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How to smarten up the grid?

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The electrical energy grid is the backbone of our society

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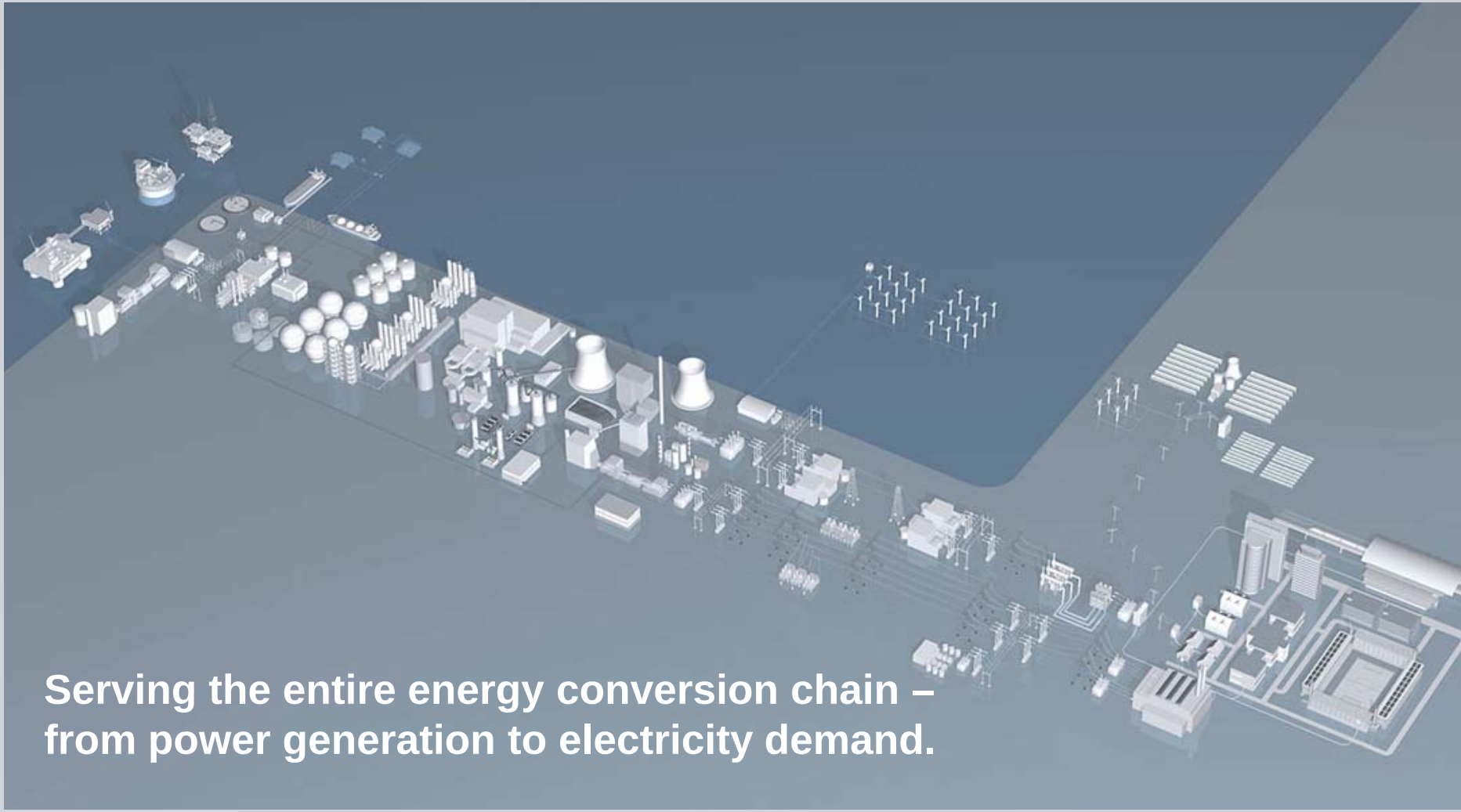

Customers' ideas of the Smart Grid

"Auto-balancing, **self-monitoring** power grid that accepts **any source of fuel** (coal, sun, wind) and transforms it into a consumer's end use (heat, light, warm water) with **minimal human intervention**."

"A system that will allow society to **optimize** the **use of renewable** energy sources and **minimize** our collective **environmental footprint**."

"It is a grid that has the ability to **sense** when a part of its system is **overloaded** and **reroute power** to reduce that overload and **prevent** a potential **outage** situation."

"A grid that enables **real-time communication** between the consumer and the utility, allowing the consumer to **optimize energy usage** based on environmental and/or price preferences."

Source Xcel Energy's

The starting point: changing needs, growing demands

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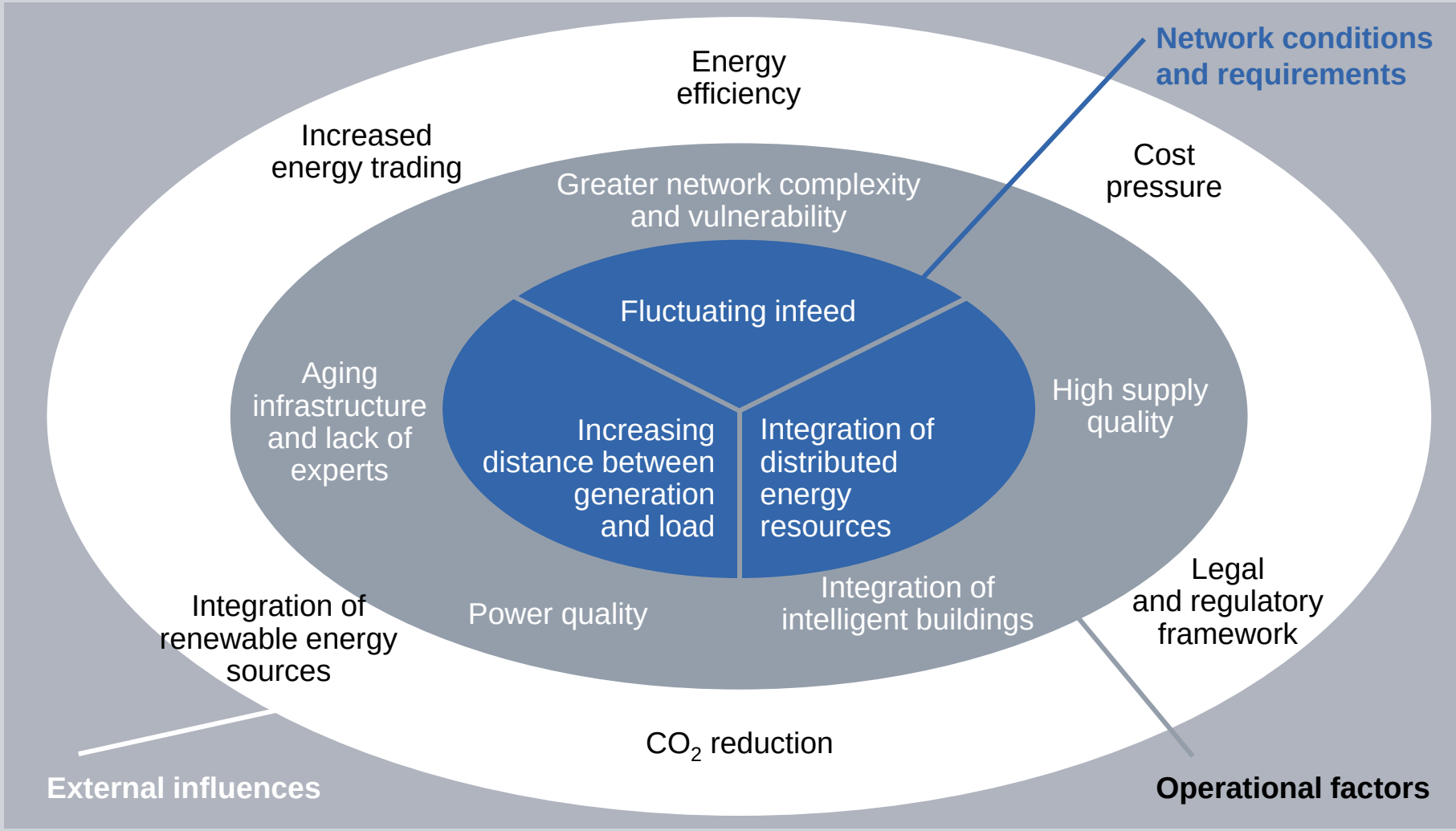

The starting point:
Drivers for flexible and (cost)-efficient grids

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Drivers

- Need for more energy
- Environmental sustainability
- Competitive energy prices
- Security of supply
- Aging infrastructure and workforce

Regulatory and political push

Challenges for the utilities

- Efficient grid **for profitability**
- Multiple infeed **for flexibility**
- Demand response management **for accessibility**
- Service Quality **for reliability**

The solution:
Smart Grid

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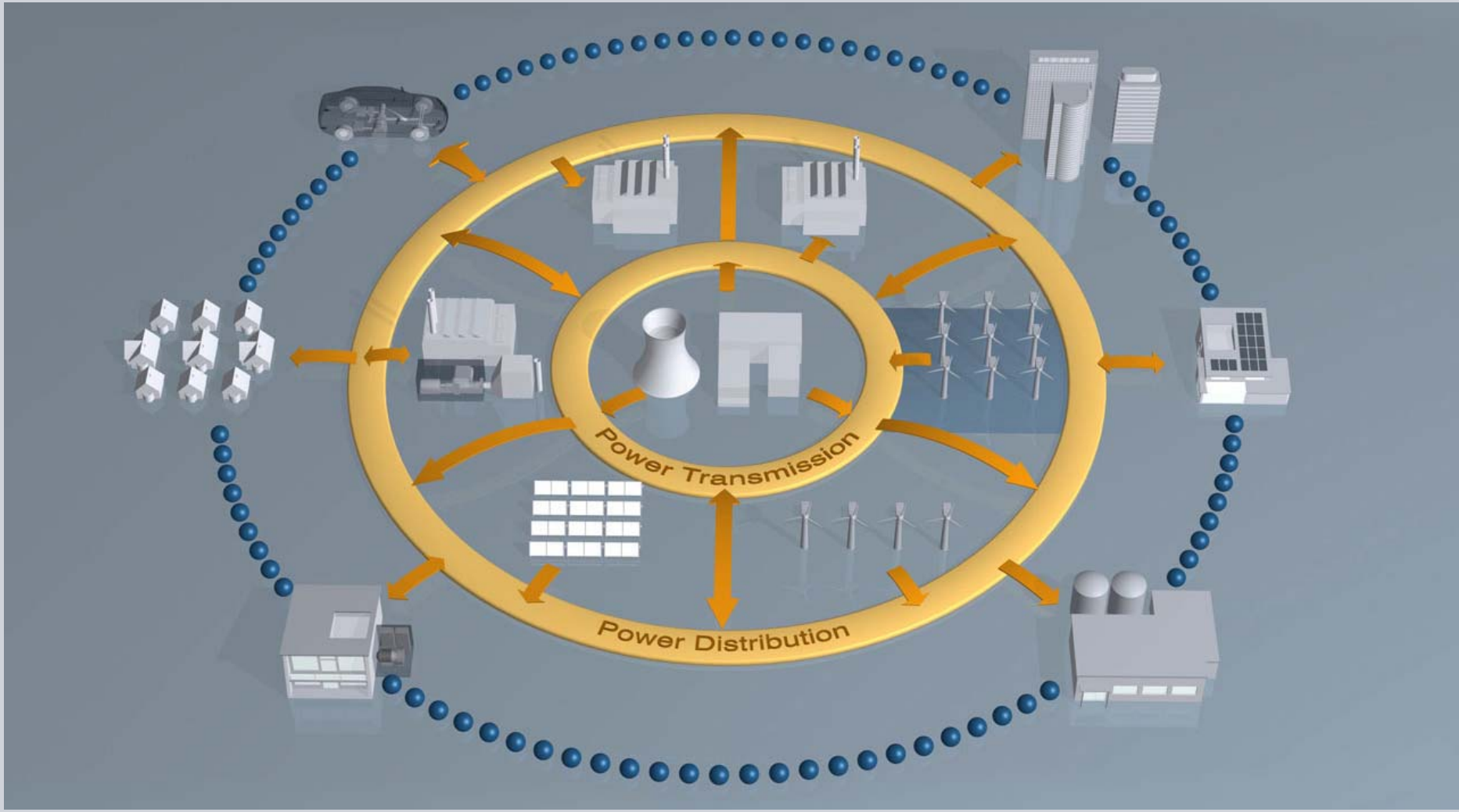
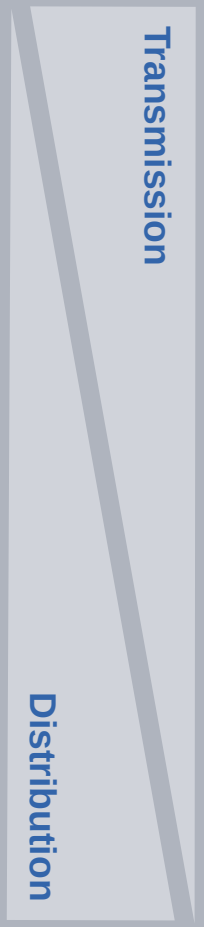


What does “Smart Grid” really mean?

From	To
Congestion, bottlenecks, and blackouts	Security, sustainability, and efficiency of power supply
Heterogenous communication networks varying in capacity and bandwidth	Homogeneous Smart Grid communication network with IP/ Ethernet connectivity between all components
Complex, personal intensive engineering and operating	Smart substation automation
Primary equipment condition not well known and not overall integrated	Condition monitoring for better asset performance and grid asset management for advanced asset management
Central generation, decentralized consumption	Integration of distributed energy resources (DER) and storage by virtual power plants
Manual and operating experience based reaction on critical situations	Smart, self-healing grid
Unmanaged, intransparent consumption	Smart metering and load management
Optimization of building life cycle efficiency as standalone process	Active participation of buildings in the grid as consumer, producer, and energy storage facility



Consequence:
Via ICT, Processes are merging and require integration

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Enterprise resource planning

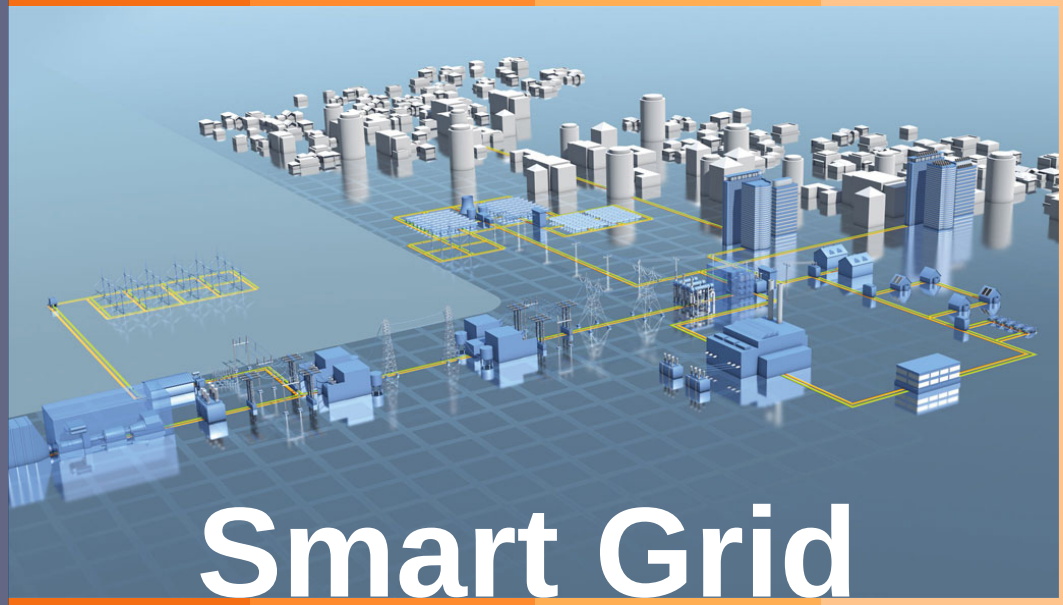
Business processes – customer and market

Grid operation

Plant operation

Power grid

Information and Communication Technology



Information and Communication Technology

Generation | Transmission | Distribution | Consumption

Siemens takes the lead in integrating Smart Grid solutions

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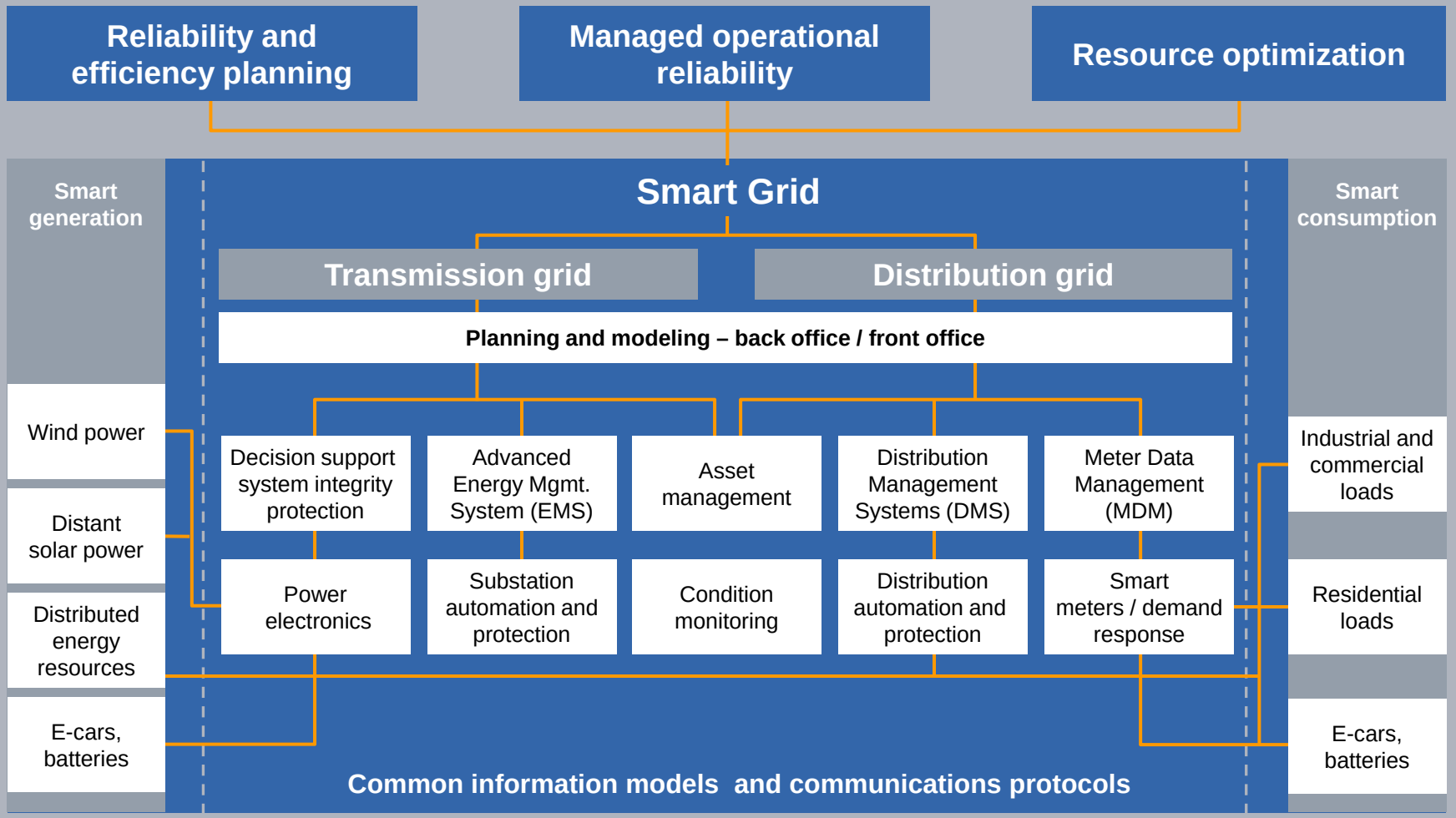

Turning the entire energy conversion chain into a smart infrastructure

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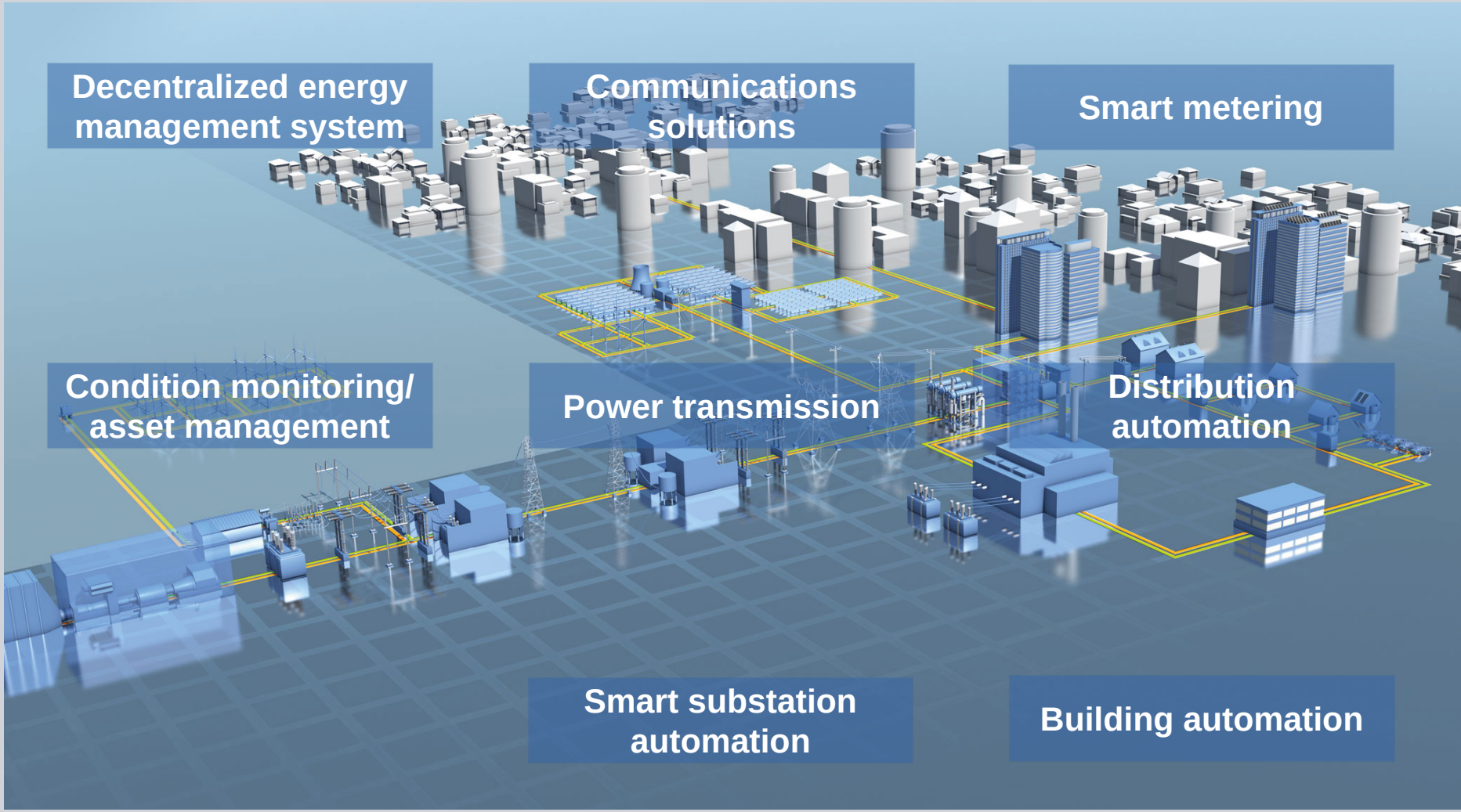

Communications solutions
that provide the basis for smart applications

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Communication network solutions

From

Heterogeneous communication networks limited in capacity and bandwidth

To

Homogeneous Smart Grid communication network with IP/ Ethernet connectivity between all components

What's necessary?

- Sufficient bandwidth from end to end
- IP/Ethernet capable devices
- Flexible backbone and access communication network solution
- Network extension down to RMUs and consumers
- Interfaces and protocols based on energy industry standards

The benefits of communication solutions

- Minimum downtime and optimized life cycle costs through **online monitoring and control of all grid assets**
- Integration of smart meters and distributed generation, and development of new business models, through **extension of the communication networks down to the end customer**
- Reliable basis through ruggedized **Ethernet- and IP components complying with utility standards**

Streamlined processes for improved, flexible workflow and reliable substation management

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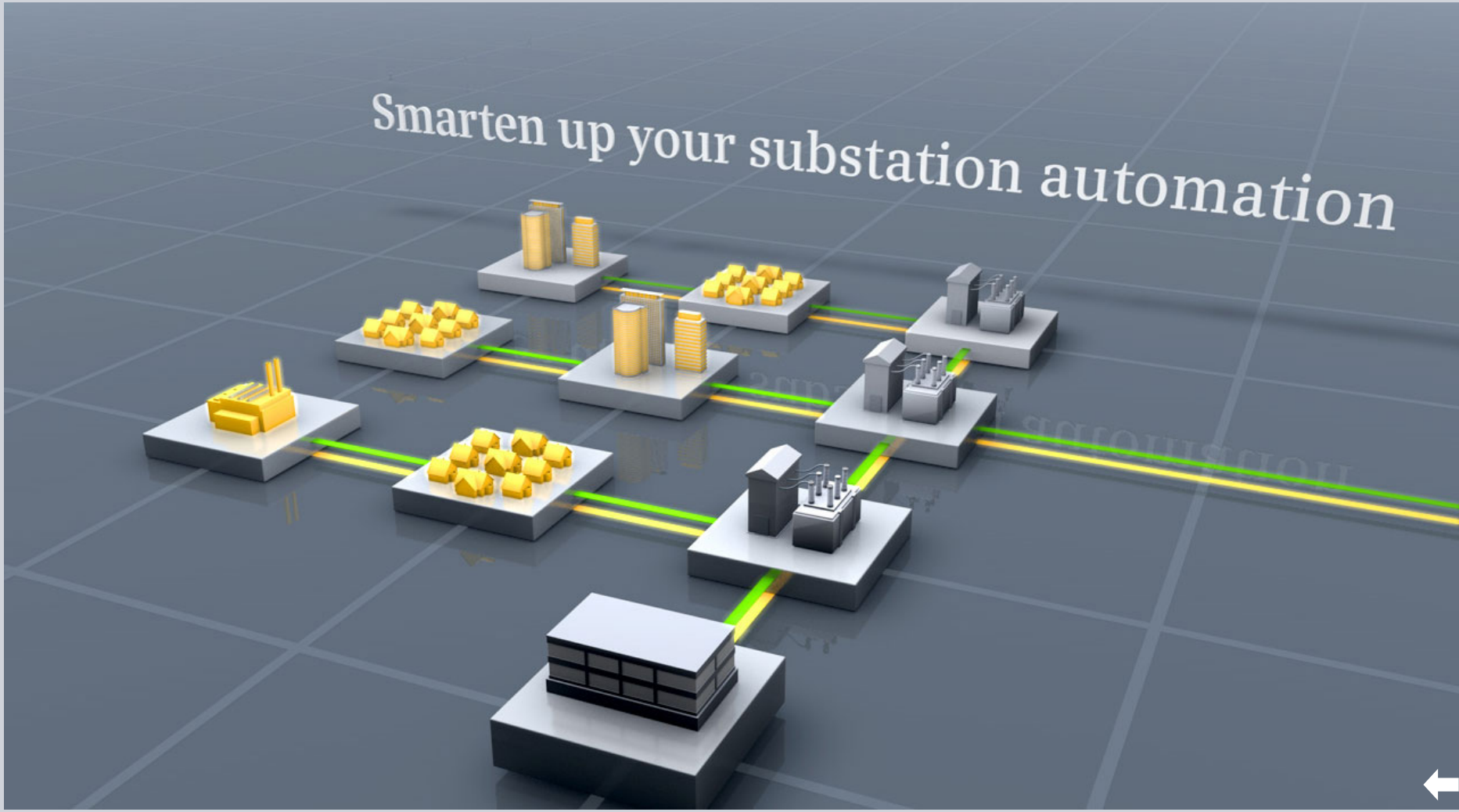


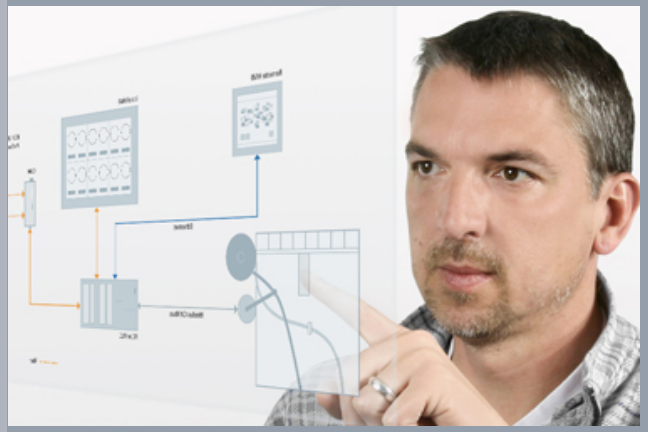
Substation automation

From

Complex, personal intensive engineering and operating

To

Smart substation automation



What's necessary?

- Standard intelligent process interfaces (Process bus IEC 61850)
- Standard communication and processes inside the station and among stations (horizontal and vertical integration)
- Digital system, online information, and intelligent applications
- Digital protection devices and components for online network analyses

The benefits of substation automation

- Over 50 percent time savings in engineering and commissioning
- Minimized wiring and documentation effort
- Fast start-up and minimal downtime by plug & play approach
- Self-healing automation functions
- Intelligent applications
- Online information (operational and non-op.) & improved monitoring
- Improved operational safety

Integrated solutions for highest economic efficiency

Why grid asset condition monitoring?

▪ Cutbacks on expenditure ▪ Retirements ▪ Downsizing	Loss of expertise
▪ Postponed invest in T&D infrastructure ▪ Extended component lifetime	Ageing equipment
▪ Renewable energy transmission ▪ Increasing energy demand	Higher loads
▪ Penalties	Increasing performance targets

Condition monitoring:

1. enables effective prediction and, thus, failure avoidance
2. offers a possibility for safe use of assets at higher loads and, therefore, supports both asset management and operation

The benefits of condition monitoring and asset management

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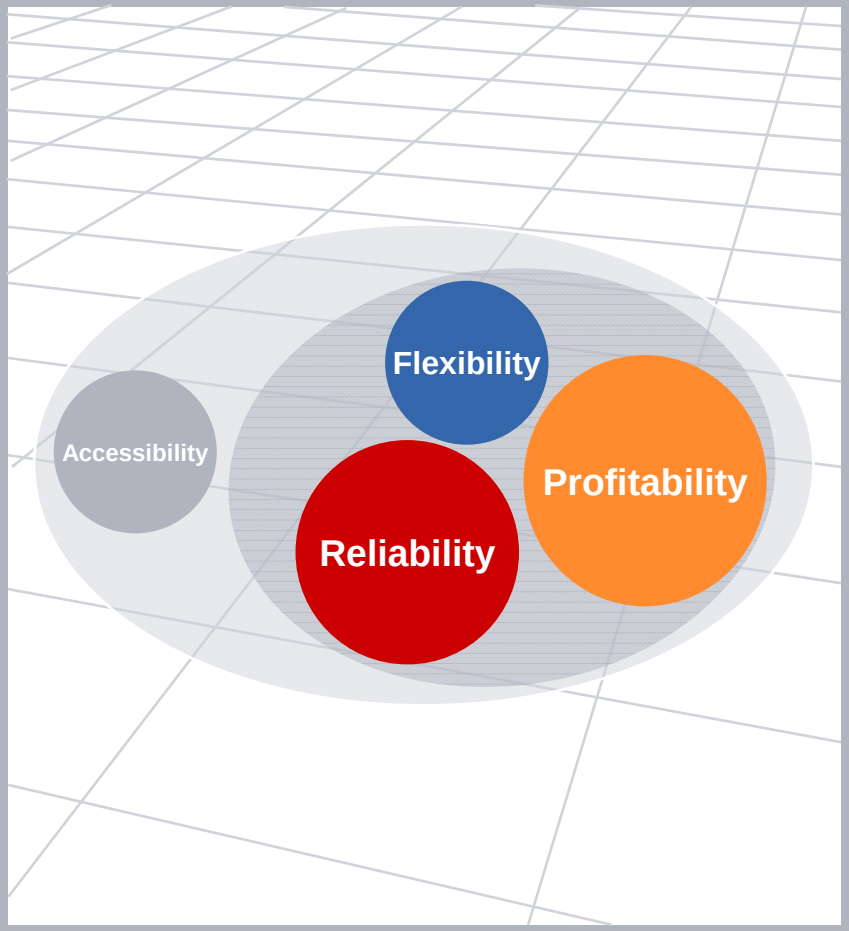

- Reduced life cycle costs
- Maximized component life
- Optimized performance
- Minimized downtime
- Avoidance of possible penalties
- Environmental benefits
- Documentation of responsible handling
- Easy implementation
- Optimized allocation of OPEX and CAPEX
- Controlled risks
- Effort-optimized regulatory compliance
- Long-term knowledge protection
- Simplified growth

Seamless integration of energy resources into the grid

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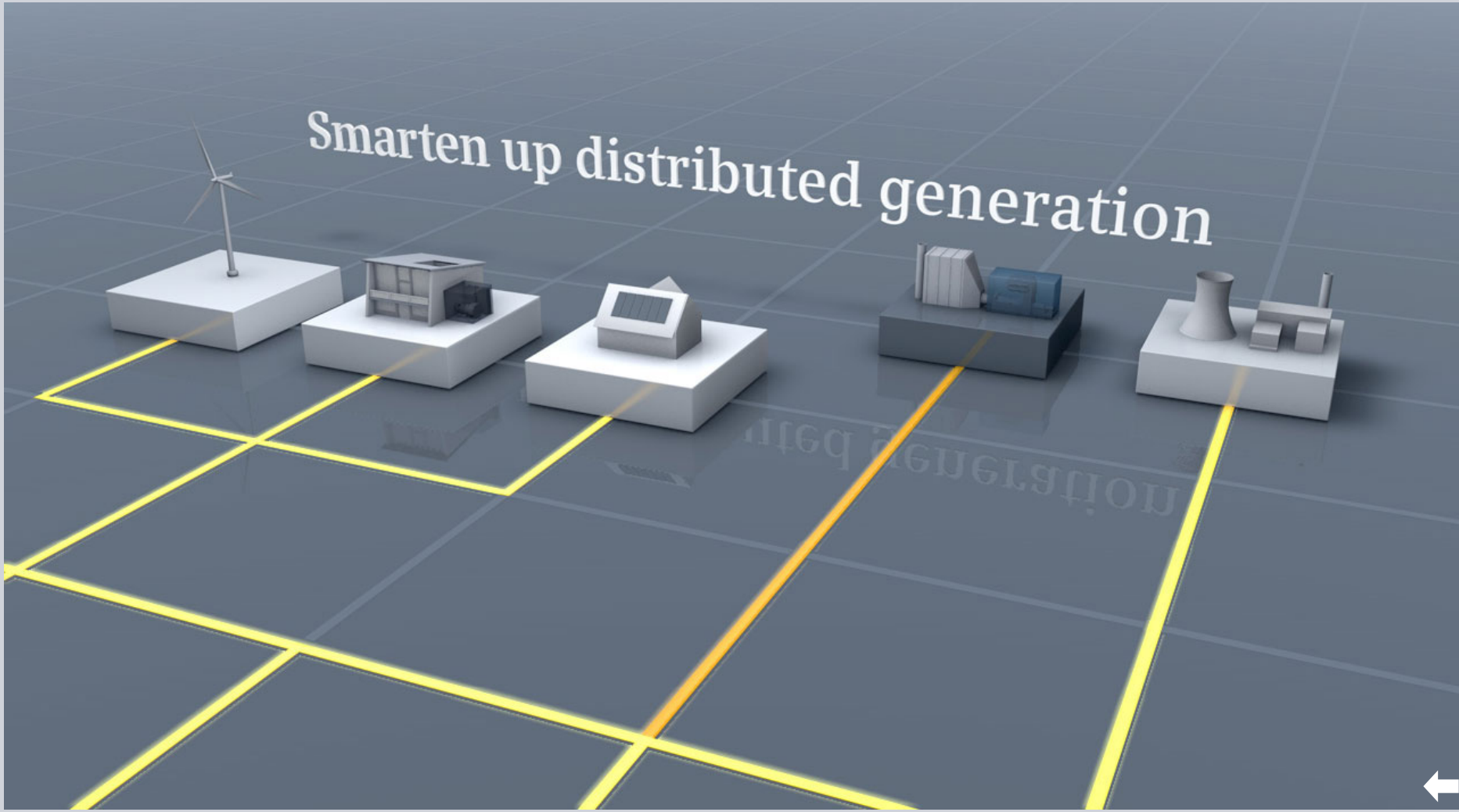

Distributed energy resources and storage

From

Central generation, decentralized consumption

To

Integration of **distributed energy resources (DER) and storage** by virtual power plants

Virtual power plants – main features:

- Energy management system for monitoring, planning, and optimization of DER
- Forecasting system for load and generation of wind power and photovoltaic plants
- Energy data management for collection and retrieval of required information, e.g., loads, contractual data
- Front-end for communication with distributed power units

The benefits of a decentralized energy management system

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- Synergies through pooling of distributed energy resources
- Remarkable economical and ecological benefits
- New market opportunities for distributed energy resources
- Optimal integration into distribution networks

Flexible and reliable distribution automation

Distribution automation

From

Manual and operating experience based reaction on critical situations

To

Smart, self-healing grid

What's necessary?

- Provide a base function for smart gird monitoring unit, section analyzer, RTU, recloser controller, PMU, etc. with ring main unit and pole top systems.
- Minimization of outages by
  - self-healing functions
  - maximized selectivity
  - expert systems for fault isolation and service restoration
  - outage management
  - network analysis, enterprise integration (GIS etc.)

Distribution automation characteristics

Today's standard	Evolution	Smart distribution automation
▪ No monitoring, control, and automation ▪ No communication ▪ No auxiliary power supply and motor-operated mechanism ▪ No active integration in control center (manual updates)	▪ Automation of distribution substations ▪ Communication in distribution networks ▪ Decentralized, intelligent application ▪ Distribution management system ▪ Harmonized networks and tasks	▪ Self-healing automation functions ▪ Intelligent applications ▪ Online information (operational and non-op.), e.g., power quality system

Distribution automation in practice: Reference examples

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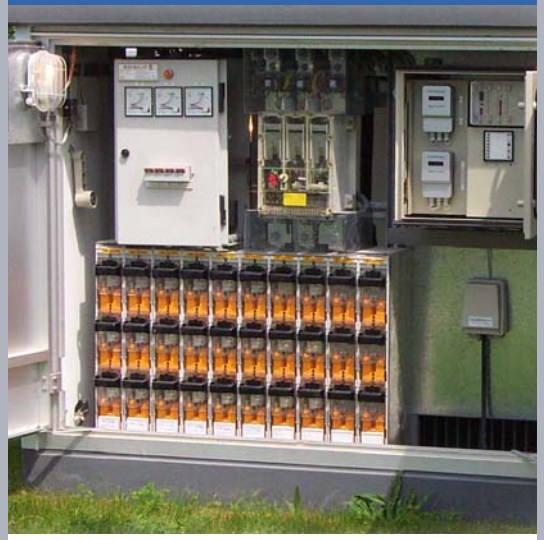
RMU-automation



Pole top automation

DA and metering

The benefits of distribution automation

- Minimized wiring and documentation effort
- High reliability through simplicity
- Improved monitoring
- Automatic isolation of faulty grid sections
- Improved operational safety
- Data and site security

Infusing intelligence into the last mile

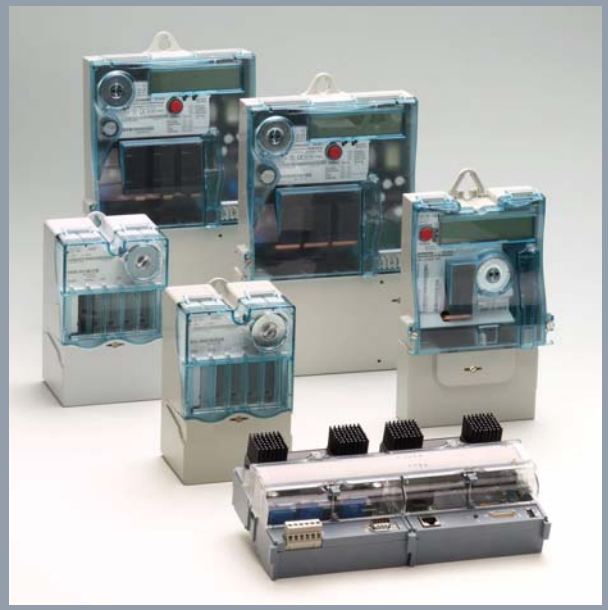
The solution: smart metering

From

Unmanaged energy consumption

To

Smart metering and load management



AMIS

Automated Metering and Information System

+

EnergyIP

Meter Data Management System

Smart metering characteristics

With regard to energy consumers

- Transparency through frequent meter reading of various media (electricity, gas, water)
- Flexible tariffs → cost reduction
- Decentralized power generation supported
- Additional services offered, e.g. home automation

With regard to the business

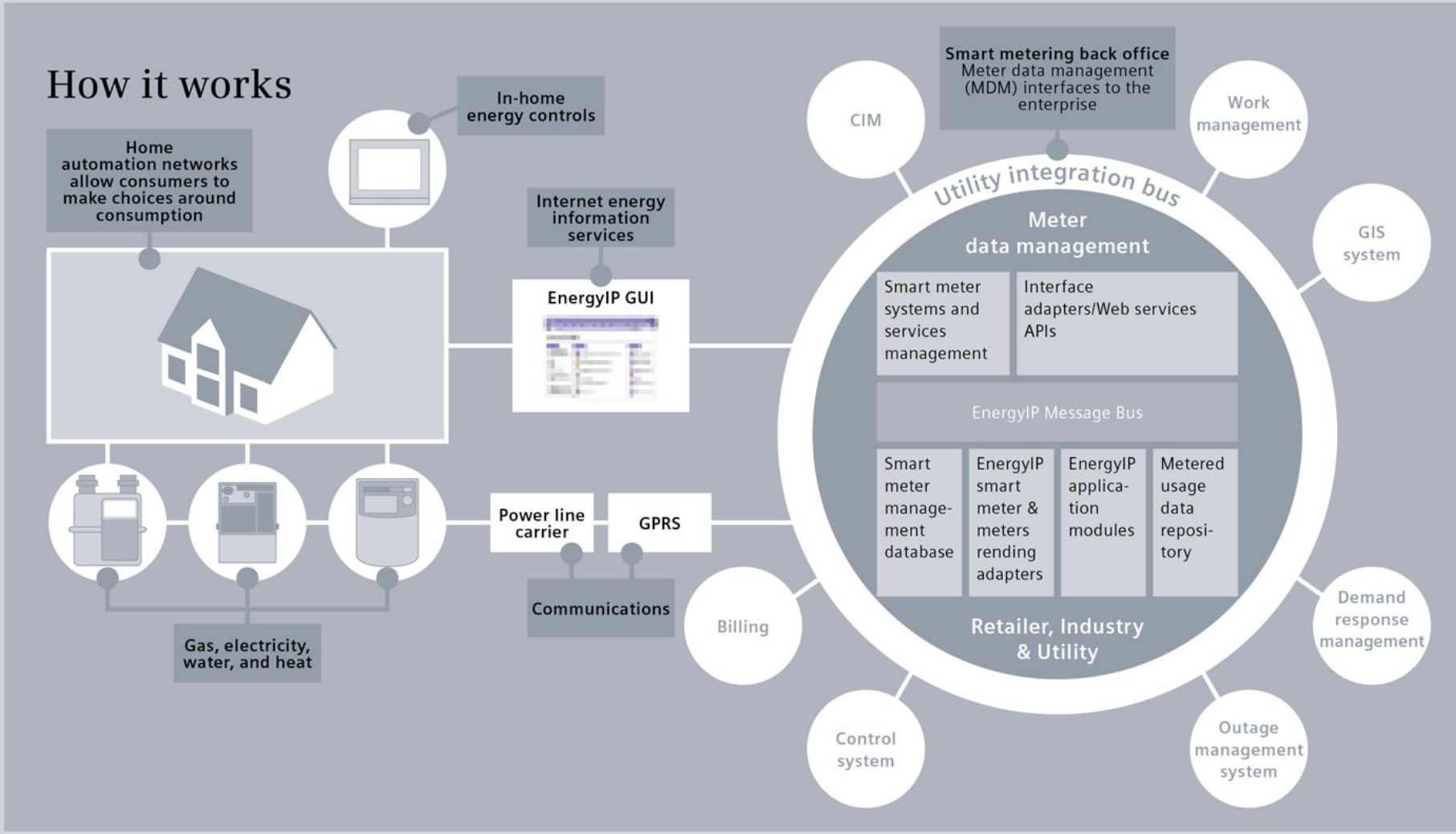
- Increased efficiency of metering business through automation
- Reduction of non-commercial losses
- High-volume, multi-purpose data platform for real-time and offline data service
- Offer of additional services possible

With regard to legal aspects

- Fulfillment of legal requirements as governmental energy efficiency directives
- Equal legal access can be provided to all market participants at required access rates

Smart metering and load management – what do they stand for?

The complete smart metering solution



Smart metering:
Case Study 1: Energie AG Oberösterreich (Austria)

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Reference project for Energie AG Oberösterreich, Austria: The most important reasons for the implementation of an AMIS system are

- Automated metering processes (meter reading, blocking of customer installations, billing, prepayment services, etc.)
- Significant improvement of customer processes
- Implementation of various tariffs
- Quality improvement of consumption data due to monthly meter reading
- Replacement of ripple control
- Recording of customer supply
- Automation of the transformer stations
- Support of Energie AG's energy efficiency program

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Case Study 1: Energie AG Oberösterreich (Austria)

Project phases:

1. Specification of Requirements + Deliverables
2. Integration Test with 1 000 consumers in the field to test all functionality of
   - AMIS Smart Meters
   - Load Switching Devices
   - Communication network
   - SAP interface
3. Performance Test with 10 000 consumers
4. Rollout of 500 000 AMIS Smart Meters by 2014.

Current results:

- Phase 1, 2 and 3 finished very successfully
- 100% of meters available via PLC at expected performance
- Longest direct PLC distance currently >1km
- 100% digital system, including all business processes in SAP and mobile PDA for maintenance engineers
  → NO paperwork any longer!
- Significant business process improvement

Smart metering:
Reference example 2

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Transitioning 800,000 retail customers in New Zealand to smart metering: Meter data management solution (EnergyIP) provides

- High volume meter data management for gas and electricity
- Time-of-use-based billing
- Residential load management
- Exception reporting and integration of field workforce
- Automated commissioning of each meter installation
- Detailed reporting for retail and distribution applications
- Web-based energy Information portal
- Integrated wireless in-home display
- Fully managed smart service

The benefits of smart metering

- Significant improvement of customer and business processes and services
- Transparent process that allows customers to monitor their energy use and optimize their consumption decisions
- AMIS is a comprehensive solution for smart metering and distribution network automation

Lessons learned:
The keys to successful Smart Grids incl. Smart Metering

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- Energy companies understand the Smart Grid as goal of strategic importance
- Standardized and open interfaces and protocols are necessary (e.g. IEC)
- Communication infrastructure to all grid components is necessary
- Perform systematic business process re-engineering
  & automation of operational and customer processes
  (e.g. prepayment, billing, tariff changes, connection/disconnection, etc.)

➔ In order to provide the highest return on invest possible, even the future!

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How smart is your grid?

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