Choose certainty.
Add value.

The Integration of Wind Energy and Photovoltaic into a Smart Grid

Hannover Messe, 24 April 2012

Dr. Kai Strübbe, Head of Embedded Systems, TÜV SÜD AG

Agenda

1) Current Situation in Germany

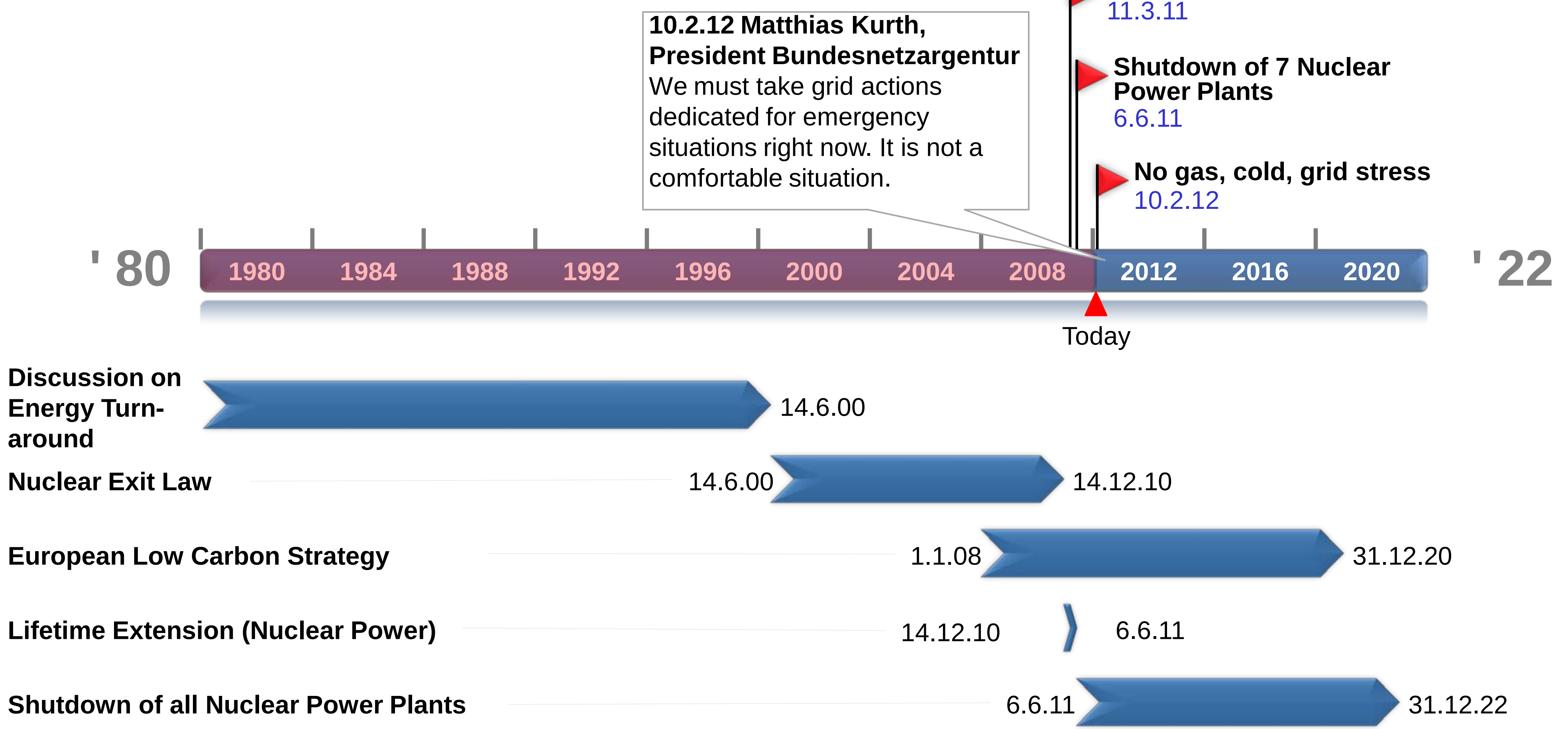
2) Integration of Wind and PV Power

3) Key Success Factor – Embedded Systems

4) Future State and Required Expertise

We are running out of time – only 10 more years to success

Timetable until replacement of nuclear power in Germany



Energy Turnaround Serves as a Motor of Change

Current state in Germany:

Energy production and consumption are changing

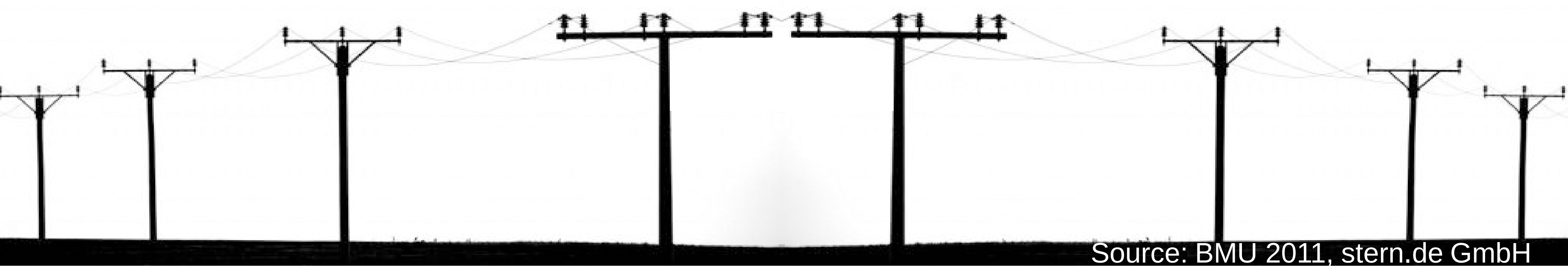
- Goal: 50% renewable energies by 2030
- Energy production:
  - *remote* from load centres: large plants (offshore wind, hydro)
  - *decentralised*: small plants (PV, bioenergy)
  - *volatile* (wind and PV)
- New consumers: eCars, charging stations

Current Grid Architecture Lacks Flexibility

Current state: production, lines, storage

- 20% of electricity currently produced by renewables
  (of these: wind 38.1%, PV 15.6%)

- Base-load-capable power plants near consumers (50-70 km)
- Production follows consumption
- Few supra-regional electricity lines
- Little energy storage capacity and little grid control options



New Systems Need to Contribute to Grid Stability

Wind/PV systems must prove grid compatiblity

- Grid compatibility as a requirement for connection
- Key documents: type and wind farm certificates
- Goal: predictable behavior in the grid

Criteria (examples):

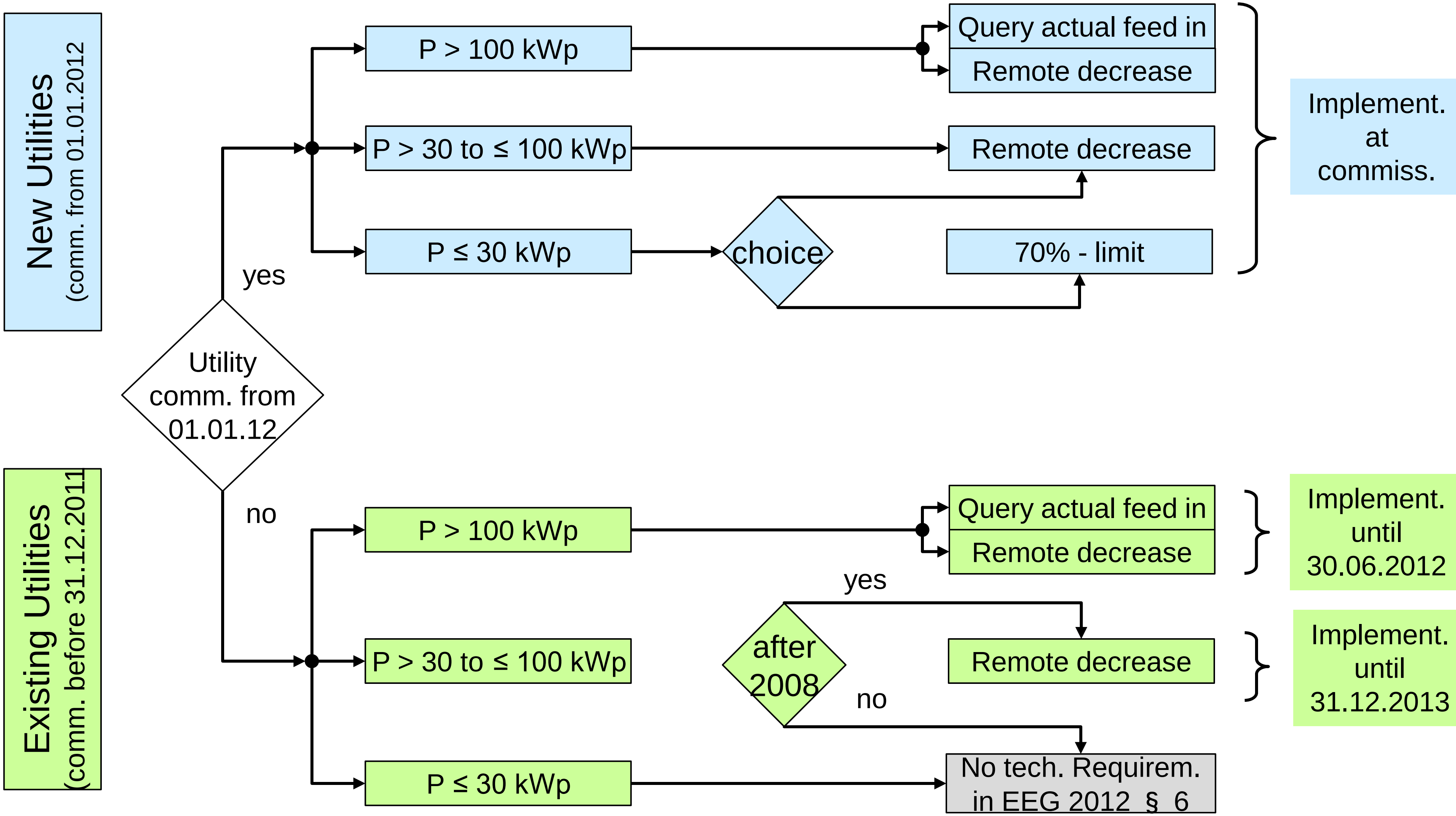
- Short-circuit resistance
- Permanent loading
- System perturbation
- Dynamic grid support
- Provision of reactive power
- Protection from decoupling

Relevant regulations:

- TransmissionCode 2007
- BDEW-regulation
- FGW-regulation
- VDE 4105

Additional interventions of grid operators from January 2012

Technical requirements for feed in management of PV-Utilities (EEG 2012 §6 and §11)



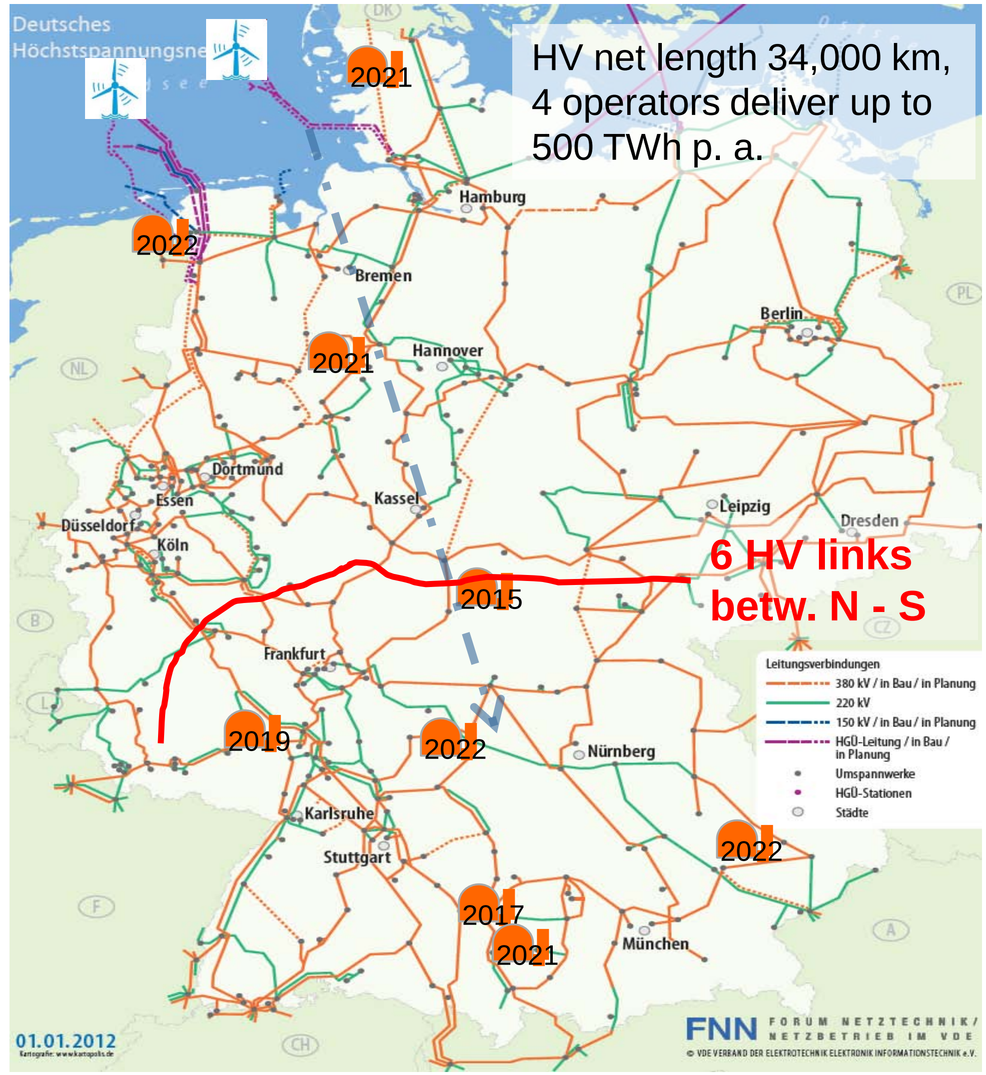
Source: VBEW

More Wind/PV Systems Require Significant Changes

Paradigm shift in the energy sector:

- 2-4,000 km of new lines to connect offshore wind parks
- Distributed across geographical boundaries
- Energy storage: pumped storage, hydrogen, batteries

Performing “open heart surgery” while business is going on.



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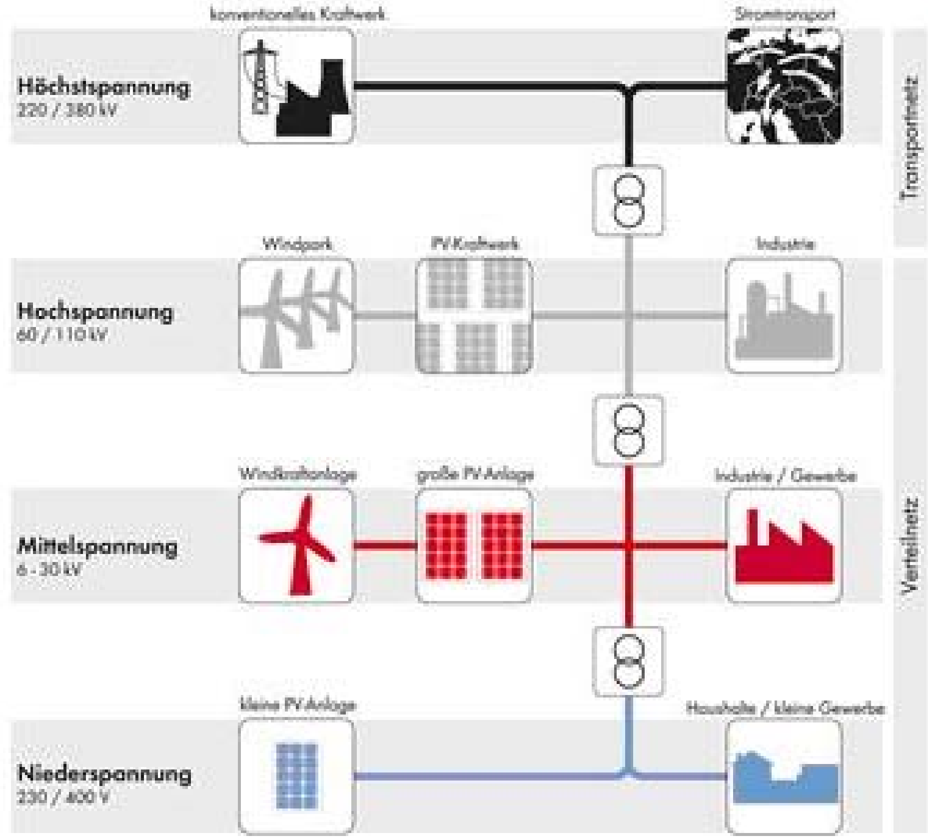
Large Parts of the Grid are not Controllable yet

High, medium and low voltage grids in Germany

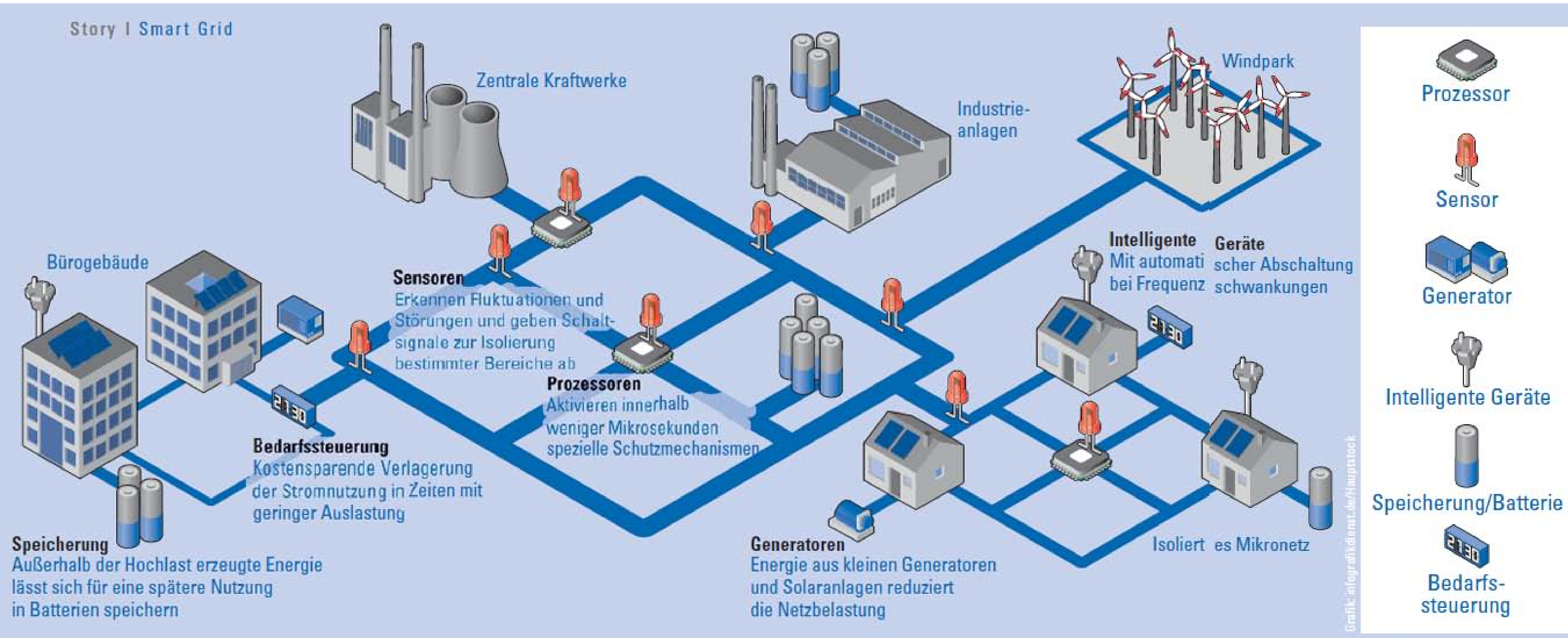
- **High voltage networks**
  (380-220 kV, 1,000+ substations)
- **Medium voltage networks**
  (60-6 kV, 50,000+ substations)
- **Low voltage networks**
  (400 V, 1,000,000+ substations)



Source: dena

Wind/PV as Part of a Smart and Controllable System

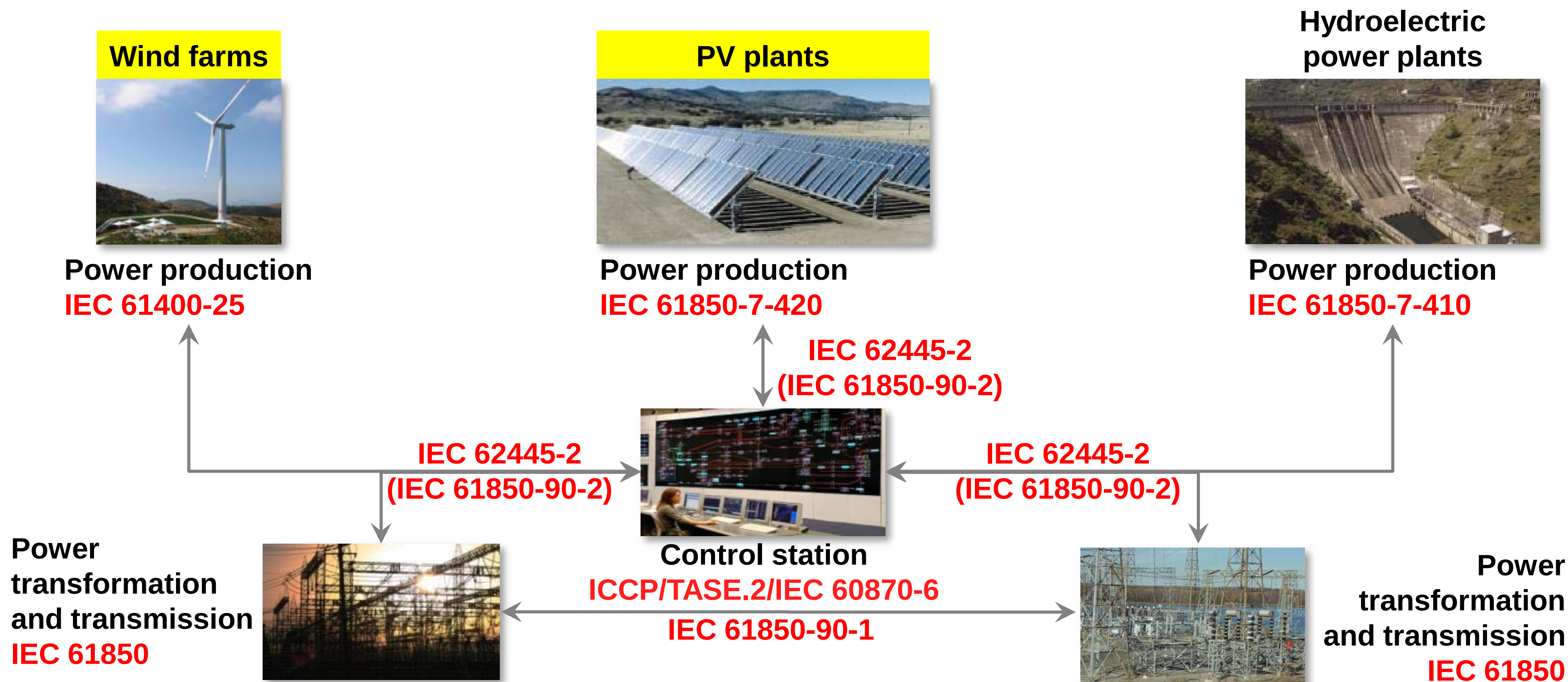
Study on grids of the future for TAB Deutscher Bundestag



Communication Protocols Enable Virtual Power Plants

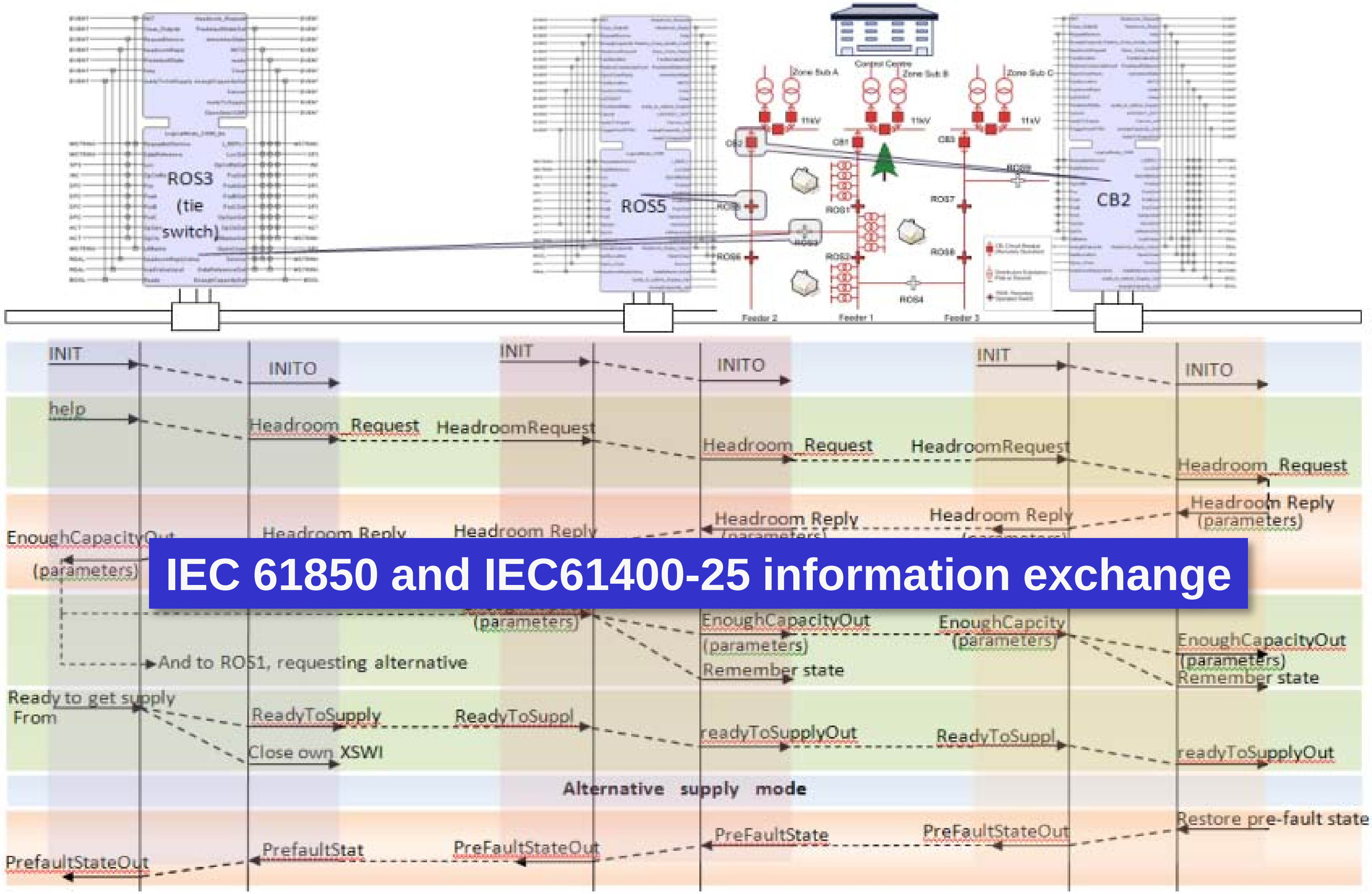
Virtual power plant concept

- *Goal:* distributed energy networks run by a main control facility
- *Benefits:* fast tracking/correction of load peaks



Source: CITCEA-UPC

The Smart Grid of the Future Will Be Self-Healing



IEC 61850 and IEC61400-25 information exchange

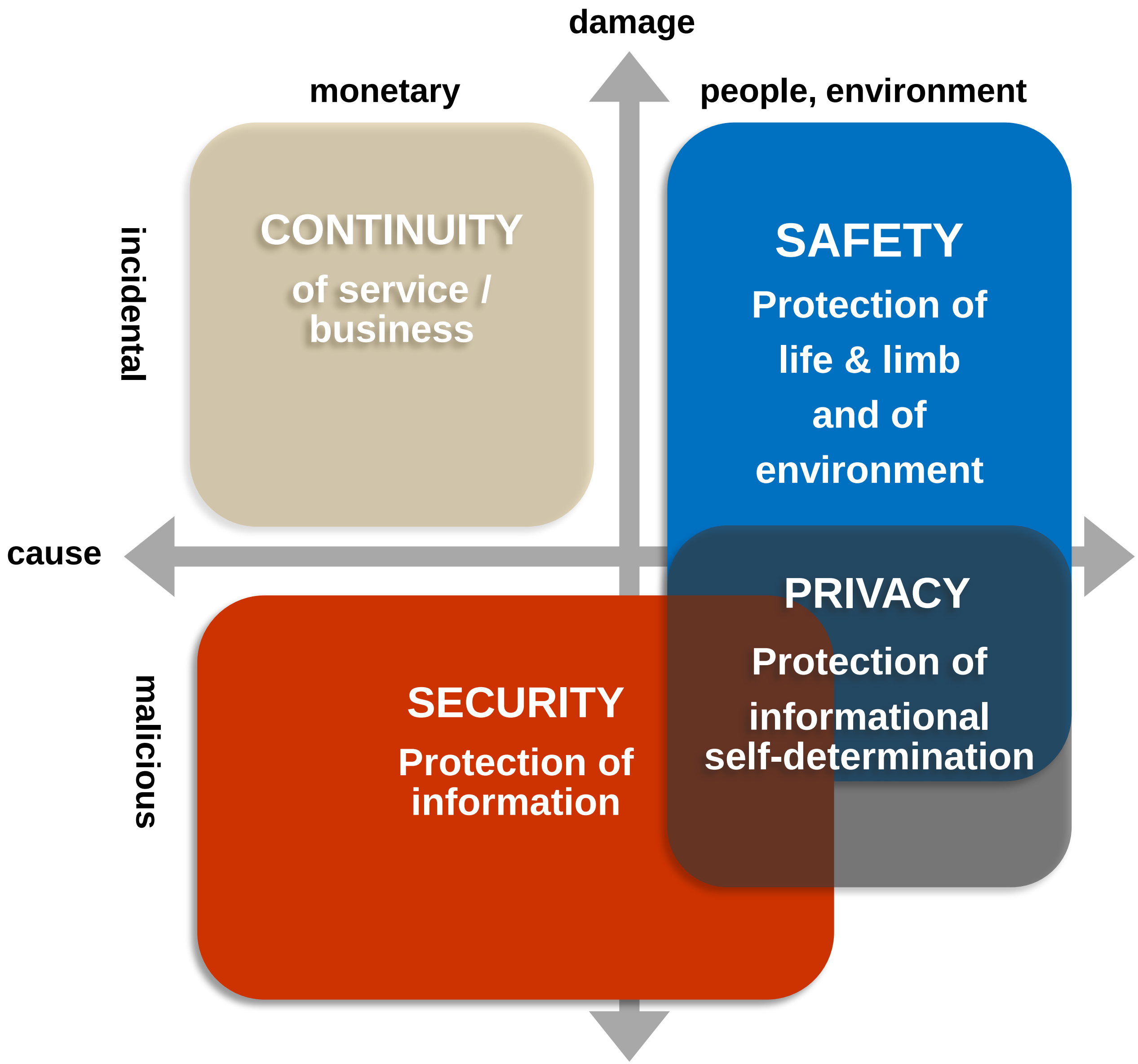
Source: © 2004-2011 NettedAutomation

IEC 61850 Will Be the Esparanto of the Smart Grid

One language for all components: the IEC 61850 in a nutshell

- Communication standard, not just a protocol
- Uses and defines *data objects* (3,000+), *naming conventions*, *semantics, information models* (400+)
- Information exchange between IEDs (*Intelligent Electronic Device*) from different manufacturers
- Provides *information exchange services*
- Based on *Ethernet* and *TCP/IP*
- Standardizes a language (SCL – Substation Configuration Language) to describe topology, information models, etc.
- *Configures IEDs*, defines when and how (service) to exchange information (to/from whom)

Safety and Security – Two Sides of the Same Coin



Classify Risks, Anticipate Solutions

Security challenges…

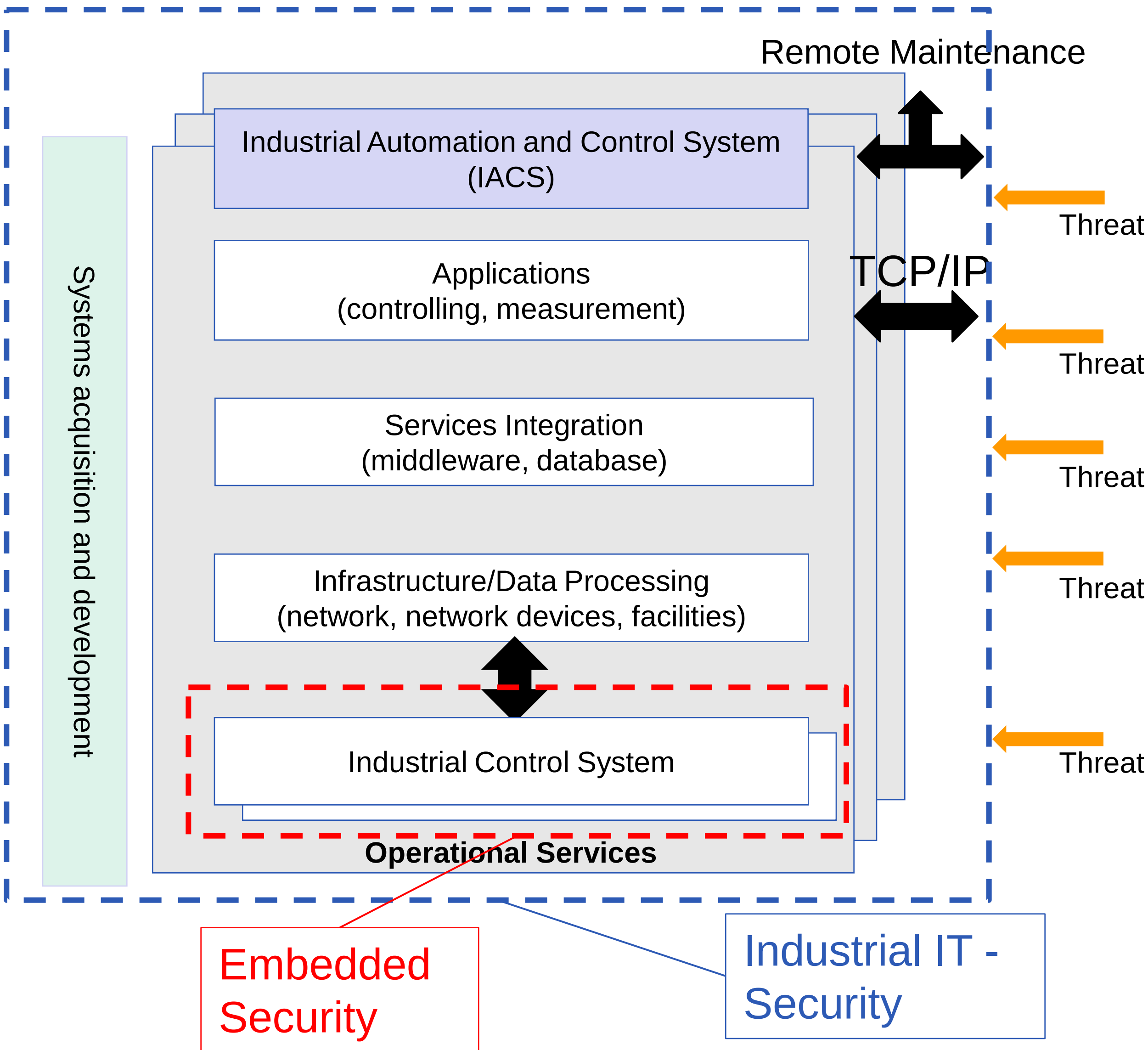
- External threats and attacks
- System stability
- Privacy and data protection

…and solutions:

- Combined hard- and software systems
- Risk analysis (SAL – Security Assurance Level)
- Encryption, anonymization, and pseudonymization of data
- Use international standards (IEC 62531, IEC 62443)

Industrial IT Security as Threat Countermeasure

Type of attacks and main characteristic of market



Market characteristic

- At the very beginning: growing awareness of companies with respect to IT security
- Increasing regulations can be expected
- Lack of know how for design and implementation of security concepts
- Network connection to the Office IT
- Transfer of Office IT Security concepts to the industrial Security are sometimes challenging due to real time requirements
- Different threat scenarios for the different branches
- Target groups:
  - system integrators
  - plant operators

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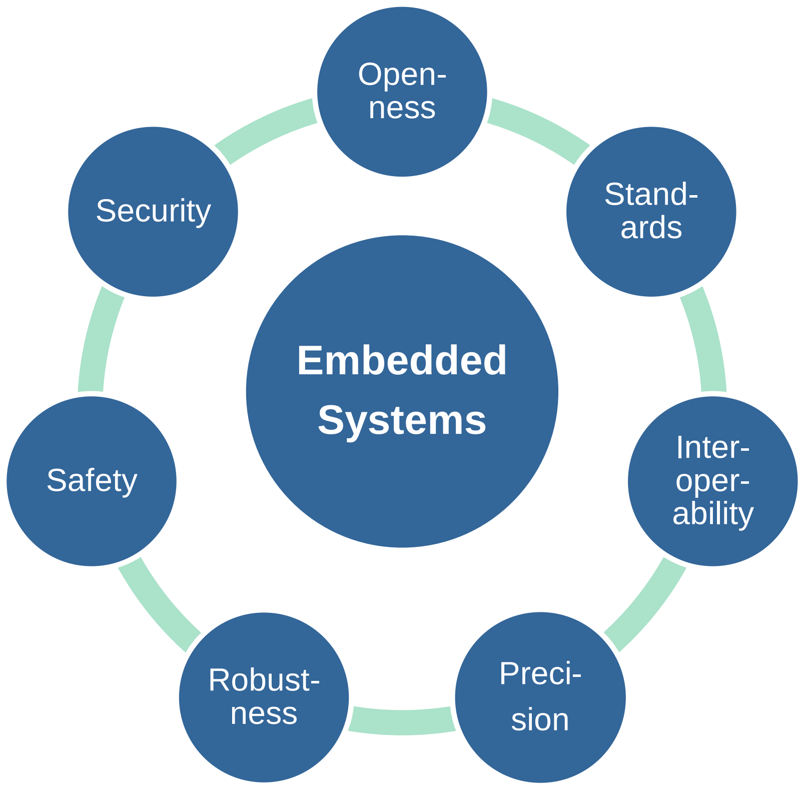
Utilizing Existing Security Solutions

Embedded systems are a key success factor

They form the heart of the smart grid and have been successfully used for years in…

… industry, medicine, telecommunications, automobile, consumer goods…



… providing solutions for:

- Functional safety (automobile)
- Industrial security (military)
- Privacy and data protection (office)

Smart Grid Brings Interdisciplinary Requirements

Communication across all domains:
electricity, data, home, mobility

- Grid needs to transport energy *and* information

> Energy- and Information-Net<u>*www*</u>ork → Smart Grid

- Integrating the behavior of all network participants

> Smart Grid and Smart Home grow *together*

- Utilizing storage capacities of consumers:

> i. e. electric cars, heating and climate control

Sectors are merging:

energy technologies, automation, infrastructure, IT, building and construction industries…

Smart Grid Requires Significant Efforts

TÜV SÜD supports the ENTSO-E statement on the IEC 61850

European Network of Transmission System Operators – Electricity:

- Instantaneous interoperability to be improved (vendor combinations)
- Needed: top-down approach using standardized third-party tools
- Different suppliers have to implement standards in the same way
- High degree of standardization, backward compatibility of the standard
- Interoperability over lifetime crucial for protection/control applications
- Innovation to optimize the “quality of services” and “solution costs” ratio

Source: 50Hertz Transmission GmbH

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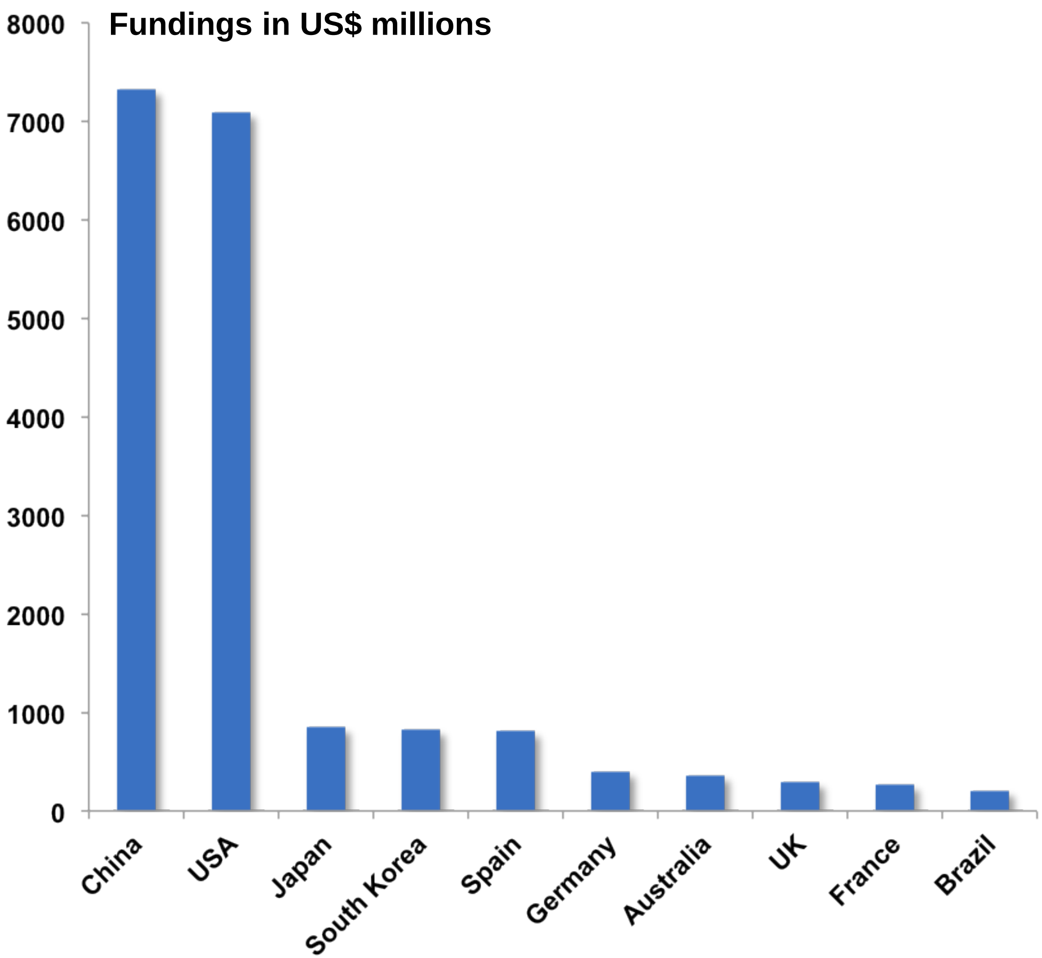
China's Investment Surpasses the USA's

Overview global smart grid markets

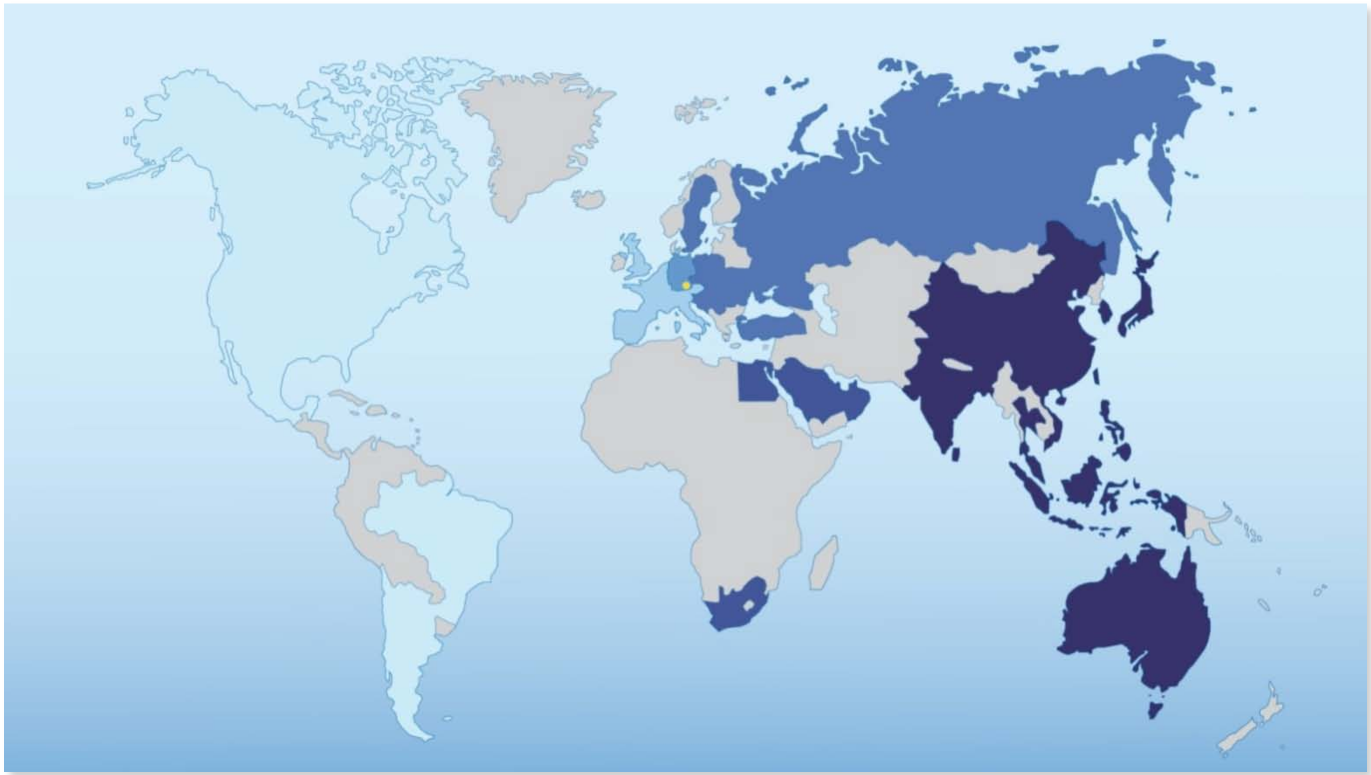


Source: Zpryme Research, 2010

- **China**
  - Top spending market
  - $ 10 billion p. a. through 2020
  - 360 million smart meters by 2030
- **Smart Grid investments**
  - 99 billion in China and
  - $ 7.18 billion in South Korea over the next decade
- **Japan**
  - expected to launch pilot smart grid programs this year

Technical Services Throughout the World

TÜV SÜD – a global partner



AMERICAS	WESTERN EUROPE	GERMANY	CENTRAL & EASTERN-EUROPE	MIDDLE EAST/ AFRICA	ASIA PACIFIC
€ 110 Million[1]	€ 139 Million[1]	€ 1,040 Million[1]	€ 59 Million[1]	€ 10 Million[1]	€ 194 Million[1]

- Success in the market for over *140 years*
- Headquarters: *Munich (Germany)*
- *600 locations*
- *17,000 experts*
- Turnover 2010: *€ 1,552 million*

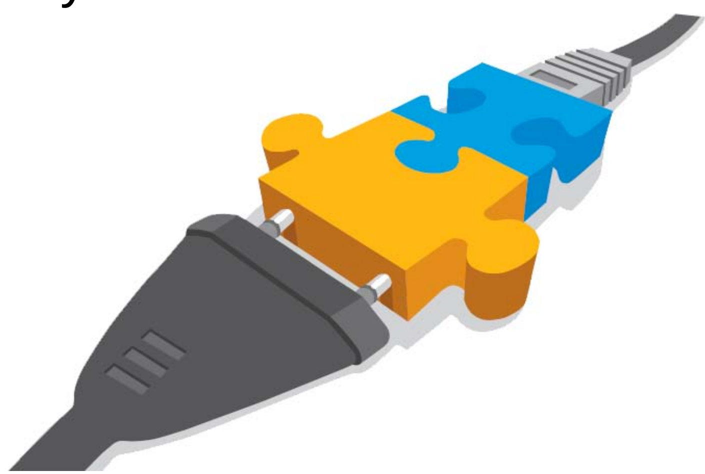
[1] Sales revenue in 2010

Interdisciplinary Solutions for Tomorrow's Grids

TÜV SÜD – Consultancy, Testing, Certification, Training

- TÜV SÜD Center of Competence Smart Grid (incl. IEC 61850 components testing)
- Certification of grid compatibility for wind energy and PV systems (accredited and recommended by DakkS and FGW)
- TÜV SÜD Competence Center of Industrial Security

In addition, TÜV SÜD is an active member of many standardization committees, initiatives and research projects
(e.g. IEC TC 57, IECEE WG Smart Grid, KITS).



Thank you for your attention!

Do not Hesitate to Contact Us

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