# Smart Grid Technologies

## Transforming Cities for the better through Sustainable Technologies

## The Siemens Perspective

# Siemens – Who we are

SIEMENS

Siemens is a global powerhouse positioned along the electrification value chain – from power generation, transmission and distribution to smart grid solutions and the efficient application of electrical energy – as well as in the areas of medical imaging and in-vitro diagnostics.

As of September 30, 2014, we had around 343,000 employees worldwide.

Orders totaled €78.4 billion and revenue from continuing operations was €71.9 billion in fiscal 2014.

We operate in excess of 289 major production and manufacturing plants worldwide. In addition, we have office buildings, warehouses, research and development facilities or sales offices in almost every country in the world.

# Technologies will improve energy efficiency, eco-friendliness and quality of life of cities

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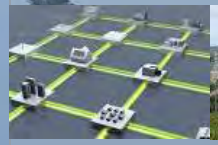
## Energy


Power Generation & Distribution




Smart applications HVDC[1)]

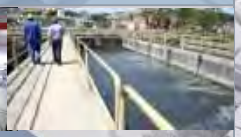

Smart Grid Renewable

## Transportation


High-speed train Traffic Mgmt


E-mobility Alt. drive system

## Water & Waste

Waste, Water and Wastewater Mgmt


## Health


Medical Technology Green Hospitals

## Building,Lighting&Security



Smart and efficient buildings

Efficient lighting Safety Center

# Growth of power demand is driving investment in transmission and distribution

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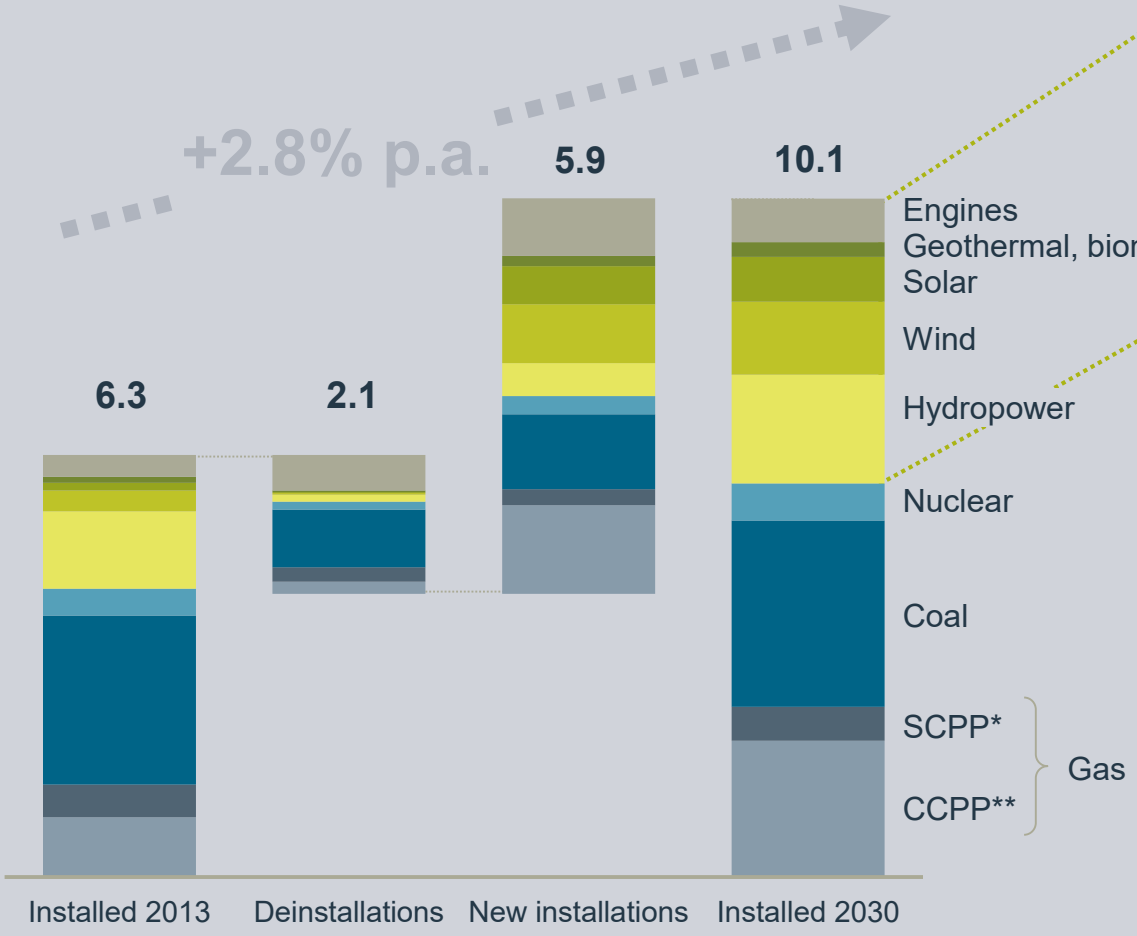
## Global power generation in TW




**Renewables and distributed power generation grow above average**

**Main driver for the Energy Management market**

* Simple cycle power plants **Combined cycle power plant

Source: Siemens Energy 2020 Project 2014 - Base Case Scenario

# Growing share of renewables and distributed generation calls for end-to-end energy management

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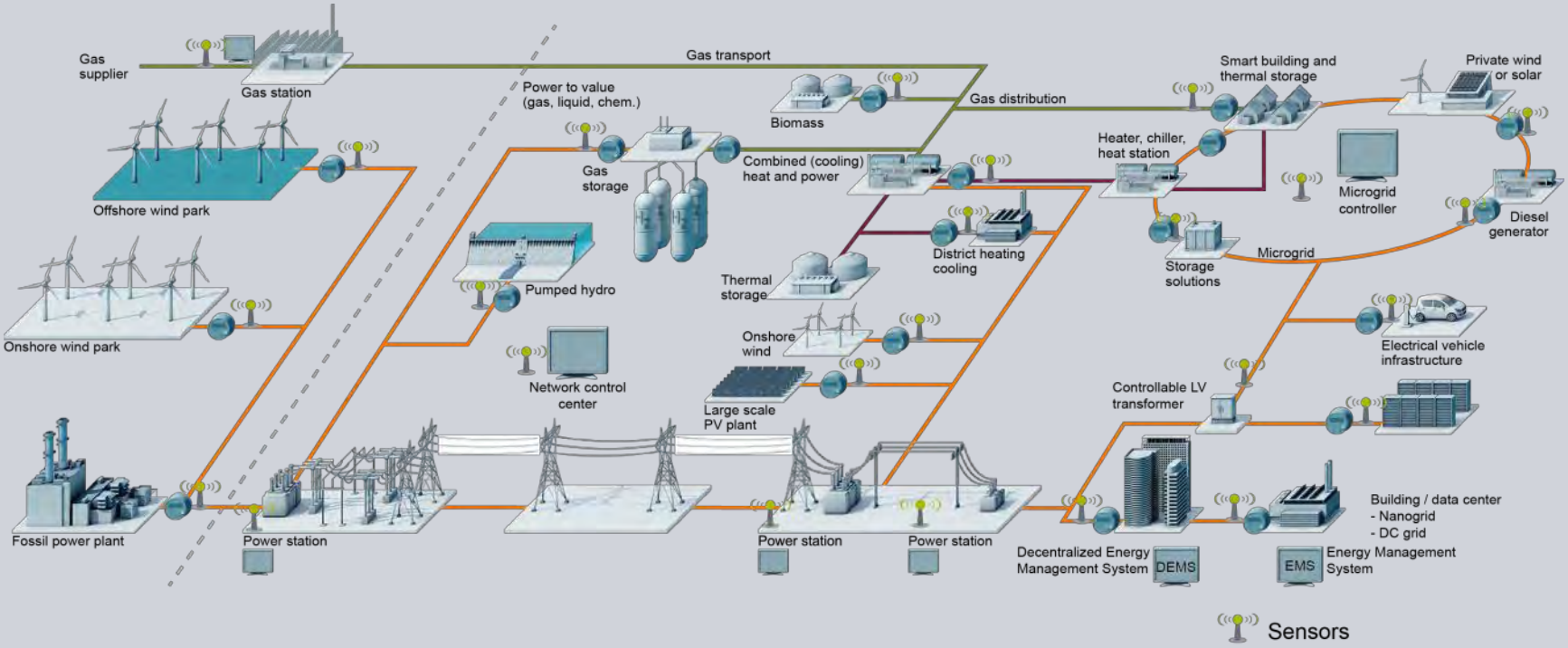


**More electrification**

- Further development of electrification levels in emerging economies
- Grid modernization required in many regions

**Distributed generation**

- Increasing level of renewable and distributed generation
- Grid stability challenges

# Siemens Energy Management lives up to future challenges with the most comprehensive portfolio

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Large power generation | TSOs | DSOs and municipalities | Distributed generation | Oil and gas | Industries | Infrastructures / construction

Digitalization

## Software/IT

Grid control – big data analytics – grid application

Automation

## Communication, automation, protection, and field devices

Electrification

## Electrification solutions

High-voltage direct current (HVDC) transmission – grid access – FACTS – air-insulated/gas-insulated substations – power systems solutions – microgrids / nanogrids

## Products and systems

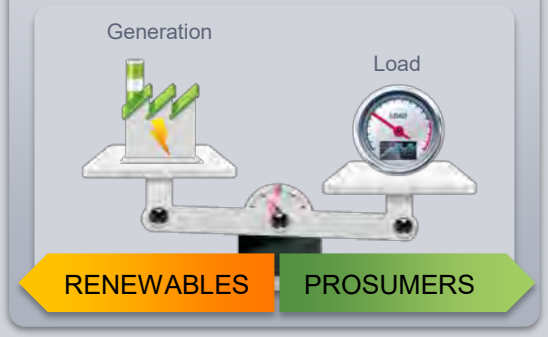
High-voltage switchgear and systems – power transformers – medium-voltage switchgear – distribution transformers – low-voltage circuit breaker

Services and security

[1] Transmission system operators [2] Distribution system operators

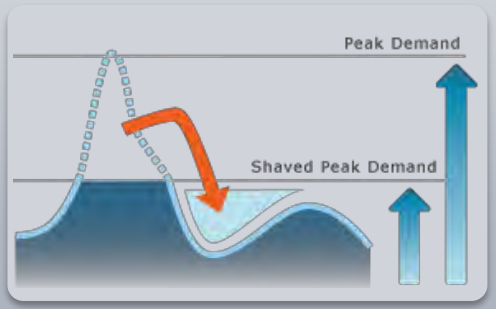
# What problems are we trying to solve?

## Integrating Renewables

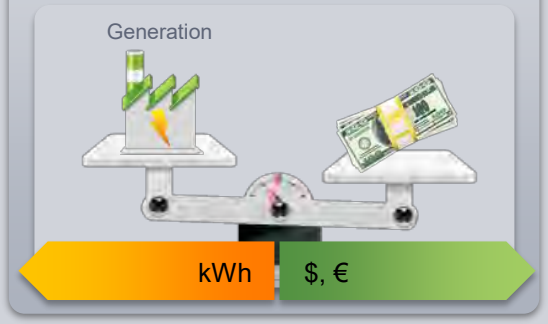



## Customer Operations


## Load Shifting




## Reduction of System Losses

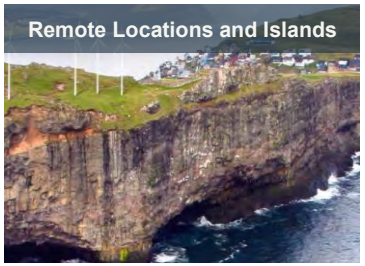



## Outage Prevention / Restoration

## Efficiency

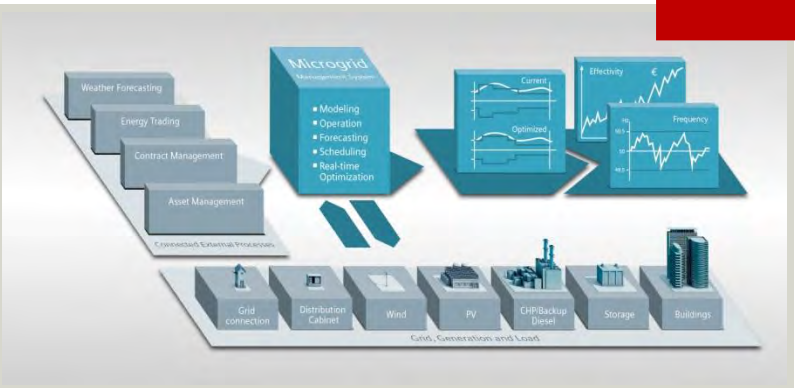
# Renewable Integration => Microgrids

- Increasing installation of renewable energies
- No clear direction of power flow
- Violation of voltage limits
- Overload situations
- Observability improvement
- Volt-/VAR management
- Capacity management




- **Reliable network operation** in diverse scenarios
- **Inclusion of all network assets**, distributed generation, storage systems and loads
- **Modular,** allowing a flexible and scalable structure
- **Forecasting and planning** of generation and loads
- **Load Frequency Control**
- **Real-time optimization**



# Outage Restoration : Infrastructure Age 50+
# Down Times in MV Distribution Networks

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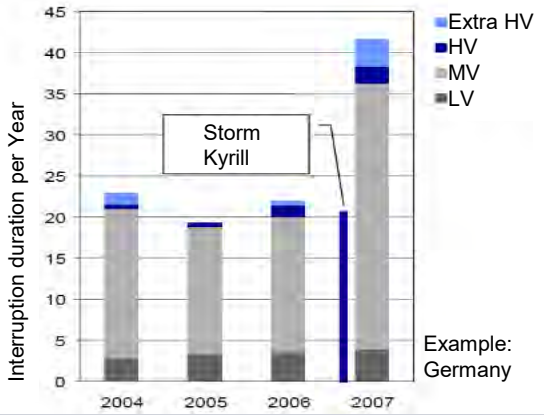
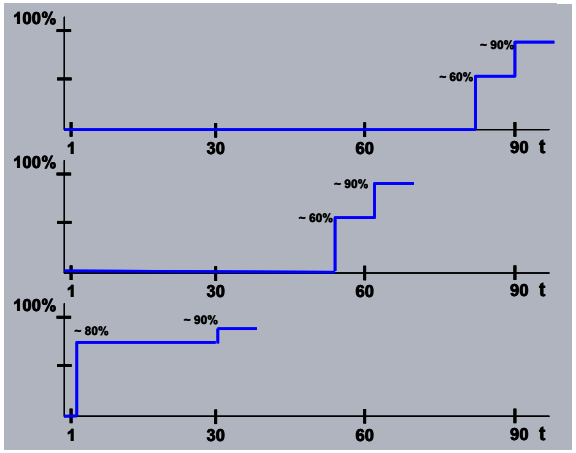
Many times, outages in the distribution automation are caused by components older than 50 years.




Interruption frequency ➔ Modernization of the distribution network on the long run

Interruption duration ➔ Distribution Automation / Feeder Automation




Typical distribution network

Fault indicators

**Distribution Automation**

**Smart IED**
**SICAM 1703 emic**

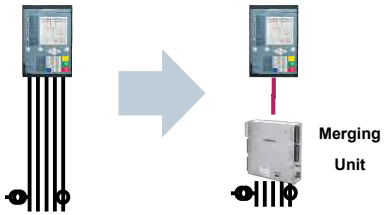
Loss of revenues
Need of high personal resources
High travel expenses

Reduced loss of revenues
Reduced personal resources
Medium travel expenses

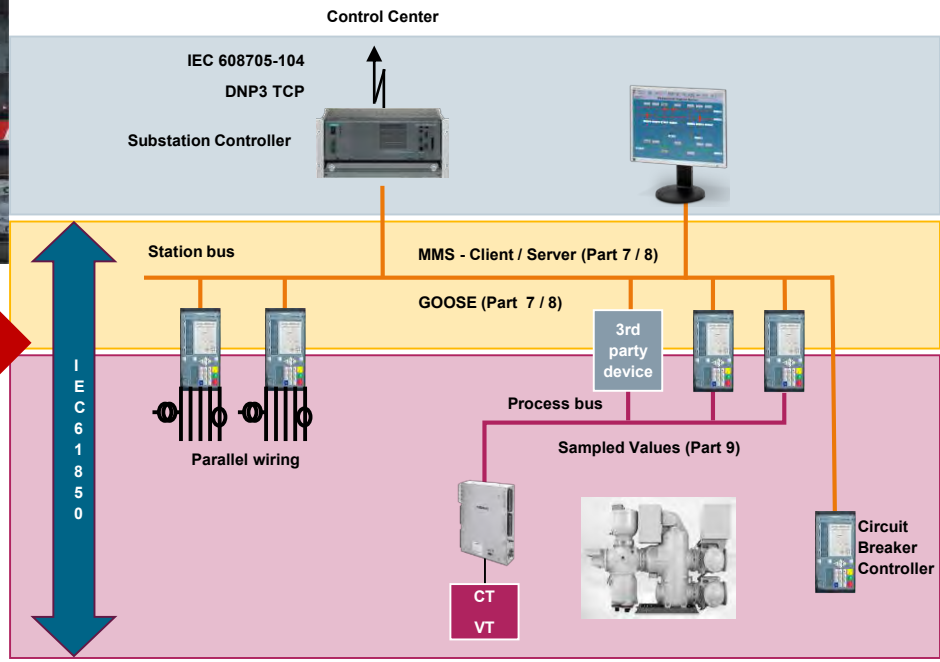
Minimized loss of revenues
Lowest need of resources
High customer satisfaction
Basis for further network optimization

# Robust Substations : “Process Bus”

1. Replacement of hard wires with communication links




2. Use of smart instrument transformers


## Why there is “Process Bus”?

Several drivers have propelled the development of the process bus technology and the standards related:

- Seek for space and cost reduction in existing and new power system facilities
- Continuous improvement of the security for personal and assets
- Fast evolution of the Ethernet technology
- Usability of new digital technologies (i.e. Instrument transformers)
- Simplification of installation and maintenance of the field – bay interface

# Demand Side Management

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**From**

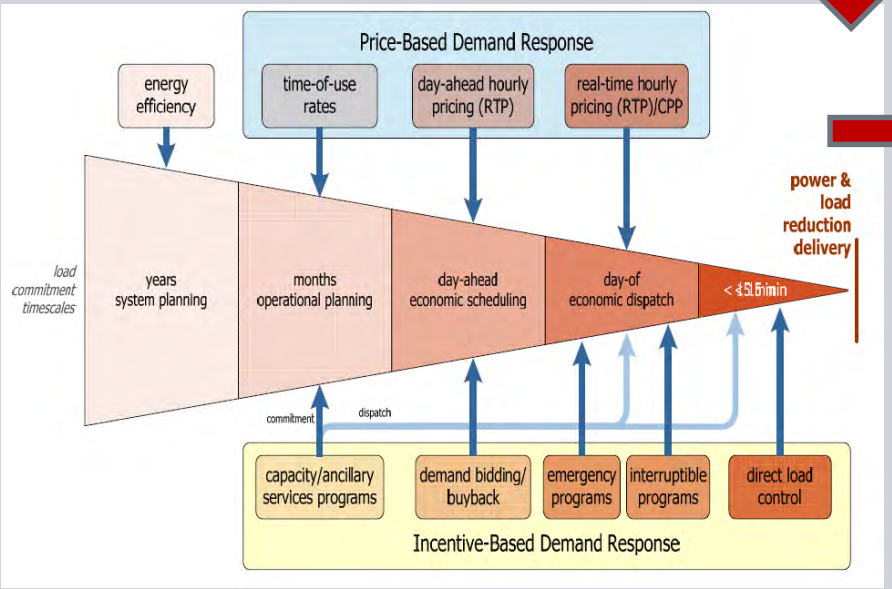
Optimization of building life cycle efficiency as a standalone process

**To**

Active participation of buildings in the grid as consumer, producer, and energy storage facility

**What's necessary?**

- Active management of power generation and loads within buildings
- Advanced metering concepts
- Integrated communication of Smart Grid management systems with individual smart buildings
- Innovative energy contracts (e.g. flexible tariffs)




**Price -based**

- Desired results are slower to achieve since it is linked to direct response from consumers
- Sustained awareness necessary to reach targets
- Not predictable depending on the customer base

**Incentive-based**

- Transparent incentive for participation
- More popular because consumers are paid each month regardless of whether DR event is called or not
- More active tool for load serving entities, utilities or grid operators to manage costs and maintain reliability- minimises brown-outs/blackouts, savings in building additional infrastructure

**MANUAL**
- Labour intensive
-Switching off lights/eqpt

**SEMI-AUTOMATED**
-Controls for load-shedding
- Person initiates pre-programmed strategy through BMS

**FULLY-AUTOMATED**
-2-way communication with consumers
-Open, inter-operable industry standards in control & communication technologies

# Utilities are on the big data and digitalization journey like other industries

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**40 zettabytes** of digital data in 2020

IDC prediction

**26 billion** IoT physical connected units by 2020

Gartner prediction

**$2.9 billion** investment in Energy and Chemical industry by 2013

Booz & Co

**~ 75 million +** connected smart meters around the globe

One Siemens large NA customer has already reached **32 terabytes** of data

Utilities are already collecting 100's of **gigabytes** and **terabytes** of data from smart meters and it will **increase sharply** due to additional telemetry from the distribution grid and distributed generation. **Utilities will soon need to manage petabyte of data**

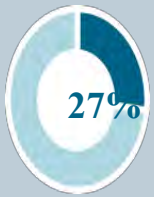
**Zpryme Survey 2014 of 115 North American Utility Executives (sponsored by Siemens)**

Utilities have ambitious plans for the next 12 months

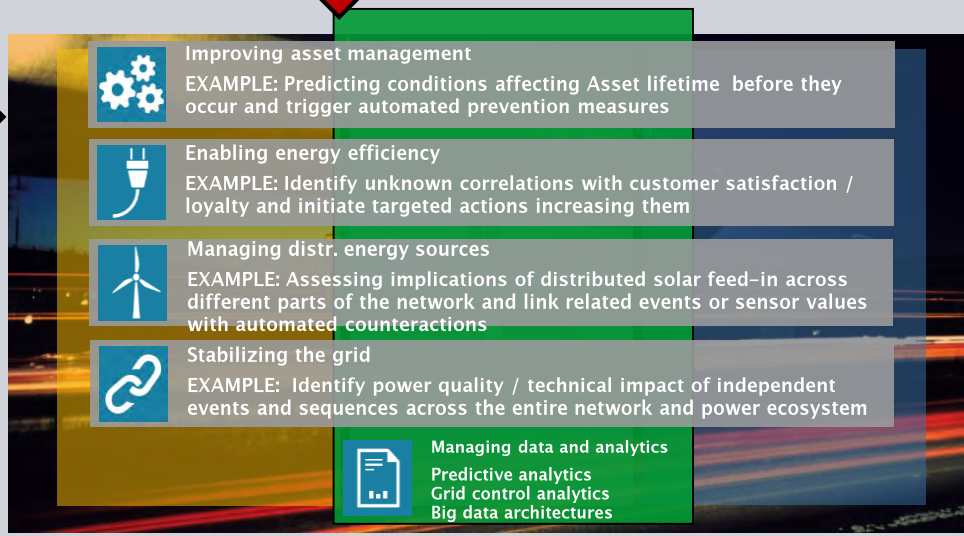

Improve outage management process


Track and monitor grid assets


Understand consumer energy consumption choices




Provide additional services to consumers



# OT / IT Landscape
# Pre- Smart Grid Utility Applications

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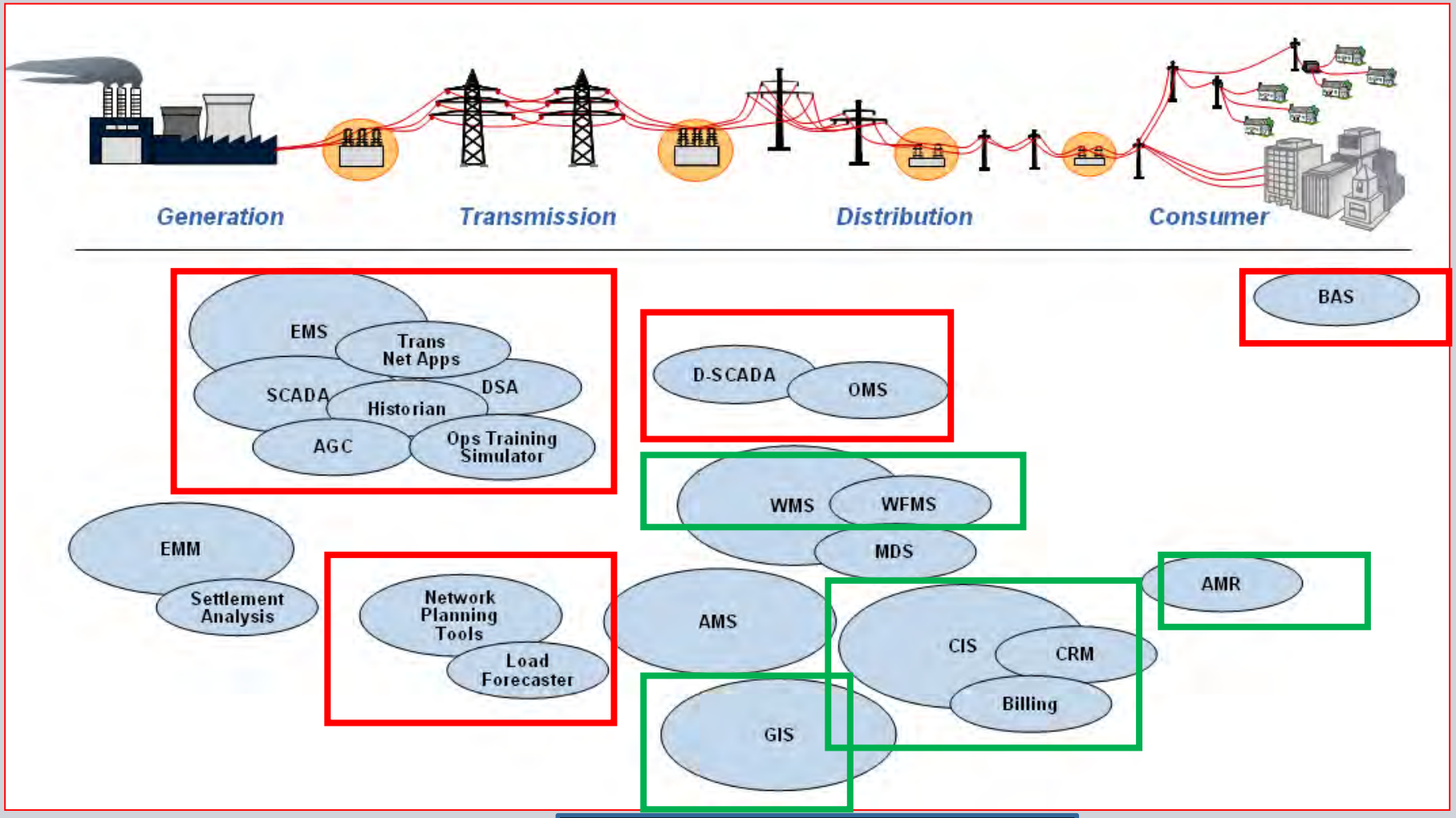
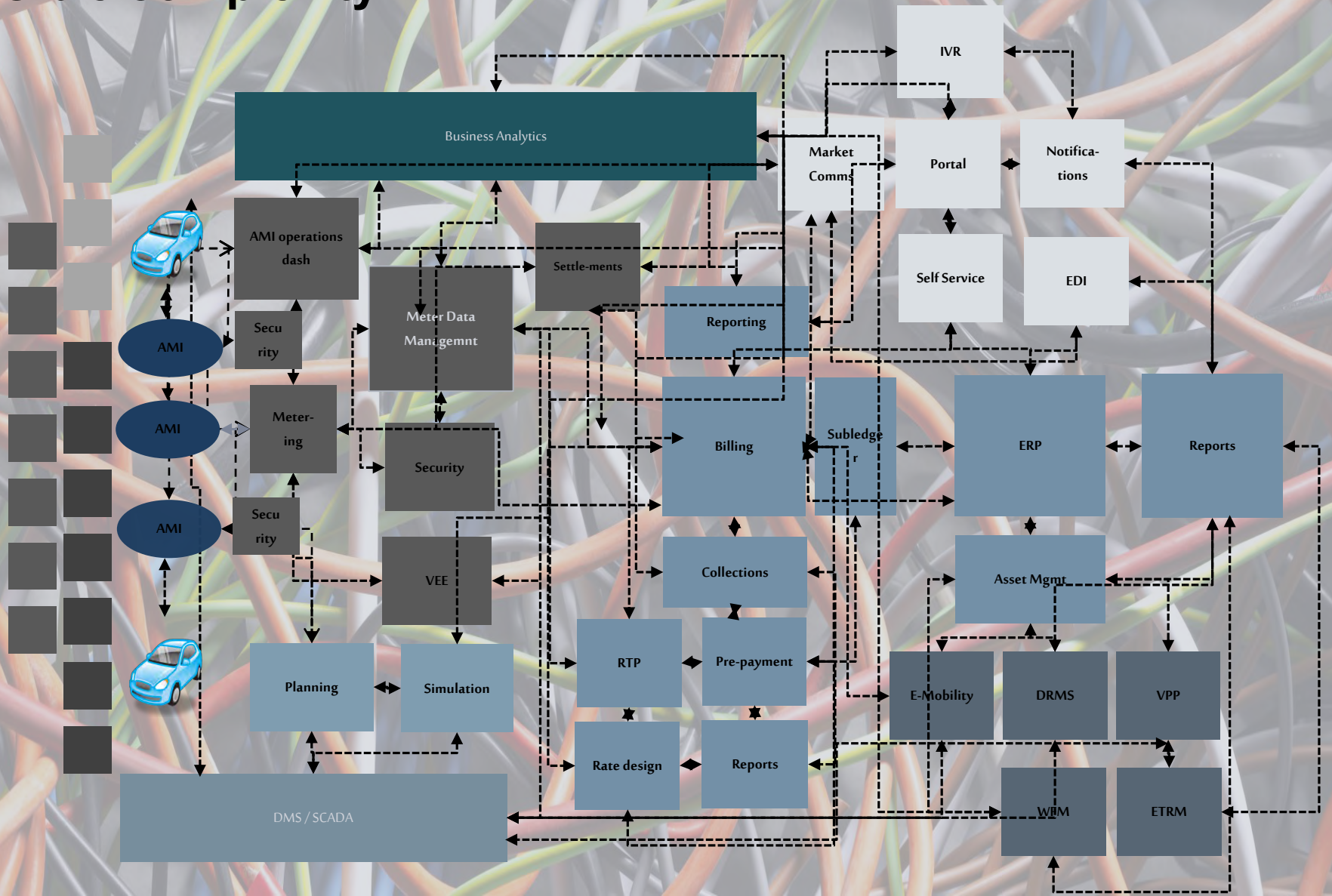


# Adding application on application and silo thinking leads to infeasible complexity



# OT / IT Implementation Startegy :
# Post- Smart Grid Utility Applications

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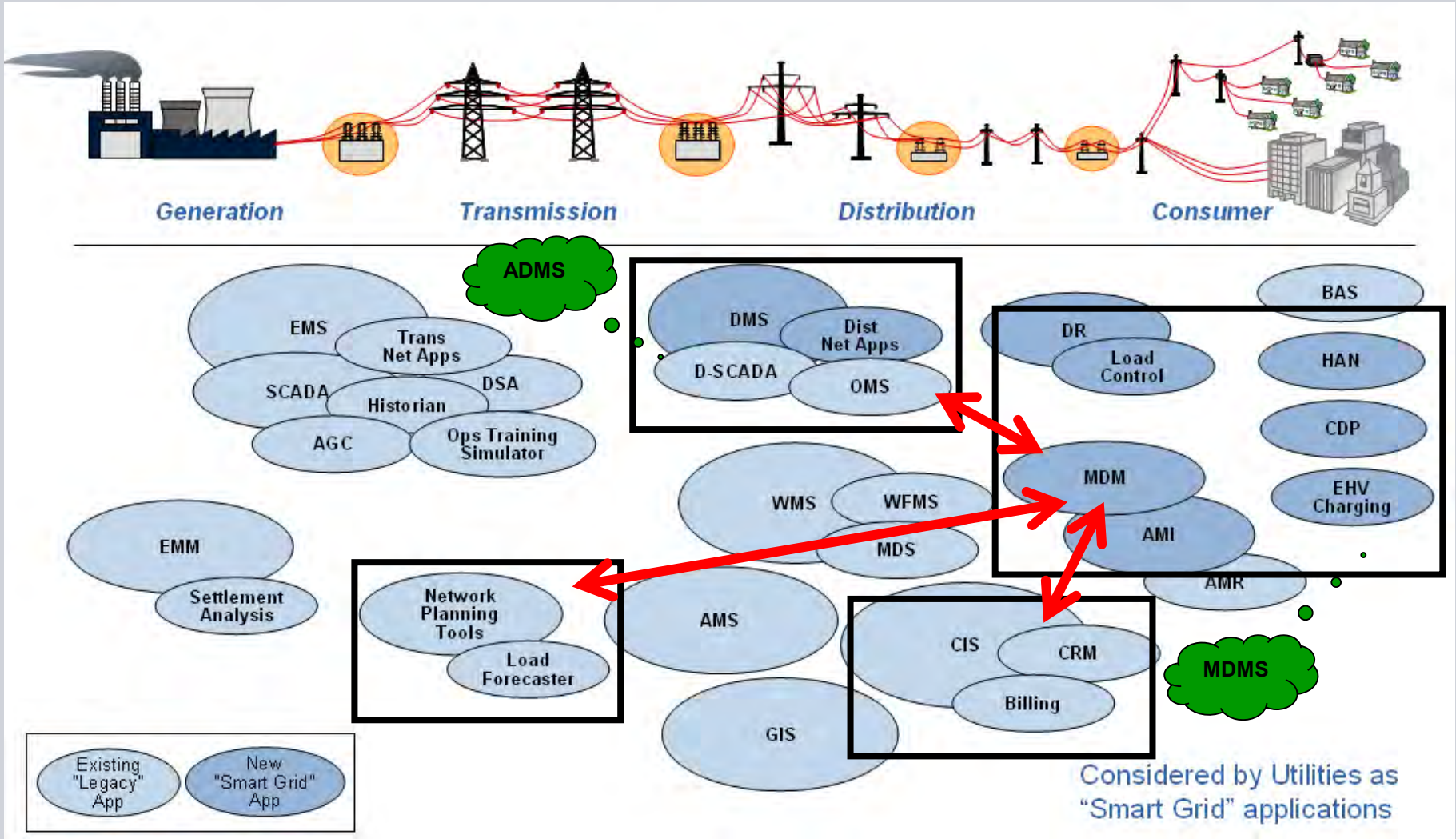
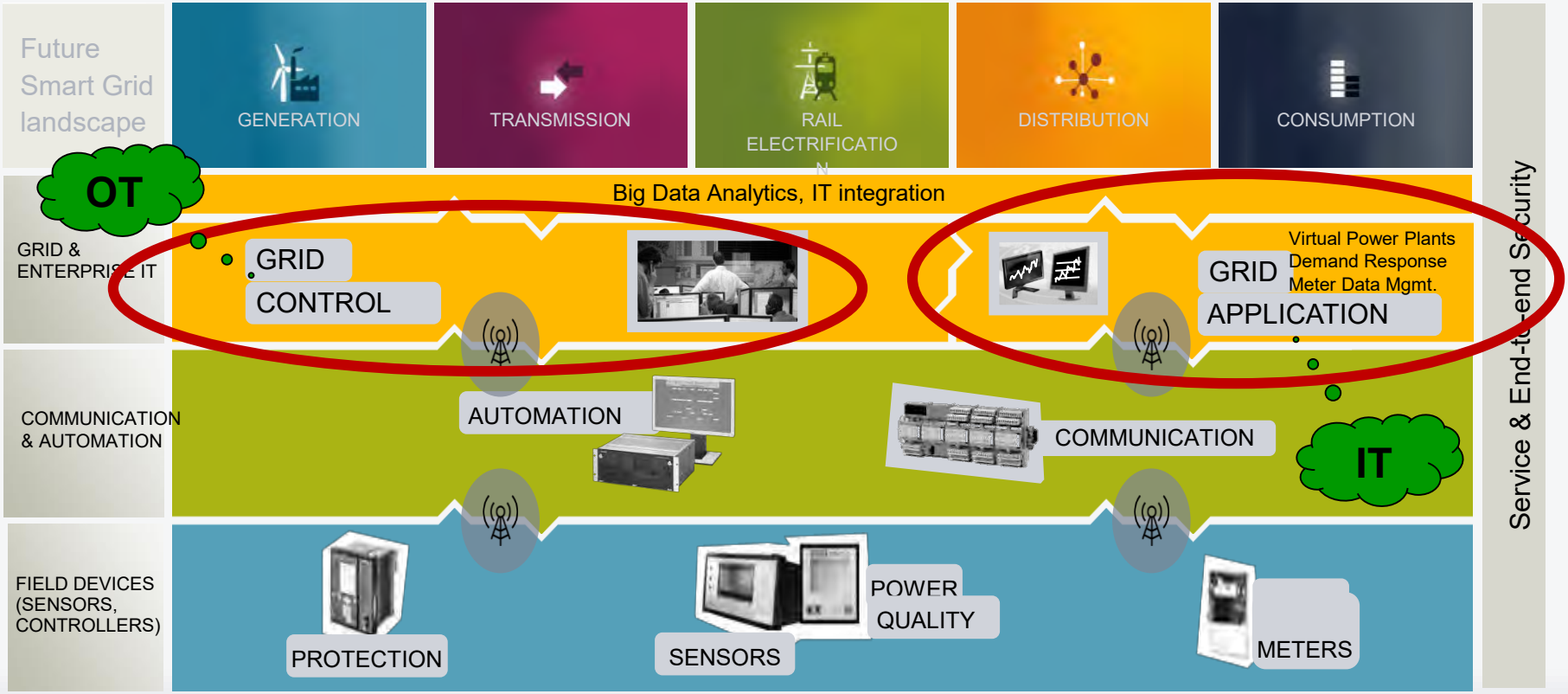
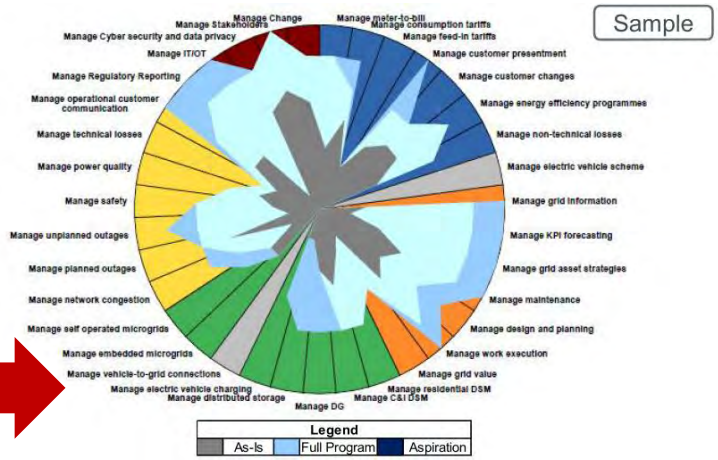


# Smart Grid IT/OT Infrastructure



# While the Smart Grid concept is accepted, some questions will still remain……


| Orientation | Destination | Routing |
|---|---|---|
| **Where do I want to go?** (strategy) | **What does make sense?** (qualitative design) | **How do I realize it?** (quantitative planning) |
| ▪Which objectives do I want to achieve?<br>▪Which levels of process sophistication do I aspire? | ▪What is the perceived value of the initiatives?<br>▪What is the required effort to implement initiatives and technologies?<br>▪Which scenarios end up with a positive business case?<br>▪What budget should I plan for the coming years? | ▪Do the numbers make sense?<br>▪Which steps do I have to take in which timeframe?<br>▪Which skills do I need?<br>▪How can I integrate existing programs? |



# Thank You!

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