Smart House and Smart Grid
www.smarthouse-smartgrid.eu

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Agenda

1. The Smart Grid vision: Problem statement and solution approach
2. The Smart House, Smart Grid (SHSG) project
3. SHSG Business cases
4. SHSG Field tests
   A – ICT Mass Application and PowerMatcher
   B – Domestic Cluster Mannheim-Wallstadt and BEMI
   C – Microgrid operation in Meltemi, Greece
5. Conclusion and Outlook
The Smart Grid Vision

- A smart grid allows electric energy needed by loads to be transferred from generators ... securely &
  ... highly efficient
    (technical, economical, ecological) &
  ... while maintaining or improving security of supply
  ... where loads are distributed and partly controlled &
  ... where generators are centralized or distributed,
    using fossil or renewable energy sources
  ... providing technical means for efficient energy use

1. Problem statement and solution approach – the Smart Grid vision
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1. Problem statement and solution approach – the Smart Grid vision
The Smart Grid Vision

System Boundary 20/ 0,4 kV

Goal:
- efficient use of renewable energy sources, avoid derating DG
- Consumption AND Generation optimized
- Communication down to LV grid

Consumers become Prosumers

1. Problem statement and solution approach – the Smart Grid vision
Smart Grid Building Blocks

- Generation technology: PV, CHP, Wind power, Biomass, ...
- Storage technology
- Energy management systems
- Smart Metering
- Electric networks adapted to distributed generation
  - Transmission (e.g. HVDC), Distribution
  - self-healing grids
  - advanced SCADA
  - grid protection technology
- Business Models and Business Integration
- ICT systems
- Standards

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1. Problem statement and solution approach – the Smart Grid vision
Potential of Smart Houses

- ~ 25% of german energy consumption attributed to households
- ~ 40-50% of electricity consumption caused by shiftable loads
- Future: heat pumps, electric vehicles, generators …
- Restrictions for load management (e.g. user constraints)

Management of micro-generators and demand side is key element in future smart low-voltage grids!

1. Problem statement and solution approach – the Smart Grid vision
SHSG Project Goals

- Demonstrate how ICT-enabled collaborative aggregations of Smart Houses can achieve maximum energy efficiency

- Concept:
  Aggregate houses as intelligent networked collaborations instead of seeing them as isolated passive units in the energy grid

- Develop real-life technology with potential for mass application across Europe for enabling energy efficiency gains

- EU co-funded, timeline Sept 2008 – Feb 2011
SHSG Project Partners

**Research**

Energy Research Centre of the Netherlands

Fraunhofer Institute for Wind energy and energy system technology

Institute of Communication and Computer Systems

**Industry**

MVV · Energie

SAP

Public Power Corporation (PPC) S.A.

Source: http://www.smarthouse-smartgrid.eu/index.php?id=147
SHSG Key Issues

- ICT and Interfaces for mass scale integration of Smart Houses into Smart Grids


SHSG Key Issues

- Enterprise integration by SOA and optimization at network level
- Electronic markets and Business models

SHSG Key Issues

- Agent-based distributed monitoring and control for large numbers of DER

SHSG Key Issues

- In-house technology for smart customer interaction and energy management
- Smart House market participation using variable tariffs and real-time demand information
Business Cases (selected)

- Joint coordination of smart houses energy use by commercial aggregator through direct access or by incentives (e.g. variable tariffs)
- Aggregation of Smart Houses in Virtual Power Plants for real-time energy balancing by BRP’s
- Utilization of prosumer flexibility for real-time participation in Smart Grid balancing energy markets (e.g. by BRP)
- Day-ahead variable tariff based load and generation shifting (for combination with other business cases)
- Monitoring, Optimization and Visualization Services for improving end users energy efficiency and help reducing energy consumption
- Grid Cell Islanding in case of mains outage, black-start support from Smart Houses

More information:
SHSG D1.1 “High Level system requirements”,
www.smarthouse-smartgrid.eu
SHSG Field Tests

FT A: ICT for Smart House mass application scenario

FT B: Smart house roll-out in Domestic cluster

FT C: Smart Houses supporting the grid in emergency cases

Source: http://www.smarthouse-smartgrid.eu/index.php?id=147
Fieldtest A Technical Architecture

Receives aggr. bids
Computes settlement price

Aggregation of bids and distribution of res. market price

Local device agents exchange supply and demand bids

Objective agents making bids, striving for technical goals

Fieldtest A Key Facts

- Automatic Aggregated Coordination of Smart houses
- Web-Service based information exchange with enterprise systems
- Mass-application strengths: approx. 1 Million smart houses (partly real, partly simulated)
- Applicable to different business cases, e.g. imbalance reduction

4 SHSG Field Tests

Source: K. Kok e.al.: "Smart Houses for a Smart Grid", 20th Int. Conf. on Electricity Distribution (CIRED), Prague, June 2009
Fieldtest B Technical Architecture

Transmission system operator → control energy

Energy service provider (Pool-BEMI)

- Energy management
- Remote meter reading
- Remote supervision

Distribution grid services

Electricity stock market

control energy market

Balance account

Hourly reserve

Electricity stock market

Spot market buy/sell

Energy service provider

Billing

Distribution system operator

Remote meter reading

BEMI: Bidirectional Energy Management Interface

4 SHSG Field Tests
Fieldtest B Key Facts

- ~ 100 smart houses in Mannheim including the ecologic settlement Mannheim-Wallstadt
- Controllable loads, PV and CHP
- Real-life End Customer contact
- Demonstrate new BEMI hardware and software implementation to be used for mass application
- Future field test with further developed business case studies and equipment with up to 1500 customers planned within a separate project
- Applicable business case: Day-ahead variable tariff based load and generation shifting combined with others to achieve win-win-win situation

4 SHSG Field Tests
Fieldtest B Gateway Framework

Open source operating system (e.g. Linux)

OGEMA for energy management

- user display
- co-generation
- loads
- smart meter
- fridge app
- resource admin
- emergency power reduction

4 SHSG Field Tests
Fieldtest C Technical Architecture

- Multi-agent system (MAS)
- Every agent controls one unit, e.g. DG
- Agent characteristics:
  - capable of *actions*  
    e.g. switch operation
  - with respect to *resources*  
    e.g. fuel level
  - to carry out *behaviours*  
    e.g. battery management
- Local decisions by single or cooperating agents
- Agents decide how to realize system goals, e.g. Microgrid power schedules

4 SHSG Field Tests
Fieldtest C Key Facts

- Meltemi: Seaside camping site near Athens
- Microgrid-like electrical LV network with Diesel generator and PV
- Testing ability of Smart House cluster for transition into electrical isolation
- Testing provision of ancillary services, e.g. load shedding to avoid grid congestions, Black Start ability
- Using new Multi-agent system algorithms and intelligent load controller hardware

4 SHSG Field Tests
Conclusion and Outlook

Smart Grid is **key technology** for reaching energy efficiency goals

Smart Houses are **key Building Block** for Smart Grids

Consumers become **Prosumers**

We need a Roadmap to **mass-application**!

→ **Field test results coming up in 2010**

Thank you for your kind attention!

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