Federal Ministry
for Economic Affairs
and Climate Action

MITTELSTAND
GLOBAL
ENERGY SOLUTIONS
MADE IN GERMANY

Grid Integration of Renewables

Dr.-Ing. Michael Popp – Bergische Universität Wuppertal

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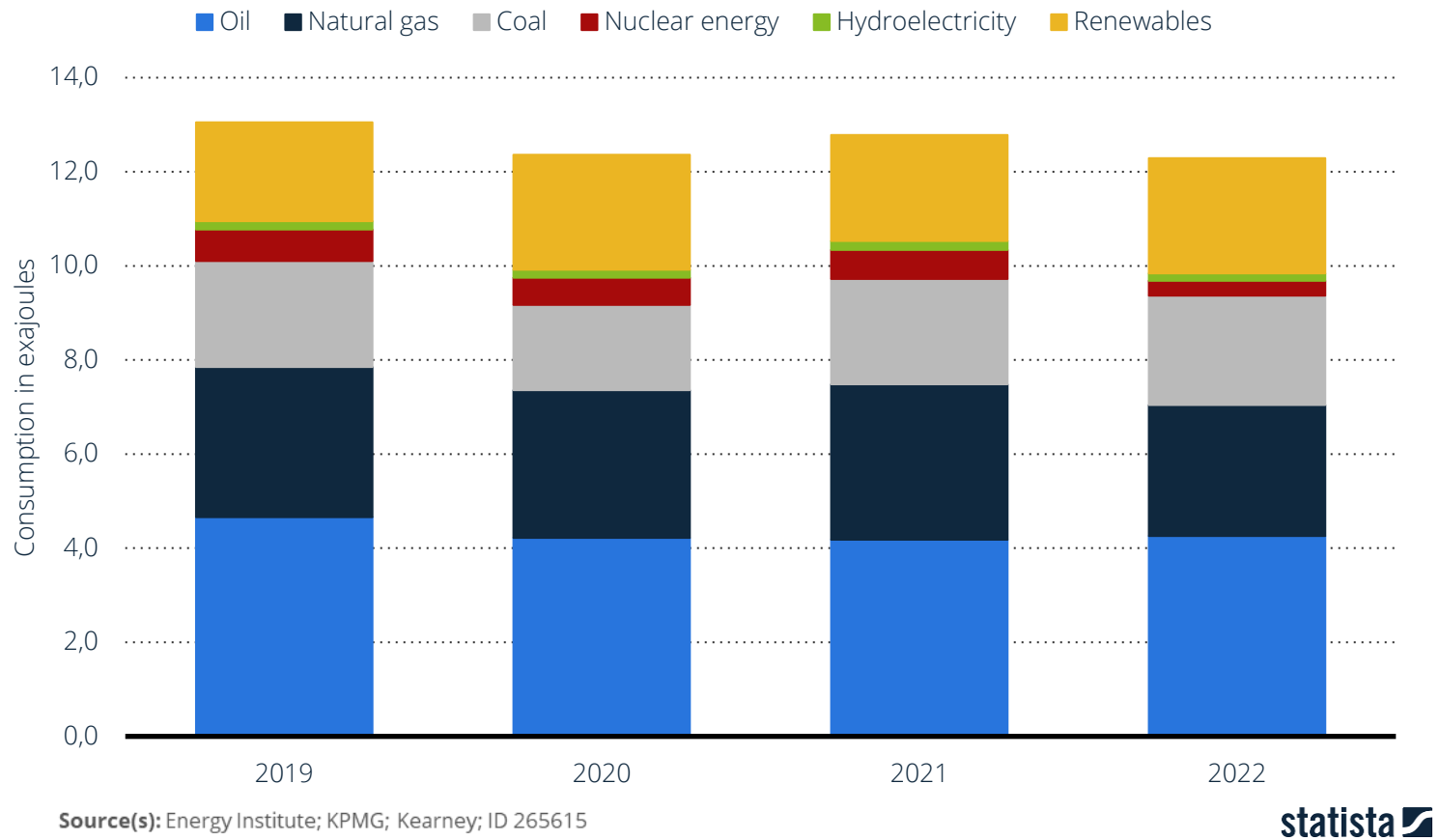
Primary energy consumption in Germany from 2019 to 2022, by fuel



- Oil and Natural gas mainly used in transport, industry and heating
- Phasing out of Nuclear energy completed in 2023
- Coal Phase-out until 2038

- Electrification of different sectors ongoing
- Significant increase of Renewables ongoing

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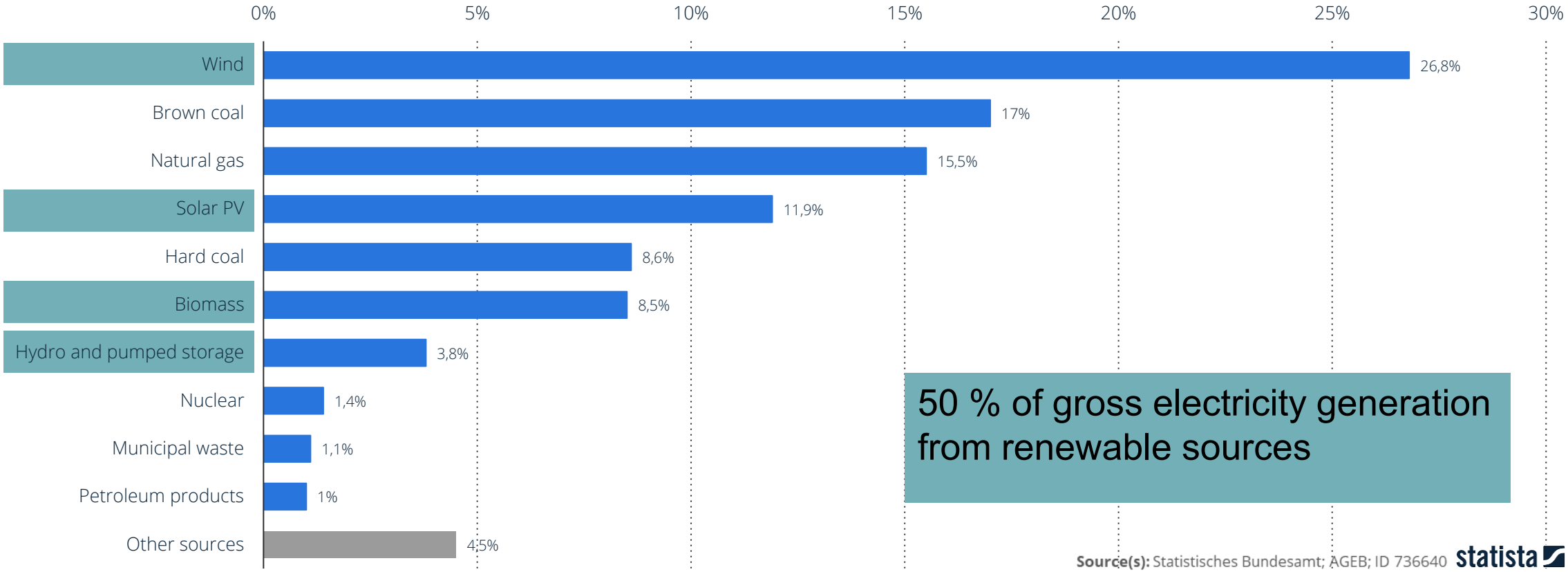
Distribution of energy sources used for gross electricity generation in Germany in 2023



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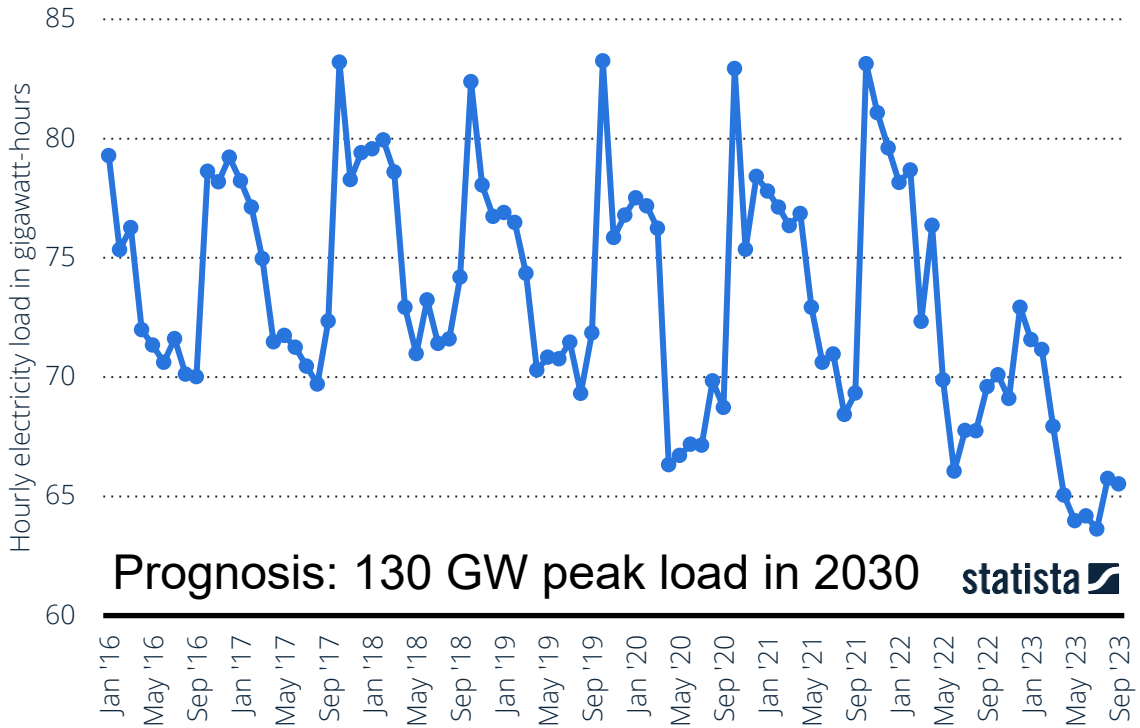
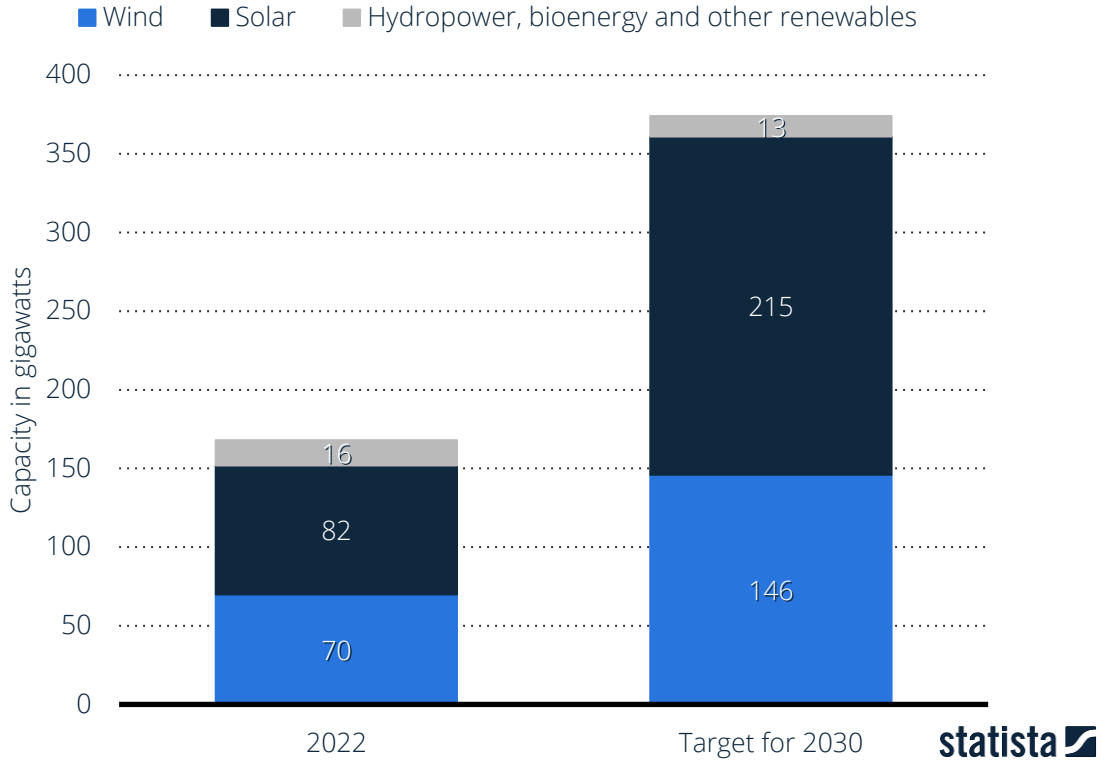
Peak hourly electricity load and Installed and targeted renewable capacity in Germany

Peak hourly electricity load in Germany 2016-2023, by month



Source(s): ROITI; ENTSO-E; ID 1342214

Installed and targeted renewable capacity in Germany 2023-2030, by source



Source(s): Ember; BMWK; Bundesregierung; ID 1468460

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What happens to the German grid?

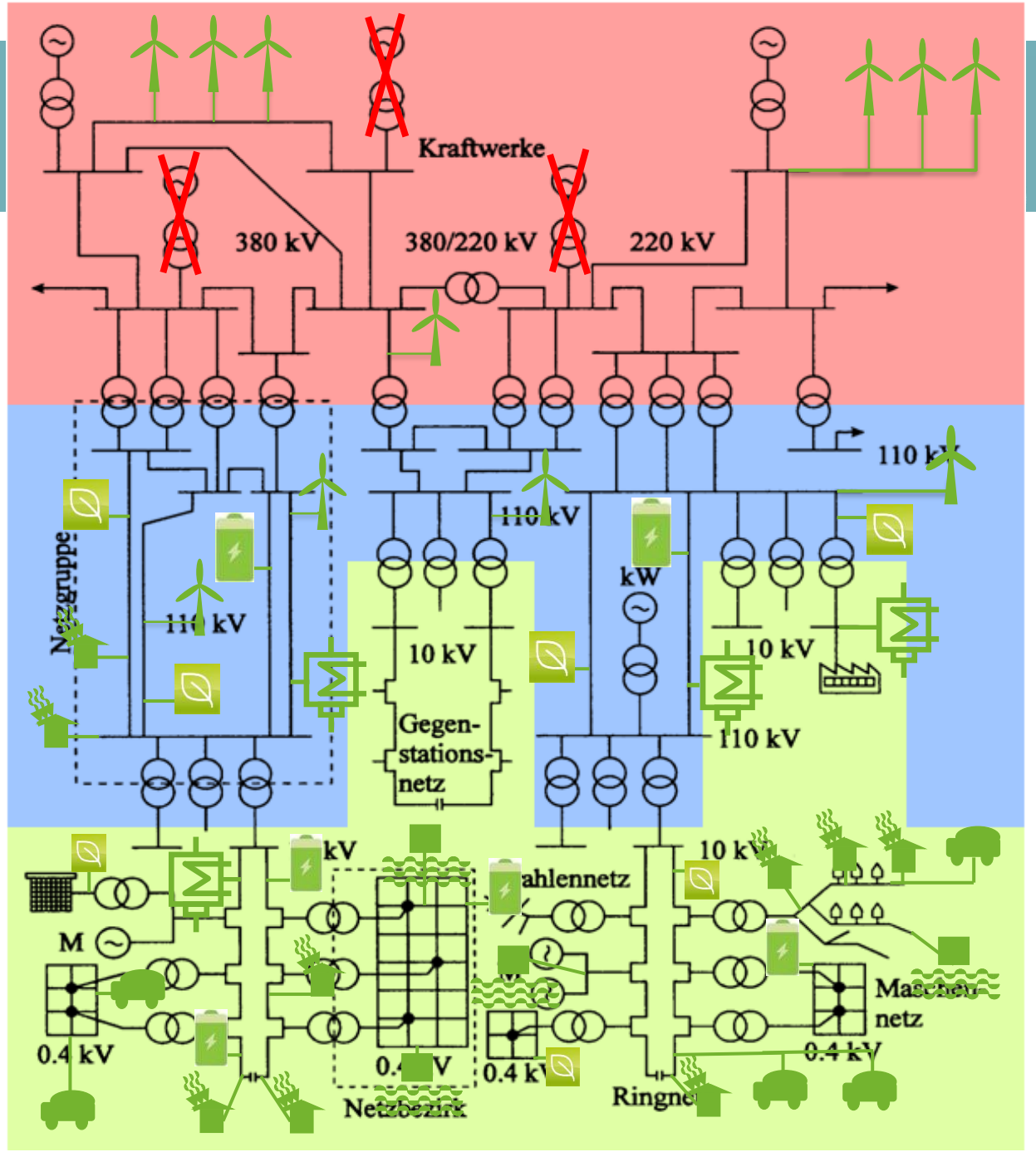
Change in Generation

- Wind Power
- Photovoltaics
- No Nuclear Power
- Comb. Heat/Power plants
- Biomass

New electrical loads

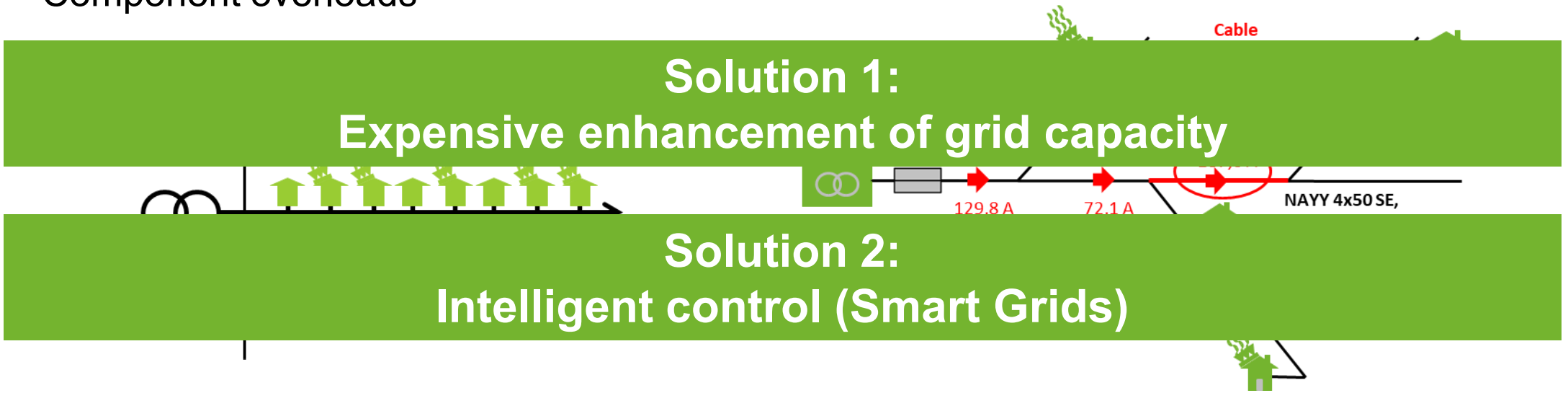
- E-mobility
- Air condition
- Heat pumps

Storage units



Challenges for the distribution grids

- Strongly increasing distributed generation especially in rural **Medium-** and **Low-Voltage-grid**s leads to:
  - Power flow inversion: (Rural) grids are rather **collection** than **distribution** grids (“**green grids**”)
  - Local violations of the permitted voltage rage
  - Component overloads



Solution 1:
Expensive enhancement of grid capacity

Solution 2:
Intelligent control (Smart Grids)

Enhancement of Grid Capacity (Solution 1)

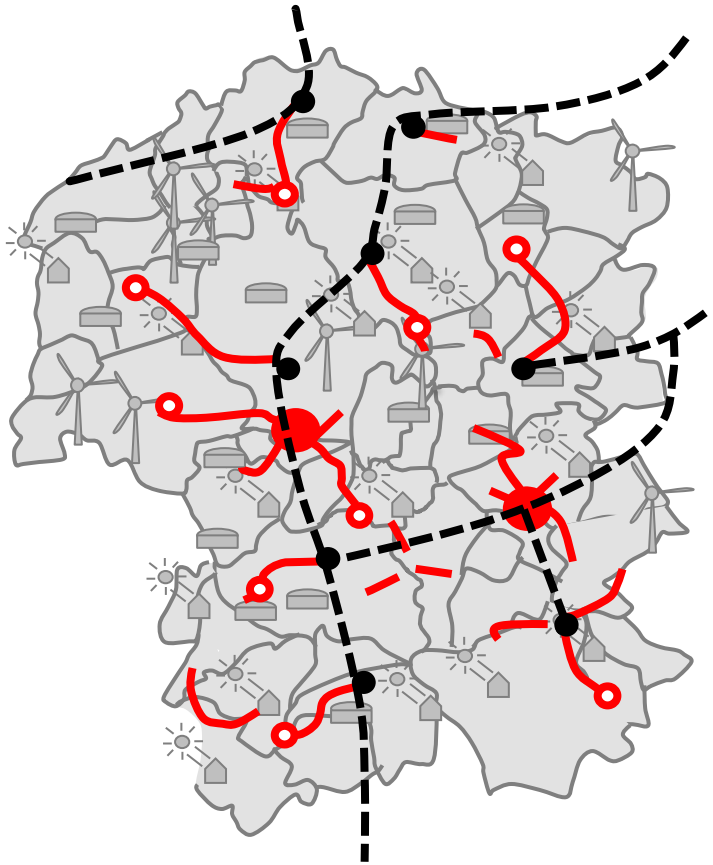
Specific Measures:

- Increase capacity of Medium Voltage Grid as foreseen in scenario 2030
- Adherence to today's guidelines in 2030

> **New** 55 km cables (300 mm²)
>
> **New** 9 MV satellite grids (81 km, 800 mm²)
>
> **New** 2 HV/MV-substations

- 30 Mio. € investments until 2030 in MV
- Massive additional investments in LV- and HV-grids

Example: rural distribution grid operator



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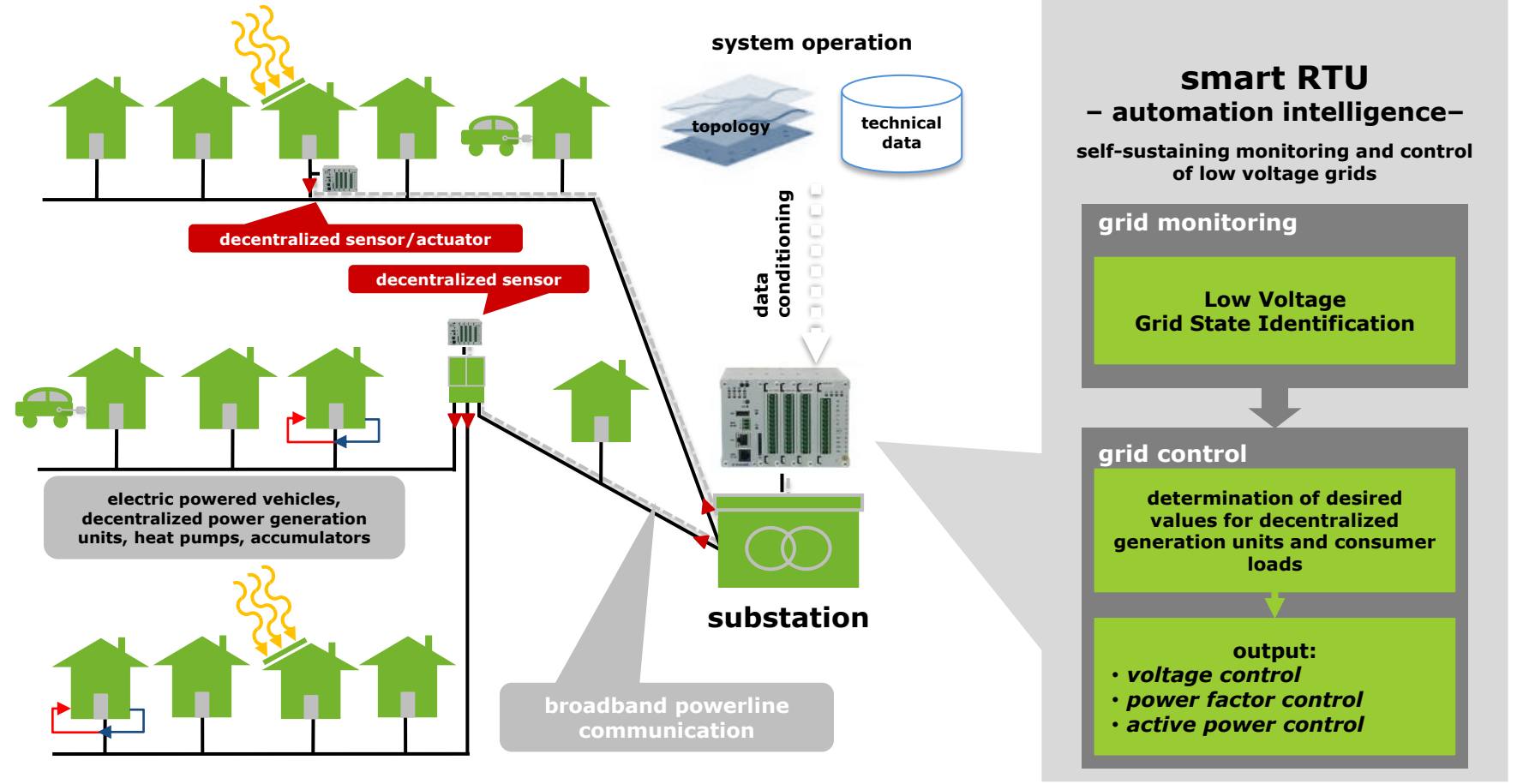
Smart Low-Voltage Grid Concept (Solution 2)



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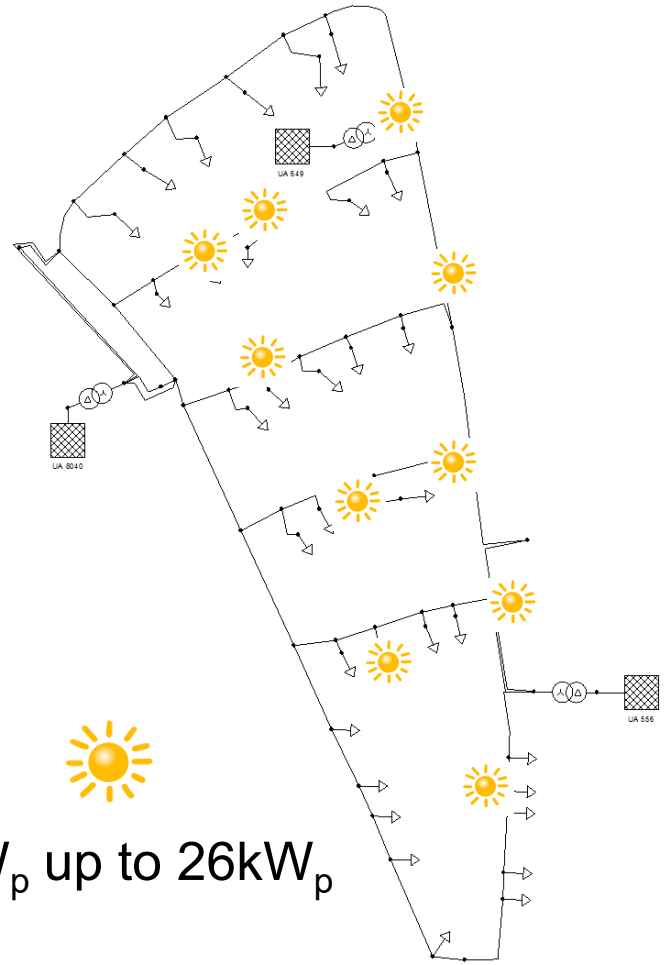
Smart Low-Voltage Grid Concept (Solution 2)

Sattelite-View

Grid-View



$11kW_p$ up to $26kW_p$

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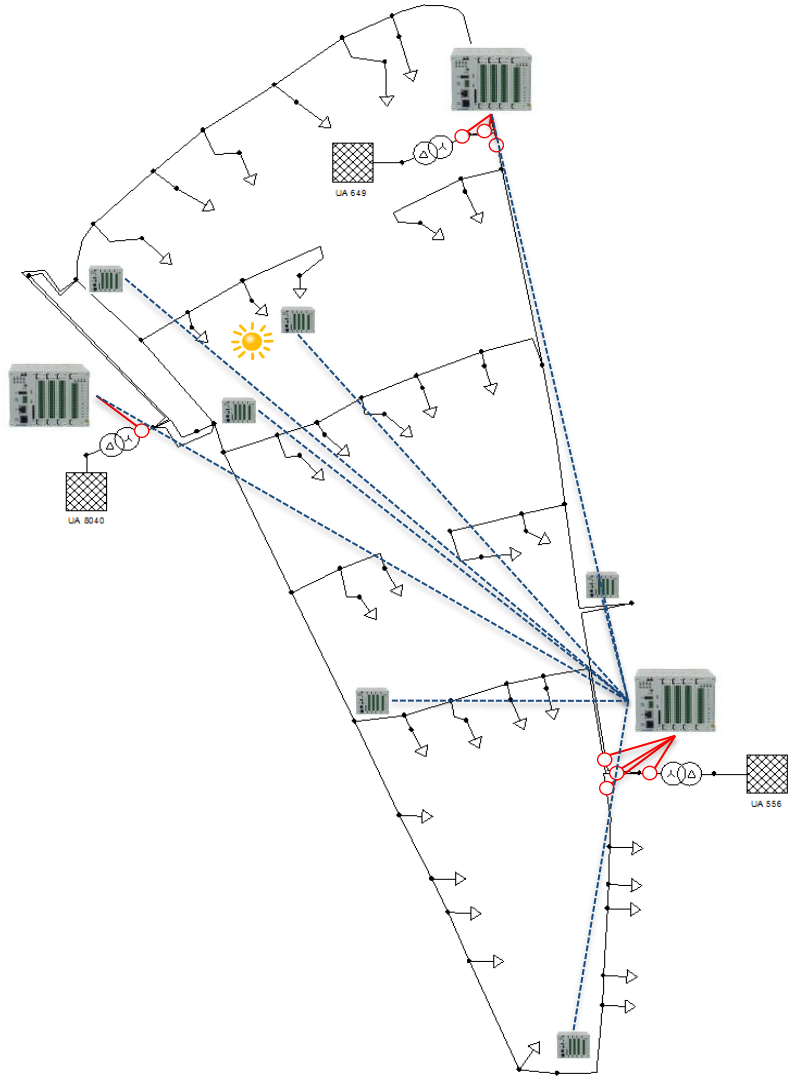

Hardware:

- 3 SmartRTU in 3 MV/LV-substations with 8 points of current measurement
- 6 decentralized direct measurement units
- Broadband powerline communication infrastructure

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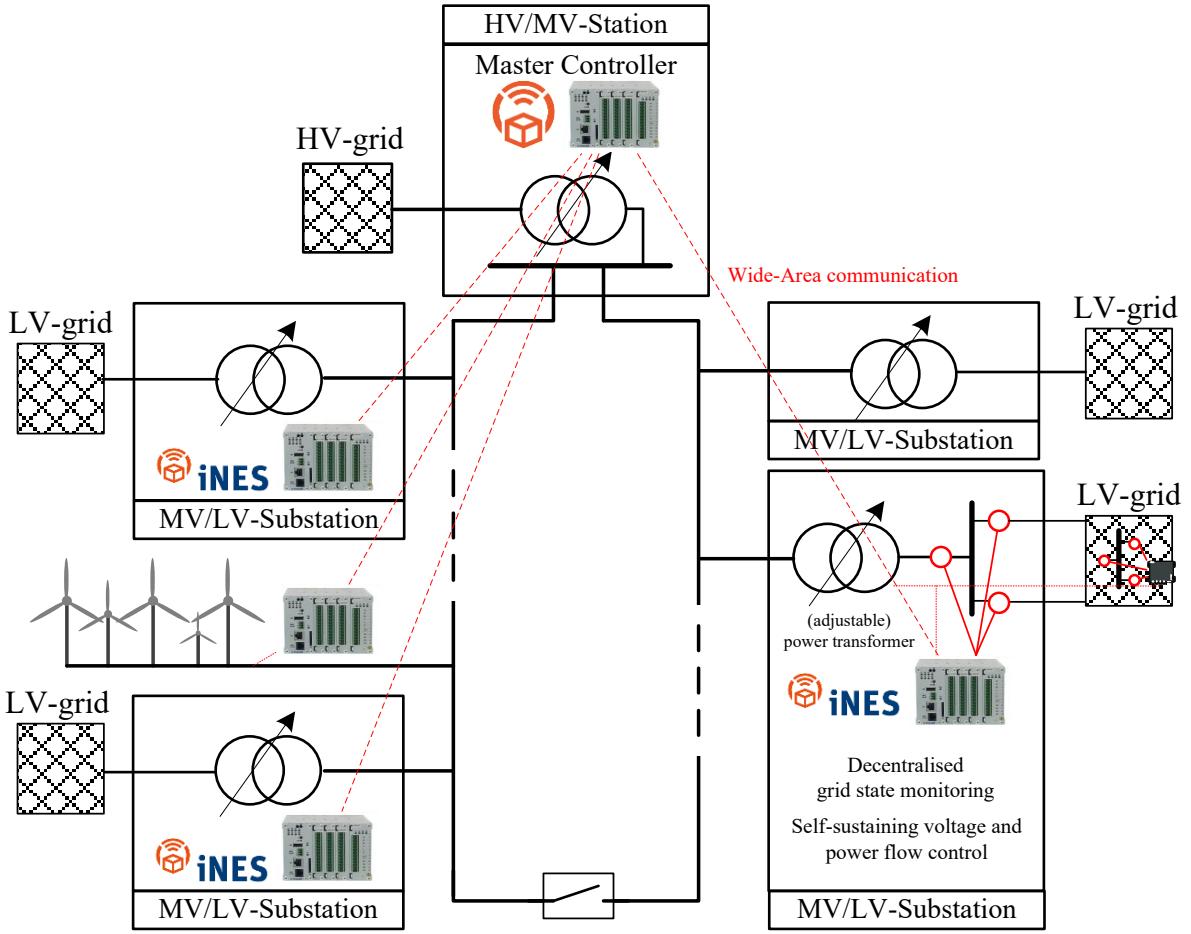
Smart Medium-Voltage Grids

- Transferring the Concept to Medium-Voltage level
- Ensures cost-efficient integration of distributed generation on **all distribution levels**



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Conclusions

- The German “Energiewende” changes the grid structures fundamentally – both in urban and rural areas!
- The Smart Grid solutions:
  - are established
  - avoid expensive grid enhancement in many cases
  - … but grid enhancement is necessary, too!
- Smart Grids enable Smart Markets

A cost-optimized smart grid solution complemented by inevitable grid enhancement forms the basis for Germany’s “Energiewende”.

Contact

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