Smart House and Smart Grid

www.smarthouse-smartgrid.eu

SEVENTH FRAMEWORK PROGRAMME

2011 IEEE SmartGridComm, European Smart Grid projects workshop
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SmartHouse/SmartGrid

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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

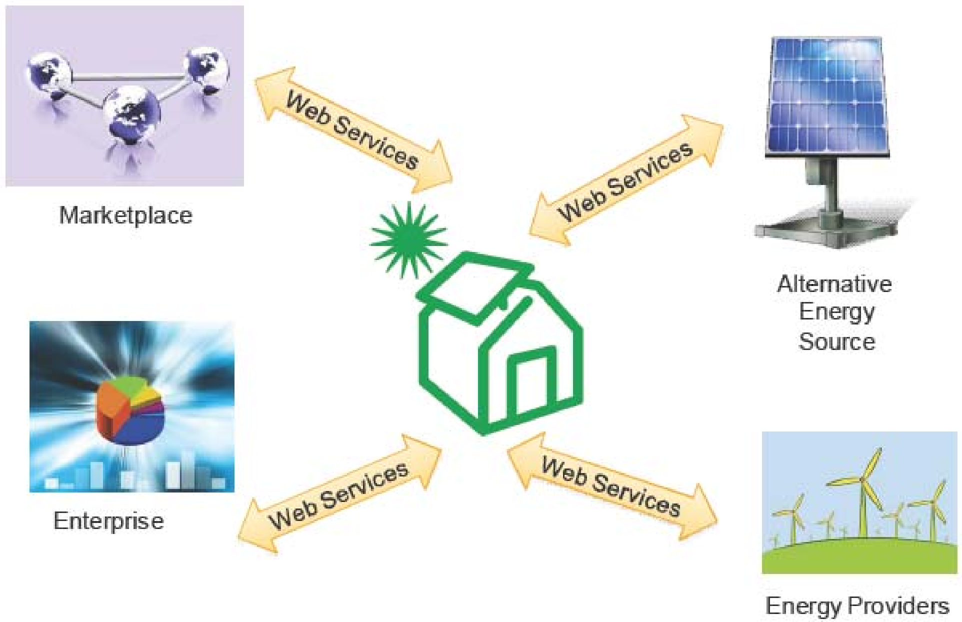
  with potential for mass application across Europe

  for enabling energy efficiency gains
- EU co-funded, timeline Sept 2008 – Aug 2011

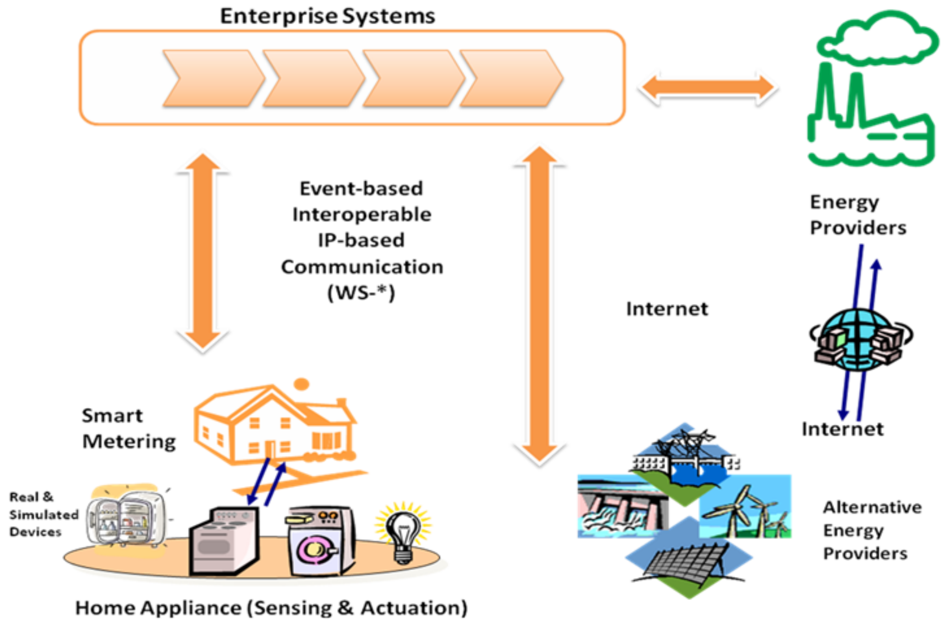
SHSG Key Issues

SmartHouse/SmartGrid

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



Source: SHSG Deliverable D2.1, „In-house architecture and interface description“, June 2009, www.smarthouse-smartgrid.eu



Source: SHSG Deliverable D1.2, „Technology Trends for SmartHouse/SmartGrid“, Feb 2009, www.smarthouse-smartgrid.eu

SHSG Field Tests

SmartHouse/SmartGrid

FT A: ICT for Smart House mass application scenario

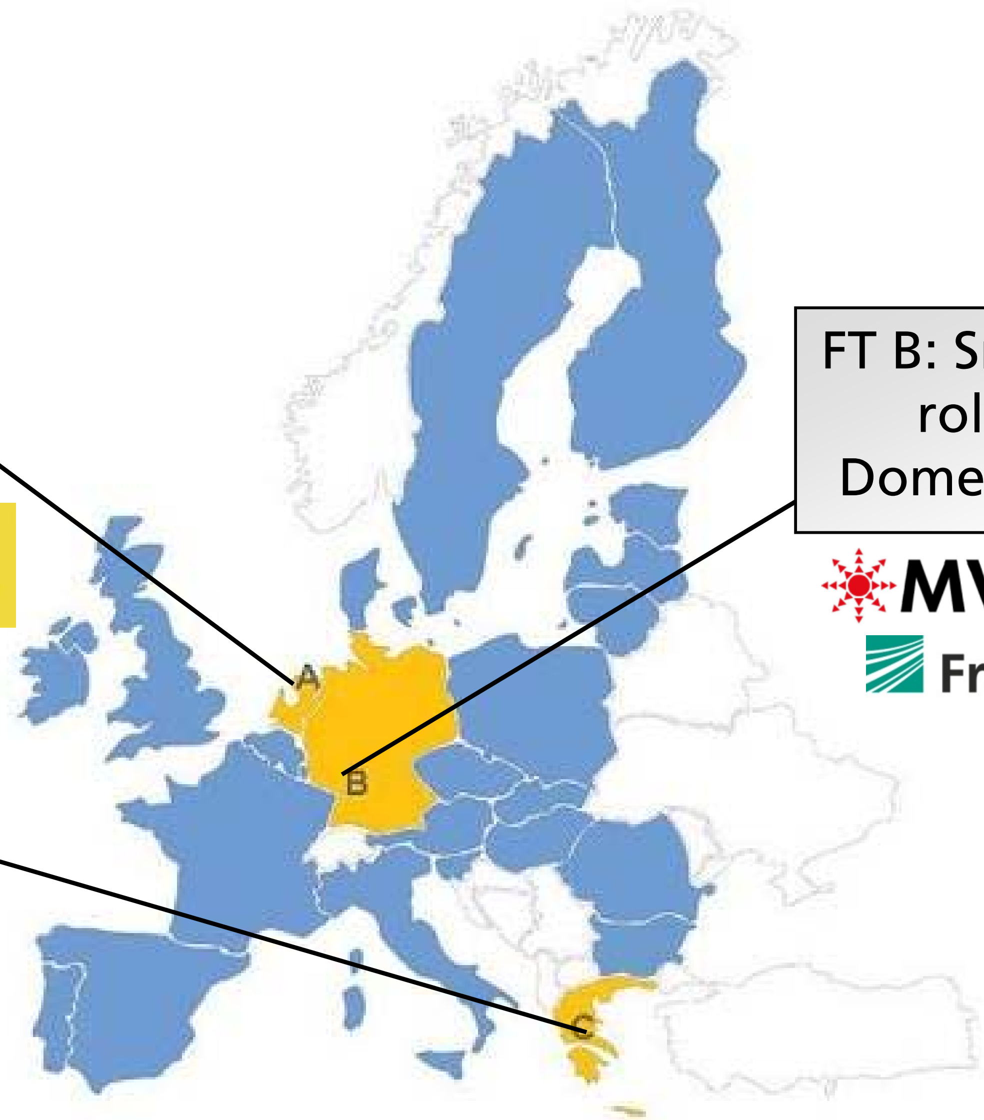
SAP ECN Energy research Centre of the Netherlands

FT B: Smart house roll-out in Domestic cluster

MVV Energie
Fraunhofer IWES

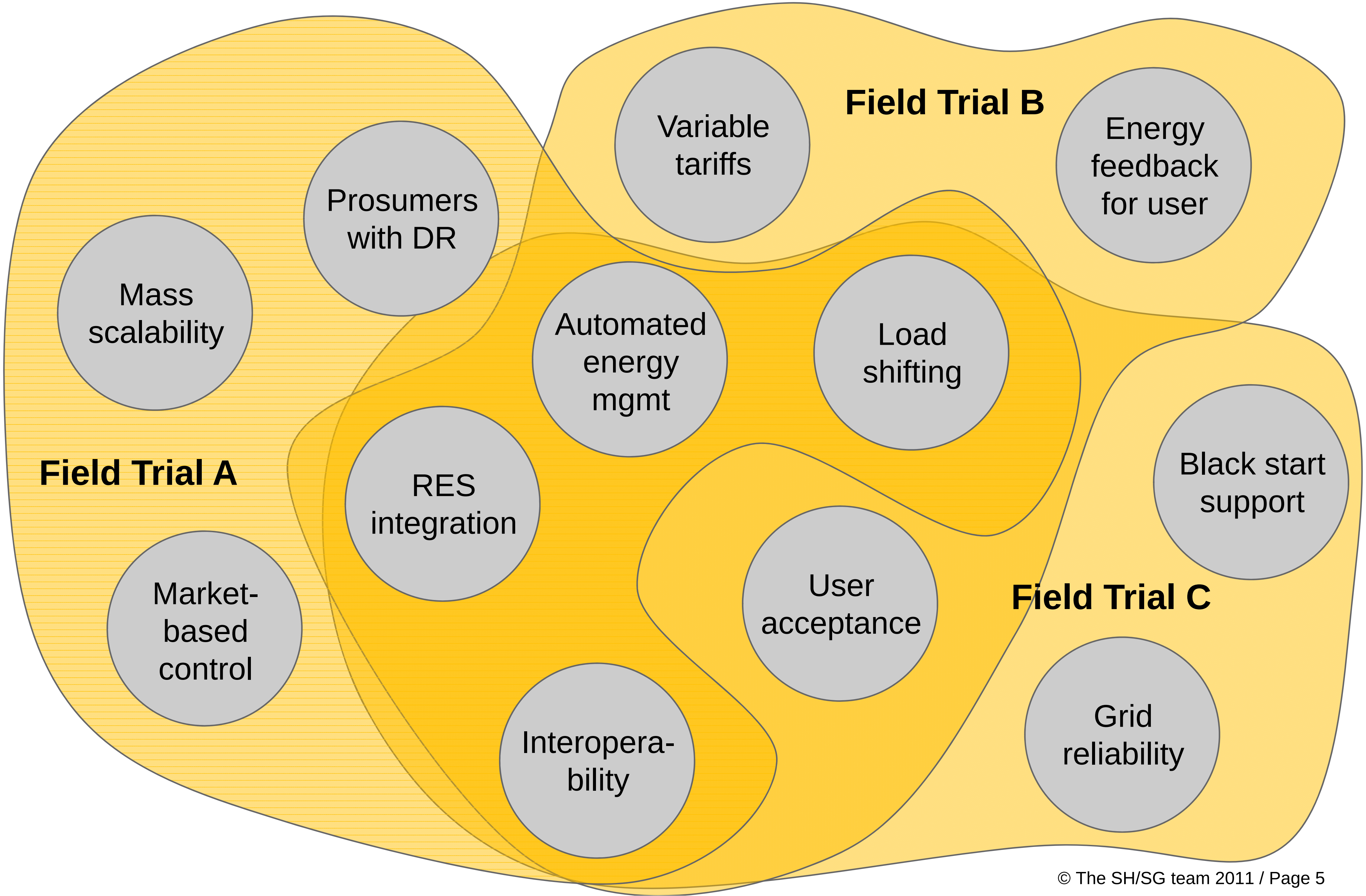
FT C: Smart Houses supporting the grid in emergency cases

ICCS-NTUA



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

SH/SG Architecture Functionalities



Amalgamated Service Architecture
Basic Concepts

SmartHouse/SmartGrid

Power Matcher	BEMI	MAGIC
• Decentralized decision making • Automated control of production and consumption units	• Decentralized decision making • Automated control of production and consumption units	• Decentralized decision making • Automated control of production and consumption units
• Decision-making based on centralized market equilibrium	• Decision-making based on centralized tariff generation	• Decision-making based on centralized negotiation
• Real-time mapping of demand and supply	• Day ahead mapping of demand and supply	• Mapping of demand and supply

Source: The SH/SG Team, 2011

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Simulation Team A – Study 1 setup

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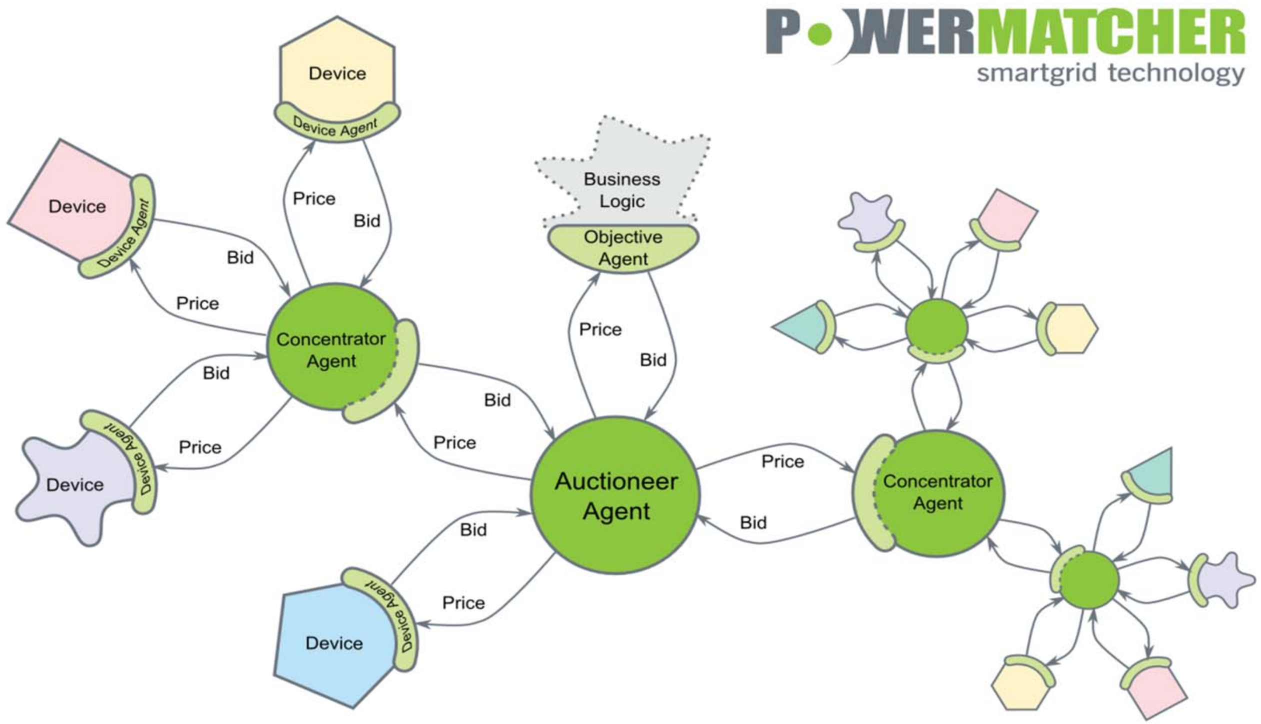
- 3000 Households, 1500 with micro CHP, 1500 with heat pumps
  - Scaling down from 2040 Dutch network scenario
    - Offshore wind installed power: 750 ... 1000 kW
- Comparision of operation in 2 November weeks with and without PowerMatcher controlling micro CHP and heat pumps



Source: The SH/SG Team, 2011

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Simulation Team A – Study 1 results

SmartHouse/SmartGrid

Effects of PowerMatcher control:

- Energy Exports reduced by 90 ... 65 % → less need for export capacity
  - Energy Imports reduced by 14 ... 21 % → potential CO_2 reduction

AMOUNT OF TOTAL IMPORT FOR EACH CASE			
Offshore Wind	Traditional	PowerMatcher	Reduction
750 kW	27389 kWh	23447 kWh	14%
800 kW	26287 kWh	22154 kWh	16%
850 kW	25218 kWh	20920 kWh	17%
900 kW	24178 kWh	19739 kWh	18%
1000 kW	22194 kWh	17478 kWh	21%

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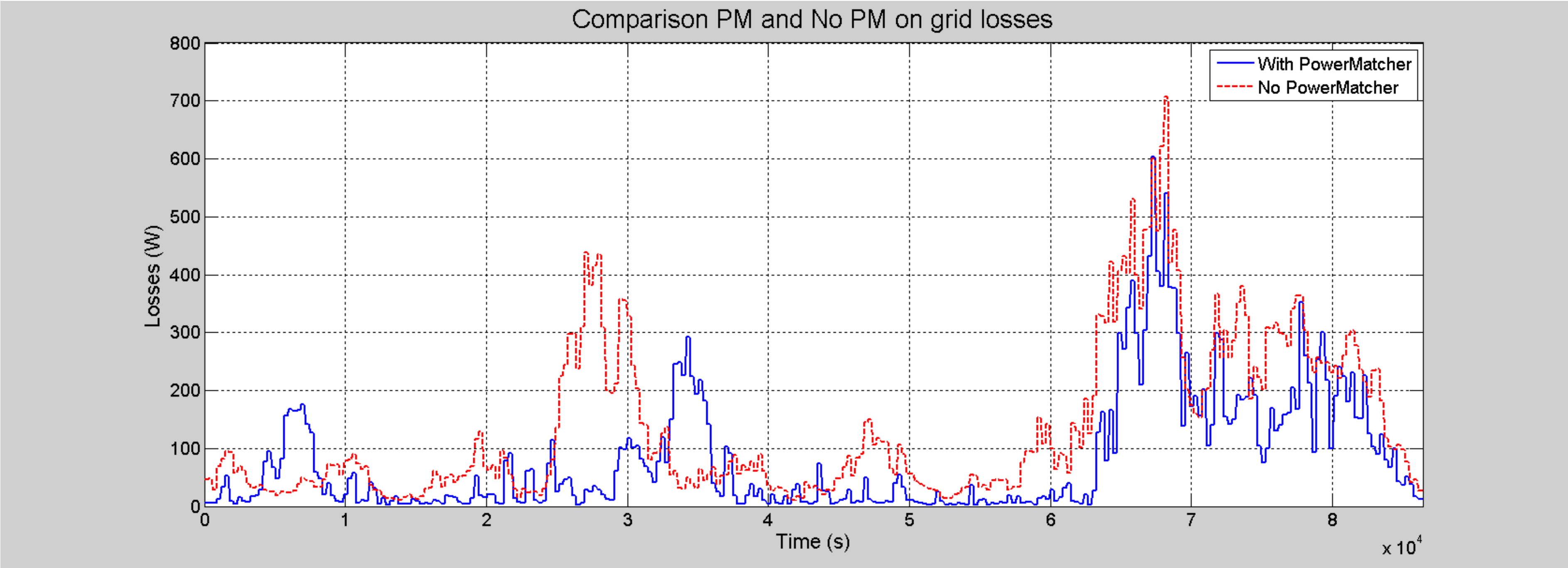
Simulation Team A – Study 2
Results (cable losses)



- Considering fictive LV feeder, 25 households, 12 with heat pumps, 13 with micro CHP
- Cable loss reduction from 11.7MJ to 7.0MJ by adding PowerMatcher control
  - I.e. 1.3kWh of energy / day or annually 100+ euro / 25 households

Source: The SH/SG Team, 2011

Simulation Team C overview

SmartHouse/SmartGrid

Simulation for the year 2030 of the autonomous system of Crete

for various load control scenarios

- Steady-state simulation
  - economic dispatch
  - load flow analysis
- Transient analysis

The Cretan System:

1. 690MW installed thermal capacity on 3 power plants (Chania, Atherinolakkos, Linoperamata)
2. 166MW installed wind power capacity (December 2009), most on the eastern part of the island
3. Since 2000, wind energy accounts for around 10% of the annual energy demand of the island

Source: The SH/SG Team, 2011

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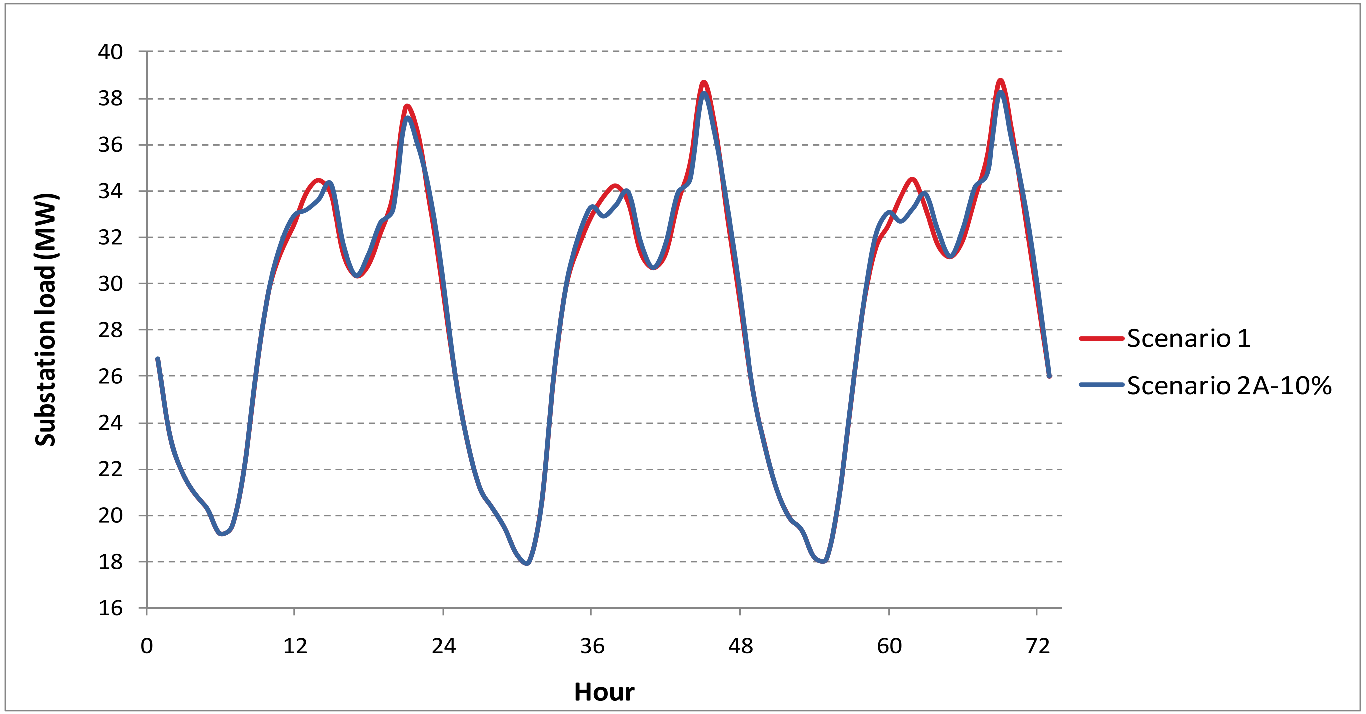
Simulation Team C load control scenarios

SmartHouse/SmartGrid

Scenario 1 (Business as usual): no load control actions considered

Scenario 2 Various levels of controllable load (water heaters & A/C) considered (varying from 10% to 30%)

- Scenario 2A: load control is performed equally to all the regions of Crete
- Scenario 2B: load control is performed primarily to the households of Chania and Iraklio, which are the most populated cities of the island



Reduction of peak demand: as high as 4.49% (annual average) depending on the scenario

Source: The SH/SG Team, 2011

Simulation Team C results

SmartHouse/SmartGrid

CO2 emissions (tonnes) per Scenario –
Percent change of CO2 emissions with respect to Scenario 1

	Scenario 1	Scenario 2A		Scenario 2B	
10%	1,468,351	1,467,728	-0.04%	1,465,906	-0.17%
20%		1,466,253	-0.14%		
30%		1,464,271	-0.28%		

Higher load control penetration level improves CO2 reduction

Operational cost (€) per Scenario – percent change with respect to Scenario 1

	Scenario 1	Scenario 2A		Scenario 2B	
10%	215,957,553	215,204,940	-0.35%	214,455,919	-0.70%
20%		212,843,853	-1.44%		
30%		213,694,172	-1.05%		

An optimum load control penetration level exists. Controller location is relevant.

Transient analysis: Load shedding supports system frequency from reaching low levels - should be part of a complete protection scheme

Source: The SH/SG Team, 2011

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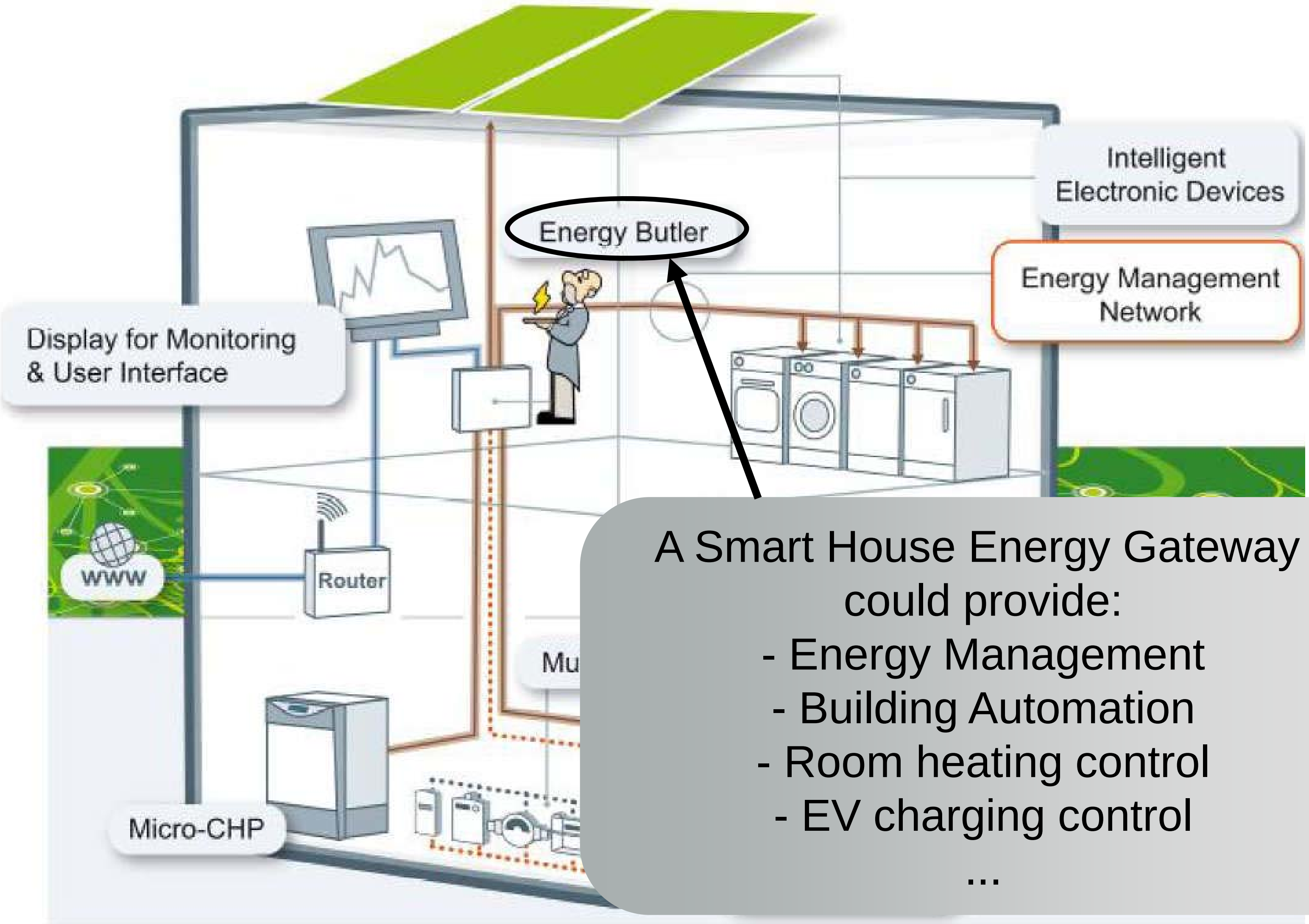
Field Test B (Mannheim, Germany)



A Smart House Energy Gateway could provide:
- Energy Management
- Building Automation
- Room heating control
- EV charging control
...

Source: MVV Energie AG, Mannheim

OGEMA Key Facts

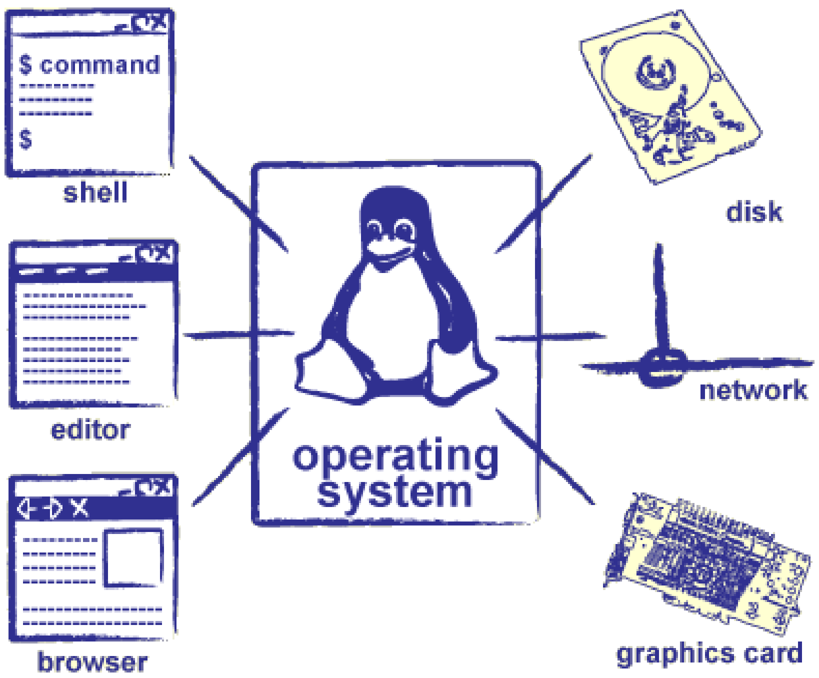
SmartHouse/SmartGrid

- OGEMA defines gateway core specification
- Environment for parallel execution of different applications with access to smart grid data and devices (e.g. controllable loads)
- Standardized data models and services for different home automation systems
- Support of different in-house and smart grid communication systems
- OGEMA defines a public open standard
- Public (open source) reference implementation for quick start

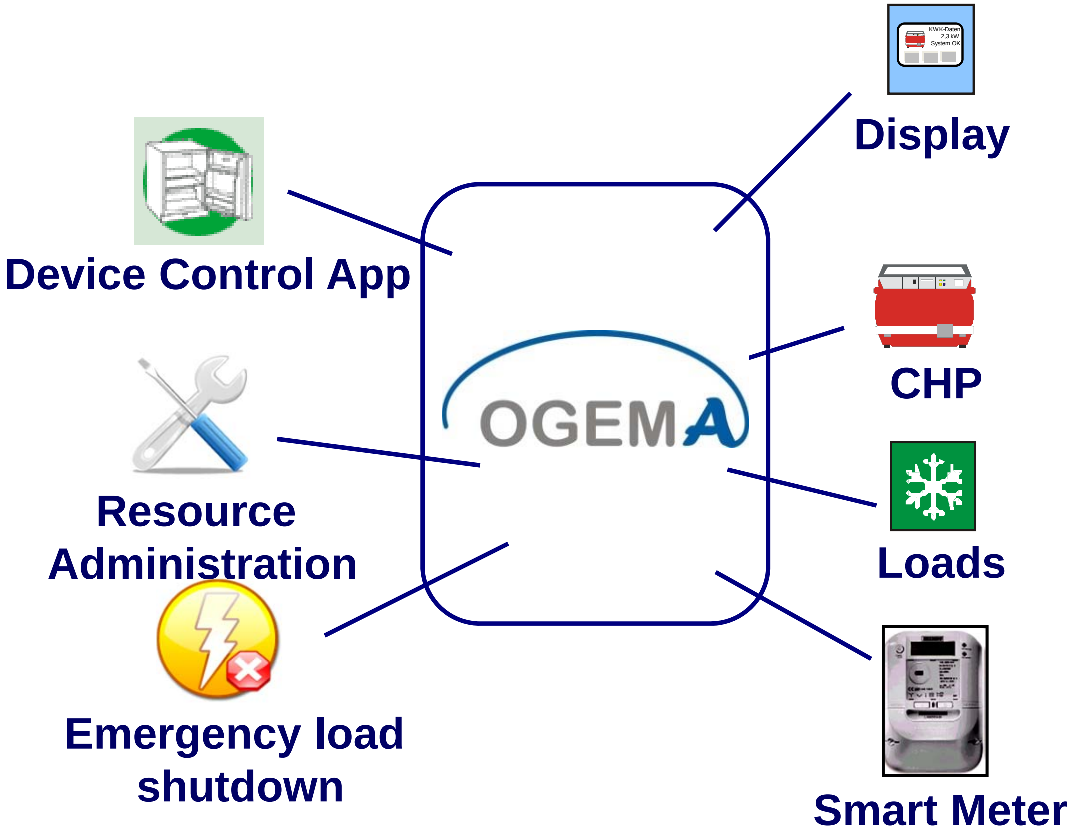
Open Gateway Energy Management Alliance (OGEMA)

SmartHouse/SmartGrid

Open source Operating system (e.g. Linux)



OGEMA for Energy management



www.ogema-alliance.org

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Open Gateway Energy Management Alliance (OGEMA)

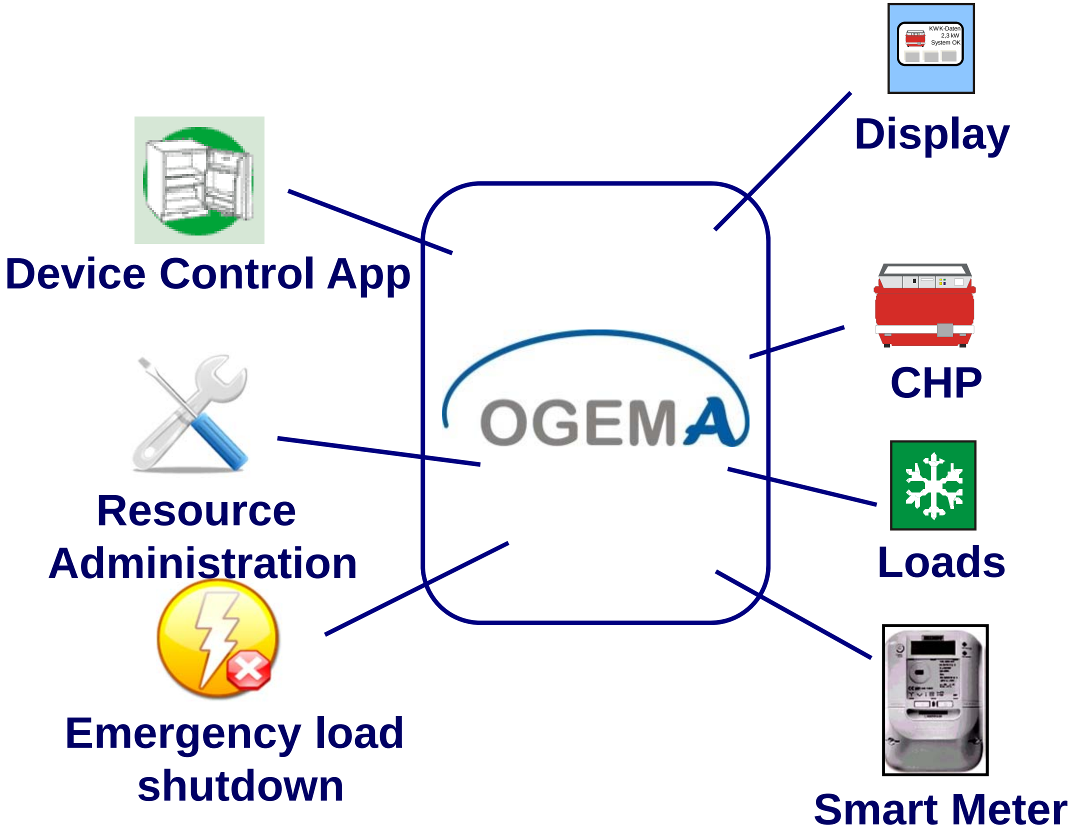
OGEMA features:

- applications from different manufacturers run in parallel
- standardized data models
- flexible and modularized architecture

OGEMA goals:

- develop an open, manufacturer-independent standard
- develop and test open source reference implementation
- pave the way for energy management gateway mass-roll out

OGEMA for Energy management



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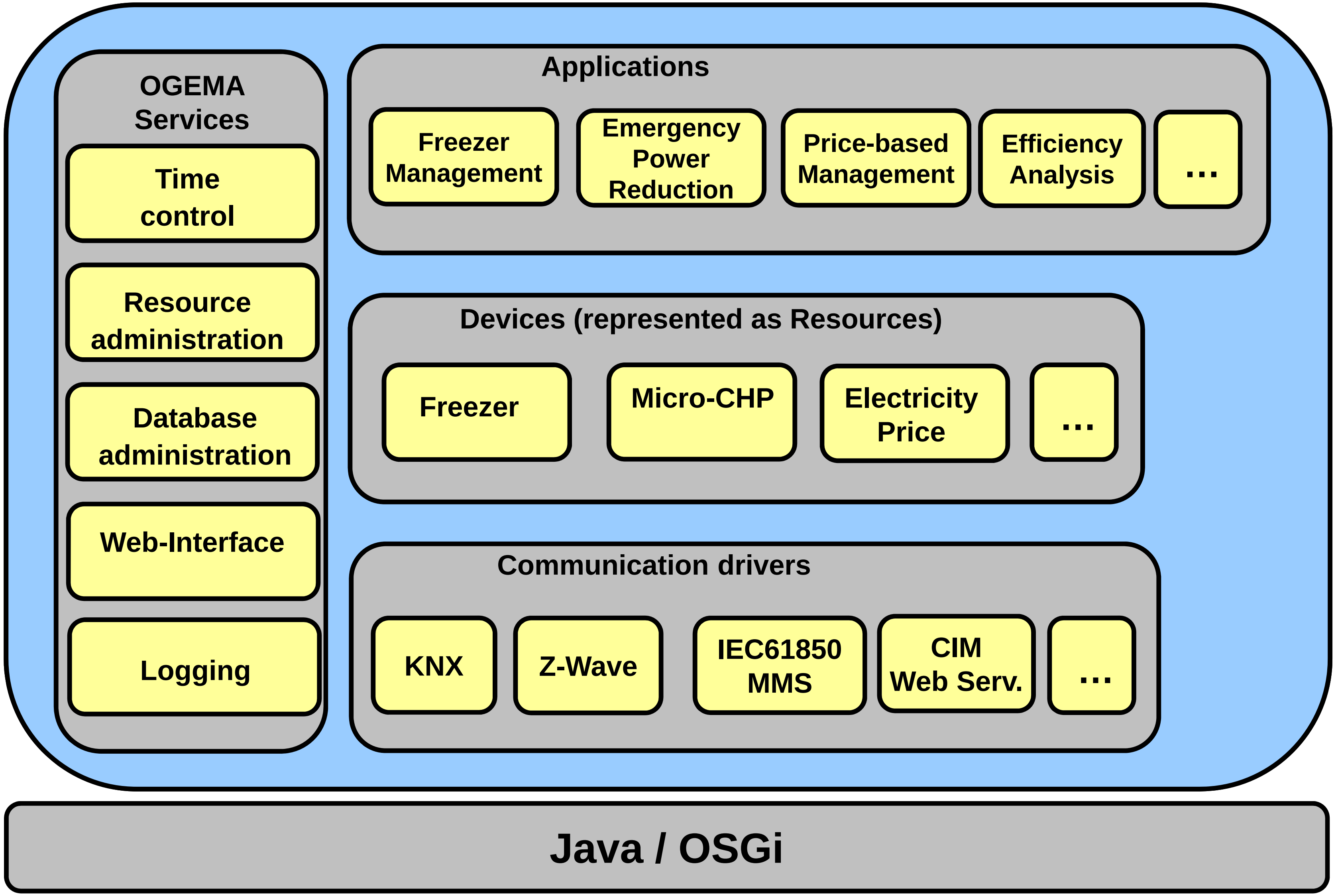

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Thank you for your attention!

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http://www.ogema-alliance.org

http://www.modellstadt-mannheim.de

http://www.smarthouse-smartgrid.eu

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