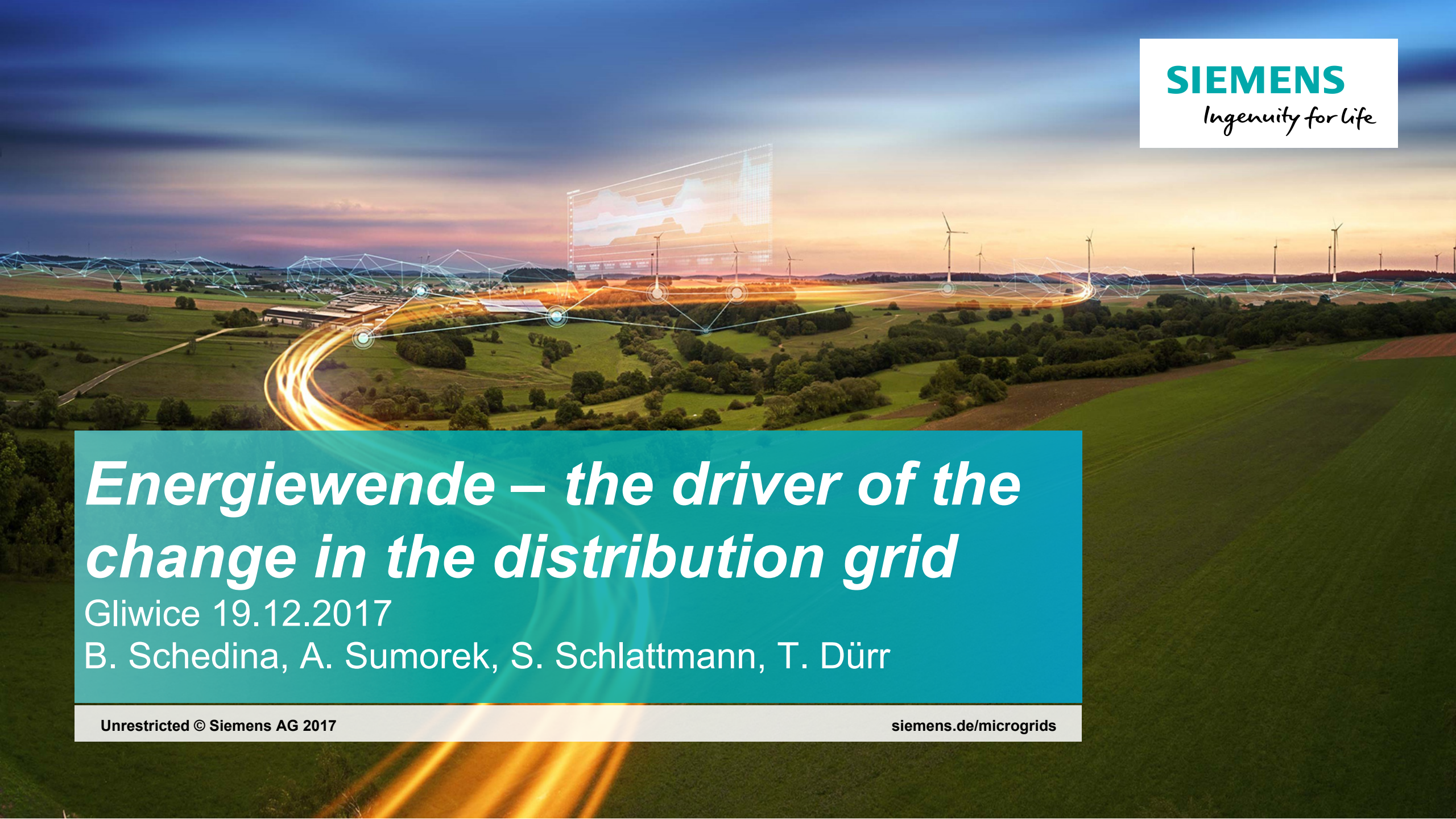

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Energiewende – the driver of the change in the distribution grid

Gliwice 19.12.2017

B. Schedina, A. Sumorek, S. Schlattmann, T. Dürr

The energy systems are changing dramatically

From monopoly power …


… to deregulated markets.


From downstream power delivery …


… to smart distribution and bidirectional power flows.

Increasing electrification in all sectors – Heading towards an all-electric world

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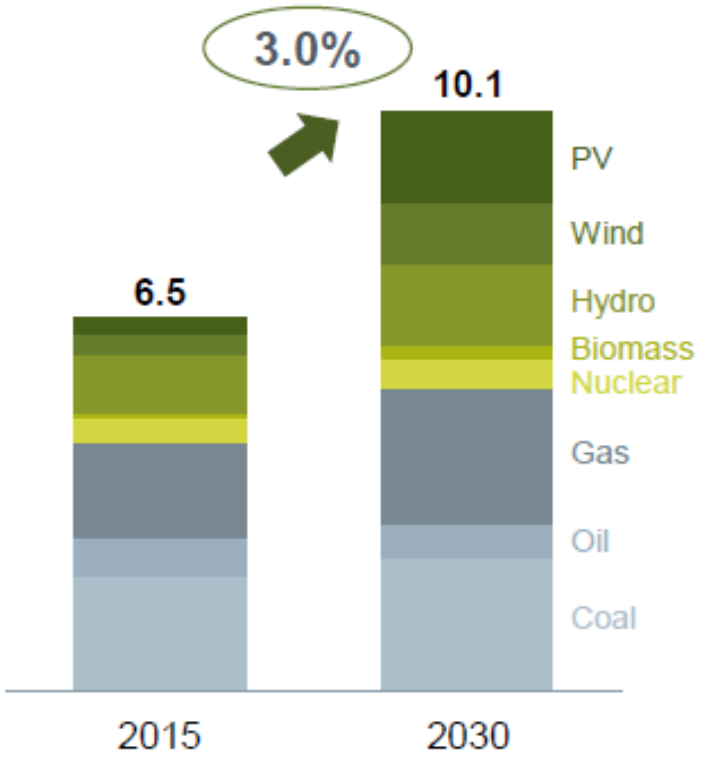
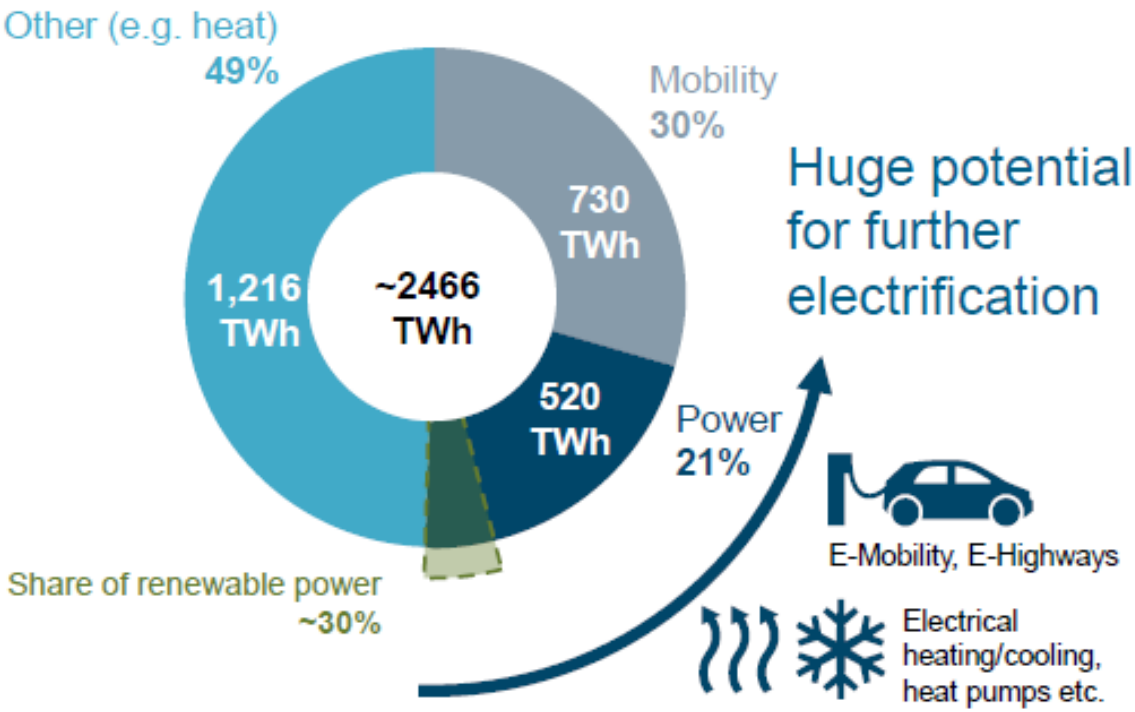
Global power generation capacity in TW



Renewables and distributed power gene-ration grow above average

Source: Siemens Energy 2020 Project 2014 – Base Case Scenario ⬭ CAGR 15 – 30e

Final energy consumption in Germany 2015



Huge potential for further electrification

Source: umweltbundesamt.de/Arbeitsgemeinschaft Energiebilanzen, status 7/16; IHS

Germany: more renewable generation capacity than peak load

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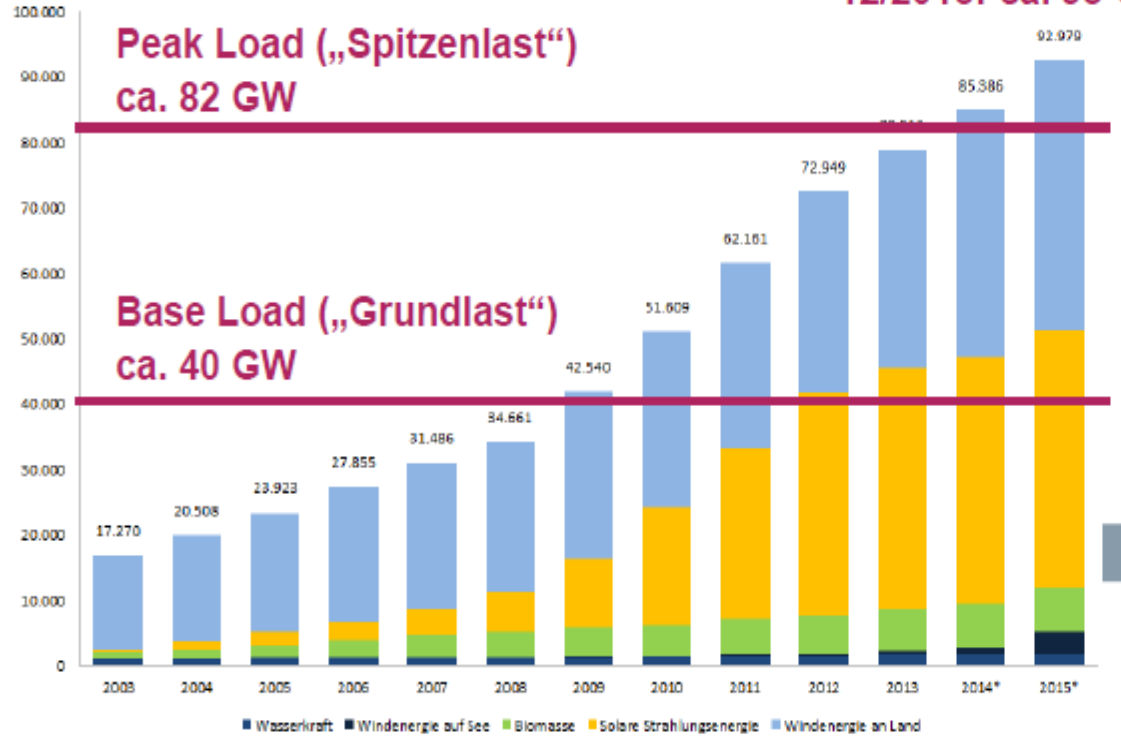
10/2017: ca. 109 GW

12/2015: ca. 93 GW



More installed Wind- and PV-capacity than Peak Load

>65GW of Wind and PV-Power Plants connected to LV- and MV-systems

Trend towards an „Electronic Grid“

Resulting Challenges for grid operators:

- Changing system dynamics
- Frequency and Voltage Stability
- Short Circuit Power
- …

Source: http://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/ZahlenDatenInformationen/zahlenunddaten-node.html

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Digitalization changes everything

Digitalization supports / enables you to turn challenges into opportunities

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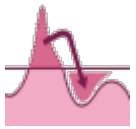
Challenges

Balancing

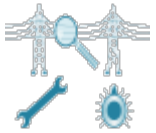
CO_2 and cost avoidance

Peak avoidance



Loss prevention

Resilience



Distributed optimization

Business models

Customer focus

Digitalization with Siemens delivers answers

Digital services

Vertical software

Digitally enhanced electrification and automation

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

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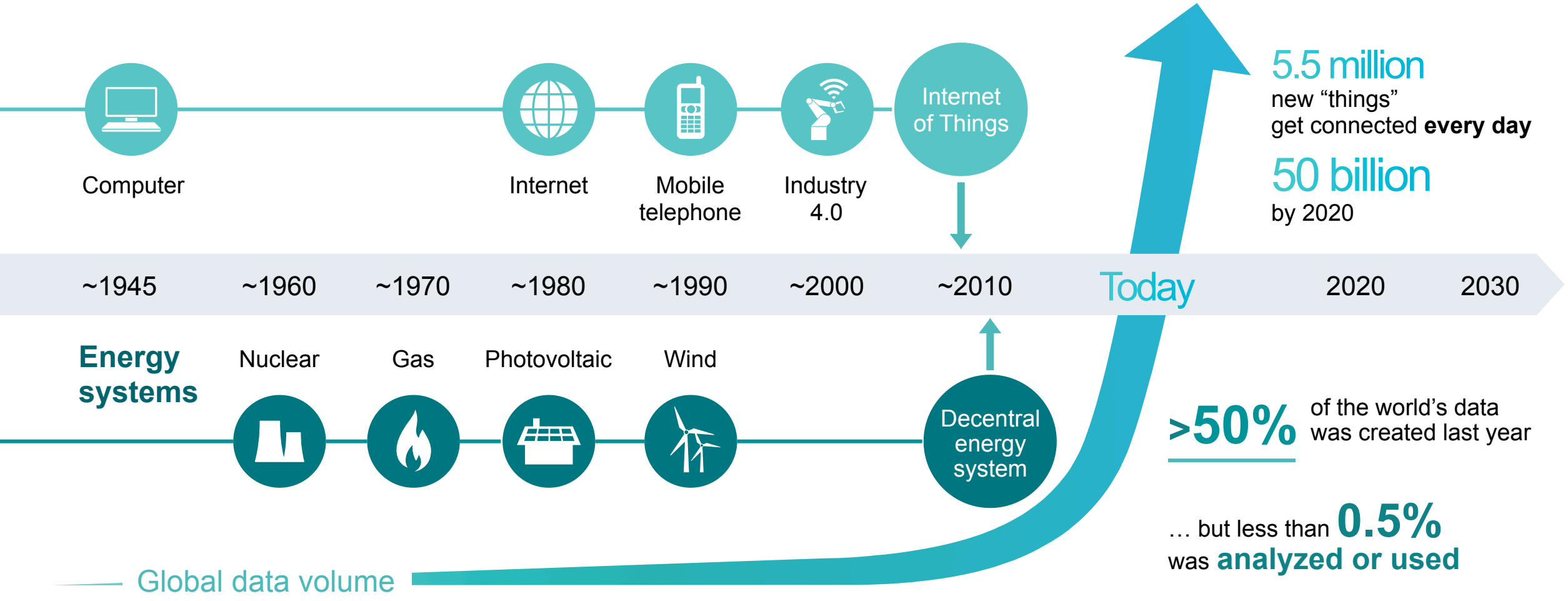

5.5 million
new “things”
get connected **every day**

50 billion
by 2020

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

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

Siemens Digital Grid masterplan architecture for a smooth transition to …

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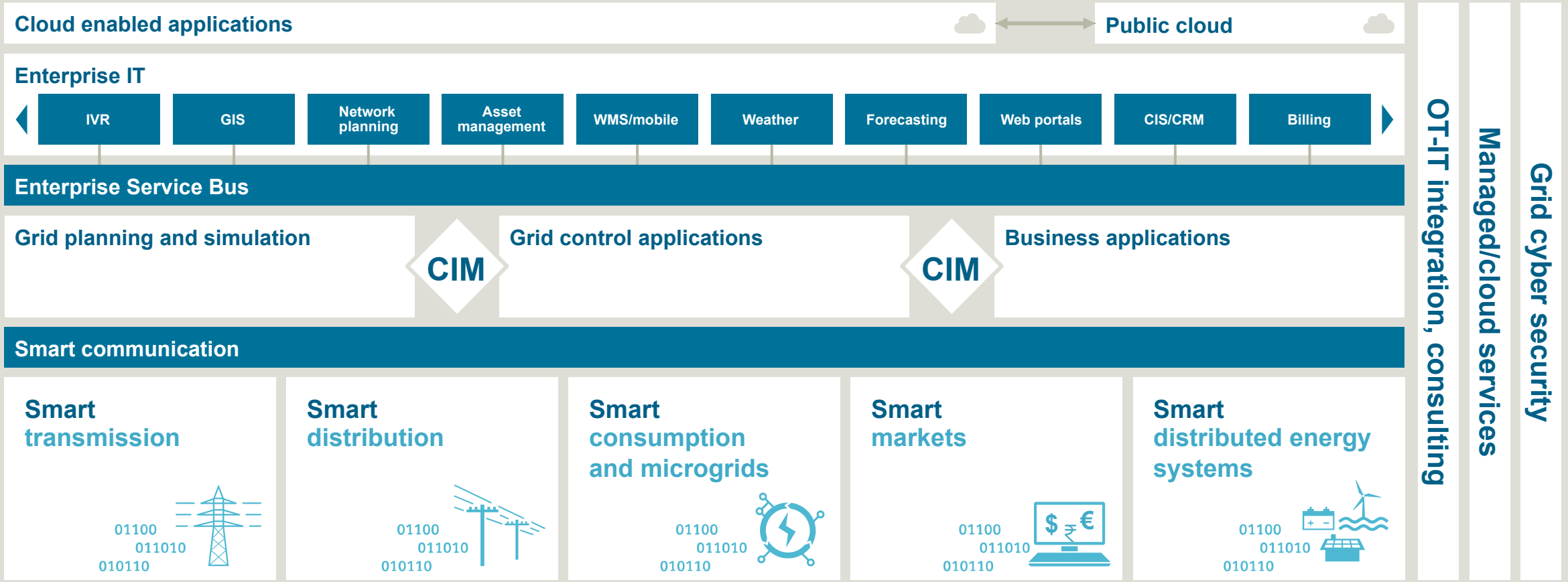

CIM – Common Information Model (IEC 61970)

Integrated platform strategy to ensure minimized risk and high cost efficiency

Digitalization & Automation

E-car Center Operation

Enterprise Service Bus

Spectrum Power
Grid control application

- Transmission & Distribution Network Analysis
- System stability and system balancing applications
- Outage and trouble call management
- Active network management
- Fleet optimization & scheduling
- Forecasting and planning applications
- Energy Market Management

CIM

EnergyIP
Smart grid & smart market applications

- Meter Data Management
- Decentralized Energy Resource Management
- Revenue protection/Non-Technical Losses
- Prepaid Energy System
- Market Transaction Management
- Energy Engage customer web portal
- Energy Analytics

Smart Communication

Smart transmission

Smart distribution

Smart consumption and microgrids

Smart markets

Smart distributed energy systems

Enterprise IT

- IVR
- GIS
- Network planning
- Asset management
- WMS/mobile
- Weather
- Forecasting
- Web portals
- CIS/CRM
- Billing

CIM – Common Information Model (IEC 61970)

Spectrum Power ADMS
The 3-in-1 Solution for Advanced Distribution Management in Smart Grids

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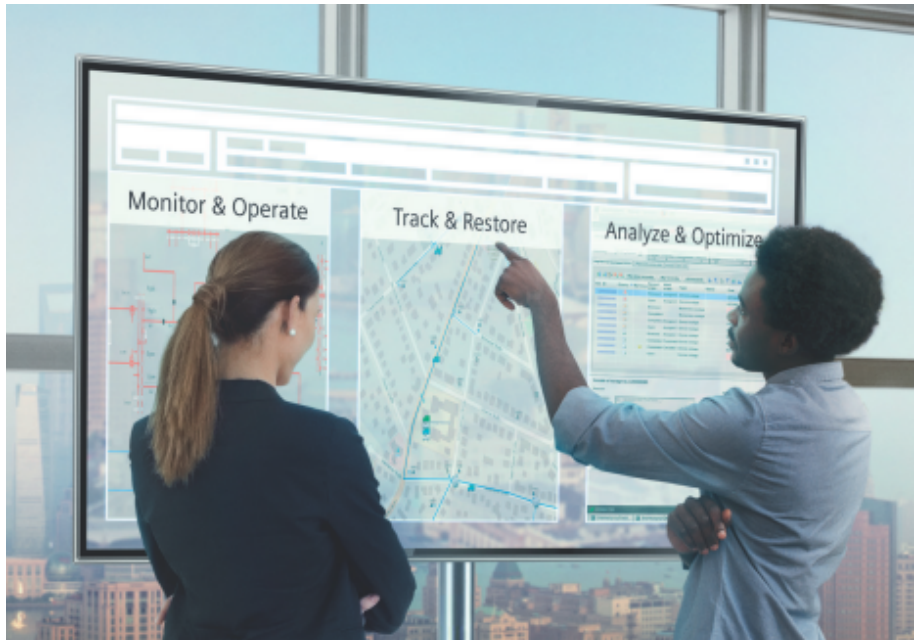
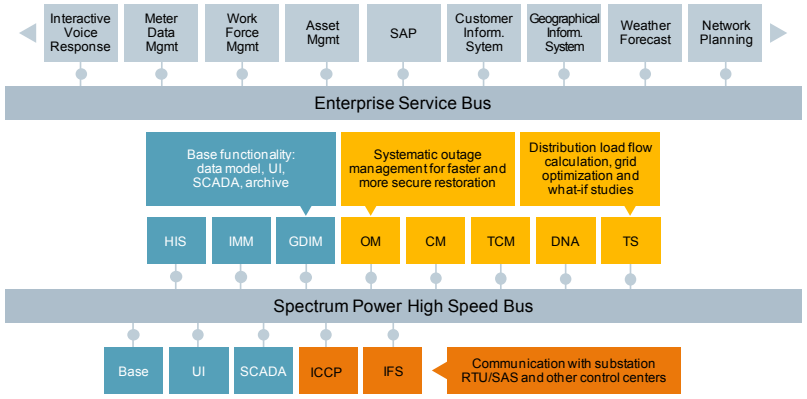


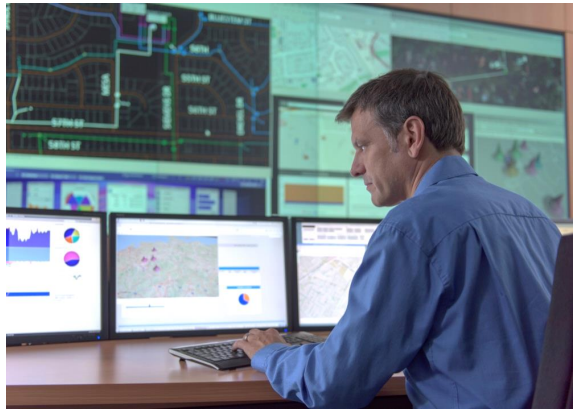
Monitor, control and optimize the secure operation of the electrical distribution network.

Reduce network loading at peak times and increase asset utilization, network efficiency and reliability.

Proactively and safely guide operators when needed most, i.e. during storms and outage-related restoration activities.

One single operational technology platform and one Common User Interface for SCADA, Distribution Network Application (DNA) and Outage Management System (OMS).





Integrated platform strategy to ensure minimized risk and high cost efficiency

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Spectrum Power
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Smart Communication

Smart transmission

Smart distribution

Smart consumption and microgrids

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Enterprise IT

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CIM – Common Information Model (IEC 61970)

EnergyIP Solution Framework

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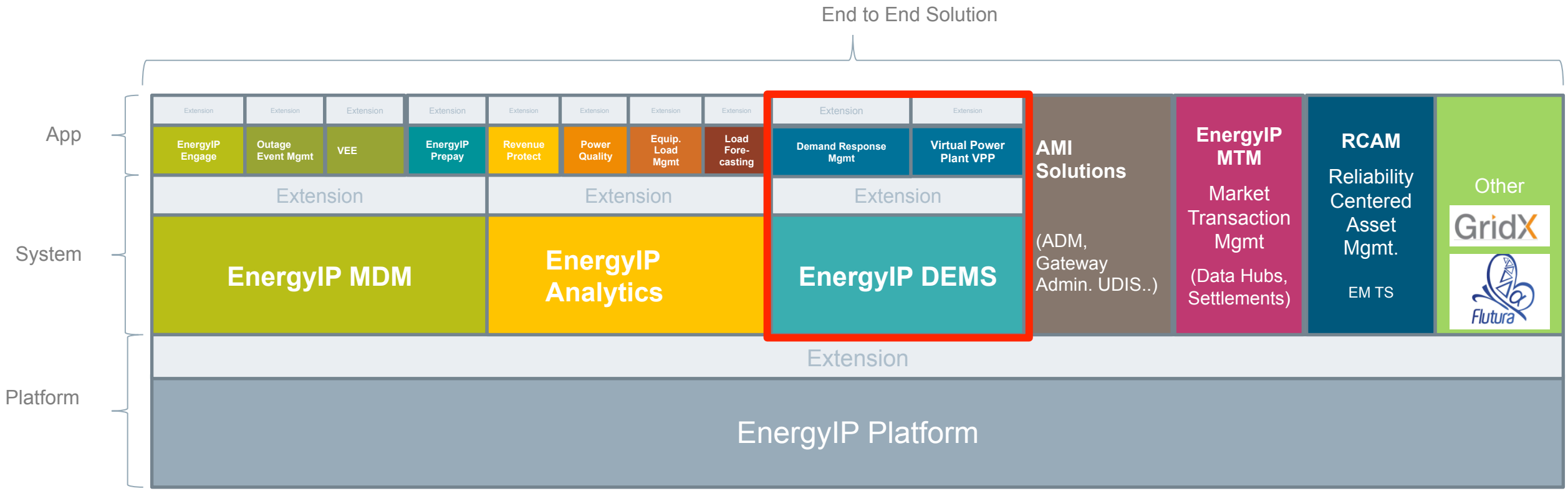

GridX

3 Apps for Customer Analytics:
- Daily revenue
- Customer impact analysis
- Revenue by asset

Flutura

2 Apps for the Retail Energy Market:
- Customer gross margin and broker rankings
- Energy block recommenders

EnergyIP DEMS
Decentralized Energy Resource Management System

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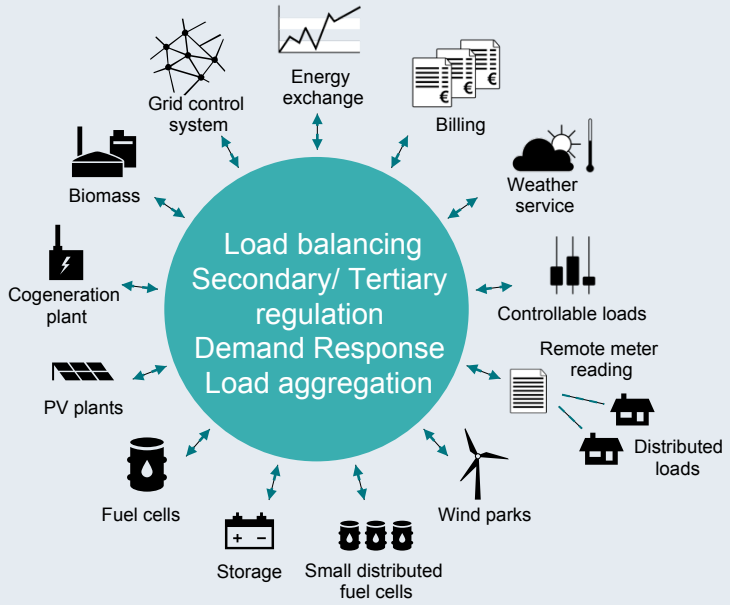


The Distributed Energy Resource Management System EnergyIP DEMS is one single platform to manage demand and supply of distributed energy resources for a wide variety of use cases.

Cost efficient integration of more and more renewables avoiding grid extension

Higher profitability with energy trading

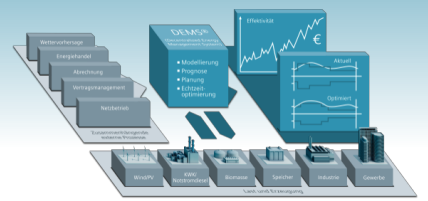
Increased customer loyalty

High scalability to integrate/ administrate a very high number of assets & customers

DEMS®

Energy management system for DER

- Forecasting generation and load
- Scheduling
- Monitoring and supervising
- Real-time optimization



Distributed Energy Resources (DER)

- Enabling optimized energy trading
- Efficient use of decentralized energy resources
- Handling distributed and wide-ranged resources
- Customer satisfaction and loyalty

DRMS

Aggregation management system for DER

- Administering loads and participants
- Contract management
- Multiple and flexible aggregations
- Scheduling and dispatching events
- Preparing settlement data

Actual and upcoming tasks for Virtual Power Plants

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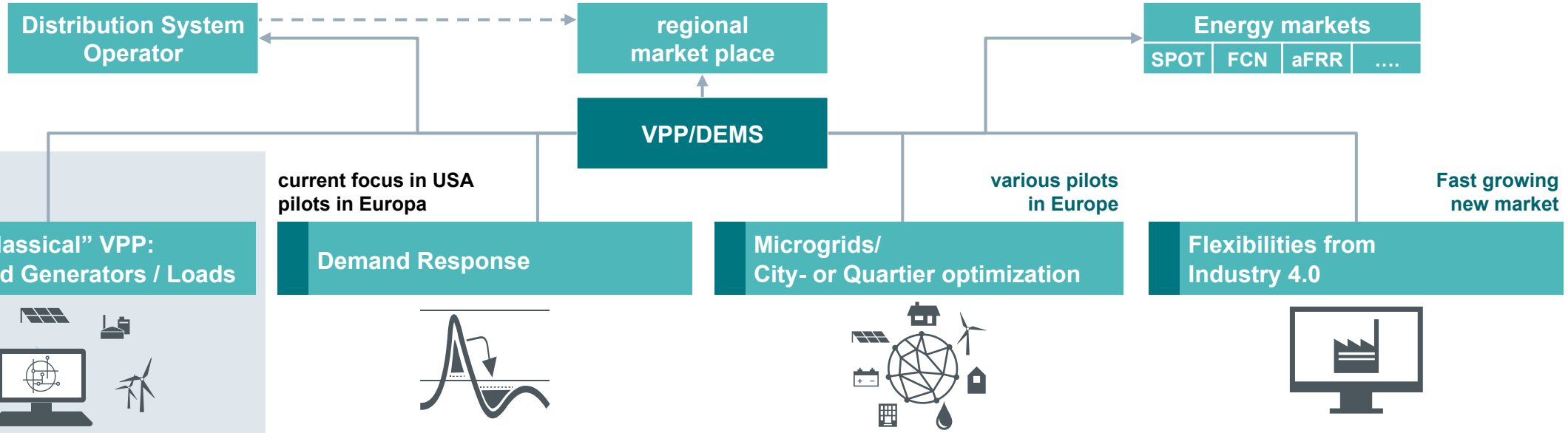
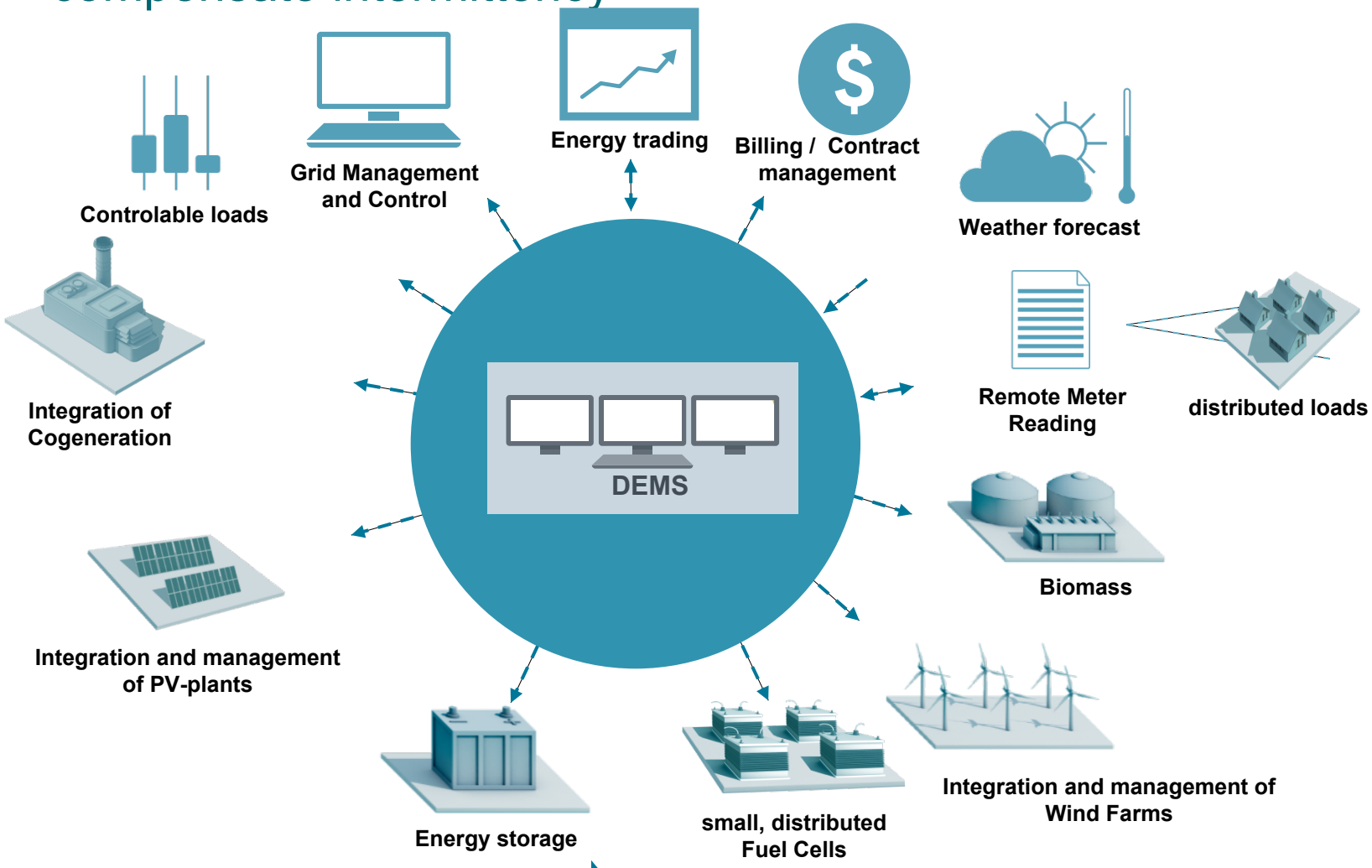


DEMS: Decentral Energy Management System, **FCN:** Frequency Containment Reserve (PRL), **aFRR:** automatic Frequency Restoration Response (SRL)

Virtual power plants (VPP) manage distributed generation, storage and load to optimize trading, provide ancillary services and compensate intermittency



- **Trading** of **internal** and **external** assets in various energy markets (ancillary sevices, intraday)
- **Availiability declaration** via
  - web portal or
  - via calculated profiles or
  - due to unavailability declarations
- **Data communication** to
  - TSO via IEC 60870-5-101 or ICCP
  - decentral assets via IEC 60870-5-104, openadr etc.
- (technical) **Billing** via web portal

One communication connection to an asset
Flexible use for different use cases

„Smart – Pool“
Virtual Power Plant for RWE

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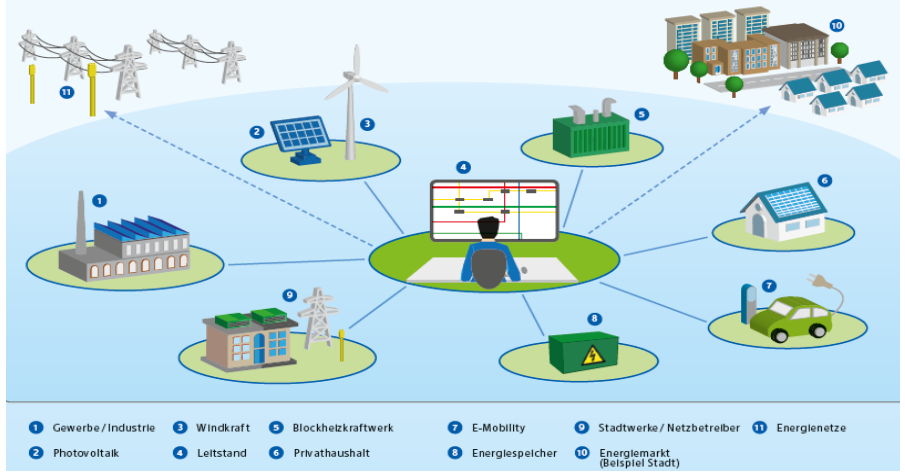

http://www.siemens.com/press/en/pressrelease

Many innovative steps must be taken in order to successfully manage the energy transition to the new energy mix. By collaborating with Siemens, we will be able to significantly expand the benefits of new IT technology systems and thus provide customers and grid operators with efficient solutions for their business.

Dr. Joachim Schneider,
Chief Technolgy Officer
RWE Deutschland AG

The Task

- Connect a large number (up to 30.000) of assets in distributed energy resources, such as generators, consumers (loads) and storage units and create earnings from all kind of ancilliary services (PRL, SRL, TRL) or Spot/Intraday-market
- handle multiple clients
- Support DSO Services
- support the structuring between market participants and the grid in line with the traffic light concept of the BDEW industry association, couple existing SCADA via ICCP.

Our Solution

- Establish Energy IP as platform using modul Decentral Energy Management System (DEMS) for VPP.
  Offer further platform Moduls as possible extension (e.g. Demand Response)

The result

- Fully automized aggreagtion and trading of connected/forecasted assets
- Online-Control of ancillary services (SRL, TRL) due to integration of all process steps and data communication to the asset in real time (via IEC 60870-5-104)
- Support of Grid Scada System via ICCP Connection

Actual and upcoming tasks for Virtual Power Plants

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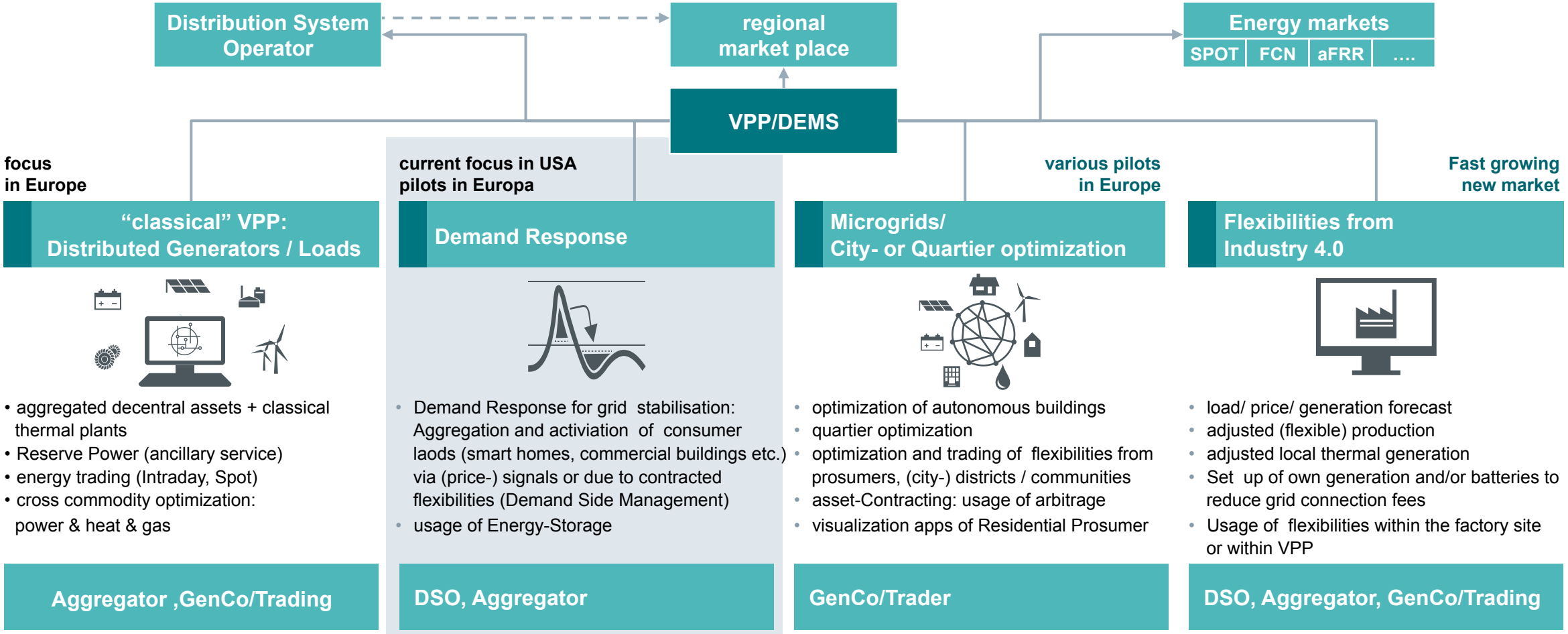

DEMS: Decentral Energy Management System, **FCN:** Frequency Containment Reserve (PRL), **aFRR:** automatic Frequency Restoration Response (SRL)

The Distribution-System Operator has three possibilities to manage grid congestions

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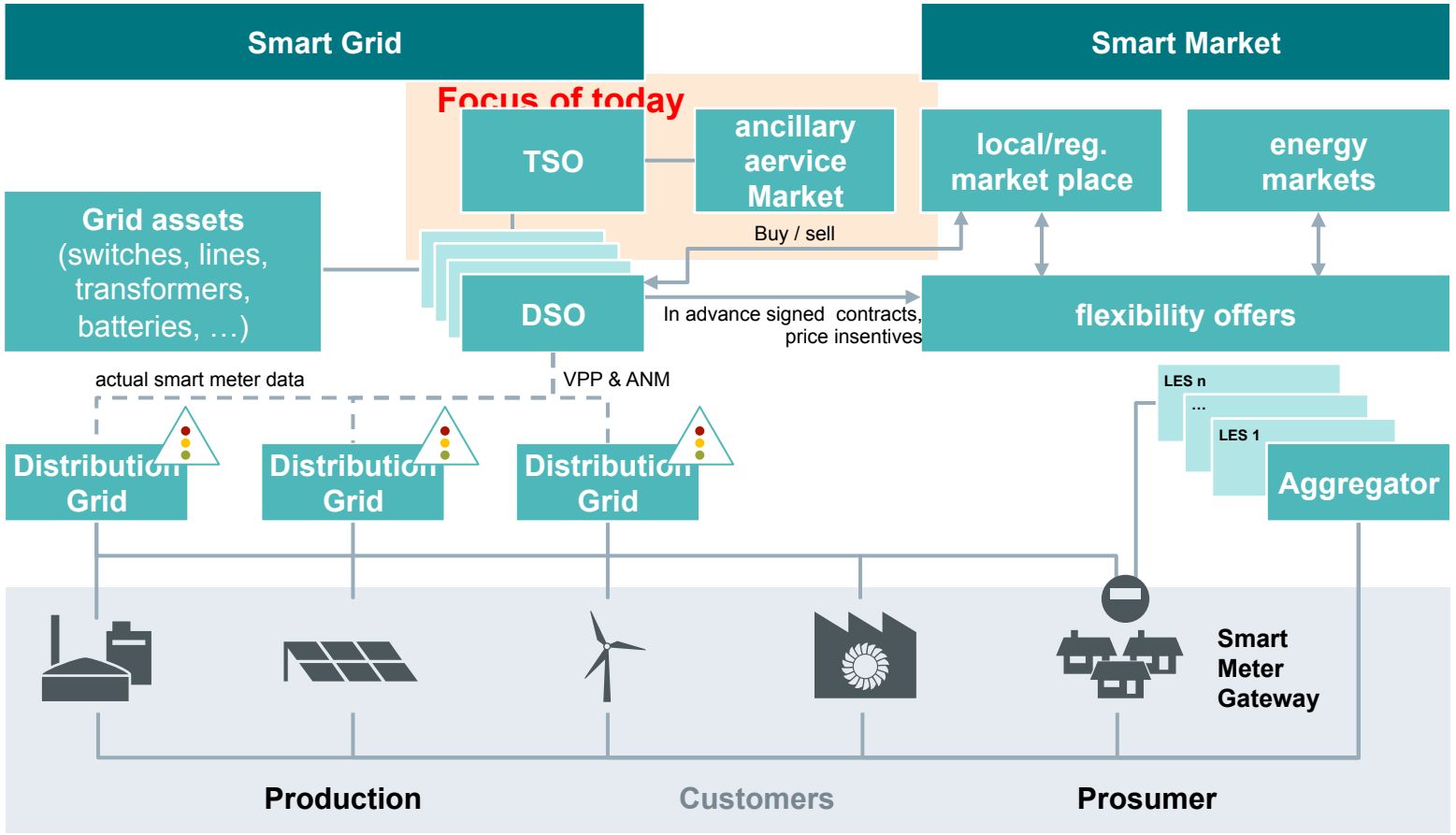
Slide shows how the integration of distributed assets into grid operation and energy market might look like



1 A_review_of_distribution_grid_congestion_management_methods_2_1.pdf **DER:** Distribution Energy Ressource

1. Classical« approach

- grid extension
- grid reconfiguration
- active voltage control (ANM)
- reactive power control

2. New appraoch

Direct[1]

- **Demand Side Management**
- distribuion grid – capacity market

Indirect/ Incentive methods

- **flexibility-(regional) market**
  (z.B. process according USEF-Framework)
- **Demand Response**
  user reaction on dynamic pricing (e.g. TOU, VPP)

In some cases they can only partly solve the congestion due to market failures or forecasting errors.

3. Gid connection between two (independent) distribution grids (MVDC)

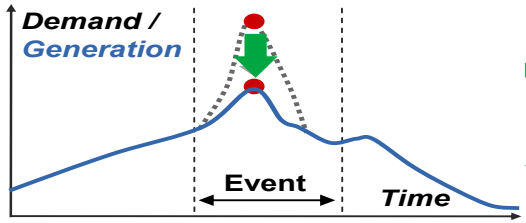
What is Demand Response?

Definition

- a mechanism used by utilities to alleviate volatility due to supply and demand and/ or price constraints, while maintaining or increasing overall system reliability
- An opportunity that a utility provides to residential, commercial and/ or industrial customers that requires reduced consumption to create “negawatts” that can be employed to address system and/ or energy market objectives

Value Chain

Energy Markets



- Sets the value for DR capacity
- Operates DR markets

Money

Regulated/ Unregulated Entity

Load

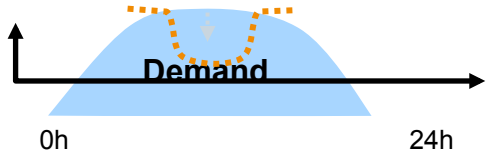
- Develops DR Programs
- Aggregates Load

Customers

- Subscribes load to DR programs

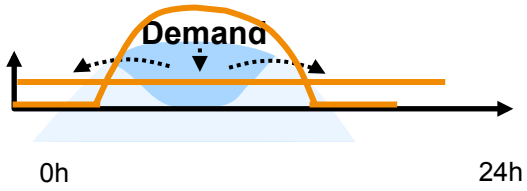
Impact

Peak demand reduction



Saving 5 - 15% is possible by factoring reduced energy costs plus incentives

Load shifting



Reducing energy consumption by 20% - 40% is possible

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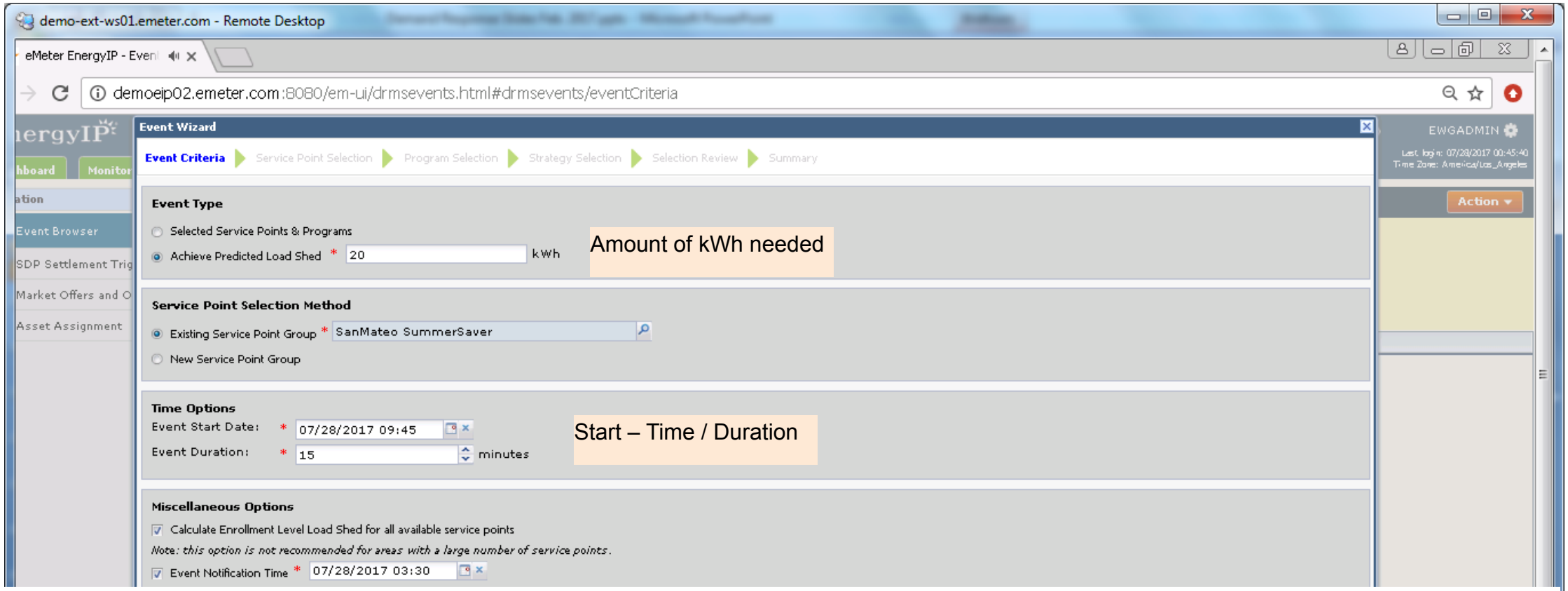
Wholesale Market Demand Response Programs

Market	Program	Notification	Event Duration	Frequency	History	Metering
New York (NYISO)	Capacity	20 hrs & 2 hrs	4 hours	1-2 times / yr	max 20 hours	15-minute
New York (NYISO)	Reserves	10 or 30 min	~ 15min - 2 hrs	~ 8 times / yr	16 hours	1-minute+
New England (ISONE)	Capacity	30 min or 2 hrs	2-4 hours	1-2 times / yr	avg 4 hours	5-minute
New England (ISONE)	Reserves	10-minutes	15 min - 2 hours	~ 12 times / yr	~ 12 hours / yr	5-minute
Mid-Atlantic (PJM)	Capacity	2 hrs	up to 6 hrs	1-2 times / yr	avg 4 hours	utility / 15-minute
Mid-Atlantic (PJM)	Reserves	10-minutes	up to 30 min	~ 12 times / yr	~ 6 hours / yr	1-minute
California - Capacity Bidding Program	Capacity	Day-ahead or 3 hours	client choice; max of 4, 6, or 8 hours	~ 12 times in about 3 months	varies by utility: ~20-50 hrs	utility / 15-minute
California - SCE Annual	Capacity	Day-ahead	1-4 hours	96 hours yr max	12 times; 44 hrs	utility / 15-minute
Texas (ERCOT - EILS)	Capacity	10-minutes	up to 4 hours	"once in 10 yrs"	1 time; 4 hrs	15-minute
TVA	Capacity	30-minutes	up to 4 hours	40 or 80 hours	up to 40 hours	5-minute

DEMS Overview:
How to Operator initiates an Demand Resonse Event - Part I



Event Targeting:

The load shedding resources that are the intended recipient for the DR event.
This may be a geographic area, a particular class of devices, a group identifier, resource ID, or other identifier.

A Demand Response program definition should specify how specific resources are going to be targeted.

Time Varying Rates
TVR Customers by Region: 2016-2025

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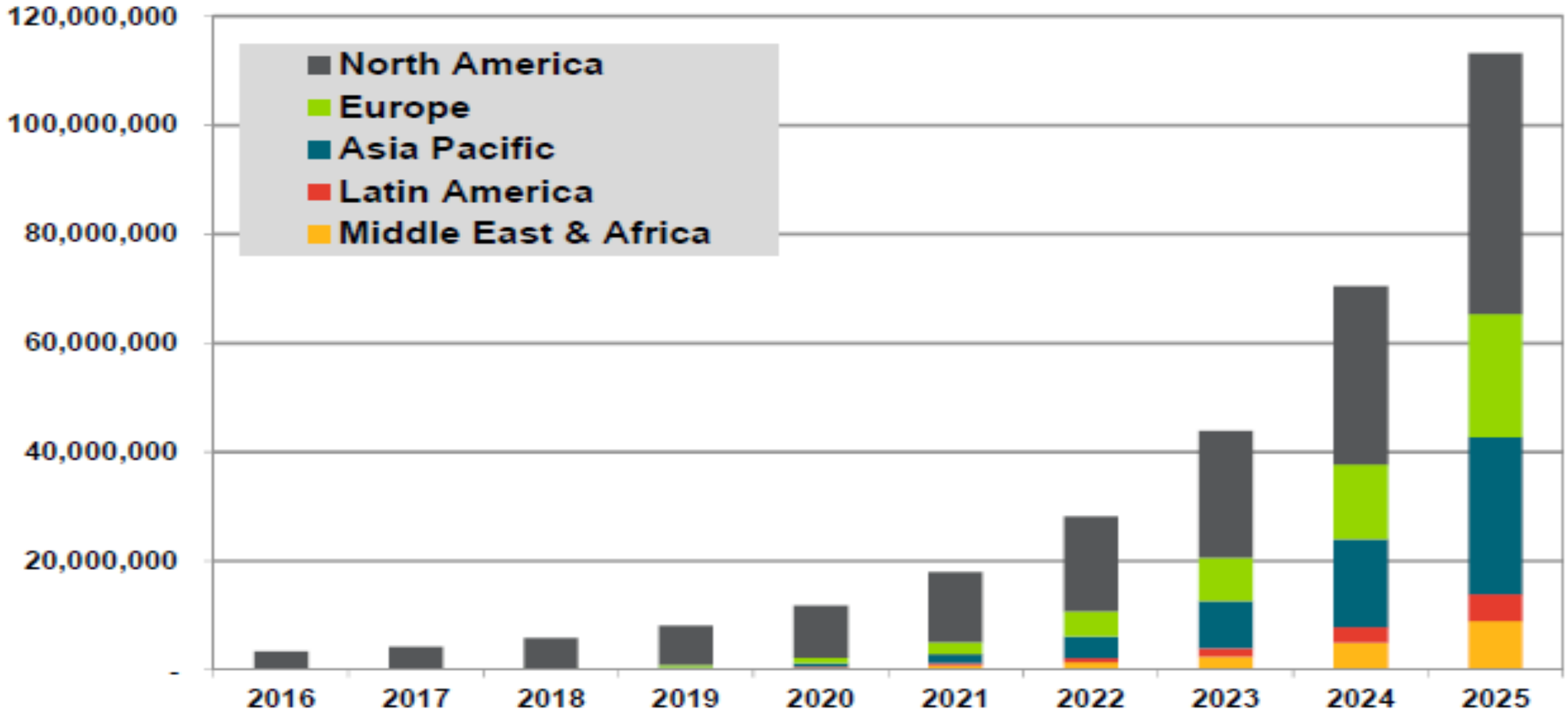

Source: Navigant Research

California Goes All In 100% Renewable Energy By 2045

California (199,038 GWh) is currently the 4th largest renewable energy producer in the United States


California breaks energy record with 80% of state's power generated using renewable methods

Vision
DSO in California

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Renewable Power for California

Wind farms and solar plants typically are **located in remote areas**. To deliver wind and solar power homes and businesses, our **infrastructure** must be **expanded**

Solar Power on Warehouse Rooftops

By positioning **solar stations** on the roofs of existing warehouses in sunny, inland areas, we are putting **otherwise-unused rooftops** to good use.

Helping Go Solar

We’re connecting a new solar **customer** every **15 minutes**.

Siemens Advanced Grid Management Control

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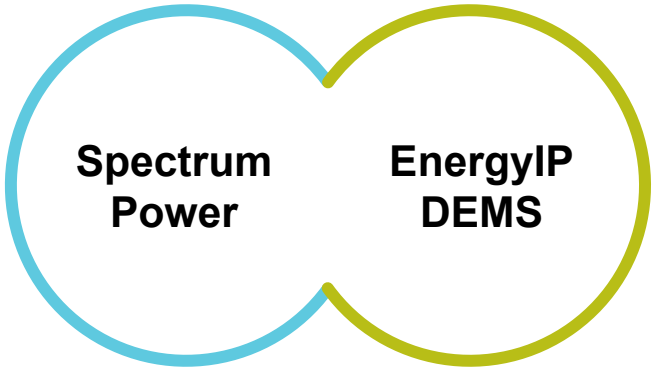
DERMS

EMS
Energy Management System

DMS/ADMS
Advanced Distribution Management System

MGMS
Microgrid Management System

Control and optimization of utility grid assets
- Network optimization
- Economic optimization



Program management of consumer resources and Demand Response
- Prosumer Aggregation
- Registration, contracting, settlement
- Fair play (consumer optimization)

Net new and emerging
Monitor, Optimize and Dispatch DERs to meet grid and market needs

Technology Architecture – DERMS Solution Architecture

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DERMS Output

- Power Generation Forecast
- Charge/Discharge Timing
- VAr flow management (voltage and efficiency)
- Network constraint mitigation
- Economic constraint management

DERMS Rules Engine

Optimization of network and economic constraints

- Aggregated, Grouped, Stand Alone

Settlements

Economic Optimization

Reliability Optimization

Registration

Load and Gen Forecast

Aggregation

Market Interface

Economic Programs

Topology Processing

Network Constraints

Load Scheduler

Power flow

Alarm Processing

EnergyIP DEMS

- Passive Control through Open Standard Protocols
- Device Setting Management

Engine

Batteries

District heating and cooling

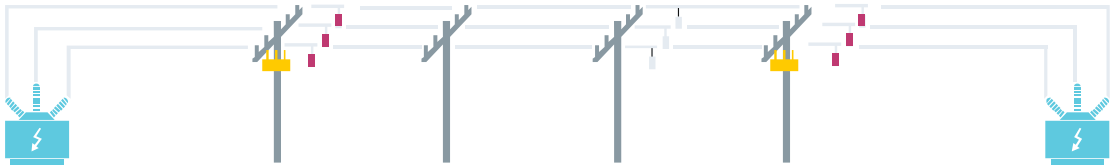
Photo-voltaics

Onshore wind

Small power plant

Spectrum Power

Active Control through Persistent Communication Protocols



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Innovation – Always at the edge of technology

Digitalization is a key enabler to create additional value for many use cases in the energy business

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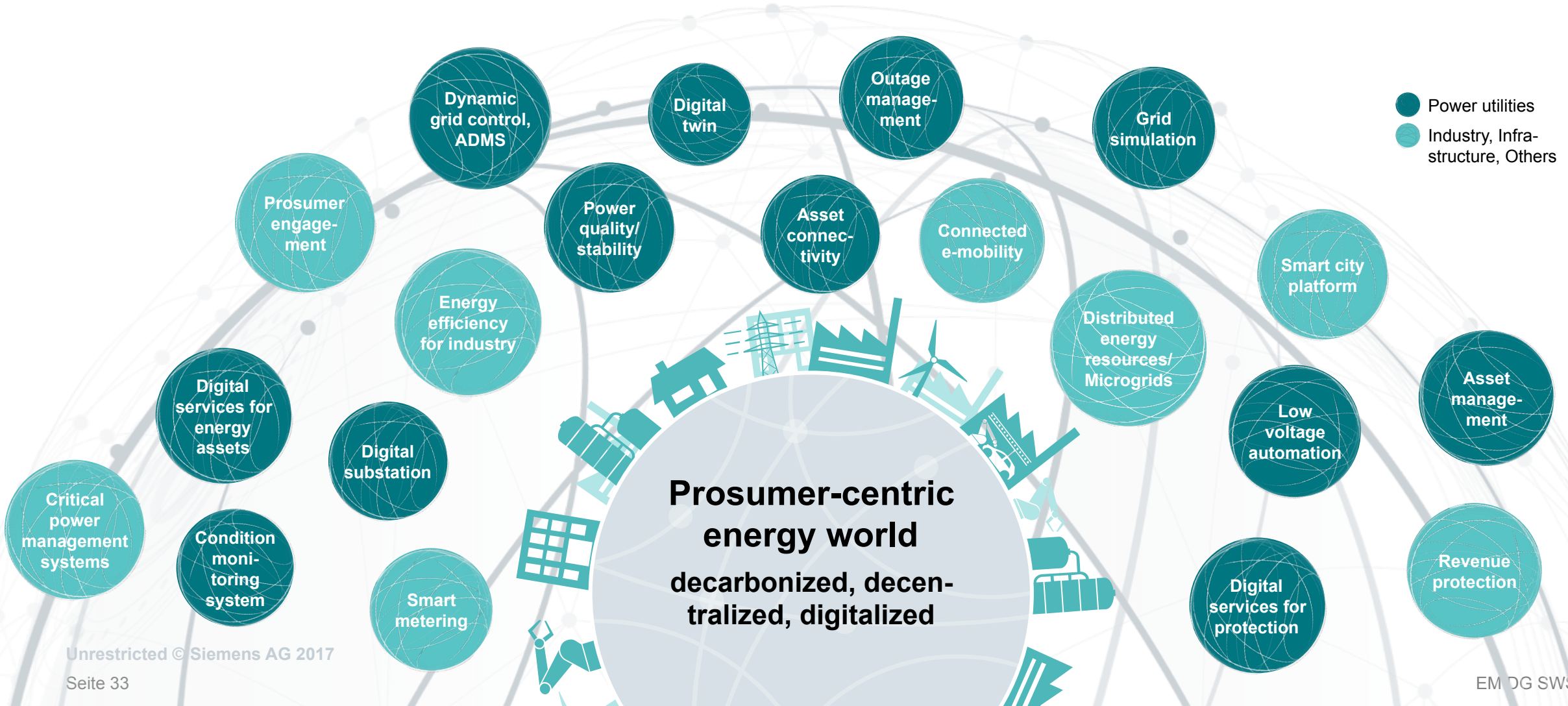

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MindSphere enables everything

MindSphere for energy – The open, cloud-based IoT operating system

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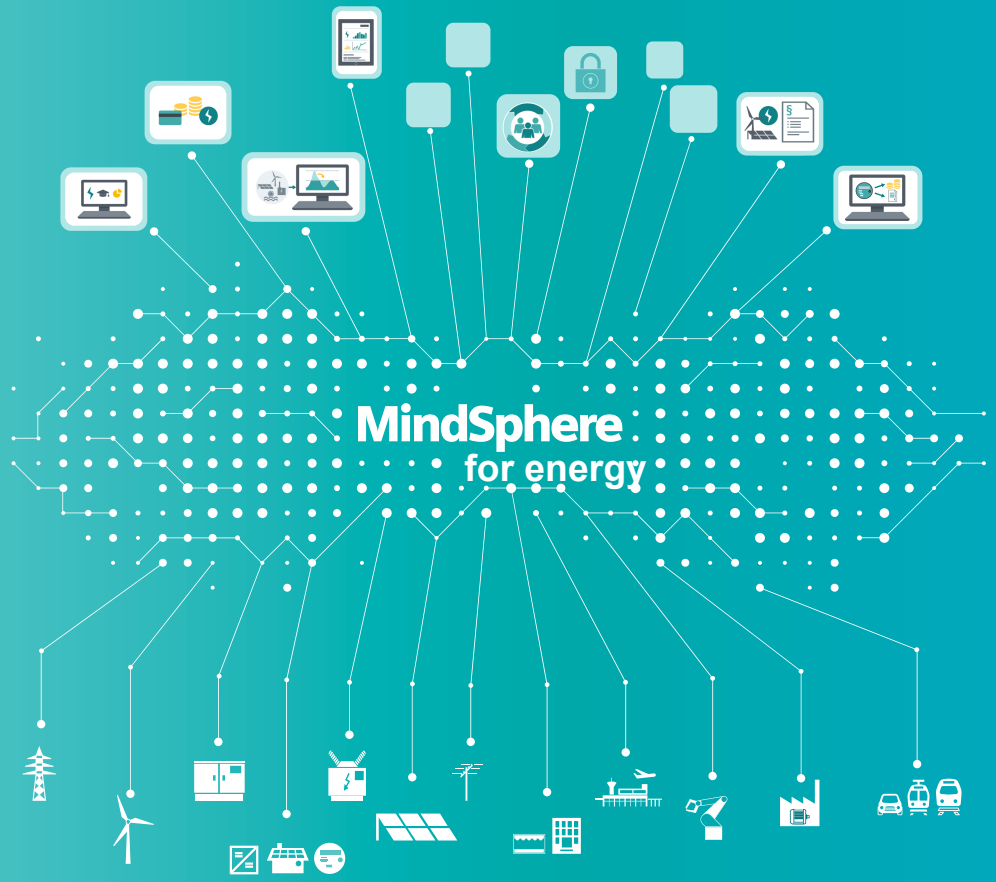

MindApps

Powerful industry applications and digital services for asset transparency and analytical insights

MindSphere

Open Platform as a Service (PaaS) for scalable, global IoT connectivity and application development

MindConnect

Secure plug and play connection of Siemens and third-party products and equipment

Benefits

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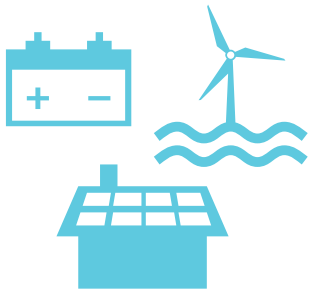
Increased DER operational capabilities and economic realization

Grid Reliable

- Provide visibility and control of all distributed resources on the network
- Deliver DER data for integrated resource planning, enrollment, management and market
- Optimization of network constraints with economic constraints/goals

Digitally Flexible

- Support future functionality through scalable technology platforms
- Design efficient workflows across functional areas



Business Model Focused

- Enable new energy services to consumers (e.g. Trading, Incentives for DER participation)
- Engage DER asset owners in operator programs

Contact

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