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

Phase 3: Systems View on Enabling Flexibility in the Smart Grid

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Increase of distributed generation – need for flexibility

- Increase of (local) distributed generation (e.g.: PV, CHP, Wind)
  - PV: „grid-parity“:
  - Impact on network: curtailment
    (Germany: since 2013: 60% Peak curtailment)

- Need of Flexibility of the demand
  - DR potential of storage
    - thermal: hot water, heat pumps
    - electric: batteries

Grid parity in Germany (Quaschning, 2012)
Background and Motivation

More reasons for the integration of demand resources

- **Integration** of renewable and distributed generation
  - Avoid peak generation
  - Mitigate fluctuations

- **Increase** of system efficiency and self coverage
  - (Local) supply - demand match

- **Reduction** of peak power, balancing reserve
  - Example: California „Title 24“ Building code: Requires building systems to be ready for demand response energy management
Background and Motivation

Studies and ongoing activities

- “Shift, not Drift: Towards Active Demand Response and Beyond“ – Think, June 2013
- “Integration of Renewable Energy in Europe” – Imperial College, NERA. DNV-GL, June 2014
- IEC/TR 62746-2 (DRAFT), Systems interface between customer energy management system and the power management system, June 2013
Background and Motivation

Sectoral electricity end use in Austria (2012)

Transport in Rohrfernleitungen: 144 GWh
Textil und Leder: 441 GWh
Bau: 635 GWh
Fahrzeugbau: 763 GWh
Landwirtschaft: 792 GWh
Nicht Eisen Metalle: 979 GWh
Bergbau: 1.072 GWh
Sonstiger Landverkehr: 1.318 GWh
Eisenbahn: 1.621 GWh
Sonst. Produzierender Bereich: 1.656 GWh
Holzverarbeitung: 1.673 GWh
Steine und Erden, Glas: 1.826 GWh
Nahrungs- und Genußmittel, Tabak: 2.130 GWh
Eisen- und Stahlerzeugung: 3.999 GWh
Maschinenbau: 4.104 GWh
Chemie und Petrochemie: 4.263 GWh
Papier und Druck: 4.614 GWh
Öffentliche und Private Dienstleistungen: 13.371 GWh
Private Haushalte: 16.860 GWh

Source: Statistik Austria, 2013
Background and Motivation

Categories of electricity use in households (2012)

- Warmwasserbereitung inkl. Hilfsenergie: 13%
- Heizung inklusive Hilfsenergie: 12%
- Beleuchtung: 11%
- Herd, Backrohr: 9%
- Kühler: 8%
- Diffuser Stromverbrauch: 7%
- Geschirrspüler: 6%
- Weitere Küchen- und Haushaltsgeräte: 5%
- Unterhaltungsgeräte (Fernseher etc.): 4%
- Gefriergeräte: 4%
- Zusatzheizung: 4%
- Wäschetrockner: 3%
- Waschmaschine: 3%
- Bürogeräte (PC, Laptop etc.): 3%
- Unterhaltungsgeräte (Fernseher etc.): 2%
- Umläufpumpe(n) Heizung: 2%
- Sonstige relevante Stromverbraucher: 2%
- Umläufpumpe(n) Warmwasser: 1%
- Kommunikationsgeräte: 1%
- Küchen- und Haushaltsgeräte: 0%
- Herd, Backrohr: 0,33%
- Bürogeräte (PC, Laptop etc.): 0,25%
- Ventilatoren, Lufventilator und Befeuchter, Klimageräte: 0,01%

Source: Statistik Austria, 2013
IEA DSM Task 17
Objectives, Subtasks, Outcomes
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?
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 the interaction with the system:  
  - Existing implementations, prototypes, pilot projects  
  - Gap between theory and practice,  
  - Identify missing methods / tools (DR forecasting)  
  - 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

![Diagram showing grid and market interaction with technical interfaces](image-url)
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
- **Subtasks 13**: Conclusions and recommendations
Expected Outcomes and Results

Deliverables, Publications, Contributions

- **Deliverables, Recommendations, Publications**
  - “Roles and potentials of providing flexibility in production/consumption using CEMS/HEMS systems”
  - “Financial and maturity assessment of technologies for aggregating DG-RES, DR and electricity storage systems”
  - “Best practices in applying aggregated DG-RES, DR and Storage for retail customers”

- **Public Workshops**
  - Summary / Review / Presentations

- **Newsletters**
  - IEA DSM Spotlight

- **Networking, Collaborations**
  - Exchange Information with international and national Stakeholder Groups
  - ISGAN, IEEE IC-CSHBA, EC SG-Expert Group, IEEE IES TF Smart Grids

- **Project/Task Proposals**
Experiences from pilots and field tests
Sharing best and bad practices and defining use cases
Project SGMS-HiT– Smart Grids Model Region Salzburg

Buildings as interactive participants in the Smart Grids
Separate usage of energy from energy supply

→ Buffering with thermal storages

Use energy which is most efficient for the grid
  ▪ Biogas (CHP)
  ▪ PV
  ▪ Grid
  ▪ District heating

→ grid friendly building

Comfort must be preserved.
SGMS – HiT

User interaction

- FORE-Watch
  12 hours forecast

- (simulated) Tariffs
  - **RED**: Standard Tariff + 5 Cent / kWh
  - **YELLOW**: Standard Tariff
  - **GREEN**: Standard Tariff – 5 Cent / kWh

16.10.2014
Project: Power Matching City (NL)

In-Home Optimization
Cost Effective use of Energy

Community optimization

Integration of Renewable Energy
Valorization and imbalance Reduction

Commercial Optimization
Virtual Power Plants

Capacity Management
Reduce Peak Loads
Project: Power Matching City (NL)

Propositions are based on driving forces of customers

**Renewable**
- Utilize renewables
- Independent
- Comfort

**Smart cost saving**
- Together Minimize cost
- Lowest price
- Retain comfort

**Scope:** PV, μ-CHP, heat pump, washing machine, dish washer
Project: Power Matching City (NL)

Energy dashboard information

- Variable price for energy (real-time, history)
- kWh vs price
- Feedback on cost-effective operation of devices
- Monthly cost-saving
- Usage at several tariff zones

- Home balance: kW, kWh (real-time, history)
- Community balance: kWh (in real-time, history)
- Monthly usage per energy carrier
Project: gridSMART® RTPda Demo

- First real-time market at distribution feeder level with a tariff approved by the PUC of Ohio

- Value streams
  - Energy purchase benefit
  - Capacity benefits: e.g., peak shaving
  - Ancillary services benefits

- Uses market bidding mechanism to perform distributed optimization – transactive energy
  - ~200 homes bidding on 4 feeders
  - Separate market run on each feeder
  - “Double auction” with 5 minute clearing

- HVAC automated bidding
  - Smart thermostat and home energy manager
  - Homeowner sets comfort/economy preference
  - Can view real-time and historical prices to make personal choices
Project: gridSMART® - Residential Real-time Pricing

Overview – Transactive Grid Control

1. Automated, price-responsive device controls express customer’s flexibility (based on current needs)

2. Customer system aggregates responses to form overall price flexibility curve

3. Utility aggregates curves from all customers

4. Aggregator determines price at which grid objective achieved, broadcasts to consumers
Outlook
Status, Events
Outlook

IEA-DSM Task 17 – Phase 3

- **Start:** May 2014 - **End:** April 2016

- **Ongoing work**
  - Use case collection and analysis
  - Flexibility potential method development
  - DR Potentials in Austria – applicability of DR concepts

- **Upcoming events**
  - IEA Expert Group on R&D – *The role of storage in energy system flexibility* – 22./23. October in Berlin
  - Next Expert Meeting 3./4. November in Leiden (NL)

**Countries**
- Austria
- Switzerland
- Sweden
- Copper Alliance
- Netherlands
- USA
- Italy
- Belgium
- India
- Finland
- Germany
- Serbia
<table>
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<tr>
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Appendix
Additional Information
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) interaction
- 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
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
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
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 architecture
- → Use Case collection

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