Reliable Power Electronics for the Energy Transition

Dutch Israeli Mini-Symposium on Energy System Integration

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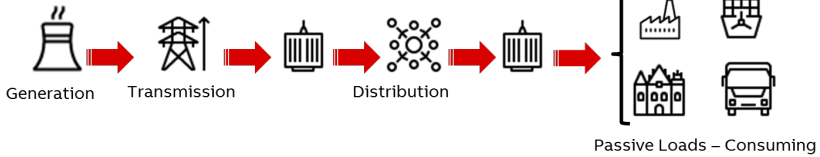
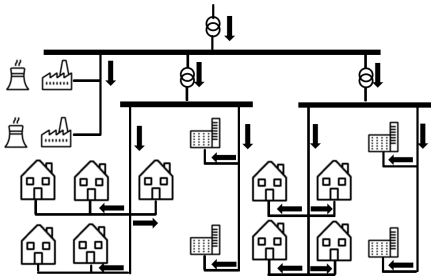
Some conventional wisdom

“Power Electronics is everywhere.”

Transitioning away from the conventional

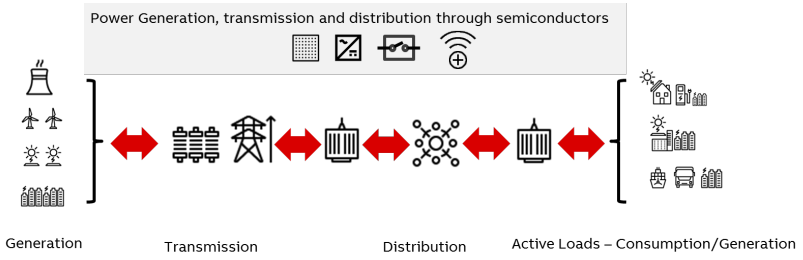
Conventional Grid

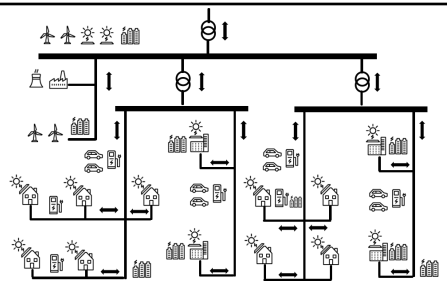




- Uni-directional power flow
- Passive loads
- Loads consuming energy

Future Grid





- Bi-directional power flow
- Passive and active loads
- Loads: consume/generate/store energy
- Roaming loads
- Added Intelligence

Evolving into electronically controlled and protected power grid - here comes **Digital & Power Electronics**

The flexible Grid – our way to Net Zero

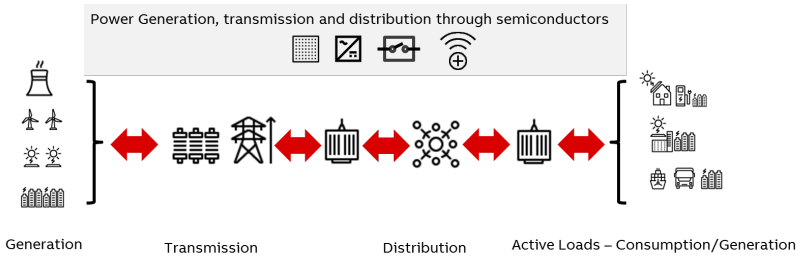
Electrification of CO2-intensive industries combined with Green energy generation

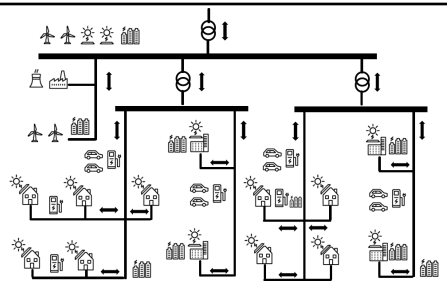
Digital communications combined with rigorous data-driven management on all levels

Power Electronics embedded in Generation, Transmission & Distribution, Consumption

Digital Grid: Enhanced dispatch and communications options using Power Electronics technologies, connectivity & data management

Future Grid





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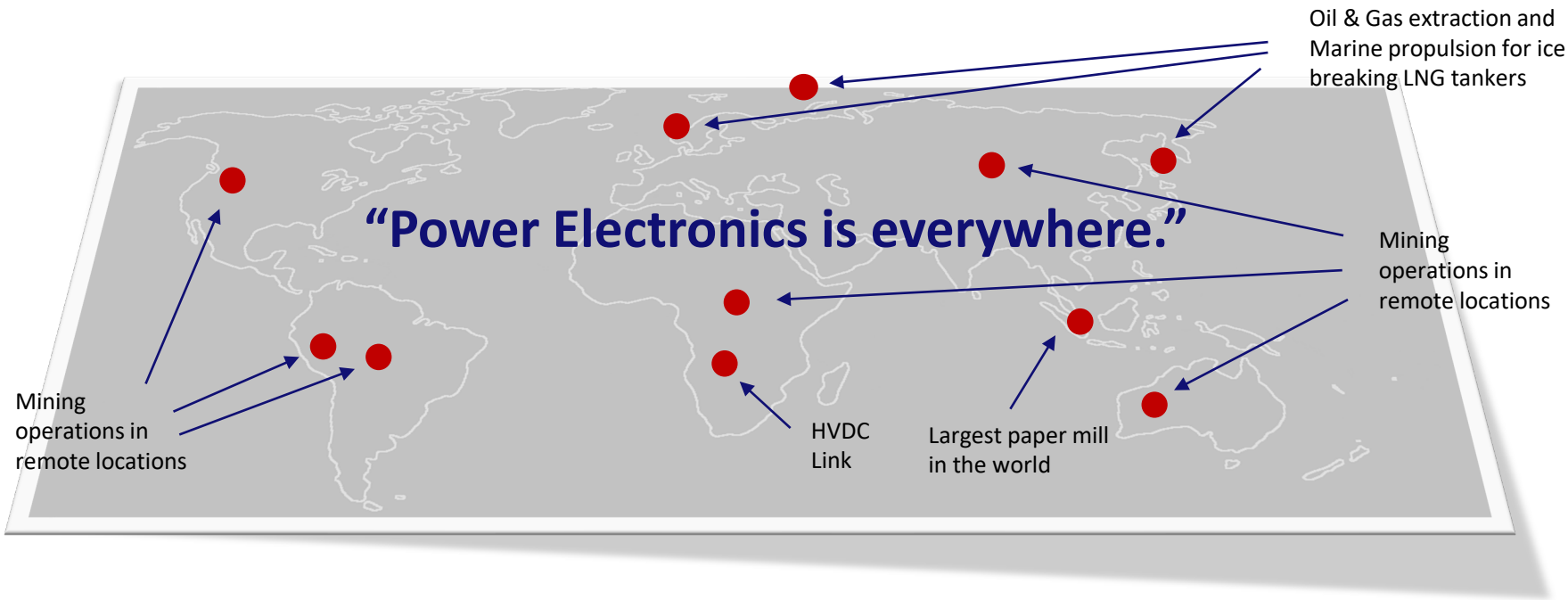
The revenge of geography



… and offshore wind energy, and irrigation projects, and pipelines, and …

The drivers


flexibility
“Power Electronics is everywhere.”
efficiency
productivity

The prerequisite

Some things are not easy to fix

- Demanding installations
  - **Remote locations**
  - Equipment installed and operated in **harsh environments**
  - Lack of situational awareness

- Operational challenges
  - (almost) impossible to return parts
  - (almost) impossible to have **complete picture of events**

The opportunity ahead

- Enhance the **availability of power electronics systems** leveraging new technologies, …
  - Materials, semiconductors
  - Data, Communication
  - Control

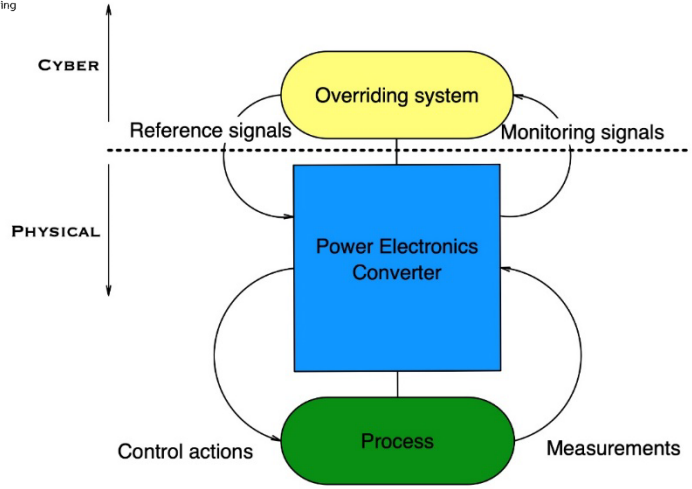
- … and thus **accelerate** the expansion of power electronics technologies and the **transition to the green digital grid**

The Energy Processing Systems of the future

Efficiency

Flexibility

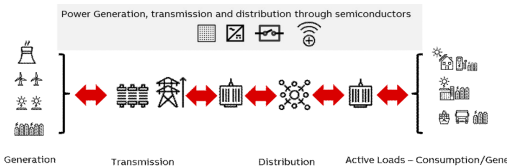
Productivity



Availability

2022

Components with computational and sensing capabilities operating isolated, majority of data generated confined within converter/device



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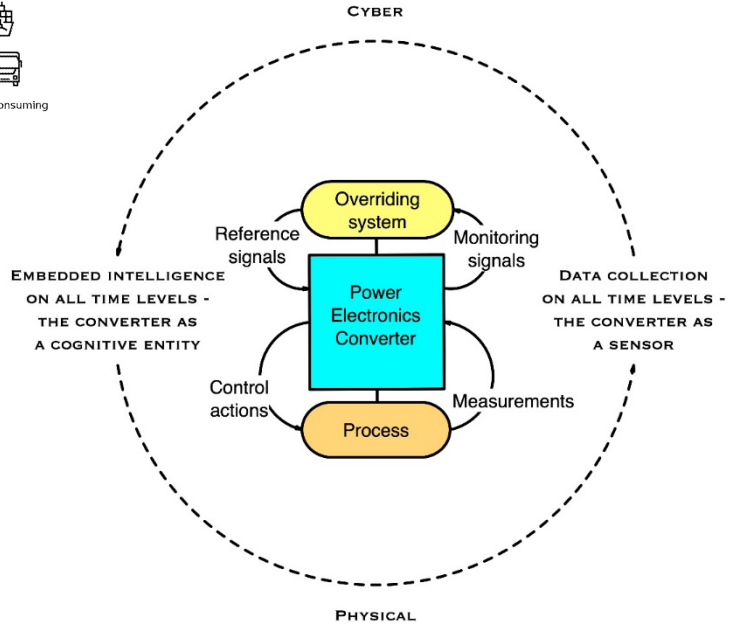

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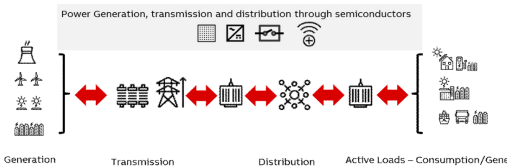
Bidirectional power flows, electronically controlled loads & sources, elements with variant roles. Energy processing device as cognitive entity: Awareness, Computation & Decision on all time levels

Availability



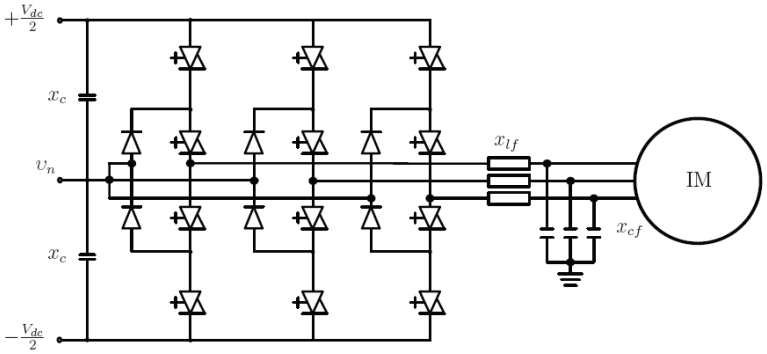
Example – enable decision making

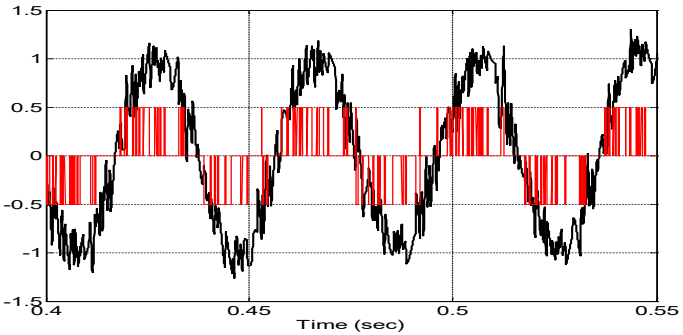
- Preempt **beyond human intervention**
  - Collect, analyze data
  - Draw actionable conclusions
- Equip devices with **control methods suitable for adaptation**
  - Computational control, e.g. Model Predictive Control (MPC)
  - Fault-tolerant control
- Enable **autonomous action on converter level**
  - Updated prediction models, constraints
  - Adapted operation for specific components

Versatile, adaptable control – an example

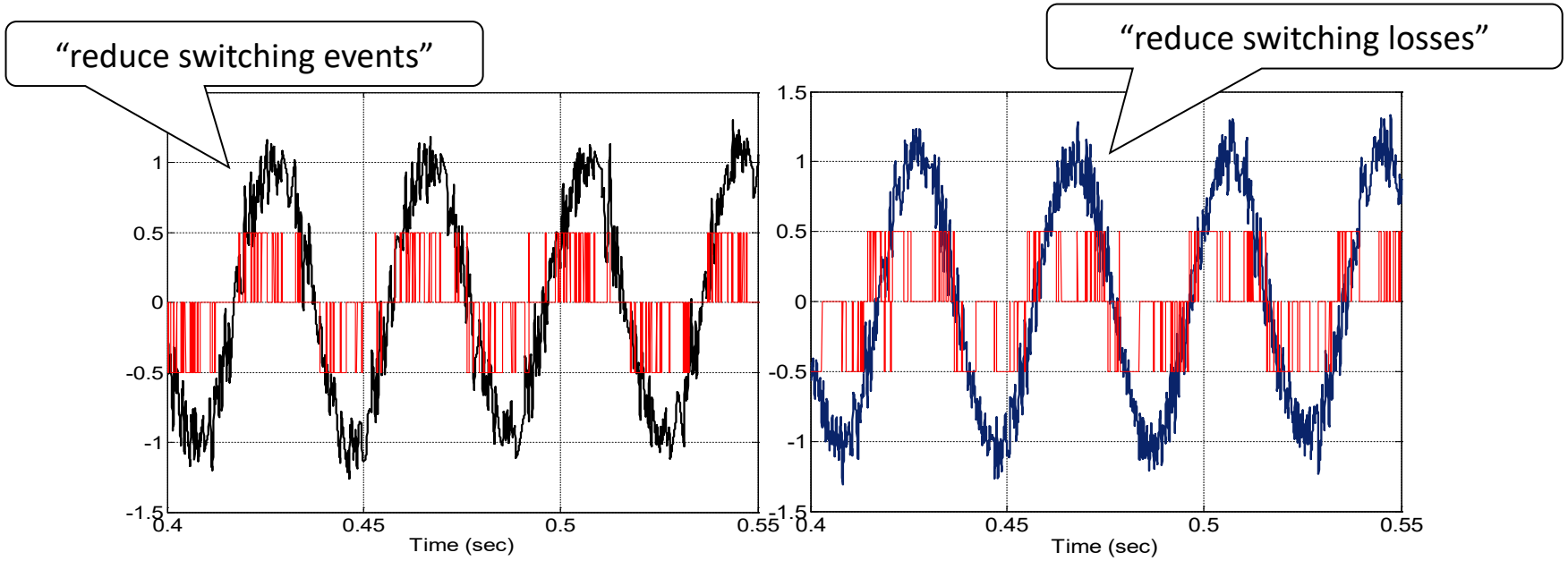
- Induction motor: Power horse of industrial motion
  - ~50% of global electric energy consumed by motors
  - induction motors accounting for the largest share by far
- Variable Frequency Drives (VFDs) employing Power Electronics Converters
  - providing controlled, variable speed operation
  - carrying significant energy saving potential improving motor efficiency

Reliable operation of VFDs key element in their acceptance and expansion in more industries





Reducing component stress by smarter control



Decision on the microsecond level enables **switching at lower currents**

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Recap & Outlook

- Power Electronics technology a **key enabler and beneficiary** of the transition to the green, digital grid
  - Efficiency, flexibility, productivity

- **Availability will "make or break"** the transition
  - Nothing matters if things don't work

- **Reliability in a real-time data-driven world** is a new, fascinating question
  - Multi-disciplinary, challenging research topics ahead

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