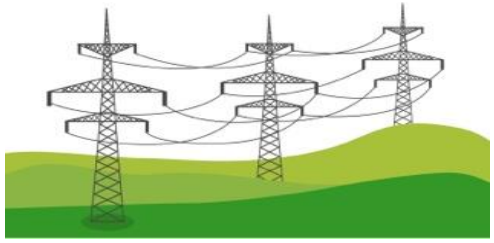
Flexibility by innovation – connecting the renewable world with smart solutions

Paul-Georg Garmer

Brussels, 20 February 2018

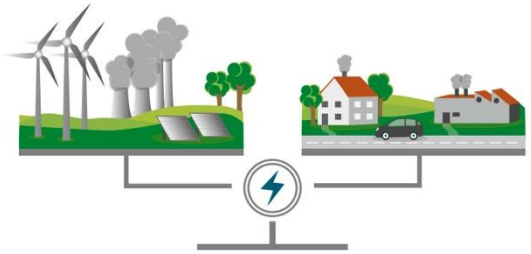
What we Do

Key tasks of a TSO



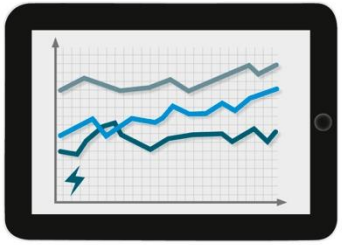
Transmission services

operating and maintaining and, if necessary, planning and constructing and maintaining a robust ultra high voltage grid



System services

maintaining the balance between electricity supply and demand at all times

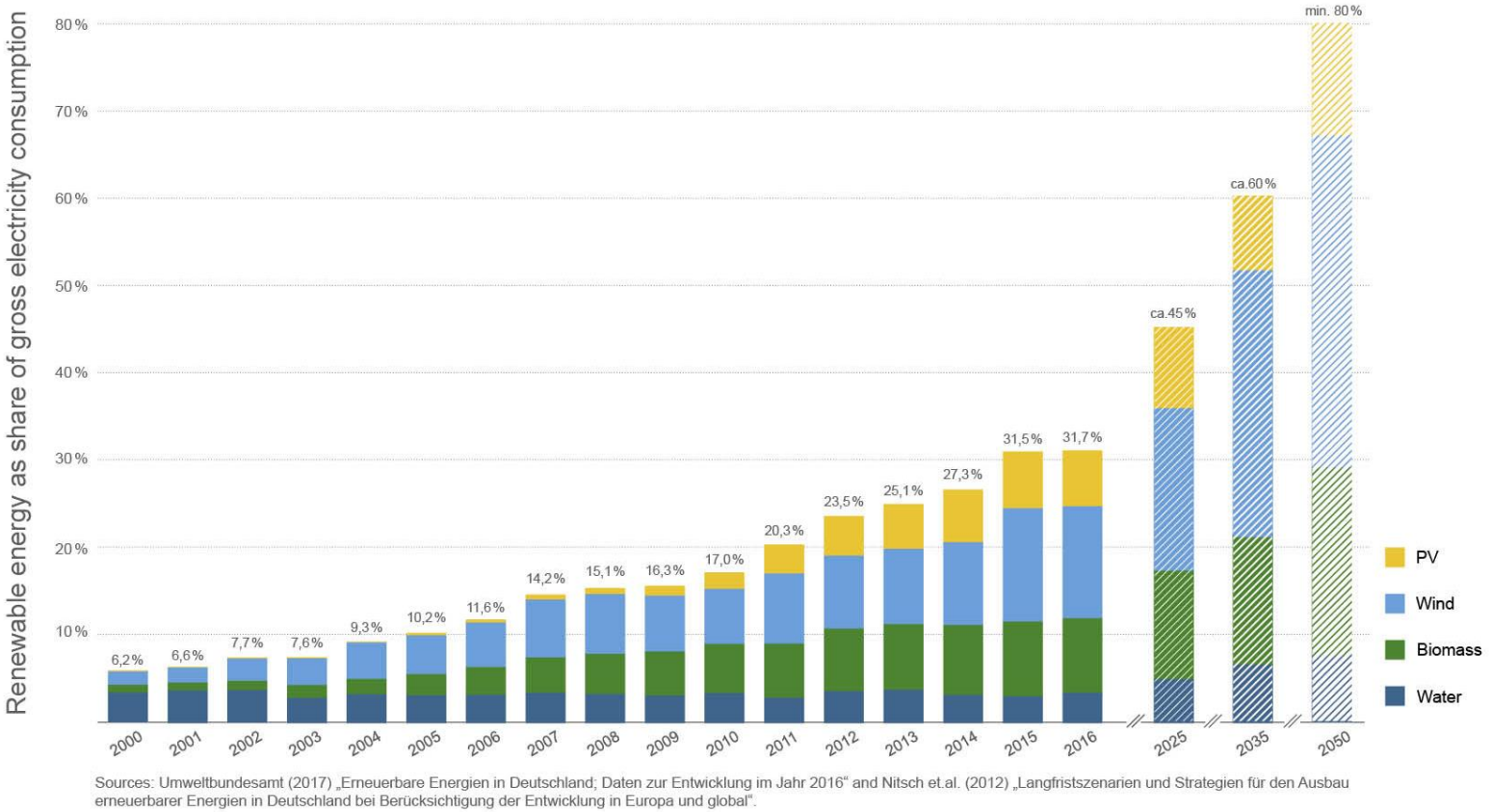


Market facilitation

facilitating a smoothly functioning, efficient, liquid, and stable electricity market

Energy Transition

Renewable Energy Consumption in Germany



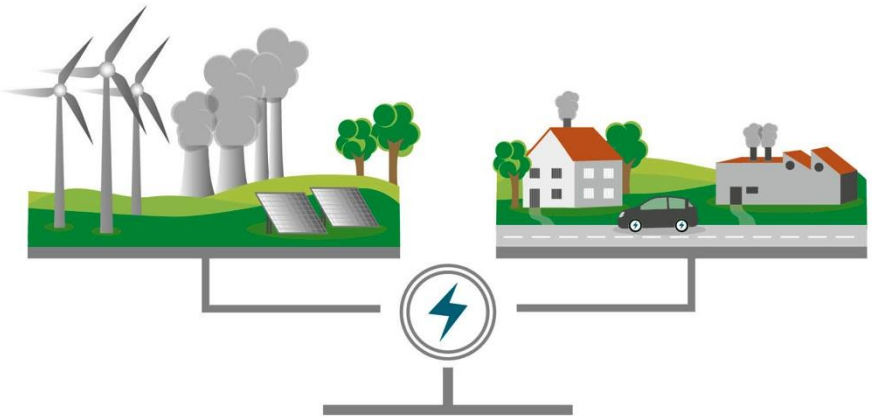
Sources: Umweltbundesamt (2017) „Erneuerbare Energien in Deutschland; Daten zur Entwicklung im Jahr 2016“ and Nitsch et.al. (2012) „Langfristszenarien und Strategien für den Ausbau erneuerbarer Energien in Deutschland bei Berücksichtigung der Entwicklung in Europa und global“.

Renewable energy in Germany:

- already 32% of total consumption in 2016 growing to 60% by 2035
- wind has the highest share with 40% of total renewable energy in 2016

Renewables
Put Grids Under Stress

Supply and demand must be balanced at all times to avoid congestion and frequency deviations



Volatile production

Renewable energy production fluctuates with weather:

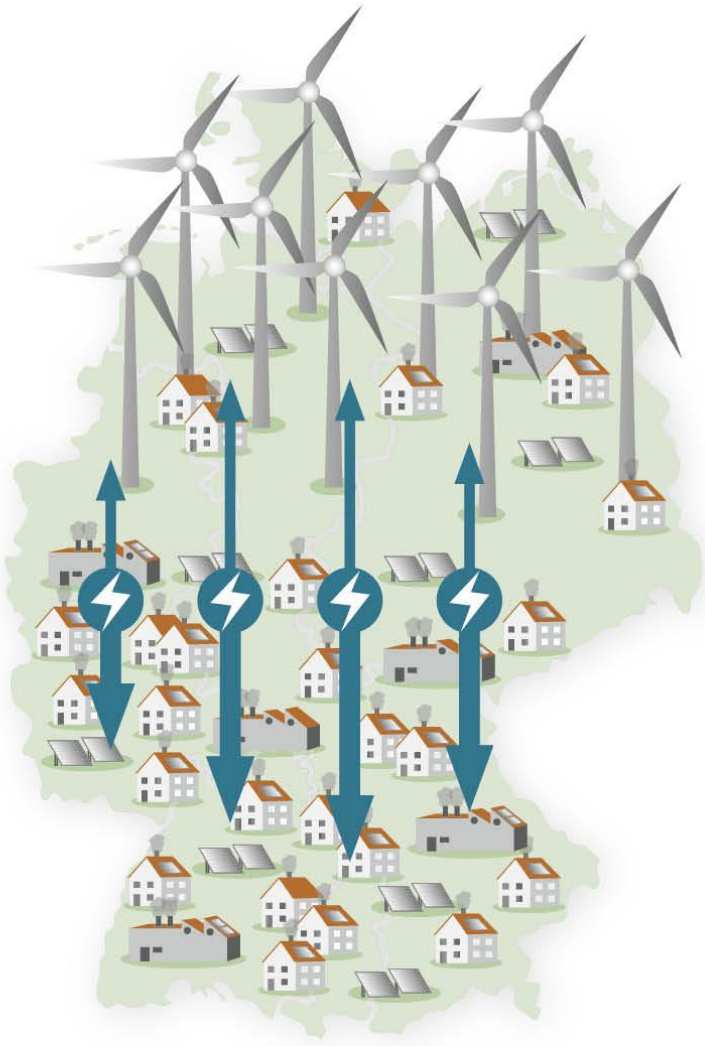
- PV-production depends on time of day, season, and clouds
- wind production fluctuates with pressure differences

Decentralisation

Locations of production multiply and come apart from locations of consumption:

- north-south transport from production- to consumption centres.
- decentralised, volatile supply from micro producers (prosumers).
- no central power plants as balancing elements

Decentralization



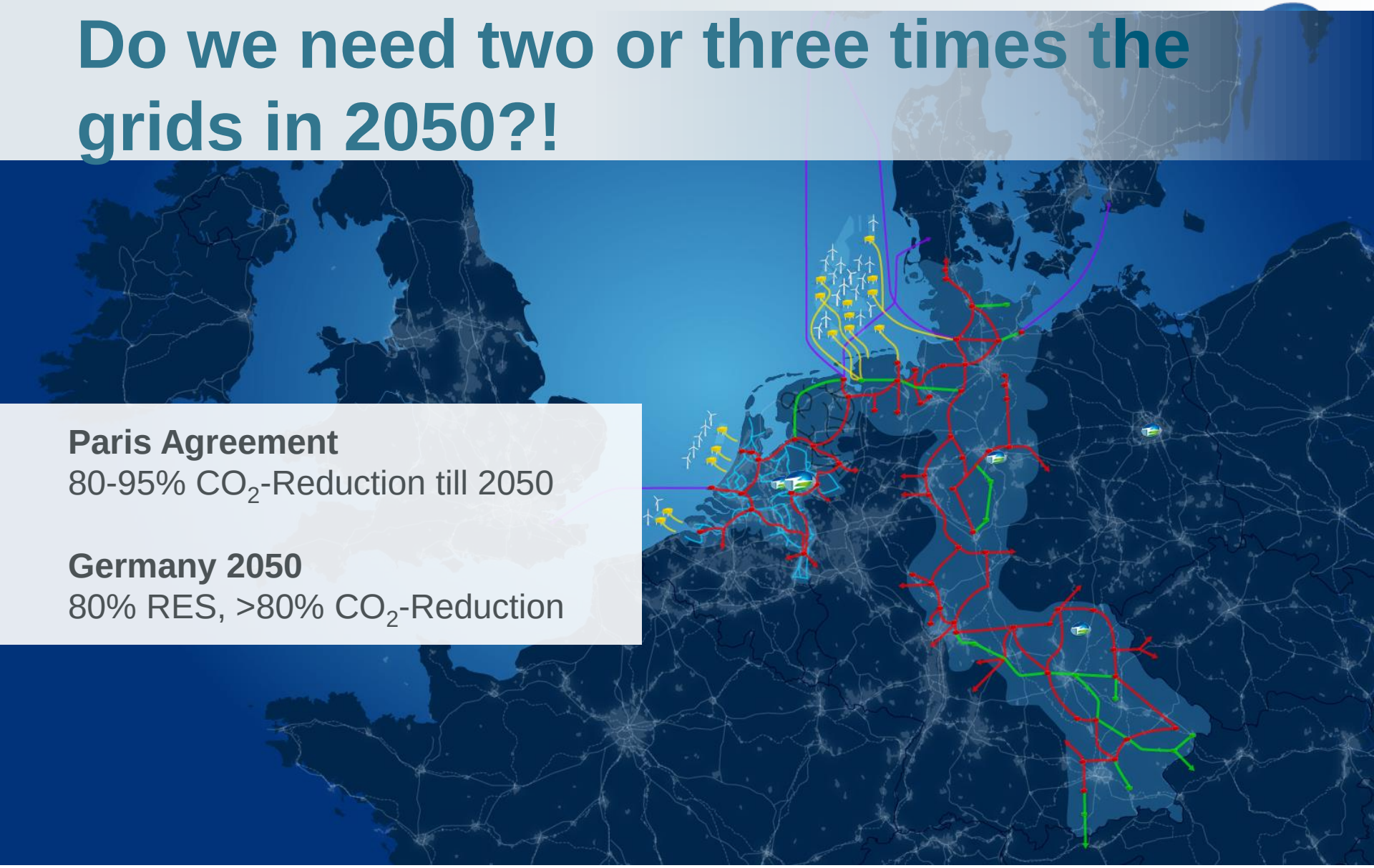
North-south energy gap:

- renewable energy is produced mainly in the north and east of Germany
- demand is higher in the south and southwest of Germany

Phase-out of nuclear and coal:

- less, and eventually no central power plants as balancing elements in the system
- production mainly at lower voltage levels

Do we need two or three times the grids in 2050?!



Paris Agreement
80-95% CO_2-Reduction till 2050

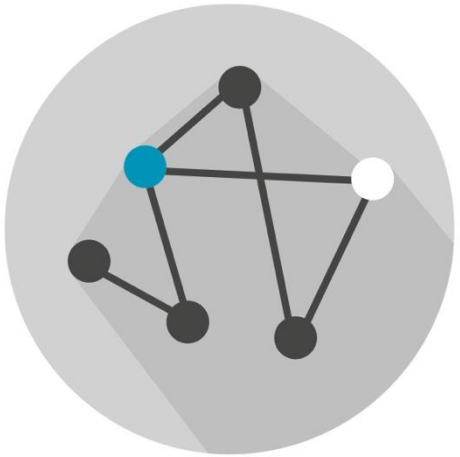
Germany 2050
80% RES, >80% CO_2-Reduction

Innovation at TenneT

Flexibility

Visibility & Forecast

Market Design

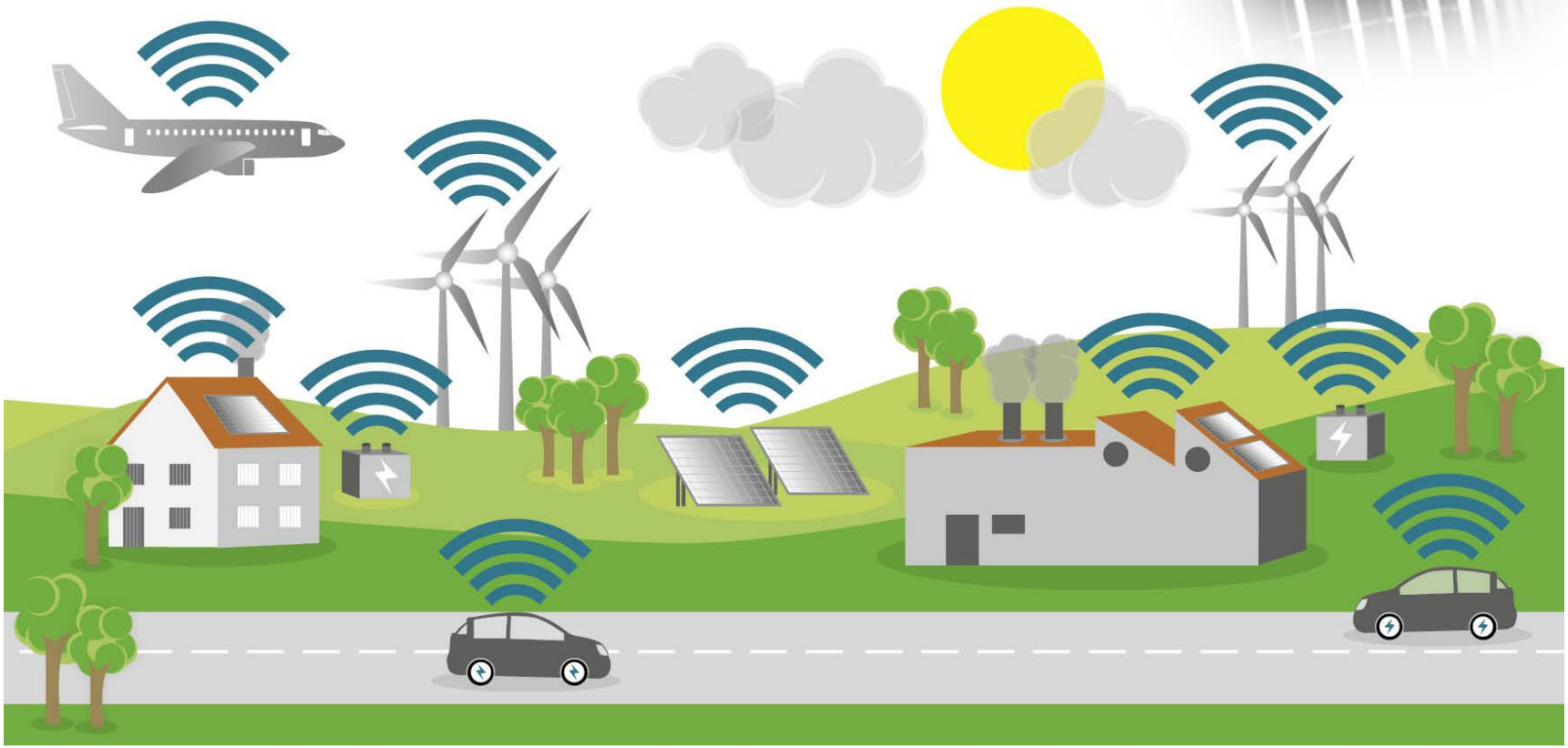


New Grid Structures

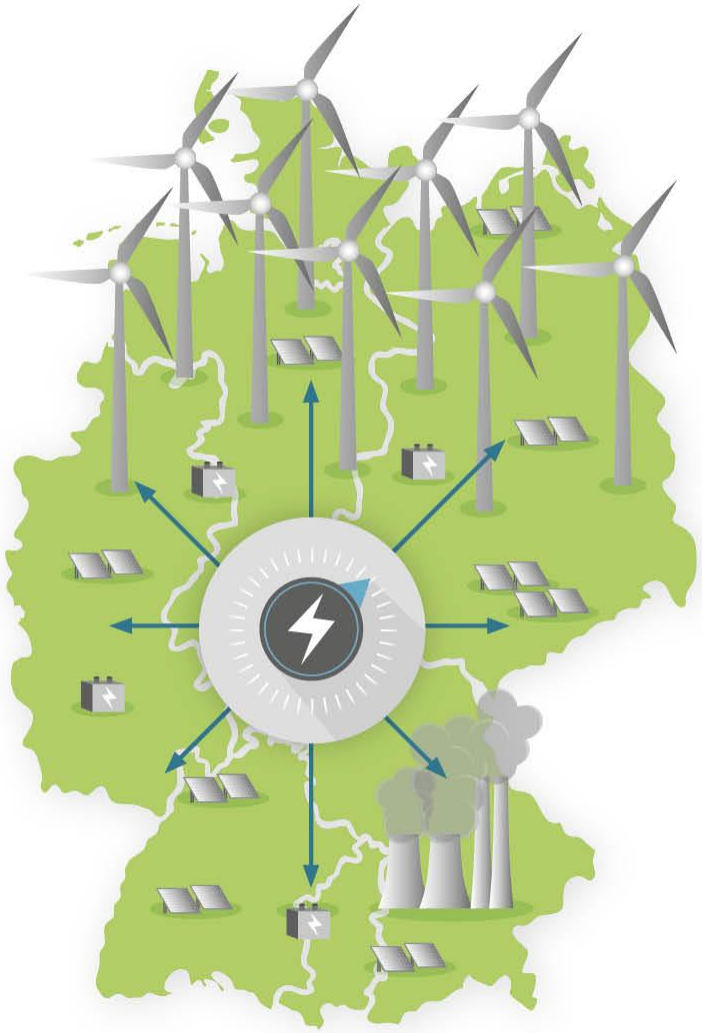
Visibility and Forecast

Sensors provide live data about the system and the environment:

- cars and mobile sensors provide local, real-time weather information
- smart meters provide live information on demand and production
- production, storage, and energy consuming assets provide information about their potential and actual energy infeed



Flexibility

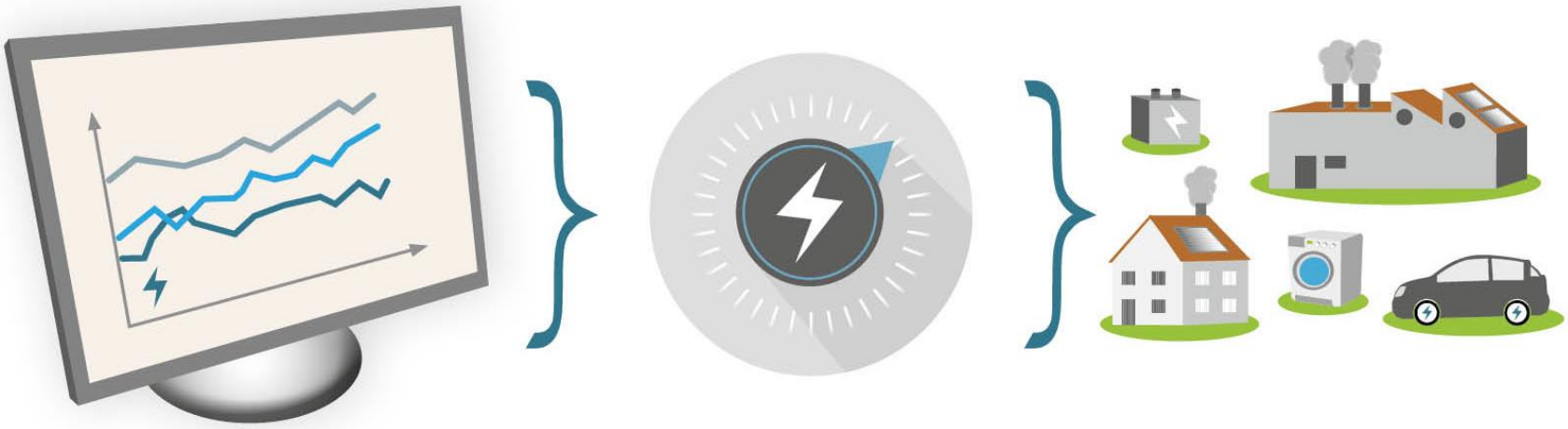


The flexible management of power production and storage facilities is key to stable grid operations.

- management of wind, PV, and storage facilities allows for quick responses to changes in system states.
- renewables will provide system services like reactive power, control power and minute reserve.

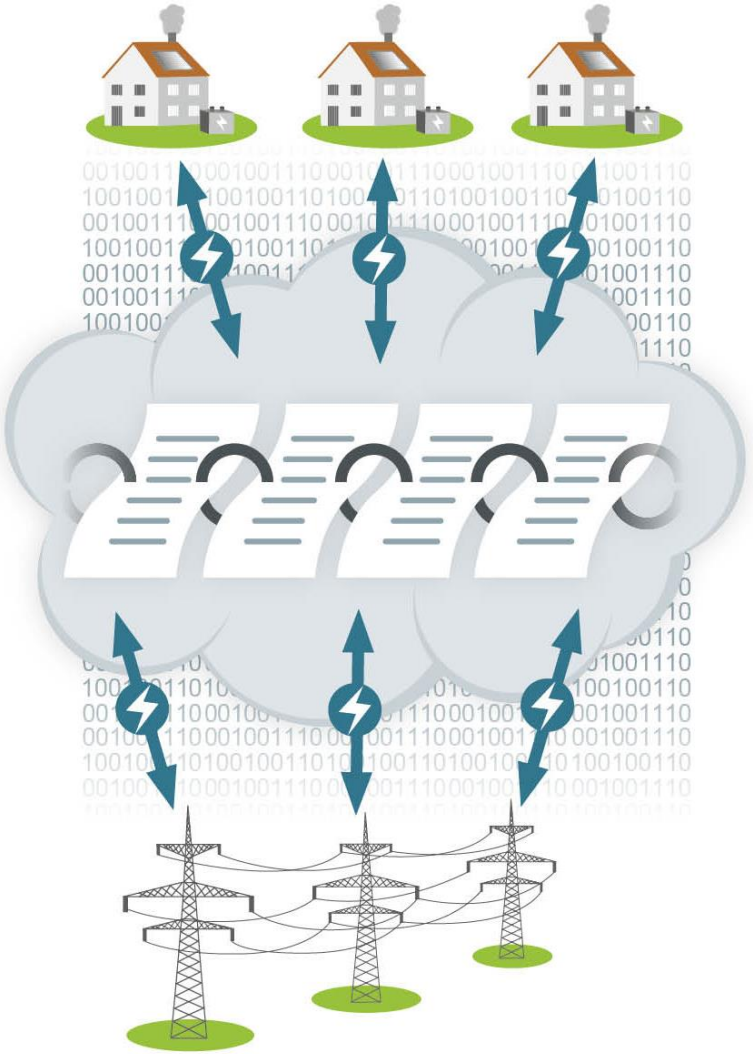
Flexibility

Flexible demand increases the efficiency of the system and contributes to stable grid operations



- a flexible demand profile can follow a volatile production profile
- flexible demand avoids production management, and maximises the feed-in of renewables into the system

Blockchain Technology



Blockchain technology facilitates crowd-balancing

- smart blockchain technology opens the market of system services to prosumers, creating a customer-empowered energy system.
- the use of many small-scale storage facilities ensures that renewable energy is not wasted.
- balancing- and overall costs of the energy system are lowered due to a more efficient use of resources.
- blockchain provides a transparent, easy to access, and safe platform for trading system services.

TenneT and Blockchain Technology

In two pilot projects with Sonnen and Vandebron, TenneT is using a private blockchain to balance the grid.

Objective: gaining practical experience with blockchain technology and interfacing with existing TenneT systems and processes.

vandebron

sonnen

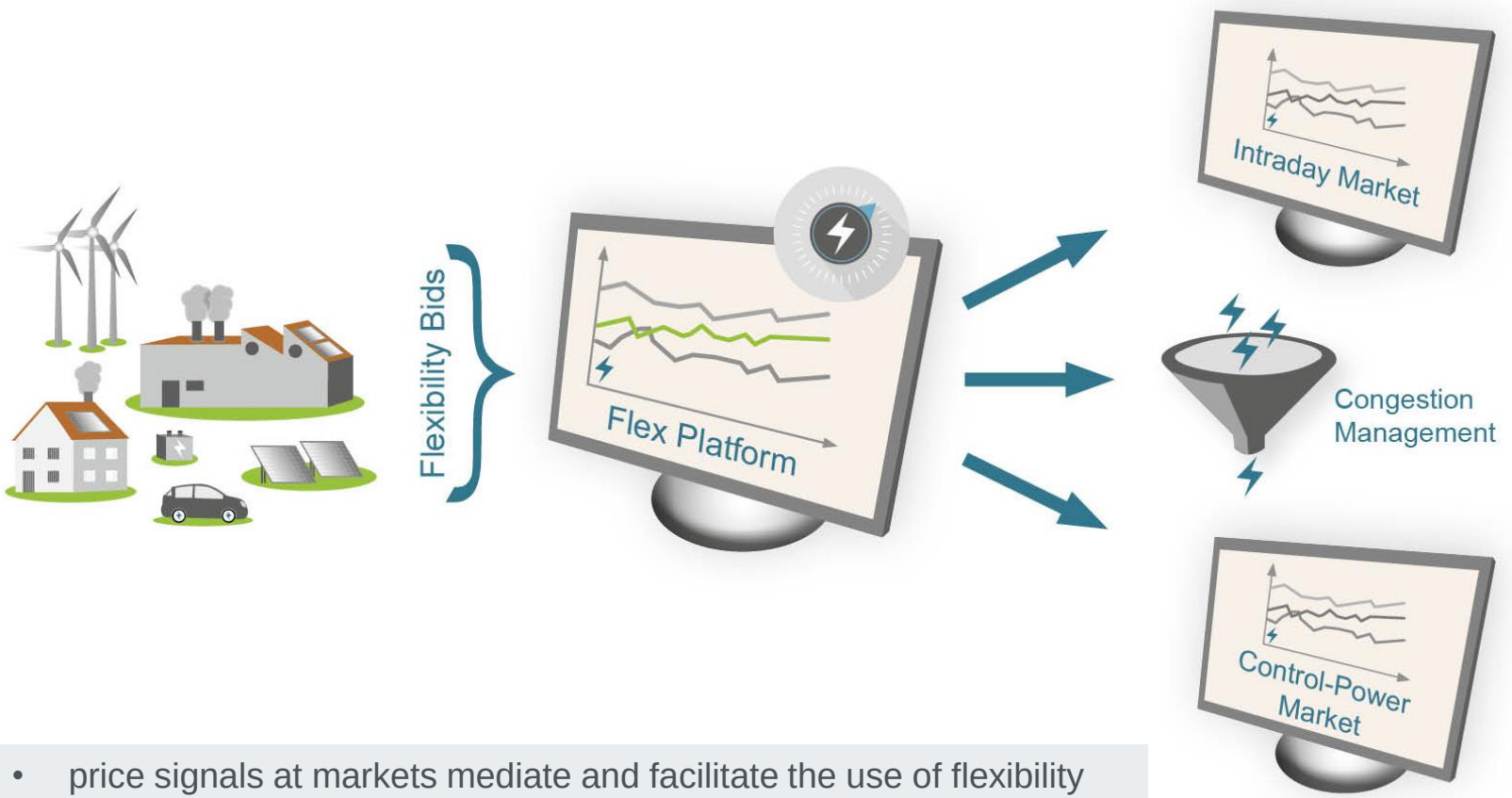
IBM

TenneT Taking power further

Market Design

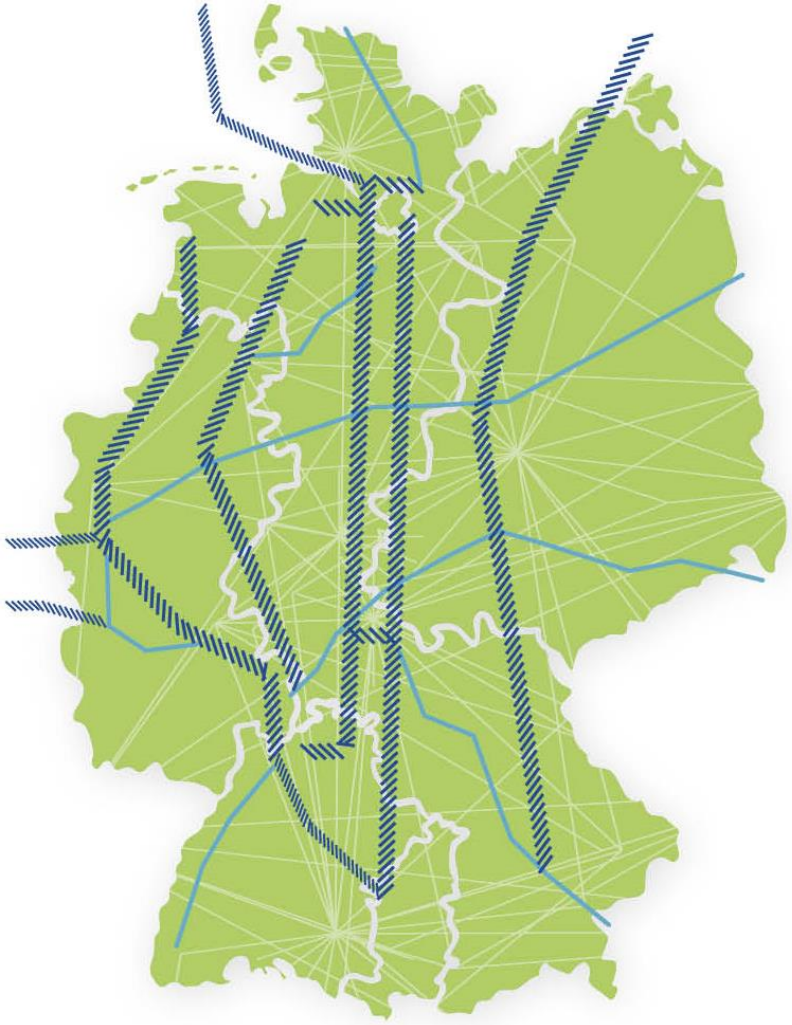
The flexibilities are organized via markets

A smart market design efficiently allocates resources, makes electricity cheaper, and helps to use flexibility potentials



- price signals at markets mediate and facilitate the use of flexibility potentials of production and demand

Grid Structures



New grid structures facilitate the integration of renewables into the energy system of the future.

- grids using a combination of DC and AC technology allow for an improved integration of renewable energy into the system
- ongoing research improves grid structures to meet the needs of a complex energy system

Gridstresstest – Energy-Transition „out of the box“

TenneT — AUFTRAGGEBER

consentec — AUFTRAGNEHMER

Agora Energiewende — BERATENDES MITGLIED IM STEUERKREIS

Fünf alternative mögliche Entwicklungen bis 2035

DE 100% kohlestromfrei

DEzentral

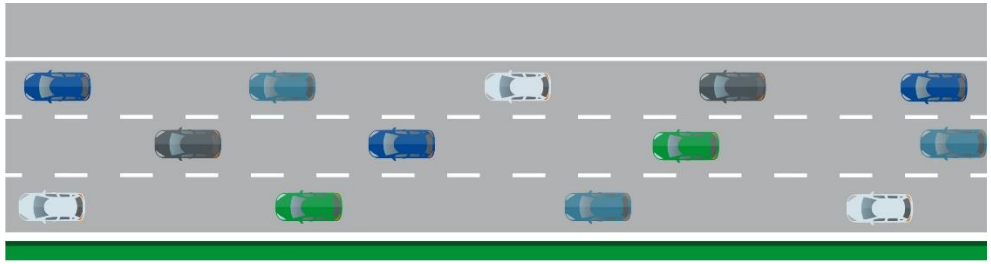
Flexibilisierung der Nachfrage

NOVA*-Prinzip weiter gedacht

Automatisierte Systemführung

Szenario automated grid operation (I)

1



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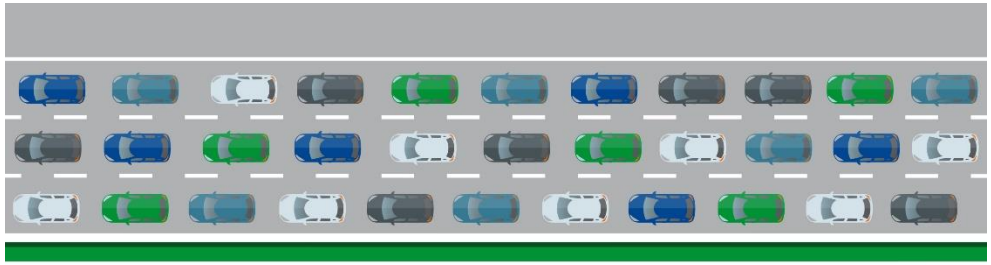

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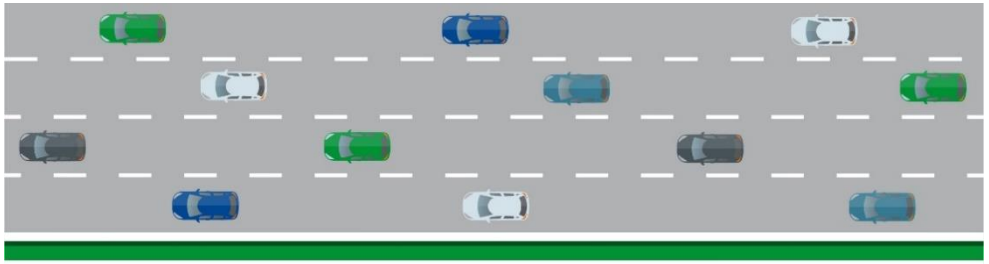

Szenario automated grid operation (II)

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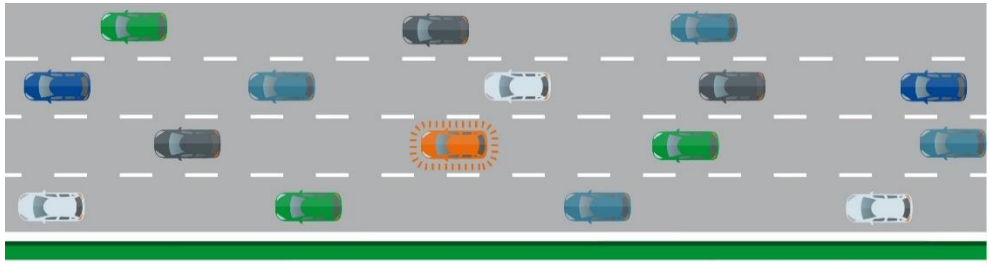

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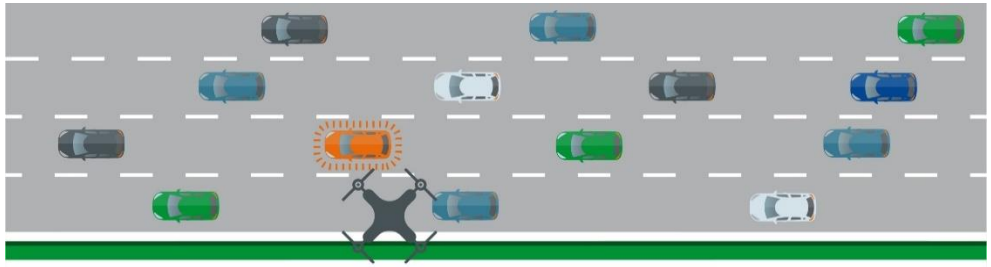

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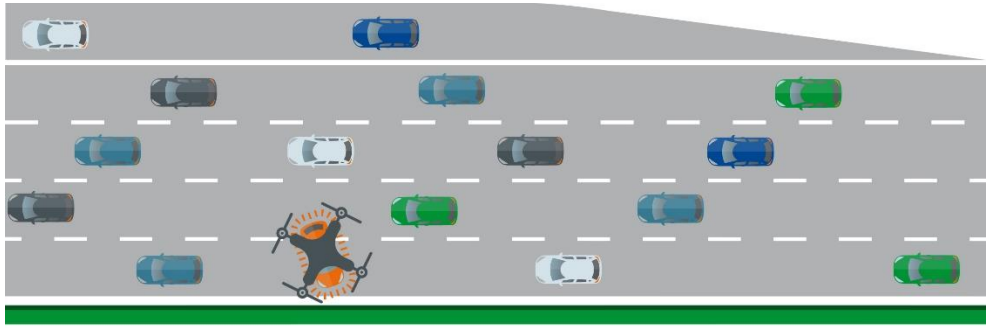

TenneT Offshore-Innovation

North Sea Wind-Power Hub

- 3 island of 6 m^3 each
- 1.5 bn for sand and stones
- connecting gas infrastructure
- enables 30 GW from OWF per island
- 15 converters (2 GW) per island
- 0.02 % of Dogger Bank