EcoGrid EU
A Prototype for European Smart Grids

Presentation at: xxxxxx
Presentation by: xxxxxx
Content

- The Challenges of Tomorrow
- What is EcoGrid EU?
- The Real-time Market Approach
- Bornholm – a Unique Demonstration Site
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The Wind Power Challenge
An illustrative case from Denmark

Today (2008)

20% wind power

Wind power covers the entire demand for electricity in 200 hours (West DK)

Tomorrow (2025)

50% wind power

In the future wind power will exceed demand in more than 1,000 hours

EcoGrid EU meets the increasing need for balancing services
EcoGrid EU in Brief

- A proposal under EU’s FP7-Energy-2010-2-TREN
- Total budget: 21 million Euro (EU: 12,7 million Euro)
- Demonstration > 50 % of budget
- A large scale demonstration of a real-time market place for distributed energy resources
- 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 RES & DR
Objectives of EcoGrid EU

- To contribute to realization of the EU 20-20-20 goals

- To demonstrate operation of a power system with more than 50% renewable sources

- To implement ICT systems and innovative market solutions - offering TSOs additional and more efficient balancing services

- To enhance small consumer and local producers to participate in the power market through real-time operation, energy storage and savings

- To make a prototype solution for Europe - offering a “fast track” option towards market-based Smart Grids in Europe
EcoGrid EU Partners

DENMARK
Energinet.dk
(Initiator)
Østkraft
Center for Electric Technology, DTU
Siemens
IBM
Landis+Gyr

BELGIUM
ELIA
EANDIS (+ORES)

GERMANY
EnCT
Siemens AG*

SPAIN
Tecnalia

PORTUGAL
EDPD

NORWAY
SINTEF ER
(Coordinator)

ESTONIA
Tallinn University of Technology (TUT)

THE NETHERLANDS
ECN
TNO

AUSTRIA
Austrian Institute of Technology (AIT)

SWITZERLAND
IBM Zürich
Siemens, CH*

* Third Party
Roles of the Partners

- Strong Industrial Participation
- Wide DSO/TSO Experience
- High Industrial RD&D Competence
- Smart Grids Experts
The EcoGrid EU project has strong relation and experience from other Smart Grids and related projects – also EU FP6 and FP7 projects
Development of a Real-time Market

- An efficient way to meet the future challenge of balancing, i.e.
  - 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 and 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

Design of an EcoGrid prototype real-time market place is a realistic approach because it “just” widening the scope of the current power market systems
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 system:
- TSOs 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 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
How does the Real-time Price Signal Work?

- DER and flexible demand will respond to variable electricity prices through broadcasted price signals:
  - **Step 1:** Electricity price from the existing, well established day-ahead Elspot market is sent to the end-user - soon after clearing (= forecast of “real-time” price)
  - **Step 2:** During the day the price signal is updated in real-time, i.e. every five minutes – to reflect the need for up or down regulation (if no imbalances the real-time price = the day-ahead Elspot price)

- The real-time price is set by a Real-Time Market Operator on the basis of the need for balancing resources

- The Real-Time Market Operator could be the TSO(s)
Development of a New ICT platform

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

- Build on proven solutions where available:
  - Use of modern information technology (incl. commercial meters etc.)
  - End-user devices/appliances - equipped with solutions demonstrated in other RD&D projects
  - Demonstration of other concepts of “real-time” markets 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
End-user Involvement

- Easy for the consumer:
  - The price is always known (each five minutes)
  - In principle possible to respond by manually turning off electric appliances, but...

- Appliances equipped with automatic end-user “smart controllers” will do most of the job!

- The requirement of end-user involvement:
  - Understandings of the potential benefits of participation (economical/
    energy savings/security/environment)
  - Accept/make contracts based on predefined “preferences”
The EcoGrid EU Architecture

**New power market architecture requirements:**

- Installation of automatic end-user “smart controllers” in DER devices
- Smart Meters to manage “real-time” price signals
- Modern communication/information infrastructure to transmit price signal to market participants/operational units
New Solutions = New Challenges

- New settlement “challenges” in the real-time market:
  - Meters should handle 5-minutes interval readings
  - Large amount of data should be managed in the settlement process

- Replication challenges:
  - Many countries have deployed meters with 15 minutes/hourly reading
  - The real-time concept must be adapted to those conditions

- End-user acceptance
  - New intelligent home installations are required
  - The concept is based on automatic control (no manual actions required)

- “What’s in it for me”? 
  - How to make the system attractive for the small consumers/small RES units
  - Keep transaction costs on an acceptable level
Bornholm – a Unique Test Site

- Demonstration in a “real” system with 50% RES
- High variety of low carbon energy sources
- Several active 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
www.eu-ecogrid.net
## EcoGrid EU related projects on Bornholm

### The EcoGrid EU project

**Ongoing Smart Grid activities on the island of Bornholm – active contribution**

<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Controller</td>
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<tr>
<td>Smart Grid Consumer</td>
<td></td>
</tr>
<tr>
<td>PViB part I + II</td>
<td></td>
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<tr>
<td>EDISON</td>
<td></td>
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<tr>
<td>PowerLabDK</td>
<td></td>
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<tr>
<td>Smart Grid Fuel Cells CHP</td>
<td></td>
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<tr>
<td>HeatPumps to Bornholm</td>
<td></td>
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<tr>
<td>EV on Bornholm</td>
<td></td>
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<tr>
<td>FlexPower</td>
<td></td>
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<tr>
<td>DFR</td>
<td></td>
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<tr>
<td>PV in Smart Grid</td>
<td></td>
</tr>
<tr>
<td>Danish Smart Grid Deployment</td>
<td></td>
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</tbody>
</table>

**Smart Grid projects performed on the island of Bornholm – active knowledge**

<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NextGen</td>
<td></td>
</tr>
<tr>
<td>More MicroGrids</td>
<td></td>
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</table>

EcoGrid.eu [www.eu-ecogrid.net](http://www.eu-ecogrid.net)
## Bornholm Activities Add Value to EcoGrid EU

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PowerLab DK</strong></td>
<td>Full implemented test facility for Smart Grids R&amp;D with Bornholm as test grid</td>
</tr>
<tr>
<td><strong>PVIB</strong></td>
<td>Photo Voltaic units on Bornholm starting with 2 MWp PV</td>
</tr>
<tr>
<td><strong>DFR</strong></td>
<td>200 Private households with automatic frequency control of appliances</td>
</tr>
<tr>
<td><strong>Cell Controller</strong></td>
<td>Ongoing R&amp;D project in Denmark. A replicate will be installed on Bornholm as part of the EcoGrid EU project</td>
</tr>
<tr>
<td><strong>Heat Pumps</strong></td>
<td>150 Private homes changing oil boilers to heat pumps with remote control. Each house gets 2,700 € from national 54 m€ scheme</td>
</tr>
<tr>
<td><strong>μCHP</strong></td>
<td>Upcoming project with 5 Fuel Cell μCHP units in private homes</td>
</tr>
<tr>
<td><strong>EDISON</strong></td>
<td>EV project in Denmark with demonstration on Bornholm in 2011</td>
</tr>
<tr>
<td><strong>PowerFlex</strong></td>
<td>250 Private households with full automatic control of all appliances</td>
</tr>
<tr>
<td><strong>Smart Grids Information</strong></td>
<td>Project to ensure/increase Smart Grids awareness/acceptance on Bornholm (take place in parallel with EcoGrid EU)</td>
</tr>
<tr>
<td><strong>More Microgrids</strong></td>
<td>Ongoing FP6 project with island operation – will be used for stress test of EcoGrid EU when local balancing is needed</td>
</tr>
<tr>
<td><strong>EV on Bornholm</strong></td>
<td>EV deployment on Bornholm with support from the Energy Authority</td>
</tr>
<tr>
<td><strong>NextGen</strong></td>
<td>R&amp;D project about Ancillary services from local CHP units</td>
</tr>
</tbody>
</table>
### What to be Demonstrated on Bornholm?

**Power Generation**
- 36 MW Wind Power
- 16 MW CHP (biomass)
- 2 MW Biogas
- 2 MW Photovoltaic (solar)

**Demand side/Storage options**
- "Intelligent" control of household appliances
- Electric Vehicles
- Heat Pumps with Smart Grids applications
- Micro CHP
- Electricity storage in District Heating

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*EcoGrid EU is a full scale demonstration of a real-time market place including a Very broad mix of distributed energy resources*

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**Synergies with other Bornholm activities, e.g.**
- EV roll-out and infrastructure demonstration (EDISON), heat pump roll-out program,
- PV roll-out, demonstration of 200 smart heating/coolers (frequency) controllers
2000 Participating Customers in the Demonstration

**Reference Group**
- 200 households with a smart meter
- No access to specific information or “smart” equipment

**Manual Control**
- 400-500 households with a smart meter
- Receiving market price information
- Must move their energy consumption by themselves

**Semi automatic Control**
- 700 semi automated households with a smart meter
- 1-2 reactive appliances responding to price signals
- All houses have heat pumps or electric heating

**Automatic Control**
- 500 fully automated households with a smart meter
- Multiple connected appliances - all responsive to price signals

**Smart businesses**
- 100 commercial/public customers with a smart meter
- Including small business units and the public customers
- 4 connected smart appliances
## Key Numbers for Bornholm

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customers</strong></td>
<td></td>
</tr>
<tr>
<td>Number of customers</td>
<td>~28,000</td>
</tr>
<tr>
<td>Number of customers (&gt; 100,000 kWh/year)</td>
<td>~300</td>
</tr>
<tr>
<td>Total energy consumed</td>
<td>268 GWh</td>
</tr>
<tr>
<td>Peak load</td>
<td>55 MW</td>
</tr>
<tr>
<td><strong>Low-carbon energy resources</strong></td>
<td></td>
</tr>
<tr>
<td>Wind power plants</td>
<td>36 MW</td>
</tr>
<tr>
<td>CHP/biomass</td>
<td>16 MW</td>
</tr>
<tr>
<td>PV</td>
<td>2.0 MW</td>
</tr>
<tr>
<td>Biogas plant</td>
<td>2.0 MW</td>
</tr>
<tr>
<td>Electric vehicles (under roll-out)</td>
<td></td>
</tr>
<tr>
<td><strong>Grid</strong></td>
<td></td>
</tr>
<tr>
<td>60 kV grid</td>
<td>131 km</td>
</tr>
<tr>
<td>Number of 60/10 kV substations</td>
<td>16</td>
</tr>
<tr>
<td>10 kV grid</td>
<td>914 km</td>
</tr>
<tr>
<td>Number of 10/0.4 kV substations</td>
<td>1006</td>
</tr>
<tr>
<td>0.4 grid</td>
<td>1,887 km</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
</tr>
<tr>
<td>Fiber network between 60/10 kV substations</td>
<td>131 km</td>
</tr>
<tr>
<td><strong>District heating</strong></td>
<td></td>
</tr>
<tr>
<td>Number of district heating systems</td>
<td>5</td>
</tr>
<tr>
<td>Total heat demand (in 2007)</td>
<td>560 GWh</td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td></td>
</tr>
<tr>
<td>Normal operation mode</td>
<td>Interconnected Nordel</td>
</tr>
<tr>
<td>Island operation capability</td>
<td>Continuous</td>
</tr>
</tbody>
</table>
Impacts: What is in it for Europe?

- EcoGrid EU will not start from scratch:
  - Obvious synergies with other national and international RD&D projects
  - The EcoGrid EU partners participates in other relevant EU RD&D projects
  - Other relevant project partners will be invited to provide input

- EcoGrid EU partners brings in innovative and proven technology solutions/knowledge:
  - To be utilized in EcoGrid EU
  - To be shared with external stakeholders

- Strong replication and dissemination efforts will ensure the development of a EcoGrid EU prototype real-time market that can be step wised implemented in Europe:
  - Establishment of a Reference group with key stakeholders and experts from Europe
  - EcoGrid EU Replication road map
## Projects Synergies and Added Value

<table>
<thead>
<tr>
<th>Projects</th>
<th>Description</th>
<th>Technical R&amp;D</th>
<th>Market Design</th>
<th>Technical Demo</th>
<th>Market Demo</th>
</tr>
</thead>
<tbody>
<tr>
<td>FENIX</td>
<td>Identification of technical capabilities of DER to provide system service through aggregation (VPP-concept). Small-scale demonstration.</td>
<td>***</td>
<td>*</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>More Micro Grids</td>
<td>Integration of small-scale DER through micro grid approach. Design of alternative control strategy to enable autonomous operation. Small-scale demo.</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>EU DEEP</td>
<td>Development of innovative business models for integration of DER into current system/market operation.</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>DISPOWER</td>
<td>Survey on present power supply systems, including ICT technologies. Laboratory facilities for development/test.</td>
<td>**</td>
<td>*</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>ADDRESS</td>
<td>New Active Distribution Networks to balance in real-time power generation and demand. 3 test field planned</td>
<td>***</td>
<td>**</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>GridWise (US)</td>
<td>Demonstration of real-time market with each participant submitting bids and offers every 5 minutes</td>
<td>**</td>
<td>***</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>EcoGrid EU</td>
<td>Demonstration of large-scale real-time market participation for DER/flexible demand</td>
<td>**</td>
<td>***</td>
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<td>***</td>
</tr>
</tbody>
</table>
“Added Value” Technology Involved...

WP 3 Implementation of market place

- Aggregators/BRP
- TSO system
- SCADA - DSO

market price
grid price

EcoGrid market

WP 4 Implementation of DER response

- PowerMatcher
  - Smart controllers
- Siemens building automation
  - Smart controllers

WP 5 Installation & education

- AMR system
- Meter Value Data Base

PV
FC
EV

Cell Controller

Siemens building automation
Smart controllers

Smart Meters

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Establishment of External Reference Group

- To strengthen the European dimension
- The ensure wide participation from "all" interests
- To ensure high level expert and stakeholder input and feedback
- To support "fast track" replication
- 30 participants is "pre-committed" members (28 by LoI)
- More members will be invited and welcomed!!!
Strong Focus on Dissemination & Replication

- Conceptual design, development and tests of the EcoGrid solutions (WP1 – 4)
- Installation of equipment on Bornholm by subsystems (WP5)
- Demonstrate the product usage on Bornholm by customer segments (WP6)
- Analyse barriers & stimulate the EU local markets for further replication (WP7.2)
- Test and support the first EcoGrid early replicates
- Finalise the EcoGrid EU Replication Roadmap (WP7.3)
- Through ad hoc EU Smart Grids working group/liaison (WP8)
- Through commercial routes (WP8)
- Through conferences, workshops, exhibitions, publication (WP8)

Management and coordination (WP9)

Feed back/dialogue with The Consortium, EC, Reference group, stakeholders etc.
Overall Impact of EcoGrid EU

- Small customers get access to balancing market
- Open Standardisation process
- Targeted roll-out of Smart Grids solutions
- Minimise balancing costs
- Improve production forecasts
- Reduce/Postpone grid investments

Contribute to the overall goal of large scale and efficient integration of DER in the European power market
Thank you for your Attention