Flexible demand as a counterpart to variable output renewables

Based on work in task 17 within the IEA/DSM program
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Brussels 13-10-2016 The Role of DSM to Provide Flexibility to provide flexibility in electricity systems

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What comes out of IEA-DSM task 17

- What are the suppliers and consumers of flexibility
  - How should they be deployed
  - When should they be deployed
- Synergy between flexibility and energy efficiency
- Transition to 100% renewables
- How is a new market design able to uncover flexibility at:
  - Right time
  - Right place
  - Right benefits
What are the sources of end-user flexibility

- Thermostatically controlled loads
  - Heat pumps
  - Micro-CHP

PowerMatchingCity II Hoogkerk

Constrained by comfort limit
What are the sources of end-user flexibility and how to automate them

- Heat pumps in a residential area after blackout
  - without automated coordination
What are the sources of end-user flexibility and how to automate them

- Heat pumps in a residential area after blackout
  - with automated coordination
What are the sources of end-user flexibility
Aggregated deployment of heat pumps commercially
What are the sources of end-user flexibility and how to automate them

- Thermostatically controlled loads
  - Heat pumps
  - Micro-CHP
- EV chargers (uncoordinated)
What are the sources of end-user flexibility and how to automate them

- Thermostatically controlled loads
  - Heat pumps
  - Micro-CHP

- EV chargers (coordination via automation)
What are the sources of end-user flexibility and how to automate them

- Thermostatically controlled loads
  - Heat pumps
  - Micro-CHP
- EV chargers
- **Wet appliances**
  - Linear project (B)
  - Dish, laundry washer

[Graphs showing power levels over time for different scenarios, labeled as weekExtra, weekendExtra, weekDelay, weekendDelay.]
What are the sources of end-user flexibility and how to automate them

- Thermostatically controlled loads
  - Heat pumps
  - Micro-CHP
- EV chargers
- Wet appliances
  - Dish, laundry washer
- Domestic hot water
Flexibility and energy efficiency; smart meter baseline potential

Energy saving / %

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Flexibility and energy efficiency; smart meter valuation

Per metering point in Euros
1st stack - filled: Cost values shown
2nd stack - Shaded: Benefit
Flexibility; flexible tariffs and automation invocation potential
Invocation and reconciliation of flexibility: Classic DSM

- Direct (Top-Down) Control
  - Top-level Actor switches devices
  - No local information used
Invocation and reconciliation of flexibility: Central control

- Direct (Top-Down) Control
  - Top-level Actor switches devices
  - No local information used

- Central Control and Optimization
  - Optimalisation and control from a central point
  - Relevant local information has to be communicated to a central point
Invocation and reconciliation of flexibility: More refined mechanisms are needed

- Direct (Top-Down) Control
  - Top-level Actor switches devices
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- Central Control and Optimization
  - Optimisation and control from a central point
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- Tariff Reaction for control
  - Prices are transmitted to customers and/or their automated devices
  - No local information is communicated

Local control

Tariff Control

Central Control

Direct Control

Central Optimisation

One way communication

Two-way communication
Invocation and reconciliation of flexibility: More refined mechanisms are needed

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- Transactive Energy (TE)
  - Automated devices are participating in market interactions
  - Information exchange on the basis of quantity (e.g., kW and kWh) and price

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energy efficiency
Transactive grid interactions; a more extended picture

**Transactive Agent**
- Optimize local business objectives
- Register and qualify capabilities to participate in others’ programs
- Judge terms & qualifications of others
- Bid for services needed, evaluate & accept offers from supplier(s)
- Value offers for services it renders, evaluate & accept bids from buyers
- Implement control of local assets under purview according to agreement
- Deliver & receive products, rights, or service required by transaction
- Deliver & receive data, measurements & verification as required by transaction
- Execute financial settlement as required by transaction & reconcile performance differences

**Local Intelligence**

**Registration/Qualification**
- One or more other Transactive Agents

**Negotiation Process**

**Operations Process**

**Measurement & Verification**

**Settlement/Reconciliation**

* E.g., operations signals or e-product exchange
Towards 100% renewables (Prosumer)
End user production is becoming a flexibility consumer
Towards 100% flexibility
This also has an effect on the system (e.g. California)
How can a new market design valuate flexibility
Amsterdam Power eXchange-arbitrage 2003
How can a new market design valuate flexibility
Amsterdam Power eXchange-arbitrage 2013
How can a new market design valuate flexibility
Tariff build-up 2003-2013
How can a new market design valuate flexibility
Increased focus on involving Transmission and Distribution

• Optimal supply<>demand control
  • Balancing (commercial, grid operational management)
  • Portfolio management
• Mitigate congestion and capacity problems
• Power quality (Voltage, reactive power, frequency)

-> Malleable and more active electricity distribution grids
  Many nodes
  • Residential
  • SME

-> Aggregate and automate on data measured on MV/LV levels within shorter time-window and time-frame
  
  From an operational perspective: months -> hours
  From an asset perspective: decades -> 5-10 years
How can a new market design valuate flexibility
Involve customer

• Remove disincentives for end-user DR
  • EU-directive succeeding Smart Meter directive
  • Rollout of systems also may not be gradual but disruptive

• More accurately map role of end-user/prosumer to commercial and grid operation
  • Dynamic/real-time tariffs
  • Use automation of DR and data extraction of grid related ICT-components
  • Use more transactive based mechanisms

• Remove legislative barriers for market access and aggregation

• Protect privacy and regulate data ownership
  • Resource -> assets
  • Aggregation of data at the functional level