Virtual Power Plants:
Enabling 100% Renewable Energy Systems

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Challenges For Renewable Energy Development

- Economic & Financial barrier
  - High capital cost
  - Long payback period
  - Subsidized electricity

- Technical barrier
  - Grid reliability
  - Power quality

- Regulatory barrier
  - Wholesale market access
  - Ancillary services provision
  - Costs & benefits allocation

- Social barrier
  - Lack of social acceptance
  - Unawareness of the benefits
  - Invisibility of the full costs of electricity from non-renewable energy sources
Virtual Power Plants

Extra High Voltage
265 to 275 kV
(mostly AC, some HVDC)

High Voltage
115kV and up

Transmission Grid

Distribution Grid

Virtual Power Plant
Advantages of VPP aggregation

- **Visibility**: VPP can give transparency to TSO/DSO of its aggregated portfolio, providing real-time information.
- **Controllability**: appropriate aggregation can perform close to conventional power plants (e.g. Wind+CHP+DR).
- **Market access**: provides new business fields for DER owners and other investors.
- **Improved local intelligence**: DER owners can obtain more valuable information from VPP.
- **Feasibility**: VPP can be implemented under current regulatory structures.
What is the state of the art of VPP?

- Direct control is normally much more favored than in-direct control.
- Two way communication is also preferred.
- Optimal operations have been claimed.
Combined Power Plant (Germany)

- Wind: Installed capacity [MW] = 12.6, Electrical energy [GWh/a] = 26.5
- Solar: Installed capacity [MW] = 5.5, Electrical energy [GWh/a] = 6.2
- Biogas: Installed capacity [MW] = 4.0, Electrical energy [GWh/a] = 10.8
- Reservoirs: Installed capacity [MW] = 1.06, Electrical energy [GWh/a] = -0.6
- Import/Export: 0.02/1.8

Total: 41.1 [43.5] GWh/a

% of Total: Wind = 60.9, Solar = 14.3, Biogas = 24.8, Reservoirs = -

Locations: Pilsum, Hünxe, Würselen, Kassel, Freiberg, Goldisthal, Schwäbisch Hall, Plienning, Tauber Bischofsheim
FENIX VPP(EU)
FENIX VPP (Northern Scenario)

- (Non-operational) Commercial aggregation
- Optimized power market participation
- Active internal balancing
- Balancing services to the TSO.
FENIX VPP (Southern Scenario)

- Participating in the day ahead market with the VPP
- Offering tertiary reserve ancillary service
- Contributing to maintain the voltage levels in transmission and in distribution
Market-based approaches (Denmark)
Market-based approaches (Denmark)
Market-based approaches (Denmark)
Remarks

*Sustainable business models* are required to meet the goal of sustainable development.
Remarks

*Market* always decides energy choices, but we can develop & introduce new *markets*.
Thank You!