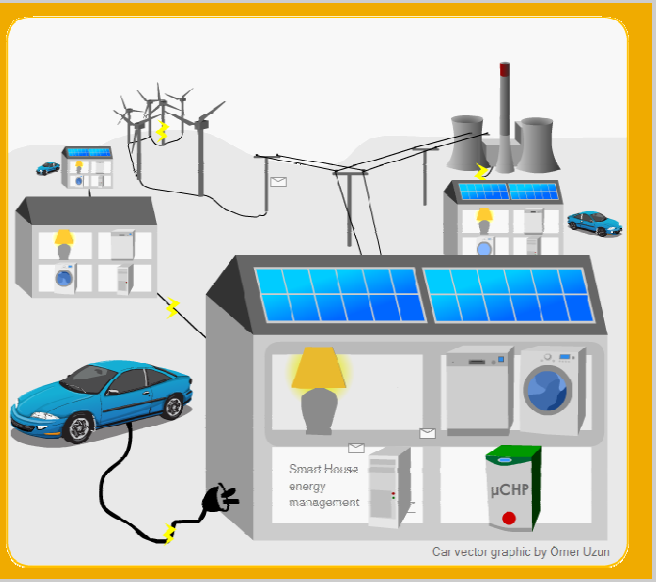
# SmartHouse/SmartGrid

Smart Houses Interacting with Smart Grids to achieve next-generation energy efficiency and sustainability

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GREEMBED

Stockholm, 12 April 2010

SmartHouse/SmartGrid

SEVENTH FRAMEWORK
PROGRAMME

# Agenda

1. **The SmartHouse/SmartGrid Project – Overview**
2. The Envisaged “Internet of Energy”
3. Device Integration
4. SmartHouse/SmartGrid Business Cases and Enterprise Integration
5. Wrap-Up and Next Steps

# Facts and Figures

Timeline of the project: Sep 2008 – Feb 2011 (30 months)

Six project partners in three Member States

- Coordinator: SAP Research
  - Enterprise integration, business processes, web services
- Institute for Wind Energy and Energy System Technology (IWES)
  - Bi-directional Energy Management Interface (BEMI)
- MVV Energie AG
  - Concept of the „Energiebutler“
- Energy Research Center of the Netherlands (ECN)
  - Multi-Agent System architecture (PowerMatcher)
- Institute of Communication and Computer Systems (ICCS), NTUA
  - Agent-based control in power systems
- Public Power Corporation (PPC), Greece
  - Renewable and diesel island power grid

# Project Objectives

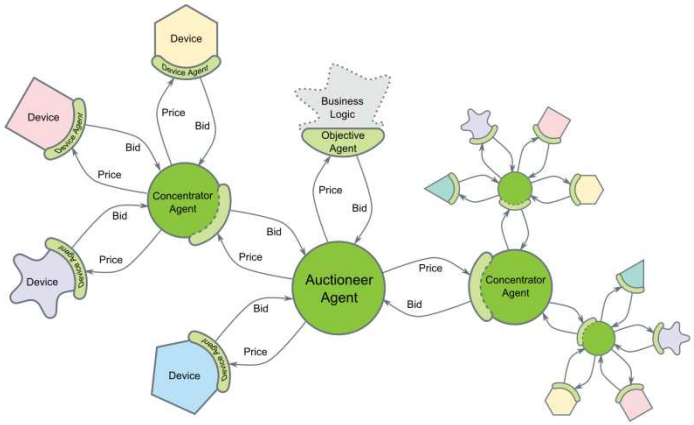
The goal is to *demonstrate how ICT-enabled collaborative aggregations of Smart Houses can achieve maximum energy efficiency*

- Customer-interactive in-house technology for energy management
  - Demand side: real-time information and dynamic tariffs
  - Customer as prosumer: generation within the house can be integrated into the system
- Interaction with the Smart Grid
- Distributed control in a decentralized energy world
  - Intelligent agent-based control
  - Web services at the device level and at higher system levels
- Electronic markets and forecasting techniques

# The Project Core: Field Trials

Trial A: Mass application scenario

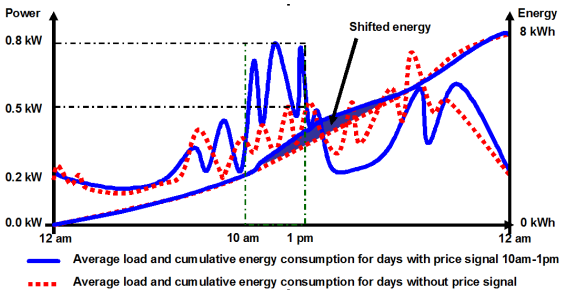
- Location: The Netherlands
- Validation of multi-agent system based aggregation of Smart Houses for maximizing efficiency
- Electricity trading via PowerMatcher protocol
- Integration of domestic appliances and µCHP plants
- Testing scalability for mass application
- Simulation with real households and additional entities mimicking the households‘ behavior




# The Project Core: Field Trials

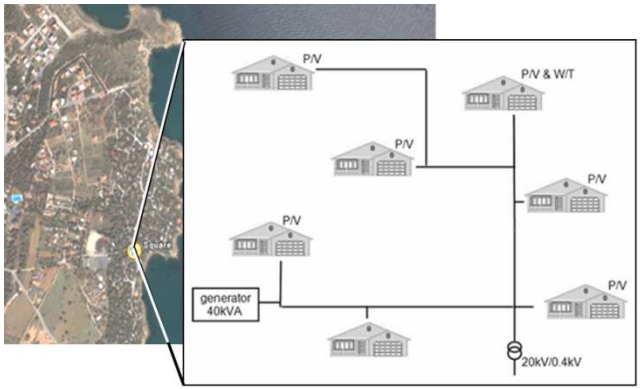
## Trial B: Domestic cluster Mannheim

- Carried out by MVV (= supplier and DSO)
- 100 Smart Houses in an ecological settlement
- Photovoltaic and CHP in many houses
- Prior experiment „Washing with the sun“ (2006)
- Validation of the BEMI developed by IWES
- Testing the ability to control a network of energy devices in a decentralized manner for achieving higher efficiency




## Trial C: Micro-grid operation Meltemi, Greece

- Seaside camping site
- Diesel generator and photovoltaic panels
- Island mode operation
- Testing the ability to provide ancillary services such as load shedding support



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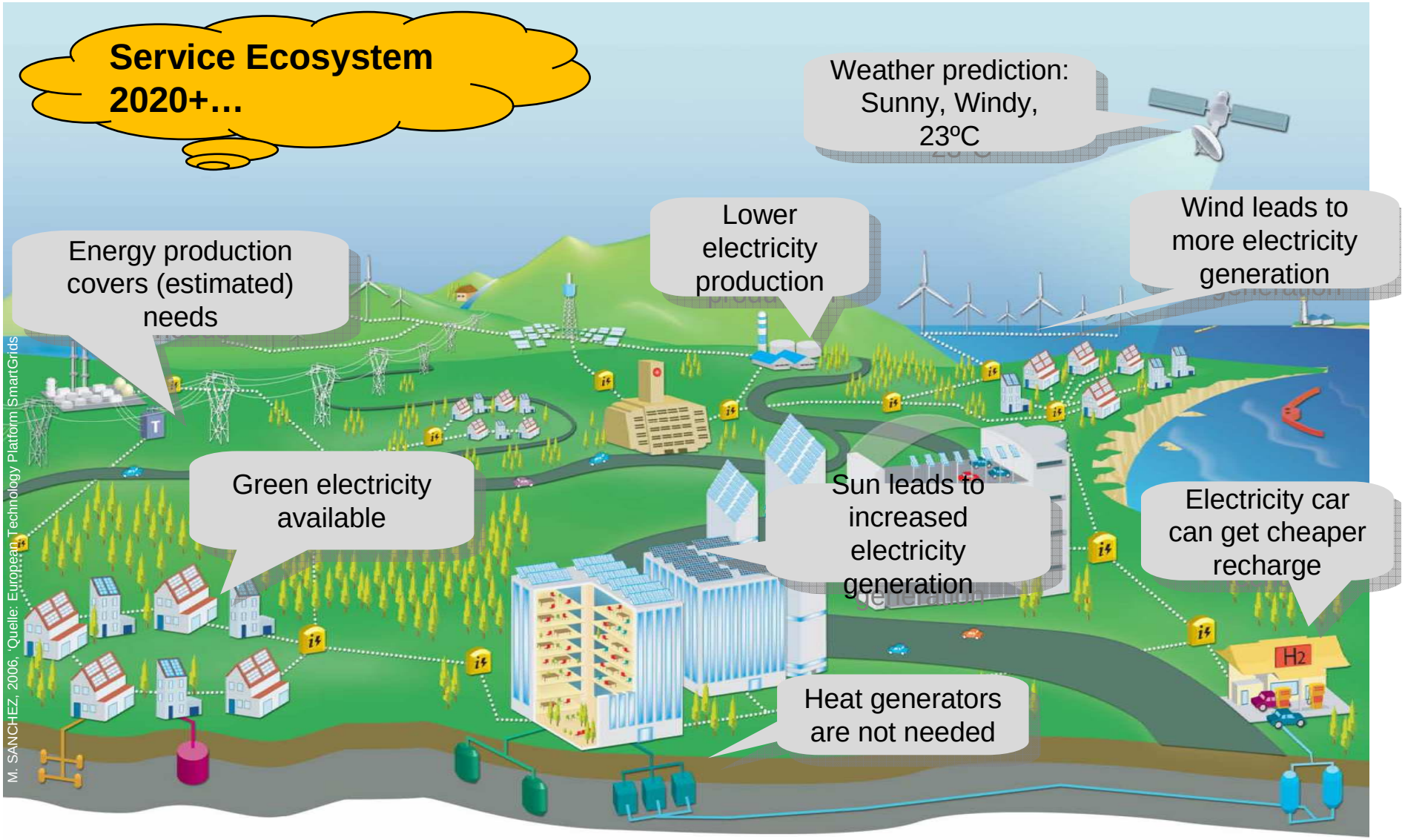
# An ICT-based System of Systems



# Goals of Intelligent Energy System Operation

## Avoid peaks, spread shoulders

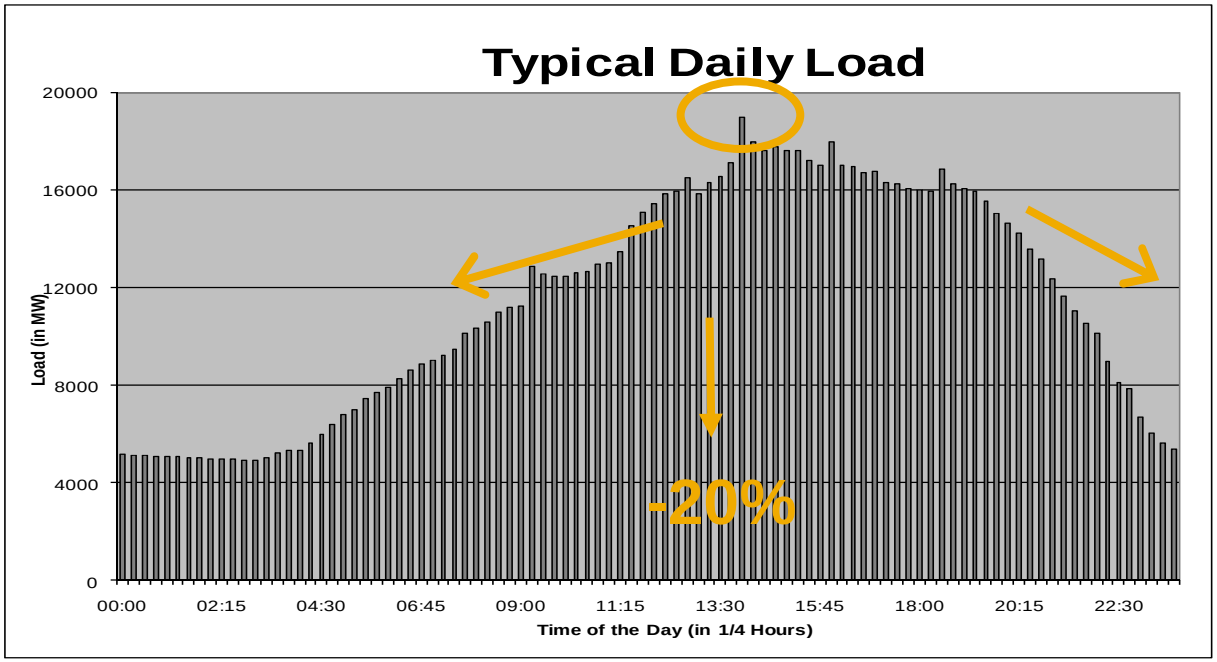
- Use demand side management (e.g. dynamic pricing) and load-shedding
- Enable load shifting

## Increase DES & renewables

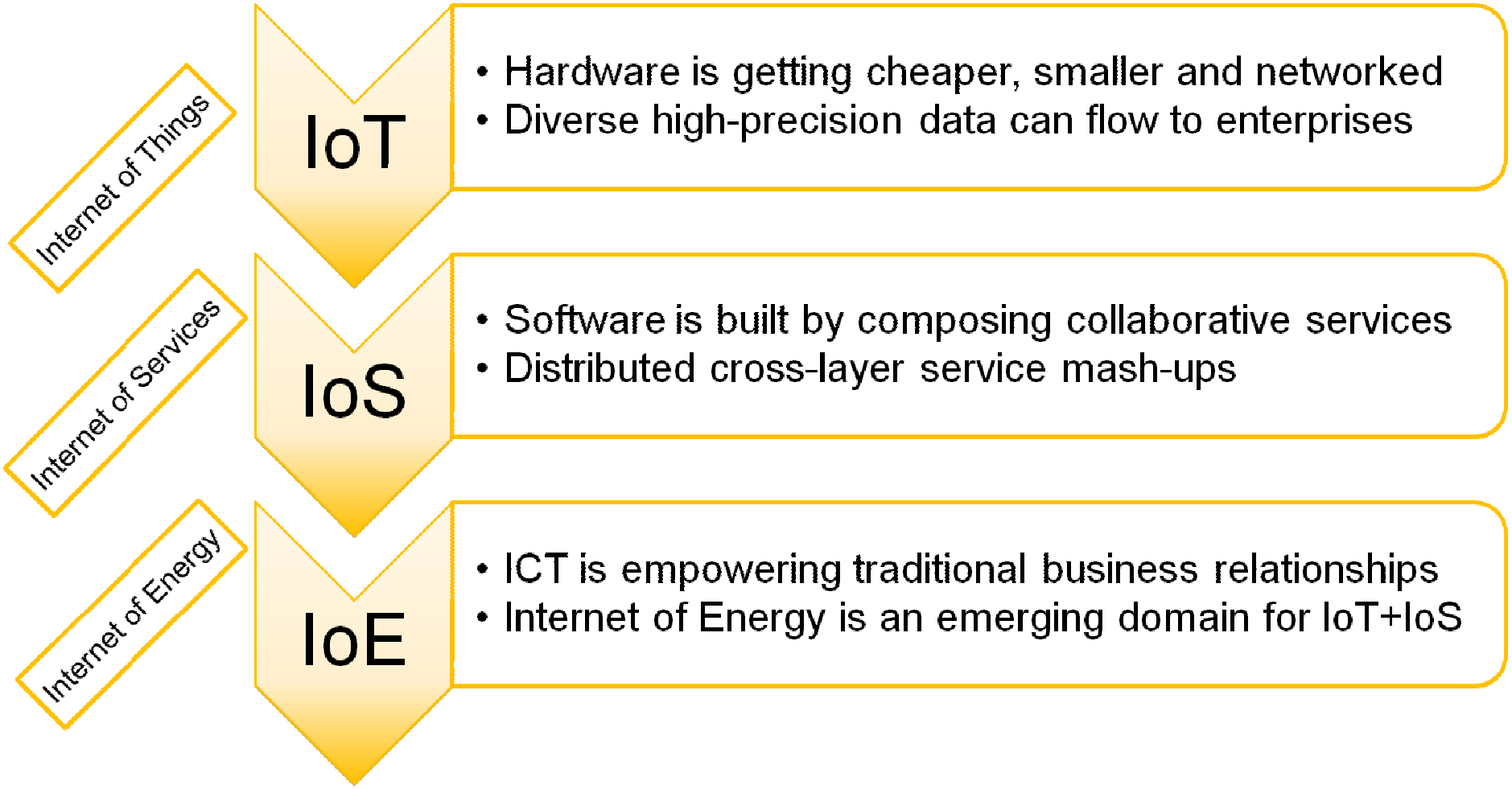
- Adapt to availability of renewable, volatile energy resources
- Integrate other decentralized generation, e.g. CHP plants

## Reduce consumption

- Stimulate innovation through market-driven pricing



# The Emerging Internet of Energy



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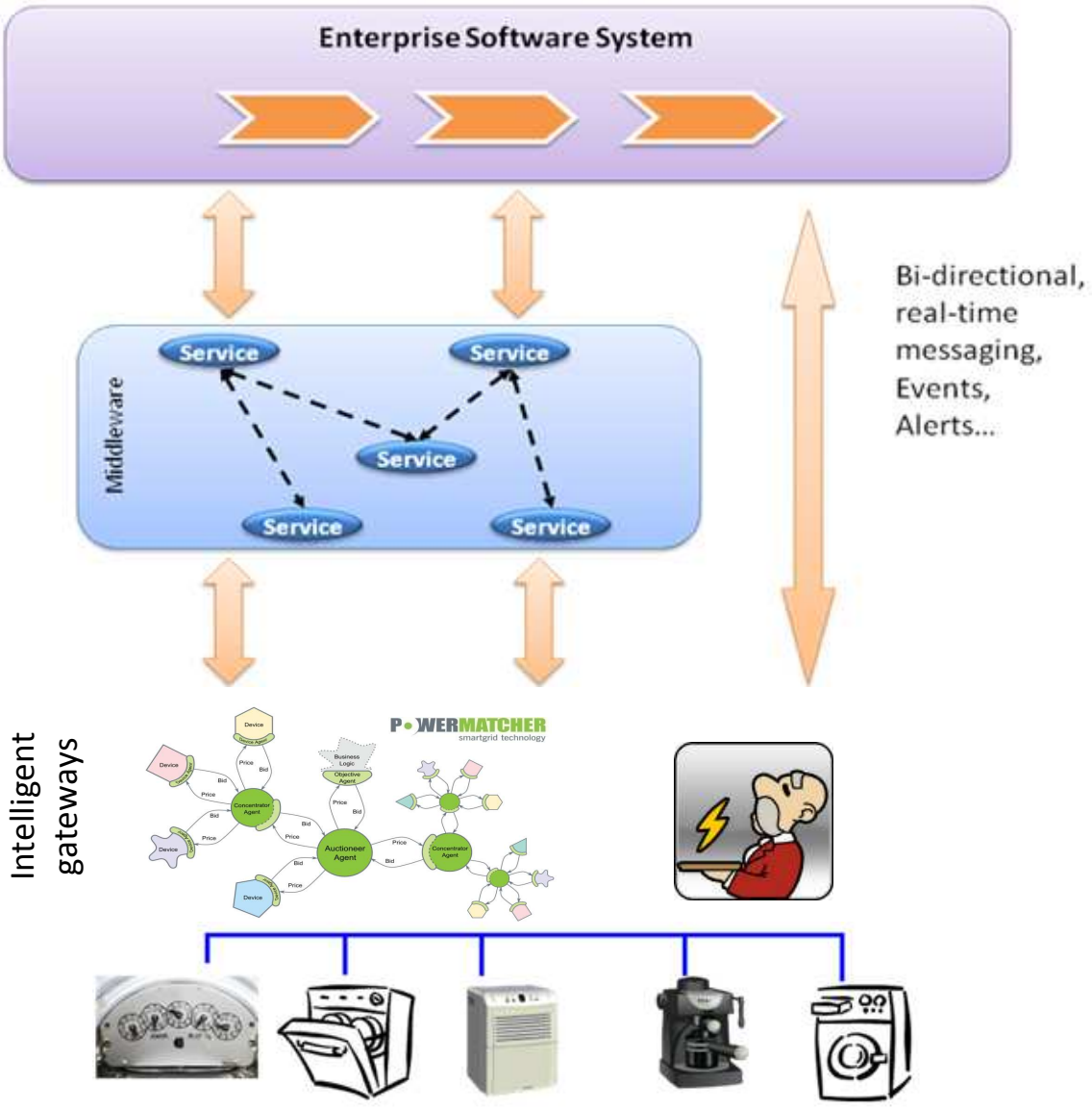
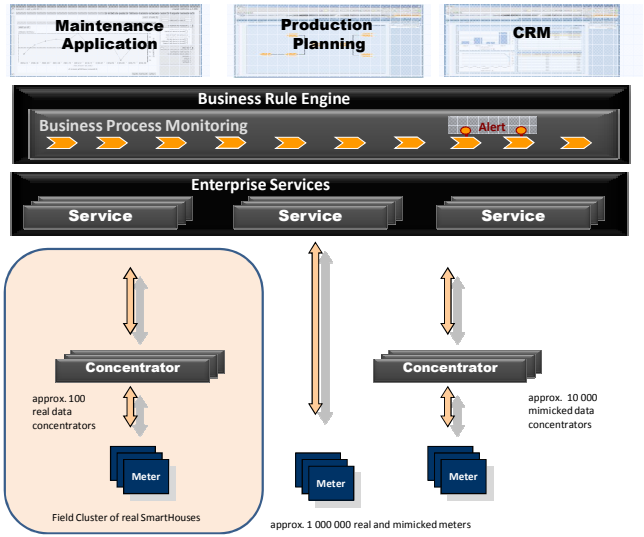
# Smart House/Grid-to-Enterprise



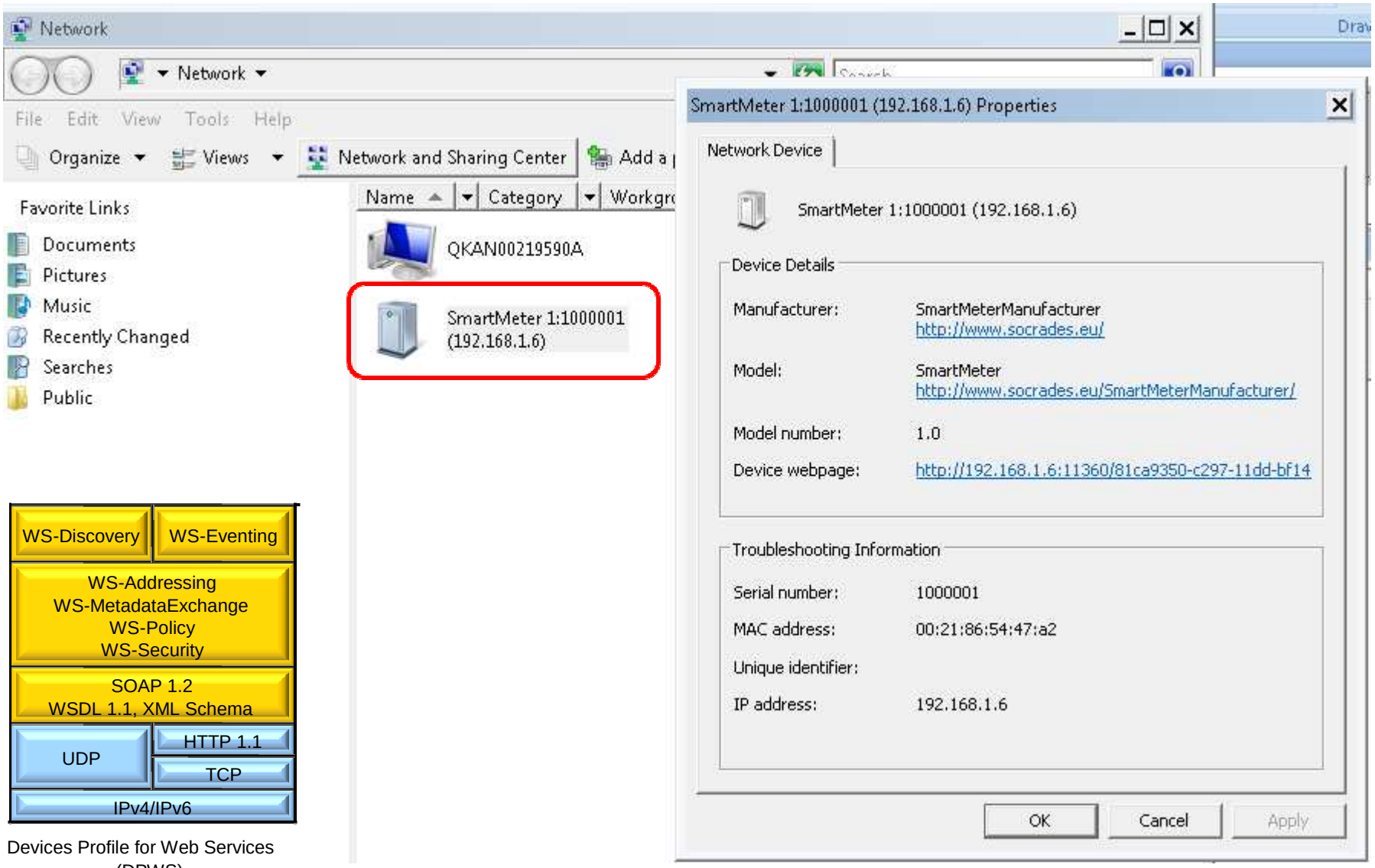
# Scalability and Interoperability through SOA

Service-oriented architectures (SOA) allow flexible composition of functionality

- Embedded services within smart meters home gateways and and household devices
- Higher-level services for business applications
- SOA can ensure interoperability and compatibility in heterogeneous software environments



# DPWS: Easing Asset Management



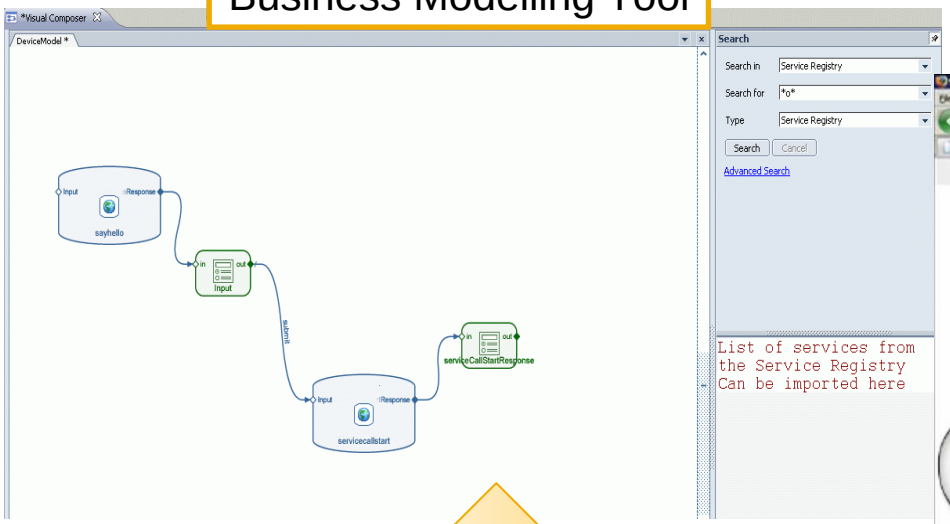




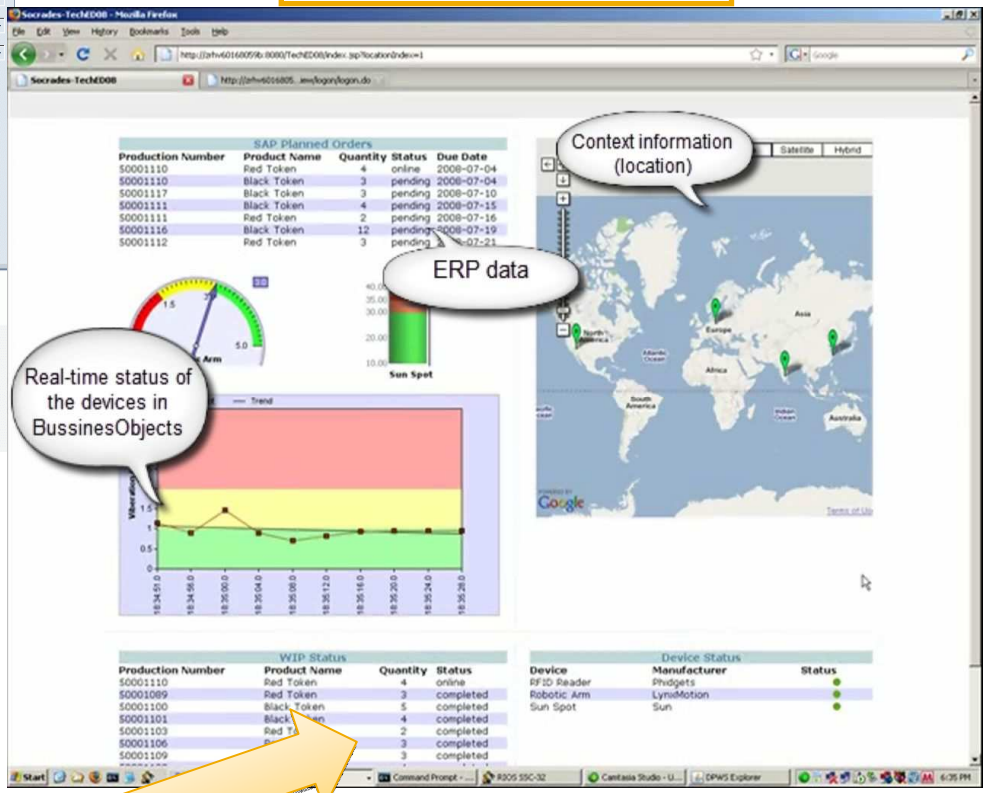
Devices Profile for Web Services (DPWS) protocol stack

# Example: Direct Interaction with Smart Meters

Business Modelling Tool

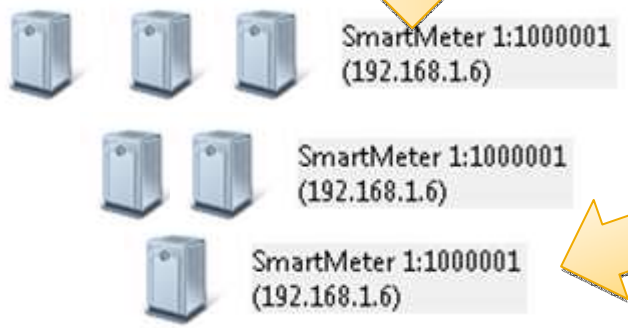



Reporting in real-time




SOA Meters

Service based modelling




Real-time Events

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# SH/SG Business Cases

## (1) Aggregation of Houses as Intelligently Networked Collaborations

- Overarching business case

## (2) Variable-Tariff-Based Load and Generation Shifting

- Day-ahead price profile communicated to the smart house
- Response from in-home demand and supply: automated and behavioral

## (3) Energy Usage Monitoring and Feedback

- Home display
- Increase energy awareness & stimulate behavioral changes

## (4) Real-time Portfolio Imbalance Reduction

- Balancing Responsible Party: counteract portfolio unpredictability
- Use smart-house near-real time flexibility for portfolio balancing
- Automated response using market-based control (Virtual Power Plant, VPP)

## (5) Offering (secondary) Reserve Capacity to the TSO

- As previous, with active VPP participation into reserve capacity wholesale market

# SH/SG Business Cases (contd.)

## (6) Distribution System Congestion Management

- Deferral of grid reinforcements and enhancement of network utilization
- Active distribution management using services delivered by smart houses
- End-customer loads shifted away from congestion periods
- Improvement of simultaneousness in local supply and demand

## (7) Distribution Grid Cell Islanding in Case of Higher-System Instability

- Operation of a grid cell in island mode in case of higher-system instability
- Automatic transition to and from island mode
- Improve security of supply

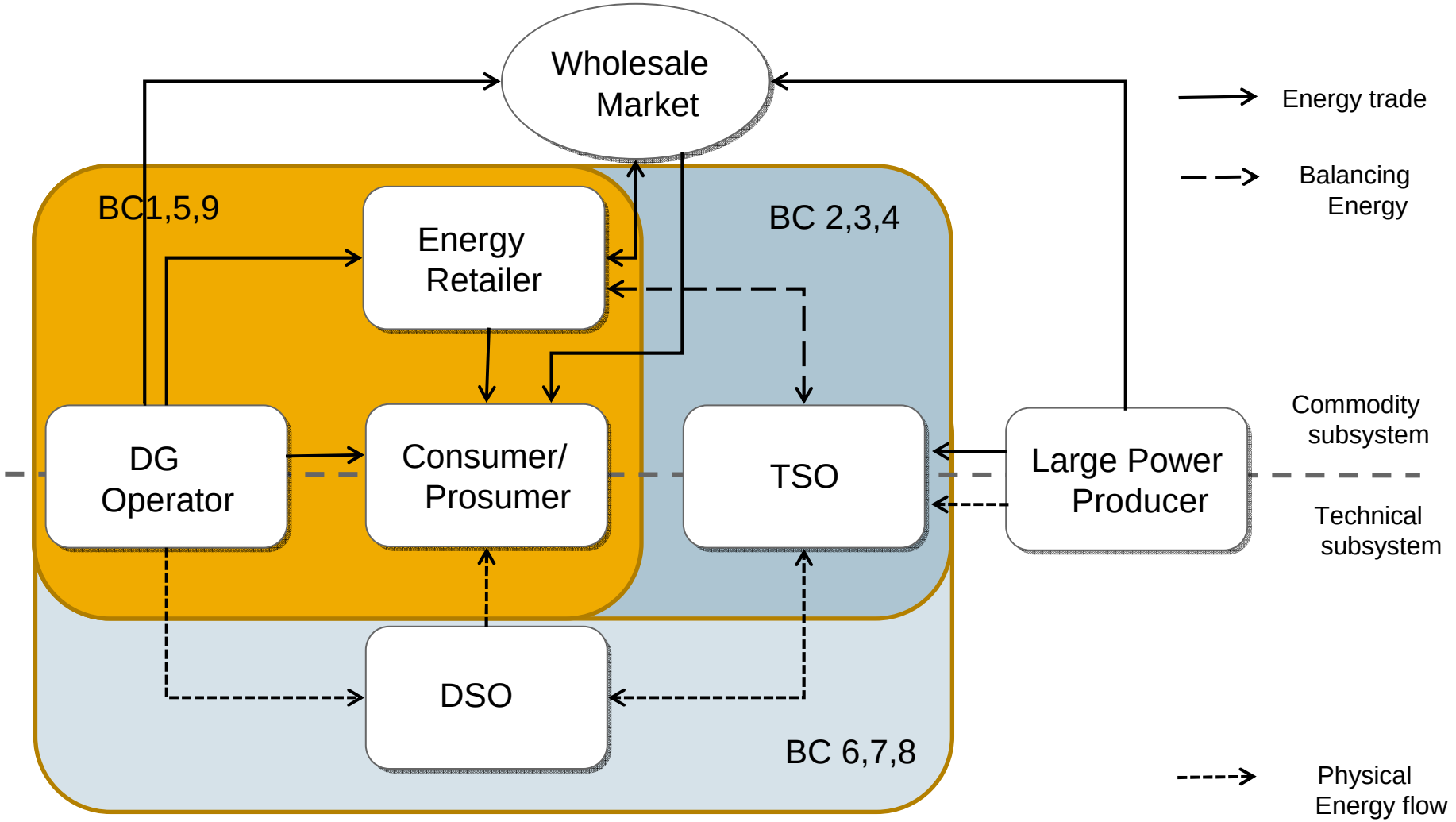
## (8) Black-Start Support from Smart Houses

- Smart-house support to black start operation of the main grid

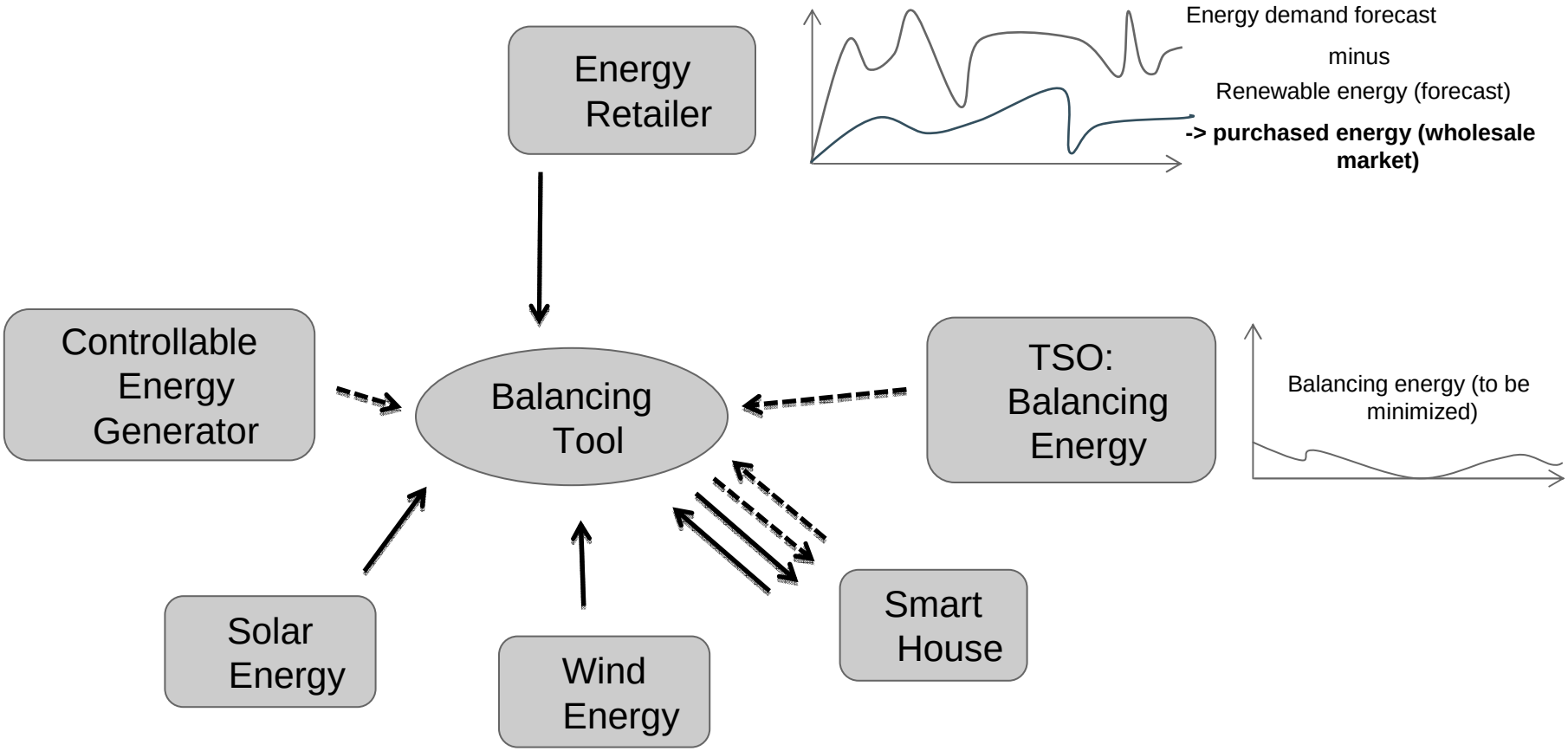
## (9) Integration of Forecasting Techniques

- Market actor: strengthen market position by reducing forecasting errors (distributed generators, large-scale wind)
- SH/SG ICT architecture: interaction with external forecasting tools

# Electricity Market Participants and their Business Cases



# Role of the Energy Retailer



# Required Functionality for the Energy Retailer – Overview

Provider of Weather Forecast

Consumer

DG Operator

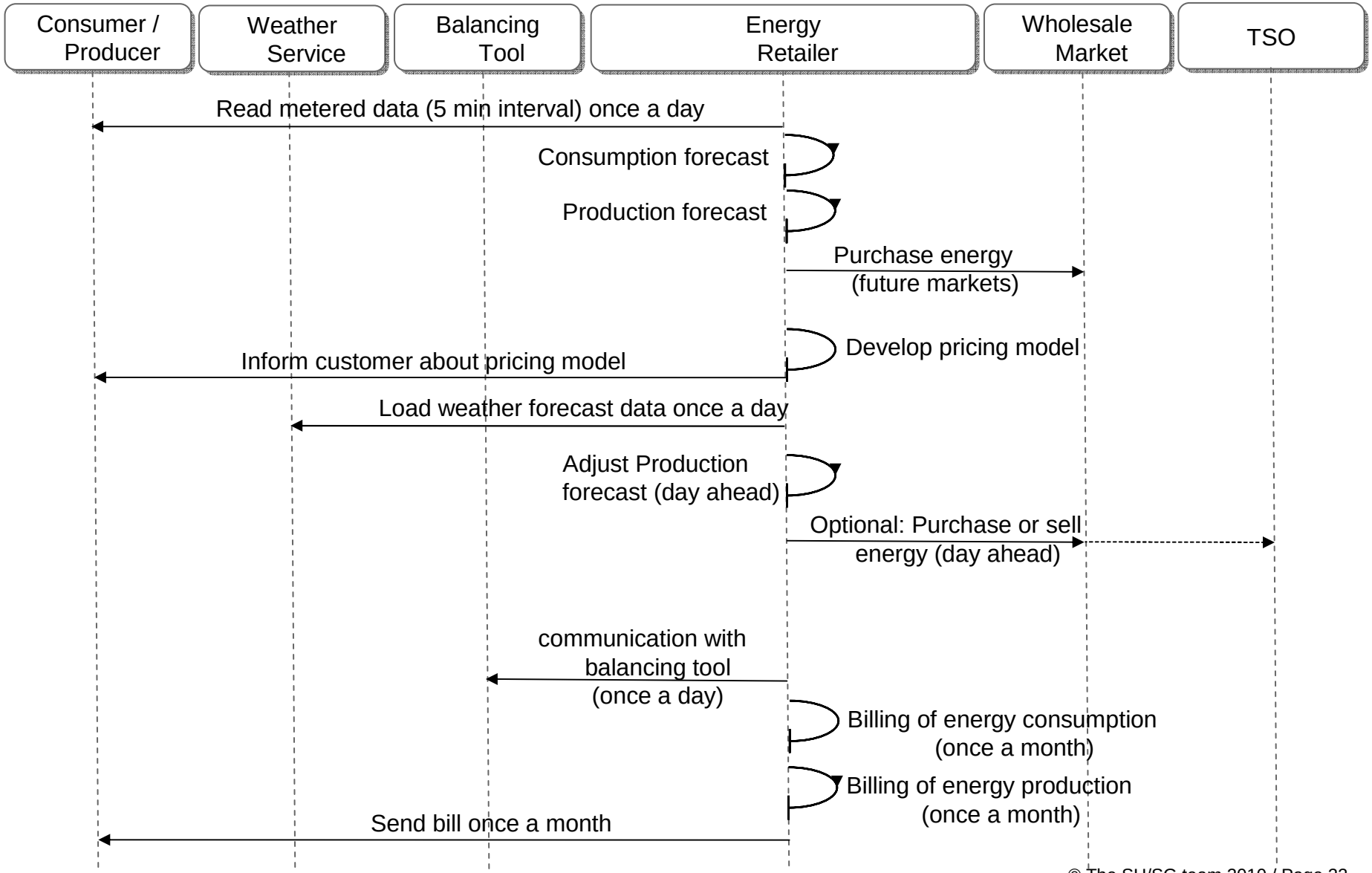
Wholesale Market

Balancing Tool

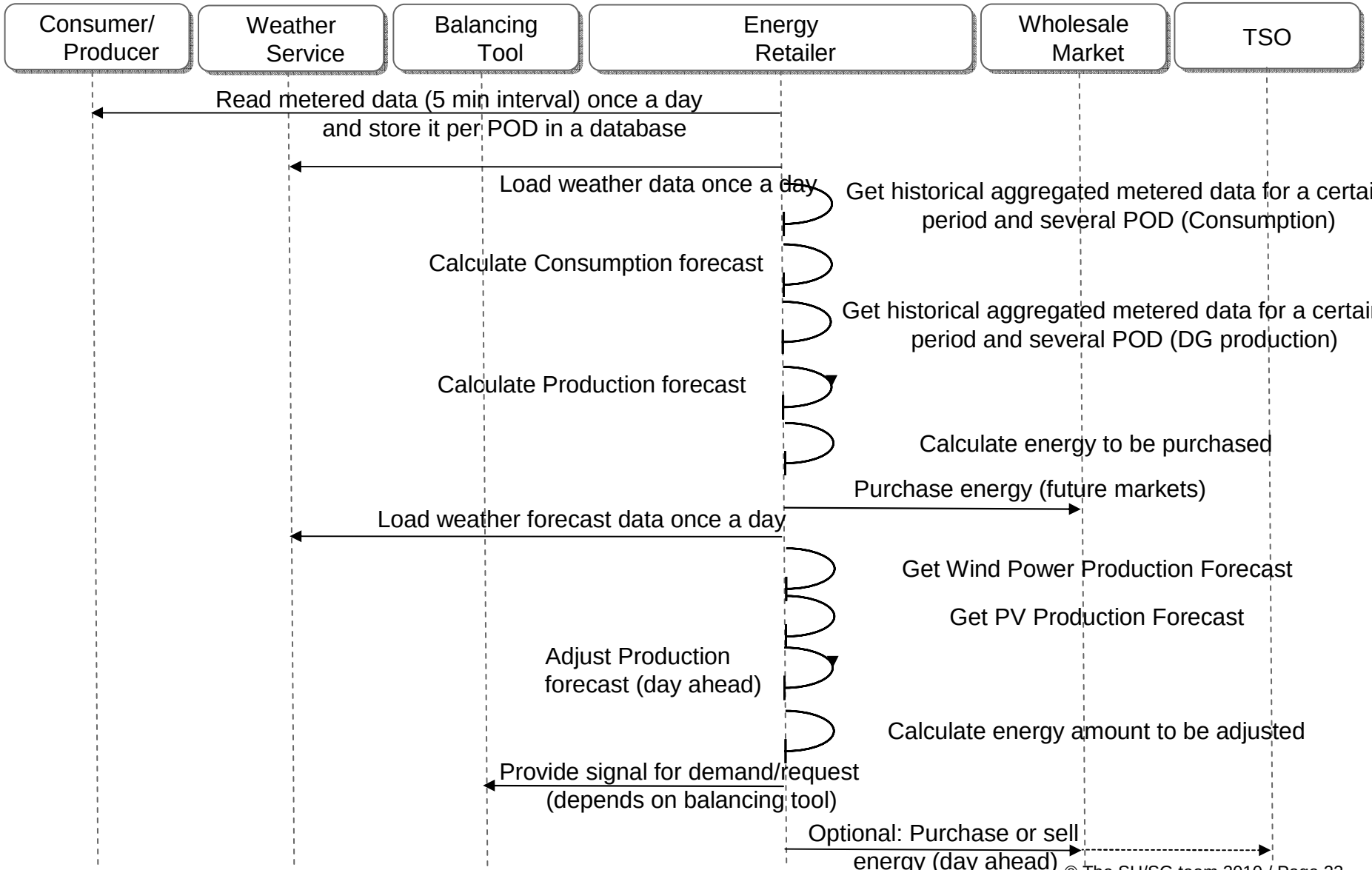
Retailer

- Metered Data Management
- Energy Forecast (Portfolio)
- Day Ahead Energy Forecast
- Buying of Energy
- Definition of Energy Products
- Billing of Energy

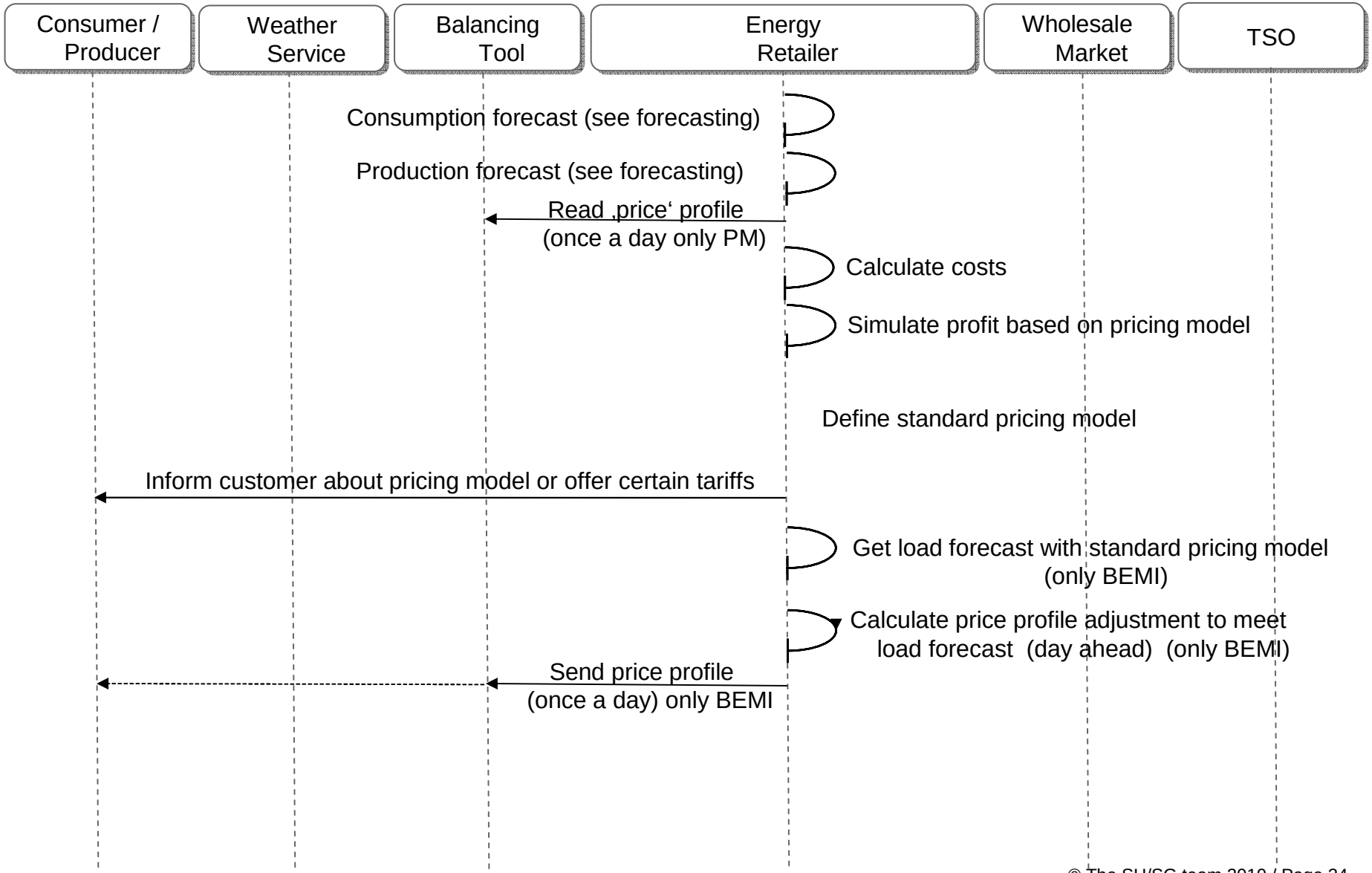
# Required Functionality for the Energy Retailer – Overview (ii)



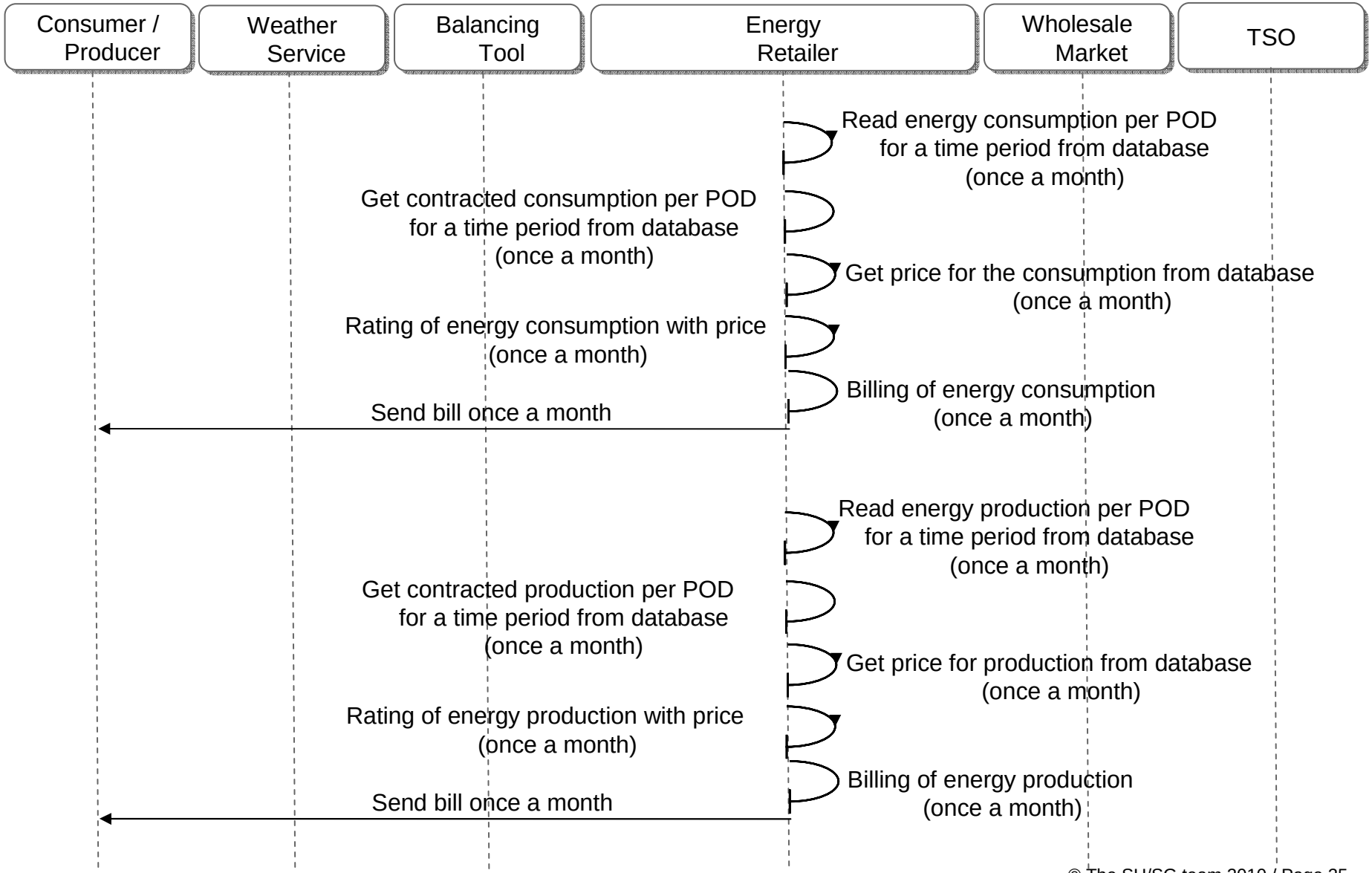
# Required Functionality for the Energy Retailer – Energy Forecasting



# Required Functionality for the Energy Retailer – Pricing



# Required Functionality for the Energy Retailer – Billing



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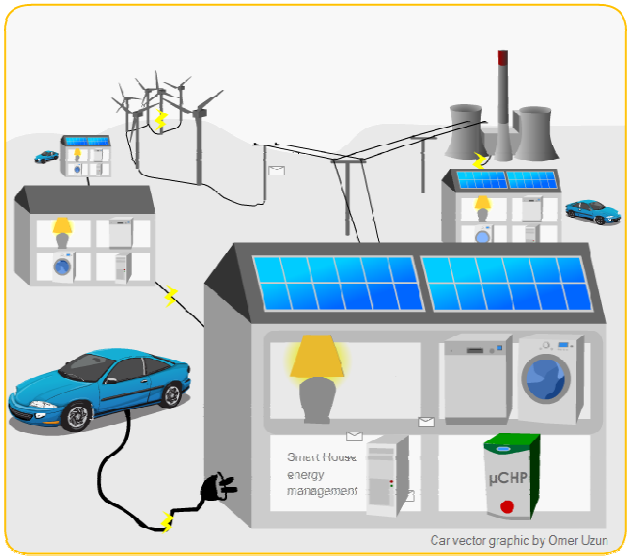
# Wrap-Up and Next Steps

## Conclusion

- Project combines three different energy management system for smart houses
- Different business cases can be realized with these technologies
- Enterprise integration makes the functionality usable for energy retailers or service providers




## Next steps

- Field trial evaluation
- Development of an “Open Gateway Energy Management” proposal – OGEMA
- Demo of enterprise service integration
- Scenario analyses for mass-scale applicability


# Thank you!