What do we need for a secure and future-proof Electricity Grid?

Alexander Nollau

Brussels, 09/03/2024

DKE

Agenda

- VDE - 130 years young
- Relevance of renewables in today's world?
- Challenges and Future Developments
- Essential Components for Future-Proof Grids
- Pathways to a Net-Zero Future

We point the way to
SAFETY, SECURITY UND SUSTAINABILITY.
Since 1893.

DKE

We are over
130 years young
and one of a kind.

The VDE Association for Electrical, Electronic & Information Technologies can look back on a unique success story. It was founded in 1893 with the goal of making the world of electricity a safe one.

Our founding members include
Werner von Siemens

What is VDE?

Over more than 130 years

VDE has developed into a globally unique technology organization combining

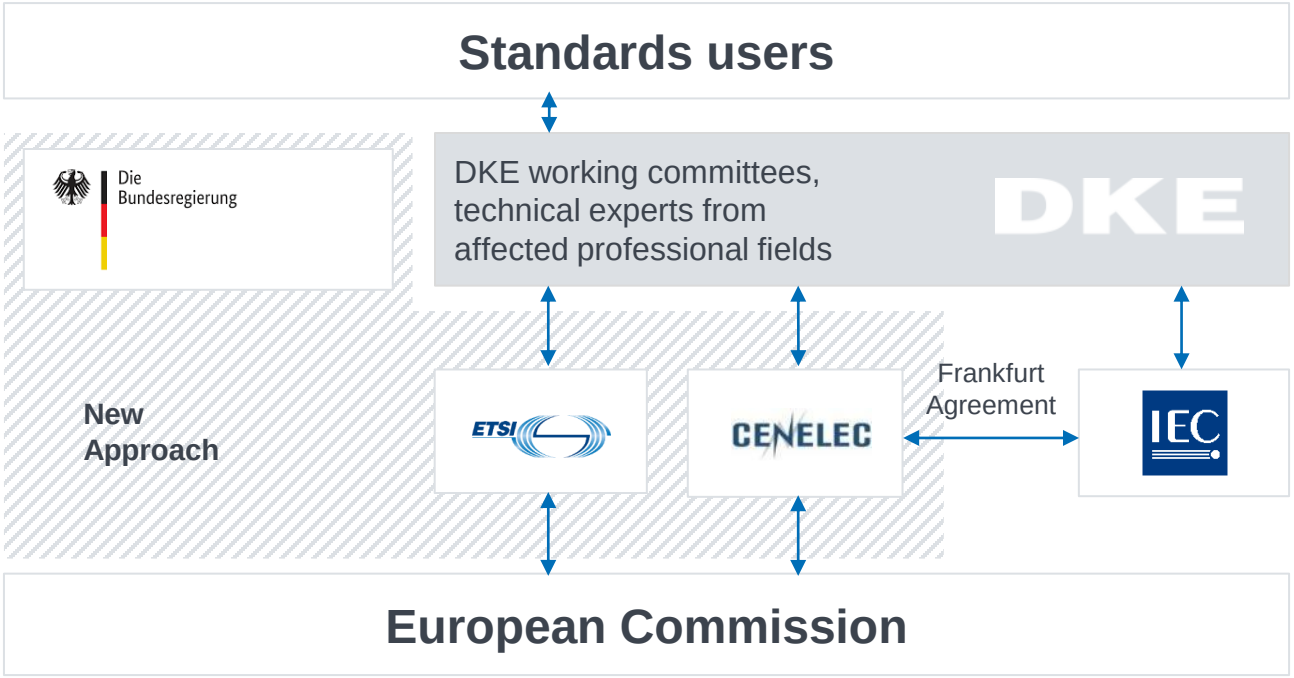
Science

Standards

Testing

under a single roof. Today, it is an internationally recognized powerhouse of expertise for all issues relating to the **electrical, electronic and information technology** industries. Worldwide.

Standardization at European and international level



National

Standardization activities

International European

Representing German Interests in Electrotechnical Standardization Activities (as in 2023/02)

24%[1]
54 secretaries

17%[1]
38 chairpersons

1.250 experts

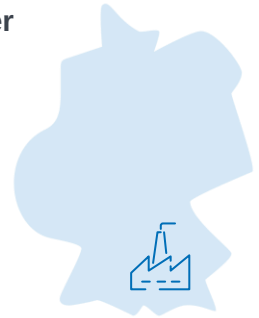
36%[1]
24 secretaries

31%[1]
21 chairpersons

550 experts

NSO

Direct member



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>9,800 experts

1 Percentages relate to all chairpersons and secretaries in the IEC or CENELEC.

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Relevance of renewables in today's world?

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„The difference between 2 and 4 degrees is human civilization. It is as simple as that.“
Prof. Dr. Dr. h.c. Hans Joachim Schellnhuber, CBE
Director Emeritus of the Potsdam Institute of Climate Impact Research

Climate Change / CO_2-reduction

Source: Adobe Stock, MYCHKO

UN Sustainable Development Goals

Source: Adobe Stock Aania

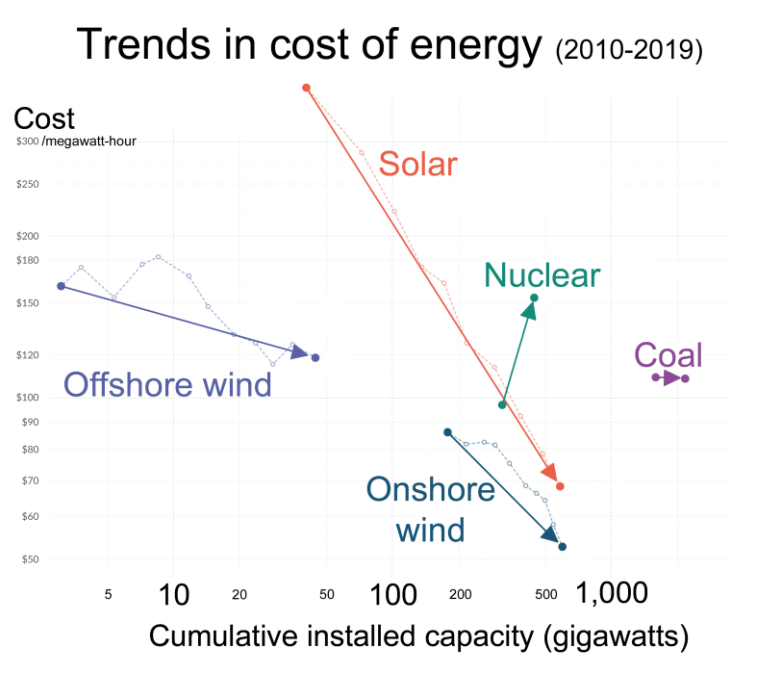
The Energy Challenge

- The world needs more and more energy so that the growing population can live in prosperity and security.
- We must reduce CO_2 emissions in order to survive.
- The quest for clean energy will create a huge economic and technological boost - unlimited clean energy will be the next driver of the global economy.

The Paradigm Shift – Energy in the 21st Century

The Paradigm Shift – Energy in the 21st Century

Levelized cost of generation



- In March 2021, Bloomberg New Energy Finance found that *"renewables are the cheapest power option for 71% of global GDP and 85% of global power generation. It is now cheaper to build a new solar or wind farm to meet rising electricity demand or replace a retiring generator, than it is to build a new fossil fuel-fired power plant. ...* ***On a cost basis, wind and solar is the best economic choice in markets where firm generation resources exist and demand is growing."***

On the way to the
All Electric Society

The All Electric Society envisions a world in which regeneratively generated electrical energy is economically accessible for everybody as the primary form of energy, sustainably powering the growth of our society.

Source: © Collage: HOLON /Graphics: stock.adobe.com 1xpert/ liuzishan

Challenges and Future Developments

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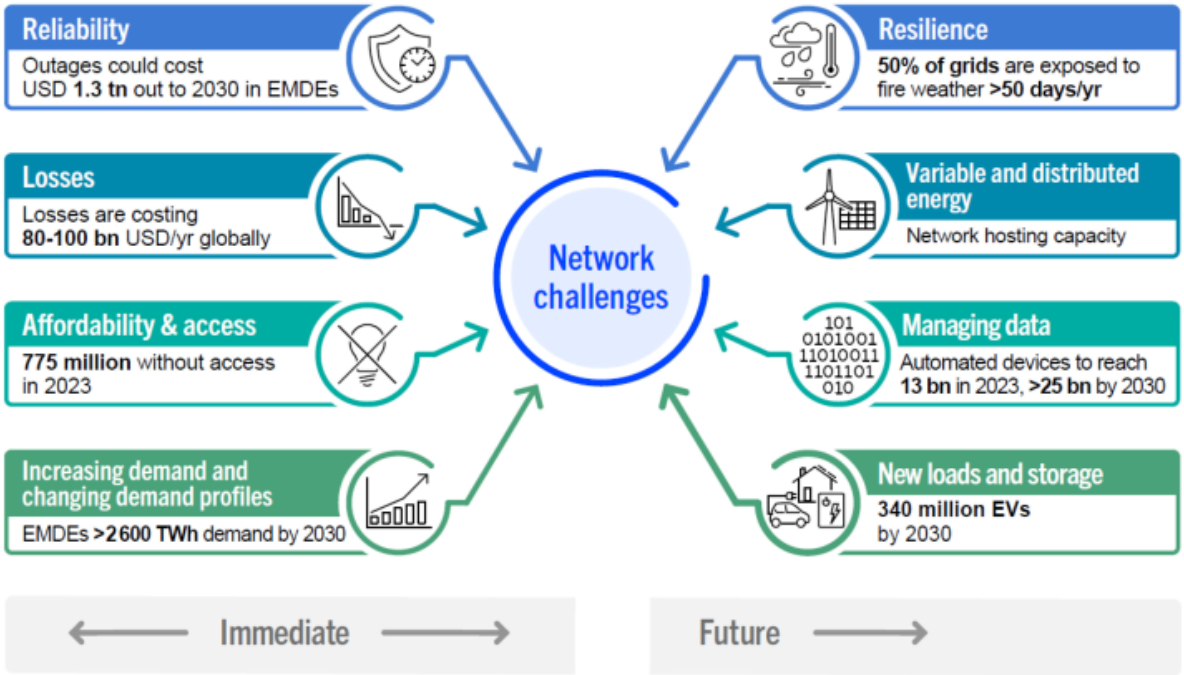
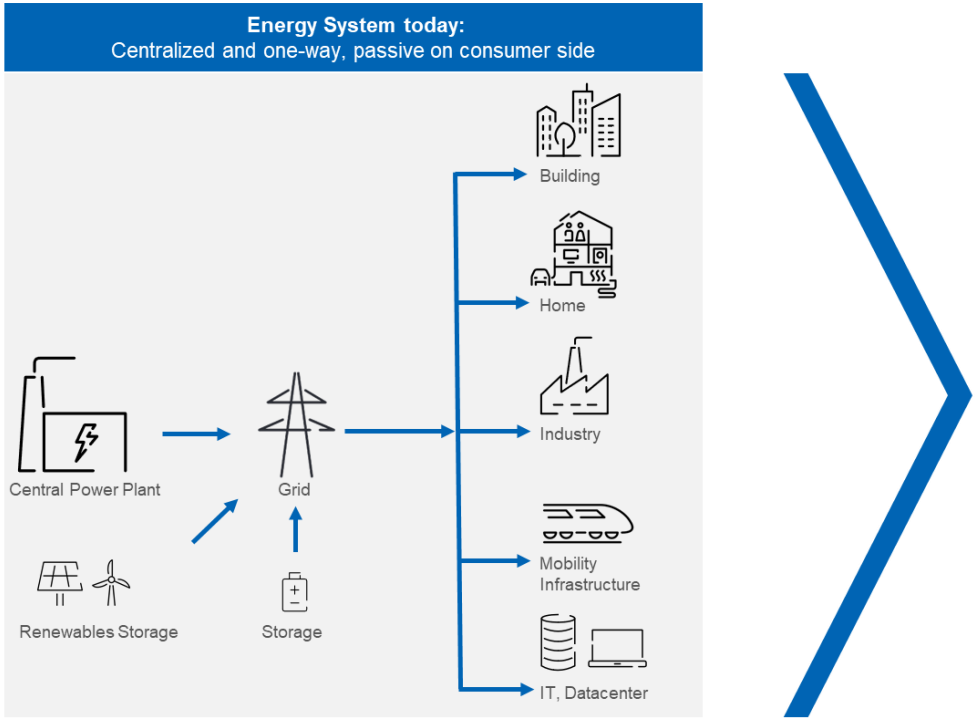
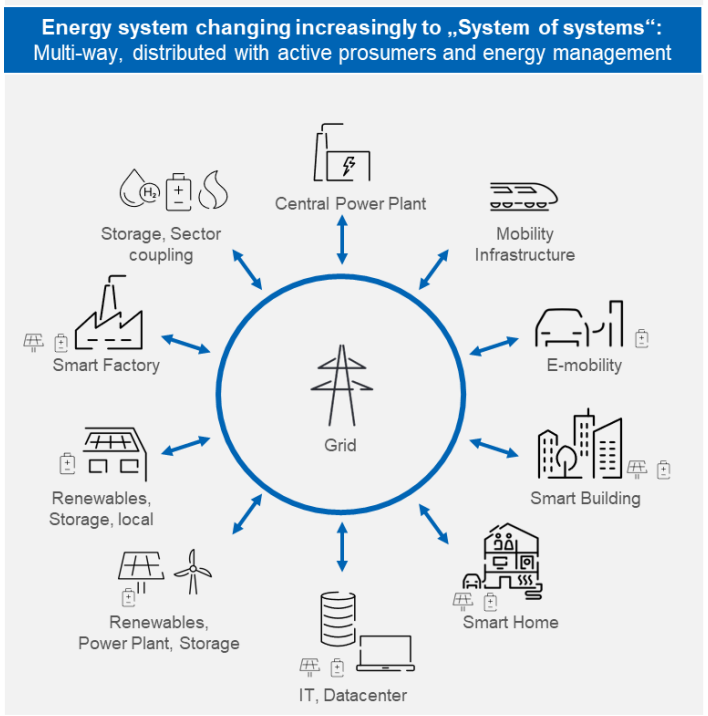
Challenges



From today's linear value chain in the energy system to a network with various possible interactions

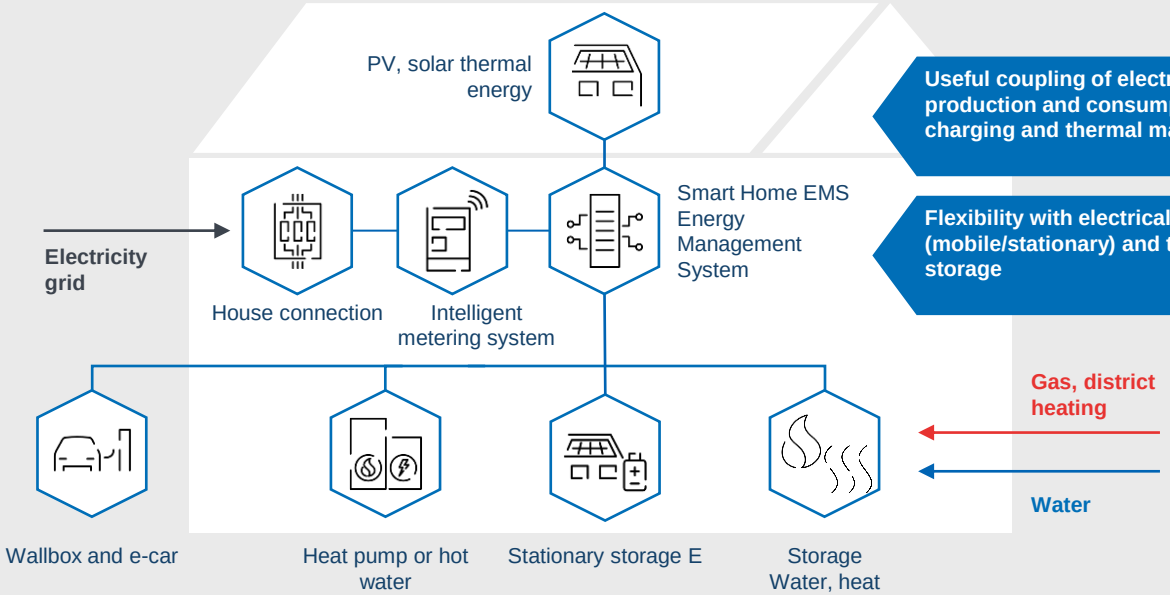




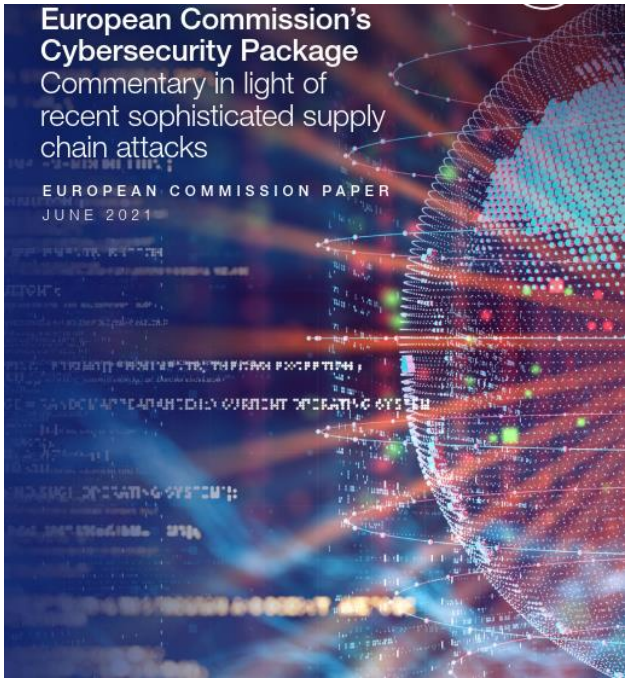
Sector coupling in buildings

Other noteworthy electrical consumers in the building

- Instantaneous water heater
- Air conditioning
- Small wind turbine
- CHP
- …



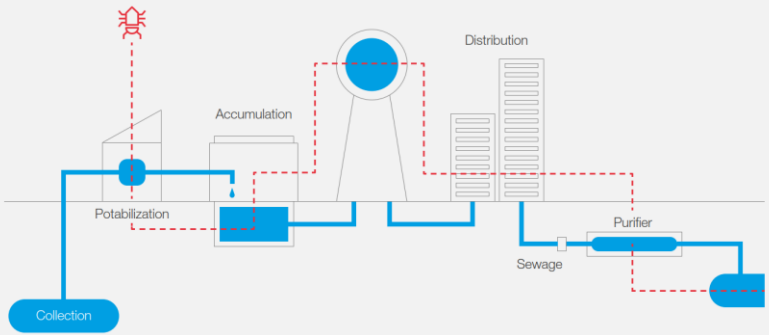
NIS 2.0 - Cybersecurity Threats



- **15 lessons learned and recommendations for improvement on the new EC Cybersecurity Directive** considering the implications of supply chain attacks and other systemic risks for cybersecurity in the energy industry.
- ***"With governments and businesses accelerating the drive toward low-carbon economies, this year marks a unique opportunity to build resilience into the energy transition by design. Weathering future threats will be much easier and more affordable if the electricity sector as a community can take collective actions for cyber defense. We are stronger together."***
- **Leo Simonovich, Vice President and Global Head, Industrial Cyber, Siemens Energy**

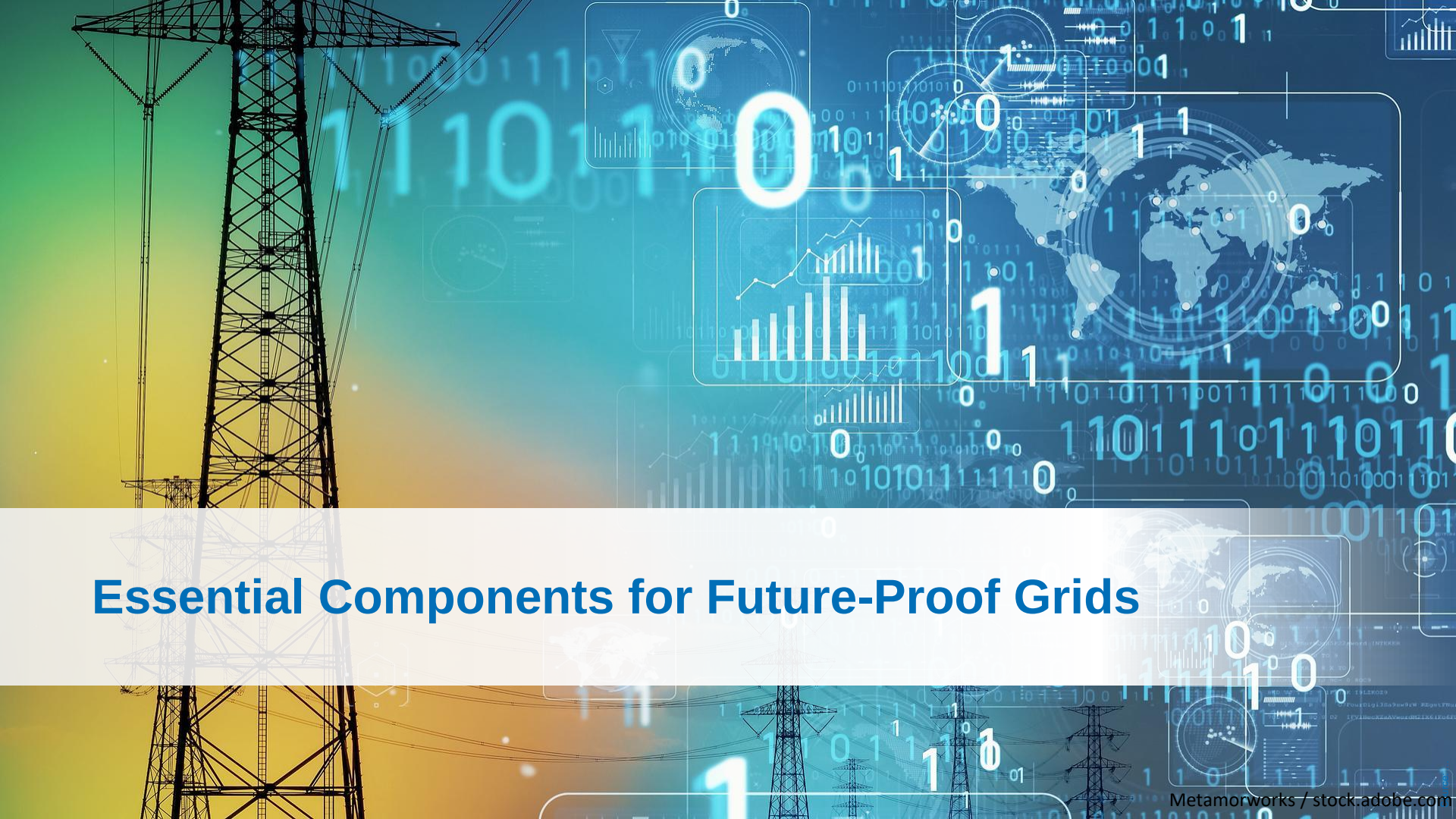
Florida water treatment plant attack

- In February 2021, malicious actors tampered with a water treatment facility in Florida, US
- They accessed the Supervisory Control and Data Acquisition (SCADA) system, which enables the monitoring and control of all peripherals (e.g., actuators and sensors) managed by it.
- The attackers exploited this access to change the chemical levels of the water supply.



Adapted graphic from: Accenture

Essential Components for Future-Proof Grids



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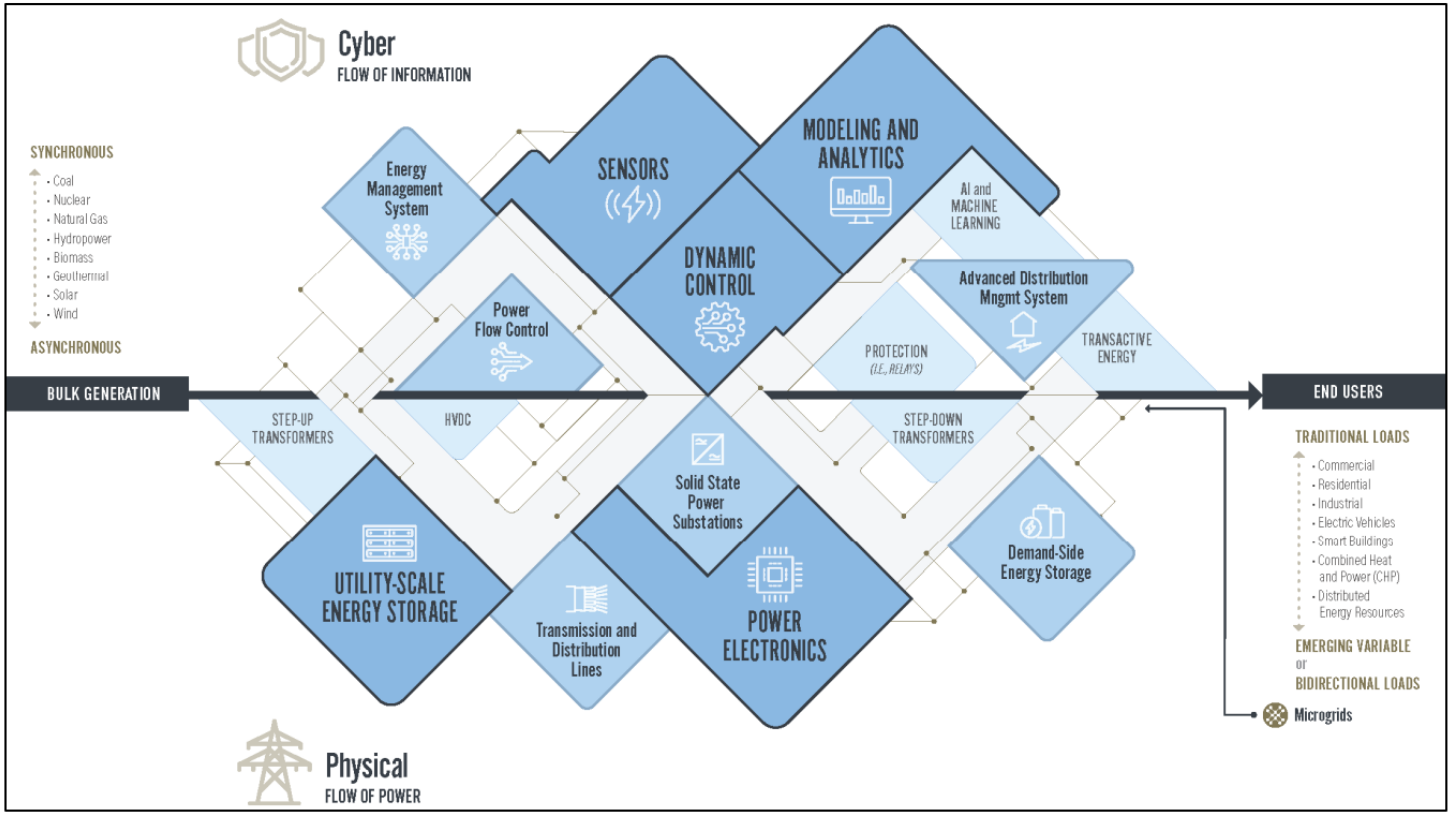
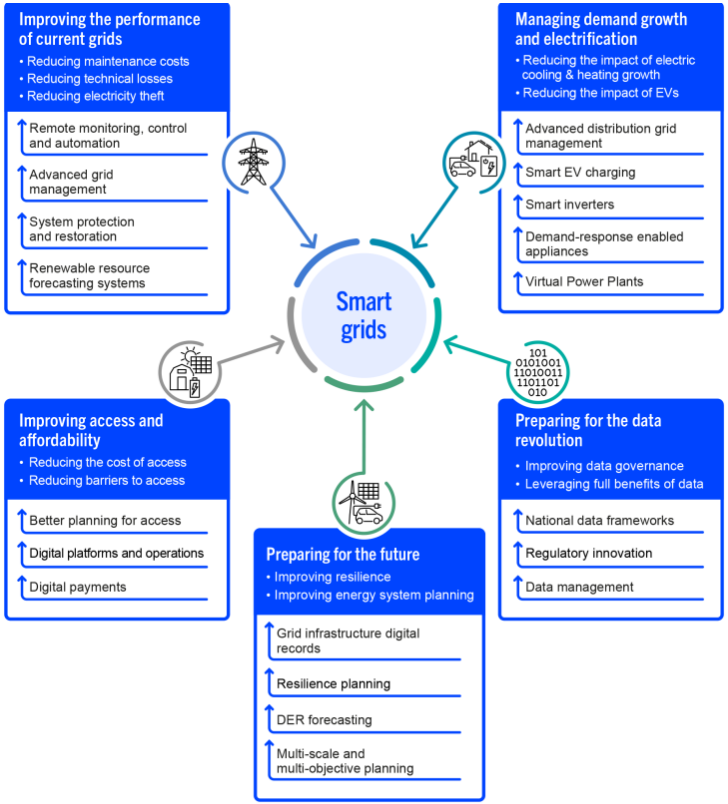
Digitalization and Smart Grids

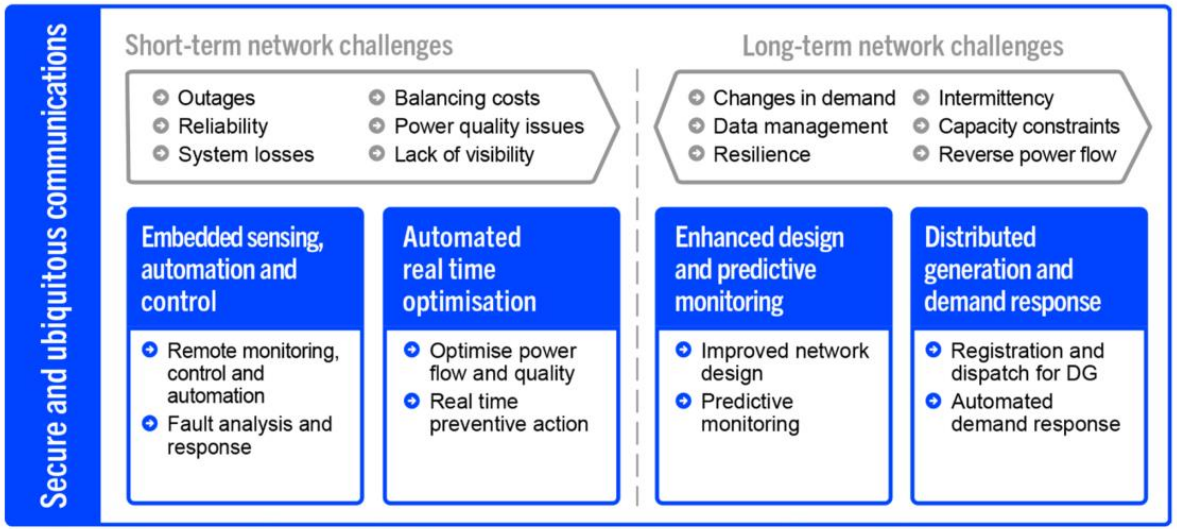


Source: U.S. Department of Energy, Office of Electricity; ICF

Advanced Analytics and AI



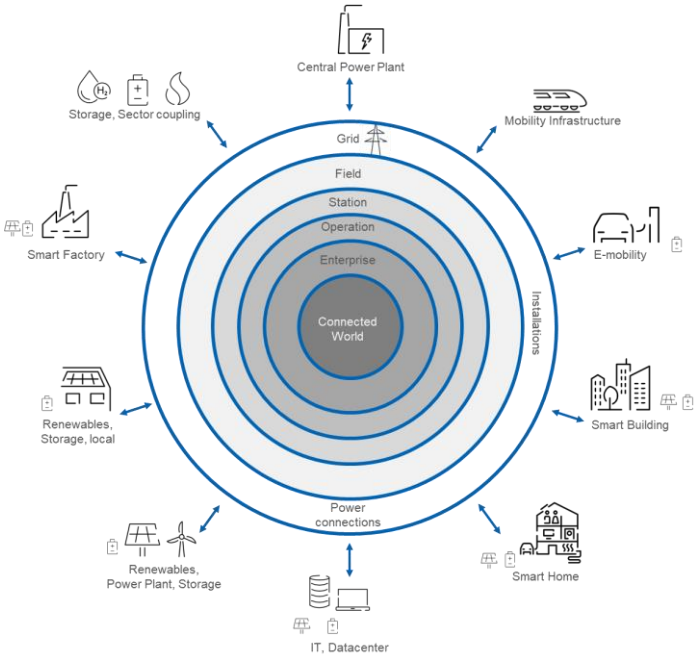
Digital solutions to tackle short- and long-term network challenges



Note: DG = Distributed generation.

Source: World Economic Forum, Accelerating Smart Grid Investments.

On the way to the All-Electric and Connected Society



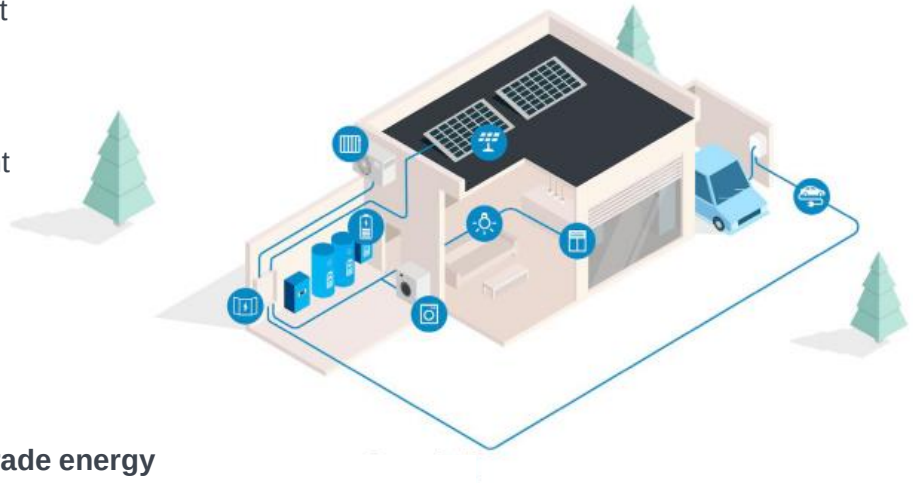
Use case: Sector coupling

- Energy efficiency
- Balancing of generation and consumption
- Flexibility thanks to energy storage and consumers

A future-proof living – Smart Energy

Digitisation & Building Automation

- Every grid connection point must be digitised
- Future-proof electrical infrastructure
- Smart energy management systems



Energy efficiency

- Self-optimisation and self-regulation of energy consumption and generation in the Building/Quarter (PV, storage, electromobility, heat generation)

Anyone can trade energy

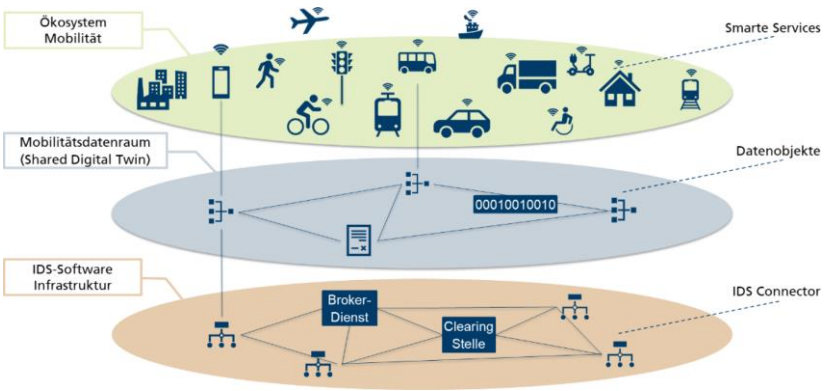
- Decentralised path: energy and power trading made possible by digitalisation
- Centralised path: CO2-free energy supply

Data spaces and data infrastructures

State of the art

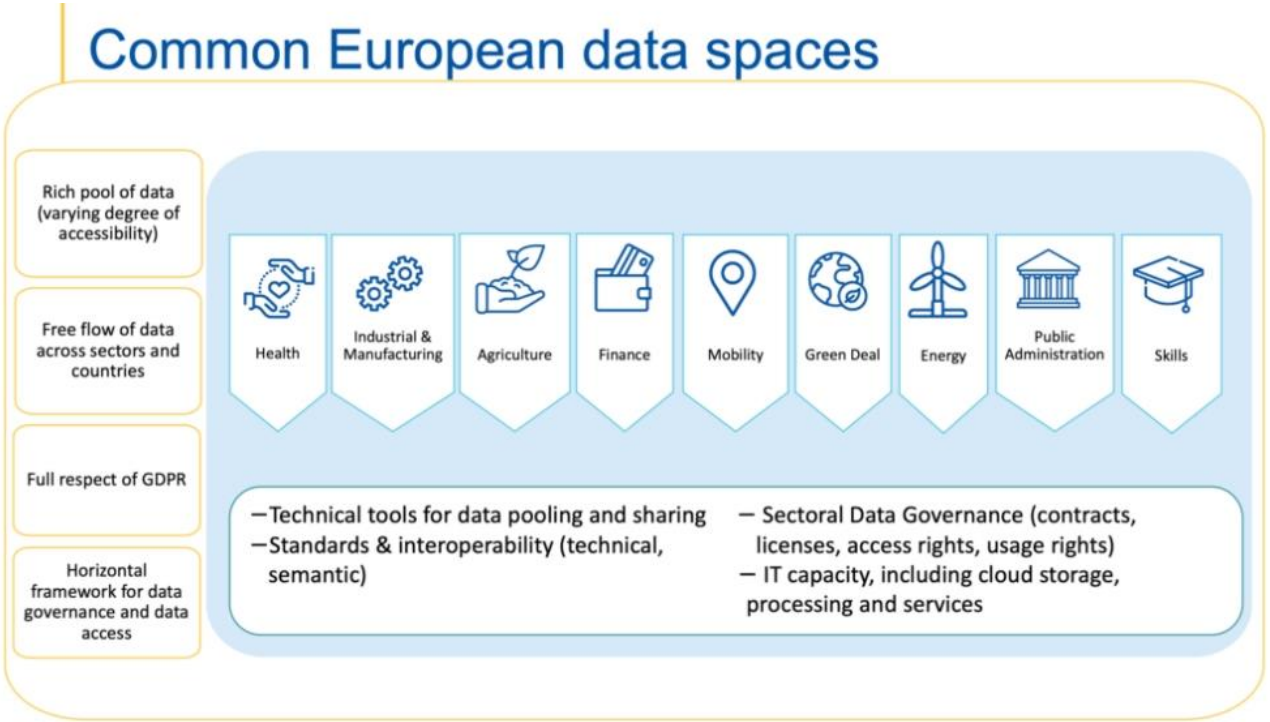
- Firstly, a data spaces does not require any physical integration of the data; instead, the data is stored in a distributed manner. A data space is therefore based on a distributed data storage architecture.
- Secondly, a data sapces does not provide for a common database schema; instead, the data is integrated on a semantic level, preferably using vocabularies.
- Thirdly, a data spaces supports the networking of data based on linked data concepts that are clearly identified and linked to each other in a coded manner.
- Finally, data spaces can be nested and overlapping. This also means that data space participants can make their data available in different data spaces and that data can be shared between data sapces.

Integration architecture for data infrastructures and data ecosystems



Quelle: https://link.springer.com/article/10.1007/s00287-021-01386-4/figures/1

A common European approach



Gemeinsame europäische Datenräume (Bild: VDMA e.V.)

Pathways to a Net-Zero Future

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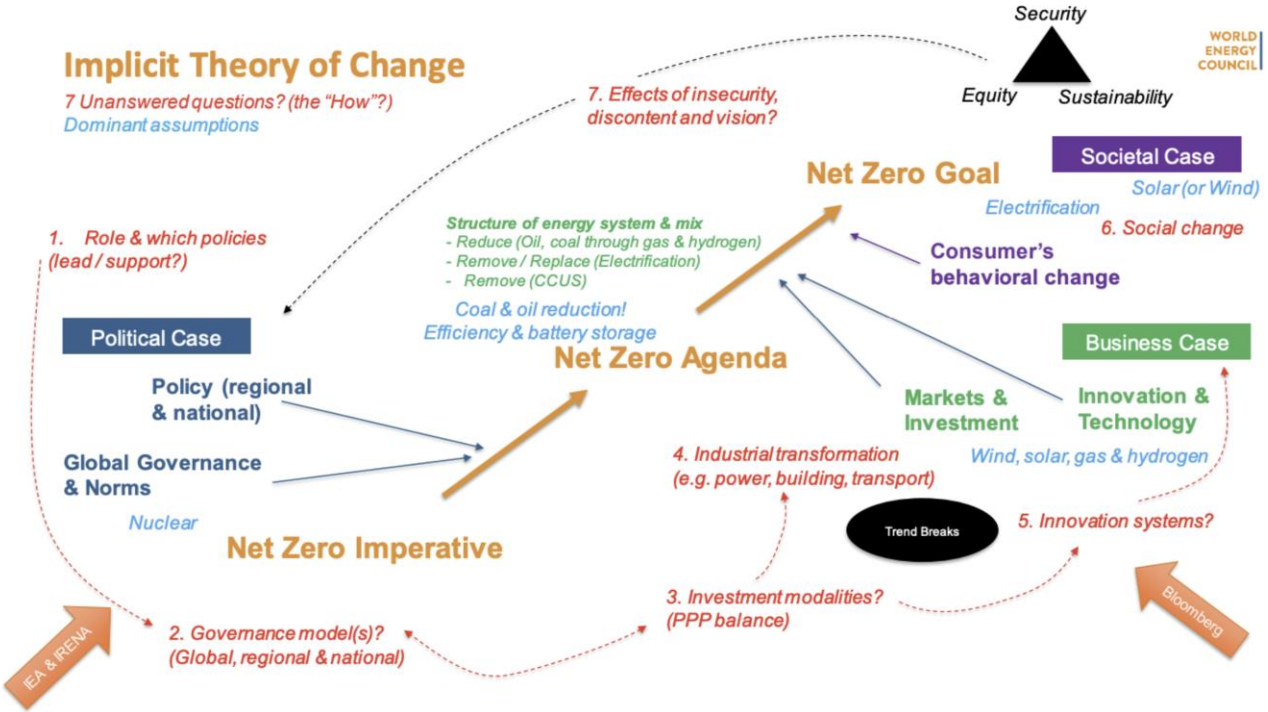
Theory of Change



Conclussion

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Stronger together!

- For a secure and future-proof electricity grid, digital, flexible, and resilient solutions, supported by appropriate regulatory frameworks and technological innovations, are essential.

- Call to Action: It is crucial that all stakeholders – from regulators to providers to consumers – actively participate in shaping the grids of the future.

The emerging AI standardization ecosystem in Europe

European Future Technologies Summit
EUREL Young Engineers

Dr Sebastian Hallensleben

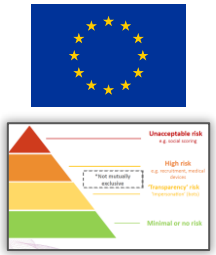
Head of Digitalisation & AI at VDE e.V.

Chair CEN-CENELEC JTC 21

Co-Chair Classification & Risk Assessment OECD ONE.AI

2024-09-02

Global three-tier standardisation landscape



New Legislative Framework

	Allgemein	Elektrotechnik	Telekommunikation	
	ISO International Standardization Organization	JTC1 SC42 IEC International Electrotechnical Commission	ITU International Telecommunication Union	Inter-national
	cen Comité Européen de Normalisation	JTC21 CENELEC Comité Européen de Normalisation Electrotechnique	ETSI European Telecommunications Standards Institute	Europa
	DIN Deutsches Institut für Normung	NA 043-01-42 DKE VDE DIN Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE		Deutsch-land

Standardisation request of the EU

1.	European standard(s) and/or European standardisation deliverable(s) on risk management system for AI systems
2.	European standard(s) and/or European standardisation deliverable(s) on governance and quality of datasets used to build AI systems
3.	European standard(s) and/or European standardisation deliverable(s) on record keeping through logging capabilities by AI systems
4.	European standard(s) and/or European standardisation deliverable(s) on transparency and information provisions to the users of AI systems
5.	European standard(s) and/or European standardisation deliverable(s) on human oversight of AI systems
6.	European standard(s) and/or European standardisation deliverable(s) on accuracy specifications for AI systems
7.	European standard(s) and/or European standardisation deliverable(s) on robustness specifications for AI systems
8.	European standard(s) and/or European standardisation deliverable(s) on cybersecurity specifications for AI systems
9.	European standard(s) and/or European standardisation deliverable(s) on quality management system for providers of AI systems, including post-market monitoring process
10.	European standard(s) and/or European standardisation deliverable(s) on conformity assessment for AI systems

1 – 2 items to be added on sustainability and foundation models (?)

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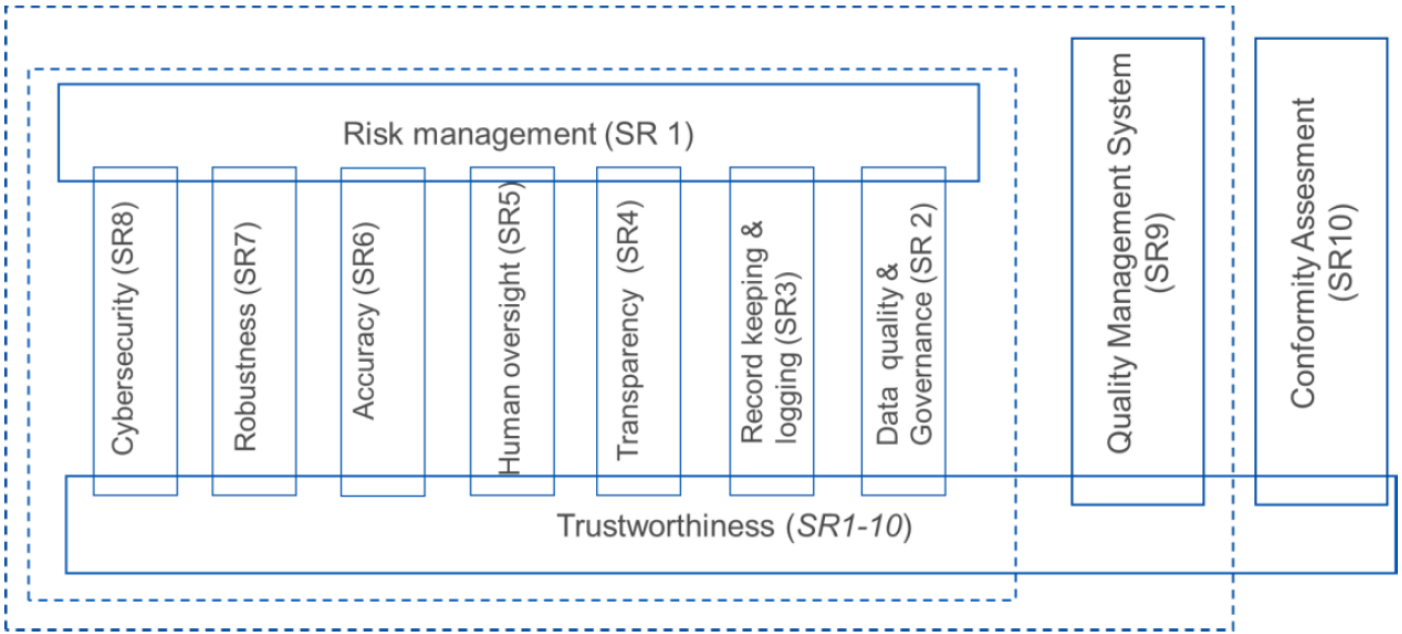
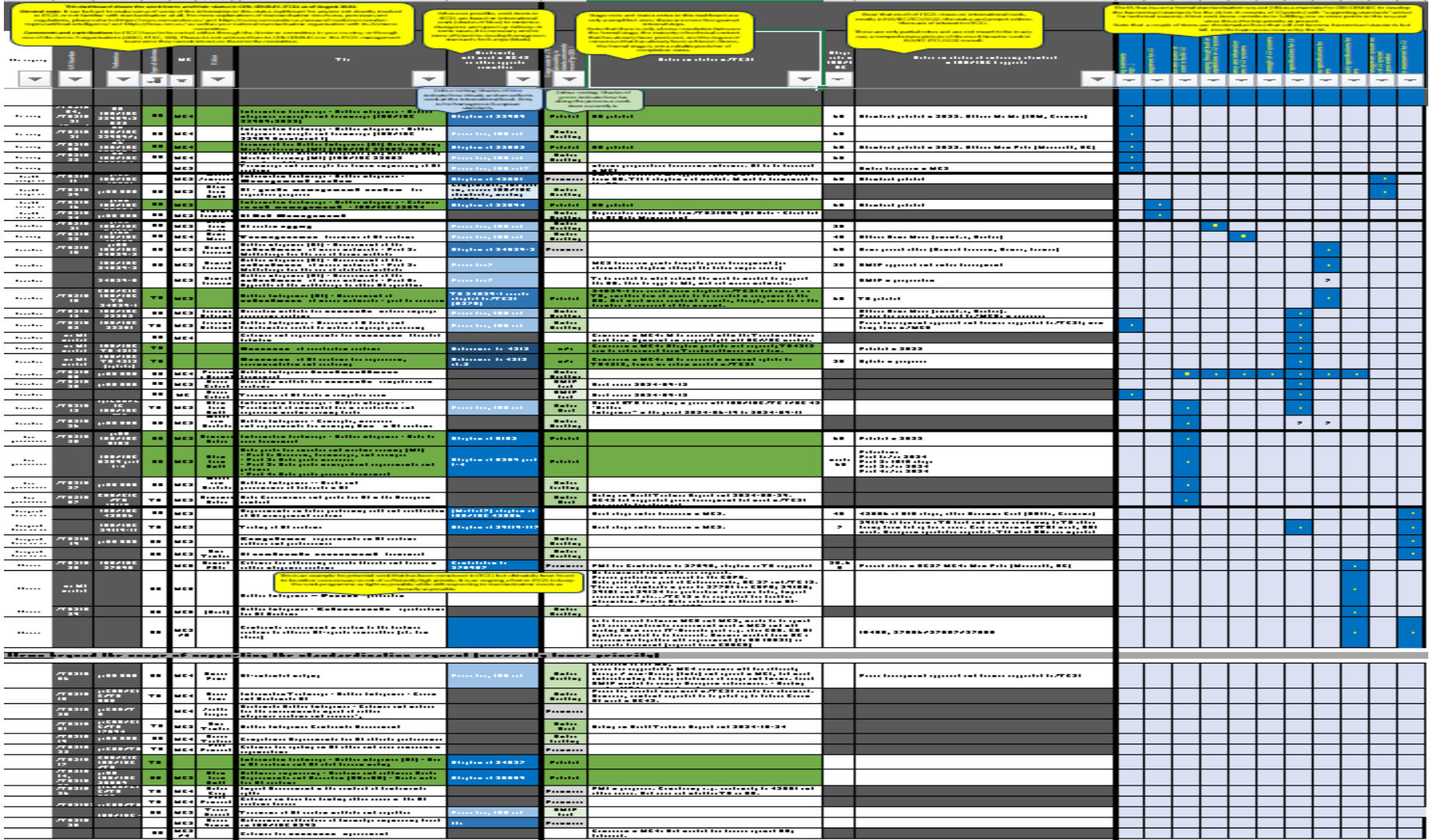
Architecture of standards in response to the EU standardisation request





Working Groups

- WG1: Strategic Advisory Group
- WG2: Operational Aspects
- WG3: Engineering Aspects
- WG4: Foundational and Societal Aspects
- WG5: Cybersecurity

  (in collaboration with ETSI, ENISA and CEN-CENELEC JTC13)

> 140 experts
> 24 countries

How can we build solid European harmonised standards in ~ 2 years (instead of 3-5 years)?

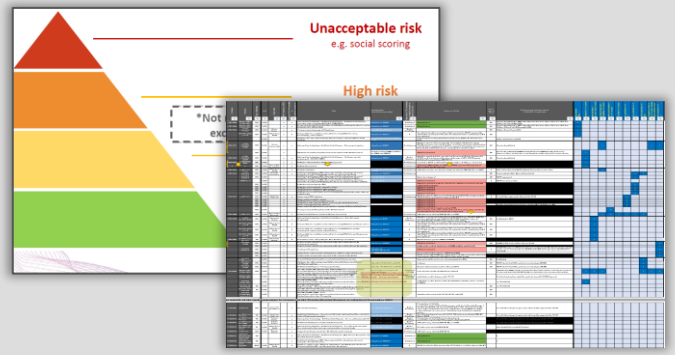
- Adopt or Adapt from ISO/IEC; Collaborate with ETSI
  (where available)
- Adapt from other standardisation and similar organisations,
  e.g. IEEE, IETF, W3C, OECD, GAIA-X, BDVA, …
  (where available and legal)
- Build on research and open consortial specs
  (where available)

How stakeholders participate in JTC21

- **Through national AI mirror committees**
- **Through Annex 3 organisations**
- **Indirectly through liaisons**
  including other technical committees, as[illegible]ons, [illegible] etc
- **Through ETSI**
  Mode 4 cooperation in place, including (but not limited to) cybersecurity
- **As Observers**
  e.g. Japan, Canada, ...

Complementing the EU AI Act:
What else is needed beyond the scope of the EU AI Act?

AI Governance Ecosystem



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Completing the European AI ecosystem

Compliance

Competitiveness

"Ecosystem of Trust" (HLEG)
Focus: risk mitigation

Completing the European AI ecosystem

"Ecosystem of Trust" (HLEG)
Focus: risk mitigation

Compliance

Harmonised Standards

Codes of Conduct (Art. 95)

Competitiveness

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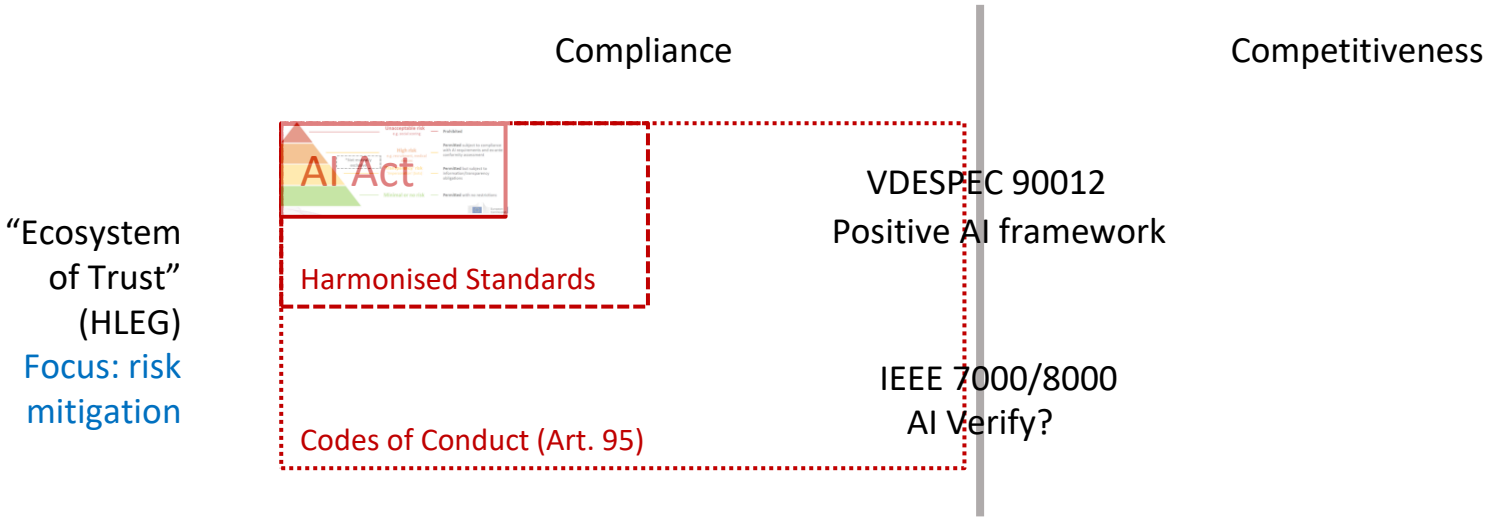
Completing the European AI ecosystem



Completing the European AI ecosystem

Compliance

Competitiveness

"Ecosystem of Trust" (HLEG)
Focus: risk mitigation

Harmonised Standards

Codes of Conduct (Art. 95)

VDESPEC 90012
Positive AI framework

IEEE 7000/8000
AI Verify?

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Completing the European AI ecosystem: AI Trust Alliance

"Ecosystem of Trust" (HLEG)
Focus: risk mitigation

Compliance

Competitiveness

Harmonised Standards

Codes of Conduct (Art. 95)

VDESPEC 90012
Positive AI framework

AI Trust Alliance

IEEE 7000/8000
AI Verify?

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4 tracks of collaboration

Measuring the characteristics of products/organizations/people (Specifications)

Communicating characteristics (Labels)

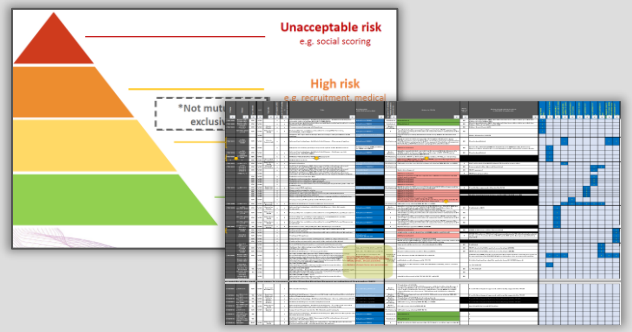
Proving that standards are followed and labels are justified (Certification, Auditing paths)

Implementing the label and **achieving** good ratings (Tools, Automation, Training)

AI Trust Alliance: current stakeholders in the discussions

Beyond implementing the EU AI Act and European AI standards: What else is needed?

AI Governance Ecosystem



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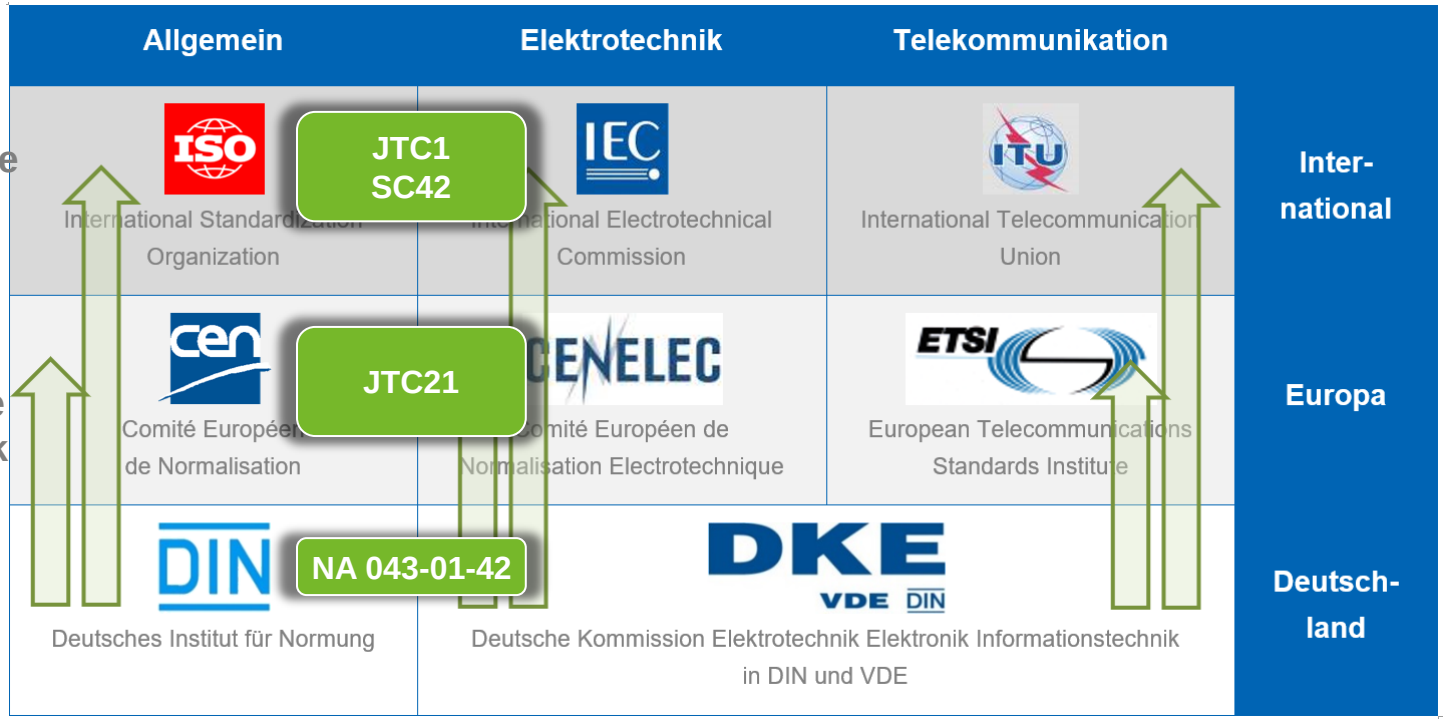
DDG for Responsible Business Conduct

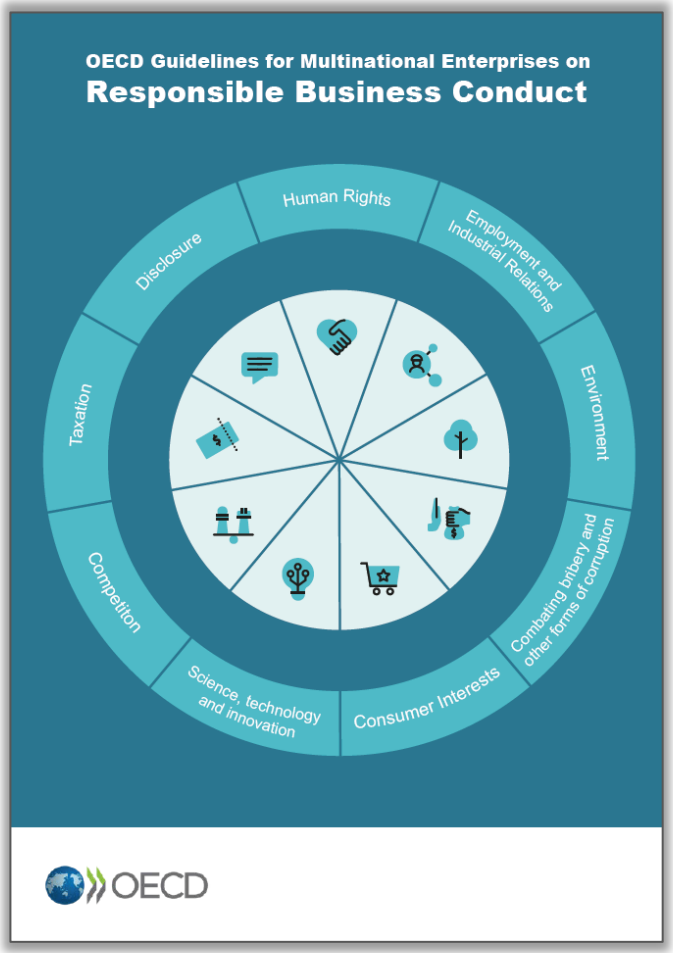
New Legislative Framework

Draft AI Act



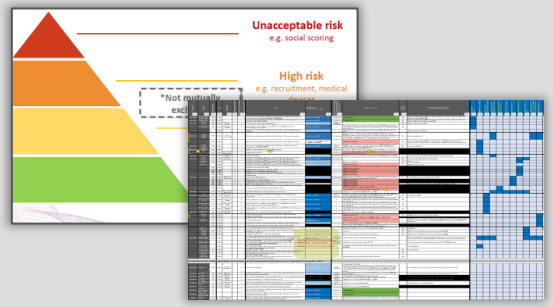
Guidelines for Multinational Enterprises on Responsible Business Conduct

- Existing **enforcement mechanism**
- OECD ONE.AI Expert Group on AI Risk & Accountability is working towards adding a chapter on **AI Governance**
- **Points to broad range of existing AI risk management standards and frameworks** for practical implementation, including NIST RMF, ISO 31000, IEEE 7000, IEC Guide 51, ...



Let us assume that comprehensive AI governance through regulation and standardisation will be in place:

AI Governance Ecosystem



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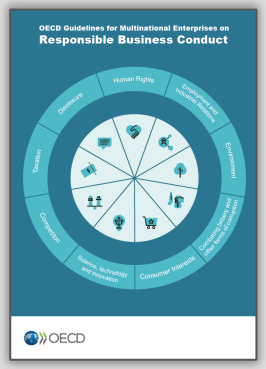

Does this mean everything is under control?

What else is needed?

AI Governance Ecosystem

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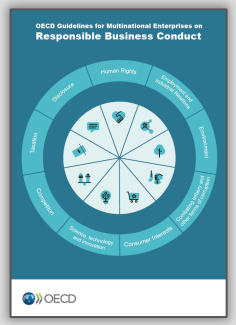

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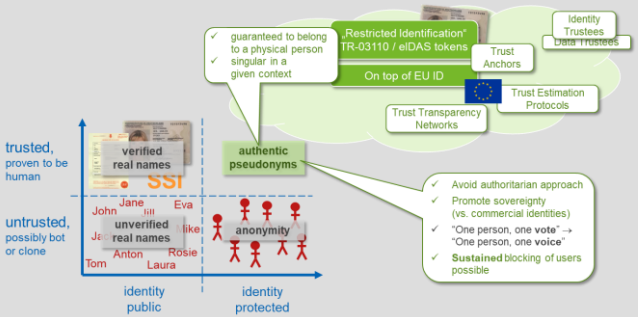
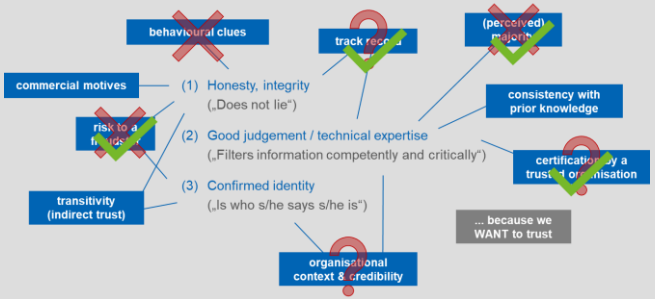
Digital Trust Ecosystem





European Future Technology Summit Brussels 2024

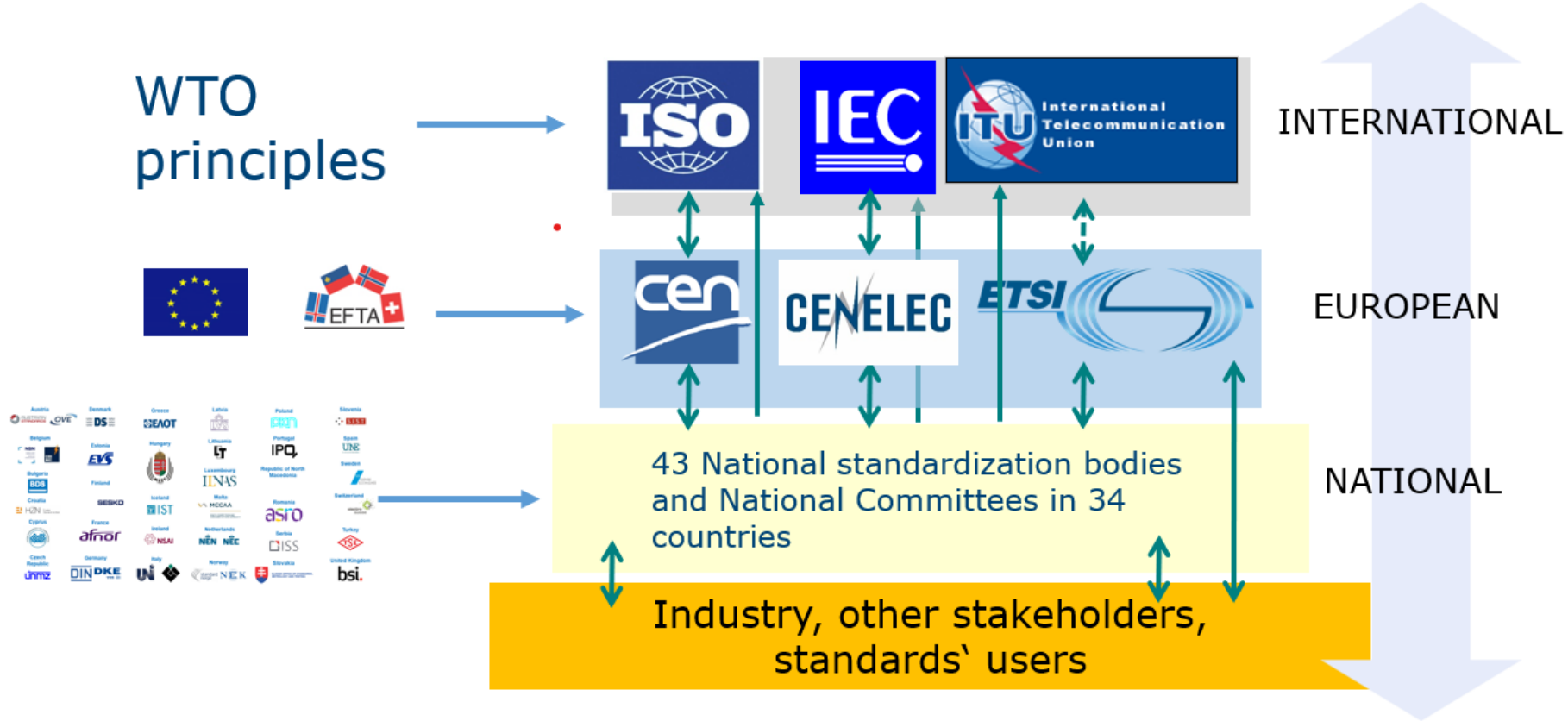
How can European Standards strengthen the Resilience of European Power Networks and Grids?

Elena Santiago Cid, Director General, CEN and CENELEC

3 September 2024

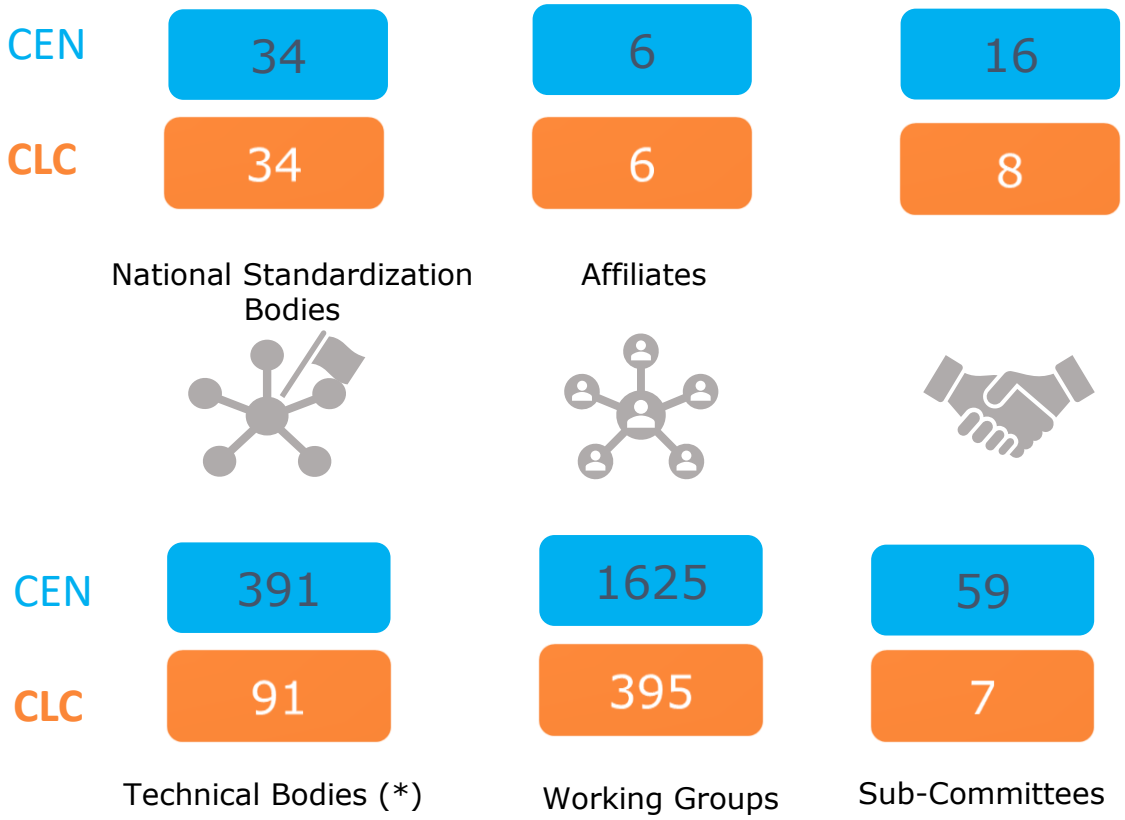
Who we are

- CEN and CENELEC are European Standards Organizations (ESOs) together with ETSI, recognised as European Standards Organizations (Regulation EU 1025/2012)



An inclusive system

- Based on the **national delegation principle**
- Representing a **consensus** among all interested parties, including industry & SMEs and societal stakeholders
- **Voluntary**
- Developed by **independent organizations** distinct from authorities
- **A continuous dialogue** for a bottom-up + top down approach



The strength of European standards

European Standards (ENs)

- Strengthen the Single Market
- Reinforce the EU position in the Global Market
- Support the digital and green transition
- Help scale up technologies
- Support the resilience
- (re-industrialization) of the European economy

CEN and CENELEC are committed to deliver the standards for the green transition (and beyond)

CEN and CENELEC's global approach

- **Primacy of International Standards:** where possible, 1 single global solution
- Avoid duplication of work at International and European levels
- Ensure rational use of available resources
- Contribute to solving global challenges (such as climate change)
- Access to global markets (focus on priority regions)

CEN and CENELEC PORTFOLIO – Q2/2024

European Standards	Technical Specifications	Technical Reports	Workshop Agreements	Guides
24.342	**786**	**898**	**376**	**93**

26.495

CEN and CENELEC Standards in relation to **international standards**:

35% of CEN Standards aligned with ISO
81% of CENELEC standards aligned with IEC

(*) Excluding CRs and ENVs

CEN and CENELEC Strategy 2030

Vision

Building a safer, more sustainable and competitive Europe through European and International Standardization.

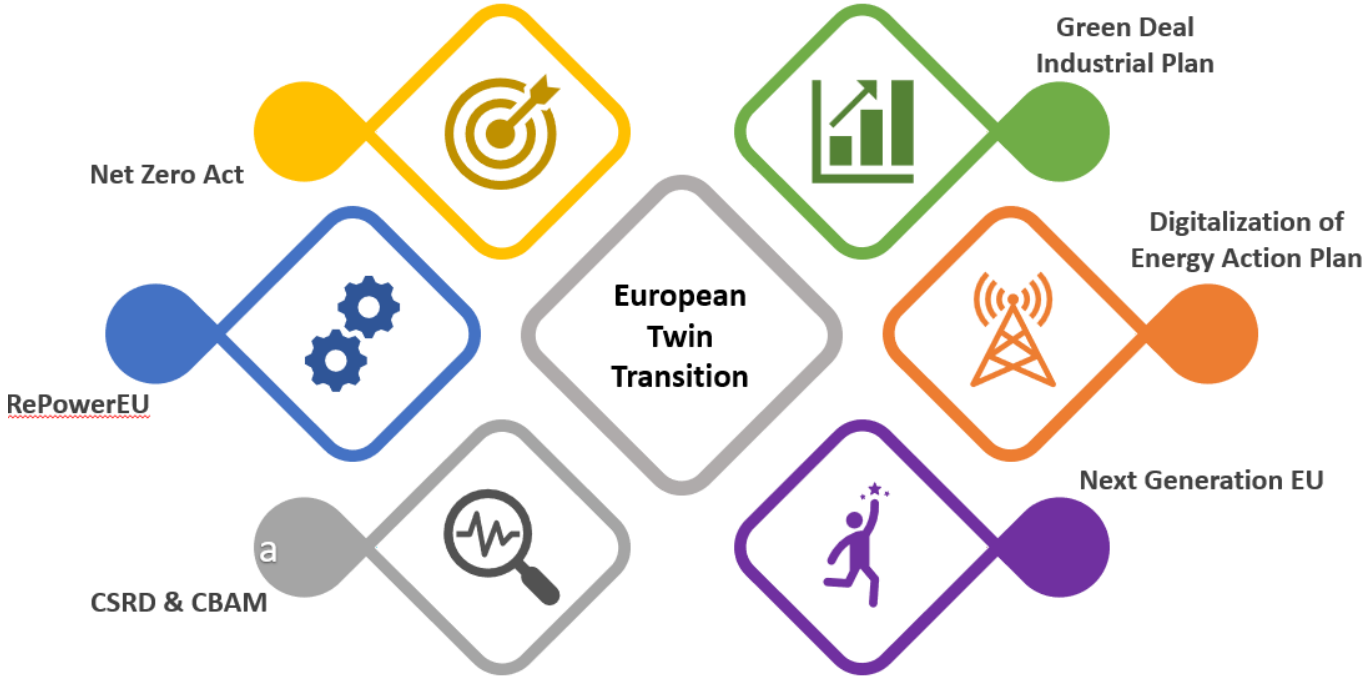
Mission

Through our stakeholder networks, we create consensus-based standards in order to generate trust, fulfil market requirements, enable market access and innovations for a better, safer and more sustainable Europe

- Goal 1: EU and EFTA recognize and use the strategic value of the European standardization system
- Goal 2: Our customers and stakeholders benefit from state-of-the-art digital solutions
- Goal 3: Increase the use and awareness of CEN and CENELEC deliverables
- Goal 4: The CEN and CENELEC system to be the preferred choice for standardization in Europe
- Goal 5: Strengthen our leadership and ambition at the international level

Standards for energy: (Geo)political challenges

- **Energy:** at the crossroads of Europe's geopolitical ambitions and (***many!)*** policy objectives
- To improve energy security, ensure reliable supply and meet climate objectives:
  - Massive investments in clean and energy efficiency
  - Fully integrate renewables into a resilient grid
  - Increase the resilience of energy networks
  - Develop standards which are essential to deploy technologies fast
  - Objective: Shift towards an "**All Electric Society**"



The All-Electric Society: a vision for the future

- **Vision**: meet energy needs entirely based on renewable electricity sources
- **How?** Electrification, digitalization, and automation of all sectors of the economy and society
- Current initiatives to coordinate work on AES:
  - **At CEN and CENELEC**: CLC/BTWG 176-3 'All-electric society coordination' (with DKE Secretariat)
  - **At international level**: IEC/SG 14 (SG = strategic group) 'All Electric and Connected Society (AECS)'.

The European integrated energy infrastructure

- Commissioner Sefkovic led initiative
- Coordination between CEN, CENELEC, E.DSO, ENTSO-E, DG GROW, DG ENER & industry (T&D Europe, Europacable, Orgalim etc)
- Incorporate recommendations from High Level Forum WS 9 ‘Green Electricity System’
- Engage all relevant Technical Committees

Need for **consistent & coherent** approach to policy & standards

European standardization work for Energy

Electrical network

EN IEC 61850 'Communication networks and systems for power utility automation' pave the way for the use of a variety of digital technologies relating to **smart energy and** the integration of renewable energies and distributed energy resources (DERs) within the electrical network.

Electricity security

CLC/TC 8X 'System aspects of electrical energy supply'

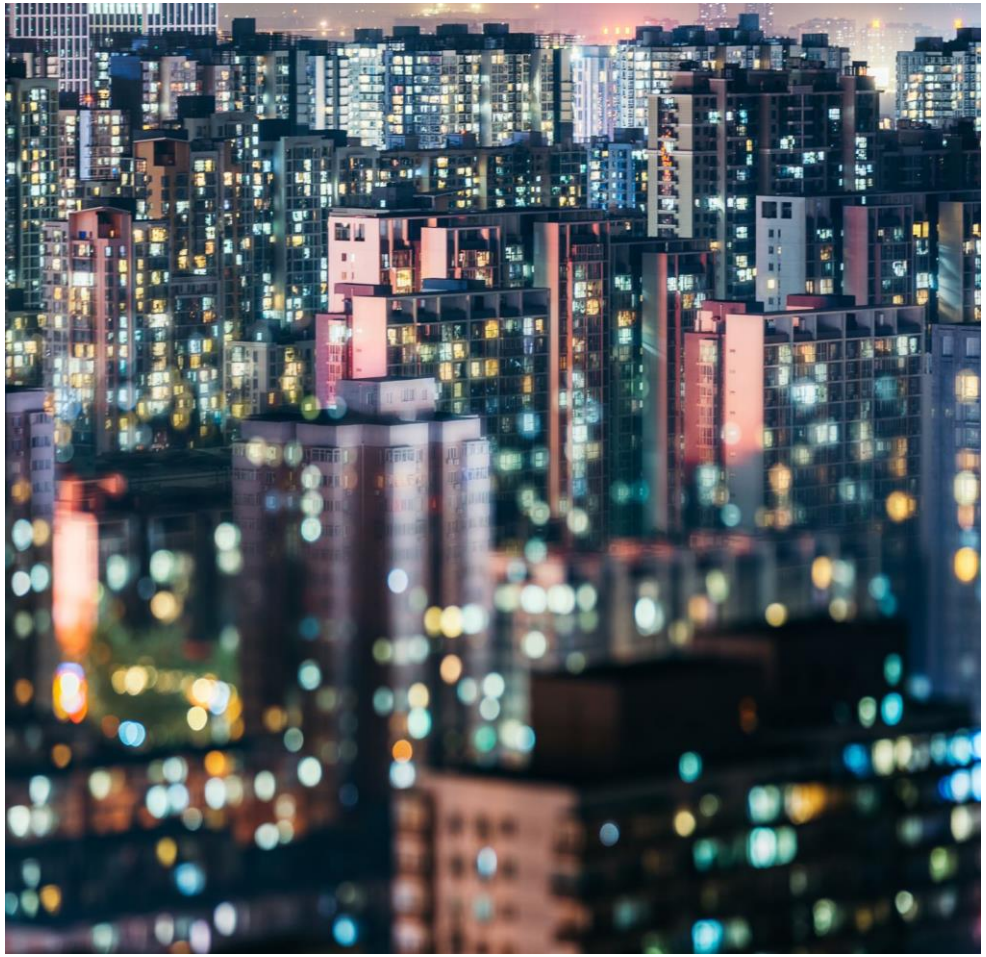
Artificial Intelligence

CEN-CLC/JTC 21 – Artificial Intelligence (AI)

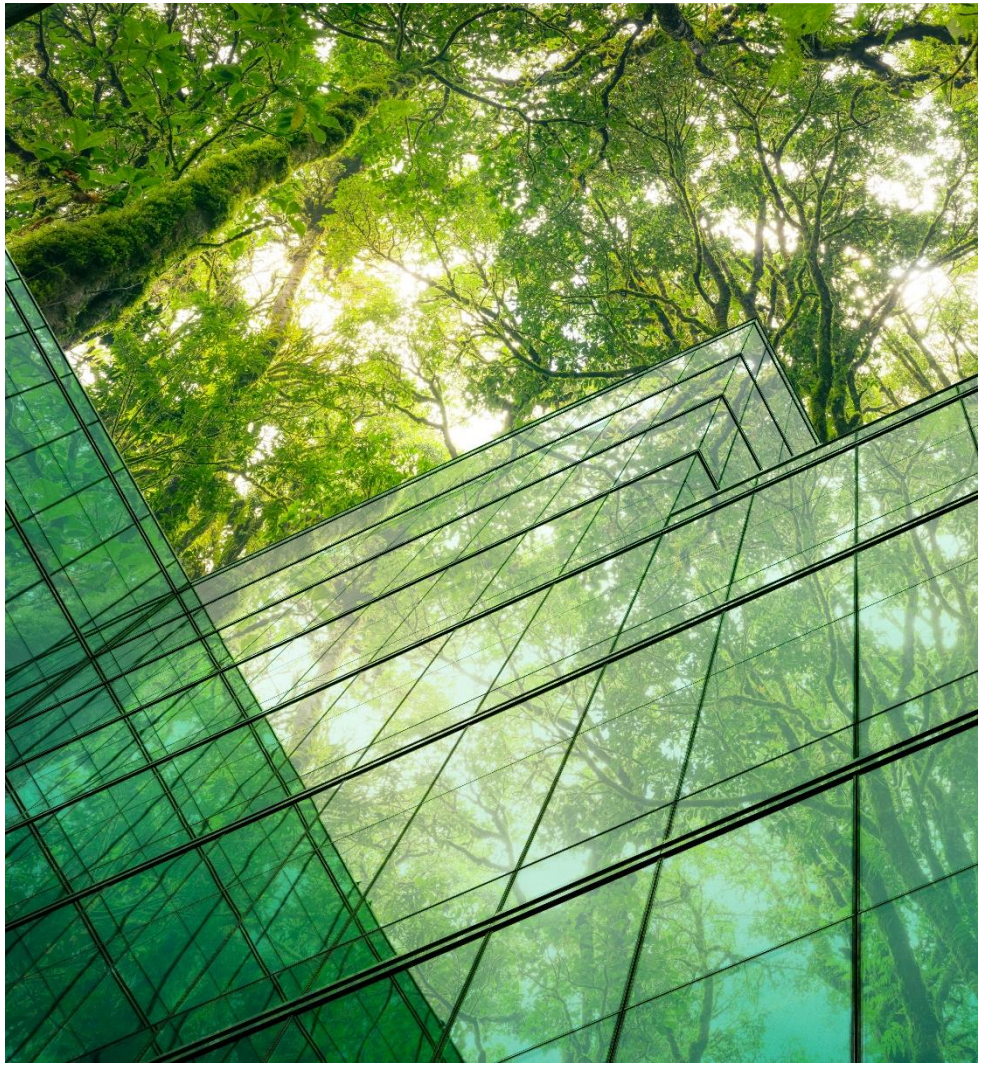
Our partners: the European Distribution System Operators (**E.DSO**) and the European association for the cooperation of transmission system operators (**ENTSO-E**)

Focus: **Smart Grids deployment**

- TCs involved: CLC/TC 8X ‘System aspects of electrical energy supply’, CLC/TC 64 ‘Electrical installations and protection against electric shock’, CLC/TC 13 ‘Electrical energy measurement and control’
- + 300 Standards that support the deployment of smart grids in Europe and that enhance the upgrading of the energy system
- CEN-CLC-ETSI Smart Grid Coordination Group (SG-CG)
- **Strategic relevance:** CEN and CENELEC Participate to the HLF WorkStream 9 ‘Green Electricity Systems’
- **Contributing to the Grid Action Plan** (COM(2023) 757 final): adopted to ensure electricity grids will operate more efficiently and will be rolled out further and faster



Future Challenges



For standards to help ensure the resilience of Europe's power networks, there are still gaps that need to be addressed:

- Need for **harmonization** across national systems
- **Strategic alignment** and planning
- **Link** research, innovation, and standardization
- Importance of **consistent policy**, clear standards, and interoperable solutions
- Role of **standardization experts** in contributing to legislation
- Need for coordination of European efforts at the **international level**
- **Bottom-up approach:** Wide participation of stakeholders needs to be encouraged!

Conclusions

- The European Single Standard Model is a unique asset to:
  - achieve energy security
  - increase energy independence

  within the Single Market

- standards are instrumental to achieve technological & industrial competitiveness
- Europe must be influential and lead on topics of strategic relevance, such as the **resilience of our energy system**

Thank you

Elena SANTIAGO CID

Director General, CEN and CENELEC

www.cencenelec.eu

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Tag us @standards4EU

NUCLEAR POWER AND ENERGY STORAGE: PILLARS FOR EUROPEAN ENERGY RESILIENCE

JACEK NOWICKI, PH.D. (EL. ENG.)

NATIONAL ATOMIC ENERGY AGENCY, POLAND

ASSOCIATION OF POLISH ELECTRICAL ENGRINEERS (SEP)

EUROPEAN FUTURE TECHNOLOGY SUMMIT (EFTS)

BRUSSELS

SEPTEMBER, 02-04, 2024

UNFORTUNATELY, OUR WORLD IS NOT PERFECT! (#1)

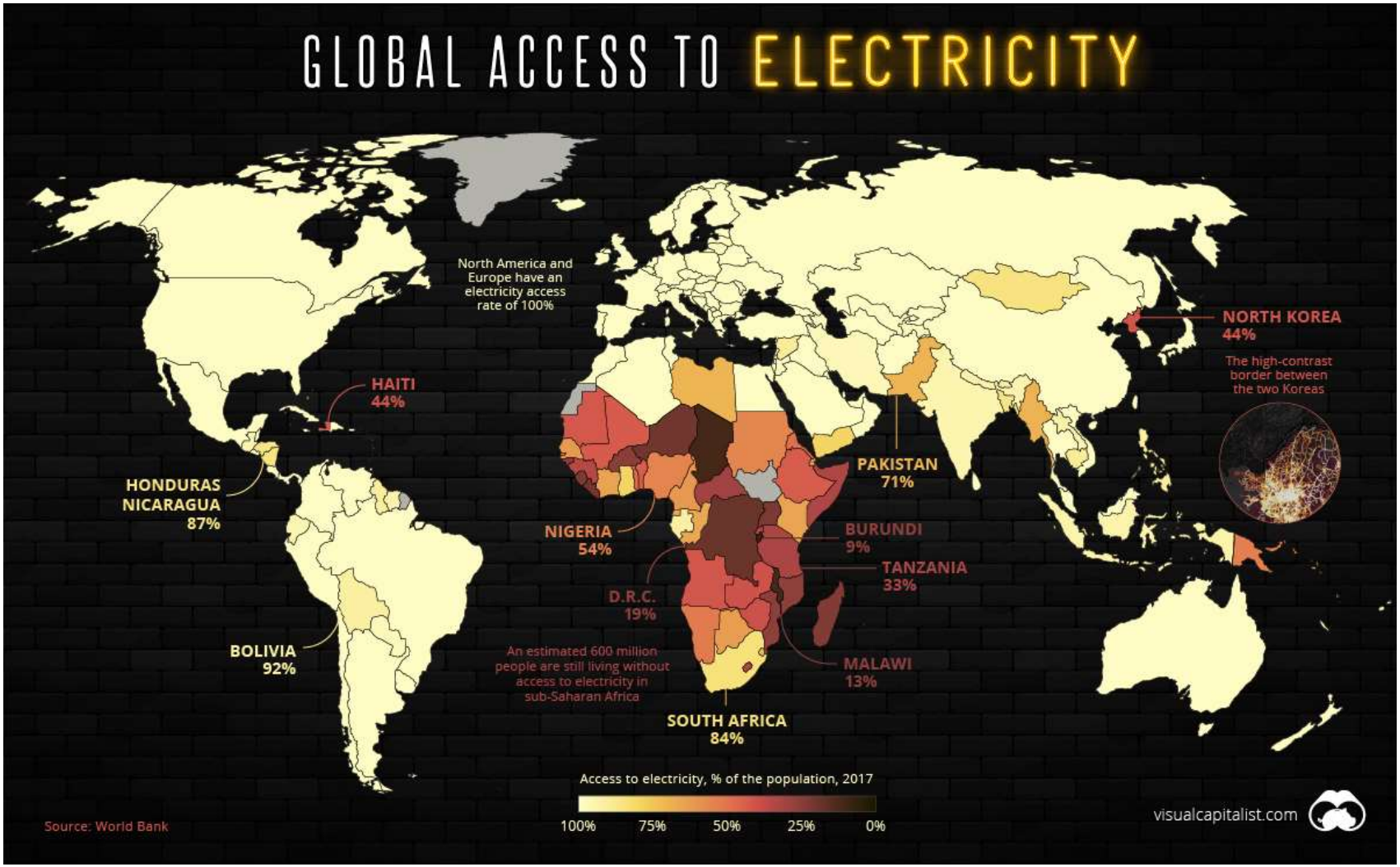
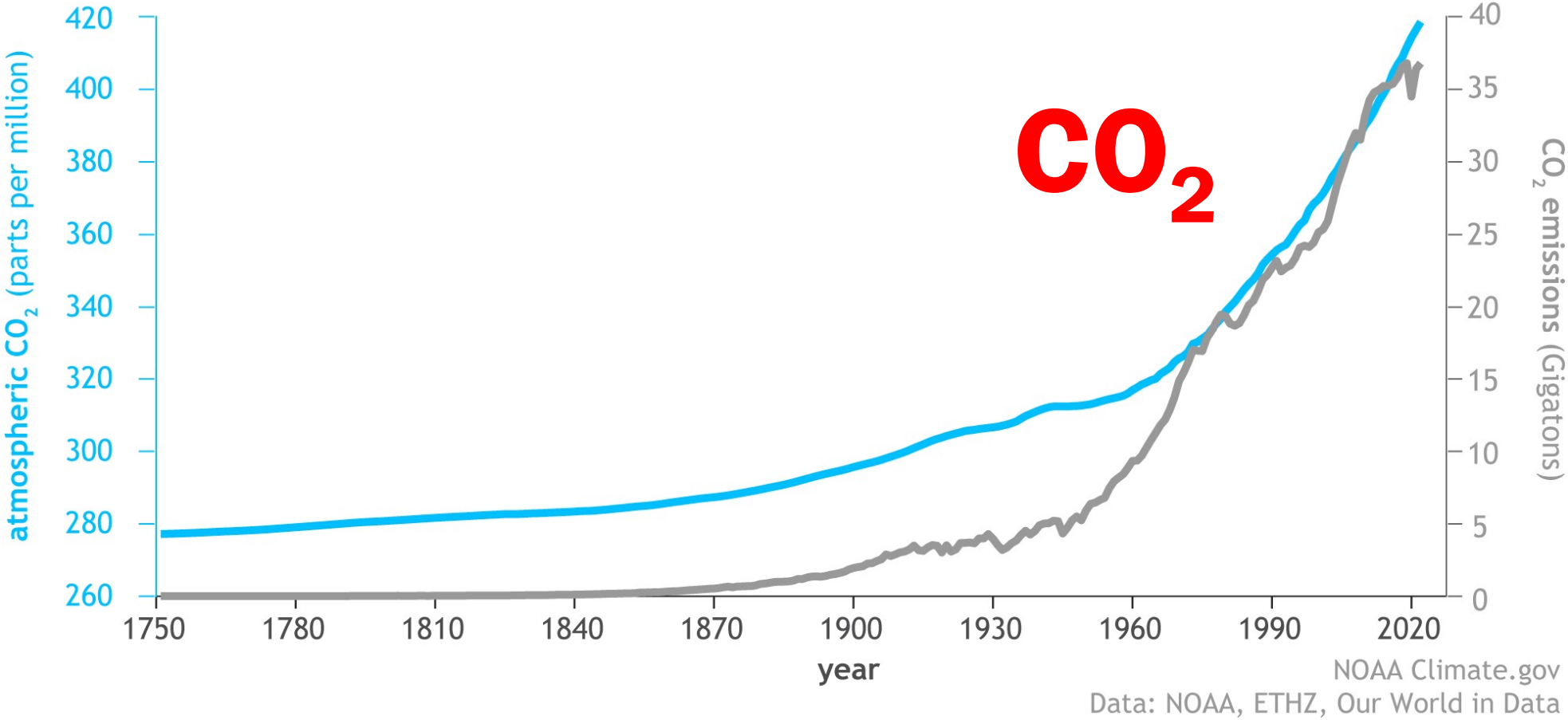


Illustration source: World Bank

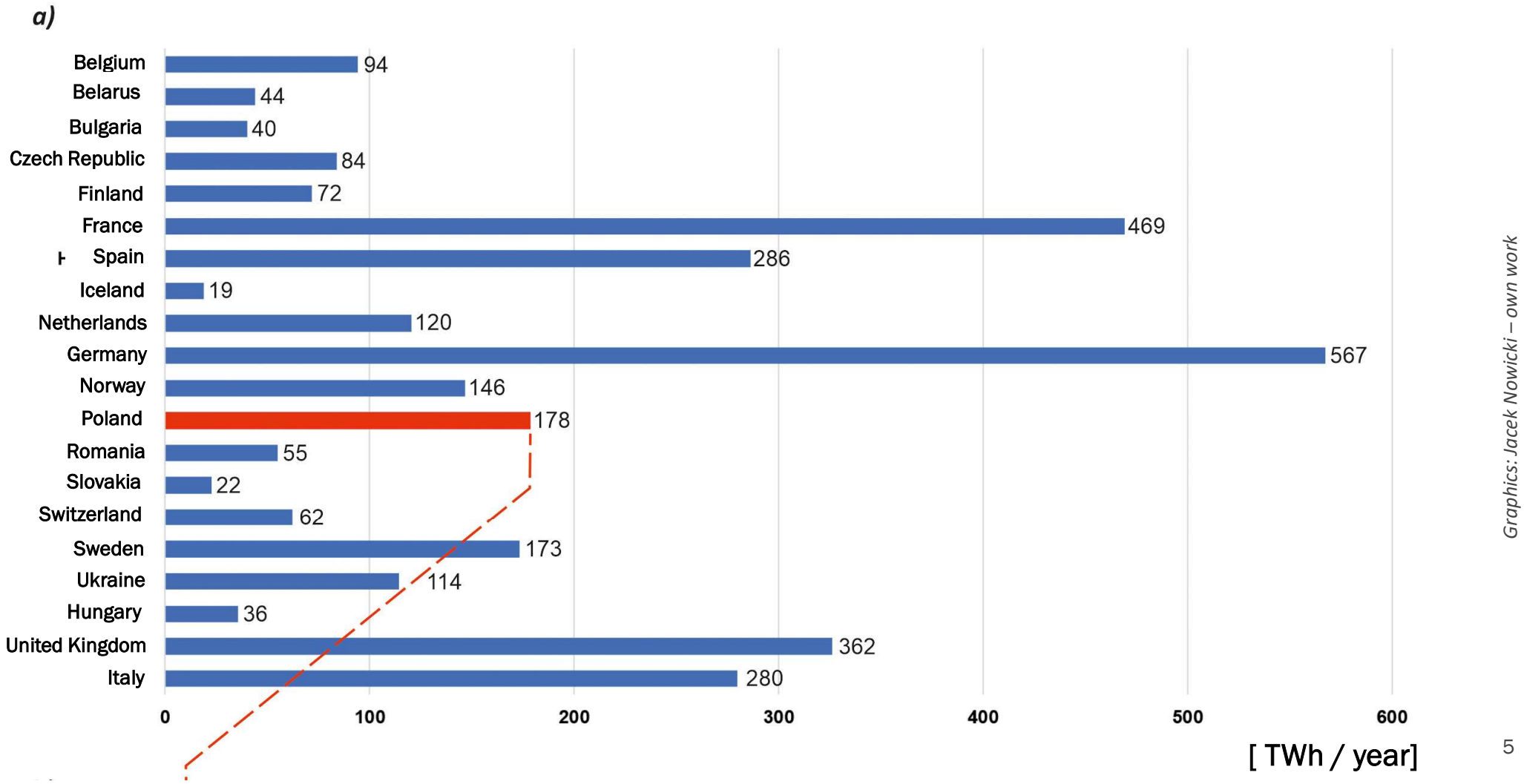
UNFORTUNATELY, OUR WORLD IS NOT PERFECT! (#2)

Global atmospheric carbon dioxide compared to annual emissions (1751-2022)



ENERGY MIX CONSIDERATIONS – EUROPE AND WORLD

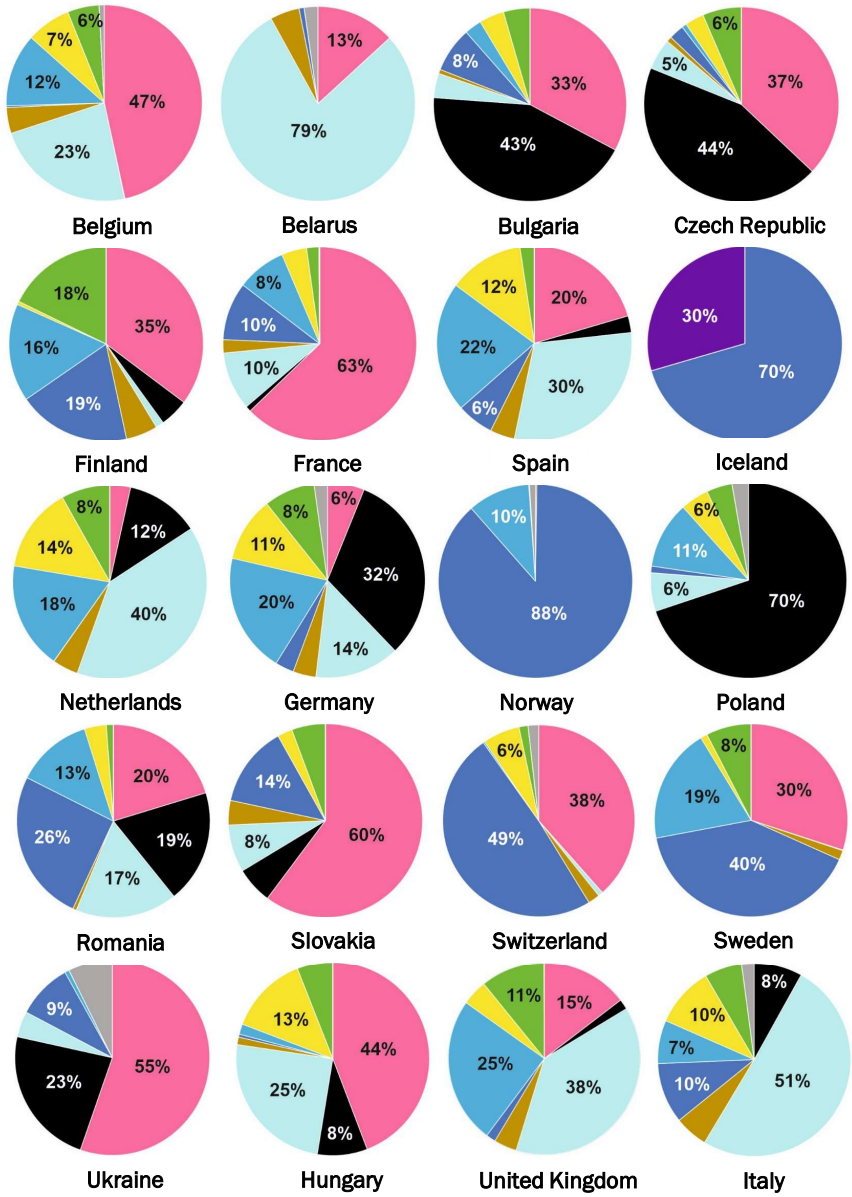
ELECTRICITY PRODUCTION – 2022 – EUROPE (20 COUNTRIES SAMPLE)



Graphics: Jacek Nowicki – own work

ELECTRICITY PRODUCTION MIX – 2022 – EUROPE (20 COUNTRIES SAMPLE)

- Europe is worldwide leader in all kinds of renewables and strong in nuclear generation.
- France >60% nuclear..
- Some countries are already practically CO2-free (Norway, Iceland).
- In many cases natural gas replaced coal (Italy, UK, Spain, Netherlands).
- Most painful situation – countries still depending on coal: Poland, Germany, Bulgaria and Czech Republic.

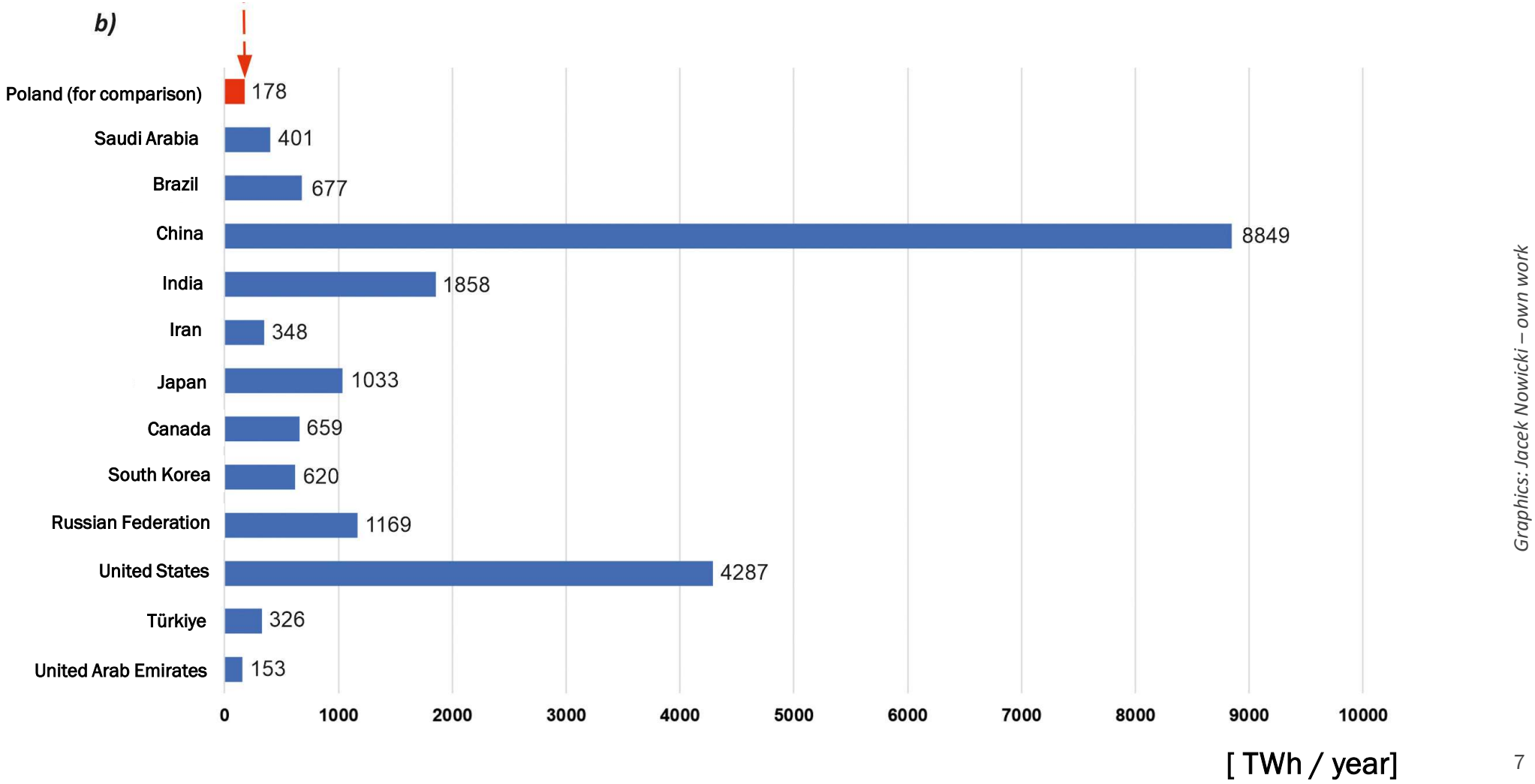


Power generation plants:

- nuclear
- coal (hard and lignite)
- gas
- oil
- water (all types)
- wind (onshore and offshore)
- solar (PV and other)
- biomas, biogas, waste
- biomas, biogas, waste
- other

Graphics: Jacek Nowicki – own work

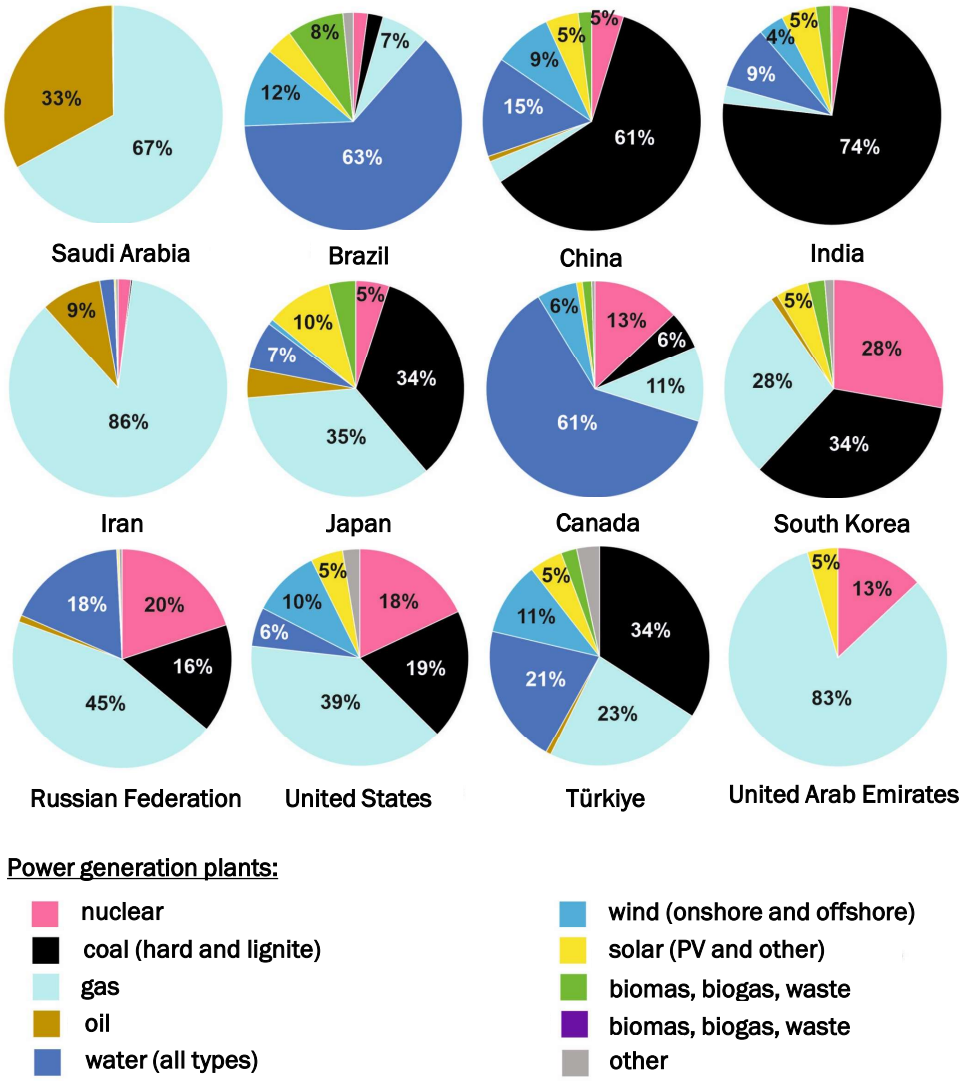
ELECTRICITY PRODUCTION – 2022 – EUROPE (12 COUNTRIES SAMPLE)



Graphics: Jacek Nowicki – own work

ELECTRICITY PRODUCTION MIX – 2022 – WORLD (12 COUNTRIES SAMPLE)

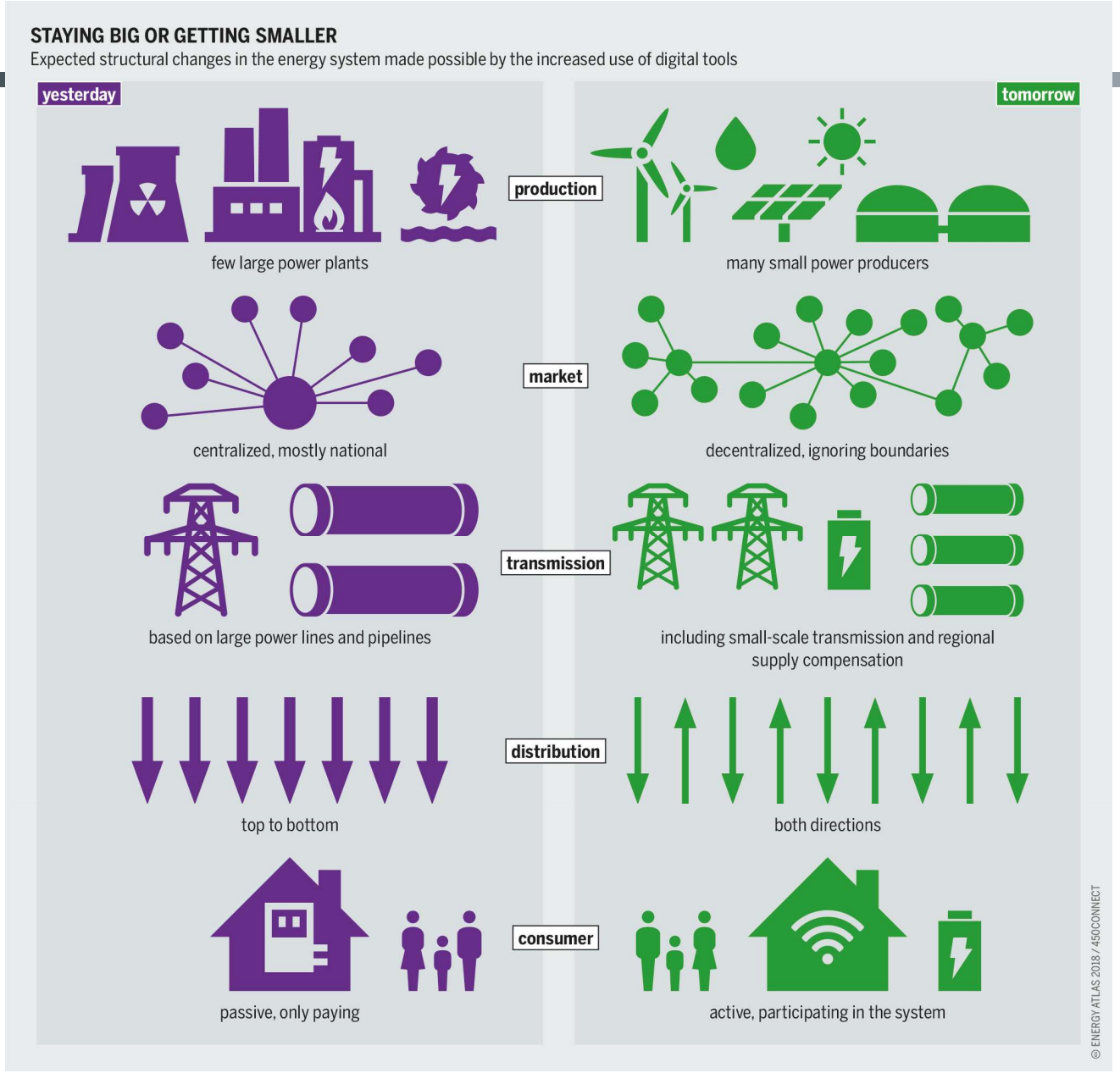
- Fossil fuels are still dominant: coal and natural gas.
- In general share of renewables is small comparing to Europe.
- Nuclear not exceeding 20% even in such ‚nuclear' countries as Unted States or Canada.
- China and India develops nuclear, but in paralel heavily invest to coal-fired plants.
- Middle East goes nuclear following Emirates (now also Turkey, Egypt and Saudi Arabia).



Graphics: Jacek Nowicki – own work

POWER SYSTEM ENERGY TRANSFORMATION

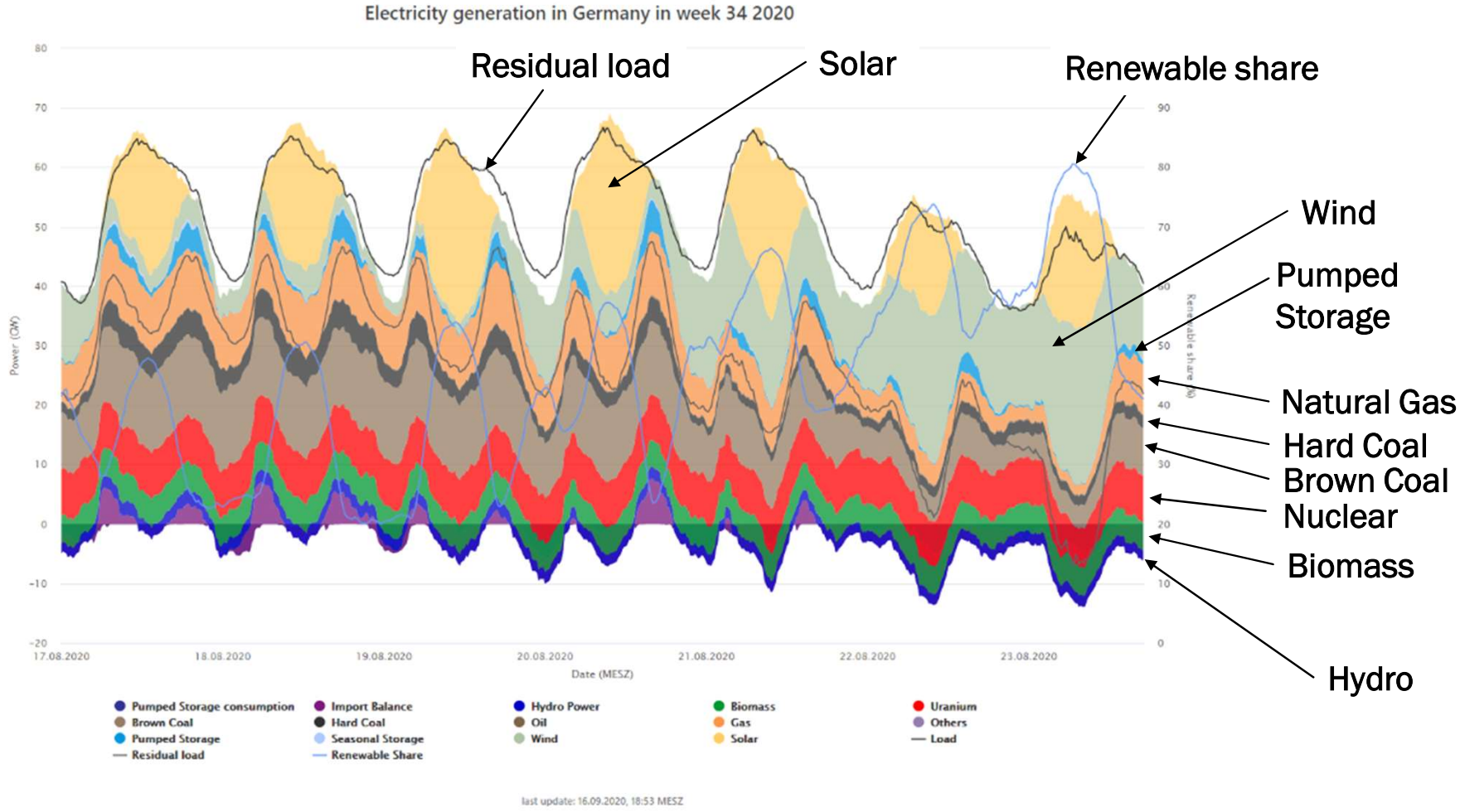
- From centralised to dispersed.
- CO_2-free.
- Elimination of fossil fuels in generation.
- Development of renewable generation.
- Development of networks in transmission in distribution to accomodate dispersed generation.
- Energy storage to be developed on each level of generation (power utility, industry, individual user).



Graphics: Bartz/Stockmar, CC BY 4.0

RENEWABLES, POWER SYSTEM STABILITY AND ENERGY STORAGE

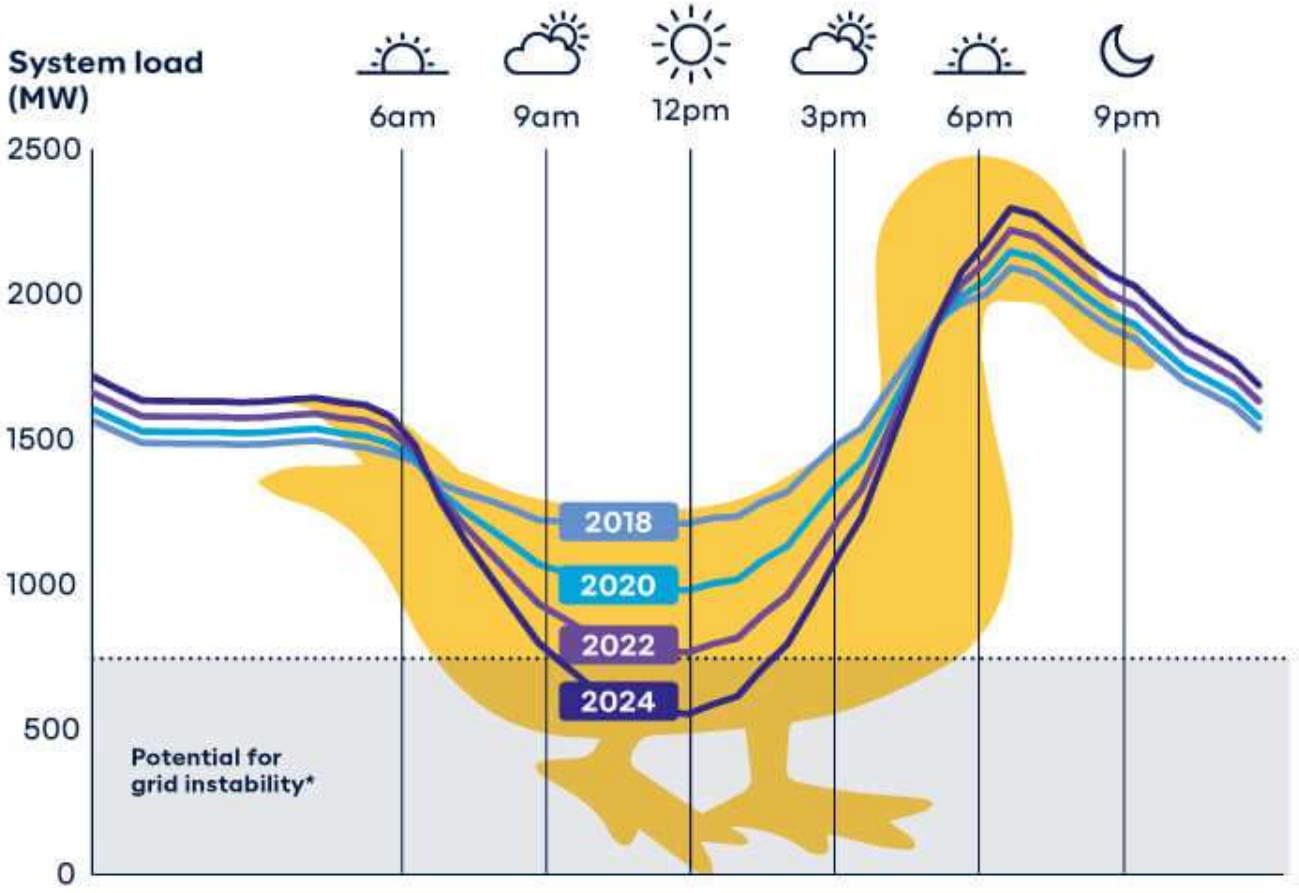
HUGE PORTION OF RENEWABLES IN ENERGY MIX – QUESTION OF INSTABILITY



Source: Fraunhofer Institute for Solar Energy Systems ISE

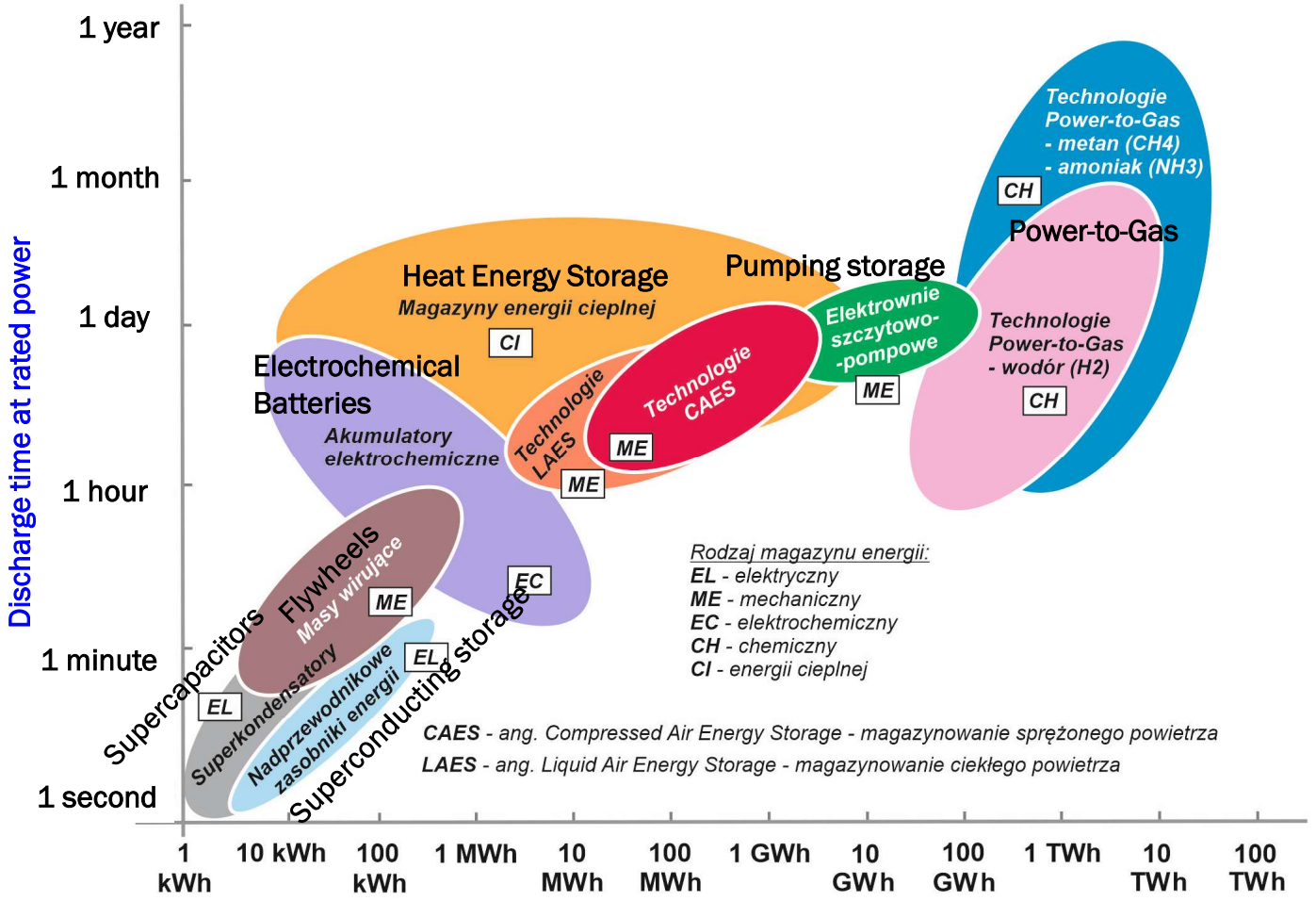
DUCK CURVE

- The **Duck Curve** refers to a graphical representation of electricity demand from the grid on days when solar energy production is high and demand in the grid is low. When plotted on a graph the lines and curves form a distinctly duck-like shape.
- Essentially, the Duck Curve represents the potential for power system instability, as the grid attempts to cope with extreme changes in demand across different parts of the day.



Source: https://www.synergy.net.au/Blog/2021/10/Everything-you-need-to-know-about-the-Duck-Curve

ENERGY STORAGE: VARIOUS TECHNOLOGIES AVAILABLE

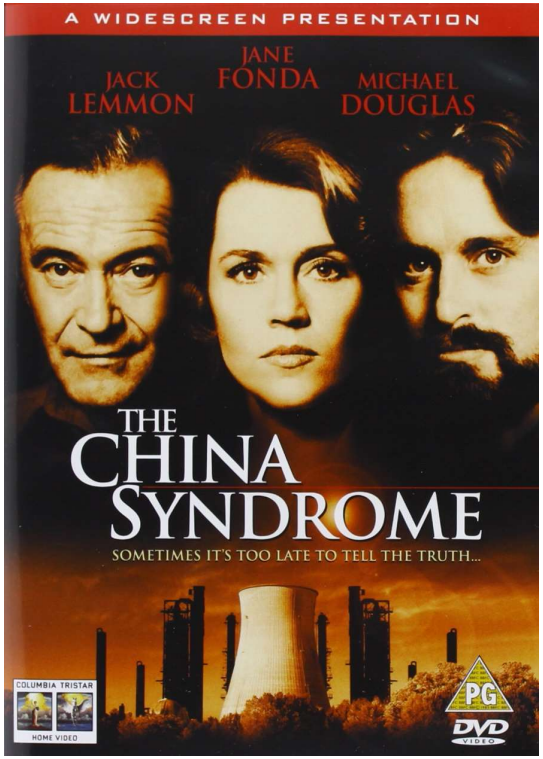


Graphics: Jacek Nowicki – own work

NUCLEAR POWER IS BACK

NUCLEAR POWER: CONTROVERSY SINCE 1970S

Danish activist Anne Lund designed the "Smiling Sun" logo in 1975 (image license: GFDL, image credit: OOA Fonden, WISE)



'The China Syndrome' - American disaster thriller film directed by James Bridges. Movie released on March 16, 1979, less than 2 weeks before Three Mile Island accident (image credit: Columbia)

NUCLEAR POWER IS BACK:
KEY DECISIONS OF EU PARLIAMENT IN 2023

- After the aggression of the Russian Federation against Ukraine in early 2022. Europeans realized that the issue of access to energy resources from Russia, especially natural gas, could become the subject of political and economic games overnight.
- The preliminary draft of the Zero Emission Industry Regulation presented on **16 March 2023 listed nuclear energy** as a means of decarbonising the economy.
- The European Parliament's change of attitude was crowned by the **inclusion of nuclear energy in the group of ‚green technologies' in November 2023.**

European Parliament

NEW NUCLEAR POWER TECHNOLOGY – WHY IT CAN BE STILL ATTRACTIVE?

- Mature – 70 years of experience.
- Practically CO_2-free.
- Limited space requirements (not more than conventional plant of similar rated power).
- High availability and effectiveness.
- Long lifetime: plants in current technology are expected to operate min. 60 years.
- Practical independence on regular fuel transport (single fuel load for 18 months in PWR).
- Suitable for heavy industry applications: steel, chemical, petrochemical, hydrogen production.
- New applications: large data centers and AI electrical supply.
- Considerably safer than nuclear plants 2nd Generation built in 1970s and 1980s.

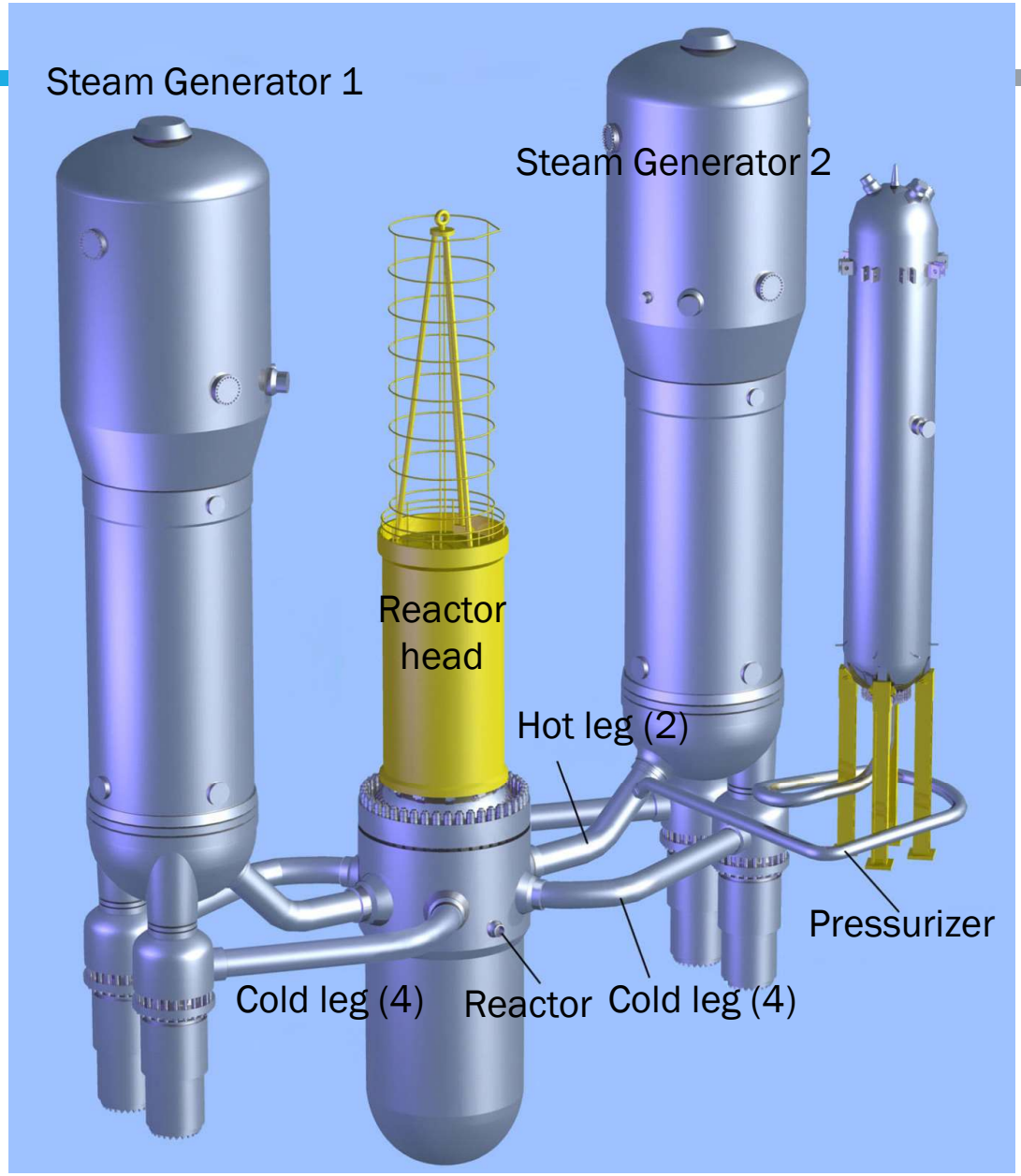
Photo: SNPTC

KEY TO NUCLEAR SATETY => PASSIVE SOLUTIONS

- Passive systems designs rely on natural forces to cool the reactor and add water:
  - Gravity (elevated water reservoirs);
  - Buoyancy;
  - Stored energy sources (for example compressed N2).
- Can include natural circulation based primary loop.
  - Hot water rises from core, transfers heat to heat sink, cool water returns to core.
- Can supply safety-injection water, perform core and containment cooling and other functions.
- Passive safety systems contain no pumps and can include valves that are operated by either air pressure or Direct Current (DC) electric power from batteries, check valves actuated by the pressure differential across the valve or even squib valves operated by micro explosive charges,

AP1000 – PRESSURIZED WATER REACTOR (PWR) – PRIMARY CIRCUIT

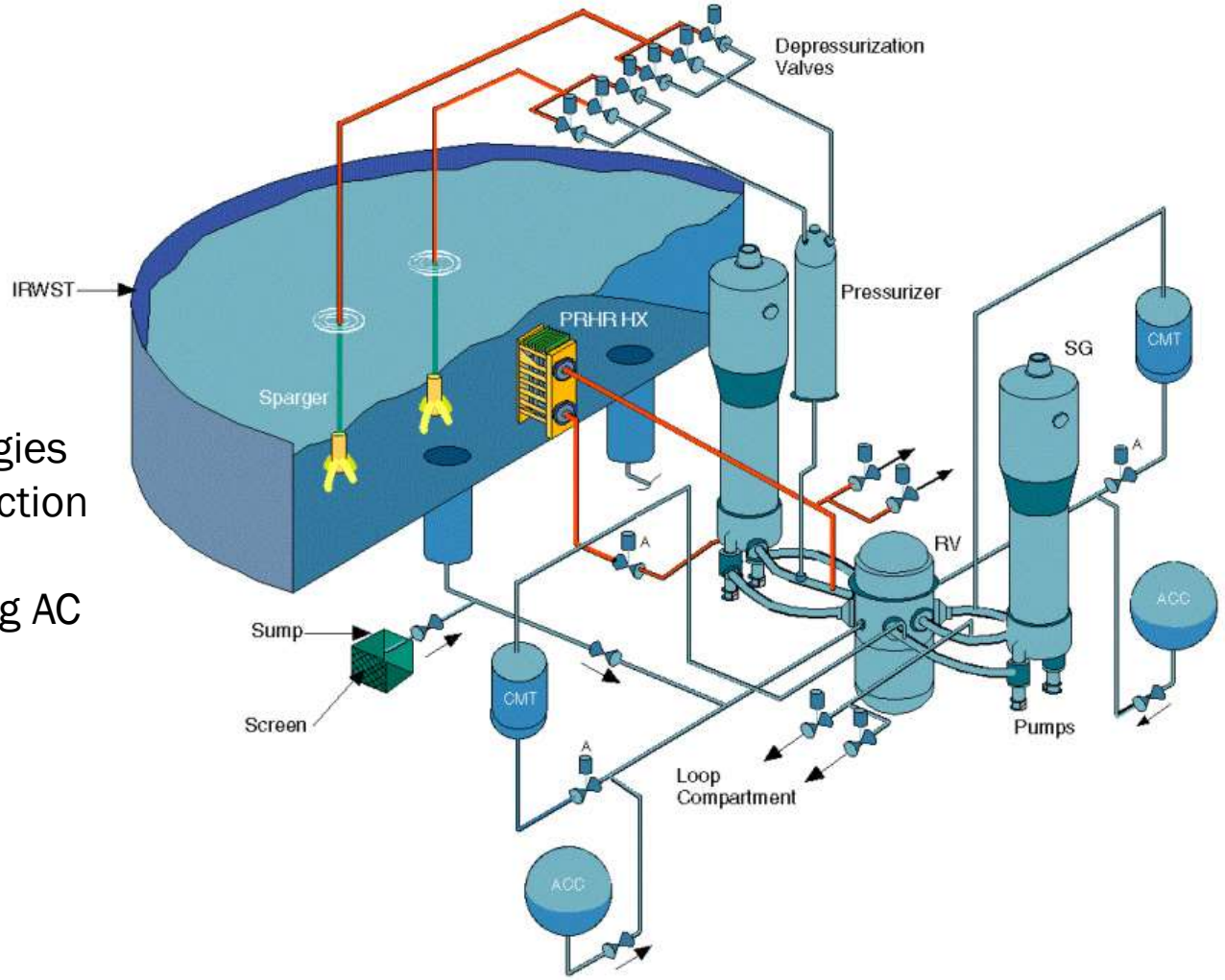
- Generation 3+ PWR (Pressurized Water Reactor).
- 6 units operational: Sanmen units 1, 2 and Hayiang units 1, 2 in China plus Vogtle 3 and 4 in USA.
- Pattern for Chinesee CAP1000 reactor intended for numerous sites in China.



Graphics: Westinghouse Electric

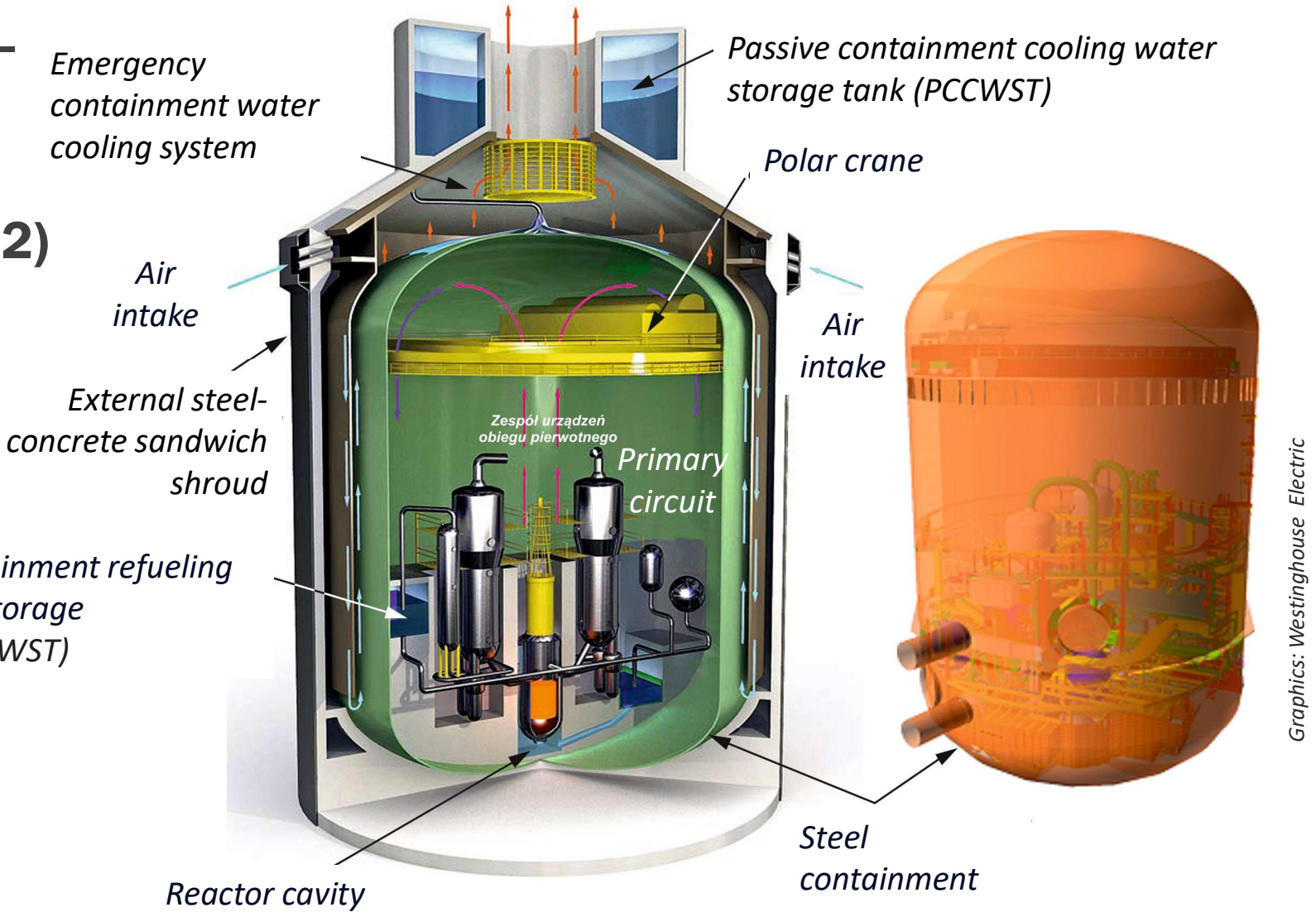
AP1000 UNIT– PASSIVE SAFETY SOLUTIONS (#1)

- Use of passive technologies allows for a radical reduction in the number of safety-related systems requiring AC power (onsite or offsite).



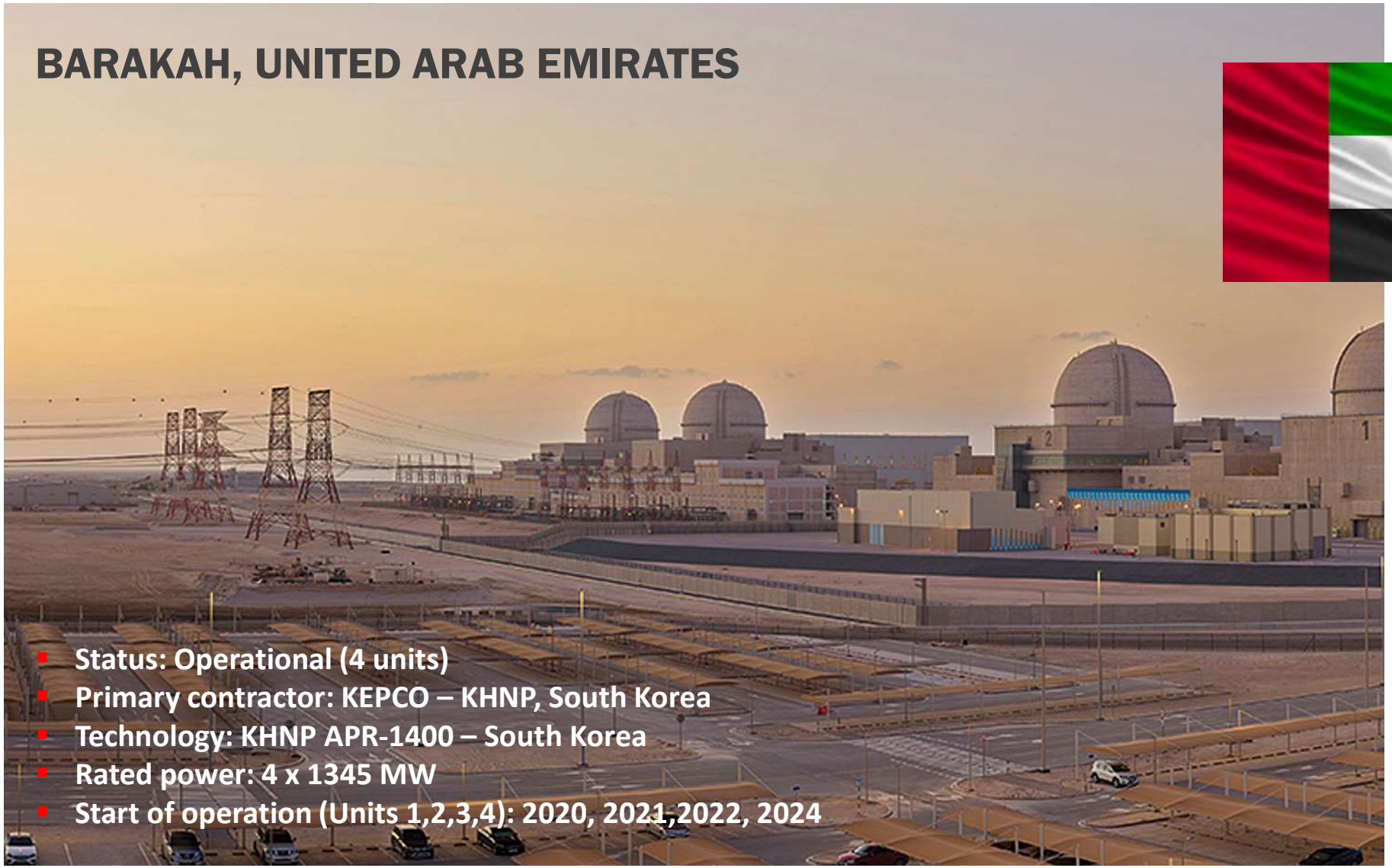
Graphics: Westinghouse Electric

AP1000 UNIT– PASSIVE SAFETY SOLUTIONS (#2)



JUST SOME EXAMPLES...

BARAKAH, UNITED ARAB EMIRATES



- Status: Operational (4 units)
- Primary contractor: KEPCO – KHNP, South Korea
- Technology: KHNP APR-1400 – South Korea
- Rated power: 4 x 1345 MW
- Start of operation (Units 1,2,3,4): 2020, 2021,2022, 2024

VOGTLE NPP UNITS 3 AND 4, GEORGIA, USA

- Status: operational (Units 3 and 4 + 2 older Units 1 and 2)
- Primary contractor: Westinghouse-Bechtel
- Technology; Westinghouse Electric AP1000
- Capacity: 2 x 1117 MW net. (Units 3 and 4)
- Start of operation 2022-2024.

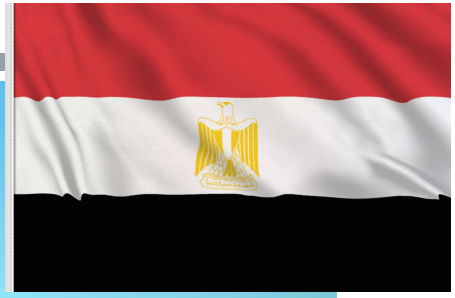
LUBIATOWO-KOPALINO NPP, POLAND

- Status: 18-months design phase
- Primary contractor: Westinghouse-Bechtel
- Technology: Westinghouse Electric AP1000
- Capacity: 3 x 1117 MW net.
- Scheduled operation start: 2033-39

AKKUYU NUCLEAR POWER PLANT - TÜRKIYE

- The Akkuyu Nuclear Power Plant will consist of four VVER-1200 units.
- Construction began in 2018 and is already well advanced.
- Planned first unit comissioning 2025.
- Akkuyu NPP will cover 10% of Türkiye’s electricity demand.

EL DABA NUCLEAR POWER PLANT, EGYPT



- The El Dabaa Nuclear Power Plant is being built in the Matrouh province on the Mediterranean coast, about 320 kilometers northwest of Cairo.
- The project is based on the use of Russian pressurized water reactors of the VVER-1200 type supplied by Rosatom.
- The turbine part is supplied by the French General Electric plant in Belfort.
- Construction work on the first unit began in 2022.

SIZEWELL-C, UNITED KINGDOM

- In the UK, the construction of the Hinkley Point C (HPC) nuclear power plant on the south coast of England with two EPR units is very advanced. Expected commision date: 2029-31.The first of them is to be launched in 2026. Another investment is in the advanced preparation phase – the Sizewell C power plant in Suffolk (see Fig. 8), which is an almost exact replica of the Hinkley Point C power plant.

Sizewell C (planowane 2 bloki EPR)

Sizewell B (1 blok PWR-SNUPPS – w eksploatacji od 1995 r.)

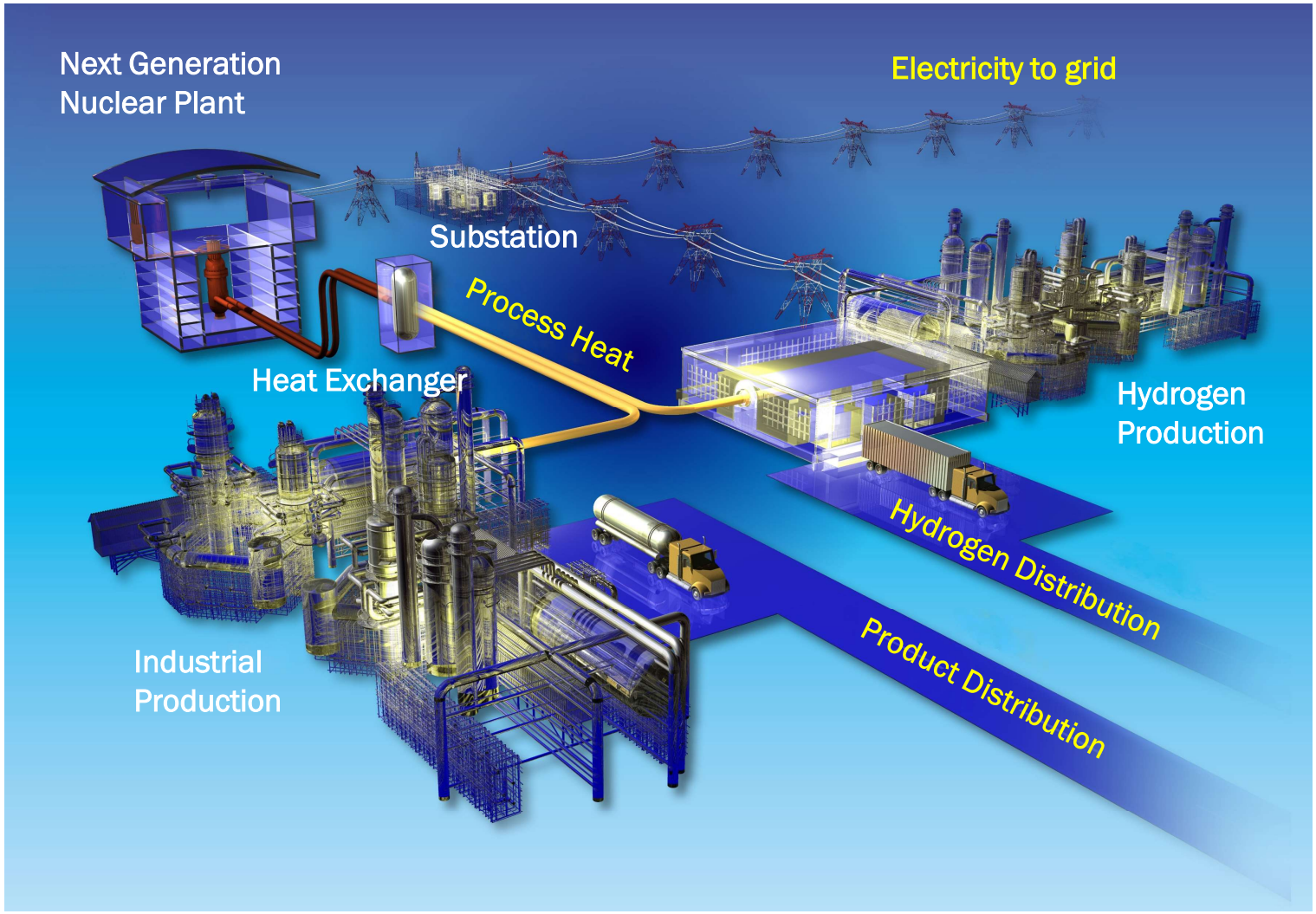
Sizewell A (2 bloki GCR-Magnox – eksploatowane w latach 1966-2006)

CHINA – 22 NUCLEAR UNITS IN CONSTRUCTION

- As of February 2023, there are 55 operational units in Chinese nuclear power plants with a capacity of 57 GW.
- 22 units with a capacity of 24 GW remain under construction.
- 70 units are planned with a capacity of 88 GW.

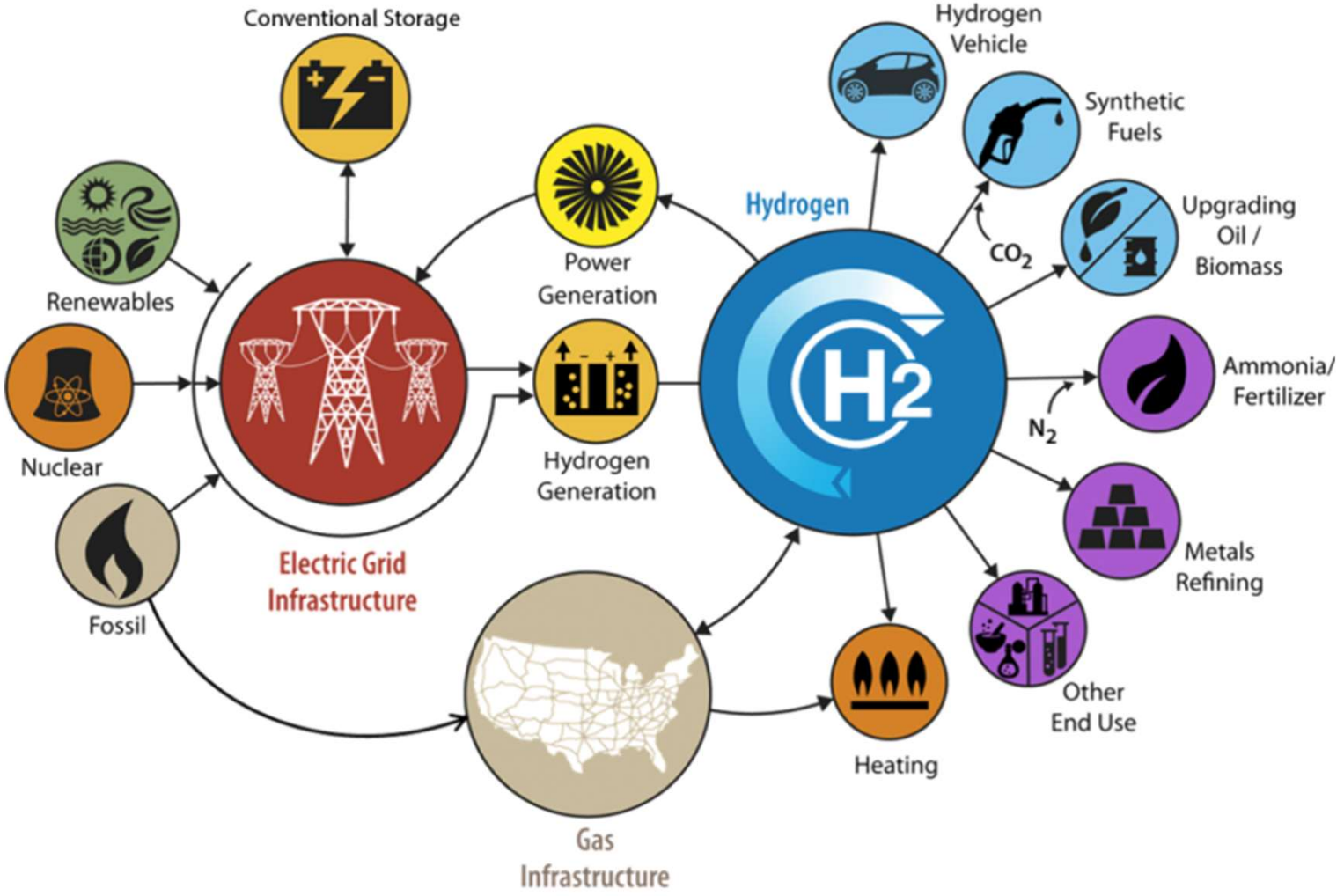
NEW IDEAS ARE COMING UP...

NUCLEAR POWER: ELECTRICITY, PROCESS HEAT AND HYDROGEN PRODUCTION



Graphics: Idaho National Laboratory,
Graphics: Idaho National Laboratory,

RENEWABLES, NUCLEAR AND HYDROGEN POWER



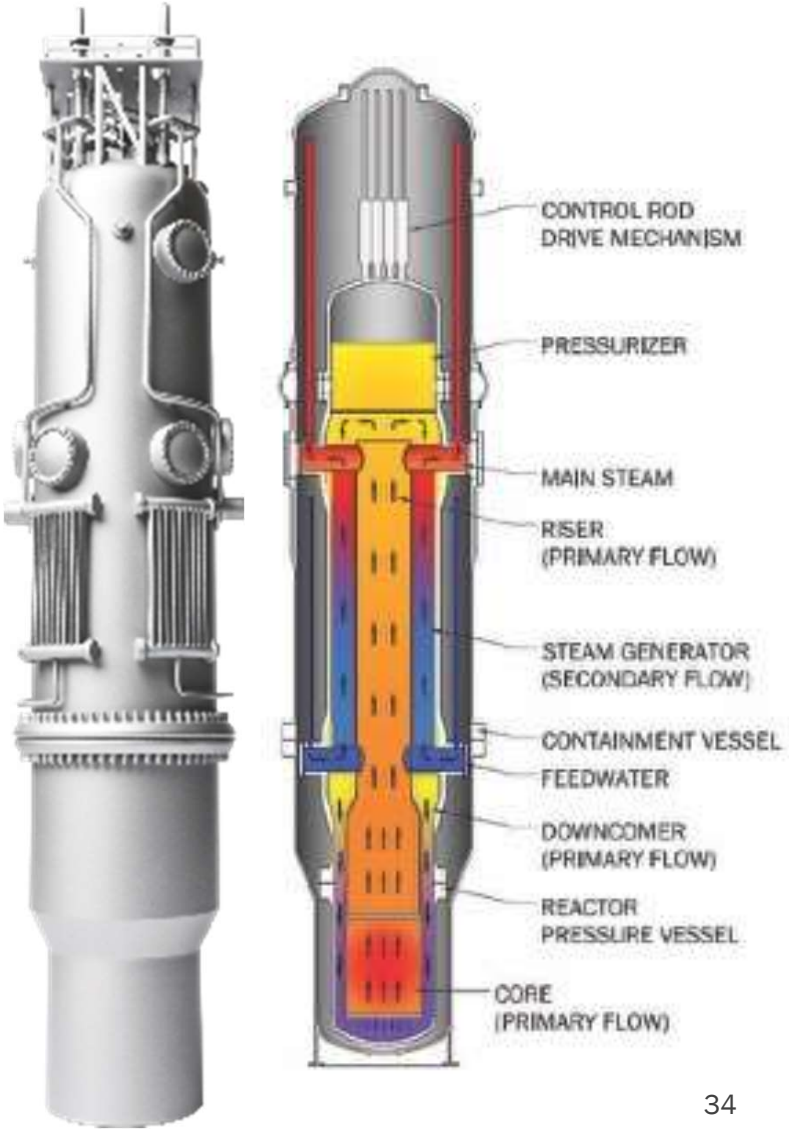
U.S. Department of Energy

SMALL MODULAR REACTOR CONCEPTS (=<300 MW)

- Transportable modules (by road or water – see illustrations) manufactured in industrial plant conditions.

Graphics: Nuscale

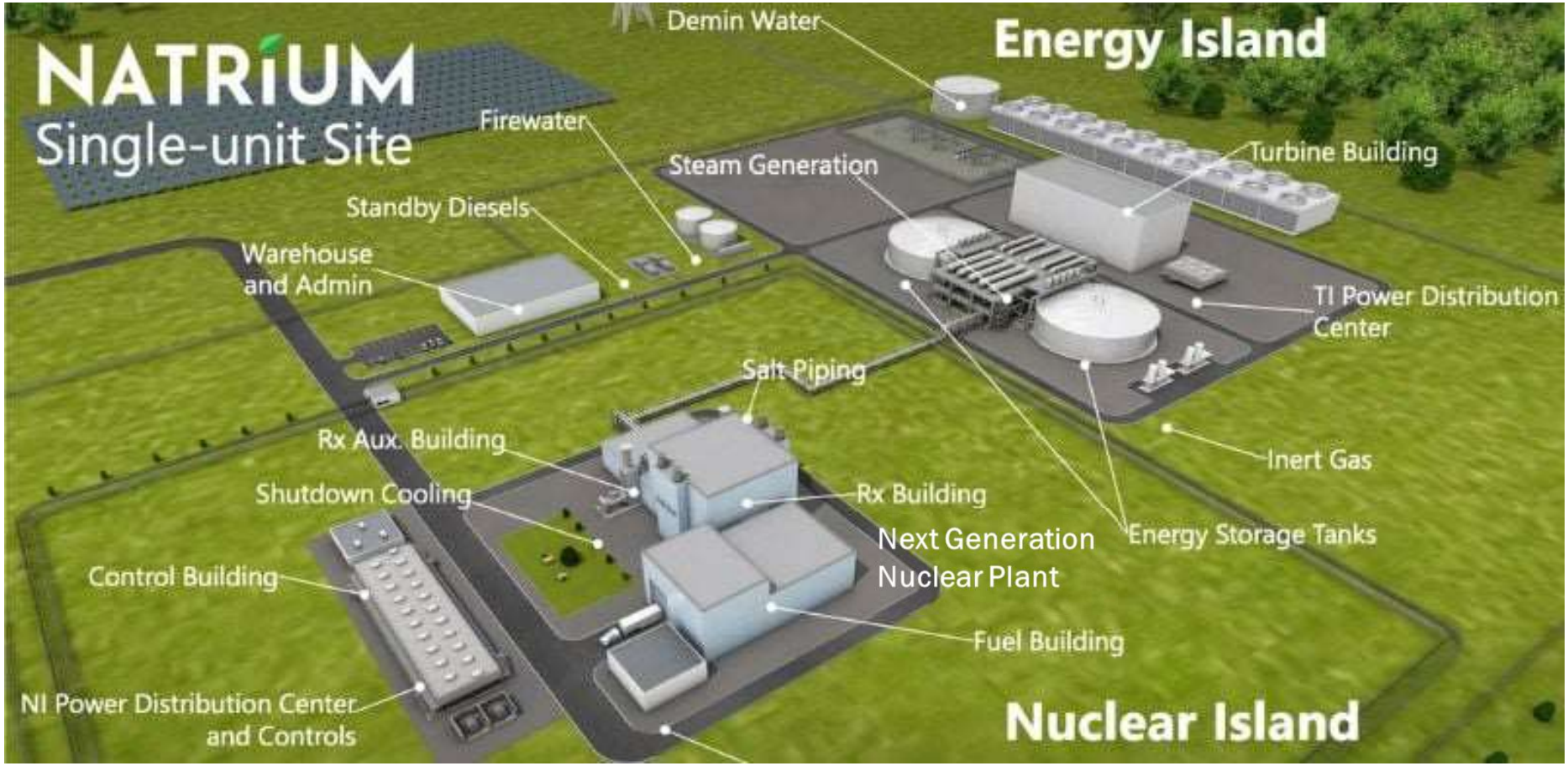
SMALL MODULAR REACTOR CONCEPTS (=<300 MW)



- Multiple modules installed in common underground water pool.
- Passive safety implemented.
- Flexibility of applications: power for utilities, heavy industry, sea water desalination and many more.

Graphics: Nuscale

TERRAPOWER



Graphics: Terrapower

- In Naughton Power Plant in Kemmerer, Wyoming. Bill Gates and his energy company are starting construction of next-generation nuclear power plant co-operating with energy storage system.

FINAL CONCLUSIONS

- Decarbonization of the EU economy forces painful decisions to be made to eliminate fossil fuels from the energy mix.
- Lessons learned from the war in Ukraine and the desire to accelerate the entire process of energy transformation have led to an opening up to nuclear power, previously pushed to the margin.
- Attention has been drawn again to its zero-emission nature and high operational certainty.
- In synergy with renewable sources, energy storage systems and nuclear power together have unique a chance to become pillars of the European energy mix of the future.


Thank You for Your Attention!

European Future Technology Summit

Superconductivity –
Key Technology for the Energy Transition

03/09/2024

Prof. Dr. Michael Bäcker

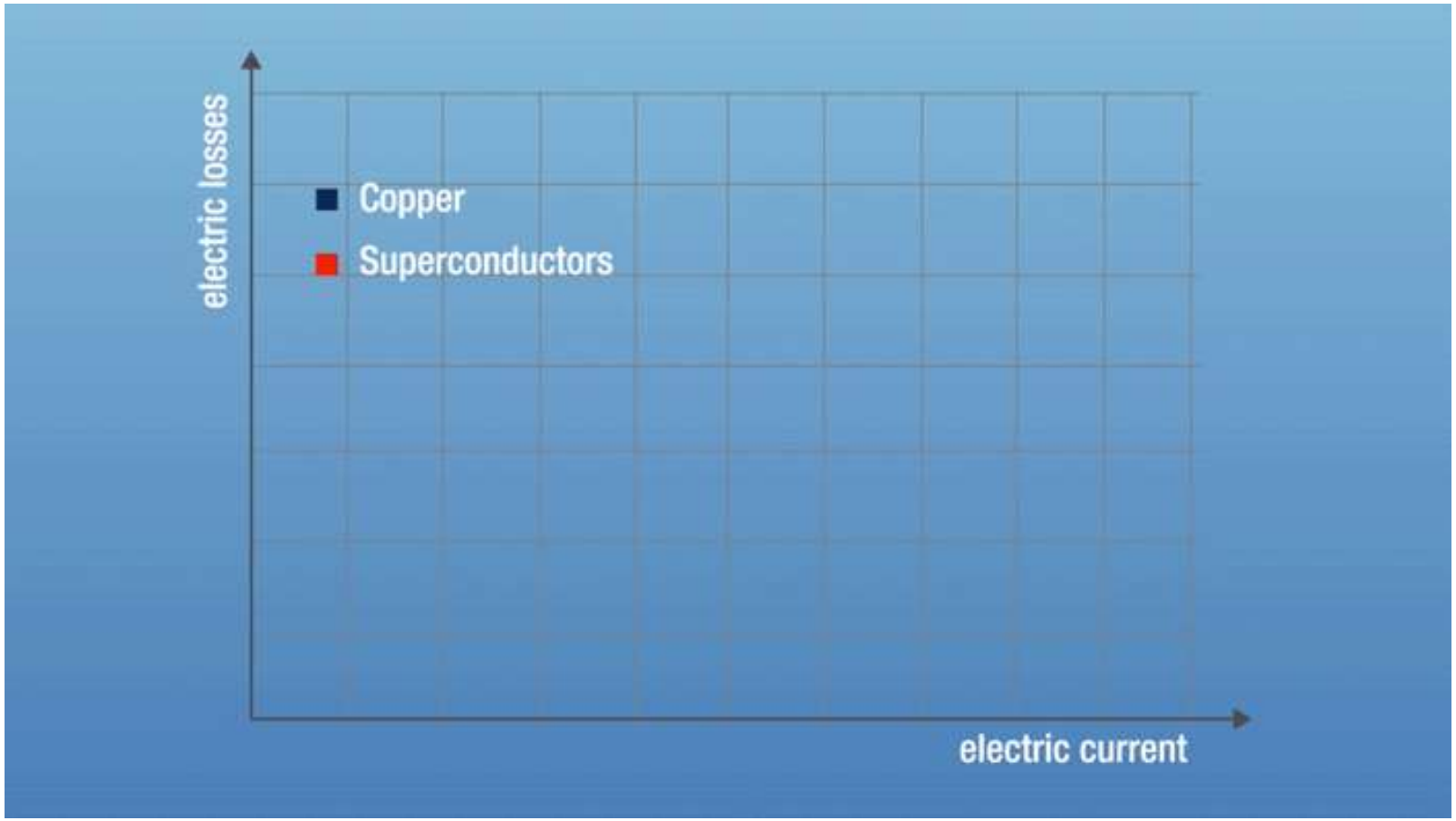
Board member ivSupra e.V., MaTech-Consult GmbH

outline

- Superconductors change paradigms in energy technology
- High Temperature Superconductors (HTS)
- Superconductors for the energy transition
  - Power distribution - HTS cables in urban areas
  - Mobility – HTS systems in all electric aircrafts
- Summary

Superconductors change paradigms in energy technology

- Energy efficiency – no ohmic restistance
- Grid protection – non-linear restistance

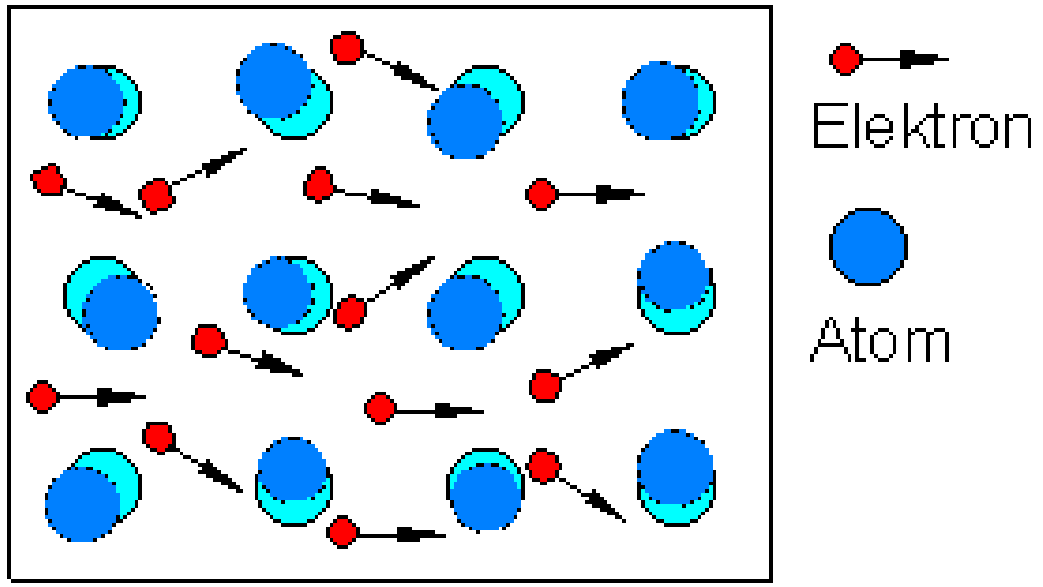


Superconductors change paradigms in energy technology

- **Material efficiency – highest current density**

Superconductors change paradigms in energy technology

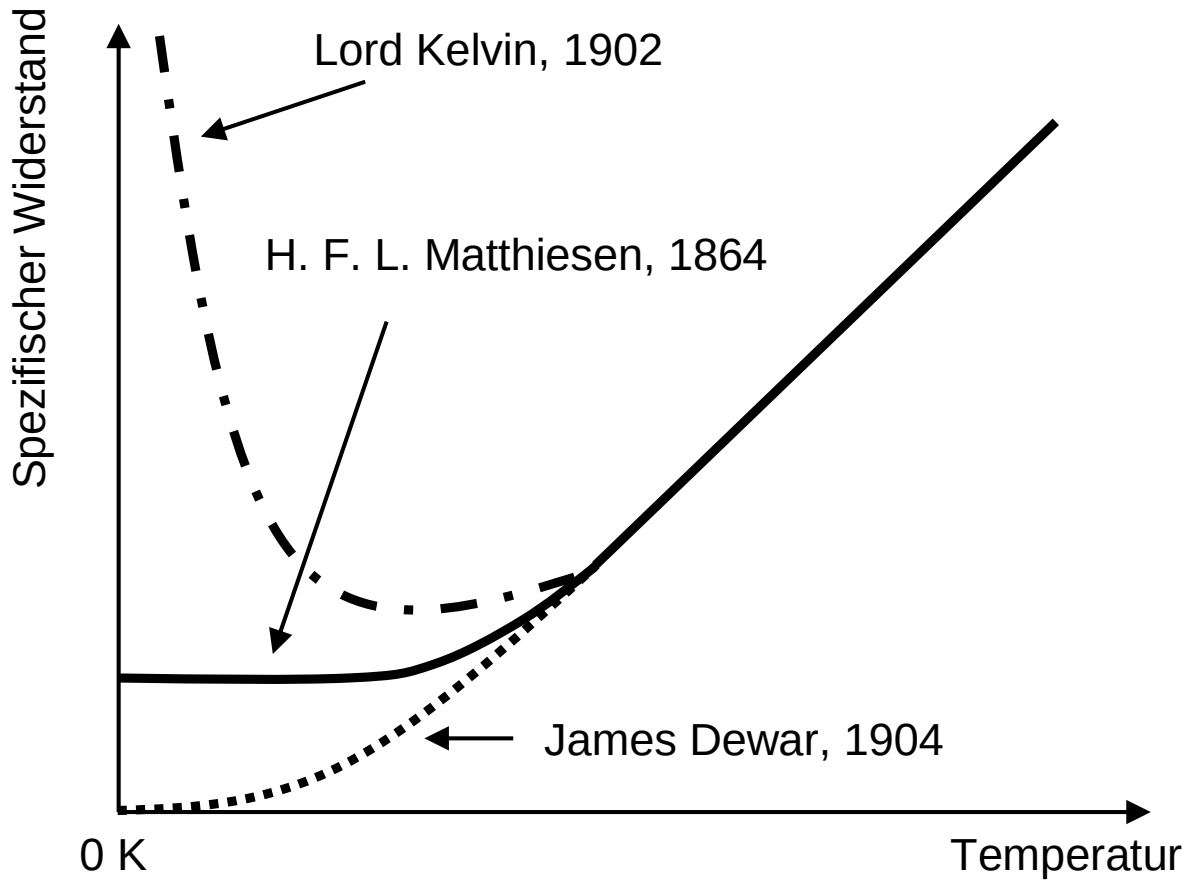
- **Electrical/ohmic restistance**
  - Charge transfer by electrons (Drude 1900)



  - Good conductivity in metals due to free charge carrier
  - Increase of resistance with increasing temperature due to thermal vibrations of atomic nuclei

Superconductors change paradigms in energy technology

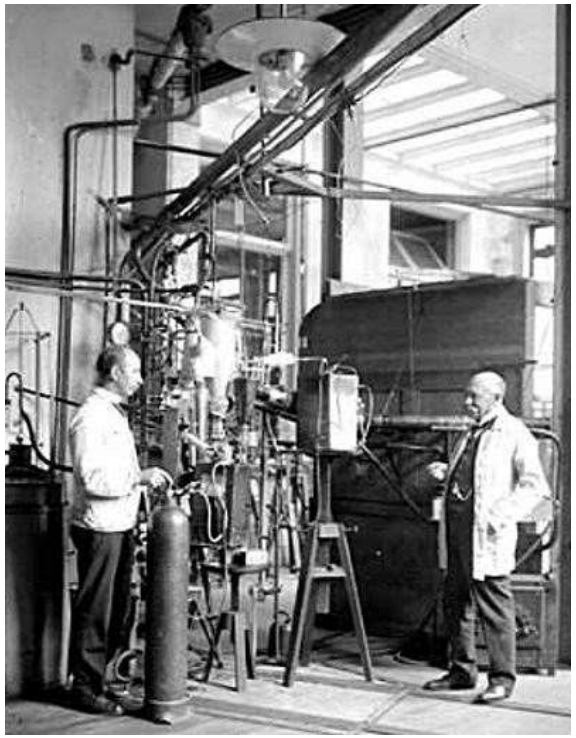
- **Ohmic restistance at low temperatures**



Supraleitung, W. Buckel, VCH, ISBN 978-3-527-41139-9

Superconductors change paradigms in energy technology

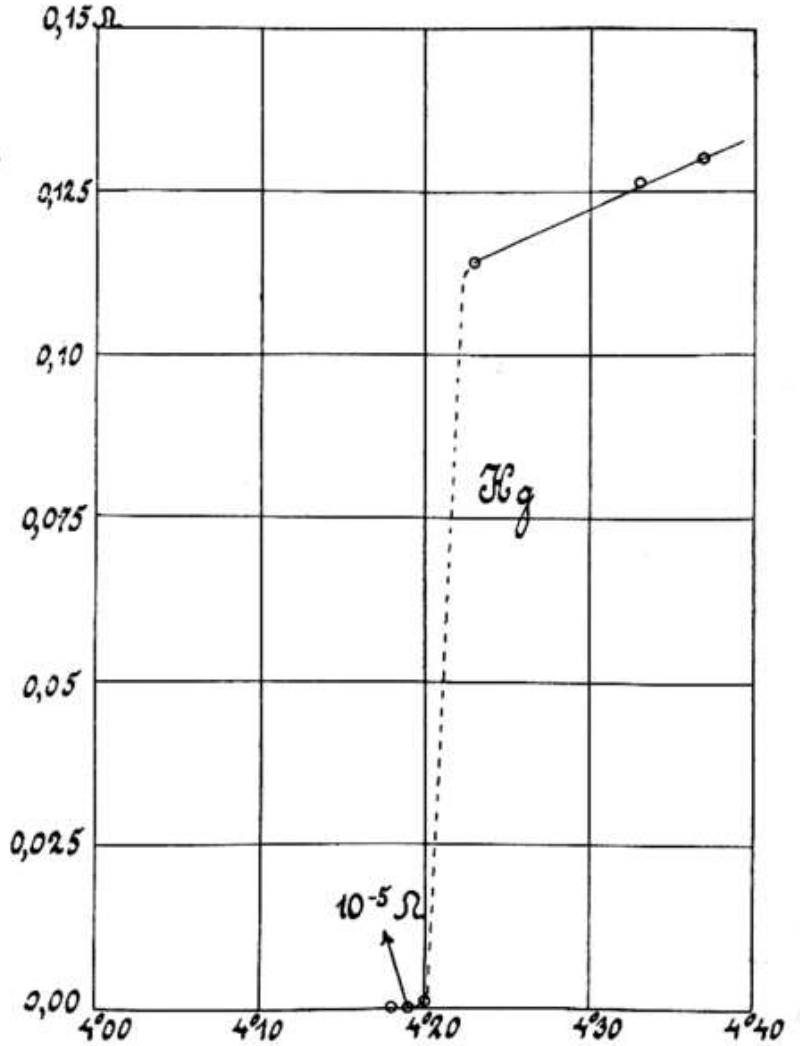
- **Ohmic restistance at low temperatures**
  - Liquification of Helium by Kamerlingh-Onnes
  - Temperatures of 4,2K accessible



Supraleitung, W. Buckel, VCH, ISBN 978-3-527-41139-9

Superconductors change paradigms in energy technology

- **Ohmic restistance at low temperatures**
  - First measurements of Kamerlingh-Onnes at Gold and Platinum
    - Residual resistance towards fixed value (Matthiesen)
    - Residual restance depending on purity of samples
    - Hypothesis: residual restistance of pure samples is 0 (Dewar)
  - New measurements at Mercury (destilled – highest purity)
    - New phenomenon: **Superconductivity**



Supraleitung, W. Buckel, VCH, ISBN 978-3-527-41139-9

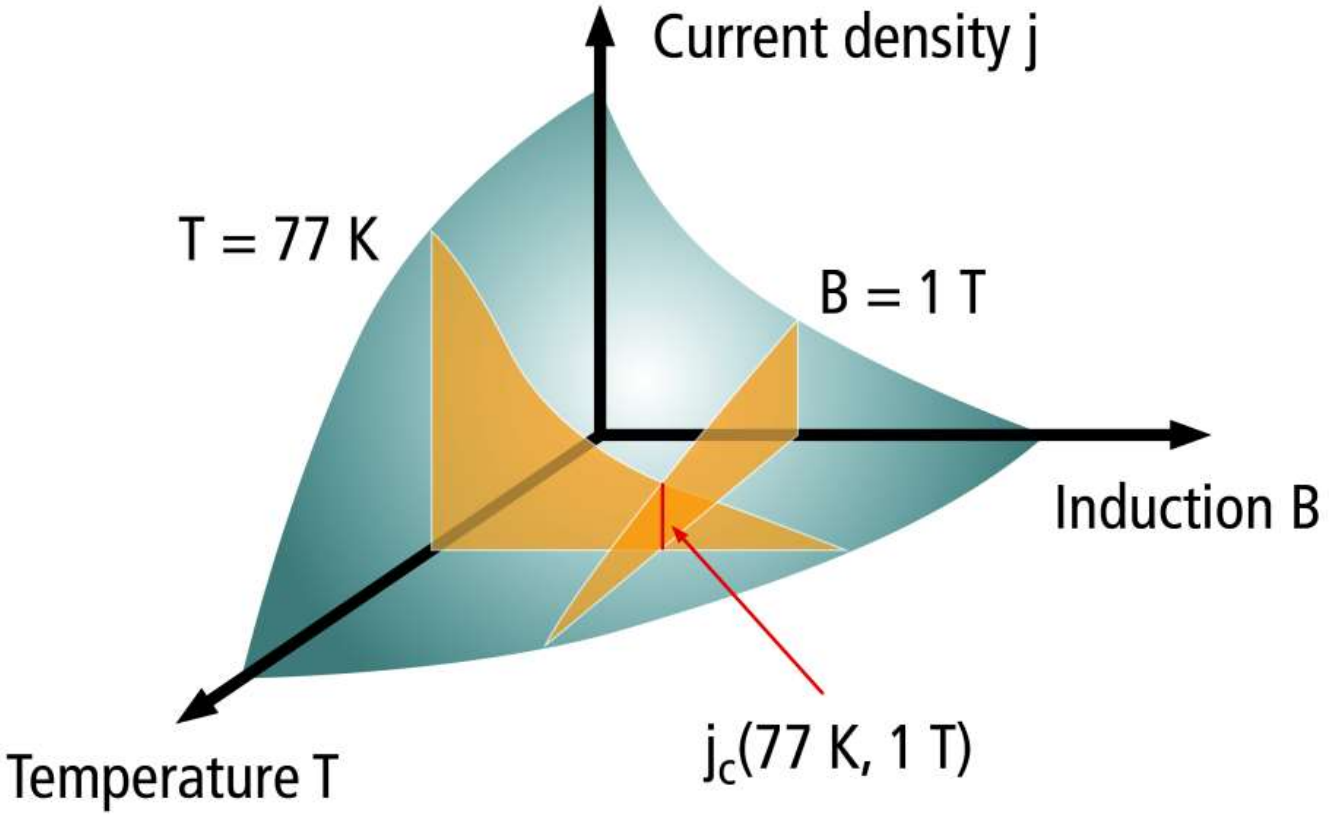
Superconductors change paradigms in energy technology

- **Quantum-mechanical interaction**
  - Interaction required for ordering of electron system
  - Interaction of electrons by lattice vibrations (phonons) (Fröhlich, Bardeen 1950/51)
  - Interaction between exactly two electrons forming a Cooper pair

  - First theory for superconductivity in metals 1957 (Bardeen, Cooper, Schrieffer), **BCS theory**

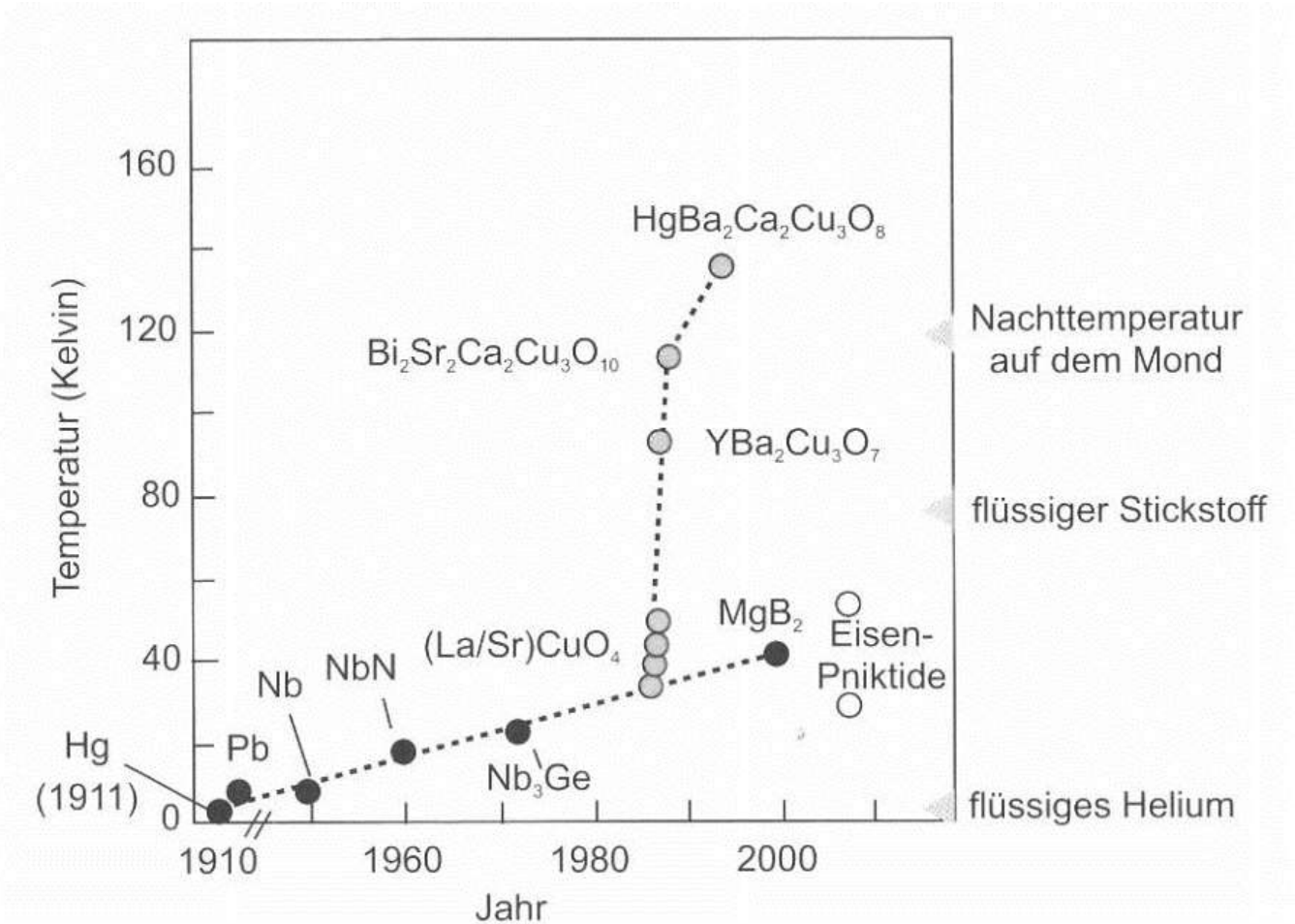
Superconductors change paradigms in energy technology

- Area of stability, electronic transition
- Critical parameter: temperature, magnetic field, electric current



High-Temperature-Superconductors (HTS)

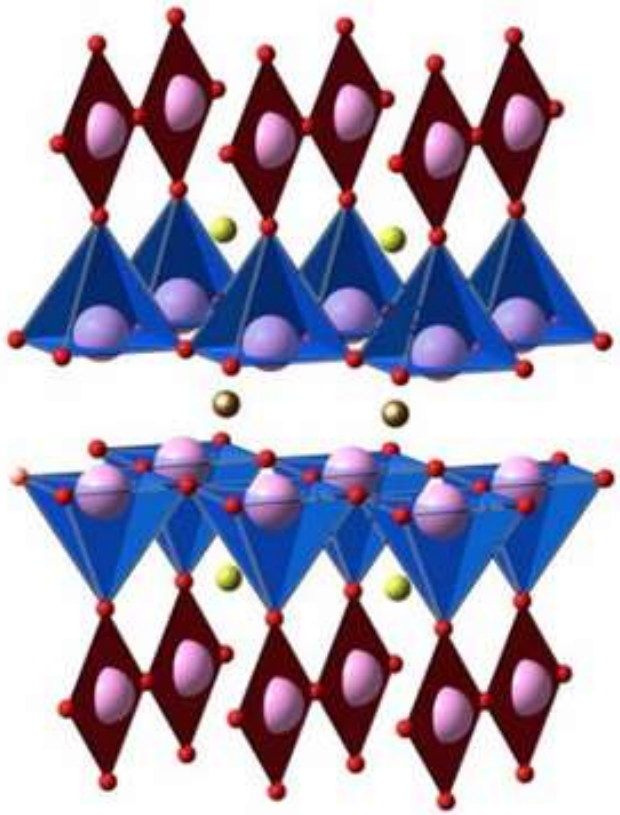
- **Discovery of High Temperature Superconductors**



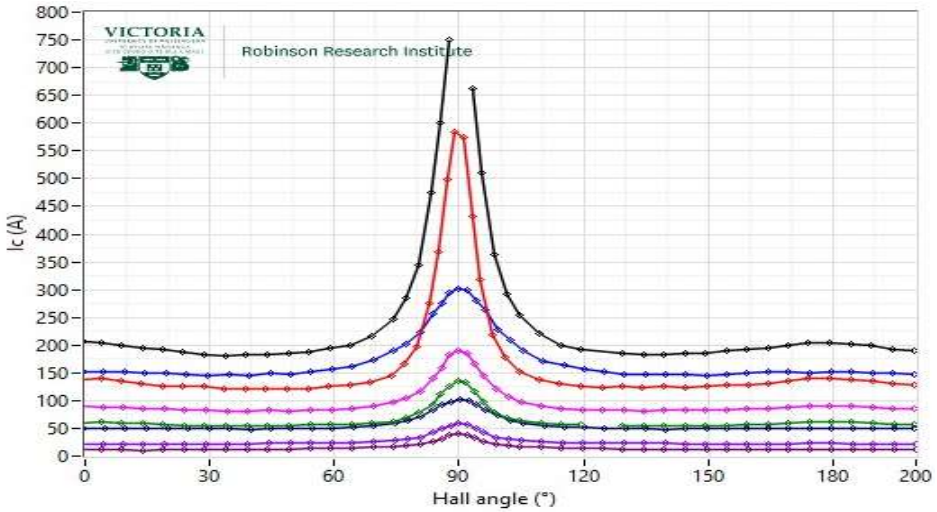
Supraleitung, W. Buckel, VCH, ISBN 978-3-527-41139-9

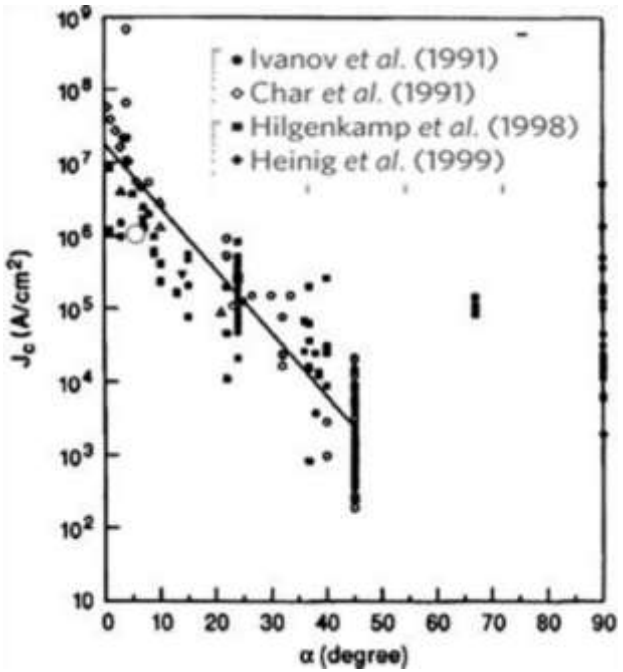
High-Temperature-Superconductors (HTS)

- **Complex structure and properties**
  - Yttrium-Barium-Copper-Oxide (YBCO)
  - Strong anisotropy



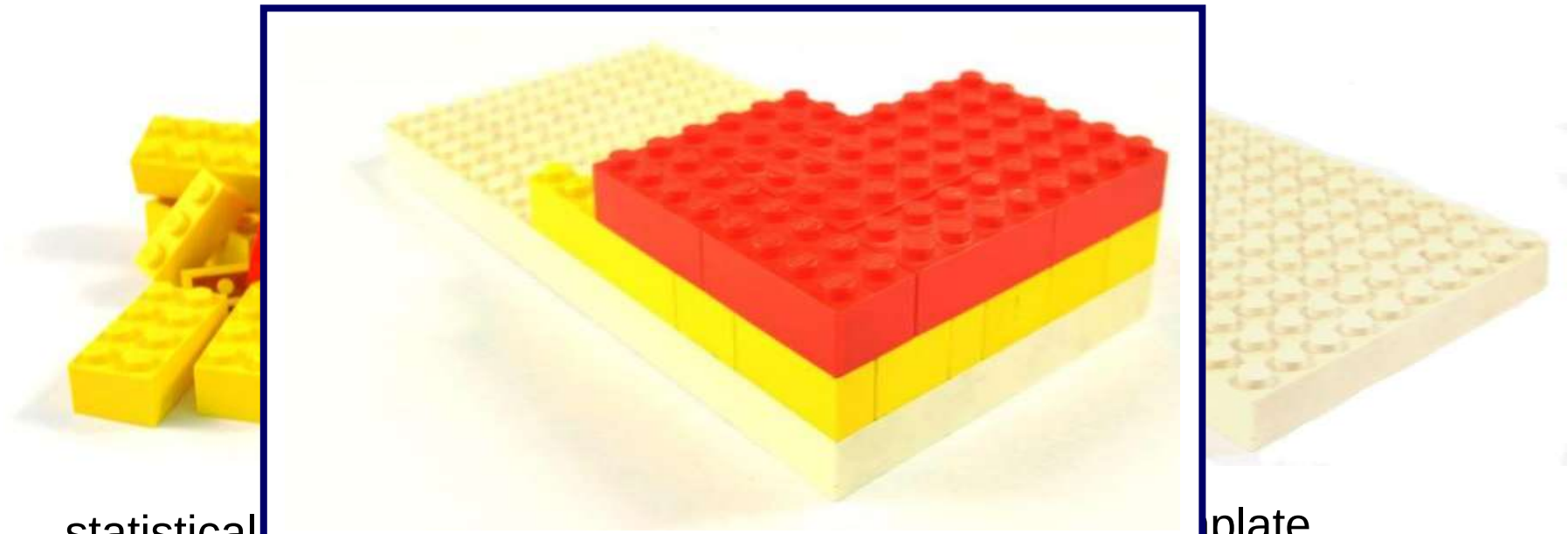
- intra-grain- vs. inter-grain-current
- Alignment of crystals along conductive path mqndatory





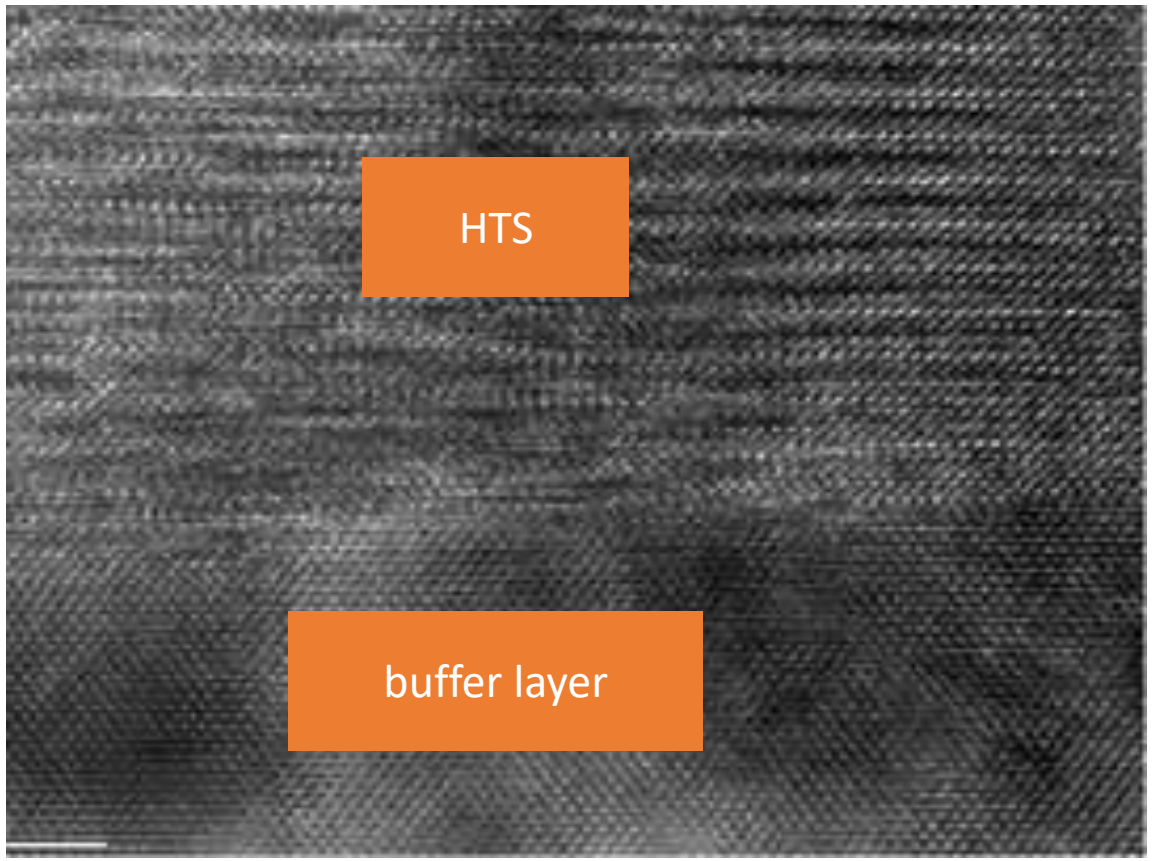
High-Temperature-Superconductors (HTS)

- **From nano-engineering to long length processing of HTS tapes**



High-Temperature-Superconductors (HTS)

- **From nano-engineering to long length processing of HTS tapes**
  - Epitaxial growth of HTS layers on buffer layer templates

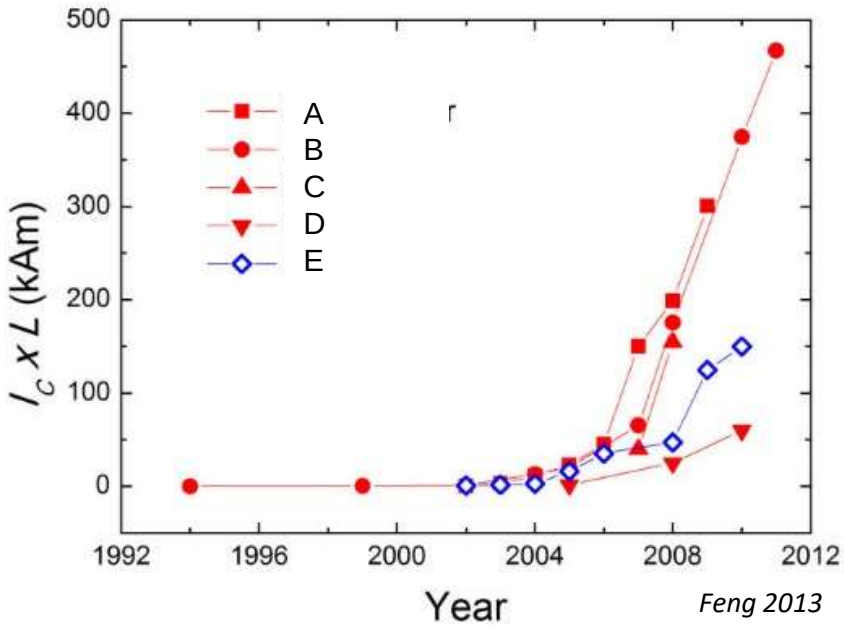


Deutsche Nanoschicht

Superconductors for the Energy Transition

- **From nano-engineering to long length processing of HTS tapes**
  - HTS tape available worldwide in high quality and rapidly increasing quantity
  - Unit lengths > 500m, joints and terminations available

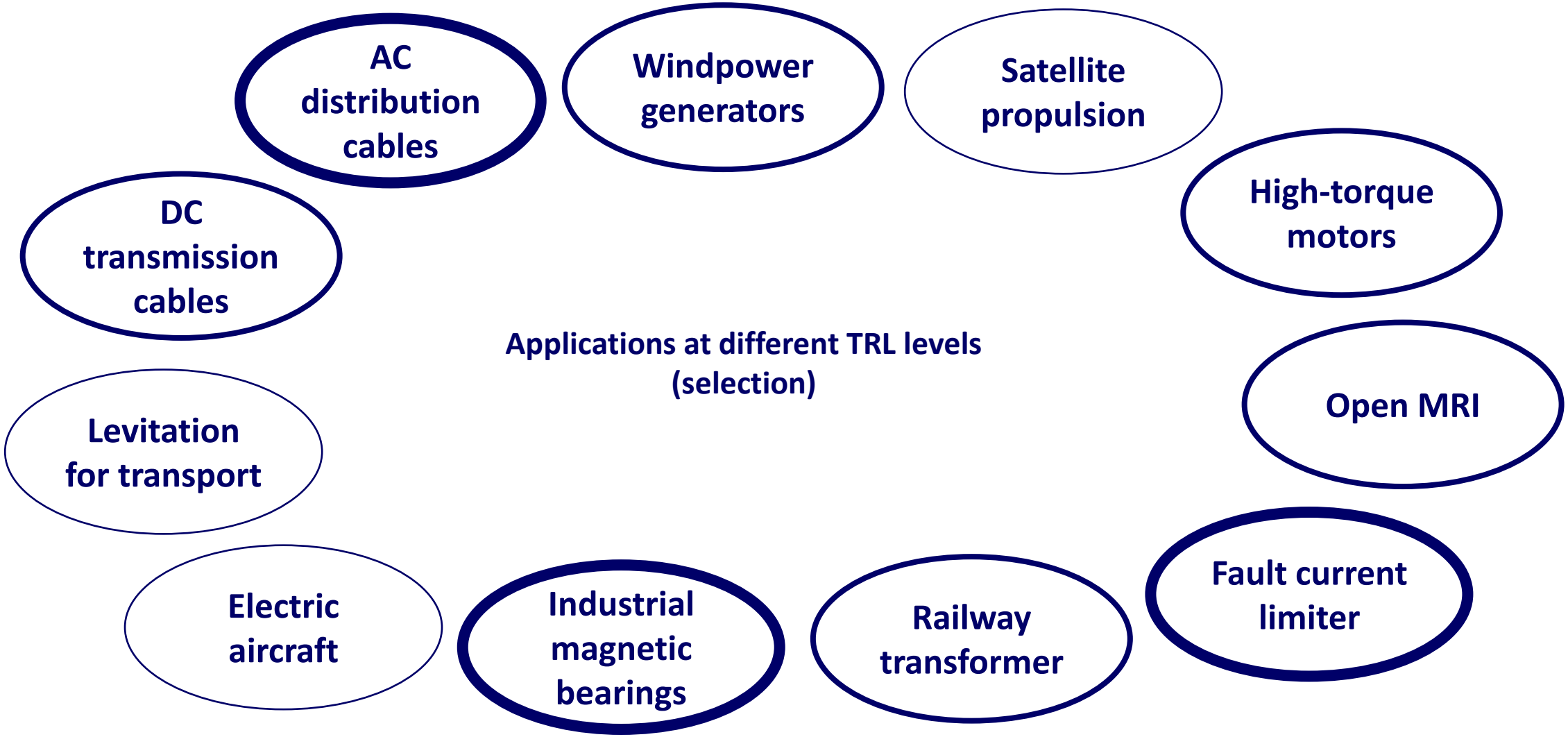
THEVA



Feng 2013

Superconductors for the Energy Transition

- **Applications of High-Temperature-Superconductors**



Superconductors for the energy transition

General considerations

1. **Technology readiness level**

   Innovations in energy technology require >30 years from (material-)discovery to system product.

2. **Power range**

   Energy technology is high power technology. Innovations must be realized in high energy ranges >>MW.

3. **Market penetration**

   Innovations in energy technology require fast and high market penetration in order to contribute to climate protection targets.

Superconductors for the energy transition

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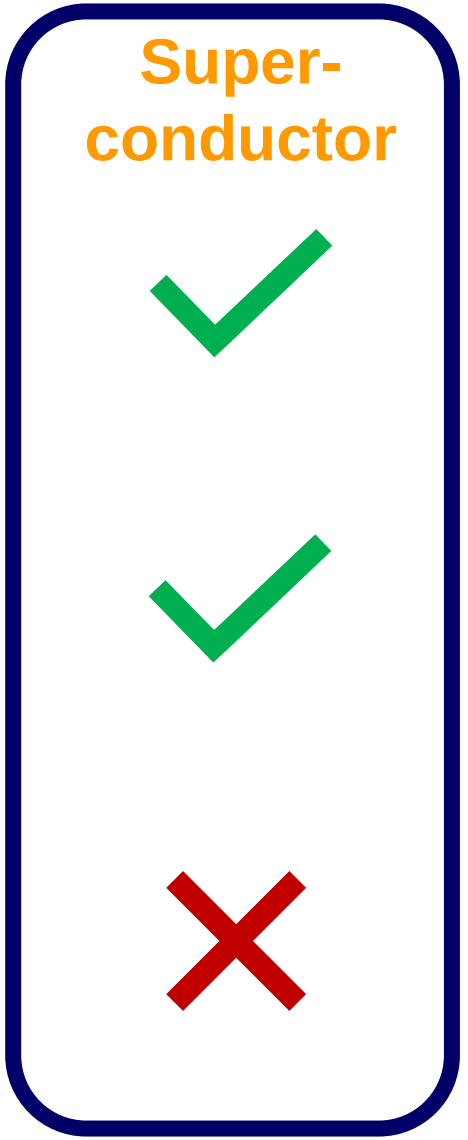
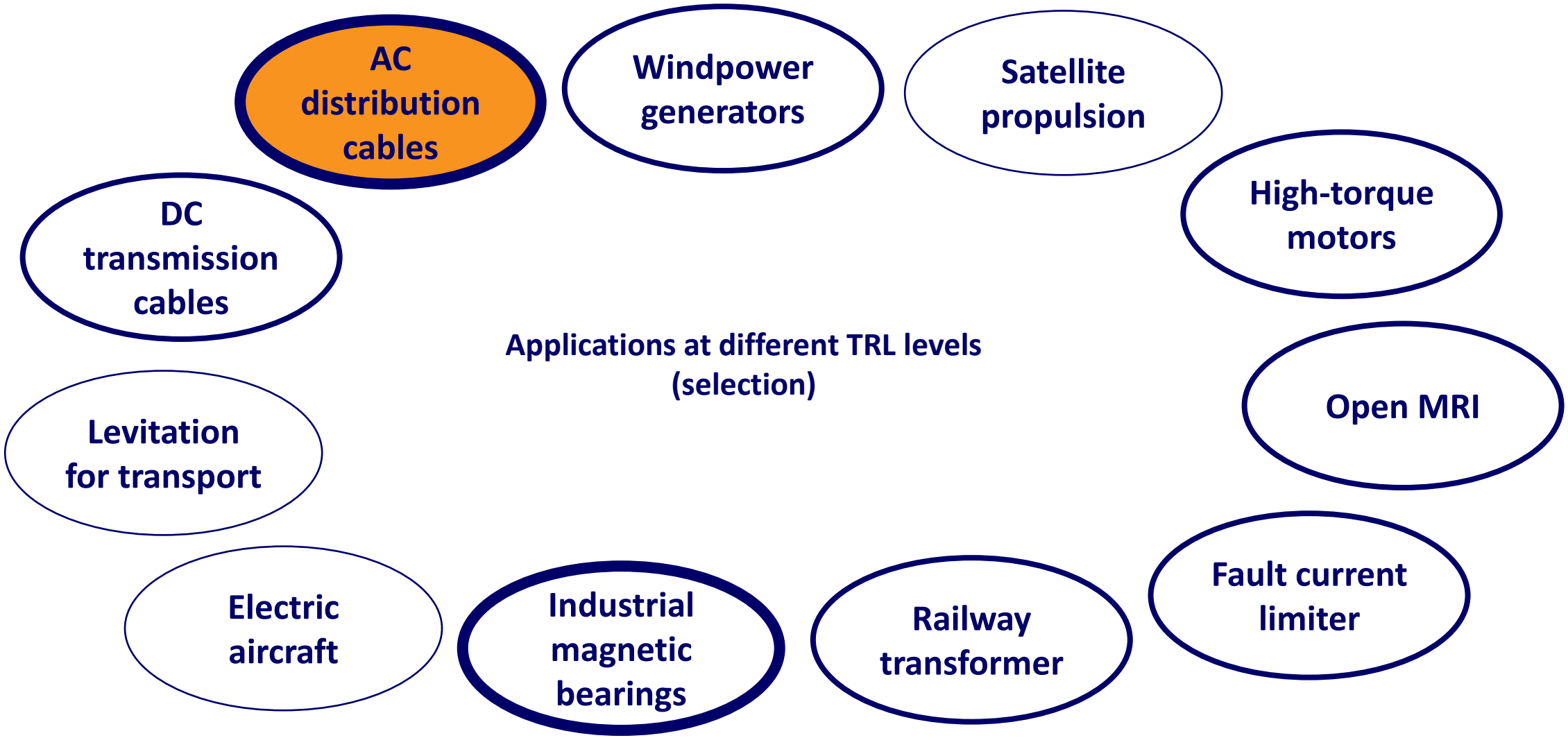


Superconductors for the Energy Transition

- **Applications of High-Temperature-Superconductors**



Power distribution - HTS cables in urban areas

HTS cables enable

- highest energy transport with lowest foot-print
- lowest electro-magnetic and thermal emission
- easier integration of renewable energies at lower voltage level
- higher public acceptance and faster realization

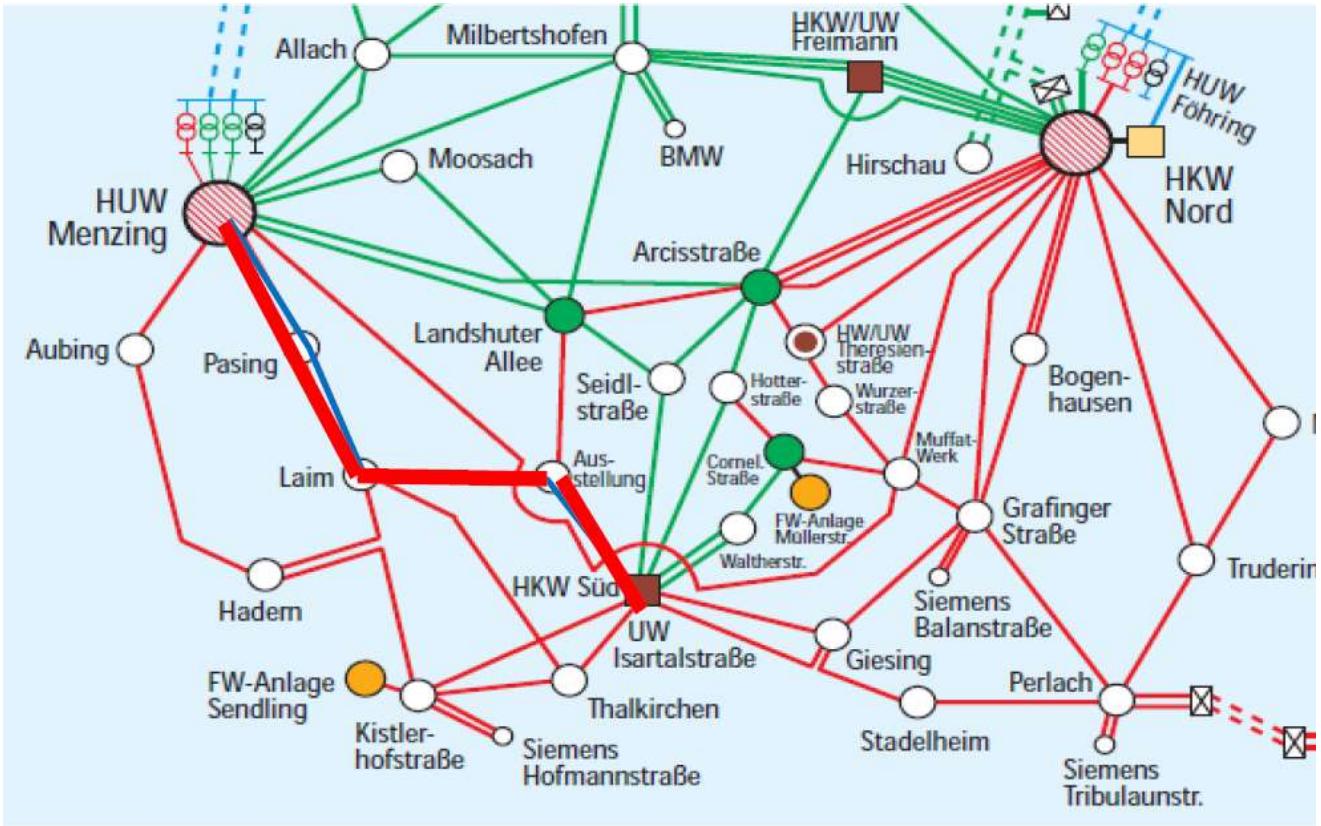
➢Energy distribution in dense urban areas – increasing demand and limited space

➢Energy transmission in critcal sections – higher acceptance with low emission and foot-print

Power distribution - HTS cables in urban areas

Project SuperLink

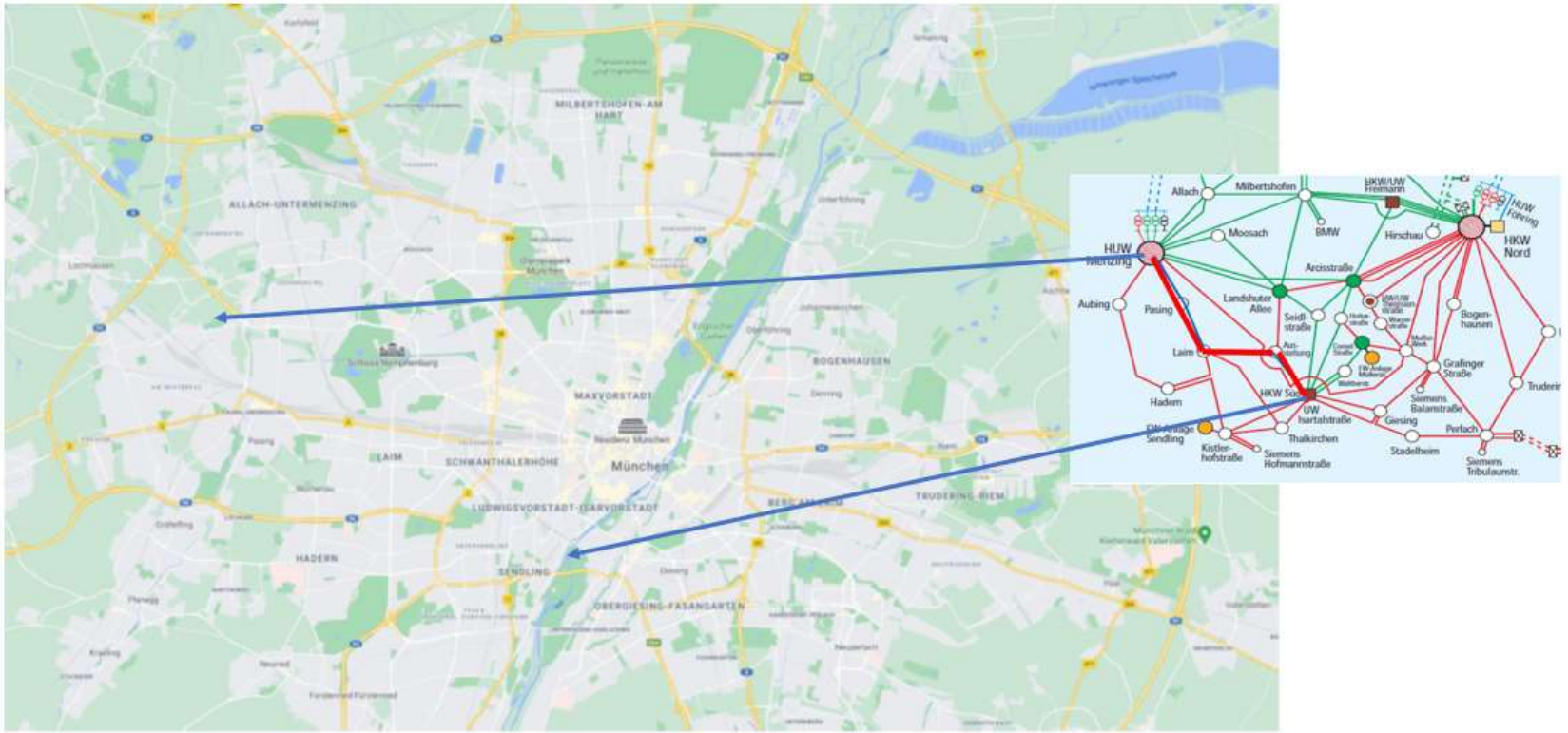
- The Munich challenge: 500MVA connection of main substation Menzing and cogeneration plant Süd



Power distribution - HTS cables in urban areas

Project SuperLink

- The Munich challenge: 500MVA connection of main substation Menzing and cogeneration plant Süd



Power distribution - HTS cables in urban areas

Project SuperLink

- The Munich challenge: 500MVA connection of main substation Menzing and cogeneration plant Süd
- **Alternatives:**

400 kV XLPE cable system
E.g. tunnel solution, as in Berlin, London

Multiple 110 kV XLPE cable systems
5 systems & routes

400 kV overhead line
Not feasible in the city

110 kV HTS cable
Novel technology

Power distribution - HTS cables in urban areas

Project SuperLink

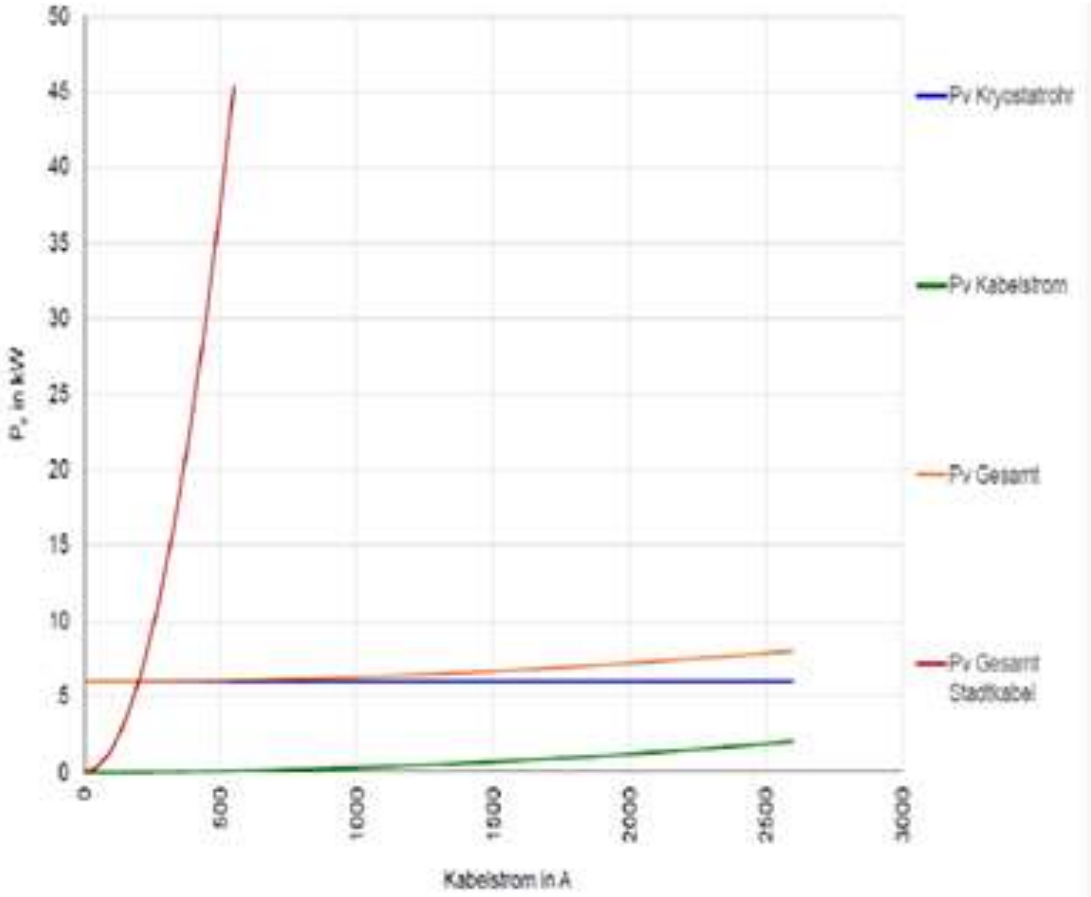
- Cable design – short-curcuit tolerant
  - 110kV, 500MW
  - 12km length (pre-project 200m)
  - Short curcuit 1s @ 40kA
- Project timeline
  - Evaluation /pre-project 2021-2023
  - Tender 12km project 2024
  - 12km commercial project 2024-2026

Three phases in one cryostat
HTS cable, NKT

Power distribution - HTS cables in urban areas

Project SuperLink

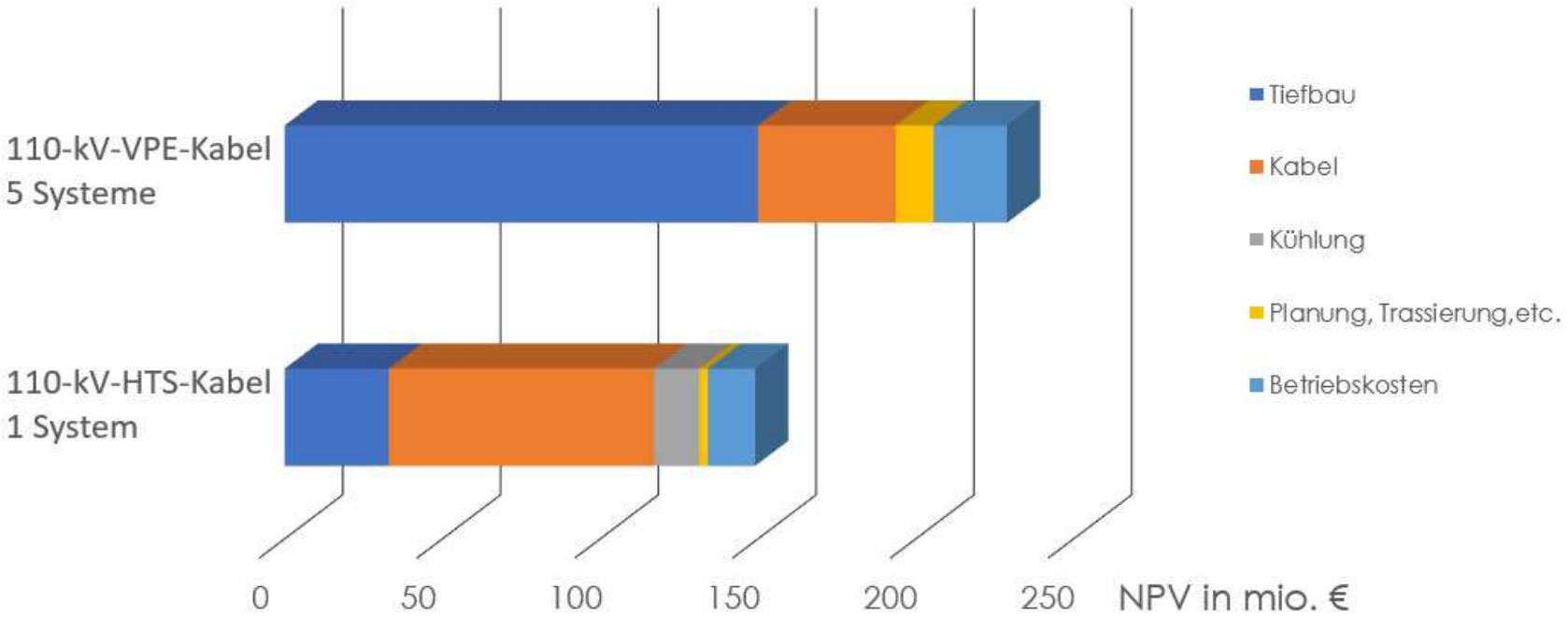
- losses of HTS cable vs. conventional copper cable



Power distribution - HTS cables in urban areas

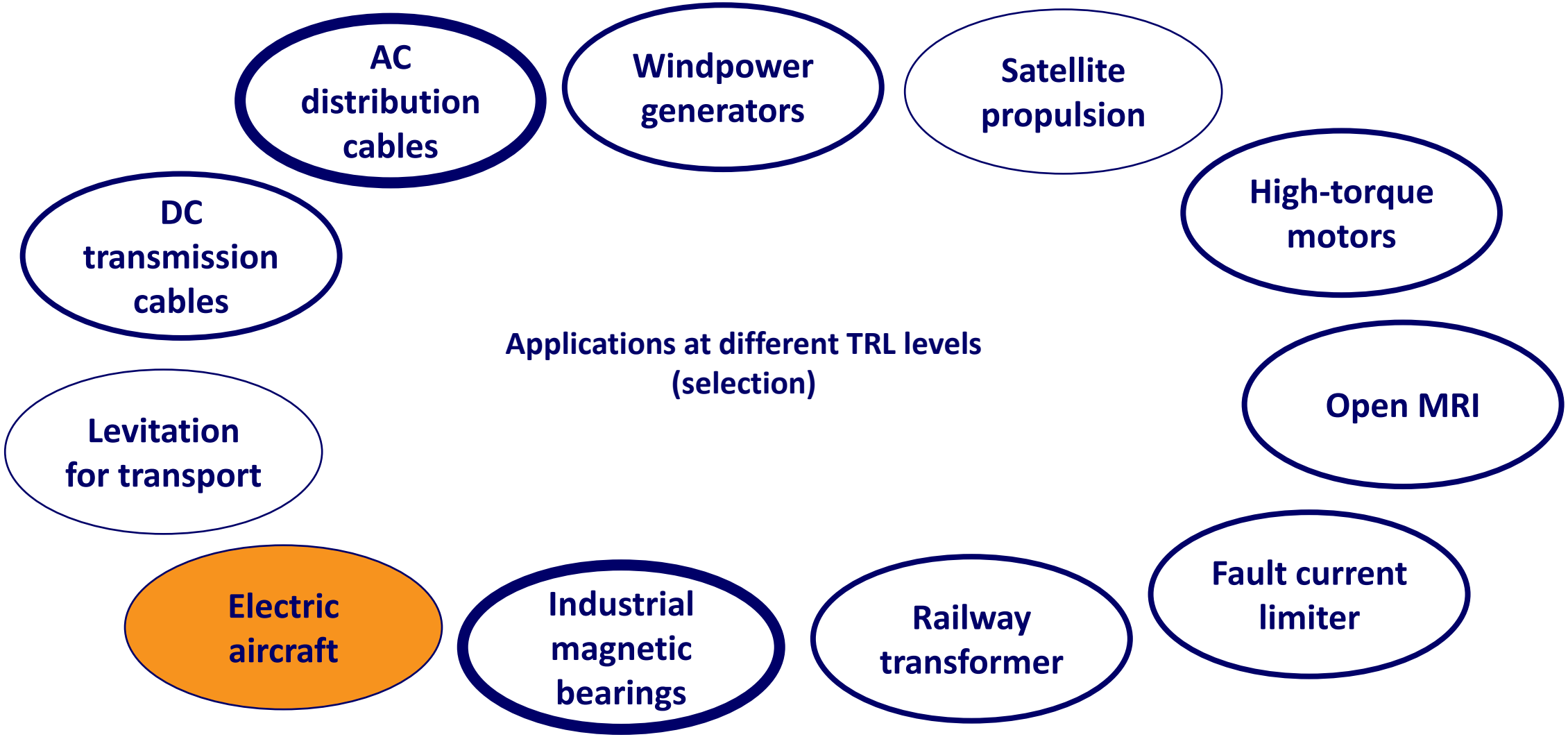
Project SuperLink

- Economic considerations
  - OPEX reduction 34% compared to MV standard solution
  - 3,820t CO_2 saving per year
  - Amortisation <<10years



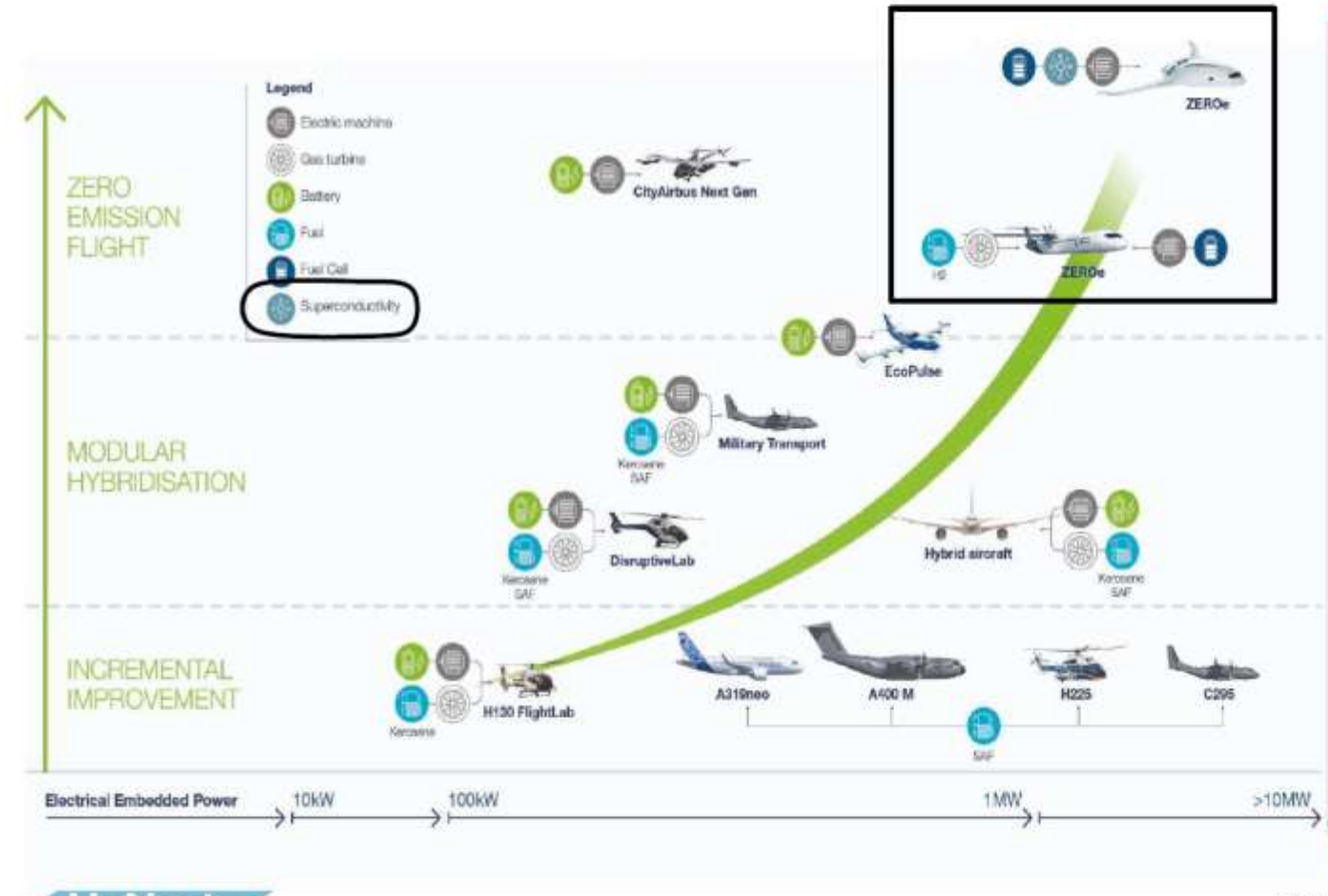
Mobility – HTS systems in all electric aircrafts

- **Applications of High-Temperature-Superconductors**



Mobility – HTS systems in all electric aircrafts

Pathways to decarbonise the AVIATION sector



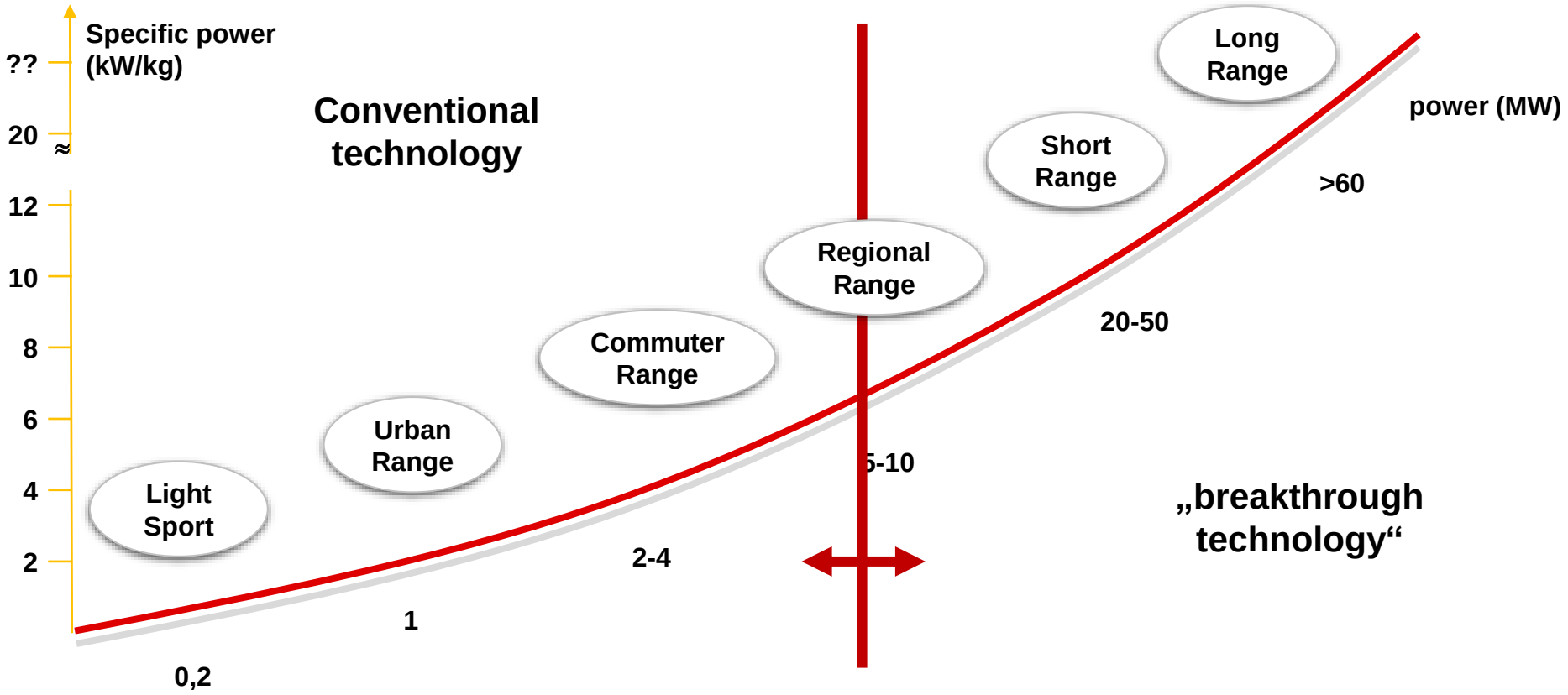
Liquid Hydrogen Cryogenic Temperatures as a **breakthrough** for future electric propulsion system

UpNext

AIRBUS

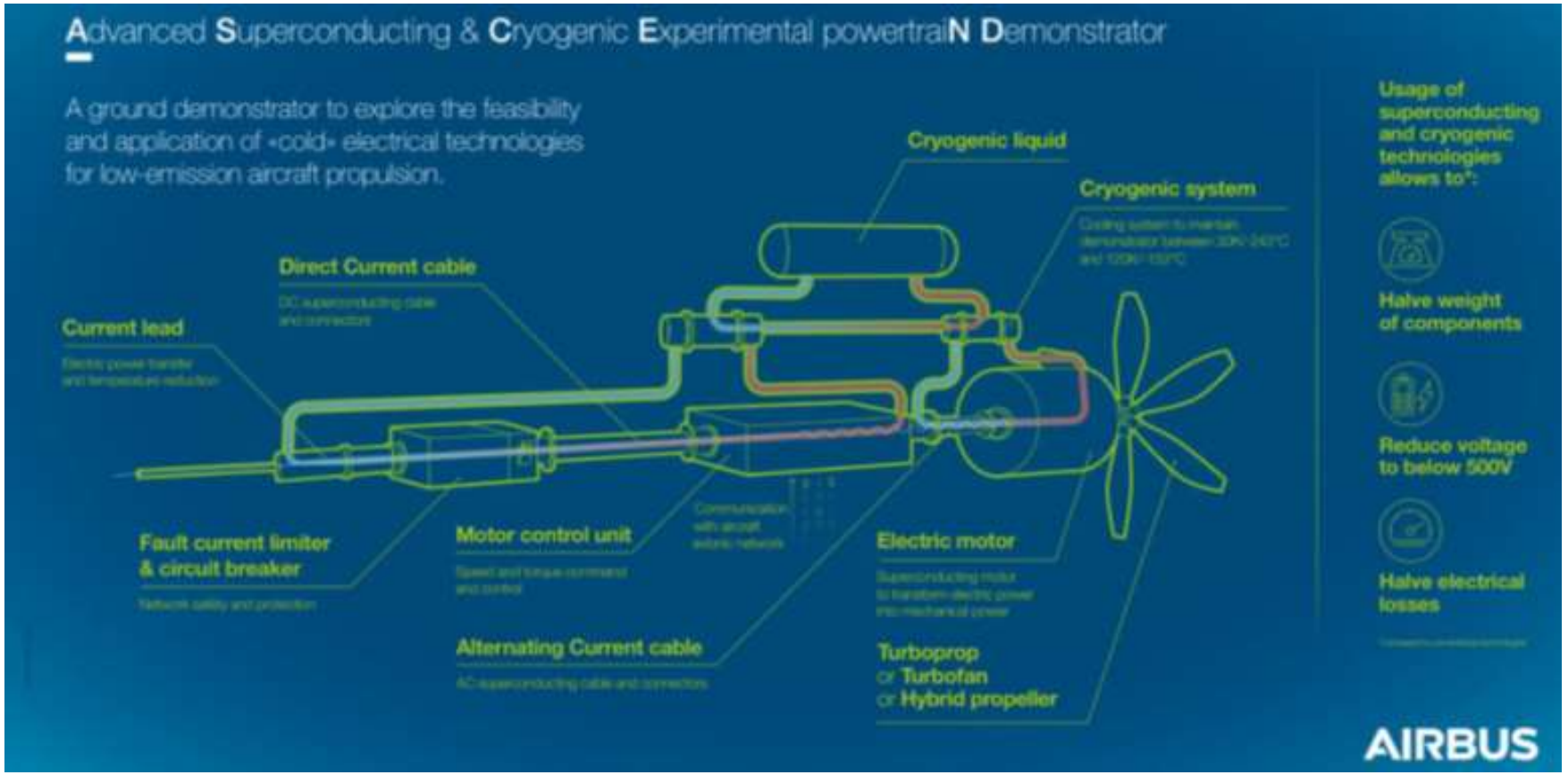
Mobility – HTS systems in all electric aircrafts

Electric propulsion for aircrafts



Mobility – HTS systems in all electric aircrafts

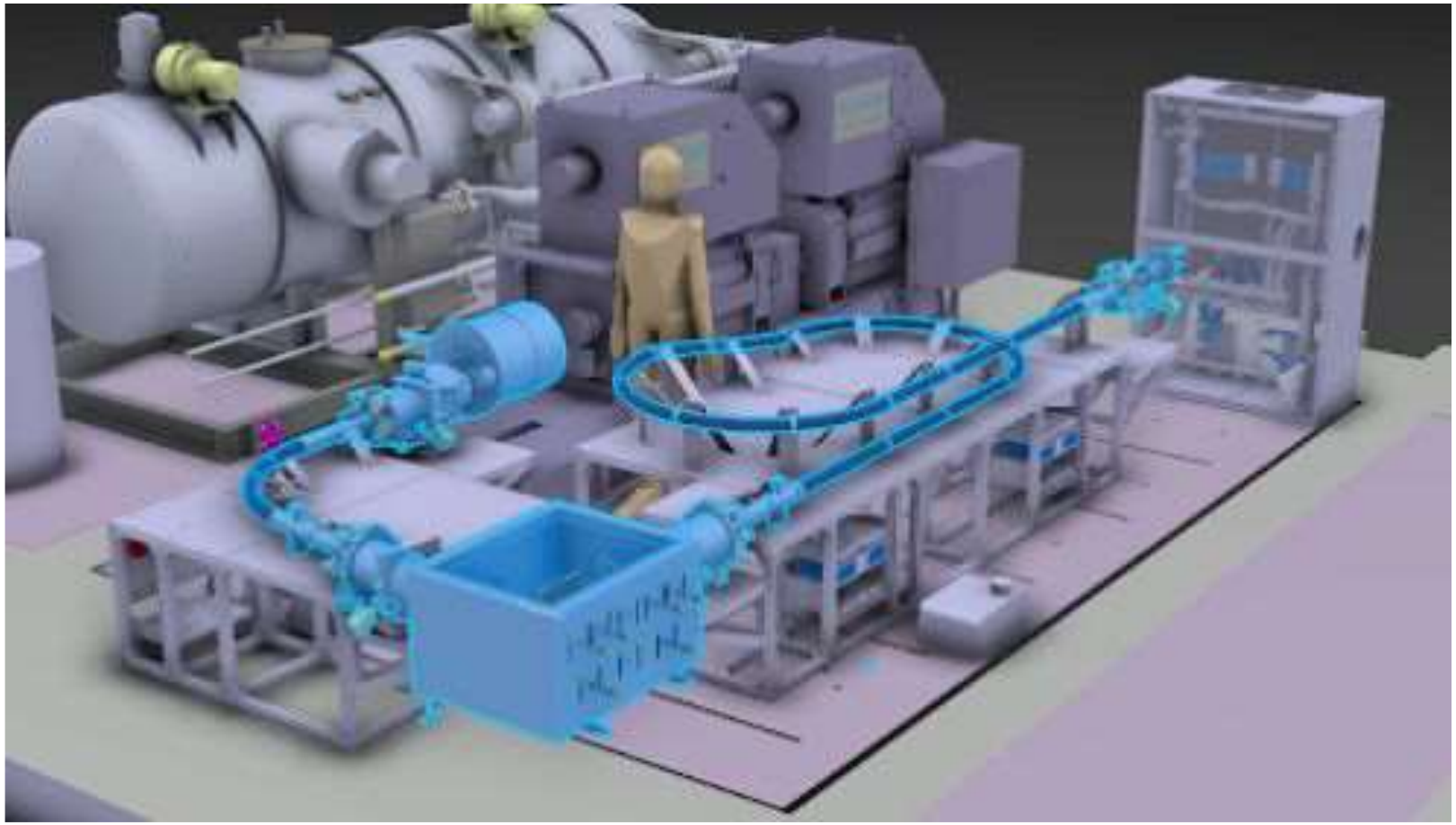
Project ASCEND



AIRBUS Rolls-Royce DEMACO SuperOx KIT hochschule aschaffenburg ELÚ IMAB Institut für Elektrische Maschinen, Antriebe und Bahnen TU Braunschweig IFAS Institut für Flugantriebe und Strömungsmaschinen Institut für Flugzeugbau und Leichtbau IFL DLR

Mobility – HTS systems in all electric aircrafts

Project ASCEND

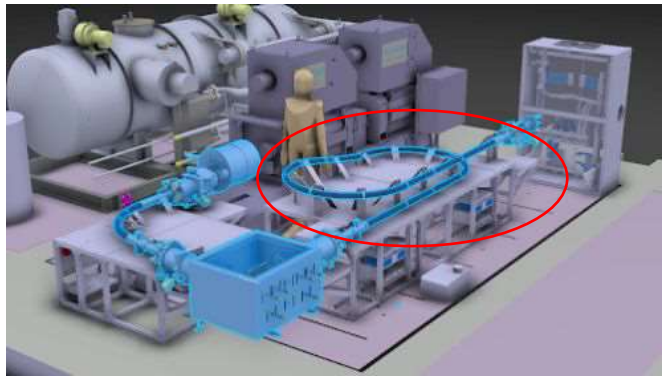


source: AIRBUS UpNext

Mobility – HTS systems in all electric aircrafts

Project ASCEND

- DC cable cooled with liquid nitrogen

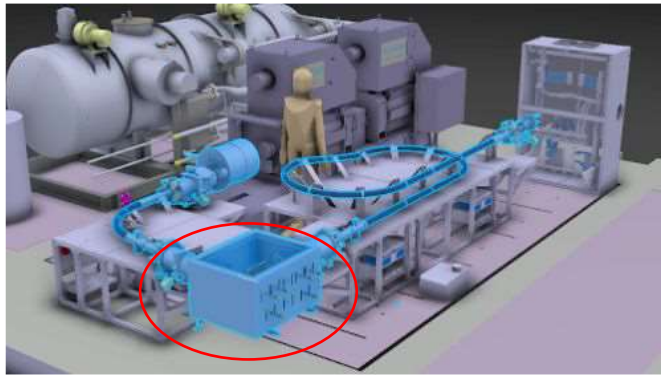


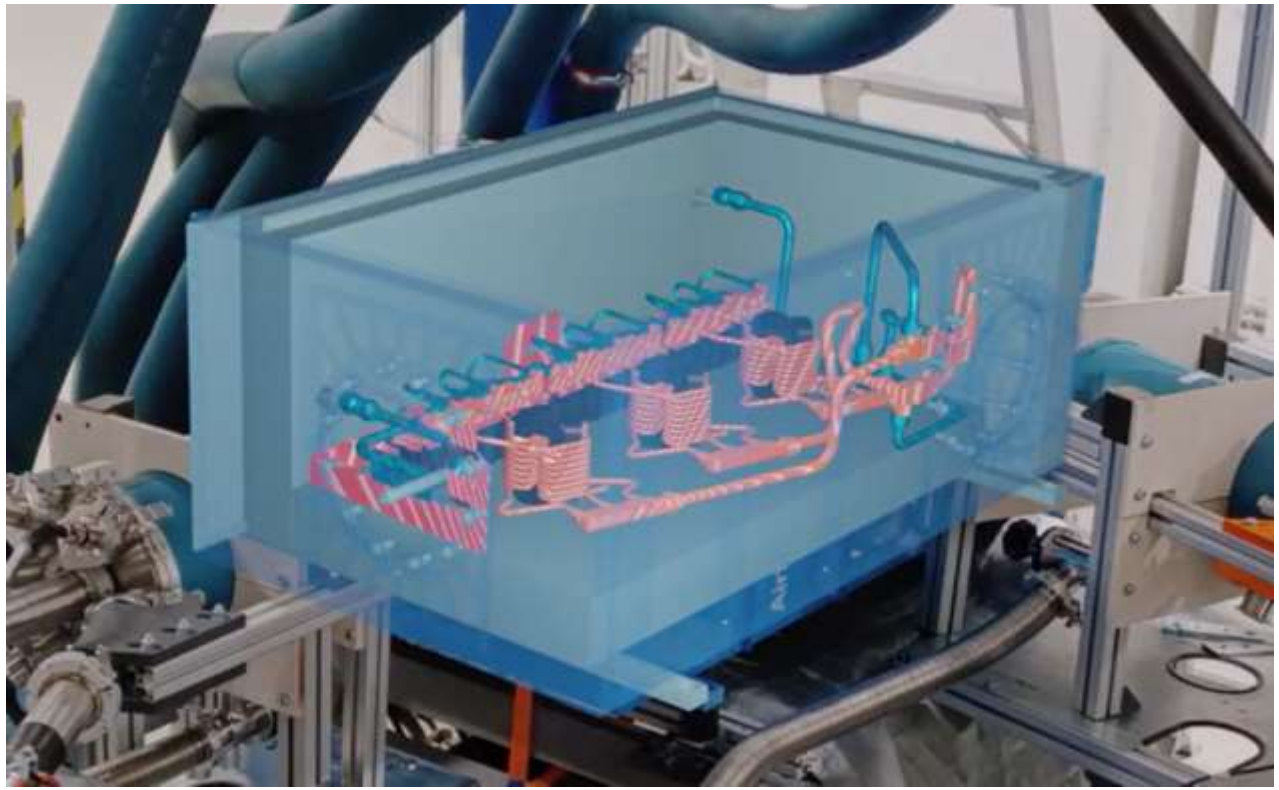
source: AIRBUS UpNext

Mobility – HTS systems in all electric aircrafts

Project ASCEND

- MCU (power inverter) cooled with liquid nitrogen



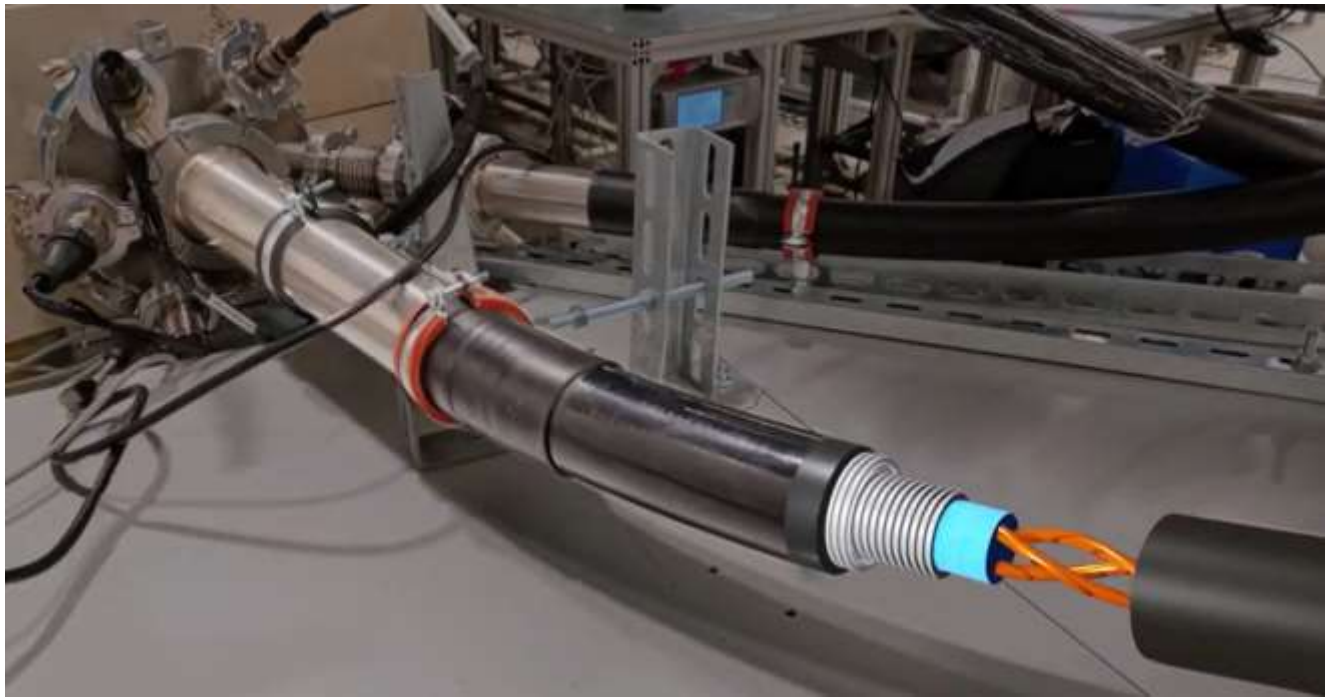


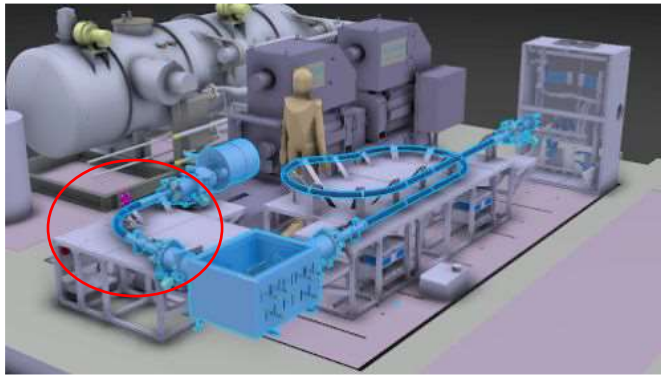
source: AIRBUS UpNext

Mobility – HTS systems in all electric aircrafts

Project ASCEND

- AC cable cooled with liquid nitrogen



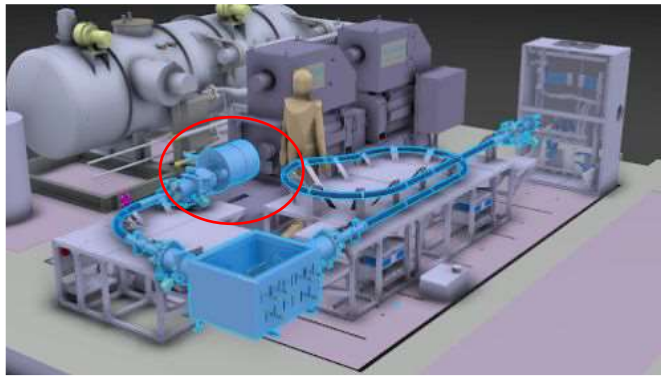


source: AIRBUS UpNext

Mobility – HTS systems in all electric aircrafts

Project ASCEND

- Motor cooled with gaseous Helium



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Mobility – HTS systems in all electric aircrafts

Project ASCEND

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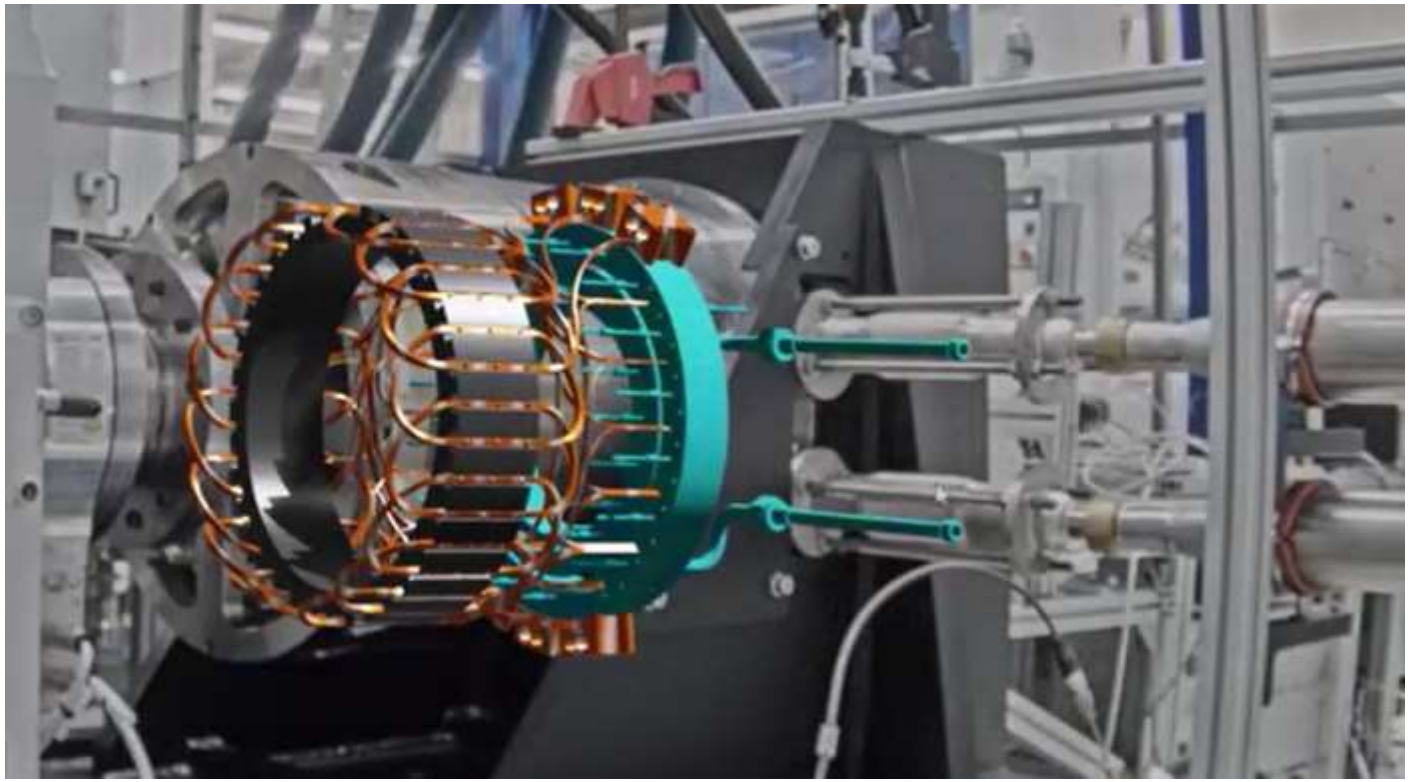
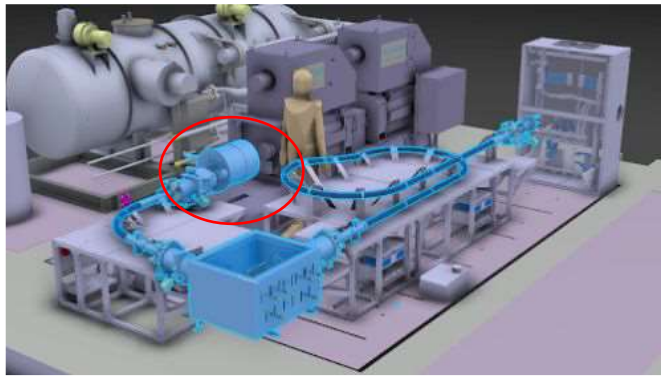




source: AIRBUS UpNext

Superconductors for the energy transition

High Temperature Superconductors are ready for applications

- **HTS offer highest energy and material efficiency**

- HTS material is available in reasonable quality and quantity
- HTS can be applied in the energy, medial, industrial and mobility sector
- HTS applications are at various TRL levels
- First applications will be commercialized well before 2030

Superconducors – simply irresistable

Thanks for your attention

Many thanks to the partners in the
SuperLink and ASCEND projects

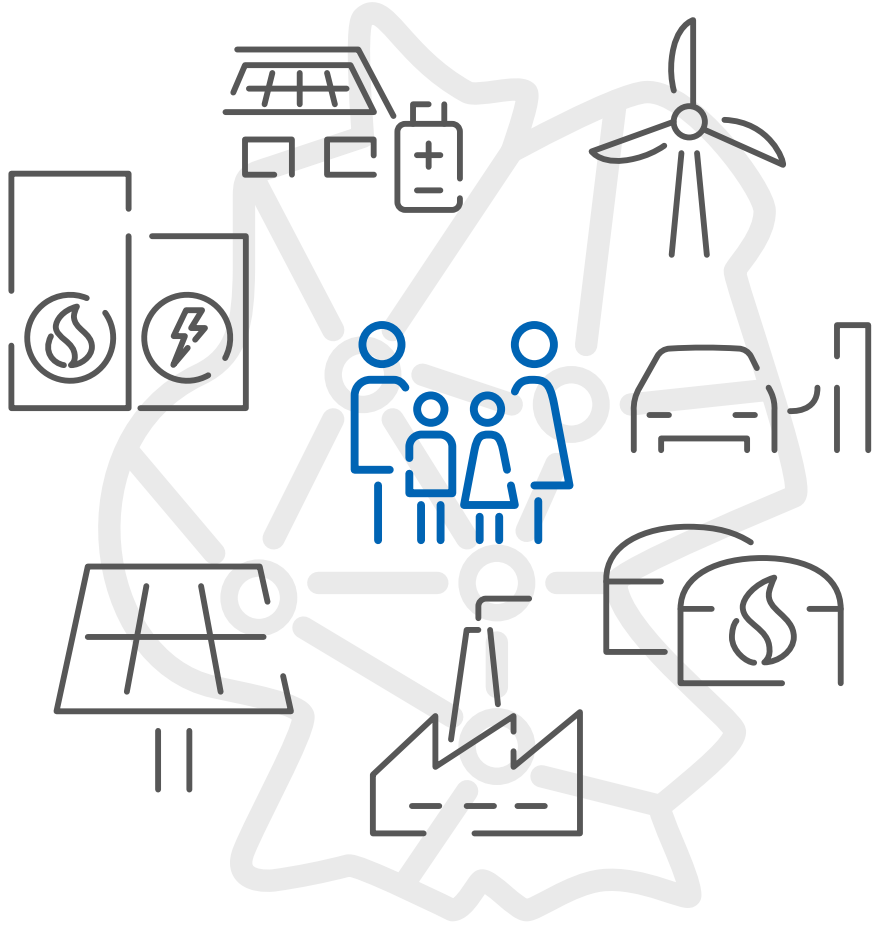
Prof. Dr. Michael Bäcker

Board member ivSupra e.V., MaTech-Consult GmbH

www.ivsupra.de, www.matech-consult.de

Cross-Border Grid Connections

Ensuring a Stable Trans-European Network



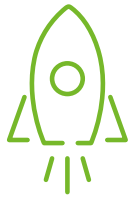
Frank Borchardt, VDE FNN

3rd September 2024, Brussels
EUREL European Future Technology Summit

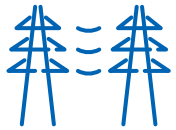
VDE FNN

VDE FNN – the Power Network Experts

Established
2008



503 Members from
12 nations
network operators,
manufacturers and scientists



About 450
voluntary experts
collaborating with 60
committees

31
application rules

137
standards & manuals

VDE FNN application rules
setting the state of
technology (§49 EnWG)

www.vde.com/en/fnn

VDE FNN

Order of the day

“Strengthening Resilience of European Power and Communication Networks”

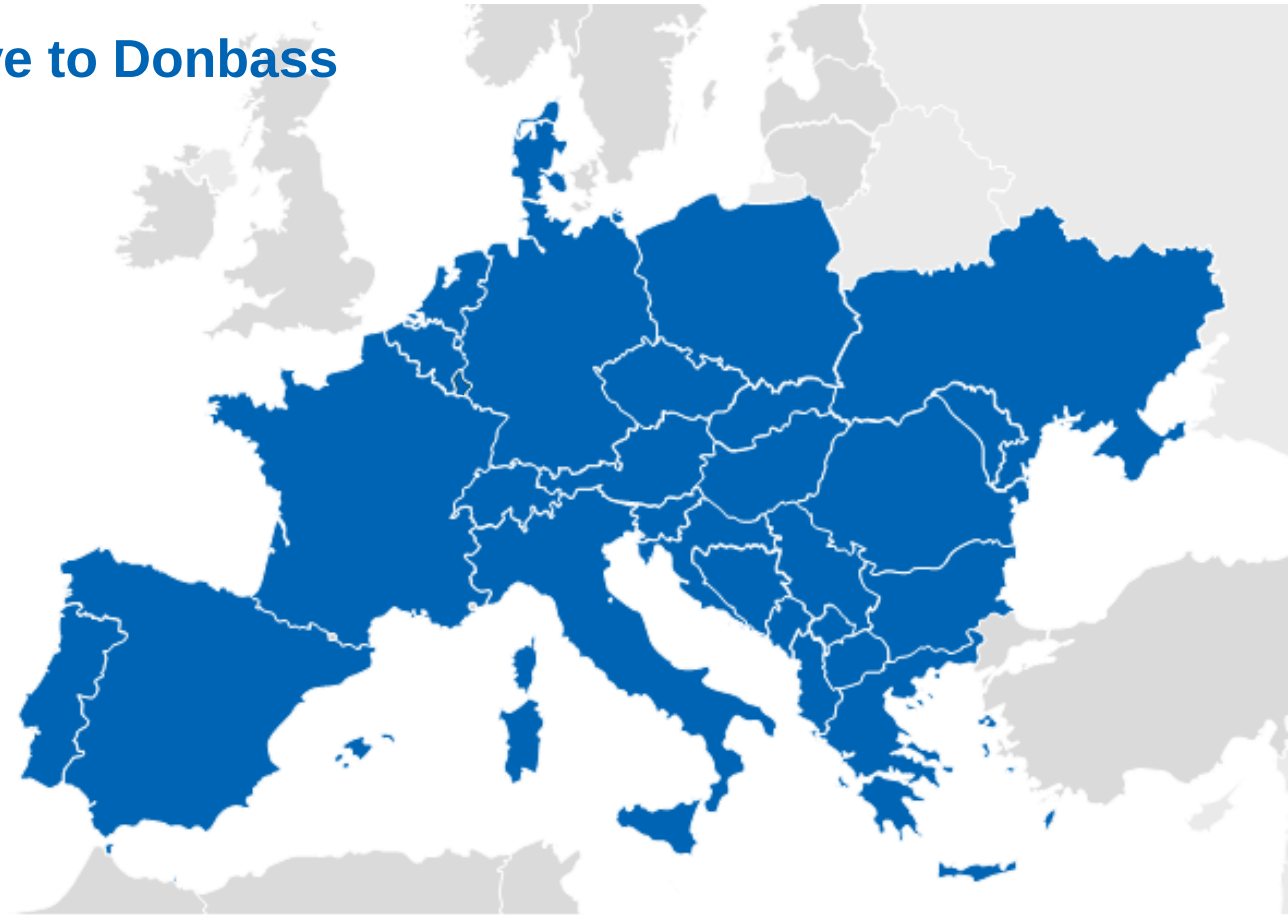
Why?

That is Why

One Interconnected System – From Algarve to Donbass

The Continental European “UCTE system“

26 Interconnected Nations (since 17/03/2022 incl. Moldova and Ukraine)	**31** Transmission System Operators
>350,000 km Transmission Lines (Voltage ≥110 kV)	**495 Millions** Supplied People



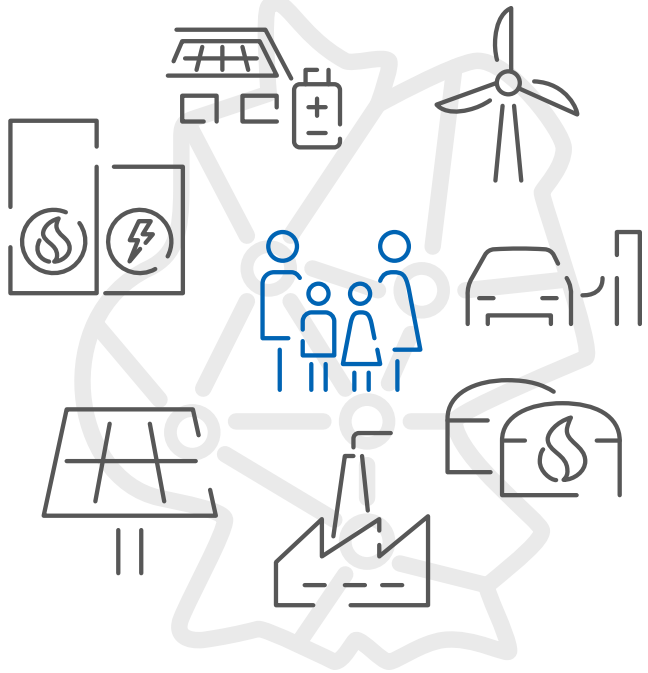
Quellen: ENTSO-E, Statista

Ensuring a Stable Trans-European Network

Building the infrastructure

The very German way towards smart grids

Developing efficient end-to-end cybersecurity requirements in support of renewables integration, demand response and flexibility



Getting the focus

Where the true weak points are

Analysing the current system to identify strengths and weaknesses as the key drivers for security measures

Daily business on cybersecurity

Play of the game in protecting networks

Understanding how an attack to control access nodes in the distribution network could bypass cryptography and secure-by-design architecture to harden the network

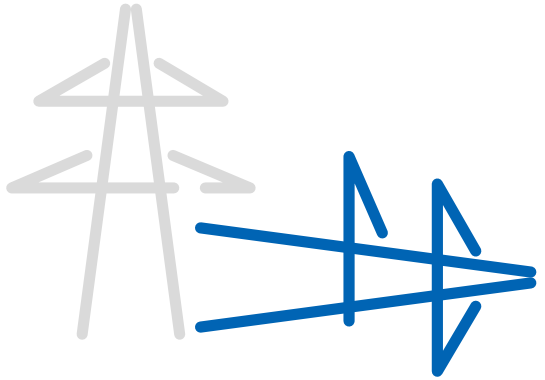
Getting the focus

About Stable Networks: The Vast Majority of Incidents is Beyond Human Control

Analysis of 33 major incidents on power networks worldwide since 1965*

- Technical Failure **15**
- Natural Disasters/Force Majeure **9**
- Human Error **6**
- Warfare **2**
- Cyberattack **1**

Only warfare and cyberattacks are under human control. Somehow…



* Source: Wikipedia (https://de.wikipedia.org/wiki/Liste_historischer_Stromausfälle)

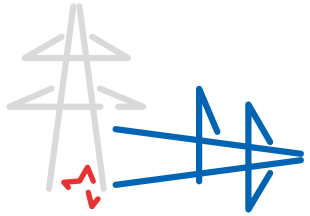
Getting the focus

Classifying Threat Scenarios for Critical Infrastructures Realistically

Blasting the Nordstream Pipelines

Outstanding targets

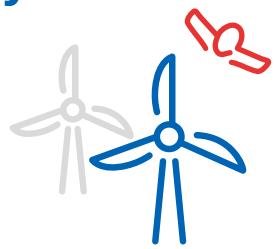
Attacks for terrorism or hybrid warfare are conditionally predictable



Sabotage of transmission lines

Vulnerable infrastructure

Politically motivated attacks are hard to predict



Attack on KA-SAT system interfering with wind turbines

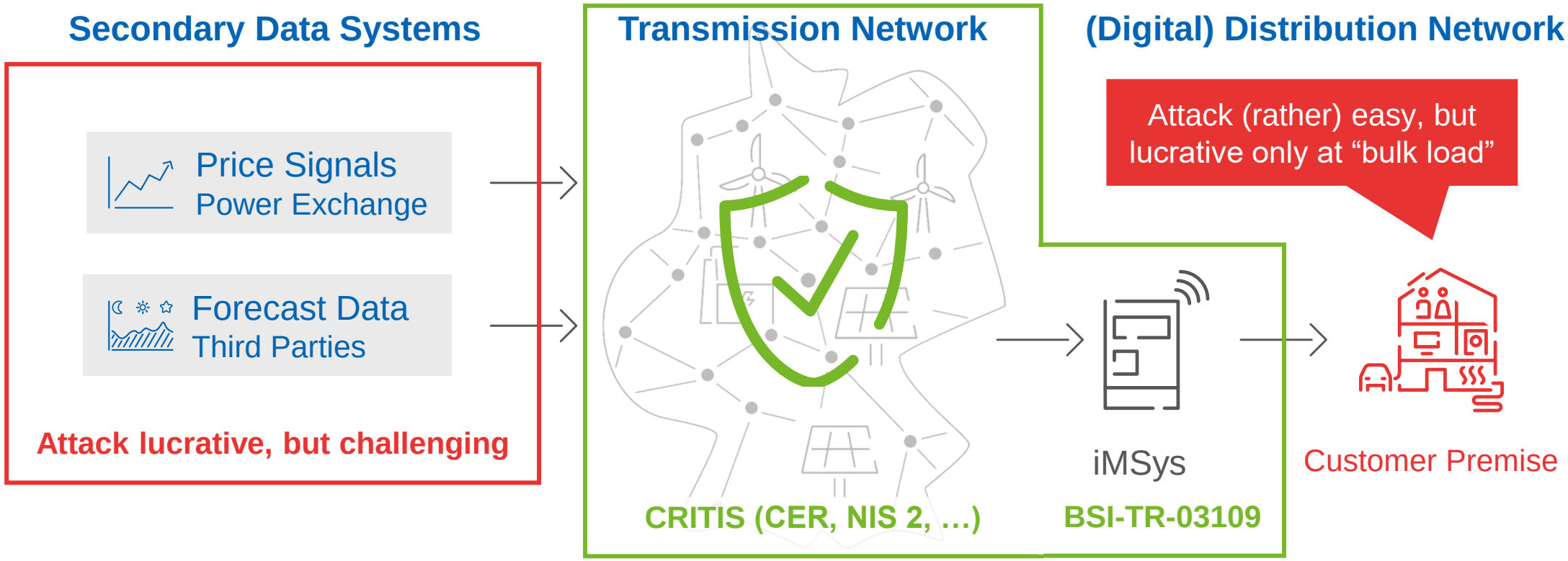
Random targets

Attacks in cyber space are daily business for CRITIS operators

Critical infrastructure as a whole is threatened only in case of n-1 is getting lost

Getting the focus

The Cost Benefit Analysis on Cybercrime – Where Does it “Pay Off”?



Getting the focus

Future Households Are of Systemic Relevance – Why?

Classic Household

Average demand (Ø/15 min)

approx. 4 kW_{max}

Future Household

Heat pump	3 - 16 kW
Home charger	11 - 22 kW
PV unit	up to +25 kW

approx. ± 25 kW_{max}

Additional load is required by an increasing number of households for several hours every day.

The assembly of heavy loads at similar times of use is turning households into preferred targets

Germany.

99 security incidents reported

for the energy sector

68 successful

ransomware attacks on enterprises

About 21,000 infected systems

per day

BSI: „Die Lage der IT-Sicherheit in Deutschland“, reporting period 2022/23
https://www.bsi.bund.de/SharedDocs/Downloads/DE/BSI/Publikationen/Lageberichte/Lagebericht2023.html

Building the infrastructure

POV: You are running a system of 900 DSOs, separated meter service operators, distributed generators, aggregators, energy suppliers, ESCOs & 15.5 M customers

Market Design

Common Understanding

Robust and state-of-the-art communication processes for various market roles

System Architecture

Initial Commitment

Unique and secure infrastructure, mandatory for all players of systemic relevance

Hardware & Software

Technical Requirements

Interoperable hardware by trusted sources, future-proofed by remote access for upgrades

Back to 2013 this was the starting point for Germany’s very individual apporach

Building the infrastructure

The iMSys* – One Unique Platform for Smart Metering and Smart Grids

Technical requirements specified by BSI for basic meter, smart meter gateway, control box

Fulfilling highest cyber security requirements

From the very beginning data protection and IT architecture are designed for embedded smart grid requirements

Part of the critical infrastructure

In combination with the goals of German Energiewende, the digitalised distribution network is gaining massive impact to system stability

Built from the scratch

System architecture and technical requirements for devices, backend, as well as manufacturing and logistics were newly invented

No adaptation of already existing solutions and products

Security by design at
Secret Service level

* iMSys = **i**nteligent **M**etering **Sys**tem

Building the infrastructure

The Smart Meter Gateway - Secured Communication on two Channels

Public Key Infrastructure

Communication to Backend (Gateway Administrator)

“Business sensitive” communications

- Mandated communications
  Dual fuel, register values, load profiles, “useful values” for network operations
- Administrative communications
  status messages, wake-up calls, firmware updates

CLS Proxy Channel

Other Communication (“In Transit“ Through Gateway)

Functional enhancements for smart meters

- Demand response services
  DSO/ESCO commands for control box
- Meter readings from sub metering
  Water, district heating, space heating allocation
- 3rd party services for customer appliances
  Firmware updates, status messages, etc.

Building the infrastructure

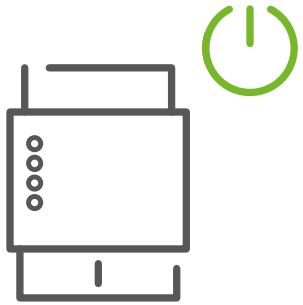
The Control Box - Enabler for Smart Grids, Gate Keeper for Secured Infrastructures

Gateway/Home Interface

Secured communication via Smart Meter Gateway CLS Proxy

Administration services

- CLS Proxy management
  Open, manage, close CLS channels for identified “eligible players”
- Local device management
  Authentication and comms management for HEMS/appliances at customer's premise



Demand Response Services

Controlling appliances on behalf of any “eligible player” in the market

Demand response services

- Smart grid daily business (energy market)
  Executing ESCO services (scheduled, ad-hoc)
- Congestion management
  market driven congestion management, DSO emergency commands

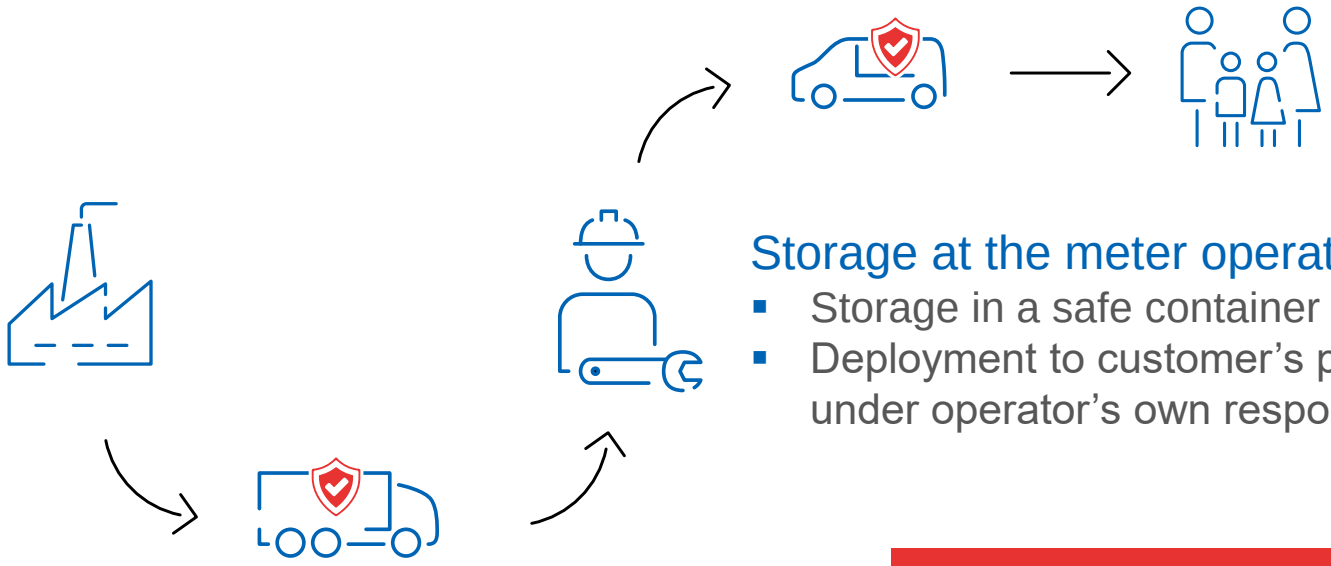
Building the infrastructure

SiLKe – The BSI* Certified Secured Supply Chain for Smart Meter Gateways

To prevent or detect any manipulation – from production to final assembly

Smart meter gateway production and storage

- Factory protected by strict admission control
- Dedicated workforce only
- Safe storage in warehouse



Transport to the meter operator

- Transport in a safe container

Storage at the meter operator

- Storage in a safe container
- Deployment to customer's premise under operator's own responsibility

No infiltration of non-authorised or manipulated devices into the assembly process shall stay under the radar.

* BSI = the German Federal Office for Information Security


You shall
not pass!

Daily business on cybersecurity

How an Attack on Critical Infrastructure Might Happen* and Who is Targeted

Ransomware
Digital blackmailing

System corruption by vulnerabilities

Data encryption, ransom for decryption?

“Industrial cybercrime”

APT
Digital warfare or spying

Long-term assault on targets of special interest

Spy out for information, sabotage

Increasingly detected in conjunction with war on Ukraine

DDoS
Operations disruption

System unavailability by multiple superfluous traffic

Service interruption for multiple reasons

Frequently used in combination with other attacks (distraction)

Spam & Phishing
Digital scam / theft

Causing human error (social engineering)

Door opener for system corruption

First-action attack to prepare further assaults

System Weakness
Exploiting vulnerability

Persistently seeking for week points in software

Compromising (out of date) systems by malware

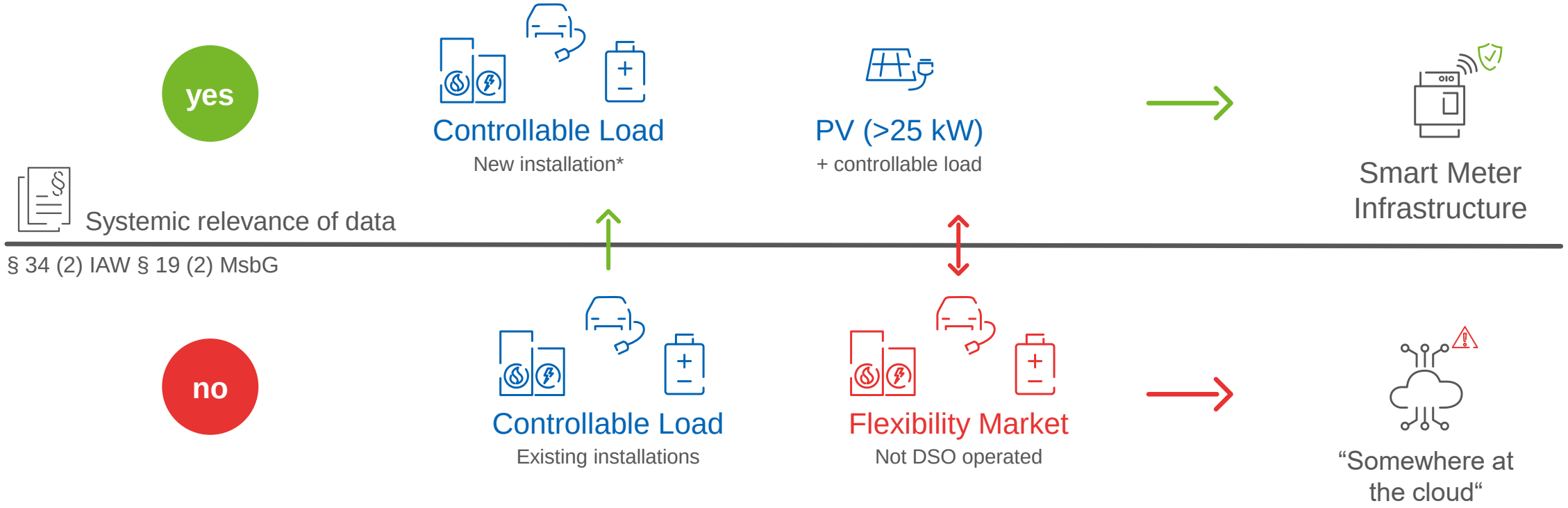
Bulk business, lucky hit

* BSI: „Die Lage der IT-Sicherheit in Deutschland“, reporting period 2022/23
https://www.bsi.bund.de/SharedDocs/Downloads/DE/BSI/Publikationen/Lageberichte/Lagebericht2023.html

Daily business on cybersecurity

“Market Expectations vs. Operational Needs” Might be a Challenge

Example Germany: new regulatory regime set into force as of January 1st, 2024



* Going live after Jan. 1st, 2024

Daily business on cybersecurity

Reminder: NIS 2 Ends Where the Customer‘s Premise Begins

DSO Infrastructure

Operated uncontrolled and blind, upward network protection at secondary substation only

iMSys is interface to distribution network, non-reactive linked to customer installation

Controllable load with mandatory non-reactive link to smart meter and distribution network

Customer Installation

Protection of parallel WAN connection is under customer‘s responsibility

Appliances linked to various third-party systems by parallel WAN connection

Market driven operation without notice to DSO

Daily business on cybersecurity

The Greatest Cybersecurity Threat is Lurking Behind the Smart Meter

Direct attack
on DSO infrastructure

</>

Backdoor attack
on customer appliances

Successful attack damages particular network section

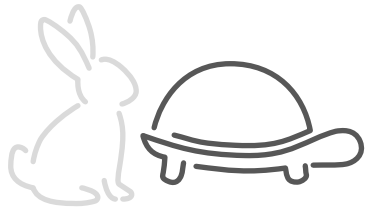
Regional limited but serious consequences for infrastructure

Successful attack damages particular product or manufacturer

Nationwide but minor consequences for infrastructure (randomised impact)

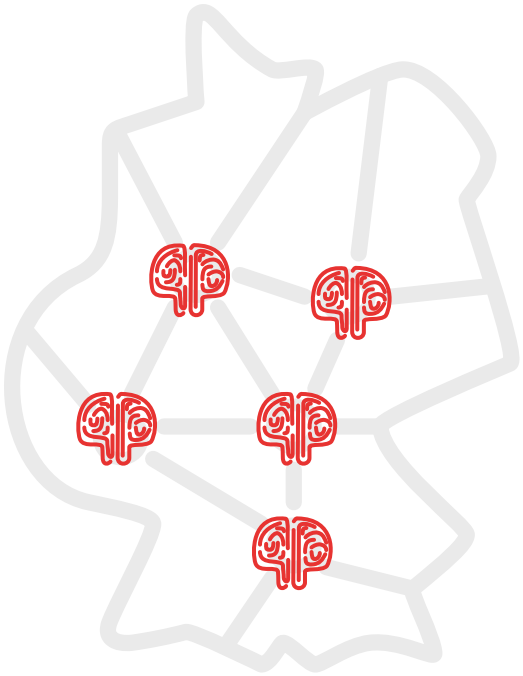
Serious in case of various products or manufacturers affected at the same time

A successful backdoor attack can be regarded as a question of time only




GOOD
LUCK...

Takeaway Facts



A resilient energy system is subject to permanent efforts. Digitalisation is a game changer not only for the “good guys”.

Building one unique infrastructure for smart metering and smart grids requires a secured eco system, based on standards far beyond NIS 2, CER, etc.

Daily business on cybersecurity begins with understanding where an attack is likely to happen and how it starts. Build firewalls against systems you cannot control 100 %.

Thank you for your attention!

FNN – empowering the future networks.

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