Vision on the Energy System Transformation

TU Delft, Faculty of EEMCS - 2019.06.13

Olivier Gueydan, Siemens Netherlands

Siemens snap shot

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Ingenuity for life

- Global Powerhouse focusing on the areas of electrification, automation, digitalization
- Producer of energy-efficient, resource savings technologies
- Pioneer in infrastructure and industrial solutions

Vision on the Energy System Transformation

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1 Trends

2 Innovation

3 Outlook

Megatrends…
Our world is being reshaped by human activity

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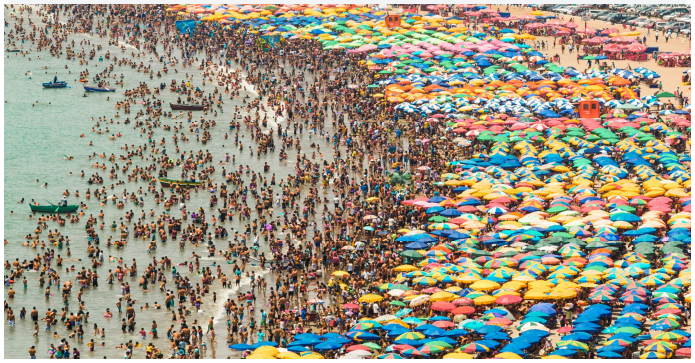
Demographic Change



Digitalization

Globalization

Urbanization

Climate Change

Megatrends…
Our world is being reshaped by human activity

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Demographic Change

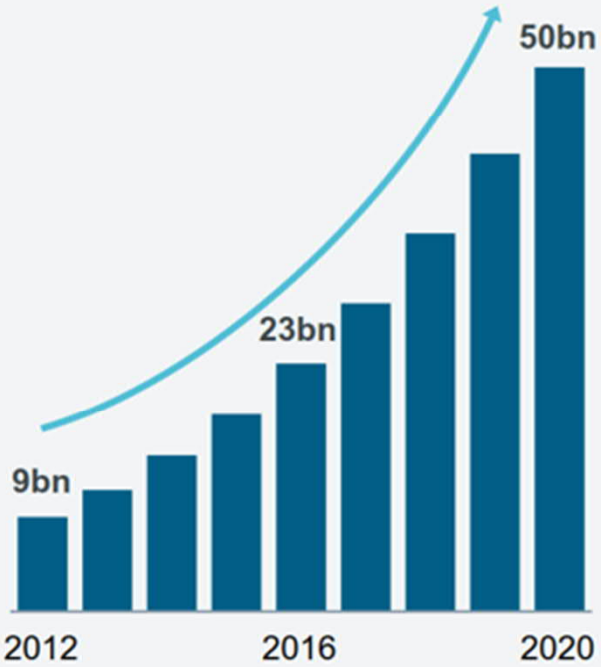
>20% of global population **over the age of 60 in 2050**

Urbanization

~70% of global population will **live in cities by 2050**

Digitalization

50bn IoT devices connected by 2020

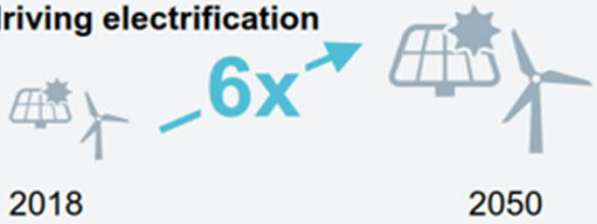


Globalization

Global trade will increase **4-fold until 2050**

Climate Change

Solar & wind power generation will **increase six-fold until 2050 strongly driving electrification**



Major factors are driving the transformation of energy systems

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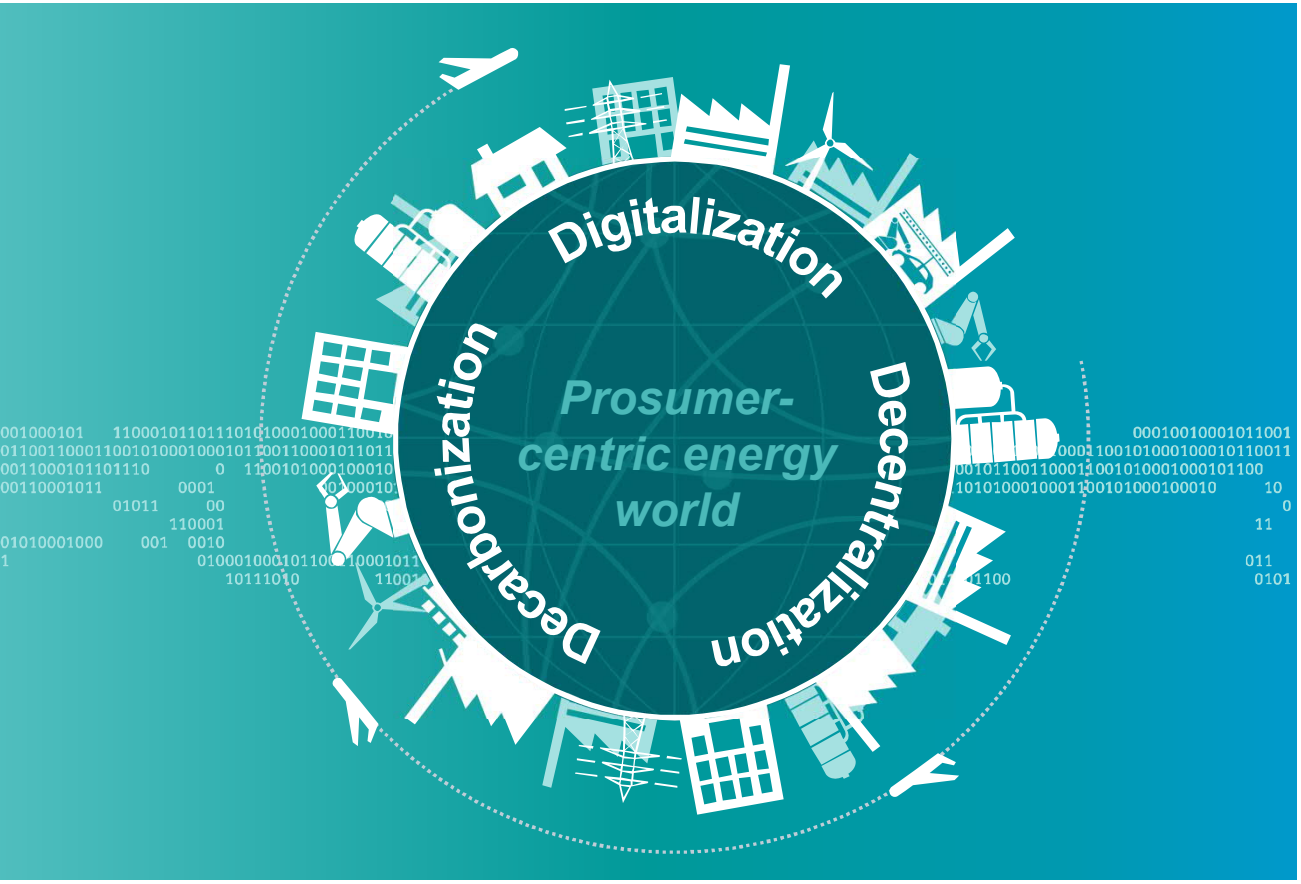

Decarbonization

CO2

From fossil to renewable & storage

Electrification of heat & transport (e-Mobility)

Energy Efficiency

Decentralization

From centralized power generation to consumers which are becoming prosumers

Distributed generation (PV, storage)

Distributed Energy Management

Digitalization

New energy services by the digital utilities & industries

Intelligent Connectivity, edge devices

With impact on system operation and consumer

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Political Targets:

1. Environment (e. g. Decarbonization)
2. Competitiveness
3. Security (e. g. Resiliency)

D

+

Breakthrough Technologies

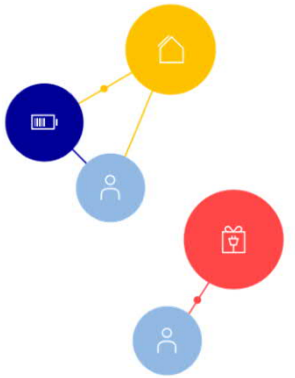
1. Wind- and **PV** Power Gen.
2. Energy Storage (Li-Ion)
3. Digitalization

D

D






The Energy Revolution: Big Picture

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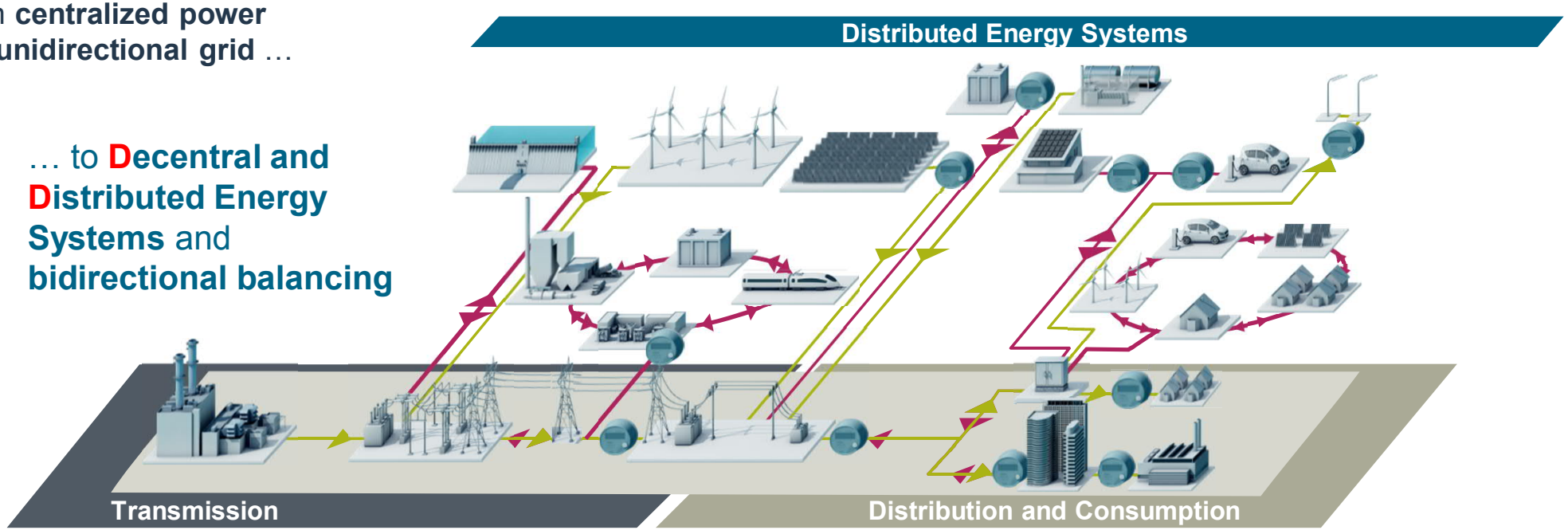
From **centralized power** and **unidirectional grid** …

… to **Decentral and Distributed Energy Systems** and **bidirectional balancing**



Data management and energy systems –
In the age of Digitalization they merge and change the world

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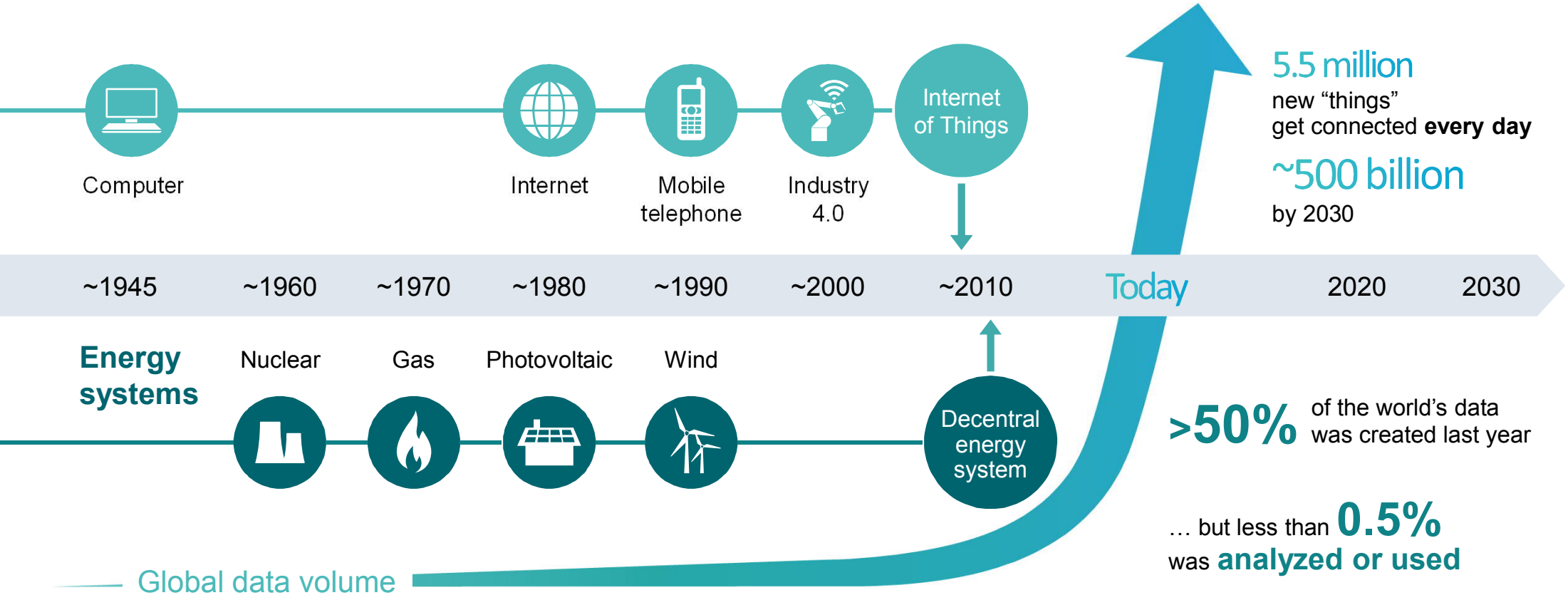

5.5 million
new "things"
get connected **every day**

~500 billion
by 2030

>50% of the world's data was created last year

… but less than **0.5%**
was **analyzed or used**

The journey to a new, better energy economy

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Key drivers of change

- Decarbonization
- Decentralization
- Digitalization

Rapidly changing, complex challenges

Fast, flexible solutions – Agility in energy

Central areas of action

- Culture
- Integration
- Technology

1. Electrification – Main driver to decarbonize the economy

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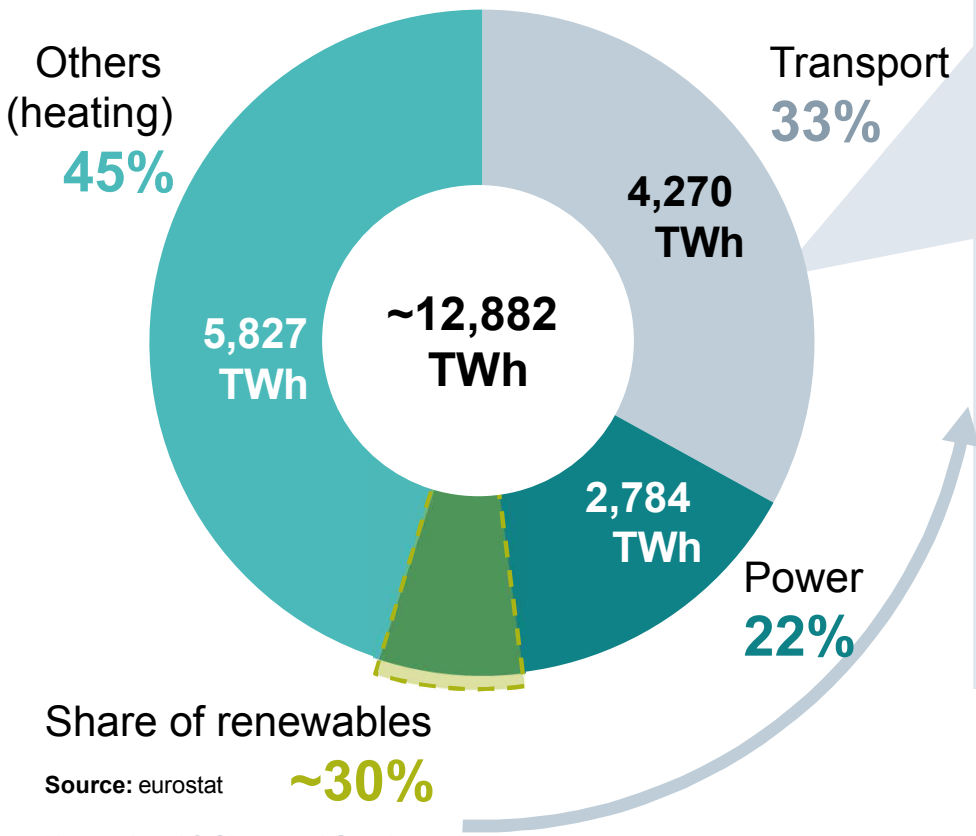
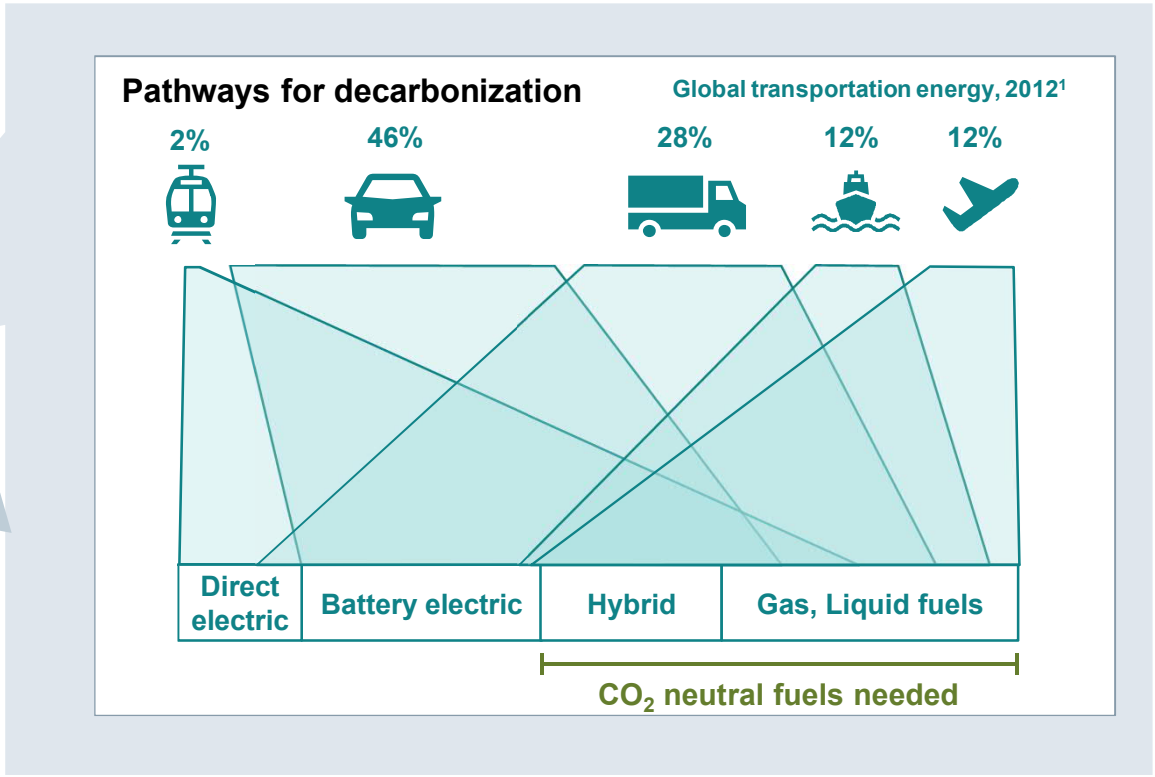
Final energy consumption EU28 in 2016



Share of renewables ~30%

Source: eurostat



Electricity grids allow direct integration, transmission and application of renewable Energy

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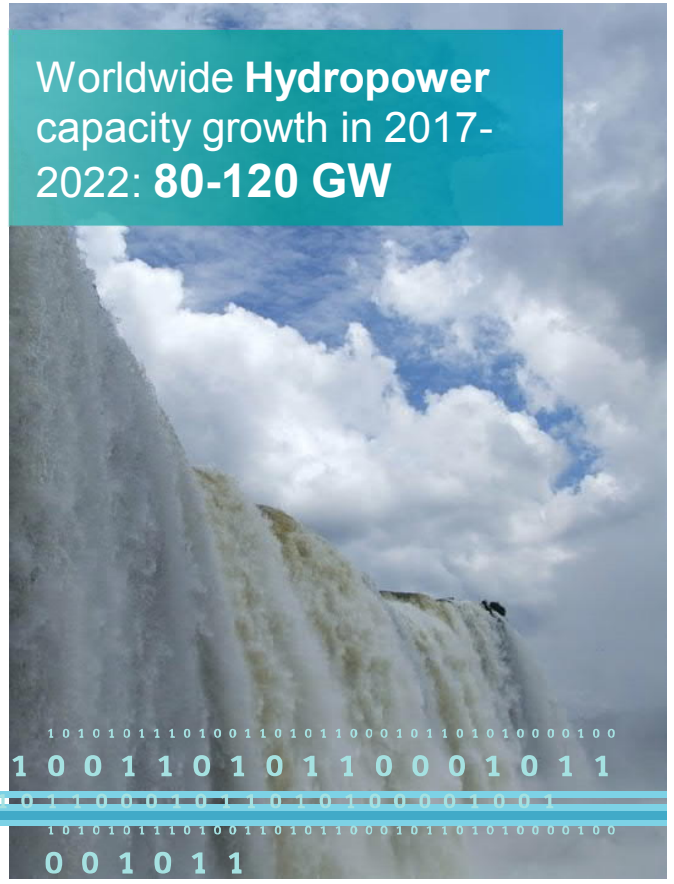

Electrical Energy is as versatile applicable as no other energy carrier

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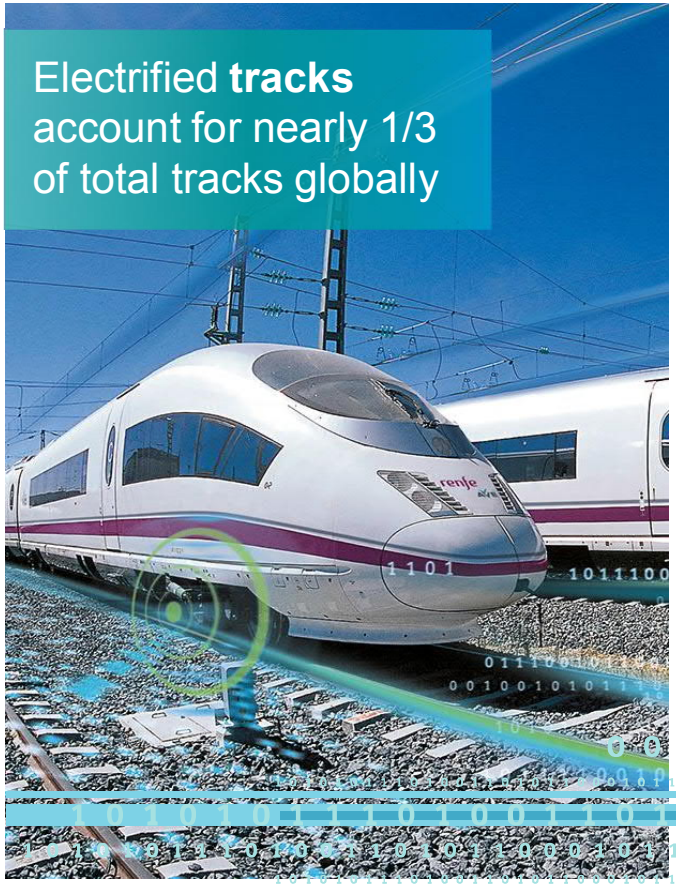

2. Flexibility – Key in the future electricity system

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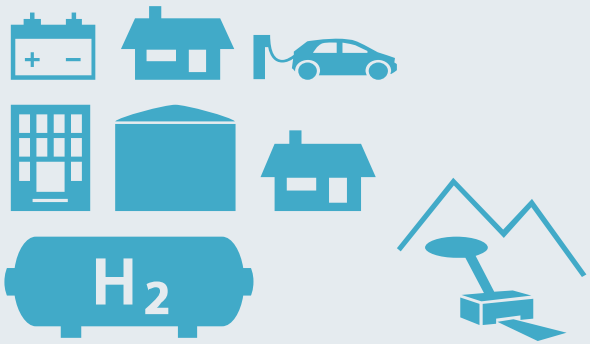
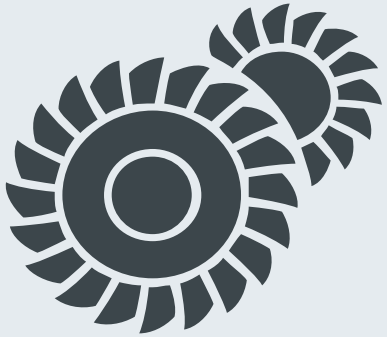
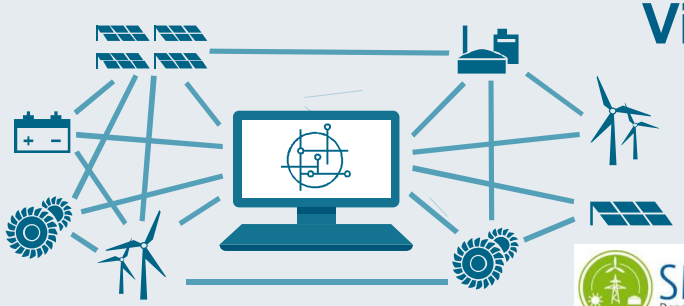


Storage



Gas-fired PP



Virtual PP

SMARTPOOL
Dezentrale Energie intelligent vernetzen

Demand Response

nordpool spot

FINGRID

Growing investments needs in flexibility solutions challenges the current kwh-based electricity market design

3. Digitalization – Energy system will be element in economy-wide IoT infrastructure

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Productivity and time-to-market | **Flexibility and resilience** | **Availability and efficiency**

Planning, simulation and engineering → Automation and control → Maintenance, monitoring and service

Use cases, applications examples

Digital twin | Energy system simulation | Energy system planning | Energy system control | Energy system diagnostics | Asset management | Digital substation | Virtual power plant | Smart Building | Monitoring DER[1)] | Energy efficiency and analytics

The cloud

Connected grid assets …




… edge devices, industries, buildings


Key areas to step up

Enhanced electrification

Automation

Digitalization

- Sensing
- Connectivity / IoT
- Monitoring
- Controlling
- Managing
- Digital twin

1) DER: Distributed energy resources like smart meters, inverters for photovoltaics, e-mobility assets, storage systems, microgrids, …

Major transformation in energy networks – Electricity Grids are core action fields

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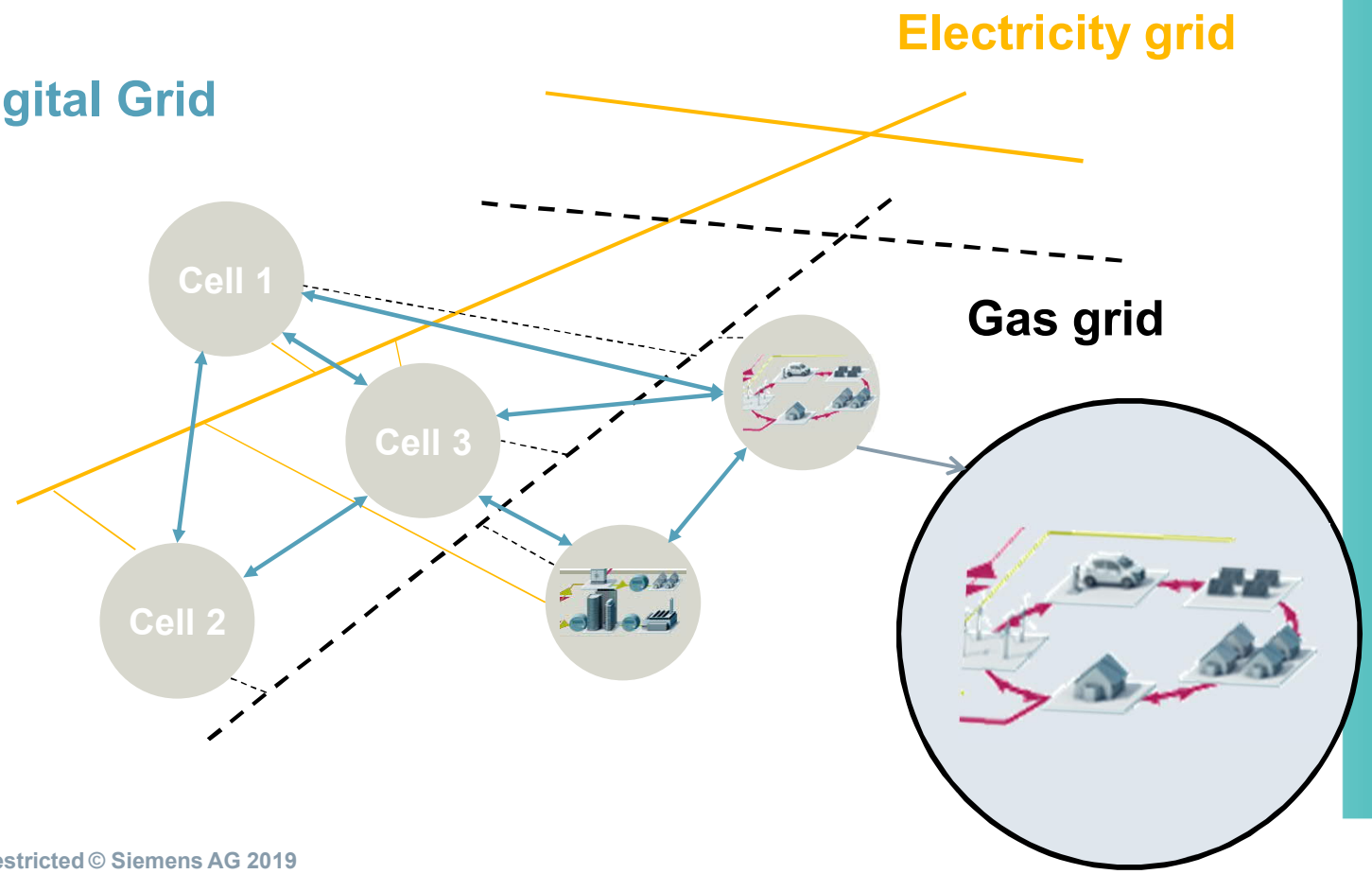

- Further decentralization and fragmentation with (semi-)**autonomous** local energy systems lead to need for local rebalancing and sector coupling
- Electrical / physical, automation and **digital layer** will merge and create a multilayered, decentralized, and connected infrastructure
- Role of energy network provider changes from operator to system provider and **platform** facilitator

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High Voltage Direct Current Transmission (HVDC) – Power Electronics managed by intelligent control software

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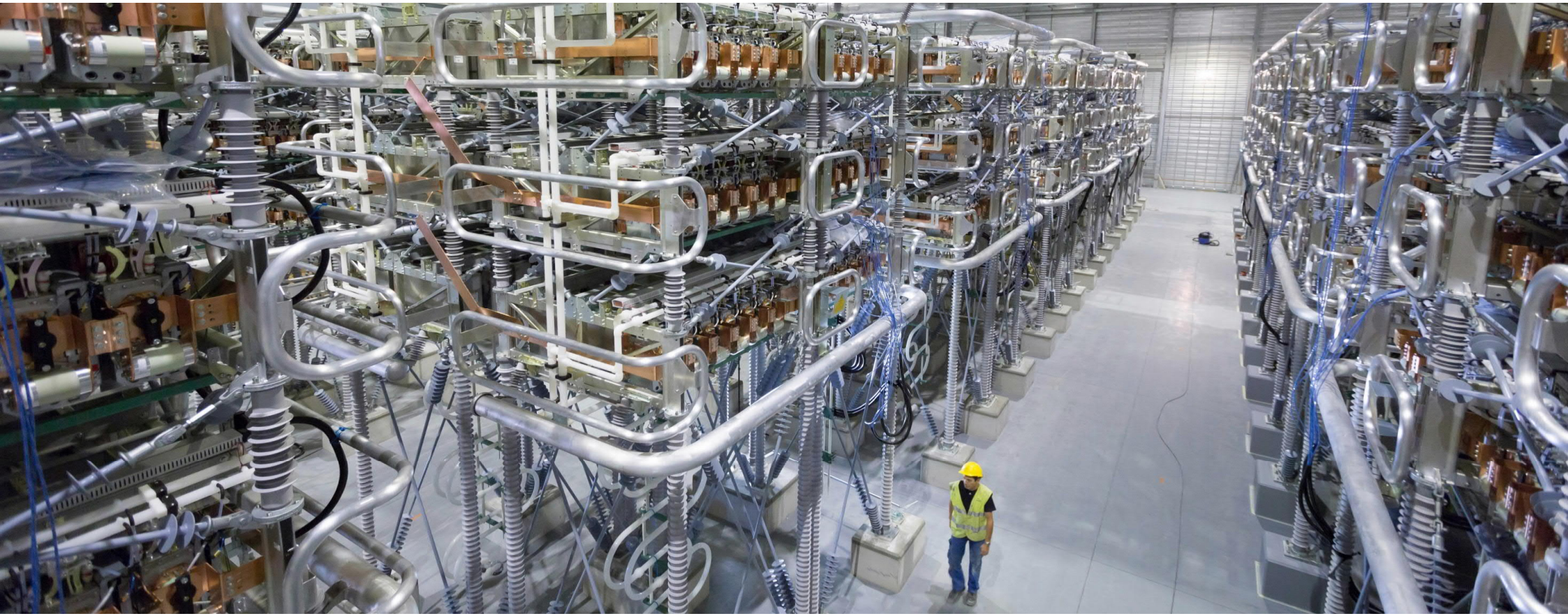

ULTRANET, Germany, 2021
World's first VSC HVDC with full-bridge converter

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Customer	Amprion / TransnetBW
Project Name	ULTRANET
Location	Osterath – Philippsburg, Germany
Power Rating	2000 MW, bipolar
Type of Plant	HVDC PLUS in full-bridge topology, 340 km
Voltage Levels	± 380 kV DC, 400 kV AC, 50 Hz
Semiconductors	IGBT

1100 kV Transformers for efficient power transmission

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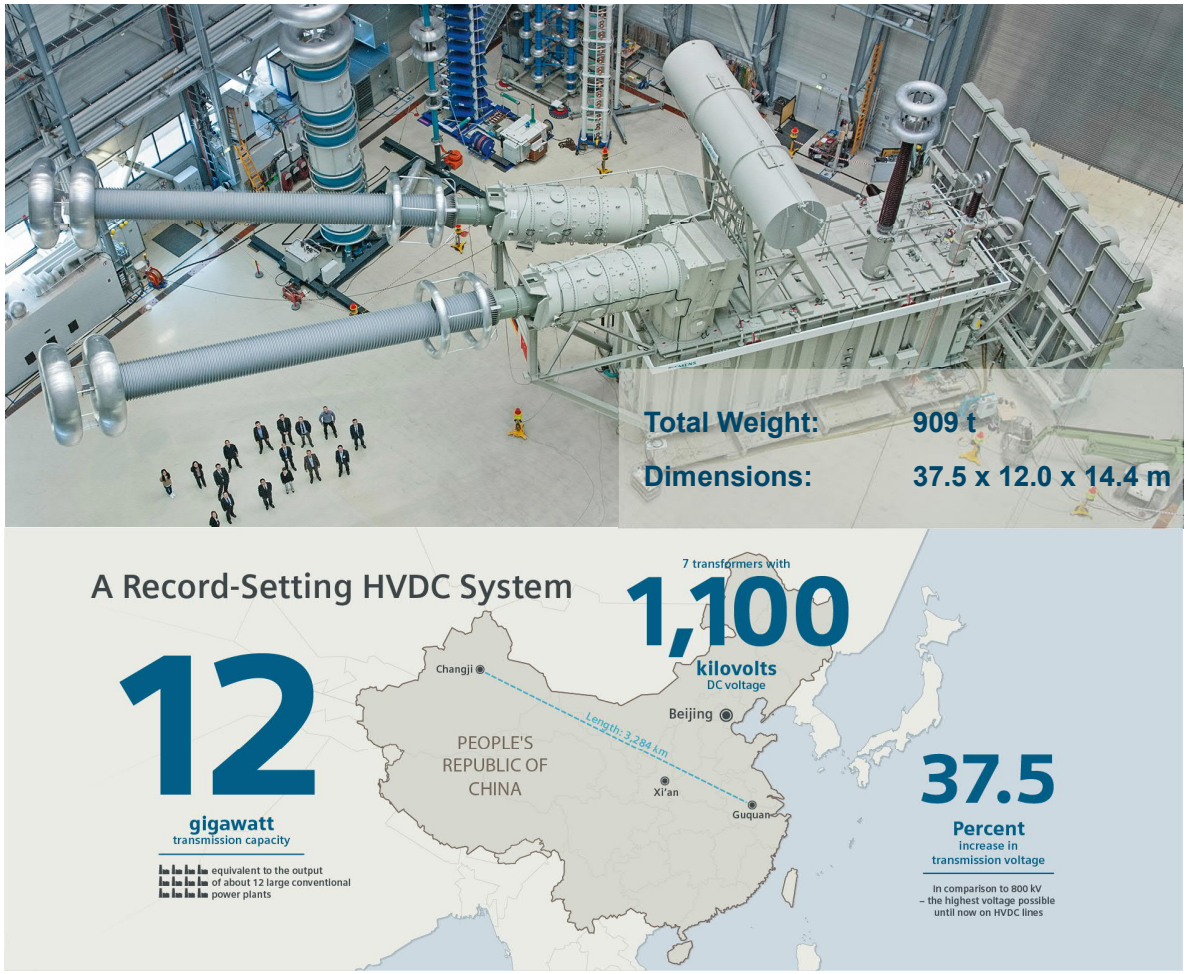

Challenge

- Often long distances between power generation and power consumption centers
- High transport losses over long distances with standard solutions

Solution

- High Voltage DC Transmission Systems to reduce
  - Power losses
  - Material usage

Outcome

- Worldwide first 1.100 kV DC System
- First Pilot Installation in China in 2018
- Secure Power transmission of 12 GW over a distance of more than 3200 kilometers

Battery-based Storage for very different purposes

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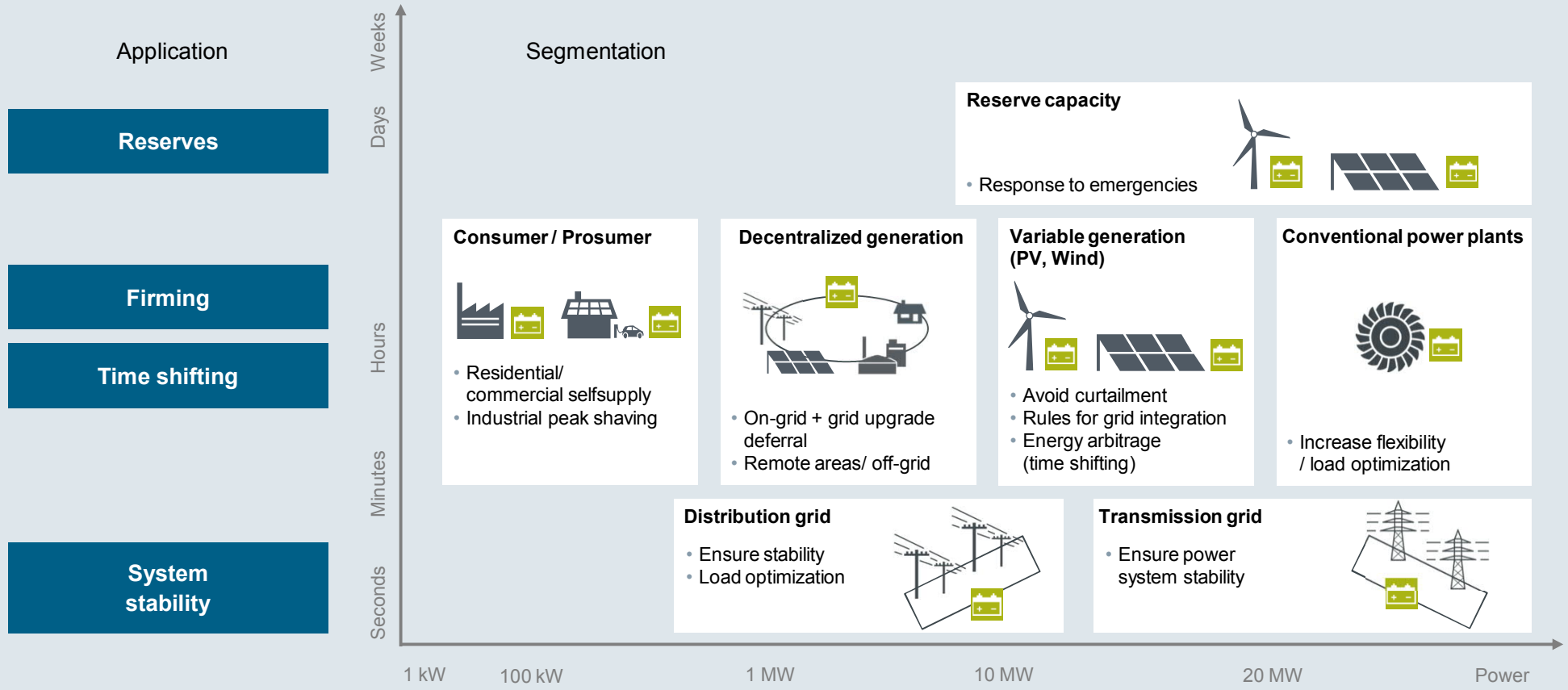

Generation alternative to peaking power plant

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SERVICES

- Capacity, local reliability
- Peak power/off peak mitigation
- Ancillary services

IMPACT

- Competitive bid vs. thermal peaker, cost effective
- Replaces environmental retired units
- Meets flexibility

Alamitos, Long Beach, CA USA

- **100 MW, 4h (400 MWh)**
- **COD Jan 1st, 2021**

IREN2 research project in Wildpoldsried, Germany

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Solution

Combining micro grid and Virtual Power Plant to form a topological power plant, which can be operated in island mode

Benefits

- Stable and economically optimized grid operation
- Black start capability
- Profitable use of renewable resources
- Ancillary services from the distribution grid

Isle of Ventotene, S-O Italy…

Challenge

- Control developments for stable operation with existing diesel gen-sets
- Demonstrate fuel saving on islanded grids
- Enable renewable integration

SICAM microgrid controller & SIESTORAGE enable stand alone electricity for a renewable integrated micro-grid

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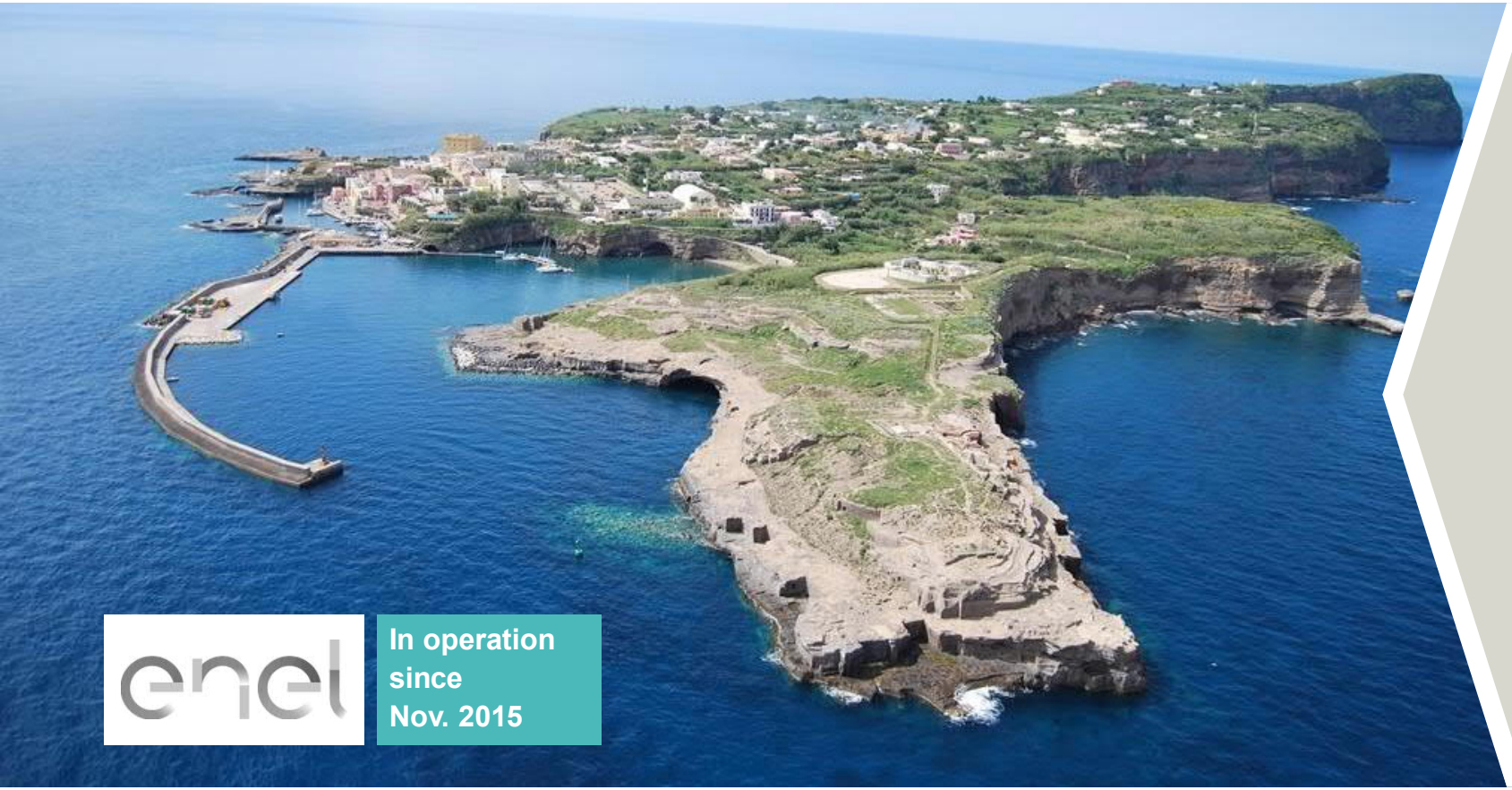

10-15%
Oil / CO2 savings

Reliability
…Performance and reliability of control is very high and consists reference for future projects. Can be considered as business excellence…
ENEL, Customer

Holistic end-to-end energy management – Example of an industrial facility

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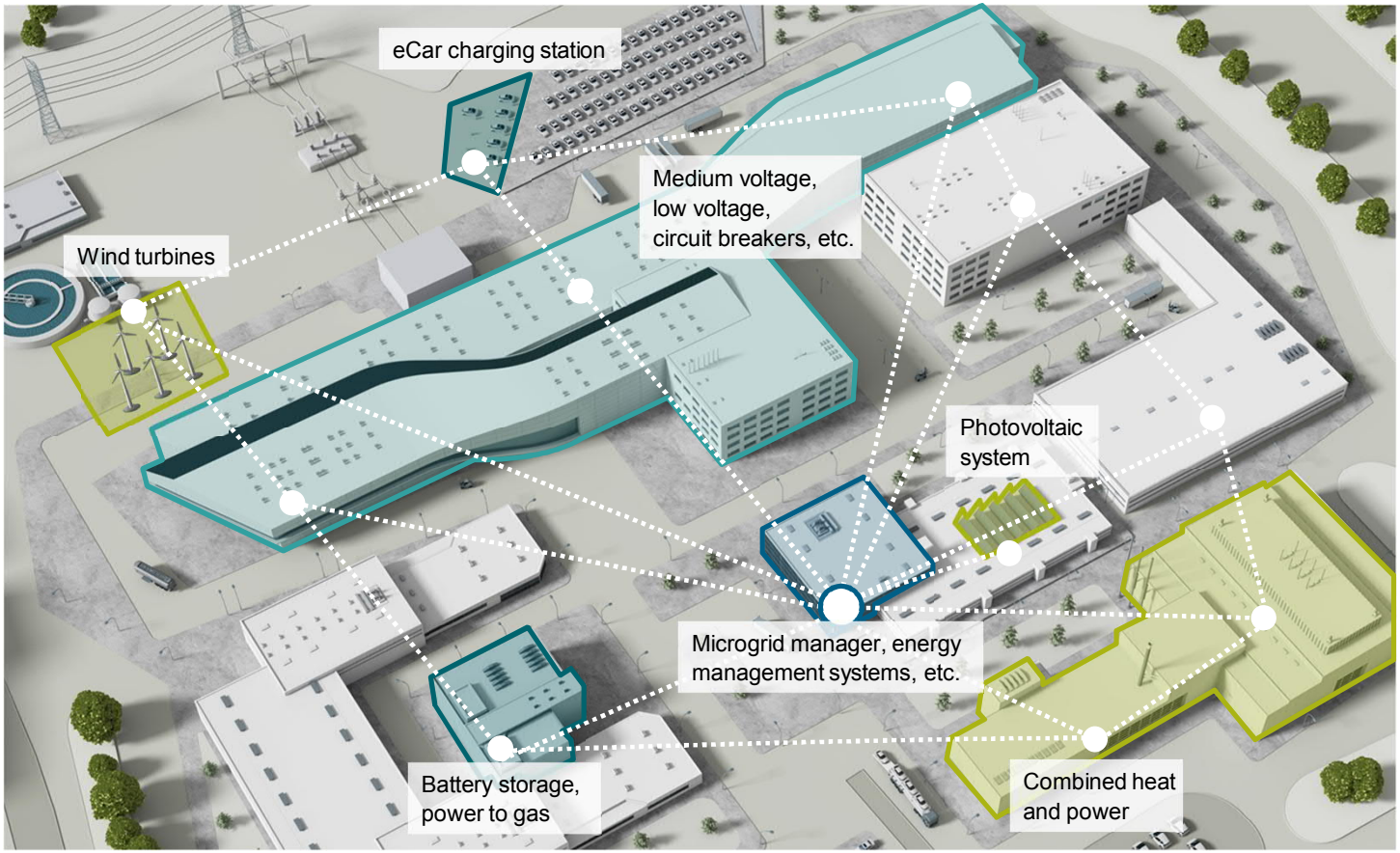

Distributed Energy Systems (DES)

- Distributed generation
- Storage solutions
- Electrical equipment and power electronics
- Energy automation and management, software

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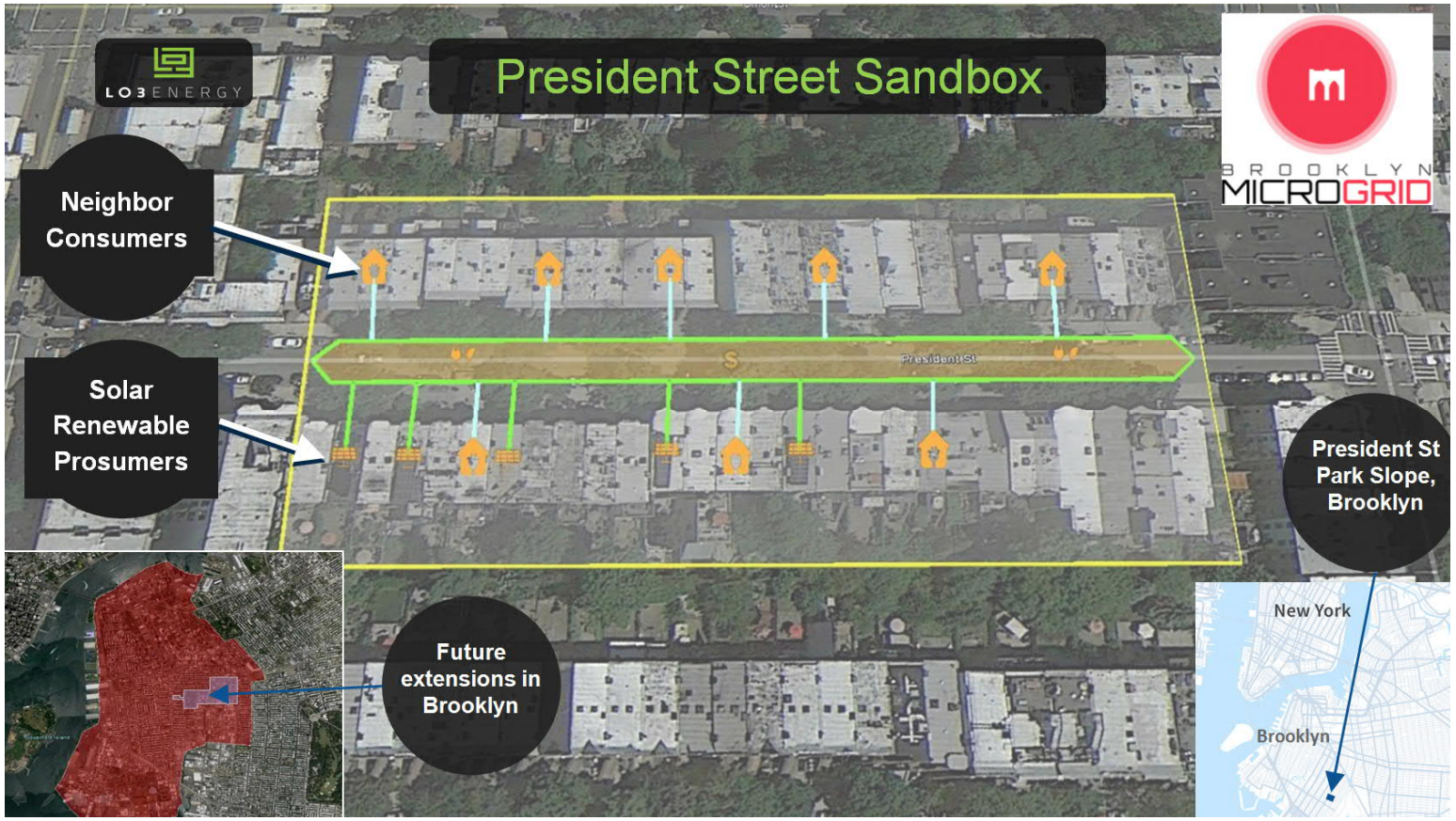
Blockchain based peer-to-peer energy trading
Innovative Microgrid solution supporting
New York's "Reforming the Energy Vision" program



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LO3 ENERGY

TRANSACTIVEGRID

Question : Possible advantages of Blockchain?

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1. Cost reduction
2. Security
3. New Business Models
4. Optimization

What else?

Hydrogen –
Energiepark Mainz H2-Electrolysis hall

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STADTWERKE MAINZ AG
Hochschule RheinMain University of Applied Sciences Wiesbaden Rüsselsheim Geisenheim
Linde
SIEMENS
Gefördert durch
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages
ENERGIESPEICHER
Forschungsinitiative der Bundesregierung

Key facts

- Three SILYZER 200
- In total ~4 MW DC nominal load
- High dynamic: load changes within sec.
- 35 bar pressure at gas outlet
- Produced so far up to 500 kg(H_2)/day ⇔ Fuel for about 50.000 km in a FC passenger car*

Assumption: Passenger Fuel cell car consumption about 1 kg/100km

Siemens portfolio scales up x10 every 4-5 years driven by market perspective and co-development with customers

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Silyzer portfolio roadmap

Reduction of specific price
(€/kW)

2011 – 2015

Silyzer 100
100 – 300 kW
Lab-scale

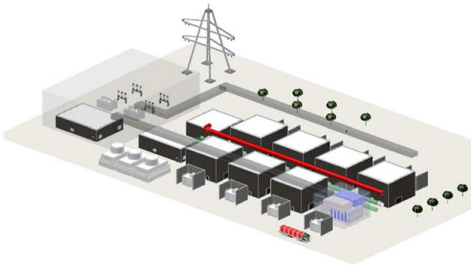
Silyzer 200
1 MW class
Current commercial product

2015 – 2018

Silyzer 300
>10 MW class
Sales release 2018

2018 – 2023+

Next generation
Silyzer >100 MW
Under development



>2030

>1,000 MW
First investigations in cooperation with chemical industry

Electrification will drive sectoral integration – Example Power-to-X electrolysis

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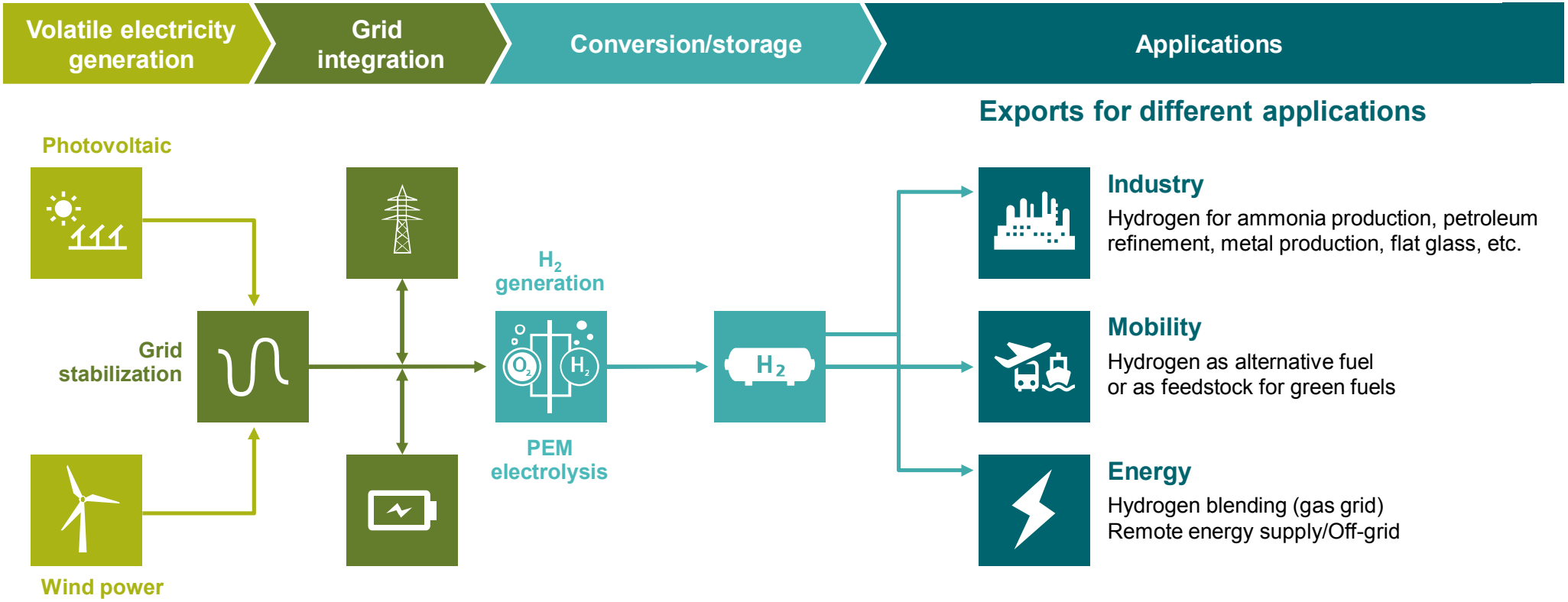

Regulatory frameworks need to be fit for green hydrogen and enable sectoral integration

Question : future H2 utilization

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In your view, which sector is the most promising to utilize hydrogen from renewables in the next years?

1. Industry
2. Mobility
3. Energy

Artificial Intelligence – Application of AI including Machine Learning

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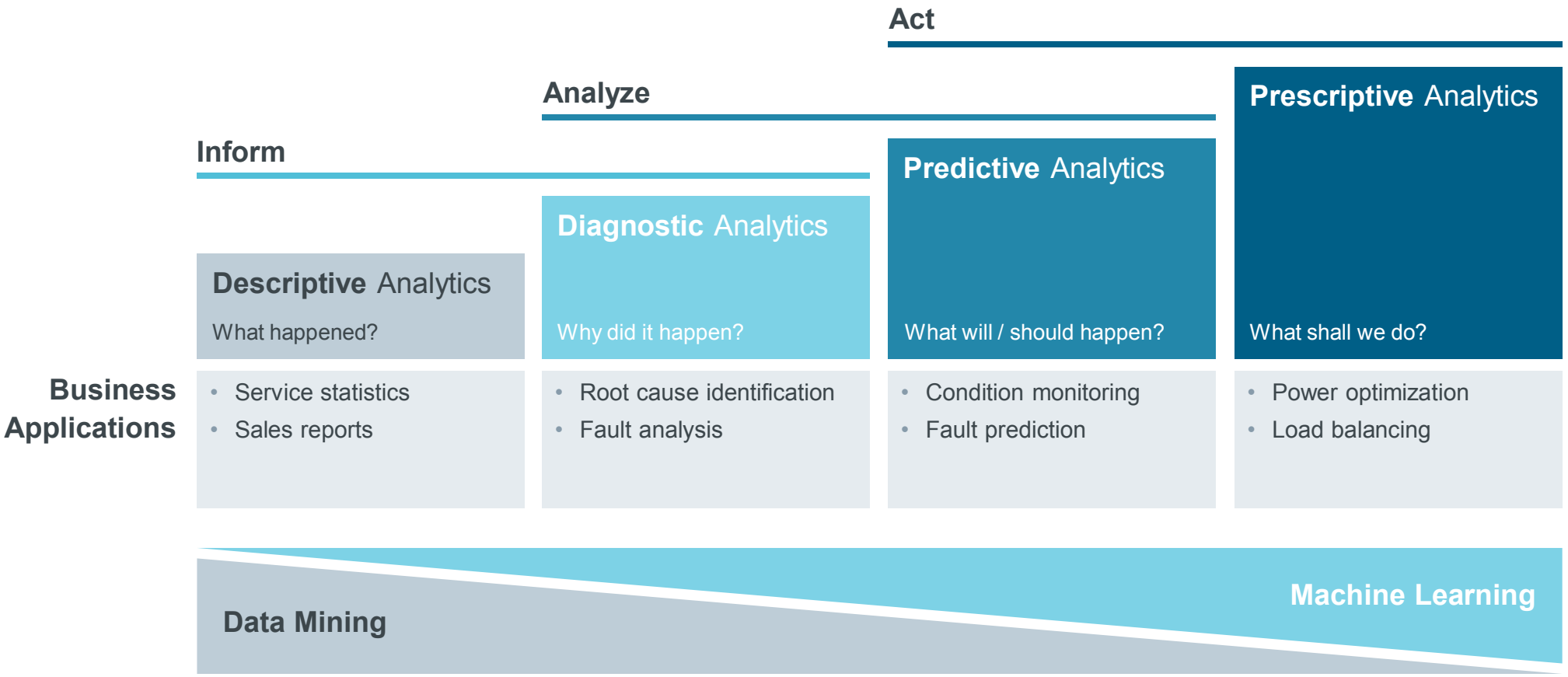

Spanish automotive supplier's energy consumption reduced using smart data and AI

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Energy efficiency analytics

Solution

Measuring and power-quality devices and data analytics as a "managed service" via cloud-based platform

20,000 tons CO2 conserved	**15%** costs cut
15 factories worldwide connected	**9** factories planned

Energy for Industry

Summary: the Revolution of Energy Systems

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1. More Wind- and PV, Electrification, Distributed Energy Systems
2. Sector-couplings and Energy Storage increasingly relevant
3. Digitalization key enabler (simulation, operation, market integration)
4. Emerging Sharing Economy concepts (for Prosumers)
5. Artificial Intelligence gaining momentum

Disclaimer

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