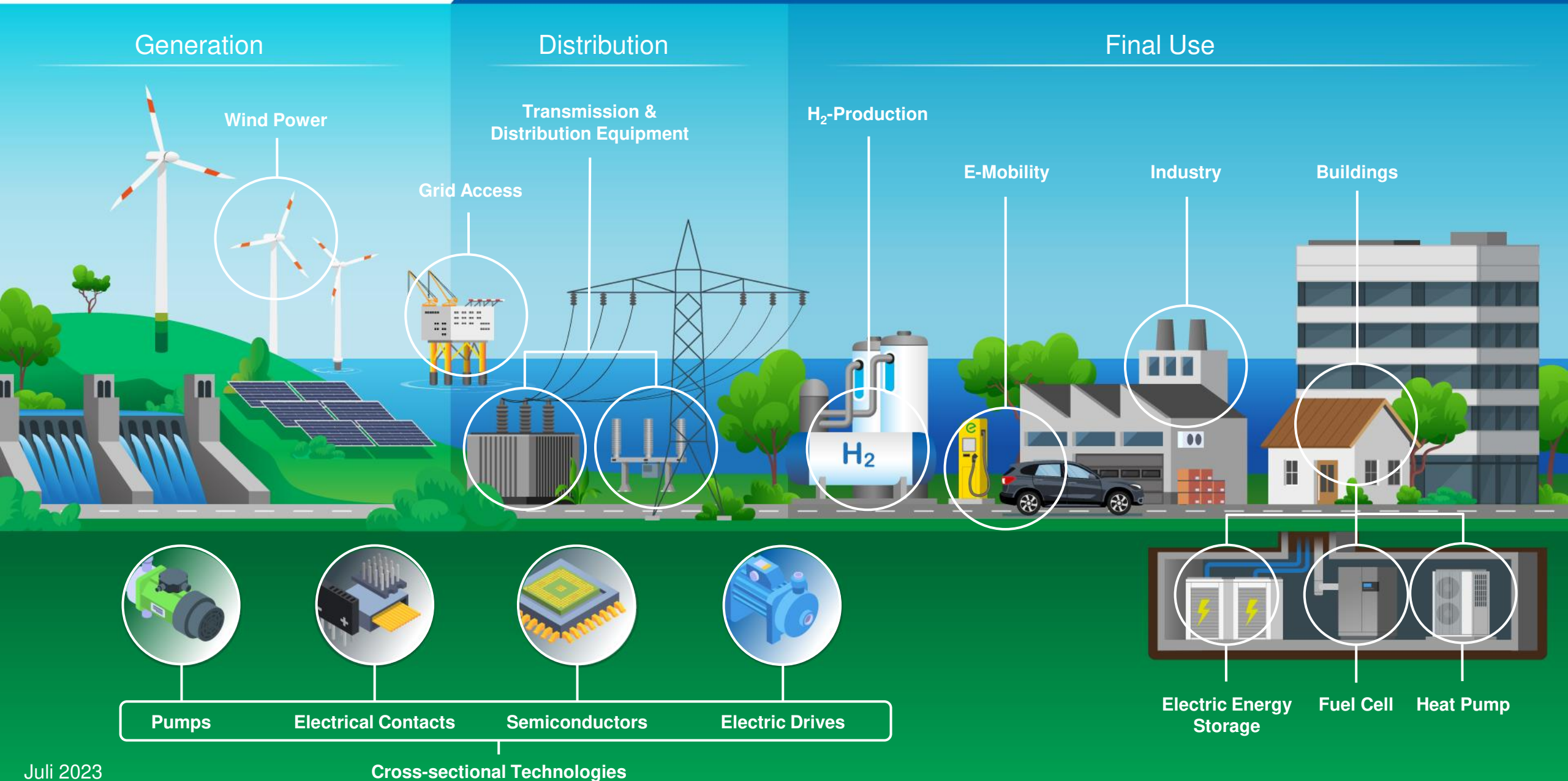
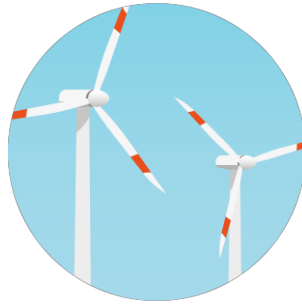




Wind Power

(onshore/offshore)

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Products:

- Wind turbine

Relevant for:

- Renewable energy production

Function of product:

- Production of electrical power by using natural wind

PFAS substance used:

- PTFE (lubricant)

PFAS containing material / component:

- taping foil moulds as release agent in production; sealing rings, gliding pads, lubricants, li-battery

Reason for use:

- separates rotor blades from mould during production, smooth kinematic motions, self sustainable turbines application

Lifetime of product:

- about 20 years

Lifetime of PFAS used:

- depending on application

Grid Access



Products:

- HV Power Converter

Relevant for:

- Enabling grid access to connect renewable offshore power generation to the grid over longer distances

Function of product:

- conversion of electric power from high voltage alternating current (AC) to high-voltage direct current (HVDC) for long distant power connections

PFAS substance used:

- PVDF

PFAS containing material / component:

- Cooling pipes (oil system)

Reason for use:

- extrem heat- and high (aggressive) chemical resistance insulation ability, low water absorption and fire retarding ability

Lifetime of product:

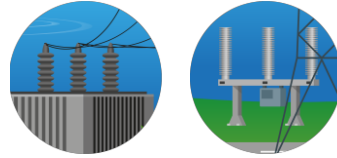
- 30 – 40 years

Lifetime of PFAS used:

- designed for product lifetime, can be easily separated for disposal

Transmission & Distribution Equipment

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Products:

- HV/MV switchgear; instrument transformer; Coils; Distribution and Power Transformer

Relevant for:

- grid stability and security (risk prevention) - power overload protection for overhead and distribution lines; metering, protection and control of the high/medium voltage power system; power transformation

Function of product:

- electrical switching in power T&D lines for industrial and commercial use, protection and controlling power loads; voltage or phase conversion HV to LV, electrical isolation, voltage measurement and monitoring in T&D lines

PFAS substance used:

- solids: PTFE, PVDF, PFPE
- lubricants: PTFE, insulating gases

PFAS containing material / component:

- cooling pipes, seals; sliding ring, switching nozzle

Reason for use:

- extreme heat-, flame- and high (aggressive) chemical resistance, low electric conductivity, dielectric insulation, low water absorption, ablation of PTFE for cooling purpose – prerequisite for arc switching, reduction of friction within kinematic chain, surface protection

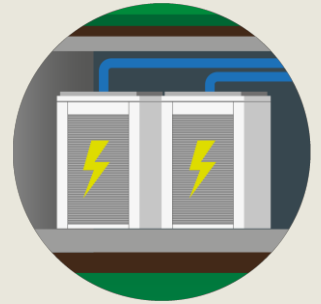
Lifetime of product:

- 30 – 40 years

Lifetime of PFAS used:

- Designed for product lifetime

Electric Energy Storage



Products:

- Lithium-Ion Batteries

Relevant for:

- Energy storage, electric mobility, ICT (information and communications technology), medical devices, tracking, smart metering, security devices

Function of product:

- Storage and supply of electrical energy with low energy loss, high charging speed and energy density

PFAS substance used:

- PTFE, PVDF

PFAS containing material / component:

- low-molecular PFAS in electrolyte, binders in the cathode of lithium batteries

Reason for use:

- intermediate electrical energy storage with minor losses and high charging cycles

Lifetime of product:

- Up to 20 years

Lifetime of PFAS used:

- designed for product lifetime

Hydrogen Production

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Products:

- Electrolyzer

Relevant for:

- renewable energy - production of green hydrogen by electrochemical splitting of water

Function of product:

- electrochemical conversion of (green) electrical energy into chemical energy (hydrogen as an energy carrier). An electrolyzer catalytically splits water into oxygen ions and protons. Applying an electrical current protons migrate through a membrane and convert to H_2 at the cathode while O_2 forms at the anode.

PFAS substance used:

- PFSA, PTFE, ePTFE, PFPE, PFA, and others

PFAS containing material / component:

- membranes, GDL (gas diffusion layer), catalyst layer for MEA (membrane electrode assembly), sealings for stacks and other system components

Reason for use:

- heat- and high (aggressive) chemical and mechanical resistance, wetting properties, low surface energy.

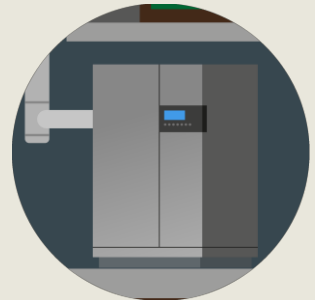
Lifetime of product:

- ~25 years, 10 years for electrolyzer stacks

Lifetime of PFAS used:

- see product, PM catalyst recovery ensures full recycling

Energy Storage



Products:

- Fuel Cell

Relevant for:

- renewable energy – efficient „re-electrification“ of hydrogen to electric power. Use of chemical energy for storage and fast refueling while having a higher efficiency than the combustion engine and no pollutant emissions.

Function of product:

- electrochemical conversion of hydrogen into electricity and water

PFAS substance used:

- PFSA, PTFE, ePTFE, PKM

PFAS containing material / component:

- membrane, GDL (gas diffusion layer) for MEA, catalyst layer for MEA, Sealing for Bipolar plate and Cathode-/Anode endplate

Reason for use:

- heat- and high (aggressive) chemical and mechanical resistance, wetting properties, low surface energy.

Lifetime of product:

- ~15 years, operating hours: 15.000 h, target: 30.000 h.

Lifetime of PFAS used:

- see product, PM catalyst recovery ensures full recycling

Buildings

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Products:

- Heat Pumps

Relevant for:

- Energy transition, decarbonization, energy-efficient houses

Function of product:

- provide heating, cooling and hot water for residential, commercial and industrial use

PFAS substance used:

- PVDF, PTFE (solids) , PFA, FEP, FKM, ETFE, PP-TFE

PFAS containing material / component:

- Refrigerants, sealings and insulation, electronics / controls and monitoring equipment, compressor (bearing, seals, electronics)

Reason for use:

- High temperature-, aggressive chemical-and UV resistance, high dielectric strength, high refractive index, inherent flame retardance, moisture barrier, non-fouling behavior in water systems.

Lifetime of product:

- average 15 – 20 years

Lifetime of PFAS used:

- designed for product lifetime

E-Mobility



Products:

- Battery, drive, cooling system, actuators for management of cooling fluid cycles

Relevant for:

- Battery electric vehicles (BEV) and its lifetime operation

Function of product:

- see description of electrical storage and electric drives; drive train components (converter, e-engine, transmission) via high performance gearmotor actuators

PFAS substance used:

- PFPE/PTFE containing lubricant, refrigerant R1234yf

PFAS containing material / component:

- cooling refrigerant, lubricants in micro-gearboxes (actuators)

Reason for use:

- resilience against temperature fluctuation, wear protection, functional precision, avoidance of significant weight increase and design challenges. Thermal management of BEV coolant cycles requires high precision actuation of gearmotor-driven valves and flaps over temperatures ranging from -40°C to +150°C.

Lifetime of product:

- ~up to 25 years.

Lifetime of PFAS used:

- Same as vehicle lifetime

Industry

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Products:

- Combined heat and power plant for decentralized power and heat generation

Relevant for:

- decentralized power and heat generation, power grid stabilization

Function of product:

- conversion of chemical energy (e. g. hydrogen, see fuel cell technology) into electricity and heat

PFAS substance used:

- PTFE (solid), PTFE lubricants, PFPE, insulating gases

PFAS containing material / component:

- Seals, hoses, PTFE tape, hydraulic fluid, cables

Reason for use:

- Prevents fluid leaks, increases longevity of products that reduces waste, fire prevention, heat, flame and high (aggressive) chemical resistance, low electrical conductivity, dielectric insulation, low water absorption, provide friction reduction.

Lifetime of product:

- 25 years

Lifetime of PFAS used:

- designed for product lifetime

Cross-sectional Technologies

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Products:

- Pumps, Vacuum technology, Compressors (H₂, Biomethane)

Relevant for:

- Production and conveying of basic chemicals (e.g. acid and leach); Conveying liquid H₂; Manufacturing of Solar cells, Compression and Transport of gaseous H₂, Bio-methan, gaseous chemicals

Function of product:

- Transport of liquid or gaseous substances by applying pressure through mechanical means, also for storage

PFAS substance used:

- FKM/FPM, PTFE

PFAS containing material / component:

- Seals, sealing rings, guide rings, non-stick coatings, Labyrinth inserts, Lubricants, Sliding bushes, hoses, diaphragms (Diaphragm compr.)

Reason for use:

- resistance against high heat and (aggressive) chemicals resistance

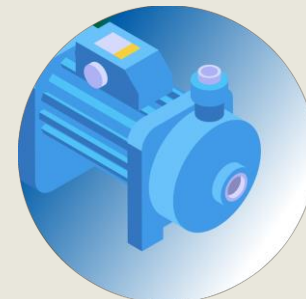
Lifetime of product:

- 30 years and more (e.g. pumps, vacuum pumps)
- 50 years and more (process gas compressors H₂)

Lifetime of PFAS used:

- designed for product lifetime

Cross-sectional Technologies



Products:

- Electric Drive

Relevant for:

- Automotive and industrial applications

Function of product:

- Convert electric energy into mechanical energy

PFAS substance used:

- FKM/FPM, PTFE, PFPE

PFAS containing material / component:

- Sealing, coating, lubricant, wire insulation, guide element

Reason for use:

- Thermal resistance, chemical resistance (e.g. anticorrosion), wear resistance (at high speeds, high-pressure cleaning), non-stick properties, low friction, resistance to environmental influences (UV radiation, ozone), lubricant compatibility

Lifetime of product:

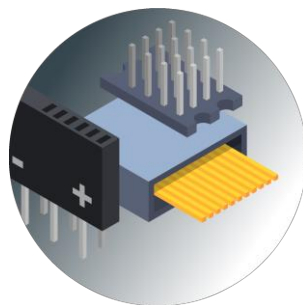
- 30 years and more

Lifetime of PFAS used:

- Designed for highest durability, replacement of sealings in case of wear

Cross-sectional Technologies

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Products:

- Electrical contacts

Relevant for:

- High performance industrial contacts with high mating cycles and high current densities; required e. g. for rail applications and BEV contacts to withstand vibration stress during operation

Function of product:

- Electrical high current transmission

PFAS substance used:

- PFPE formulated grease or oil

PFAS containing material / component:

- PFPE surface lubricant on metal contacts

Reason for use:

- only PFPE based lubricants withstand the rough environmental conditions at the extreme temperatures at high current densities, reduction of mechanical friction, prevention of contact corrosion and microwelding, reduction of electrical contact resistance

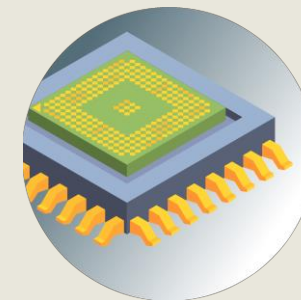
Lifetime of product:

- Up to 25 years

Lifetime of PFAS used:

- designed for product lifetime

Cross-sectional Technologies



Products:

- Semiconductor (focus manufacturing process)

Relevant for:

- electrification and digitalization in almost all technical applications

Function of product:

- electrical power control and electrical information distribution switching

PFAS substance used:

- PFPE, PTFE and other PFAS formulations (CF_4 , C_4F_8 ,...)

PFAS containing material / component:

- manufacturing process gases for plasma dry etching; chemical solutions for wet etching and wafer cleaning; additives in lithography materials; anti-stiction coatings; machinery for semiconductor processing

Reason for use:

- low particle levels (due to low surface adhesion and low wear), chemical process requirements, thermal stability, optical properties

Lifetime of product:

- lifetime of final product/facility

Lifetime of PFAS used:

- n.a.; generally only used for manufacturing

Disclaimer

The topics take into account the state of the art at the time of issue.

Everyone is requested, if he encounters inaccuracies or the possibility of misunderstanding in the document, to notify the associations immediately so that any deficiencies can be corrected.

The addition of and linking to other content requires the agreement of the authors.

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