1ST GERMANY - INDIA SMART ENERGY WORKSHOP

Germany's Experience with Rooftop PV and Importance of Smart Inverters

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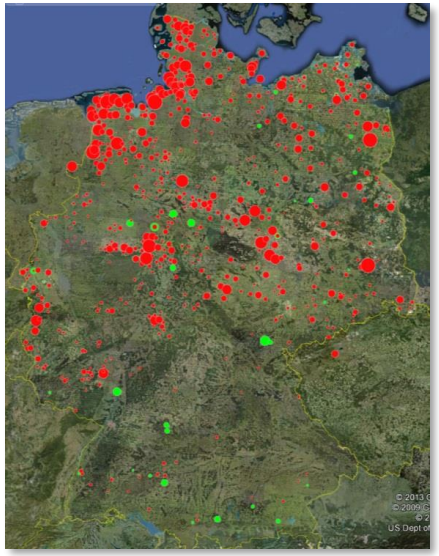
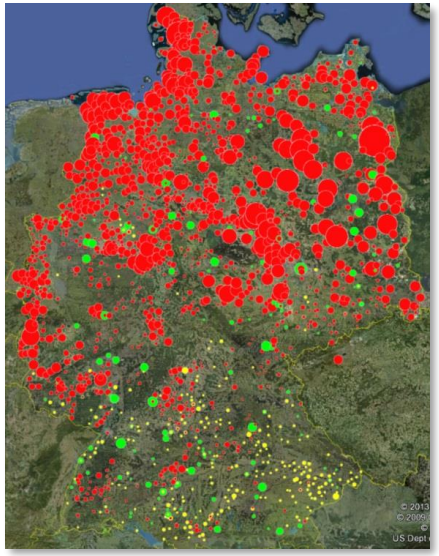
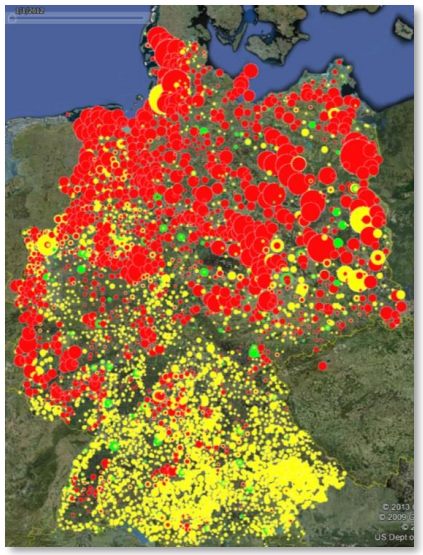
Energynautics Germany
technical consulting for the energy transition

» Studies

» Capacity Building

» Conferences

Renewables Development in Germany

2000	2006	2012	2021
			PV: 56 GW Wind onshore: 55 GW Wind offshore: 8 GW Biomass: 9 GW Min. demand: 32 GW

Wind Solar Biomass

SOURCE: 50Hertz, Amprion, TenneT, Transnet BW, Google Earth, statista

Rooftop PV in Germany

- Typical situation in German villages

Source: Google Earth

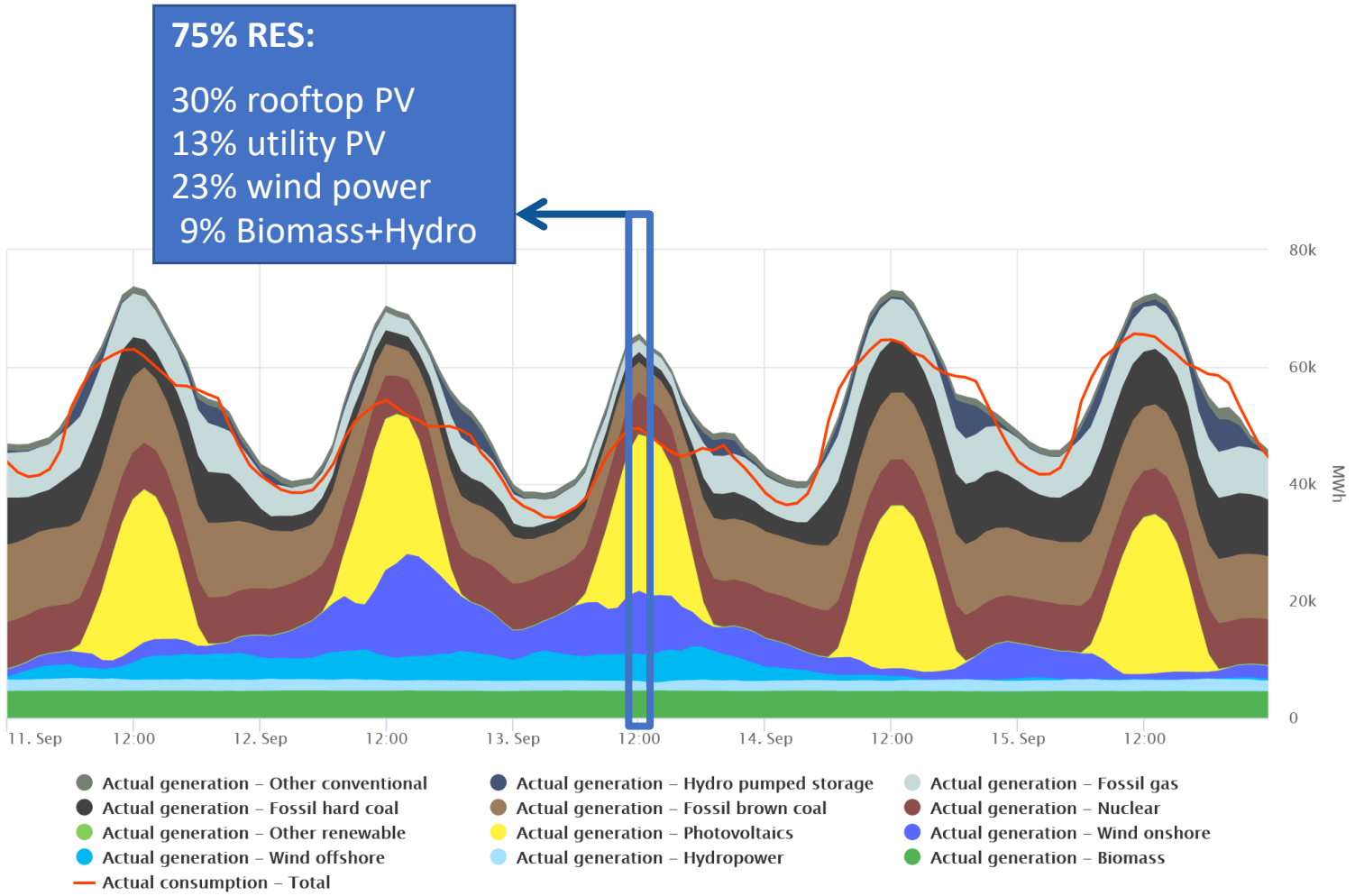
Electricity Generation in Germany 11th to 15th Sept 2020

- Original perspective:

  Get renewables out of the way as soon as there is a disturbance in the electricity grid.

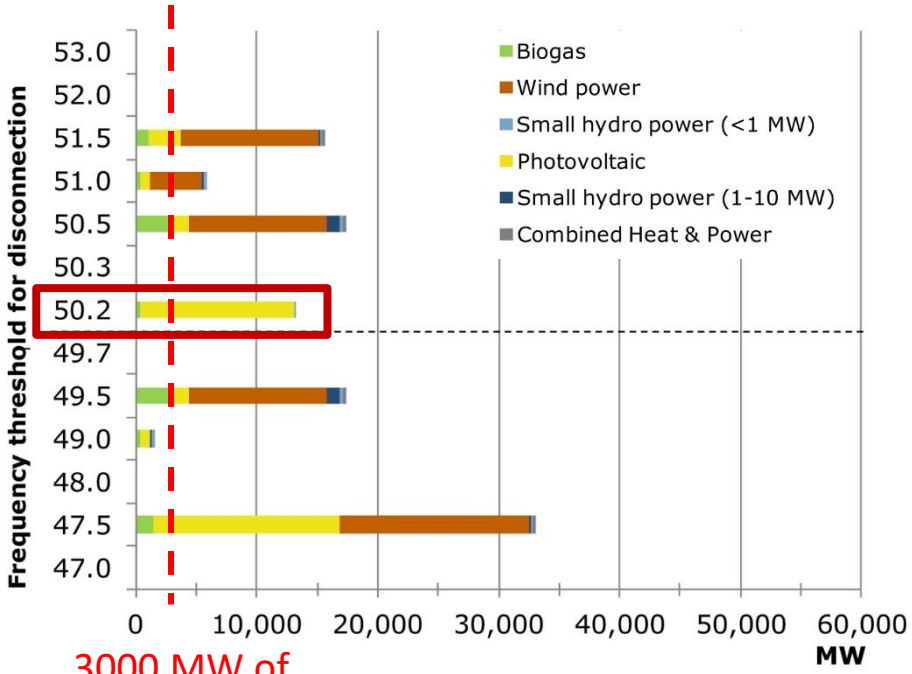
- But:

  Not a good idea if RE is major contributor!



The 50.2 Hz Problem in Germany

- Several thousand megawatts of installed renewable capacity disconnect at unfavorable frequency thresholds



3000 MW of primary reserves

Source left: EEG-registry of TSOs (1997-2008) and Federal Netzwork Agency (2009-2010)

Inverters had to be retrofitted:

- 300,000 inverters for more than €170M from 2012-2014
- For comparison: on Hawaii 800,000 inverters were reprogrammed in 2 days, remotely at no cost.

Smart Inverters
What's the difference?

Traditional Inverters

- DC/AC conversion
- Ensuring power quality
- Protecting from unintentional islanding
- Disconnection from grid based on under-/overfrequency and under-/overvoltage

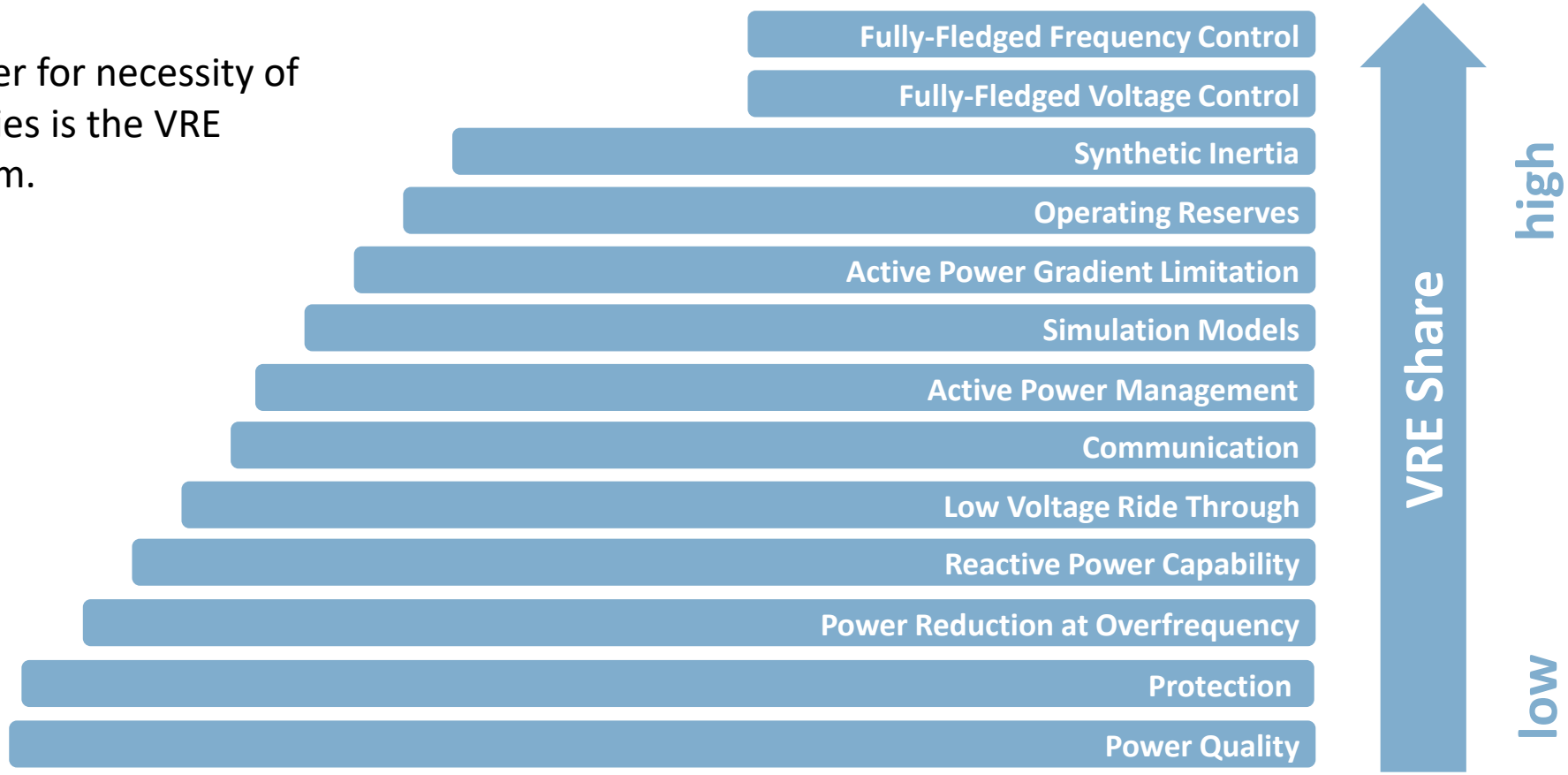
Smart Inverters

- Autonomous ride-through capabilities
- Autonomous support to system stability (voltage/reactive power and active power control)
- Communication capabilities

- Strictly required for variable renewable energy integration
- Many inverters on the market are already "smart"
- Inverters keep becoming smarter

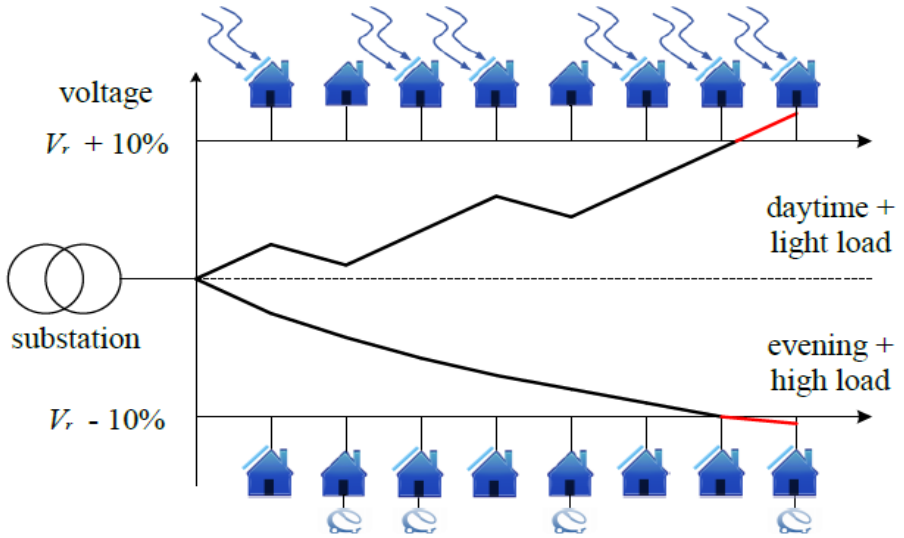
Smart Inverter Capabilities

The most important driver for necessity of certain inverter capabilities is the VRE share in the power system.



Source: IRENA Grid Codes Report, http://www.irena.org/DocumentDownloads/Publications/IRENA_Grid_Codes_2016.pdf

Reactive Power for voltage control in distribution grids

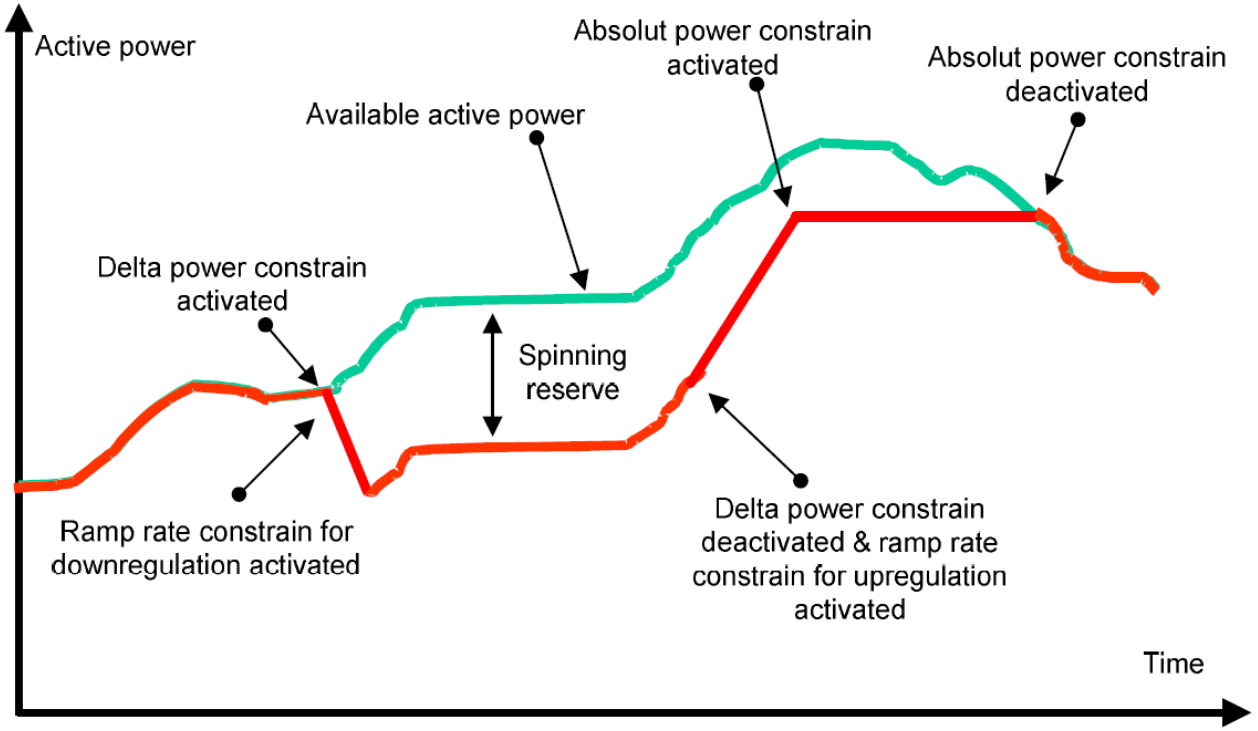


Source: Uhlig, CIRED Workshop 2014

German experience: Voltage control in distribution grids can become crucial

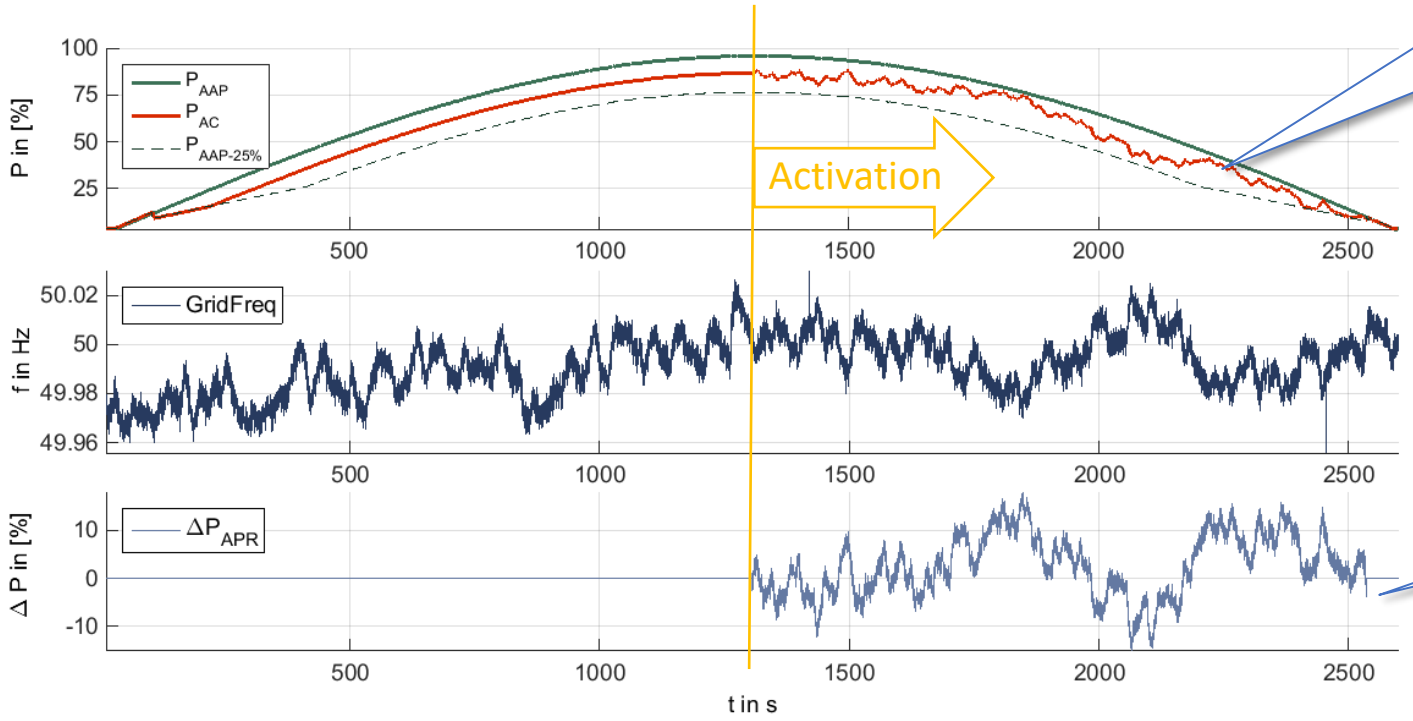
- Grid operators observed overvoltage issues especially in lightly loaded rural grids with high PV feed-in.
- PV units above 3.68 kW must be able to contribute to voltage control by feeding in reactive power.

Ancillary Services



Source: EnerginetDK, Technical requirements for PV and wind power plants above 11 kW, Denmark

Ancillary Services
Frequency control with PV



Curtailment relative to Maximum Power Point ➔ Compensation rules must be clear

PV can provide frequency support!

Source: T. Buelo: Possible Ways Forward for Solar PV Contribution to Coping with Impact of High Penetration, 16th Wind Integration Workshop, Berlin, 2017

Key Takeaways

- Many lessons to be learned from the PV frontrunner Germany (e.g., 50.2 Hz Problem)
- Smart inverters are strictly required for variable renewable energy integration (luckily many inverters on the market are already fairly “smart”)
- With higher VRE share, smarter functions need to be implemented (e.g., frequency control)
- Grid Codes need to be in place and steadily revised to adapt to the progress of the energy transition

Thank You

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