



Power semiconductor solutions for the development of green hydrogen systems

July 2022



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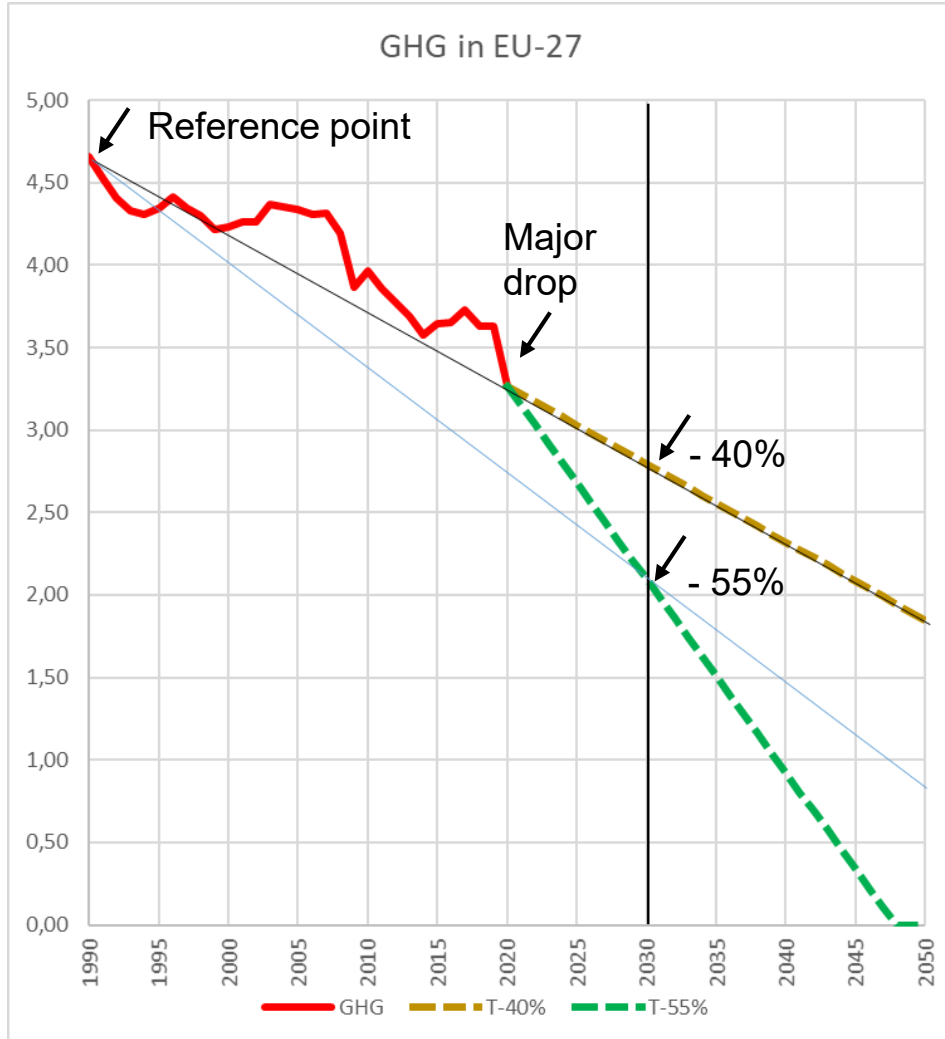
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Greenhouse gasses (GHG) effect on the climate situation has sparked interest in hydrogen and technologies based on it

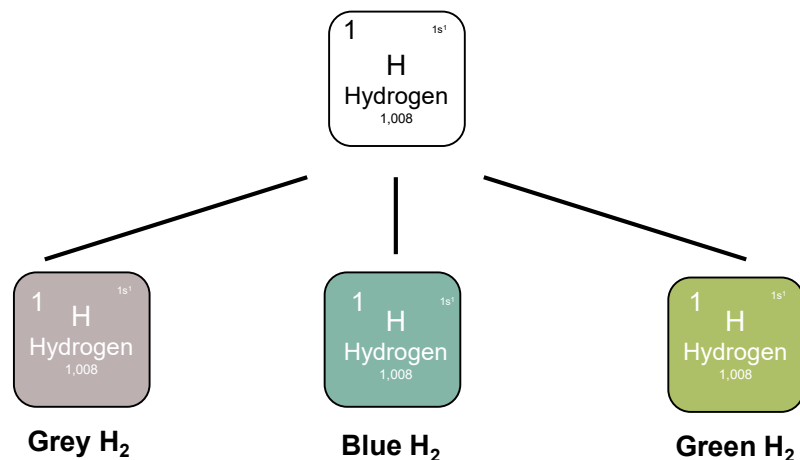


GHG in Gt CO₂ eq

Data source red part: <https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer>

- › The link between GHG and global warming is now in all people's minds.
- › A policy action is needed to avoid a rebound post crisis.
- › The EU Environment Council, the EU environment ministers agreed on a joint position on the European Climate Law.
- › By 2030, GHG in the EU are to be reduced by at least 55% compared to 1990 level.
- › The previous GHG reduction targets for 2030 vs 1990 was 40%.
- › The main target is to reach carbon neutrality (net zero emissions) in 2050.
- › Growing challenges of the climate crisis have sparked interest in hydrogen and technologies based on it as another building block for climate protection.

Green hydrogen as part of the future energy system



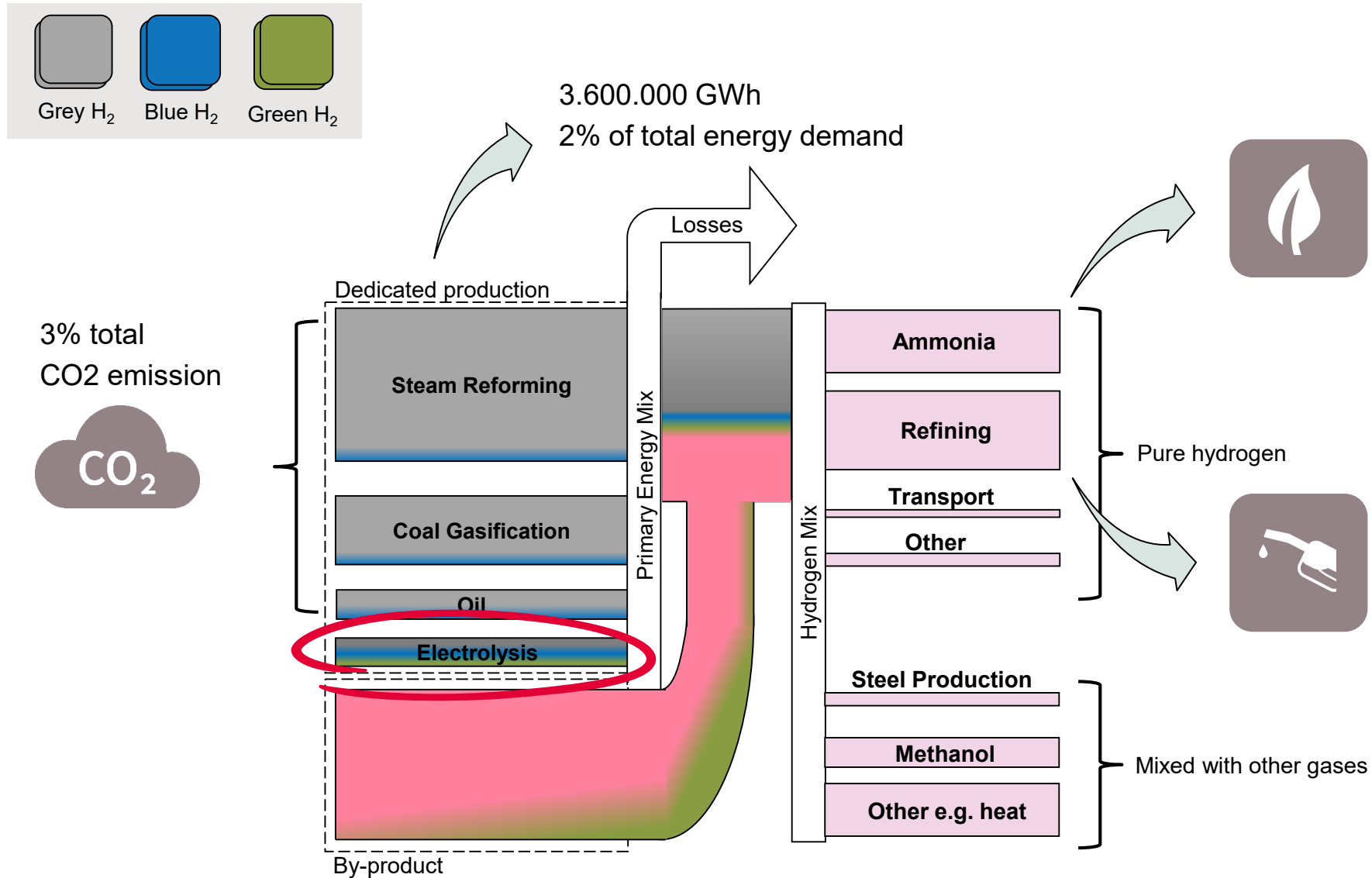
- › **Grey Hydrogen**: produced from fossil resources with CO₂ emission.
- › **Blue Hydrogen**: from fossil resources with CCUS¹ technology or nuclear electricity.
- › **Green Hydrogen**: solely produced from renewable energies like hydro, solar and wind.

1: Carbon Capture, Use and Storage

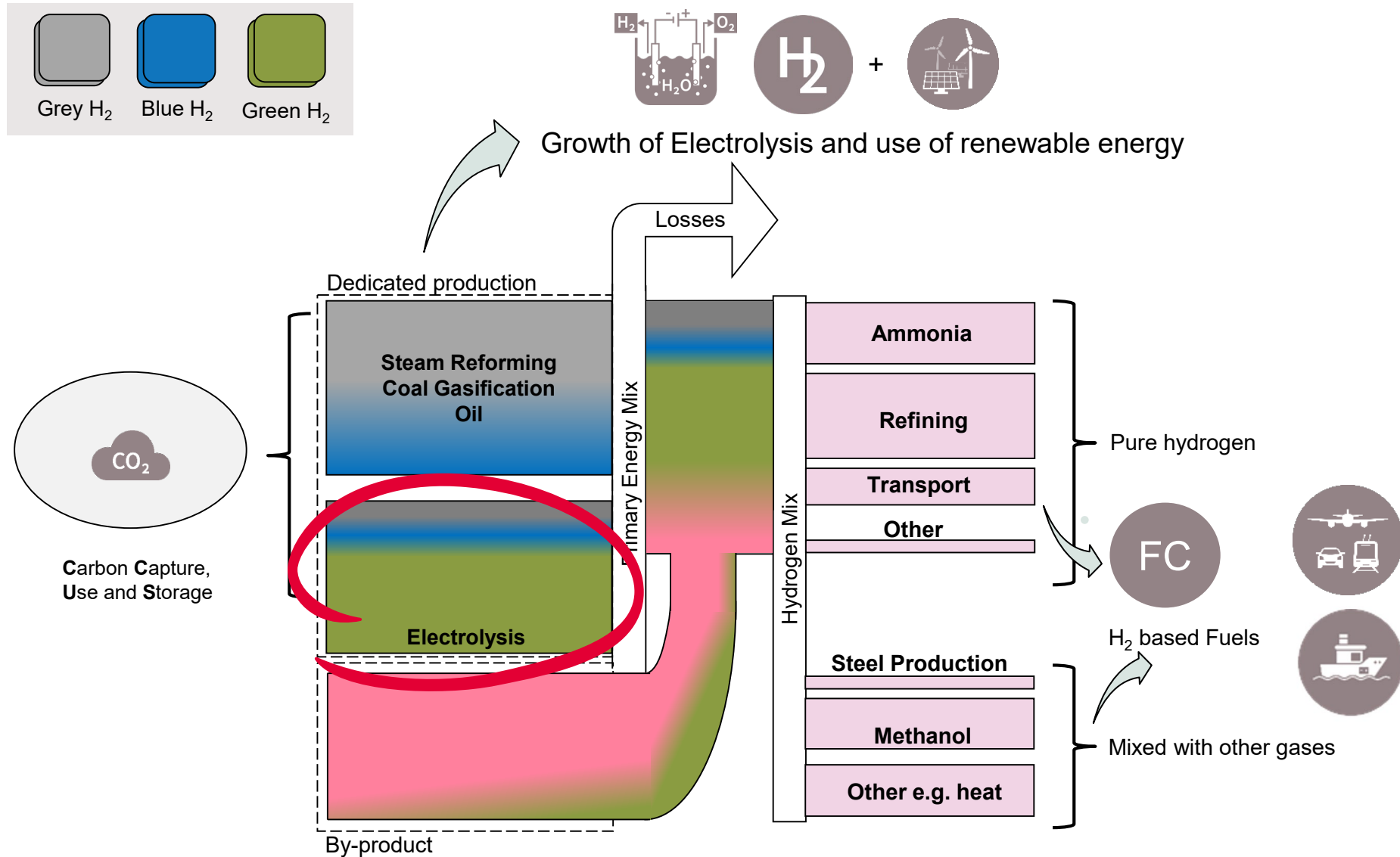


- › Hydrogen can be used as a resource, fuel, energy carrier and energy storage.
- › Hydrogen can replace fossil fuel in many industries: metallurgy, cement, heating.
- › For a sustainable hydrogen economy, the use of economically produced green hydrogen is crucial.
- › Increase of renewables requires large-scale of energy storage.
- › Hydrogen is expected as one key to reduce emission in transportation sector.
- › Railway, marine and trucks could use fuel cells as a next step to decarbonization.

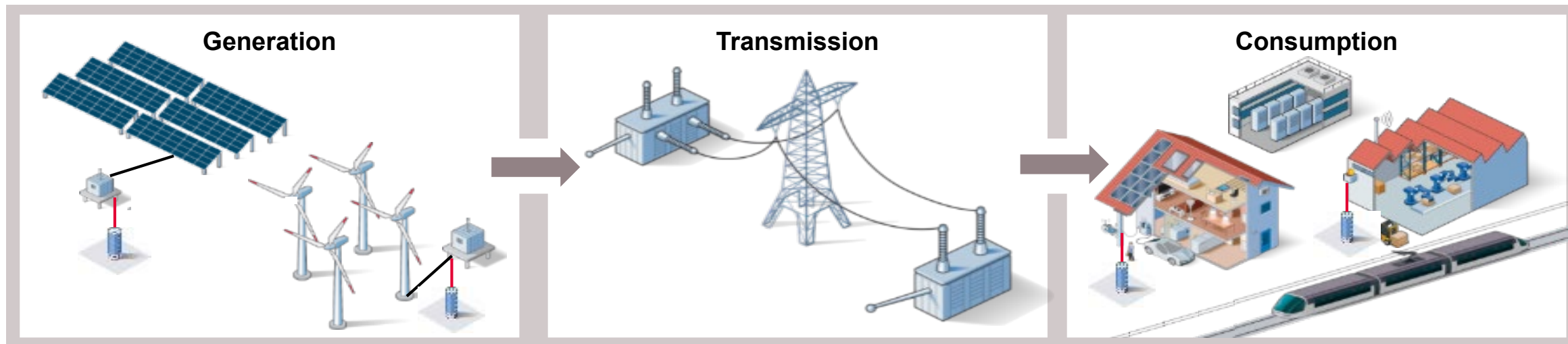
Todays Hydrogen production is dominated by Natural Gas Reforming and Coal Gasification



600 – 800 GW required electrolysis capacity to replace today's grey hydrogen production



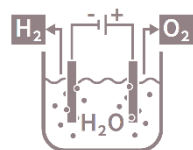
Green hydrogen as part of the electrical energy supply chain



Generation & Storage

Consumption

- › Electrolysis AC or DC coupled



- › Pure and synthesized H_2
- › Fuel cell, gas network, industrial production



System power 1 kW up to > 50 MW

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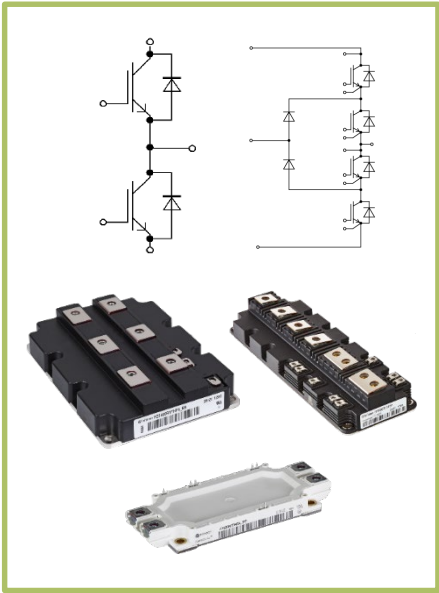
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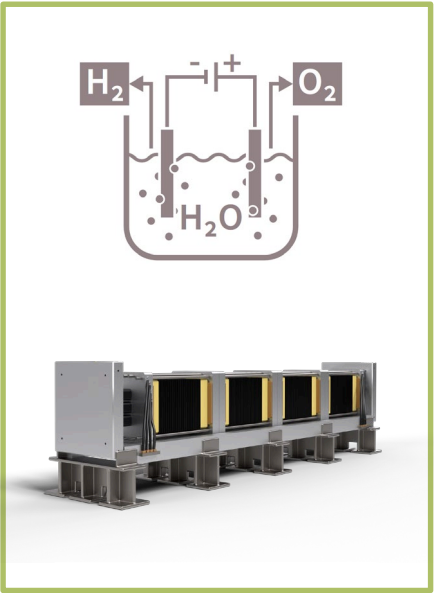
Infineon product portfolio enables Hydrogen production and value chain

Power Electronic Systems



Electricity

Electrolysis



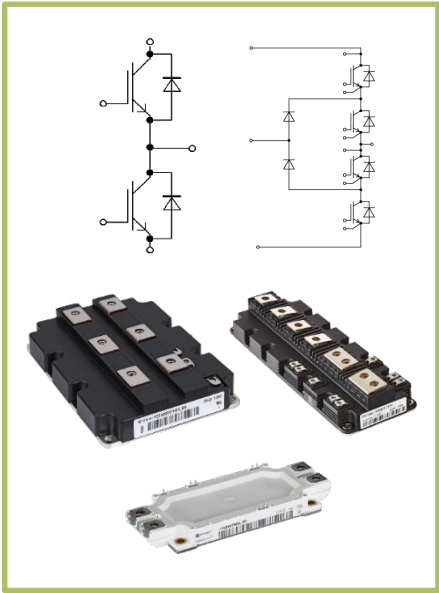
Hydrogen

Storage and Distribution



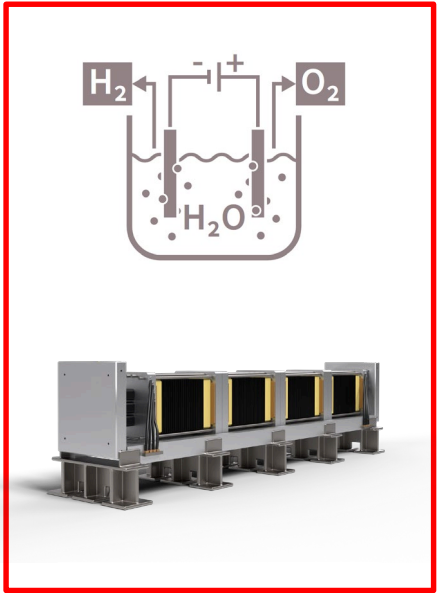
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Power Electronic Systems



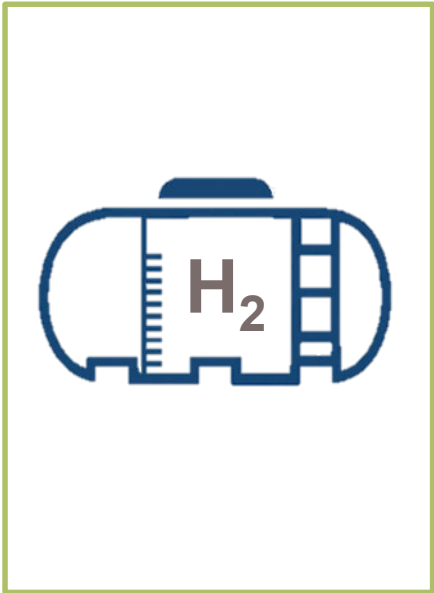
Electricity

Electrolysis

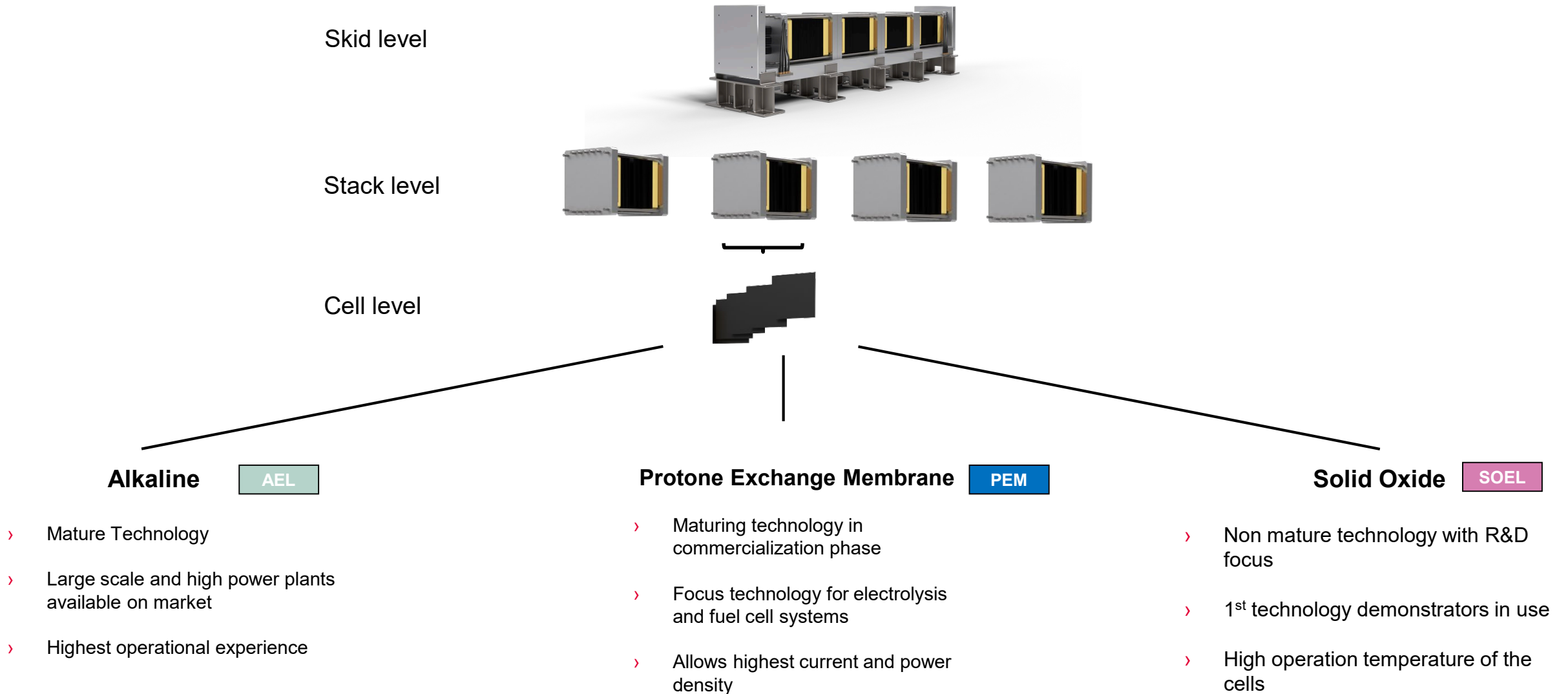


Hydrogen

Storage and Distribution

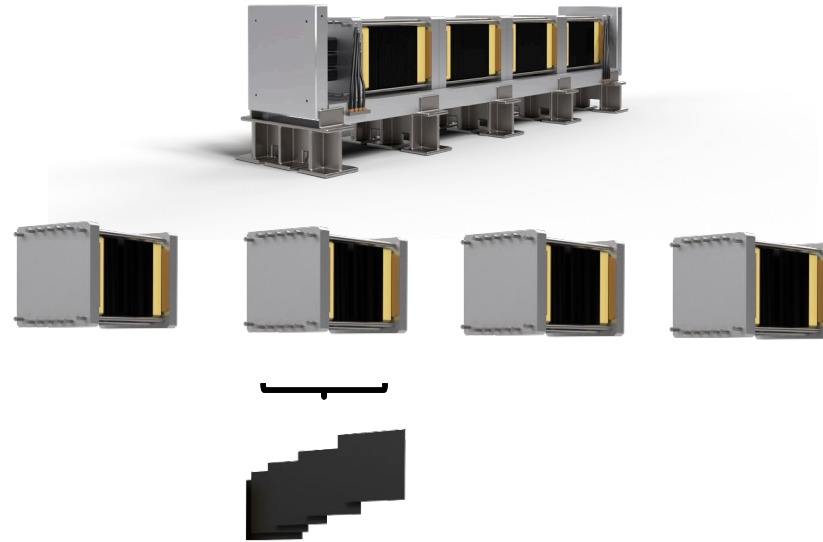


Three main electrolysis cell technologies in focus for future electrolyzer systems

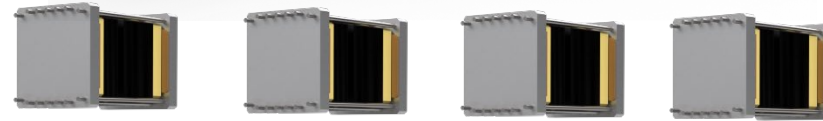


Electrical characteristics defined by cell current density and cell voltage of cell technologies

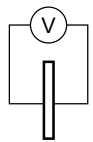
Skid level



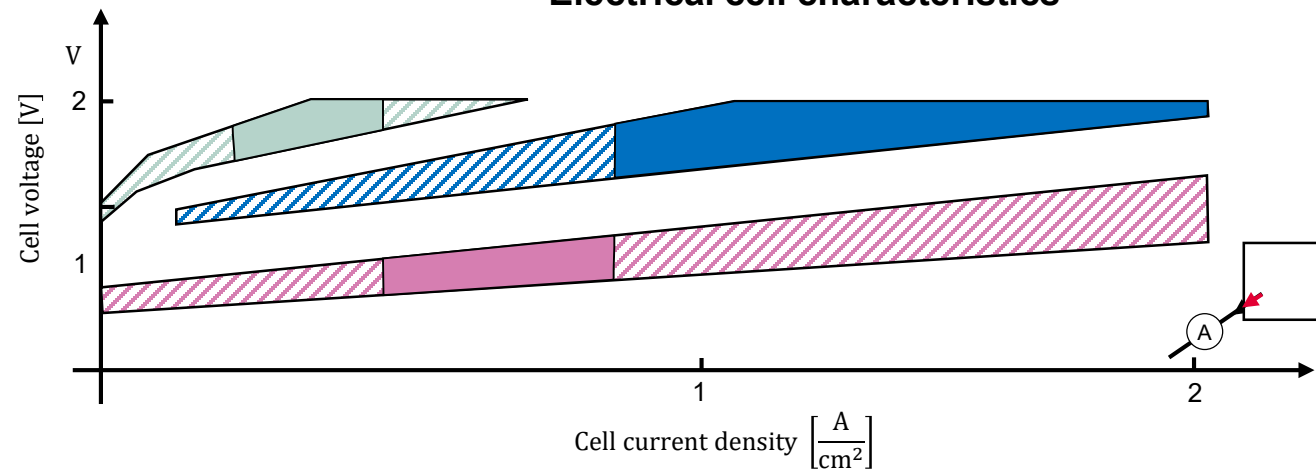
Stack level



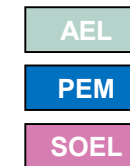
Cell level



Electrical cell characteristics

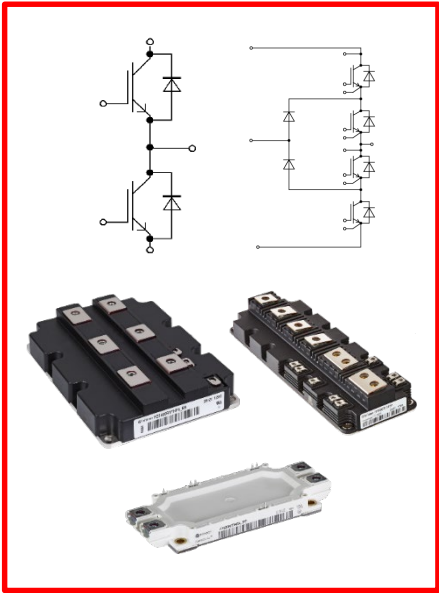


Typical operation range



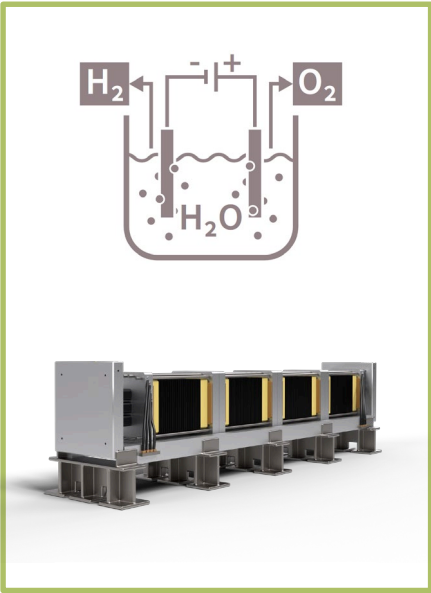
Infineon product portfolio enables Hydrogen production and value chain

Power Electronic Systems



Electricity

Electrolysis

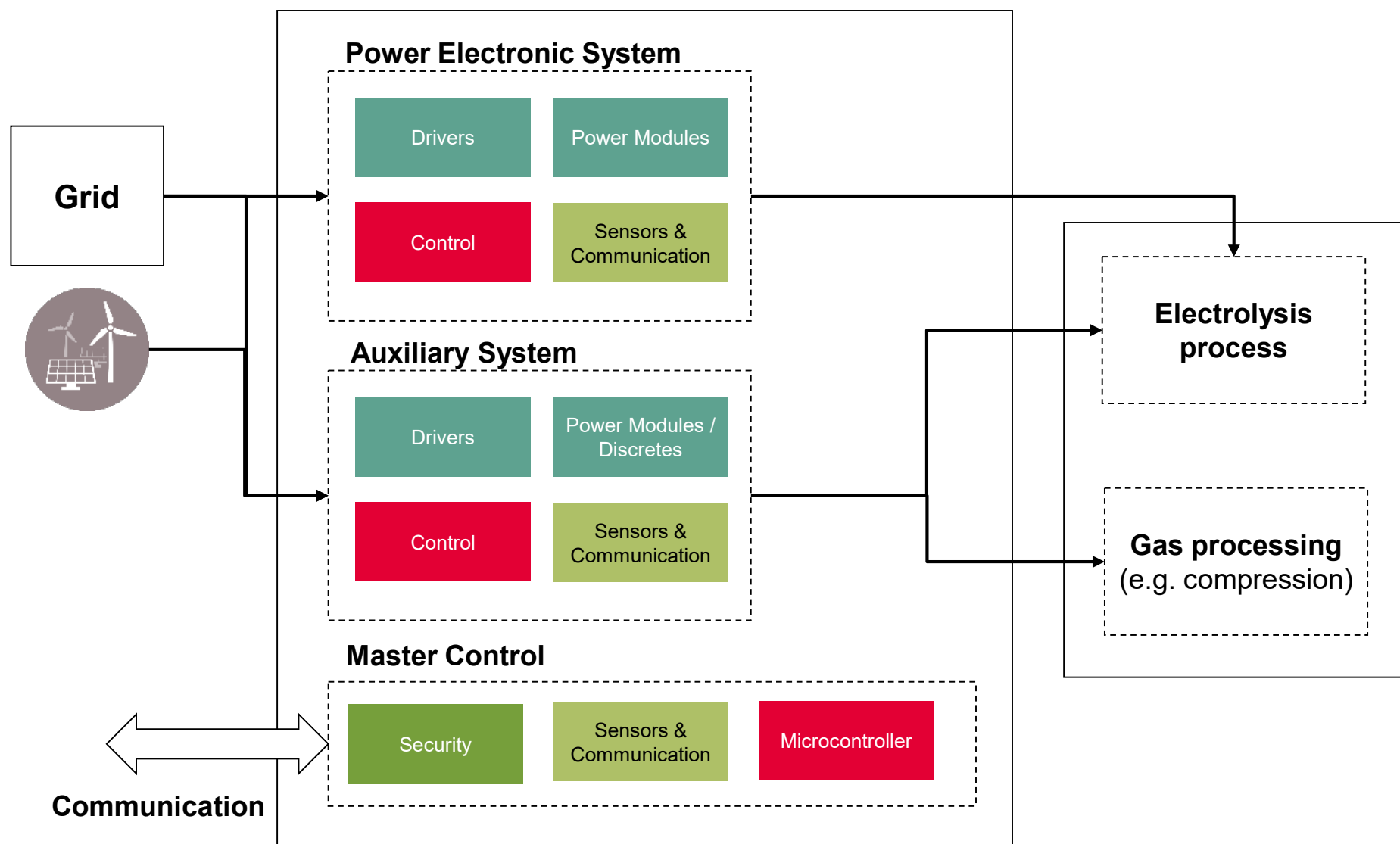


Hydrogen

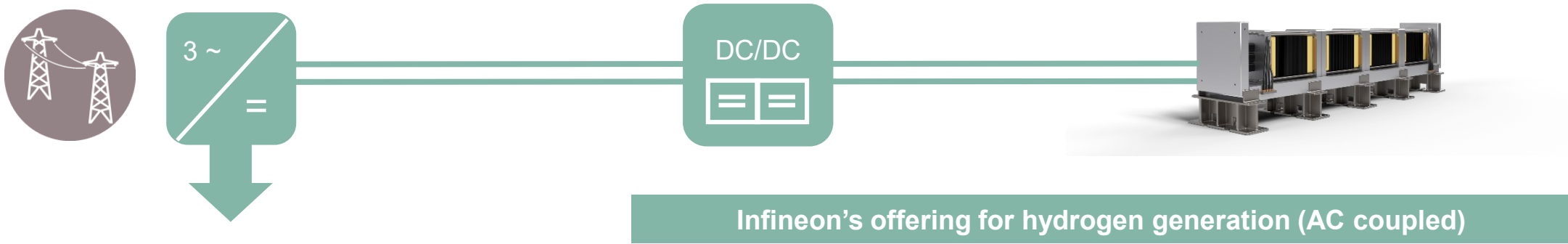
Storage and Distribution



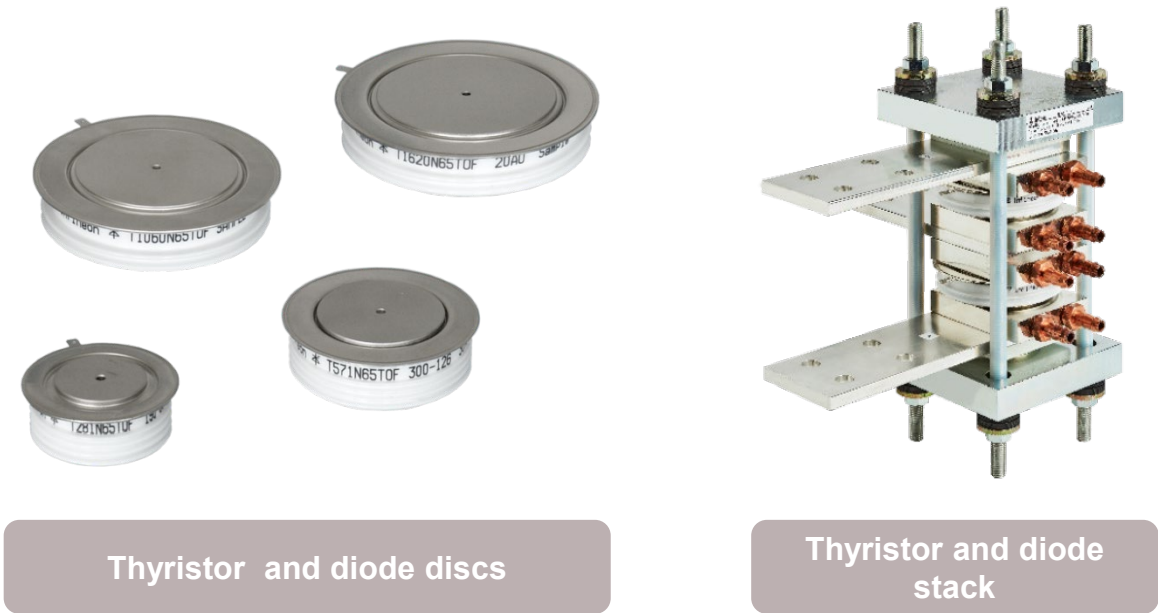
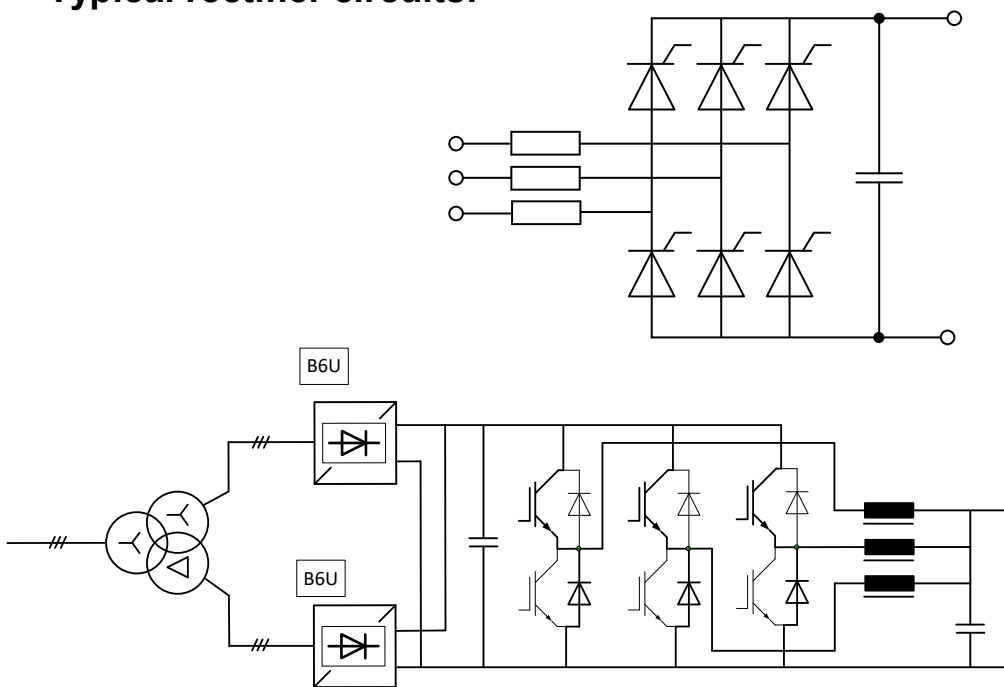
Power semiconductors enable the production of green hydrogen



Power semiconductors enable the production of green hydrogen

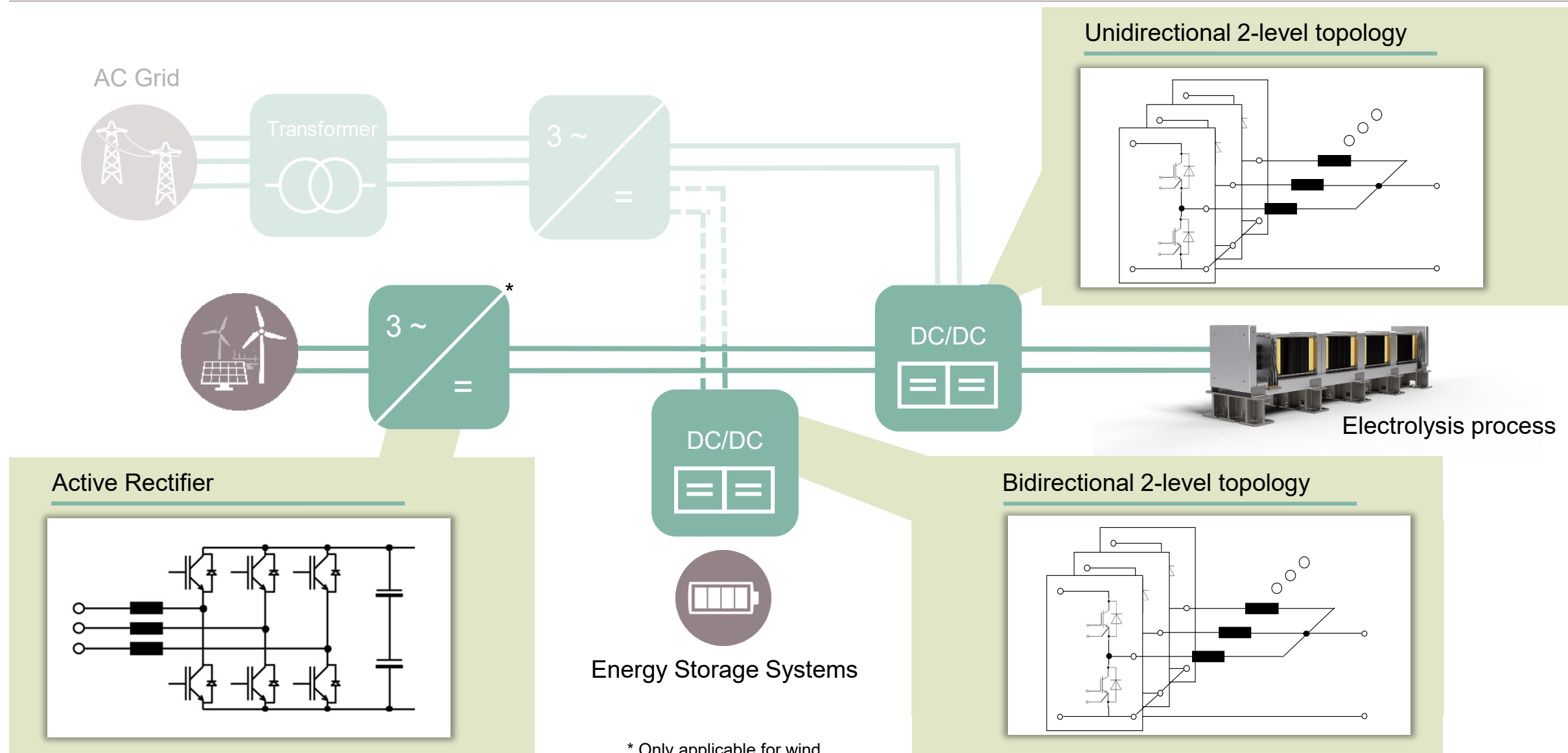


Typical rectifier circuits:

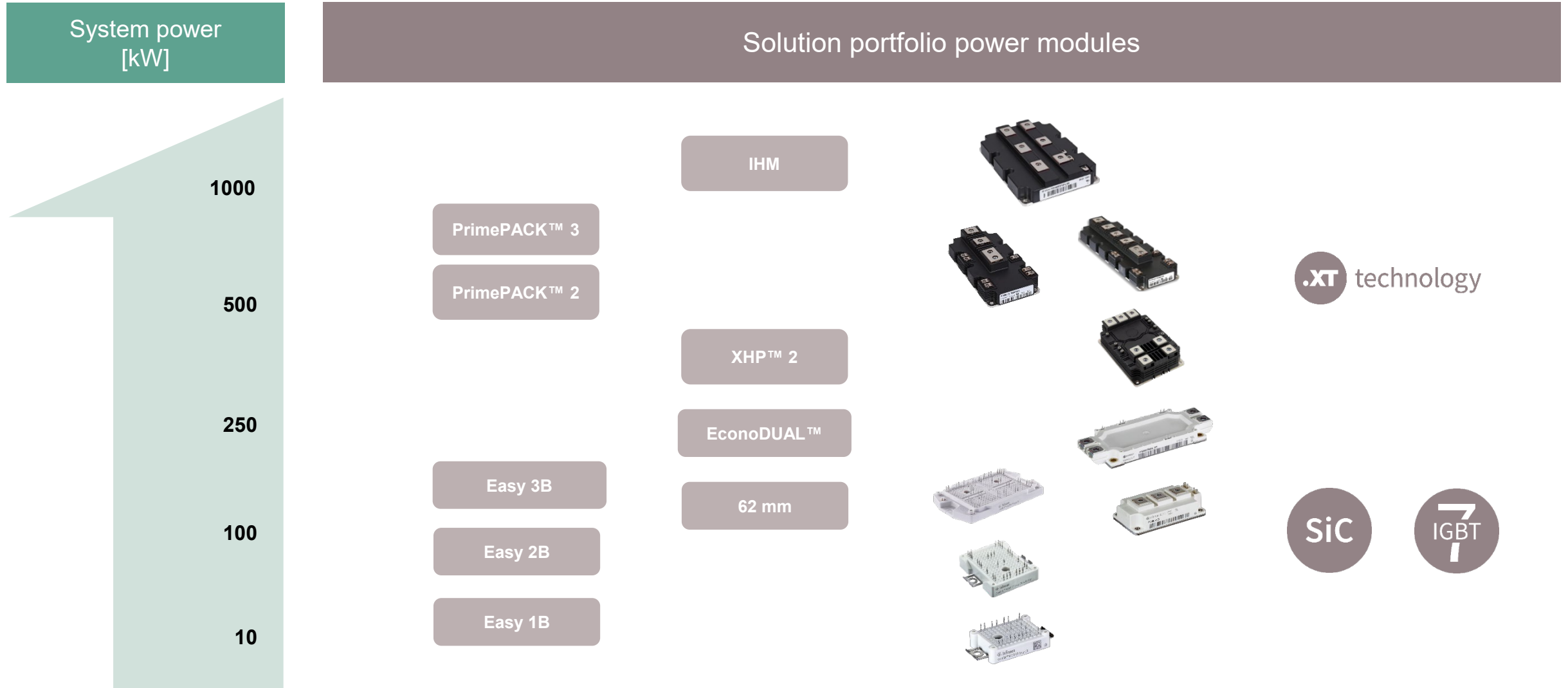


System power from 0,2 MW up to >50 MW

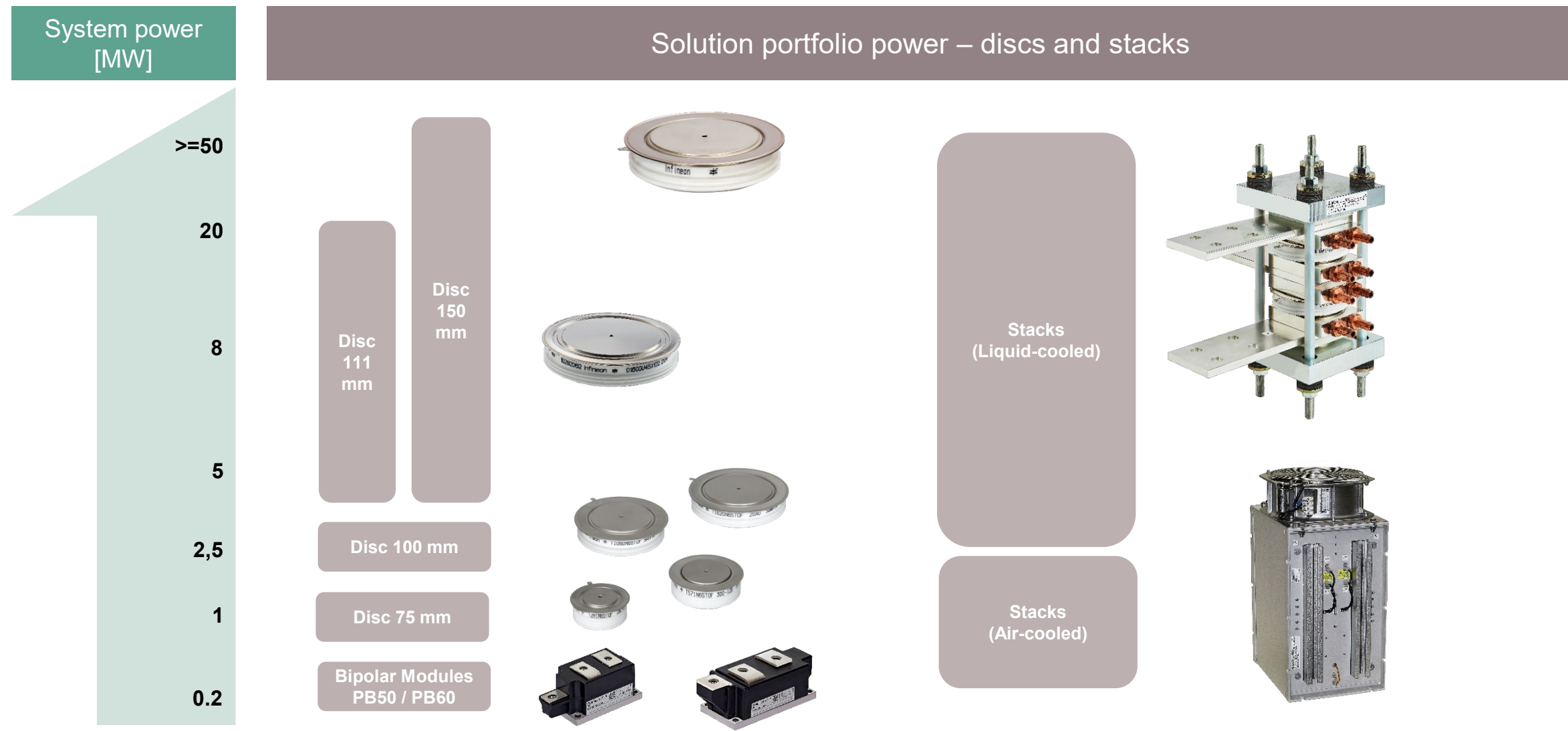
DC coupled production of green hydrogen



IPC power module offering for hydrogen production up to 1 MW and above



Bipolar offering for hydrogen production >0.2 MW



Today Thyristors are used for AC coupled hydrogen electrolysis

Advantages of the Thyristor system

- ✓ Highest power density compared with low conduction losses
- ✓ Less complex
- ✓ Cheaper compared to IGBT system
- ✓ Higher robustness compared to IGBT
- ✓ Protection by fuse is possible
- ✓ High case non rupture current
- ✓ Thyristor is line – commutated
(automatically turn off at zero crossing and turn on by phase angle working with line frequency 50/60 Hz)

Example of Thyristor housings



A Thyristor rectifier has got the highest power density and the lowest conduction losses paired together with the smallest dimensions

Product portfolio for high power rectifiers

Modular (200 kW – String)

Primary W3C + Sec. diode rectifier

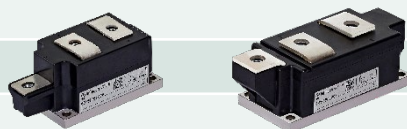
T280N65TOF

T570N65TOF

DD360N22K

DD435N36K

DD700N22K



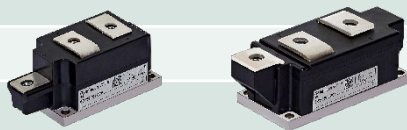
Secondary (thyristor rectifier)

TT260N22KOF

TT430N22KOF

TT520N22KOF

TT700N22KOF



Secondary with diode rectifier and IGBT

DD180N22S

DD340N22S

DD390N22S

DD700N22K

DZ1100N22KOF



Block (max. 7,500 kW)

2x thyristor rectifier B6

T1601N36TOF

T1900N18TOF

T2600N18TOF

T3800N18TOF

T3801N36TOF

T4771N28TOF



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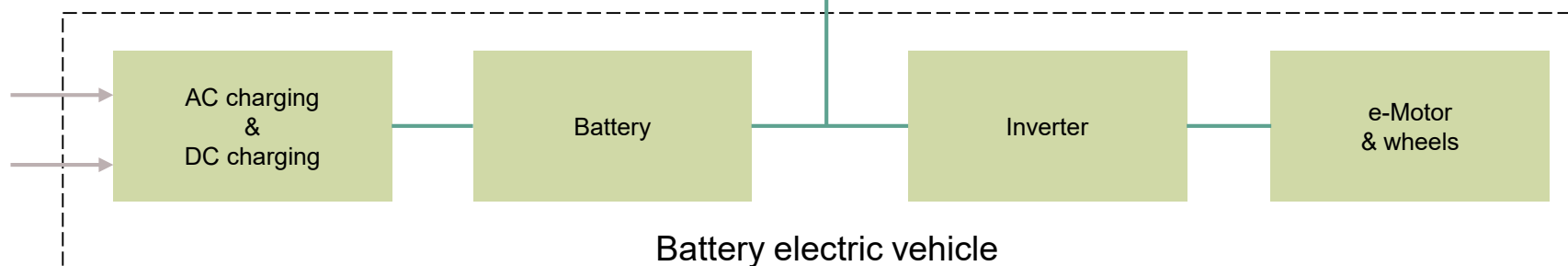
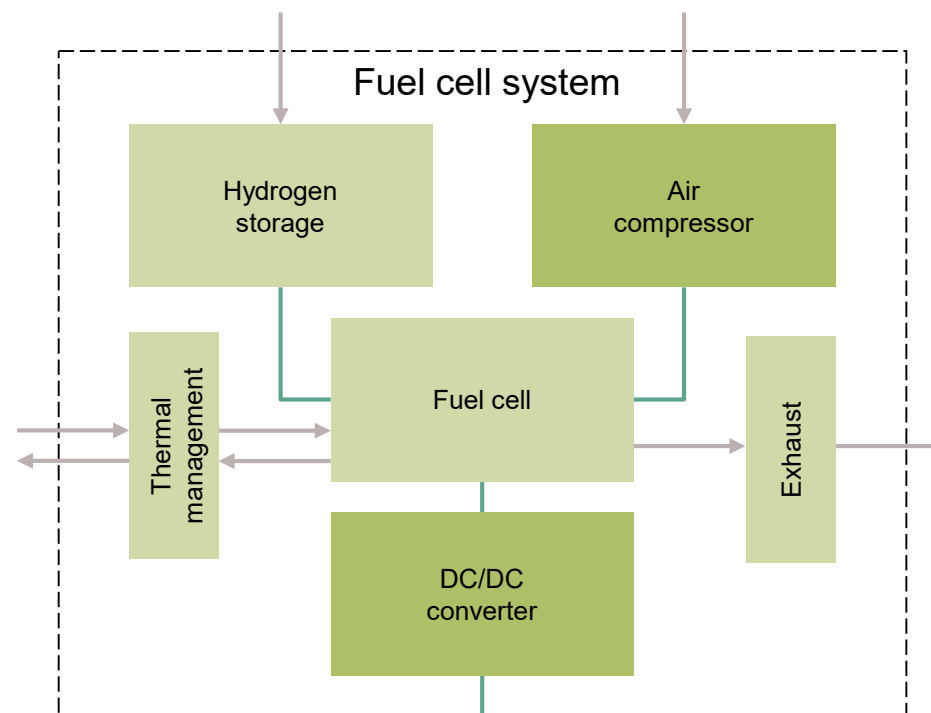
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Infineon's offering for hydrogen fuel cell

Fuel cell load list

- > DC/DC HV converter (50 - 300 kW)
- > Air compressor / turbine (10 - 30 kW)
- > Water pump (1 - 3 kW)
- > Cooling fan (1 - 3 kW)
- > Hydrogen pump
- > Pressure regulators
- > Valves
- > Injector



Example of power components



Discrete

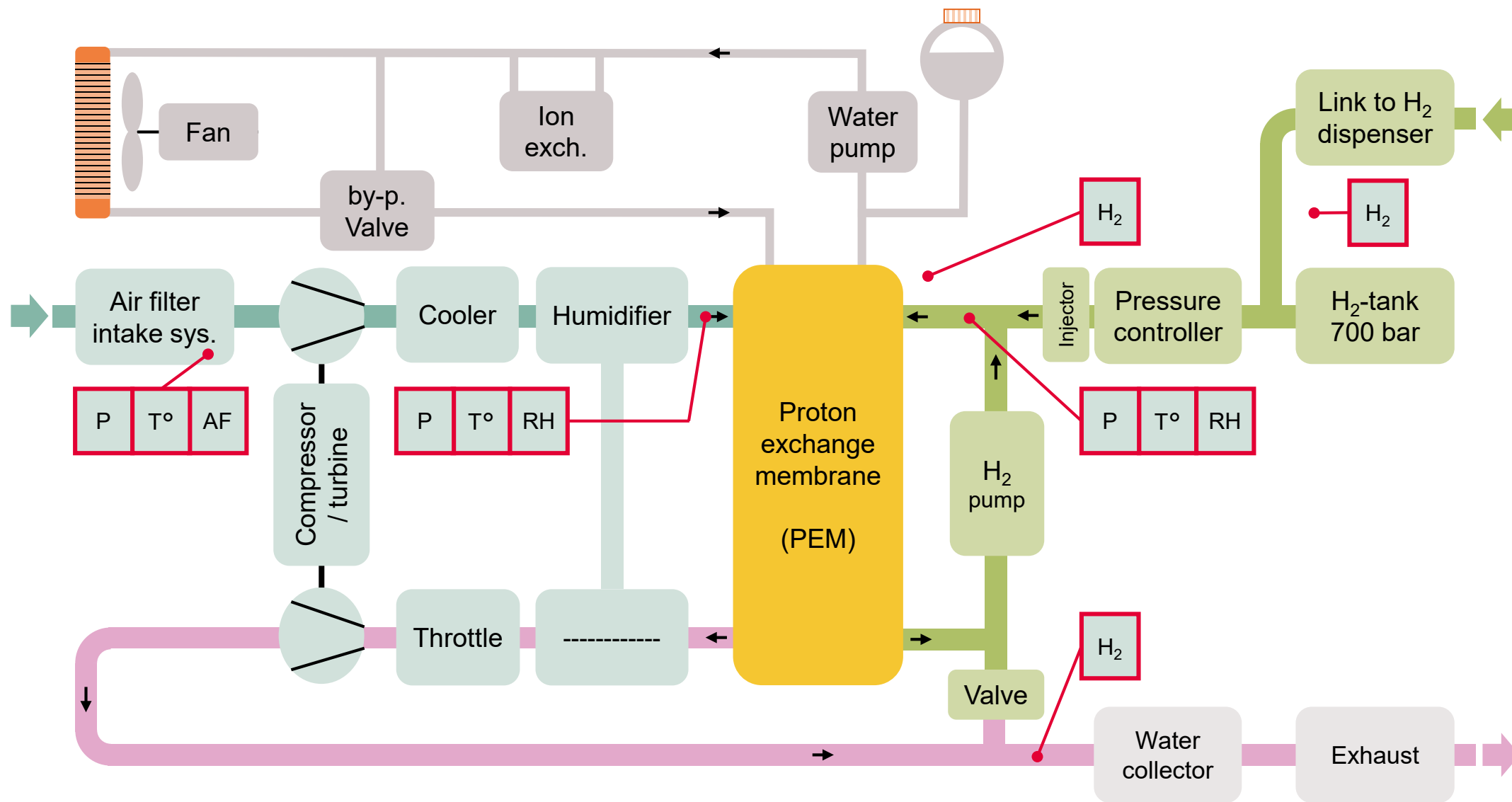
Gate driver

CoolSiC™

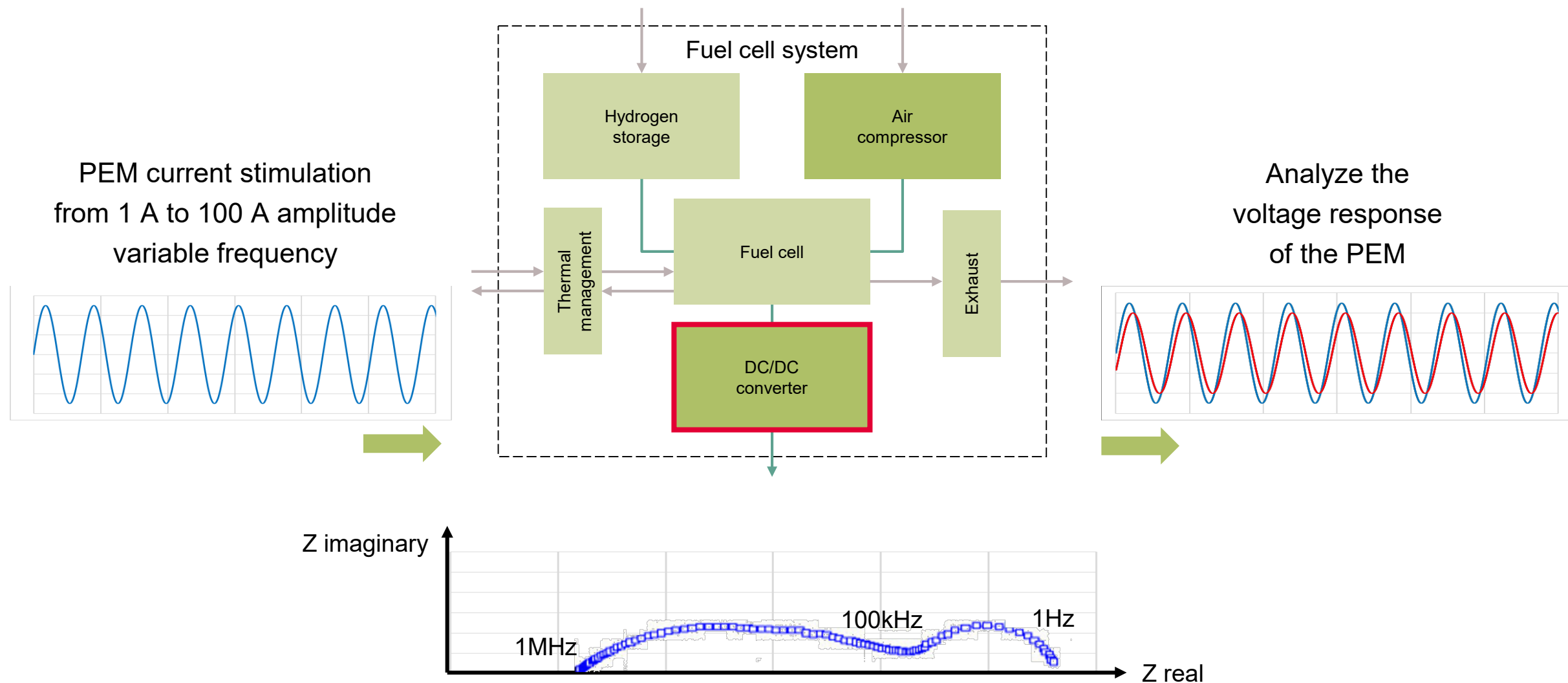
Easy

Gate driver

Fuel Cell – Application overview



Use case: Impedance spectroscopy



Electrification: several applications to address and leverage existing expertise within and around vehicles

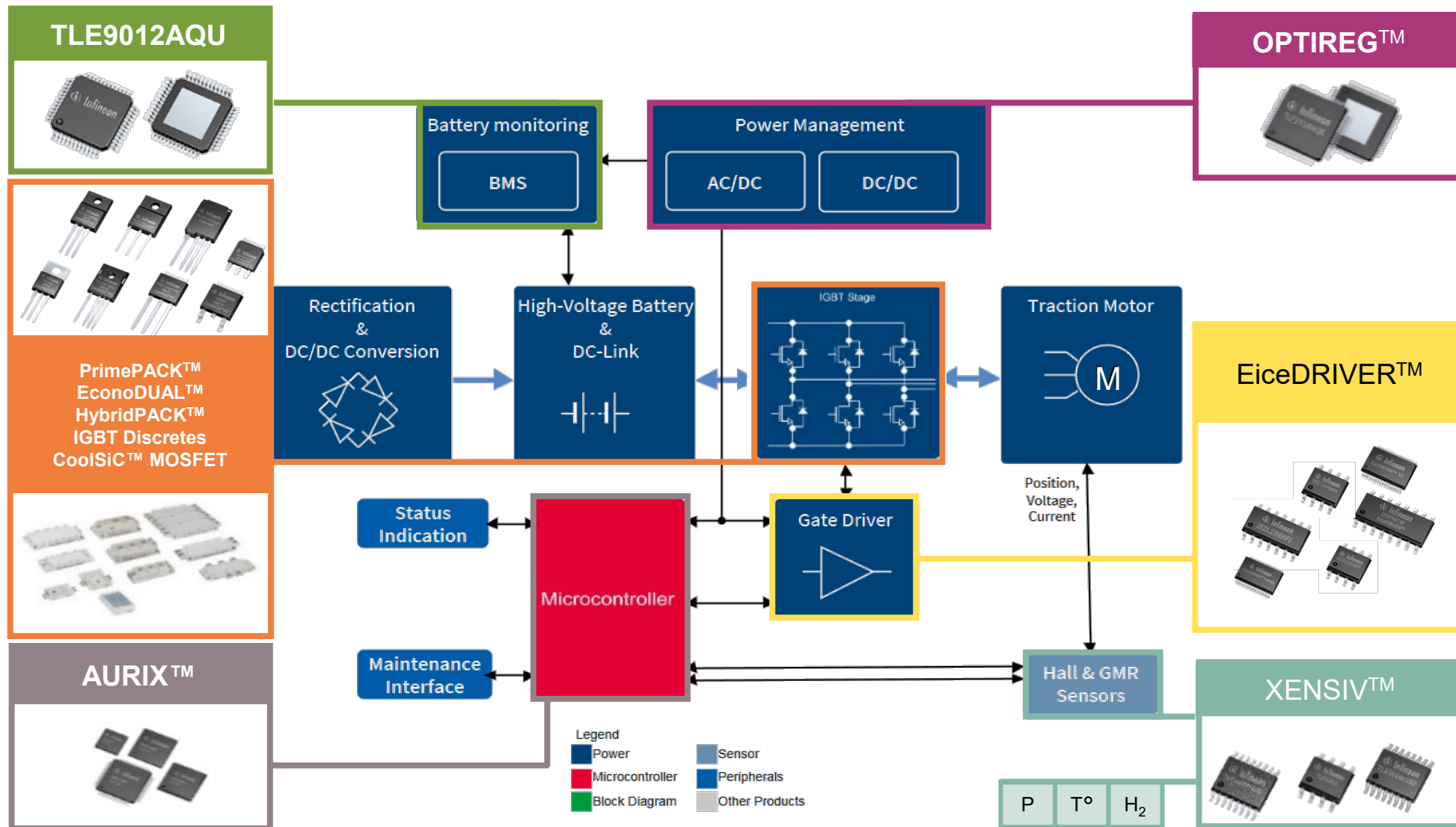





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- 

Hydrogen can be used as a basic material, fuel, energy carrier and energy storage.
- 

For a sustainable hydrogen economy, the use of economically produced green hydrogen is crucial
- 

Power semiconductors enable the production and consumption of green hydrogen.



Benefit from our leading product portfolio

Find more information on our dedicated pages:

- › [Infineon Positioning Paper](#)
- › [Hybrid and electric solutions for construction, commercial and agricultural vehicles](#)
- › [Thyristor / Diode discs](#)
- › [Thyristor modules](#)



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