IEA DSM Task 17:
Integration of DSM, DG, RES and ES

Outcome of Phase 1+2

Introduction to Phase 3

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Content

- **Task 17 introduction**
  - Phase 1 (finished: Operating Agent: VTT Finland); 2007-2009
  - Phase 2 (finished: Operating Agent: VTT Finland); 2009-2012
  - Phase 3 – Currently in the definition phase (Operating Agents: TNO/AIT)
- **Introduction to Phase 3**

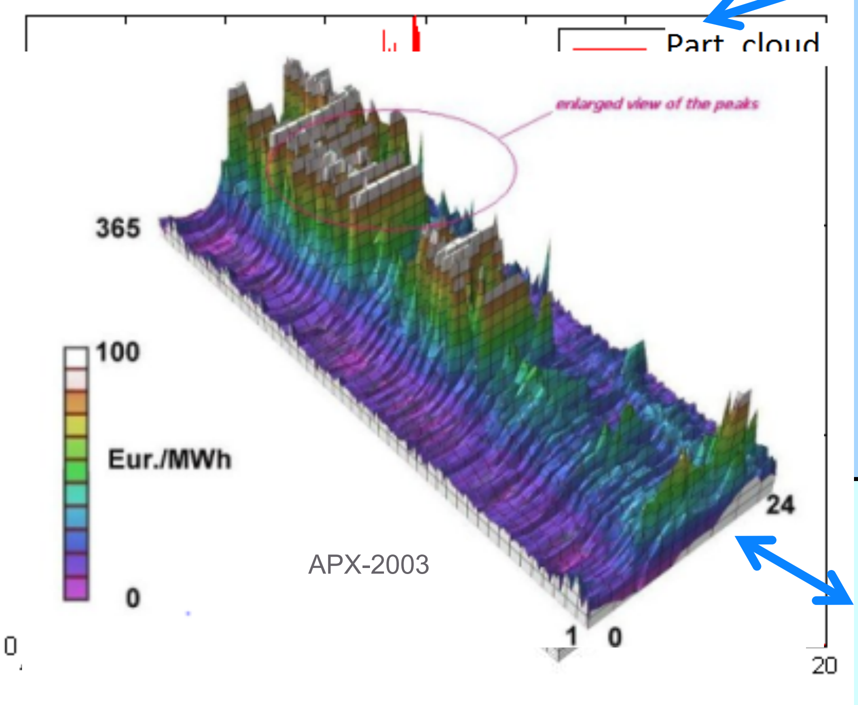
Introduction (1)

Implementing Agreement on Demand Side Management Task 17

- **Objectives**
  - Optimal integration of DR, DG and Storage
  - Mechanisms to ideally support electricity grid and market operation
- **Phase 1**
  - Inside the IEA DSM Agreement a scope study was carried out:
    - Overview of the Situation
    - Pilot case studies database
    - Vision and conclusion
- **Phase 2**
  - A assessment of **DER technologies in combination with DSM** was carried out:
    - Assessment of **technologies** and penetration scenarios(+ Pilot case studies)
    - **Stakeholders** involved and effects on the stakeholders
    - Assessment of **quantitative effects** on the power system and stakeholders
    - Conclusion and recommendations

Phase 1

Ranking technologies: Results of phase 1



Fossil fuel based technologies ▪ fuel cells ▪ micro chp ▪ conventional chp	Young Existing Mature
Renewables ▪ Wind ▪ pv ▪ small hydro ▪ waves, tidal ▪ biomass	Mature Existing/Mature Mature Young/Mature Young/Mature
Renewable production forecasting	Young/Existing
Electrical energy storage ▪ energy management ▪ bridging power ▪ power quality	Young/Mature Existing/Mature Early/Existing
Economic dispatch, SCUC software	Mature
Resource planning techniques, tools	Mature
Real-time grid operation tools	Mature
Many DSM techniques	Mature
Automated DR devices	Young
Pricing granularity (smart rates) ▪ Small customers ▪ Large customers	Early Existing
Consumer response and production	Early

Phase 1 (cont'd)

Ranking technologies: Results of phase 1

Communication, control and monitoring	Communication networks	Mature
	High-speed digital monitoring ▪ Generation ▪ Transmission (EU) ▪ Transmission () ▪ Distribution	 Mature Mature Young Early
	Smart meters deployment	Young/Existing
	Cyber-security	Young/Existing
	Interoperability	Existing
	Functional Automation/Monitoring ▪ for large assets ▪ for DER	 Mature Young
	Intelligence/Smart behaviour	Young
	User/primary process feedback	Young/Existing
	Intelligent agents and distributed controllers	Young
	Communication semantic and content	Young/Existing
Integration analytics	Modelling electricity system impacts	Young/Existing
	Understanding relative costs and benefits	Existing
	Controlling and coordinating parts	Young
	Good, real data	Early / Young
Regulation, policy and business	How to capture benefits	Young/Existing
	Incentives and subsidies	
	How to pay for everything	
	Taxation	
	Aggregator business	

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Phase 2

Methodology of Phase 2

1. Analyse the **status quo of DER penetration** at customer’s premises

2. Derive **future technology penetration scenarios** for 2020 and 2030

3. Estimate the **DG** and **DSM/DR potential** based on future scenarios and the project database

4. Analyse the **impact** of future penetration scenarios and the **benefits** of DSM/DR.

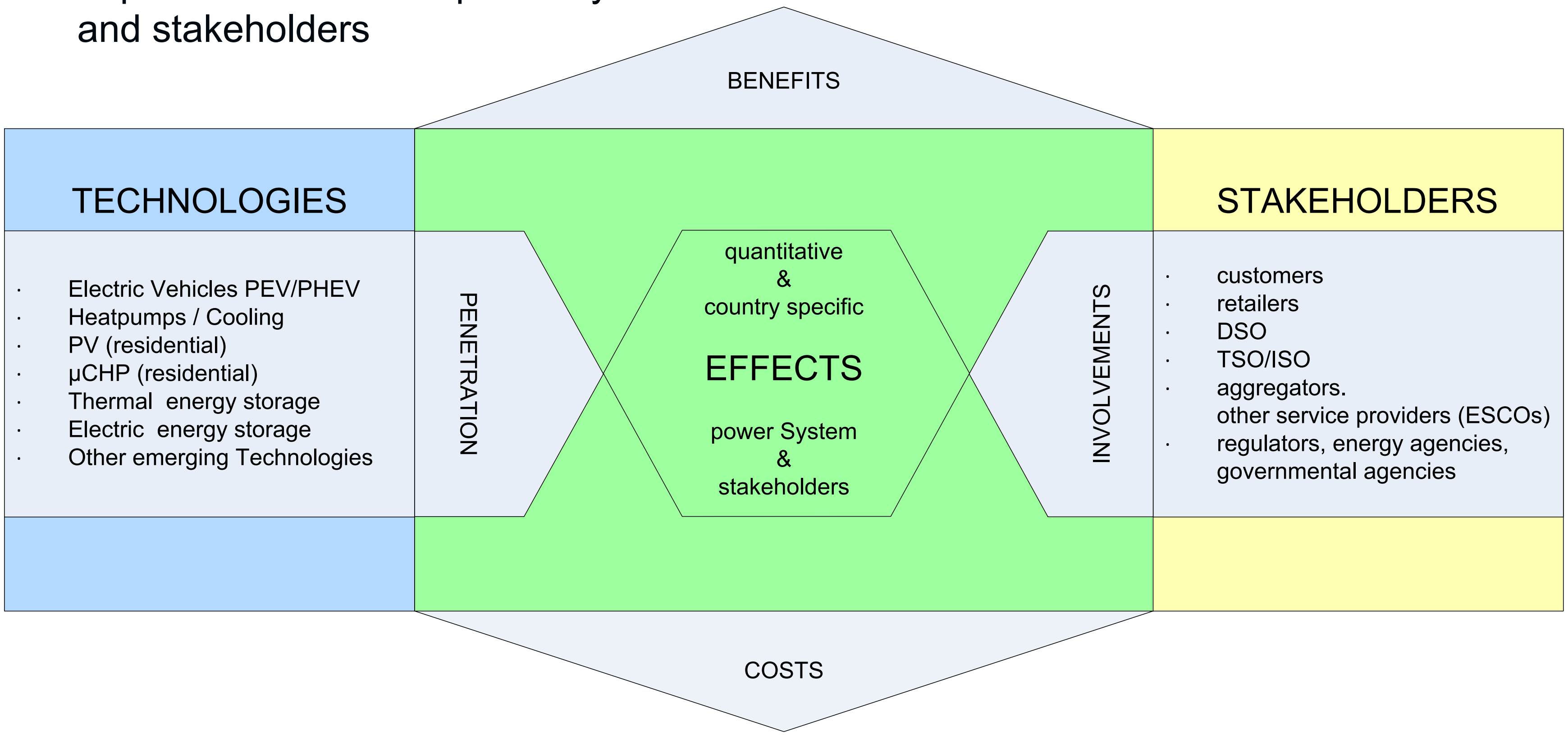
5. Estimate of **costs** which are necessary **to facilitate** DSM/DR potentials

6. Evaluate the **effects** on the involved **stakeholders**.

Phase 2

Methodology

- Impact and effects on power system and stakeholders



Example technology: Heatpumps (1)

Country situation in Austria

- Mean and total electrical power consumption (Biermayr 2010)

	Use water HP	Heating HP	Air condition HP	Sum
Thermal Power (mean) [kWth / HP a]	2,75	10,8	2,67	
Thermal Power (total) [MWth]	224	862	9	**1.096**
Electrical power (mean / HP) [kWel/ HP a]	1.1	3	1.07	
Electrical power (total) [MWel]	90	240	4	**333**

- Status quo and future scenarios (Haas 2007)

HP power classification	Percentage on the total share [%]	2009 [MWel] Status quo	2020 [MWel] Baseline scenario	2020 [MWel] Accelerated scenario	2030 [MWel] Base scenario	2030 [MWel] Accelerated scenario
Installed HP		164.000	250.000	233.000	343.000	455.000
< 20kW	90%	300	457	426	627	831
20kW-80kW	9%	30	46	43	63	83
> 80 kW	1%	3	5	5	7	9
Total [kW]	100%	333	508	473	696	**924**

Example Technology: Heatpumps (2)

Practical potentials scenario for HPs in Austria

- Assumptions:
  - Relative share of HP power classes stay the same
  - *Full load hour* from (Biermayr 2010):
    1540h → 35-40% from 924MW, availability in 6 month of cold season
    (full load hour only during 8760h/2 – half of the year)

- DSM facilitation:
  - Start with facilitating the big HPs (> 80kW to 20kW class):
    approx. 2000 HPs = **92MW** in 2030
    (Total el. power per class / mean per class)

→ **Practical potential (**2000 biggest heat pumps) would be **36,8MW**
(Assuming **thermal energy storage** and thermal capacity **to shift demand**)

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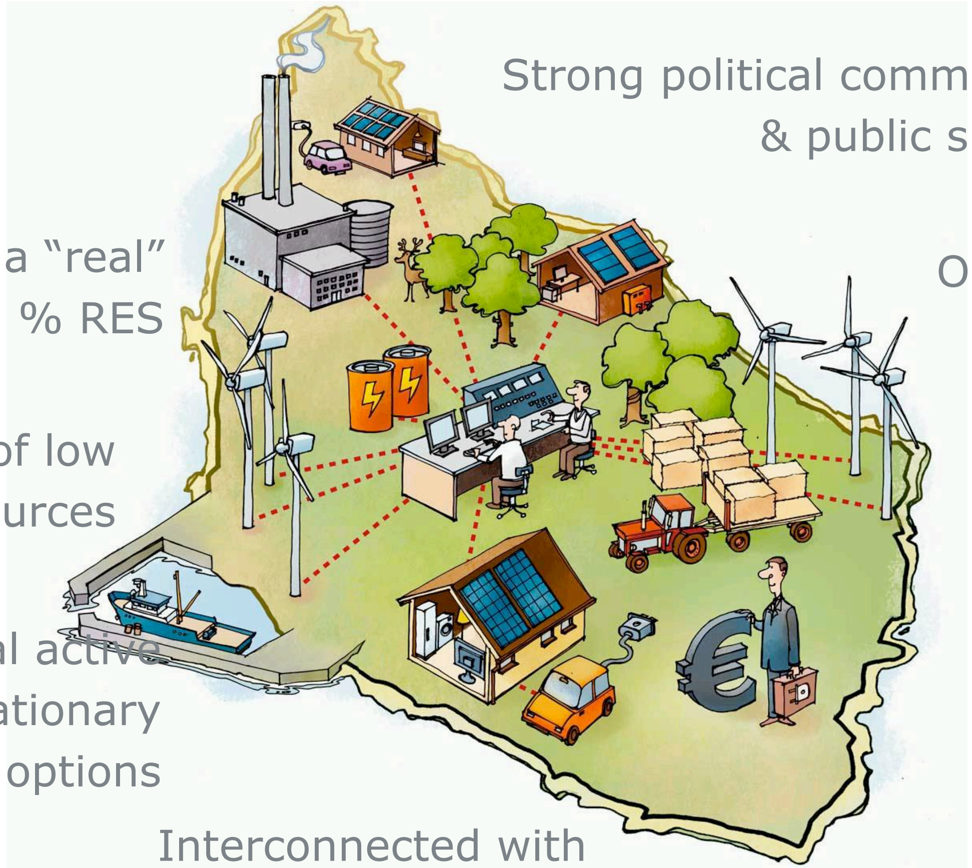
Example project database: Ecogrid Bornholm

BRIGHT GREEN ISLAND BORNHOLM



Strong political commitment & public support

Demonstration in a "real" system with 50 % RES

Operated by the local municipal owned DSO, Østkraft

High variety of low carbon energy sources

Eligible RD&D infrastructure & full scale test laboratory

Several active demand & stationary storage options

Interconnected with the Nordic power Market innovation for life

René Kamphuis
IEA

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Stakeholder analysis SmartGrids living lab Hoogkerk

In-Home Optimization

Cost Effective use of Energy

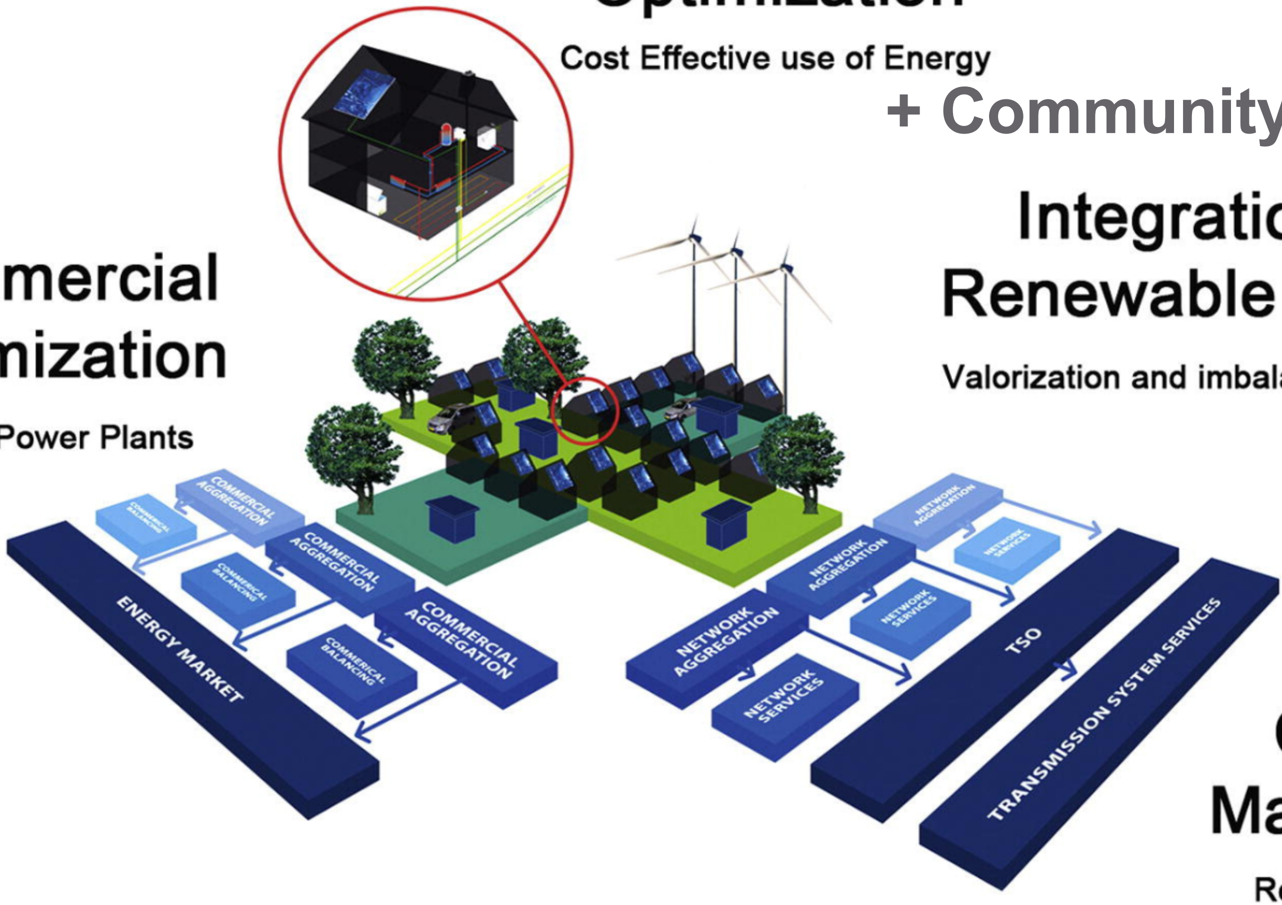
+ Community propositions

Integration of Renewable Energy

Valorization and imbalance Reduction

Commercial Optimization

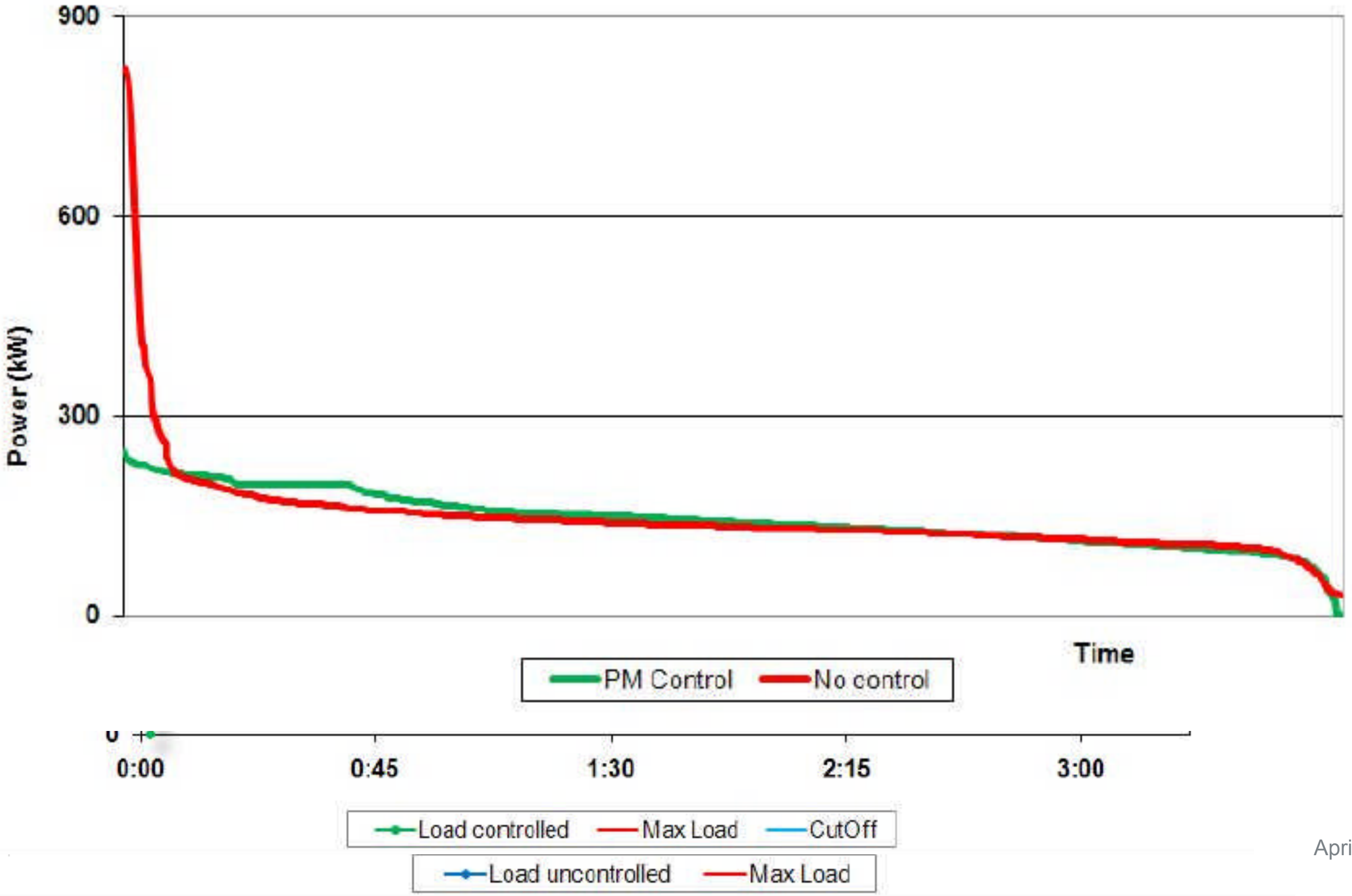
Virtual Power Plants



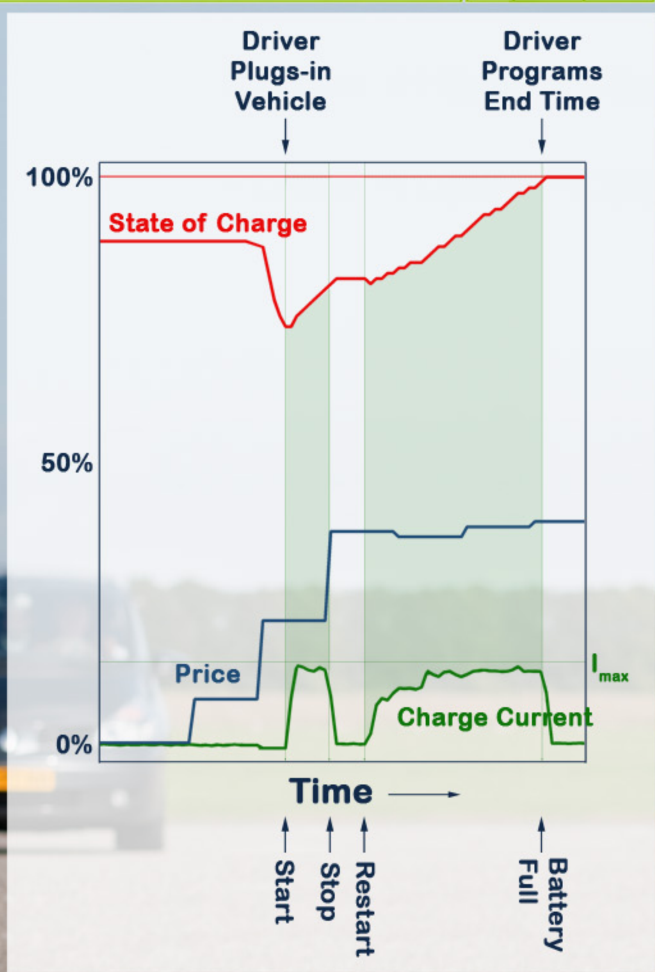
Capacity Management

Reduce Peak Loads

Example project database heat pumps: Couperus/congestion management



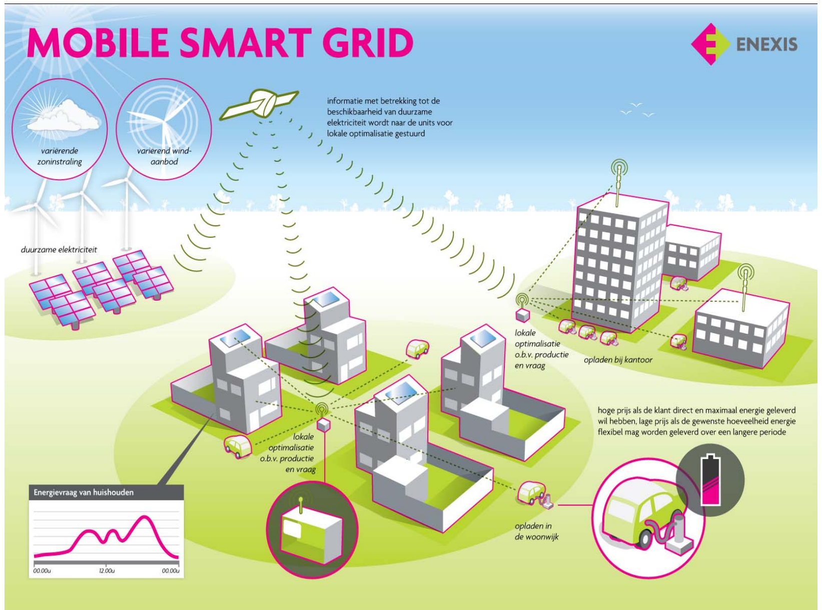
Intelligent charging infrastructures

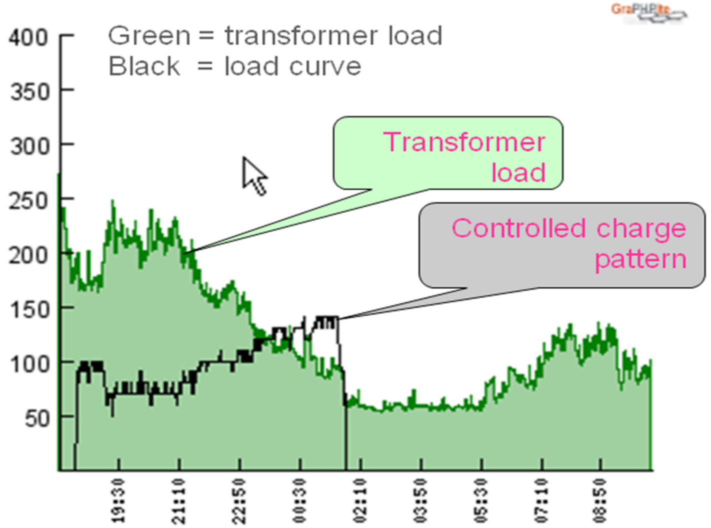


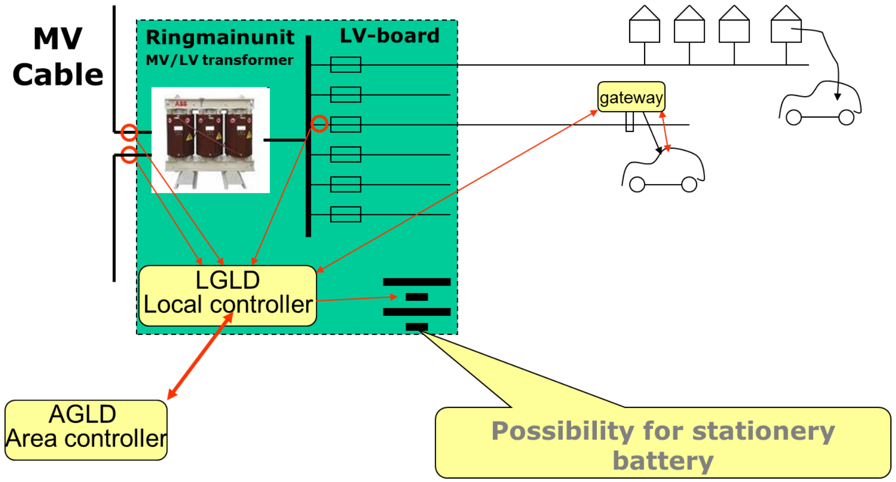
Example Project database: Electric vehicles

Pilot projects: Netherlands

- Enexis: controlled charging of EVs

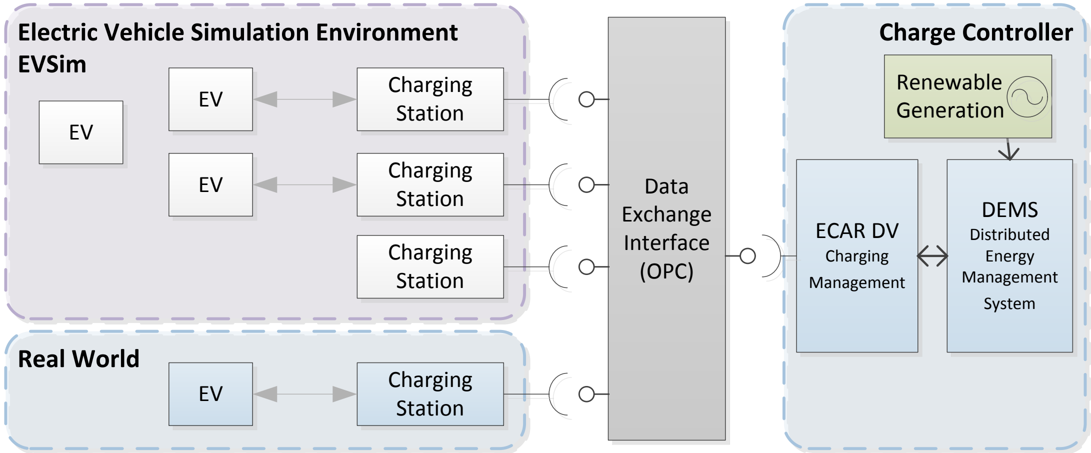


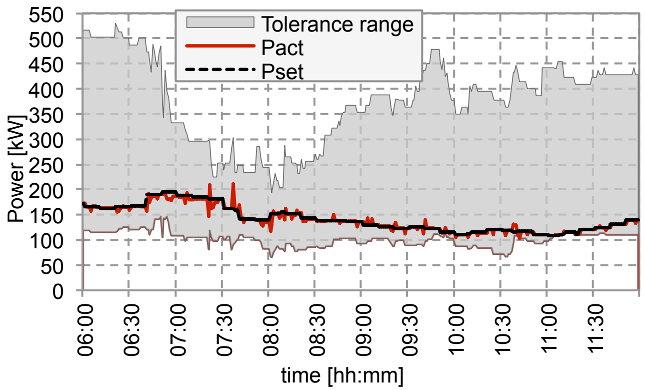


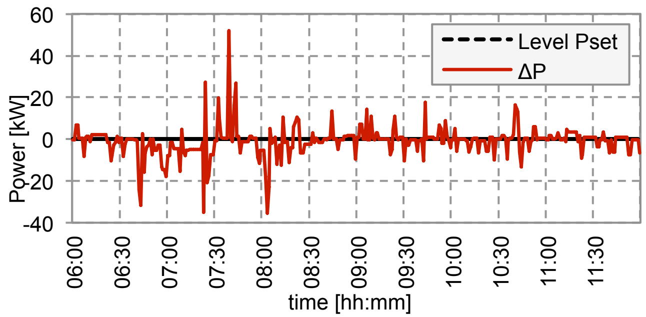


Validation of charging management

- Real and simulated EVs for charging management validation



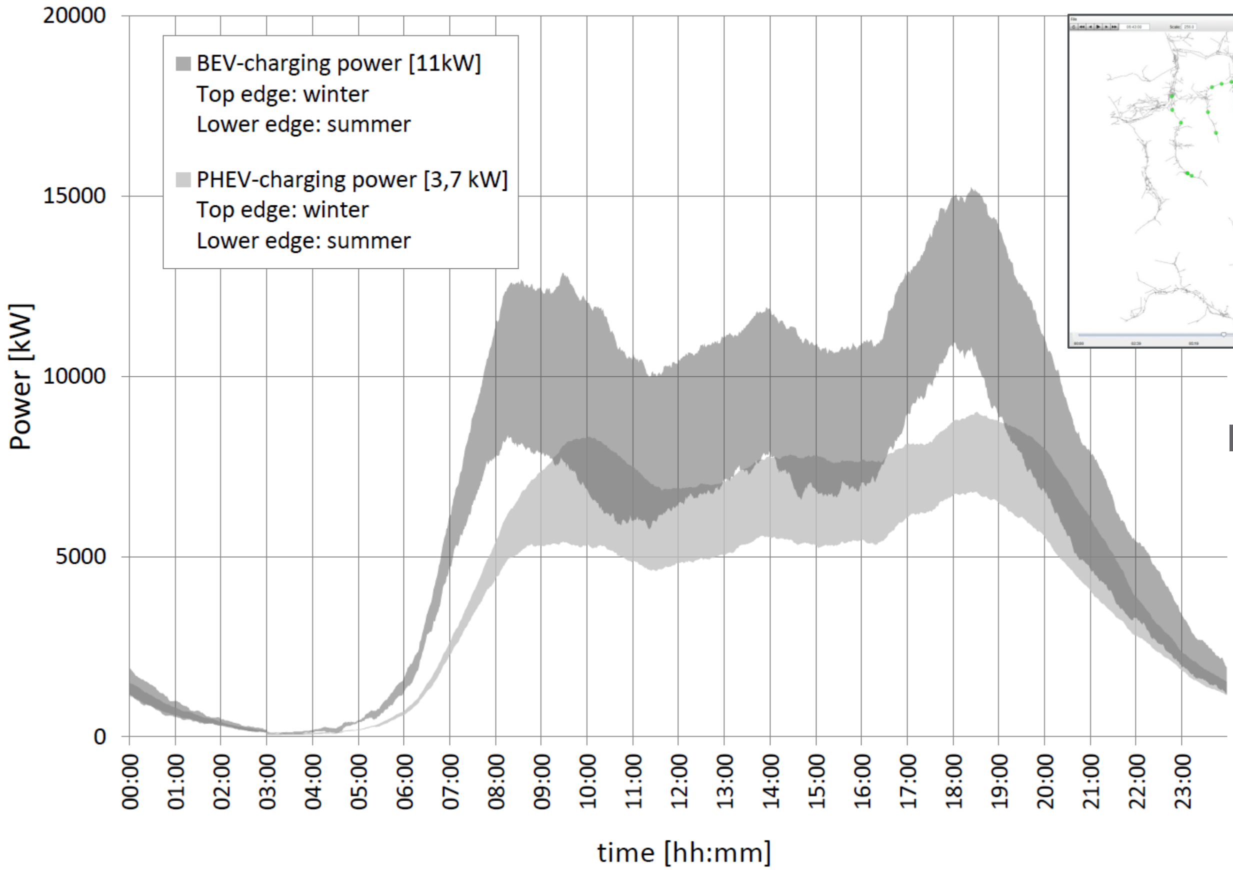


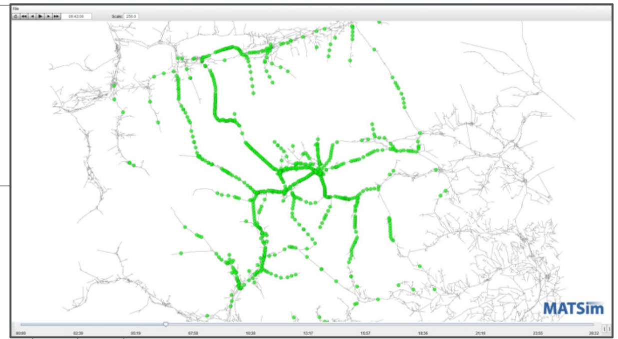


Tolerance range, P_{set} and P_{act} during simulation and deviation

Temperature dependency

- Region Lungau (Upper Austria) – approx. 6000 EVs



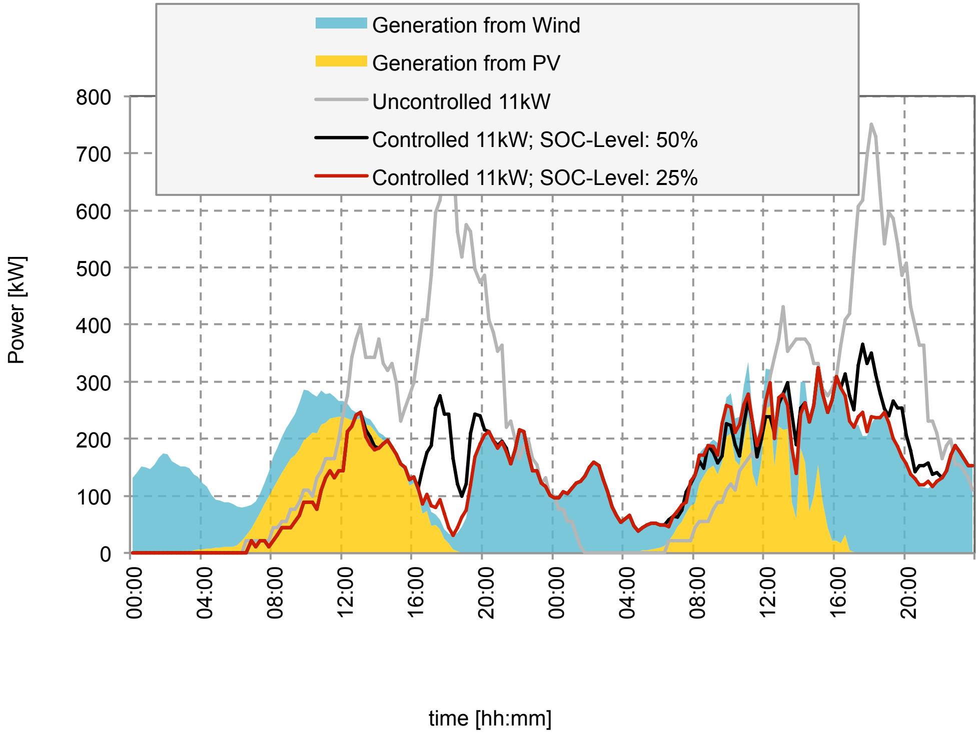


Micro-simulation of region Lungau, generating trip data

Charging power for opportunity charging on a winter and summer day

Simulation of EVs, control and power system

- Local supply - demand match in medium voltage networks



Uncontrolled and controlled charging of 306 EVs with 11 kW during two sumer days.
Note: wind is accumulated on top of PV generation

Two days simulation in summer

Charging Mode	empty EVs	P-peak [kW]	Charged Energy [kWh]	DER Energy [kWh]	DER Coverage [%]
uncontrolled 11kW	15	751	9964	8079	54%
controlled 11kW/SOC50	55	366	6832	8079	89%
controlled 11kW/SOC25	66	324	6229	8079	99%

Two days simulation in winter

Charging Mode	empty Evs	P-peak [kW]	Charged Energy [kWh]	DER Energy [kWh]	DER Coverage [%]
uncontrolled 11kW	135	883	12613	3971	26%
controlled 11kW/SOC50	197	552	7267	3971	50%
controlled 11kW/SOC25	218	353	5051	3971	71%

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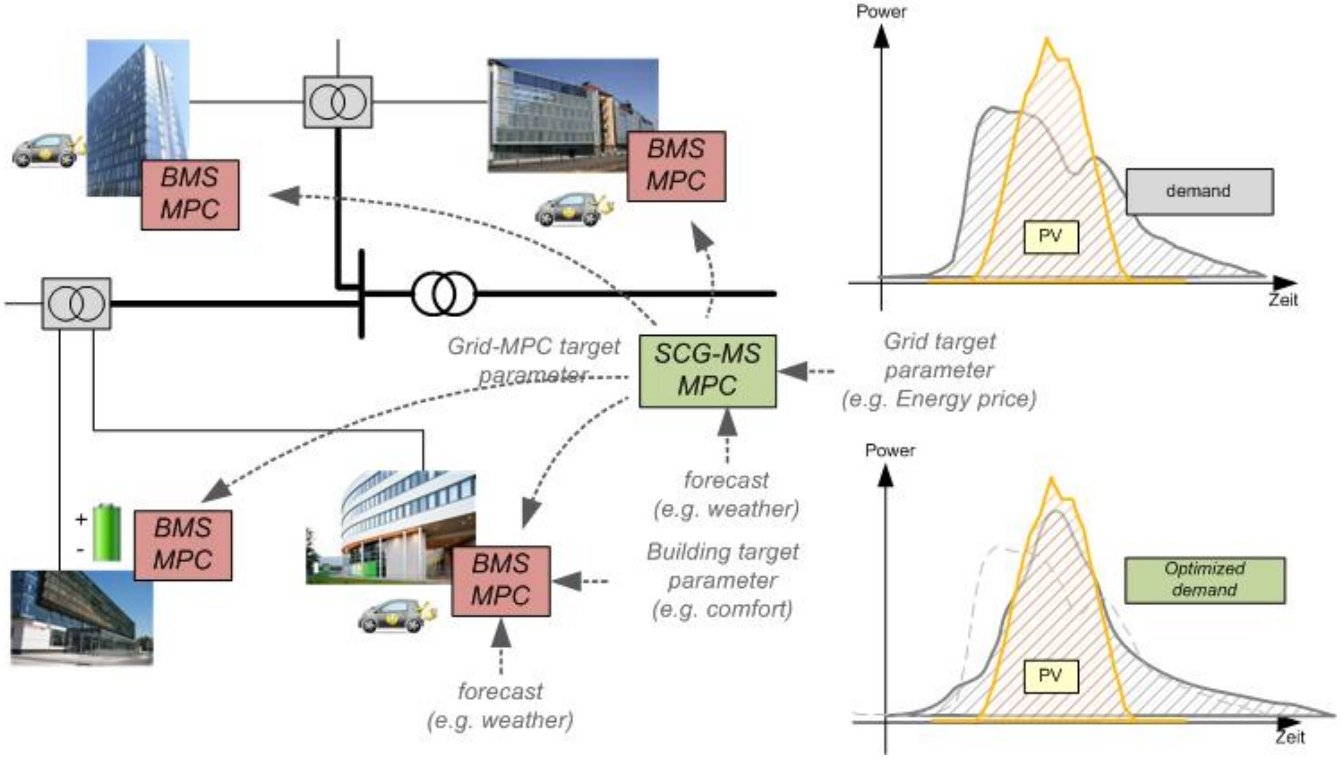
Example Building Grid Interaction

Pilot projects: Austria

- CoOpt: Model Predicted Control (MPC) in Building Management Systems (BMS)



Phase 3: Role and potential of B/HEMS to integrate RES

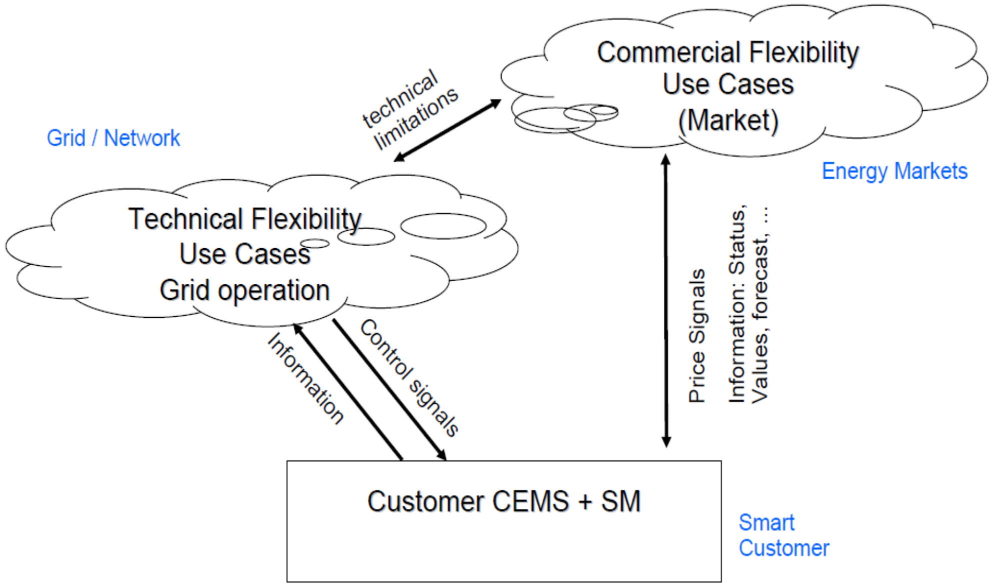
Enable flexibility of integration of Renewable Energy Resources (RES) with Building/Home Energy Management Systems (B/HEMS)

Combining electricity and heat

Subtask of Phase 3 - Introduction

Systems view on enabling flexibility in the smart grid

*Phase 3 of IEA-DSM Task 17 will address the **current role and potential** of energy management systems enabling **flexible buildings** (residential and commercials) **equipped with DER** (Electric Vehicles, PV, storage, heat pumps, ...) and their **impacts on the grid and markets**. The **scalability and applicability** of conducted and ongoing **projects** with respect to specific regional differences and requirements will be explored.*

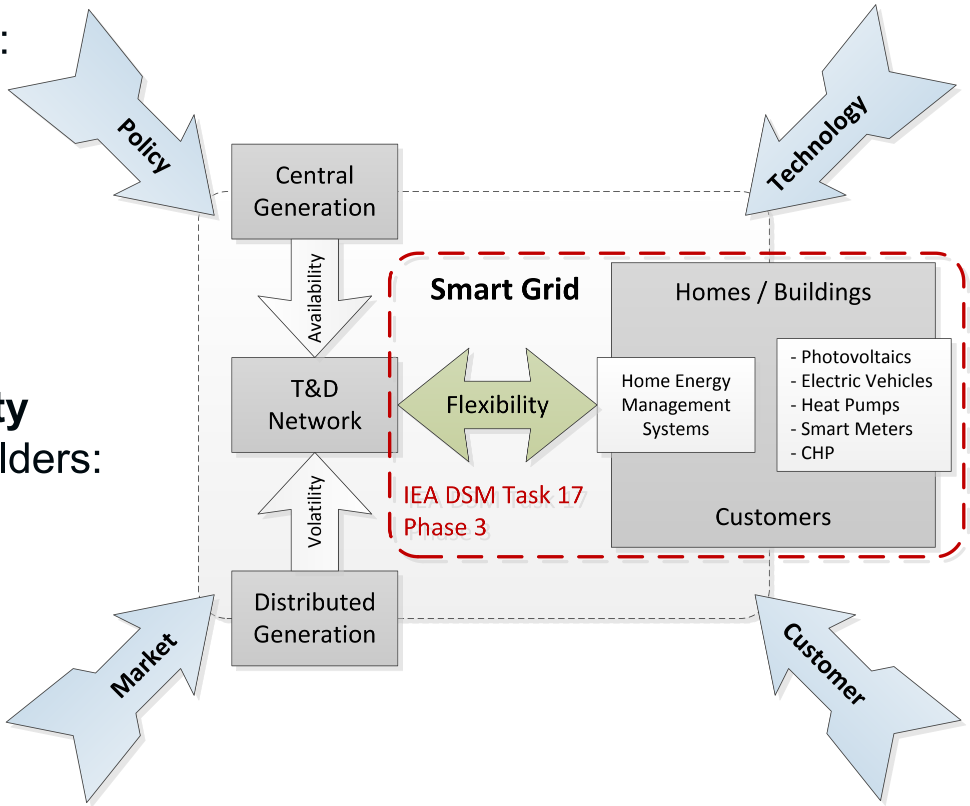


Subtask of Phase 3 - Introduction

Systems view on enabling flexibility in the smart grid

- **Different views** on the Smart Grid:
  - Technology
  - Customer
  - Policy
  - Market

- Focus on the **enabling of flexibility** and the impact of it on the stakeholders:
  - What are the requirements?
  - How do we manage it?
  - How will it effect operation?
  - What are the benefits?



End of presentation for workshop

Background and Motivation for Task 17 Phase 3

- „**Empower Demand** - *The potential of smart meter enabled programs to increase energy and systems efficiency: a mass pilot comparison“* vaasaeet for ESMIG, 2011
- „**Shift, not Drift:** *Towards Active Demand Response and Beyond“* – Think, June 2013
- IEC/TR 62746-2 (DRAFT), *Systems interface between customer energy management system and the power management system* – Part 2: **Use cases and requirements,** June 2013
- CEN-CENELEC-ETSI Smart Grid Coordination Group – **Use Case Management Process** – implementation in a standardized way, Nov. 2012

Empower Demand

Results

- About 100 pilots studied – structured into 22 variables
  - IHD can save between 3-19%
  - Good informative billing can save more even IHD is more effective in average
- Five factors which decide success
  - Socio-economic factors (surrounding variables)
  - Participant consumption patterns
  - Program content/structure
  - Supportive technology
  - Household load sources
- What makes a pilot a success or failure?
  - Meet the consumer needs with the program
  - Technology is the enabler
  - „more is more“: segmentation, feedback, pricing, multiple information
  - Meet regional market realities
  - Layered programs

Shift, not Drift

Results

- Consumer centered approach – through contract between consumers and intermediaries
- Comments from project advisors, industry and public consultation
- Recommendations:
  - Guidlines in form of good practice codes and regulations for customer empowerment and protection
  - Transparency rules for pricing, contracts, etc.
  - Pilot projects on contracts – engage consumers
  - Database of pilot studies for dissemination and extrapolation of results
  - Market entry for new players / market access
  - access to data
  - EU wide real time market

CEMS and Power Management System interfaces

IEC 62746 Technical Report Objective

Use cases and requirements for the interface between the power management system of the electrical grid and customer energy management systems for residential and commercial buildings and industry.

- User stories → use cases → data model → information content & structure
- Examples:
  - The user wants to get the laundry done / EV charged by 8:00pm
  - Grid recognize stability issues
  - CEM feeds own battery pack energy into own network or into the grid
  - Heat pump and Photovoltaic Operation with Real-Time Tariff

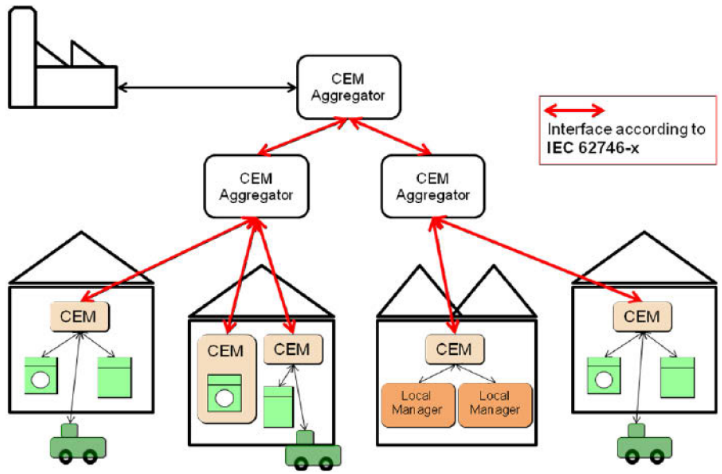


Figure 6: Cascaded CEM architecture

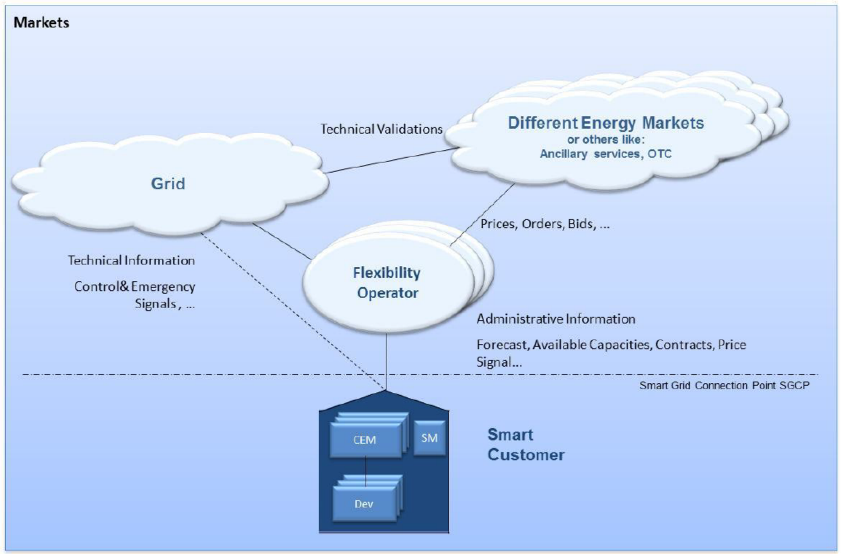
Smart Grid Coordination Group – Sustainable Processes

CEN, CENELEC and ETSI - M/490

The "Smart Grid Use Case Management Process" essentially describes the implementation of use cases in the standardization environment.

- Flexibility concept, understand demand response, Smart Grid & EV
- → Flexibility functional architecure
- → Use Case collection

- Examples:
  - Customer Energy Manager (CEM)
  - Market roles and interaction
  - Assessing impact of flexible resources on the grid (traffic light)
  - Flexibility operator



Subtask of Phase 3 - Introduction

Differences to on-going initiatives and working groups

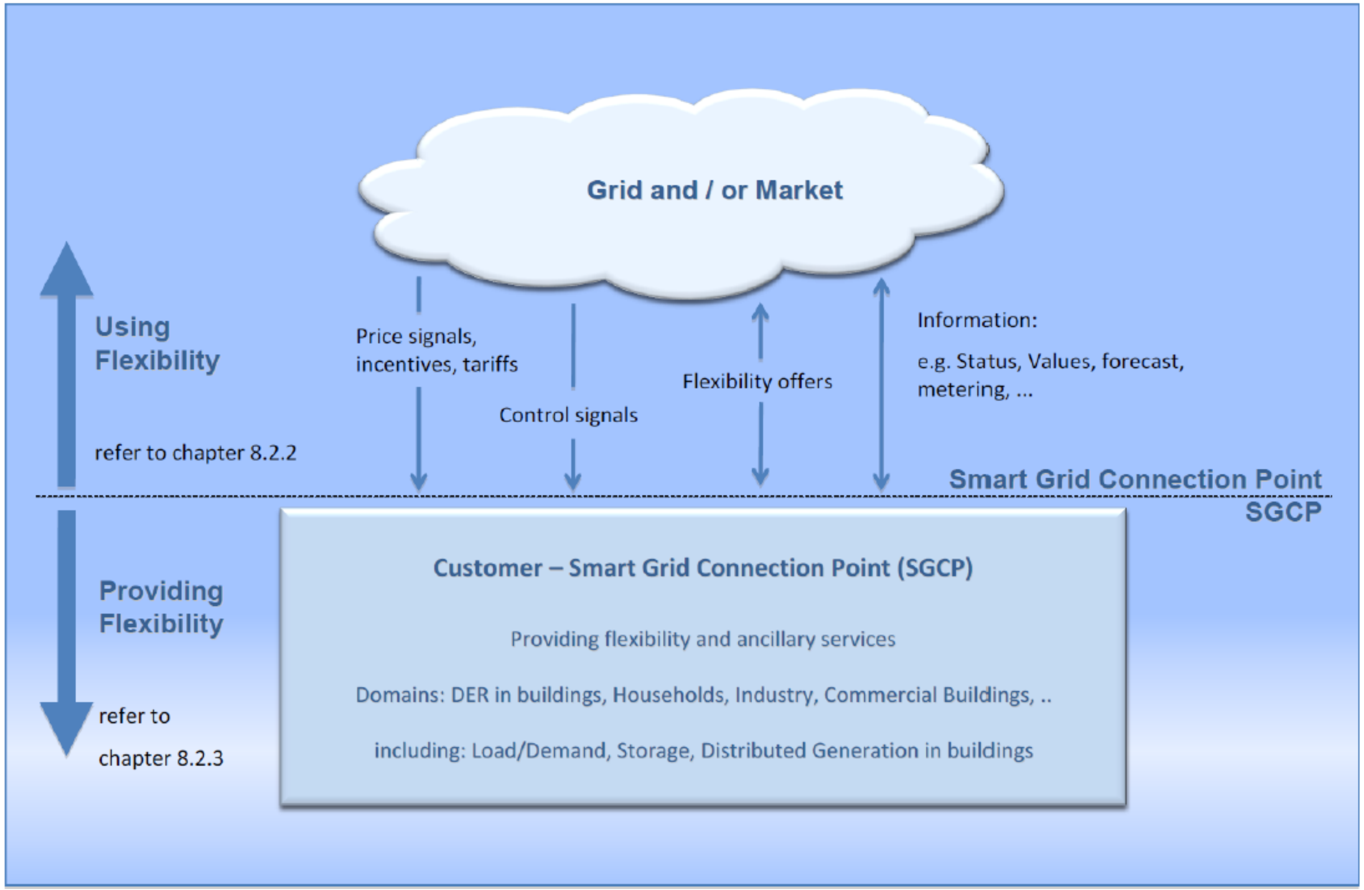
- Phase 3 is **not about**:
  - Standardisation
  - SG Reference Architecture
  - Interoperability – protocols and formats
  - Business models
  - Use case repository
  - Cyber security

- Phase 3 is **about** analysing:
  - Existing implementations, prototypes, pilot projects
  - Gap between theory and practice
  - Applicability to different countries, regions and regulatory frameworks

Subtask of Phase 3 - Introduction

Systems view on enabling flexibility in the smart grid

- **Technical Interfaces** CEN-CENELEC-ETSI Smart Grid Coordination Group



Subtask of Phase 3 – Overview of the Subtasks

Systems view on enabling flexibility in the smart grid

- **Subtask 10:** Role, and potentials of flexible prosumers (households, SMEs, buildings)
- **Subtask 11:** Changes and impact on stakeholders operations
- **Subtask 12:** Sharing experiences and finding best/worst practices
- **Subtaks 13:** Conclusions and recommendations

Subtask of Phase 3 – Subtask 10

Role, and potentials of flexible prosumers (households, SMEs, buildings)

- Controllability requirements (generation and consumption)
- Opportunities, challenges and barriers for flexibility services (providers and technologies)
- Energy and power balancing potentials
- Smart technologies (SM and Customer Energy MS)
  - VPPs
  - EV charging
  - DG-RES integration and storage
  - Integrating heat pumps and thermal storages

Subtask of Phase 3 – Subtask 11

Changes and impact on stakeholders operations

- Methodology development for assessing/quantifying impact
- Grid, market and customers (prosumer/consumer)
- Sharing common benefits/losses
- Optimization potential (eg. DR building audits and customer requirements)
- Regulatory and legislative requirements
- Comparison costs vs. delayed investments

Subtask of Phase 3 – Subtask 12

Sharing experiences and finding best/worst practices

- Collection of data
  - Workshops
- Lessons learned from existing pilots
  - EcoGrid-EU Bornholm, PowerMatchingCity I and II, Linear, Greenlys, Building2Grid, SmartCityGrid: CoOpt, eEnergy, …
- Country specifics
  - differences in the implementation
  - applicability
- Extrapolation of the results from previously collected projects on applicability

Subtask of Phase 3 – Subtask 13

Conclusions and recommendations

- Based on the experts' opinion

- Will provide a ranking based on
  - Impacts
  - Costs
  - Future penetration of the technologies

Experiences from pilots and field tests

Sharing best and bad practices and defining use cases

ISGAN

Annex 1	Global Smart Grid Inventory
Annex 2	Smart Grid Case Studies
Annex 3	Benefit-Cost Analyses and Toolkits
Annex 4	Synthesis of Insights for Decision Makers
Annex 5	Smart Grid International Research Facility Network (SIRFN)
Annex 6	Power T & D Systems
Annex 7	Smart Grid Transitions

Collaboration with ISGAN

Contributions and exchange of results with focus on DSM technologies

Collaborations on **DSM specific focus**:

- Common workshops
- Contribute to ISGAN reports

Annex 1:

- Requirements for enabling flexibility

Annex 2:

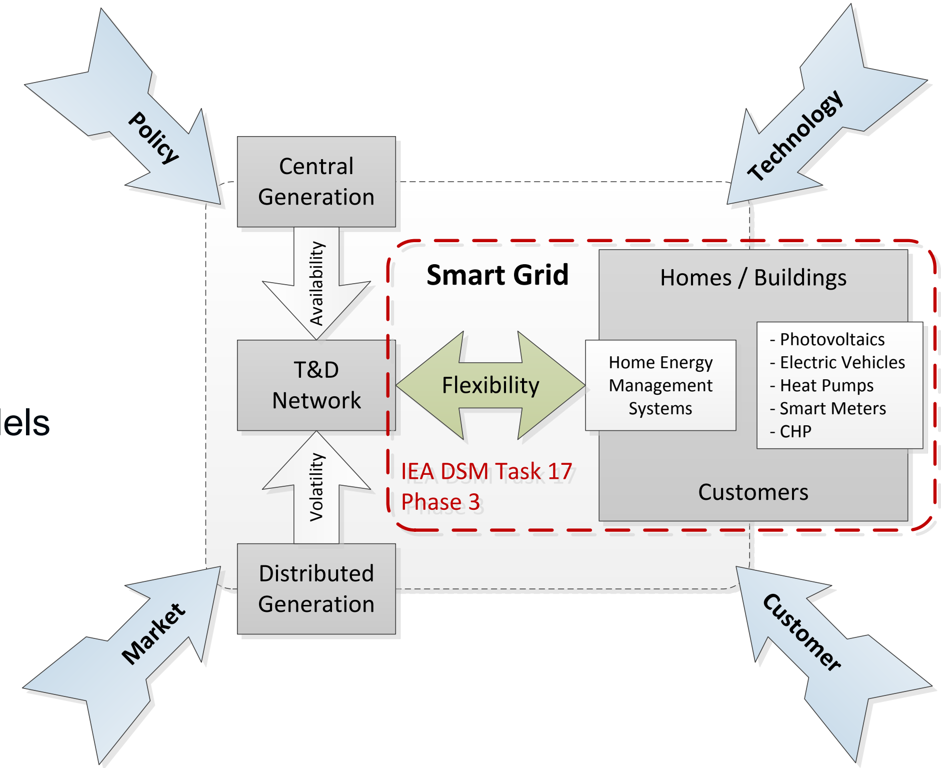
- Use Cases and implementation models
- Best and bad practices

Annex 3:

- Impact on stakeholders
- Cost and benefits

Annex 4:

- Recommendations



Collaboration with IC-CSHBA

Contributions and Exchange

IEEE-Standards Association *Industry Connections - Convergence of Smart Home and Building Architectures* (IC-CSHBA):

- Common workshops
  - Exchange experiences
- Implementation Guide white paper
  - Use Cases and implementation models
  - Best and bad practices
  - References
- Recommendations

Outlook

IEA-DSM Task 17 – Phase 3

- **Start:** January 2014
- **Collaborations**
  - ISGAN
  - IEEE IC-CSHBA
  - EC SG-Expert Group on Interoperability
  - IEEE IES TC SG
- **Next steps**:
  - Define workplan
  - Commitment from participating countries
  - Kick-off

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TOMORROW TODAY

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