New distributed energy resources
Challenges and new roles for the distribution grid

Conferencia regional de generación distribuida (GD)
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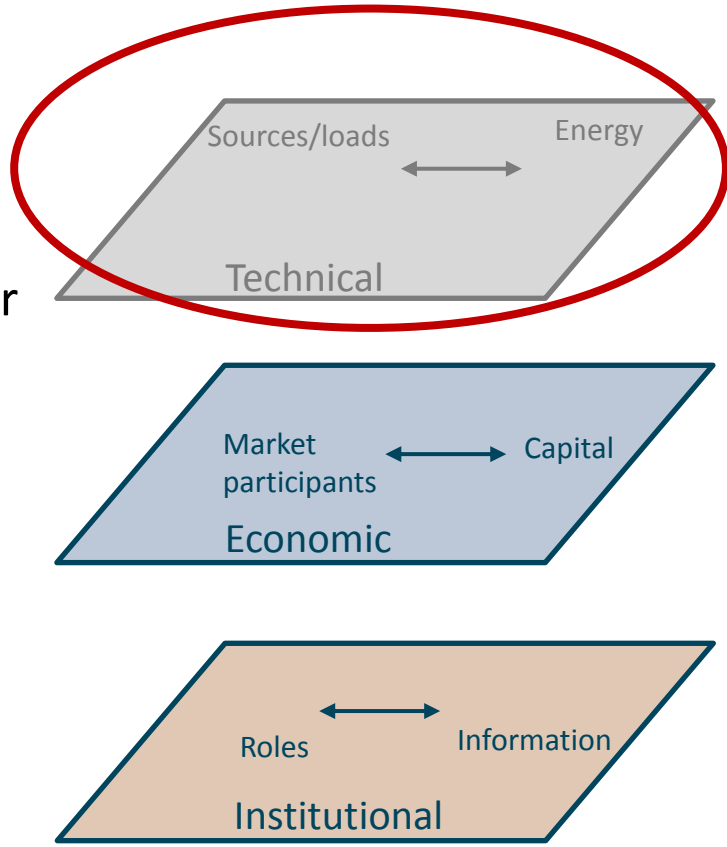
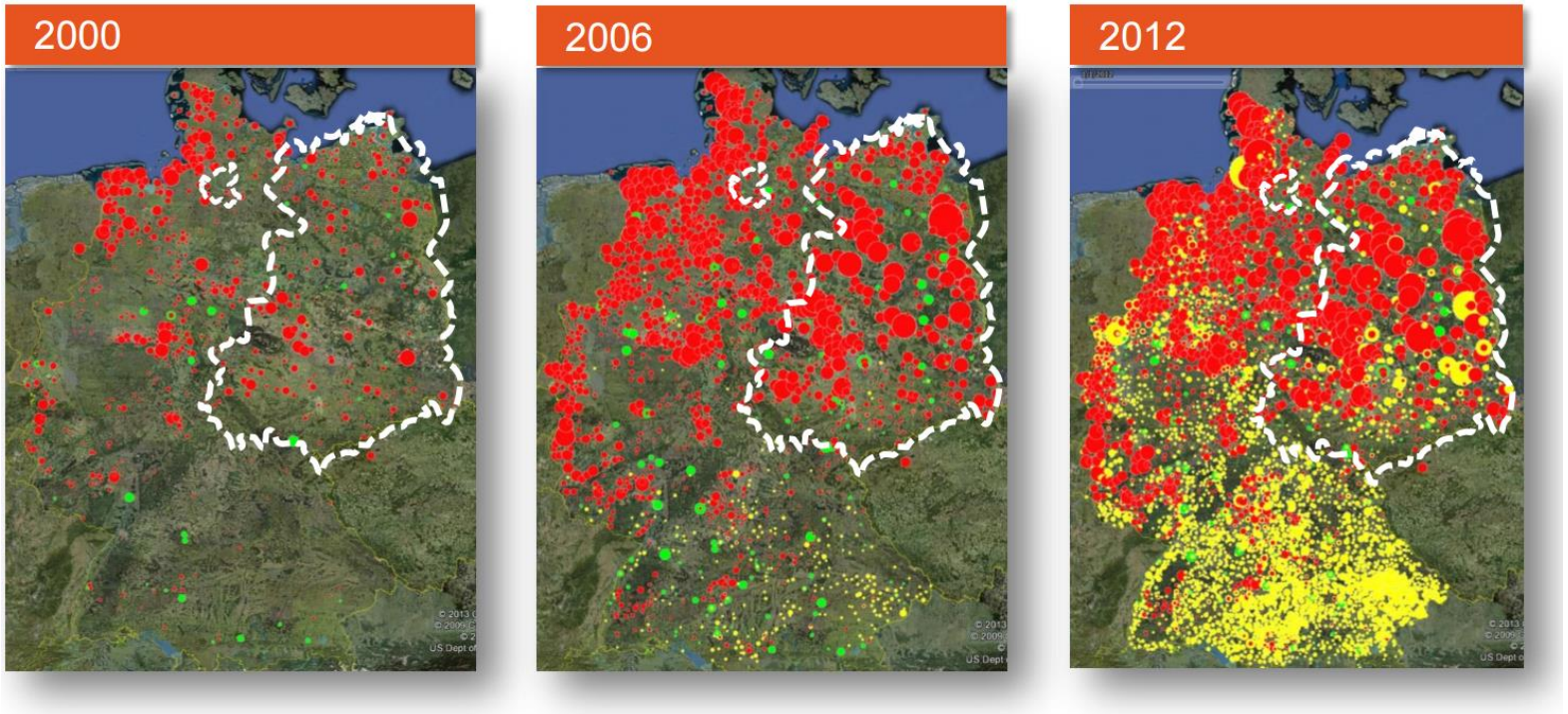
Three domains of change

- **Technical: more complex power flows**
  - New technologies, role of data
- **Economic: new value streams**
  - Innovative business models change customer engagement in energy markets
  - Social fairness at stake: tariffs and taxation
- **Institutional: new roles and responsibilities**
  - Inconsistencies between commercial arrangements and grid operations
  - Technological changes challenge today's institutional setting and regulatory paradigms



Modularity: German case

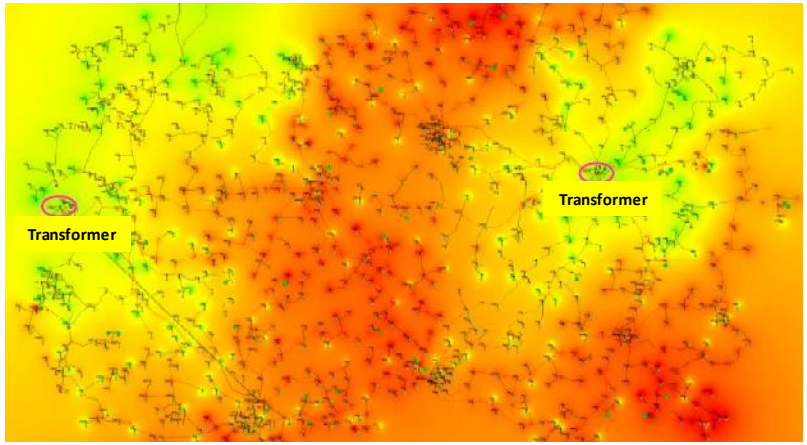


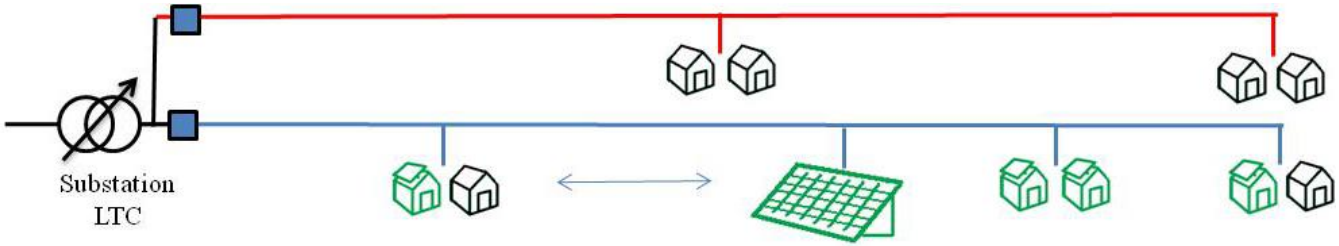
Key point: ***Managing integration of a very large number of decentralised plants connected to low- and medium voltage grid often challenging***

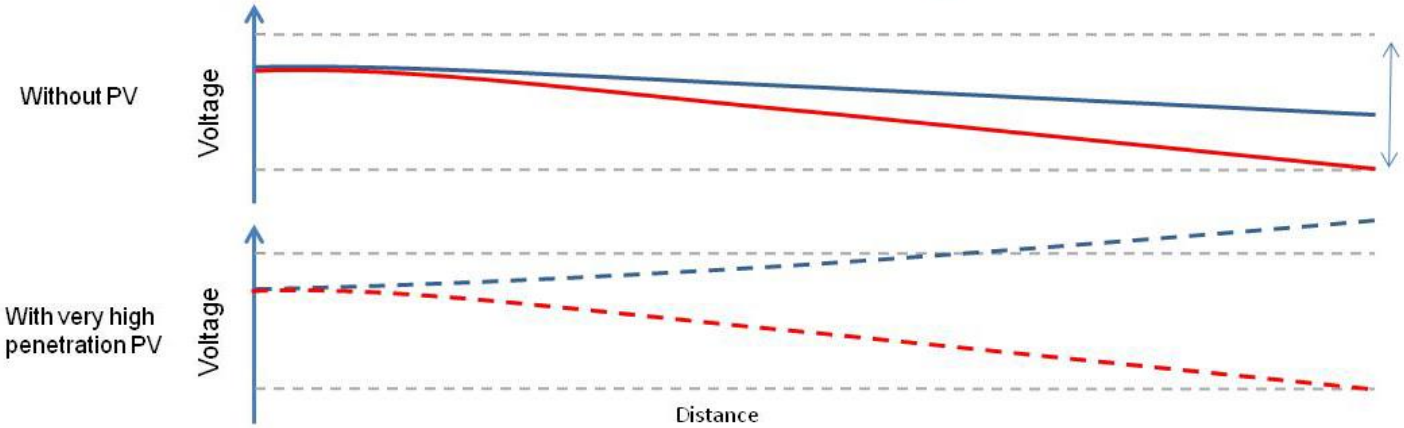
Distributed PV and the (rural) grid

- Voltage rise common issue
- Smart inverters and transformers help

Voltage rise in a rural distribution system in Germany

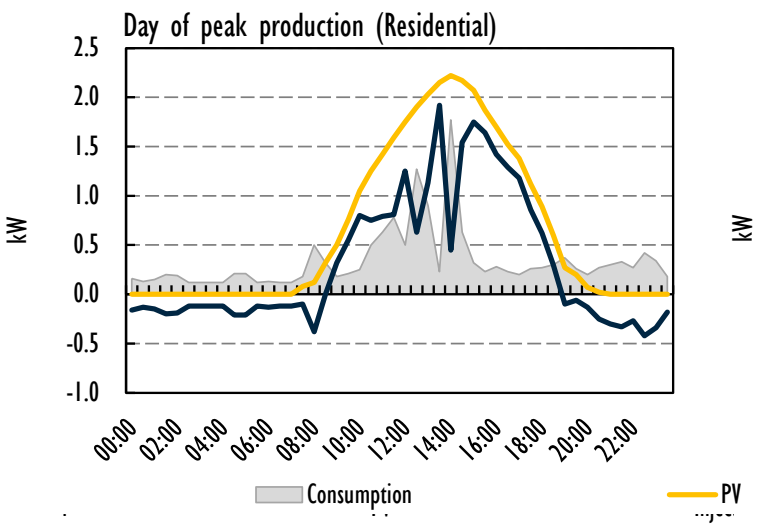


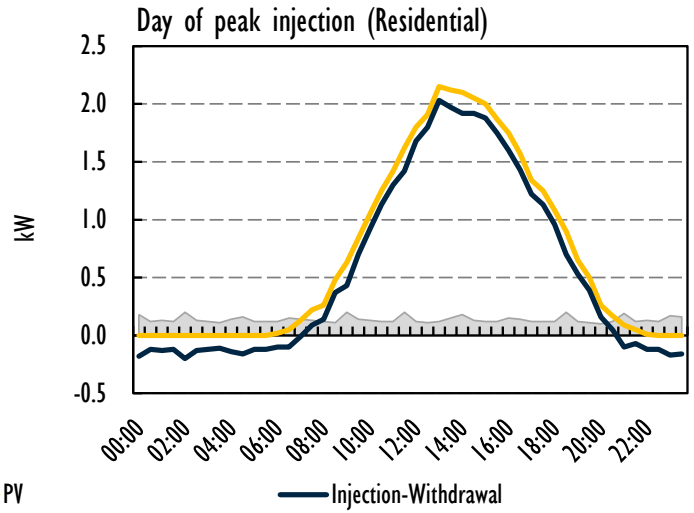


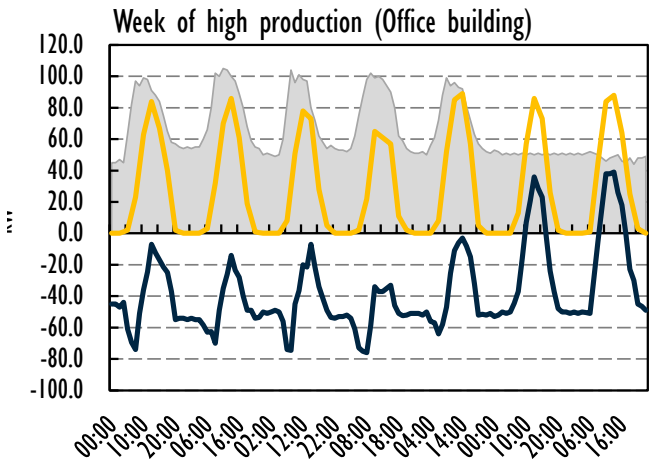


Impacts on the grid will vary by type of DG

Match of PV supply and power demand for a residential/commercial customer in France





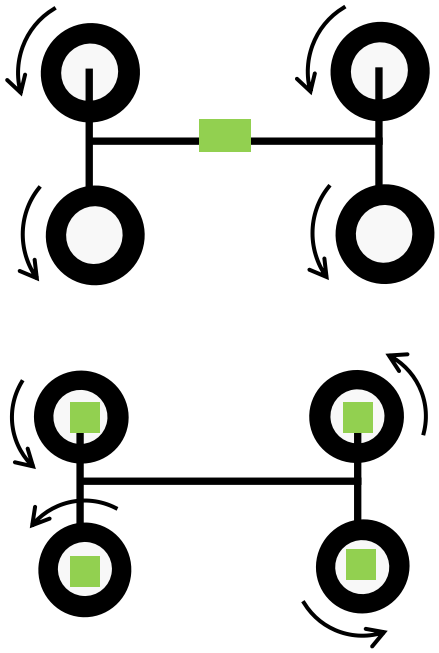


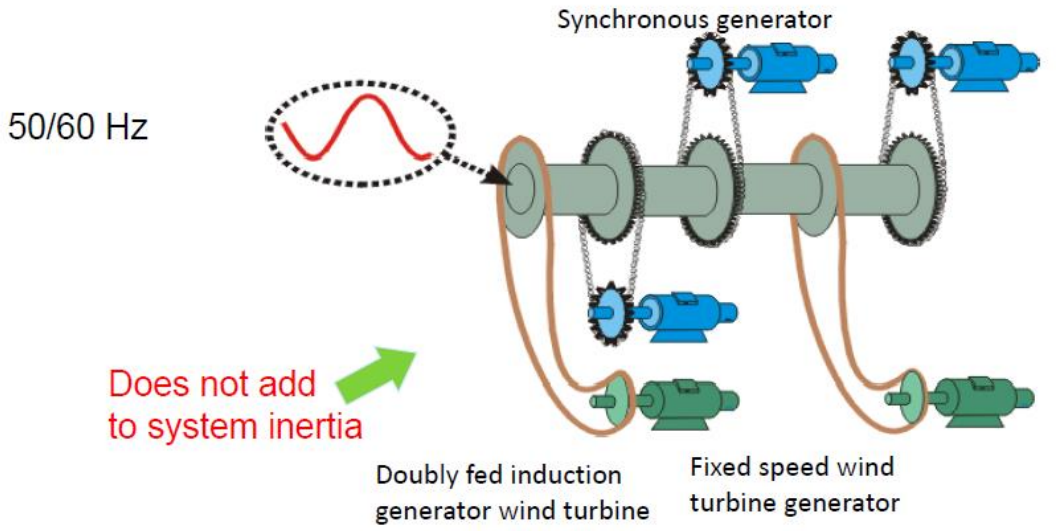
- **Self-consumption higher for:**
  - **Some office and commerce buildings with high daily consumption, and relatively small systems on multi-storey dwellings**
- **Self-consumption potentially increased with DSI, storage**

Source: ETP 2014, EDF

New type of technology

- PV: non-synchronous, non-mechanical generation
- Wind: non-synchronous, mechanical generation

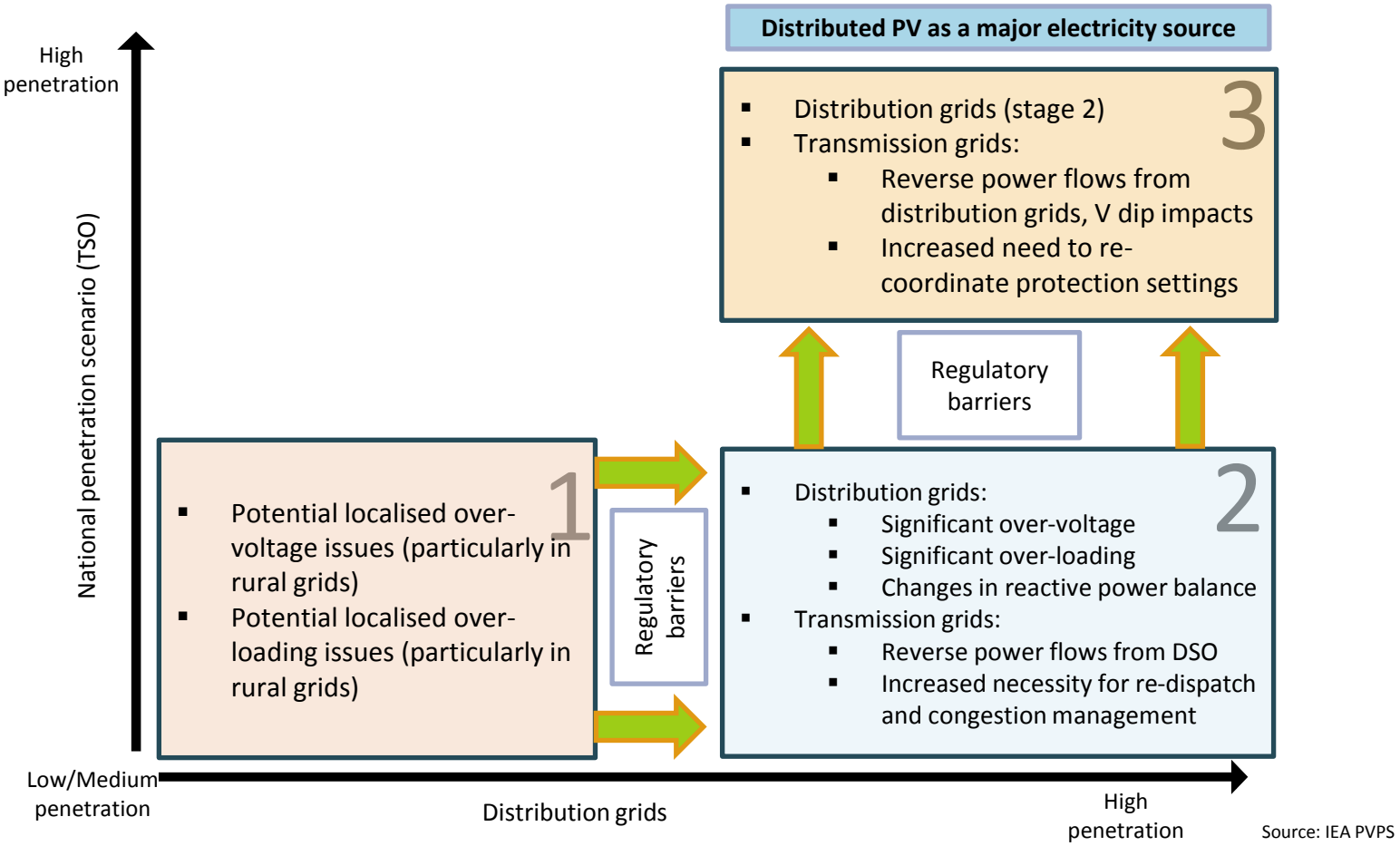




Source: Integrating Wind in Ireland: Experience and Studies
Mark O'Malley Director, MIT Wind Week January 21th 2011

Key point: *Technical connection standards critical to ensure safe operations, in particular for distributed generation*

Impact of rooftop PV on grids

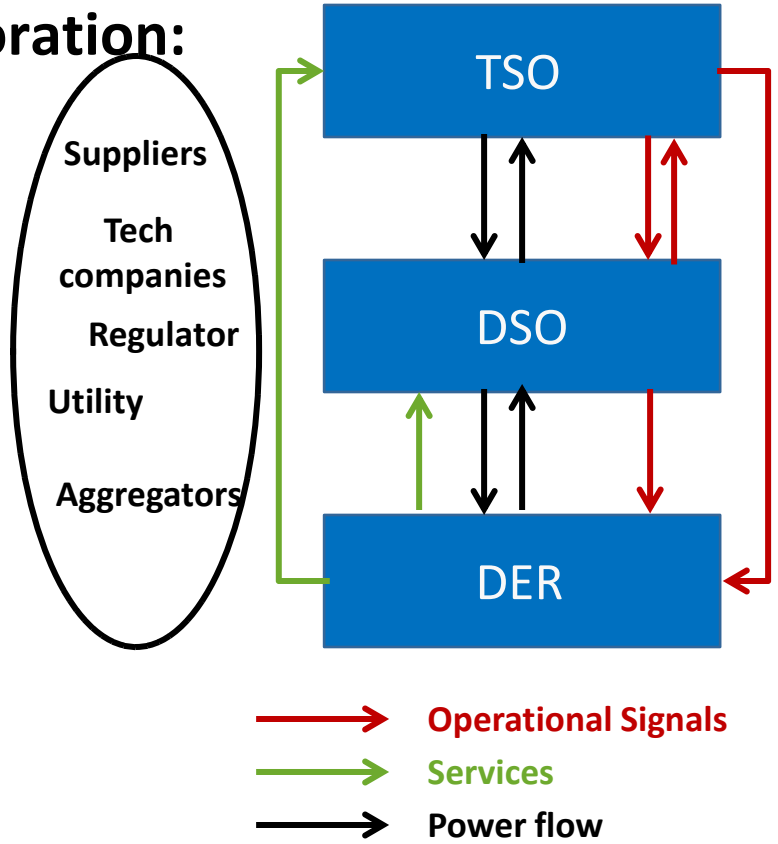


Key point: ***The impact of rooftop solar PV installations on local and bulk transmission grids will change as installation levels increase***

Changing TSO – DSO relationship

- **Key areas for coordination / collaboration:**
  - congestion management
  - grid monitoring
  - balancing and operating reserves
  - islanding & re-synchronization
  - generation / load forecasts

Future energy system interactions

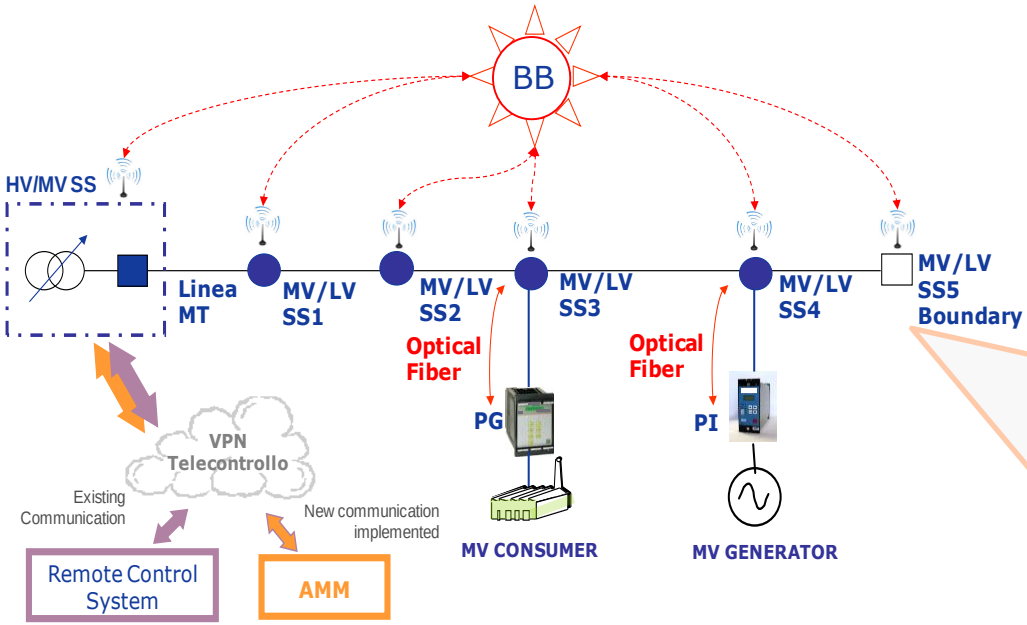


TSO = Transmission System Operator
DSO: Distribution System Operator
DER: Distributed Energy Resources

Key point: ***The transformation of local grids calls for strengthened cooperation between TSOs and DSOs.***

Adapted from Birk et al (2016)

RES control using smart grids



Smart Grids Functionalities

- ✓ *RES Observability and **Monitoring***
- ✓ ***Voltage Control***
- ✓ *Automatic **Fault Detection***
- ✓ ***Anti – Islanding***
- ✓ ***Information flow to the TSO***
- ✓ ***Ancillary services***
- ✓ ***Demand Response***

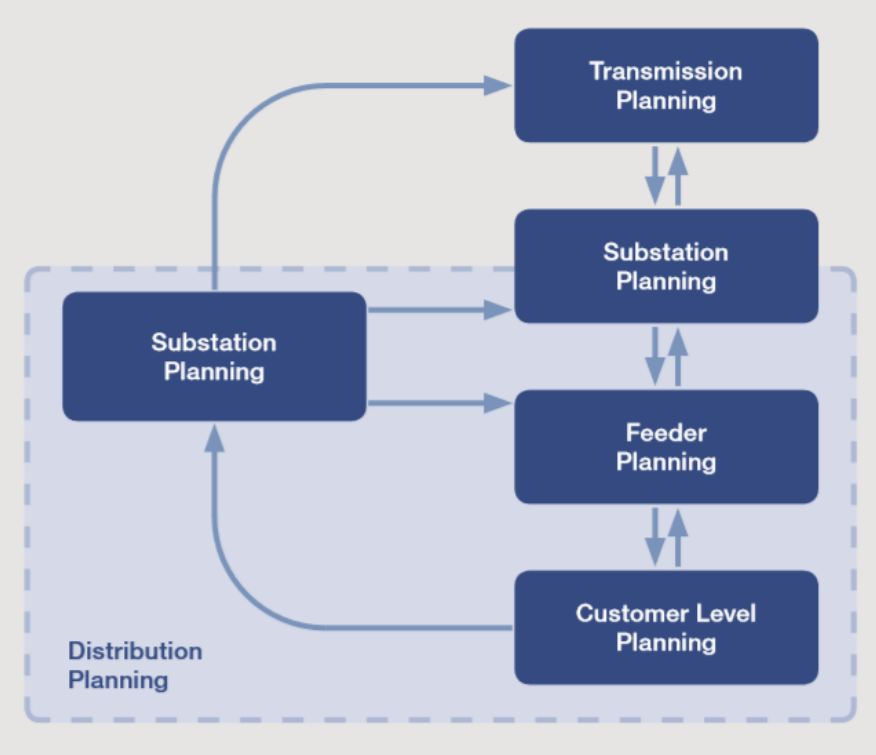
… Broad Band infrastructure connecting all the main nodes of the distribution network

Source: ENEL, FY 2013

Planning of local grids

- **Historically:**
  - Focused on sizing to match peak load
  - Single loading scenario
  - Load flow simulations
- **Revision towards**
  - Uncertainties
  - Distributed generation
  - EVs
  - Storage / DSM
  - Non-grid options
- **Raises importance of data to simulate variety of loading scenarios**

Towards stronger integration in planning local grids



Source: PlanGridEV

These loads may arrive sooner than you think

Renault ZOE40

40 kWh 3*32A / 3*64A

TESLA Model 3

60 kWh 3*32A / 3*64A

Chevy Bolt EV

60 kWh 3*16A

Conclusions

- **Adding distributed generation gradually impacts low- and medium voltage grids**
  - Change can happen quickly – so better be prepared
- **Most common technical issues voltage rise, line and transformer loading (depend on network setting)**
  - Smart inverters can help increase hosting capacities
- **Growing shares of distributed generation change the nature of interface between transmission system and local grids**
  - Smartening of medium- and low-voltage grids can be cost effective
- **Planning standards need to be adapted to new reality**
  - Linked with transmission level planning
  - Robust against uncertainty
  - Incorporate all relevant technological trends (DG, demand side response, electric vehicles)

Thanks

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