERLANDS
- DTU
- IBM

BELGIUM
- elia
- EARDIS

SPAIN
- tecnalia

PORTUGAL
- edp

NORWAY
- SINTEF

ESTONIA
- TALLINN UNIVERSITY OF TECHNOLOGY

GERMANY
- SIEMENS AG*

AUSTRIA
- AIT

SWITZERLAND
- IBM ZRI*
- SIEMENS CH*

* THIRD PARTY
Project Organisation

- CONCEPT AND ARCHITECTURE - WP 1
- PRODUCTS & SERVICES CONSUMPTION, GENERATION AND GRID MANAGEMENT - WP 2
- IMPLEMENTATION MARKET PLACE ICT WP 3
- IMPLEMENTATION OF DER RESPONSE - WP 4
- INSTALLATION AND TRAINING - WP 5
- DEMONSTRATION AND EVALUATION - WP 6
- FRAMEWORK CONDITIONS DEPLOYMENT & REPPLICATION PLAN - WP 7
- DISSEMINATION - WP 8
- PROJECT MANAGEMENT - WP 9

Price signals
Content

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Why a Real-time Market?

- An efficient way to meet the future challenge of balancing
  - High(er) demand of flexible consumption/production
  - High(er) volatility
  - High(er) balancing cost

- An efficient instrument to wide spread adoption of small-scale end-users/prosumers in the power market(s)

- Increasing competition on the power market(s)
  - Small scale end-users can attain economic benefits
  - TSOs get access to alternative balancing resources
The Scope of a Real-time Market

The EcoGRID Real-time Market will be an integrated part of the current power markets and supports the need of direct control options on a very short time scale.
An Additional Source of Regulation Capacity

The current Nordic system:

- TSO’s obtain a certain quantity by selecting/accepting bids
- Include only large producers, large consumers and aggregated smaller units (minimum 10 MW)
- Loads are updated every 15 minutes

The new EcoGrid real-time market:

- No restriction on the size of units (MW)
- TSOs set a price every 5 minutes that result in a certain quantity of fast(er) response from smaller units
EcoGrid EU in the Wholesale Market

The price will be based on present and expected system balance as well as forecasts of price elasticity (no bids).
The Fundamental Idea of EcoGrid EU

THE MARKET CONCEPT ALLOWS REGULATION OF DER PRICE SIGNAL WITHOUT DIRECT MEASUREMENT OF THE INDIVIDUAL DER RESPONSE
Content

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Development of a New ICT platform

- A new real-time market equals a new ICT platform

- Build on proven solutions where available:
  - Use of modern information technology
    (incl. AMR type commercial meters etc.)
  - End-user devices/appliances - equipped
    with solutions demonstrated in other RD&D projects
  - Demonstration of other “real-time” market platforms
    have been done successfully outside Europe

- New ICT challenges include:
  - Development of architectures that support the EcoGrid
    EU concept
  - Management of large scale demonstration/deployment
  - Management of a multiple mix of small demand
    response units/small scale production/storage
    capabilities
ICT Implementation of Market Concept

The bid-less, 5-minute market of EcoGrid EU:

- The price distribution component is designed as a combination of published subscribe and IP multicast technologies
- The Internet Service Providers (ISPs) of an area subscribe to the relevant price signals
- Within ISP domains, relevant price streams get multicasted
- The bid-less real-time market is (potentially) scalable to millions of customers
Real-time Market Distribution

- TSO
- Spot Market
- Weather Forecast
- Historical Metering Data

Real-time Price Generation Module

Real-time Market Price Distribution System

Publish-Subscribe

Data Input for Computation
- Real-time Signal
- Electric connection between home/Smart Devices and Smart Meter
- Upstream data flow from Smart Meters to Metering Data Repository (GPRS Channel)

ISP 1
- ISP 1 Multicast Network

ISP 2
- ISP 2 Multicast Network

ISP 3
- ISP N Multicast Network

Smart Meter
Content

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Bornholm – a Unique Test-site

Demonstration in a `real´ system with 50 % RES

High variety of low carbon energy sources

Several demand & stationary storage options

Interconnected with the Nordic power market

Strong political commitment & public support

Operated by the local municipal owned DSO, Østkraft

Eligible RD&D infrastructure & full scale test laboratory

EcoGrid.eu
## 2000 Participating Customers in the Demonstration

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Statistic Control** | 200 households with L+G smart meters  
No access to specific EcoGrid information |
| **Manual Control**  | 400-500 households with L+G smart meters  
Receiving simple EcoGrid market price information on dedicated web-page  
Must move their energy consumption manually |
| **Automatic Control** | 700 automated households with IBM Green Wave Reality equipment and L+G smart meters  
All houses have heat pumps or electric heating responding autonomously to price signals |
| **Automatic Control** | 500 automated households with Siemens Synco Living equipment and L+G smart meters  
All houses have heat pumps or electric heating responding to aggregator control |
| **Smart Businesses**  | Up to 100 customers with L+G smart meters  
Include small business and public customers  
Connected smart appliances responsive to control signals |
Technical Implementation on Bornholm

5-min Market Place

PowerMatcher Central Unit

PowerMatcher Control Agents

Individual Control Agents

DEMS Aggregator

Shared Services

L+G Meter Appl.

Pilot Customer Web Interface & Virtual Billing

Utility Domain

Customer Domain

200 Ref. Cust. With L+G Meter

350 "IBM" Privat Customers with Control Gateway & L+G Meter

350 "IBM" Privat Customers with Control Gateway & L+G Meter

500 "Siemens" Private Customers with Control Gateway & L+G Meter

100 "Siemens" Industrial Customers with Control Gateway & L+G Meter

500 Manual Cust. With L+G Meter

"IBM" Privat Customers

"Siemens" Private Customers

"Siemens" Industrial Customers

"IBM" Privat Customers

"IBM" Privat Customers

"IBM" Privat Customers

"IBM" Privat Customers

"Siemens" Private Customers

"Siemens" Industrial Customers

"IBM" Privat Customers
Implementation of the Real-Time Price

Demo phase I: Open-loop pricing

External input e.g. power exchange prices
Price calculation / transformation
Price signal (real-time)

Distributed Energy Resources

Meter readings

ELECTRICITY NETWORK

External input of “ex post” price information from the current day-ahead market (i.e. published spot prices from Nord Pool)

Demo phase II: Close-loop pricing

Objective e.g. power balance setpoint
Price calculation with response prediction
Price signal (real-time)
Feedback (real-time)

Distributed Energy Resources

Meter readings

ELECTRICITY NETWORK

Calculation of real-time prices based on forecast of demand response. Prices are broadcasted to the market in order to obtain a certain objective (e.g. required balancing power)
Equipment Green Wave Reality (IBM)
Equipment Synco Living (Siemens)

- Central unit
- Web server
- Room temperature censor
- Radiator control actuator
- Heating circuit controller
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Recruitment of participants

Customers on Bornholm have signed up by filling out an online-questionnaire at the Danish website www.ecogridbornholm.dk

- Increase the knowledge of the Bornholm electricity customers/potential smart grid customers
- Identify customers that technically are qualified for participation
- Support the development of tariffs
- Clarify the need for further acquisition/recruitment activities
# Recruitment and Consumer Involvement

<table>
<thead>
<tr>
<th>Increasing the EcoGrid awareness 2011</th>
<th>Starting up the official recruitment 1. – 2 Q 2012</th>
<th>Concentration of acquisition efforts 3 - 4 Q 2012</th>
<th>Recruitment campaign 1. Q 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target group:</strong> Media/politicians/community people</td>
<td><strong>Target group:</strong> “First mover” customers</td>
<td><strong>Target group:</strong> Electric heating customers</td>
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</tr>
<tr>
<td><strong>Means:</strong> Press release/EcoGrid brochures/flyers/presentations at local events</td>
<td><strong>Means:</strong> Recruitment kick off: – Press conference &amp; Villa Smart opening for the public – Local website</td>
<td><strong>Means:</strong> – More detailed information materials – Open house events at Villa Smart</td>
<td><strong>Means:</strong> Examples: – Popular EcoGrid event – Direct mails</td>
</tr>
<tr>
<td><strong>Key message:</strong> The Vision of Smart Grid/the introduction of EcoGrid</td>
<td><strong>Key message:</strong> “Participate – make a difference – put Bornholm on the world map”</td>
<td><strong>Key message:</strong> Benefits of participation – small focus on money savings</td>
<td><strong>Key message:</strong> “If your neighbour can do it – you can do it” – Example of economic benefits</td>
</tr>
</tbody>
</table>

EcoGrid.eu www.eu-ecogrid.net
Information and education of EcoGrid power consumers

Guidance of participants
- 2 hours per household with automation equipment
- ½ hour per manual control household
- 2 days per industrial and commercial customer

Demonstration house Villa Smart
- Training of participants
- Blog and forum
- Education of youth
- Training of electricians
Information and Recruitment Activities

- www.EcoGridBornholm.dk
- EcoGrid Magazine
- Kick off in Villa Smart

- Word of Mouth post cards
- Public EcoGrid Café
- Direct mails
Recruited EcoGrid Participants

- 1,900 households have signed up
- ~ 15% with heat pumps (85% of Bornholm in total)
- ~ 54% with electric heating
- > 200 are on waiting list
- ~ 200 drop-outs

*Automated response household participants covers the 700 homes with automation equipment from IBM and 500 participants with home automation equipment from Siemens*
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My EcoGrid Portal: Real-time Price Barometer

Current electricity price

1.97 DKK / kWh

Price trend
- Current hour
- Next 5 hours
- Next 10 hours

Last 24 hours
- Min. 1.87 DKK / kWh 04:45
- Max. 2.05 DKK / kWh 11:40
My EcoGrid Portal: Consumption Patterns

![Analysis Consumption](image)

Choose benchmark:
- Last period

Choose period:
- Today

Consumption development (kWh)

- Today
- Yesterday
My EcoGrid Portal: Monthly Results

My EcoGrid report June 2013

My test group:
IBM heat pump

My tariff:
Ecogrid real-time market price

Monthly result

Your result is the percentage by which your virtual monthly electricity costs in EcoGrid undercut the regular price. This gives you a simple overview of how well you matched your consumption to the variable electricity prices during the past month.

June

My bonus in June 2013
6.35%

Average bonus since January 2013
4.98%
My EcoGrid Portal: Consumption & Flexibility

My consumption

The diagram below shows your monthly consumption for the past three months. It also shows how much of the consumption took place in periods with low, medium or high electricity prices. By using proportionally more electricity at times with low prices, you reduce your virtual electricity costs and contribute to the project goal of continually increasing the use of wind power in the electricity grid.

![Diagram showing consumption by price and month]

March 2013: 21.25% High price, 49.44% Around average, 29.31% Low price
April 2013: 19.69% High price, 45.9% Around average, 34.41% Low price
May 2013: 13.47% High price, 41.13% Around average, 45.41% Low price
My EcoGrid Portal: Bonus Points

Result

- EcoGrid cost: Monthly bill with EcoGrid real-time prices
- Reference cost: Actual bill/reference cost
- Save points if EcoGrid cost are lower than actual bill
- Lose points if EcoGrid cost are higher than actual bill

In total (at the end of the project period) the participants will never lose money/have negative points
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Implementation status (January 2014)

1900 participants are recruited
(x) = Installations

(150) 200 Ref. Cust. With L+G Meter

(620) 350 "IBM" Privat Customers with Control Gateway & L+G Meter

(350) 350 "IBM" Privat Customers with Control Gateway & L+G Meter

(350) 500 "Siemens" Private Customers with Control Gateway & L+G Meter

(1) 100 "Siemens" Industrial Customers with Control Gateway & L+G Meter

(500) 500 Manual Cust. With L+G Meter

Pilot Customer Web Interface & Virtual Billing

Utility Domain

Customer Domain
Motivation for participating – first results

- Being part of an exciting/innovative project
  - Rank 1: 58
  - Rank 2: 86
  - Rank 3: 84
  - Rank 4: 64

- Doing something good for the environment
  - Rank 1: 99
  - Rank 2: 80
  - Rank 3: 69
  - Rank 4: 45

- Receive equipment that improves control of consumption
  - Rank 1: 42
  - Rank 2: 81
  - Rank 3: 83
  - Rank 4: 87

- Reduce electricity bill
  - Rank 1: 94
  - Rank 2: 46
  - Rank 3: 57
  - Rank 4: 95
The test cases consist of predefined profiles (time series) for the real-time prices as well as for the price forecasts.
Demonstration phase 1 scheduled test cases
Price-response in Siemens-houses

11th December 2014
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- Added Value and Synergies
- Deployment and Impacts
Strong Focus on Dissemination & Replication

Design, development, test and installation of EcoGrid solutions and equipment

Demonstration of products on Bornholm by customer segments

Analysis of deployment opportunities & stimulation of local EU markets for further replication

EU Smart Grids networking / liaison

Commercial routes

EcoGrid conferences, workshops, publications

Support early EcoGrid EU replicates
Finalise the EcoGrid EU Replication Roadmap

Close dialogue with the Consortium, EC and EcoGrid EU Reference group

EcoGrid Management and coordination
Overall Impact of EcoGrid EU

Contribute to the overall goal of large scale and efficient integration of DER in the European power market

Small customers get access to balancing market

Open Standardisation process

Targeted roll-out of Smart Grids solutions

Minimise balancing costs

Reduce/Postpone grid investments

Improve production forecasts

Open Standar-disation process
Thank you for your attention

Per Lund
Chief Engineer
Systems Analysis and International Affairs

Mobile: +45 2333 8609
plu@energinet.dk

Energinet.dk
Tonne Kjærsvej 65
7000 Fredericia
Denmark