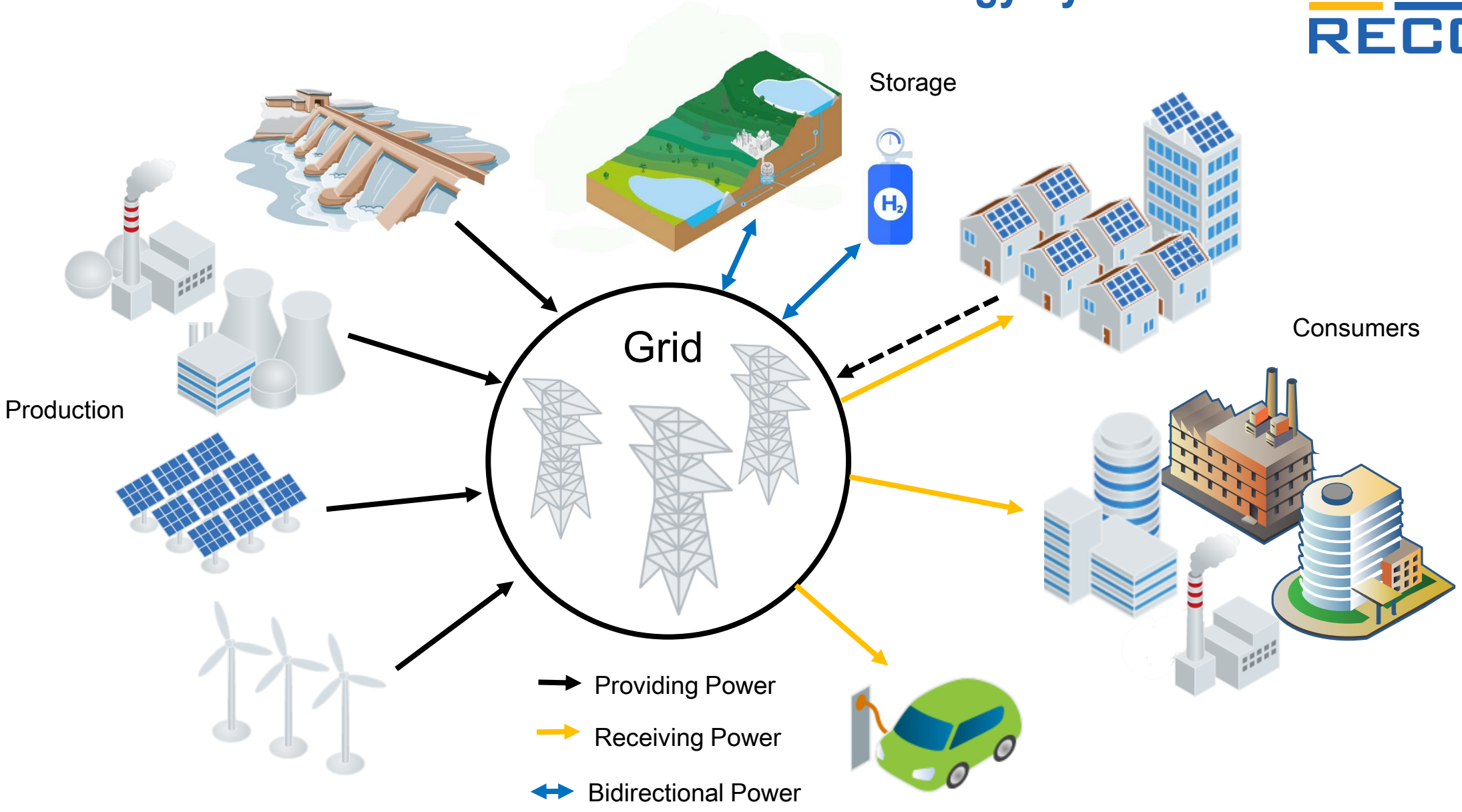
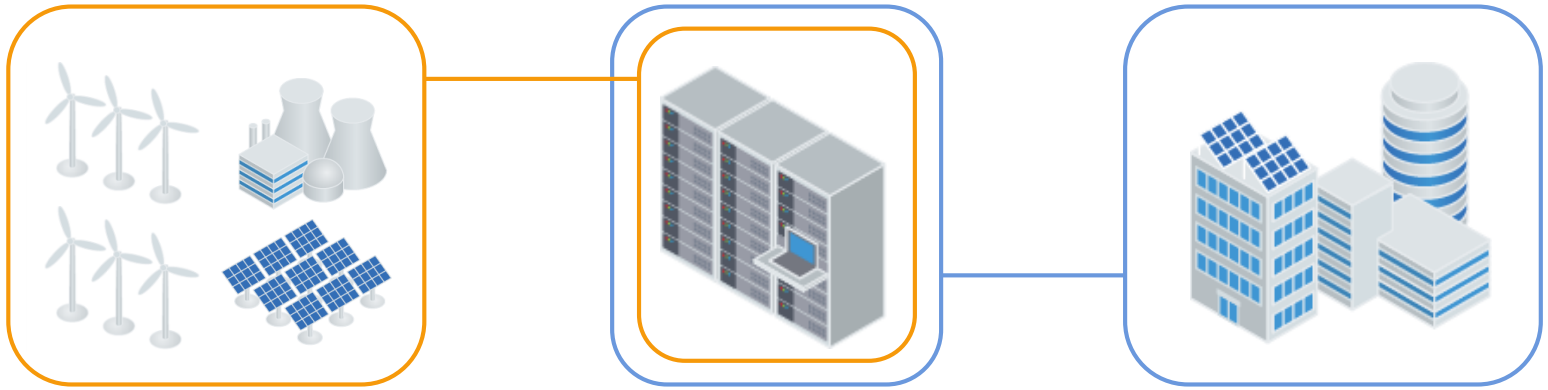
Rutronik TechTalk: Renewable Energy Systems

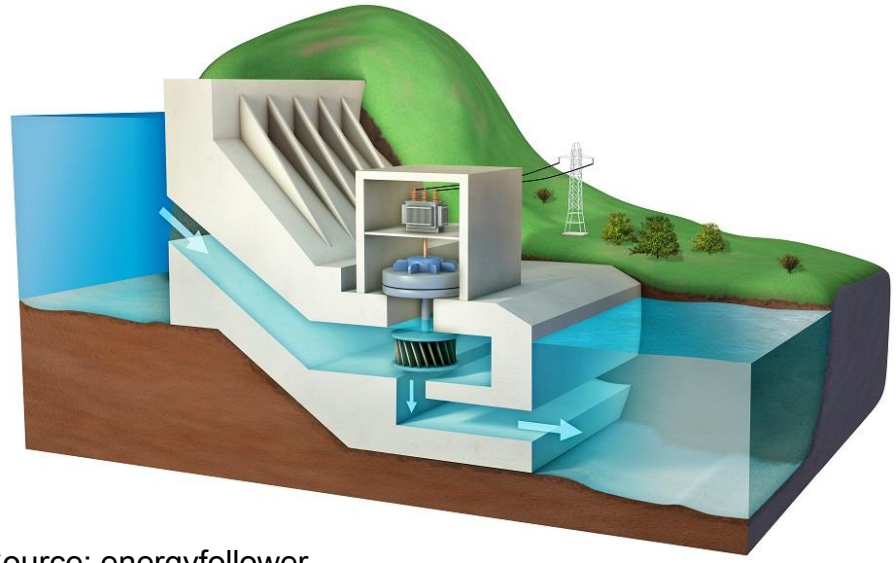
RECOM



Renewable Energy

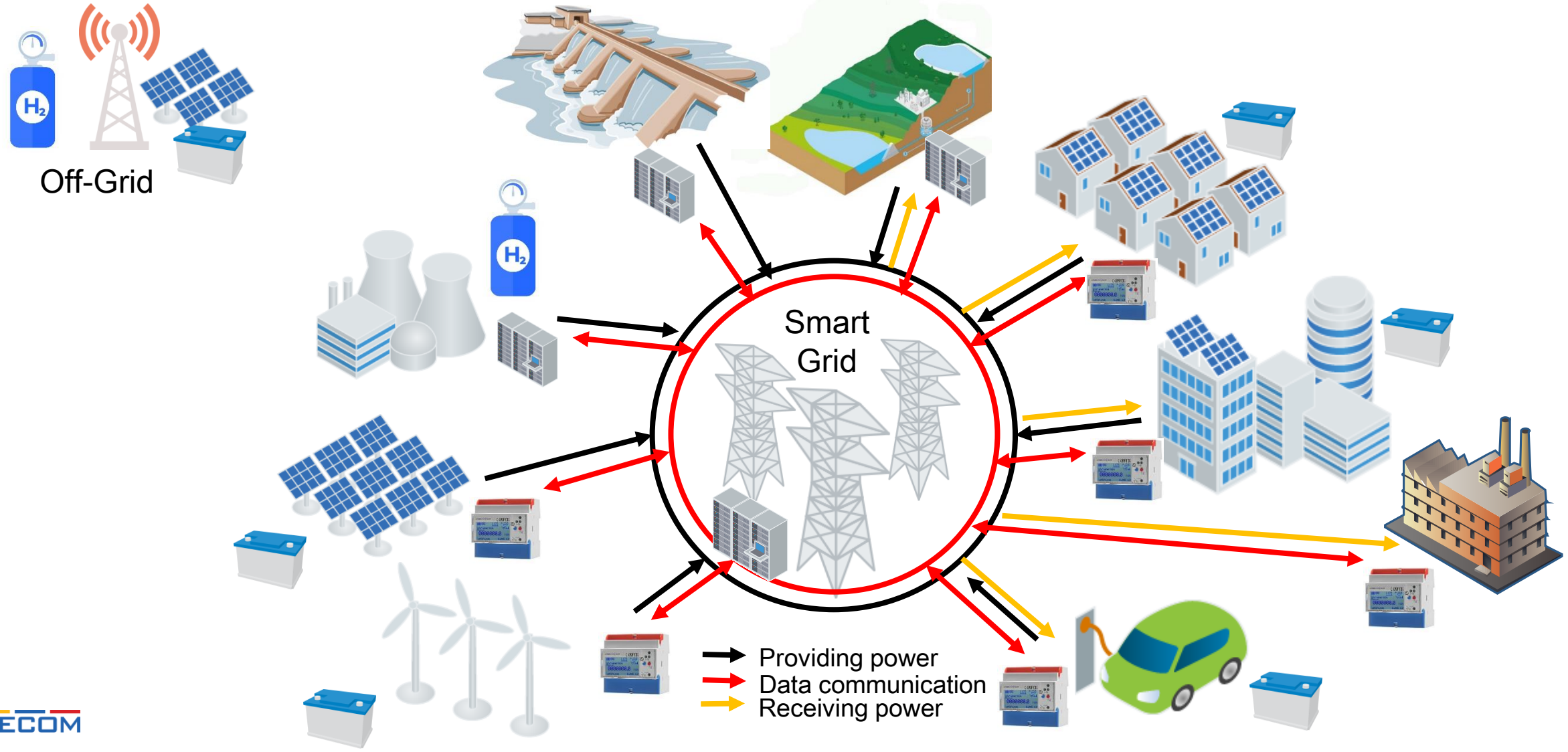
- Smart Grid
- Wind
- Solar
- Hydroelectric
- Hydrogen
- Off-Grid
- Batteries





Source: energyfollower

Smart Grid



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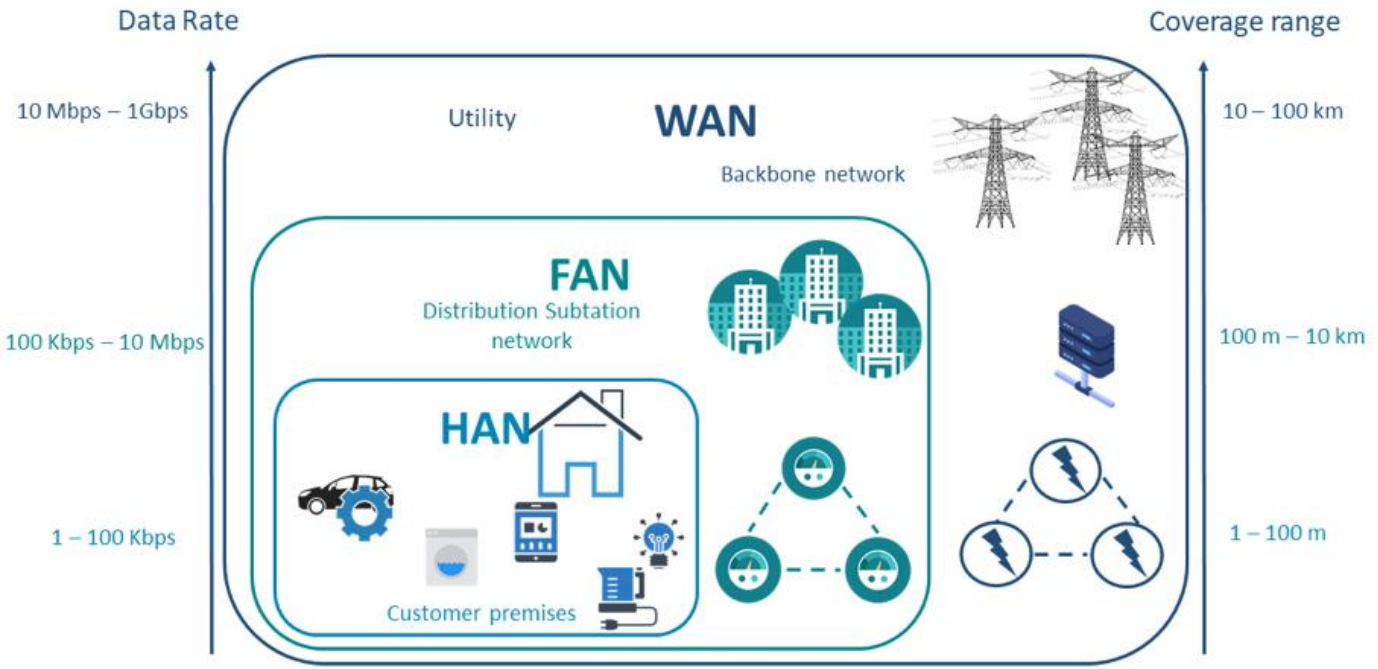
Smart Grid

Main disadvantages of current Grid:

- Power instability
- Load shifts / demand peaks
- High maintenance cost
- Unreliable energy harvesting (wind, solar, etc)
- No control / up-to-date information of usage

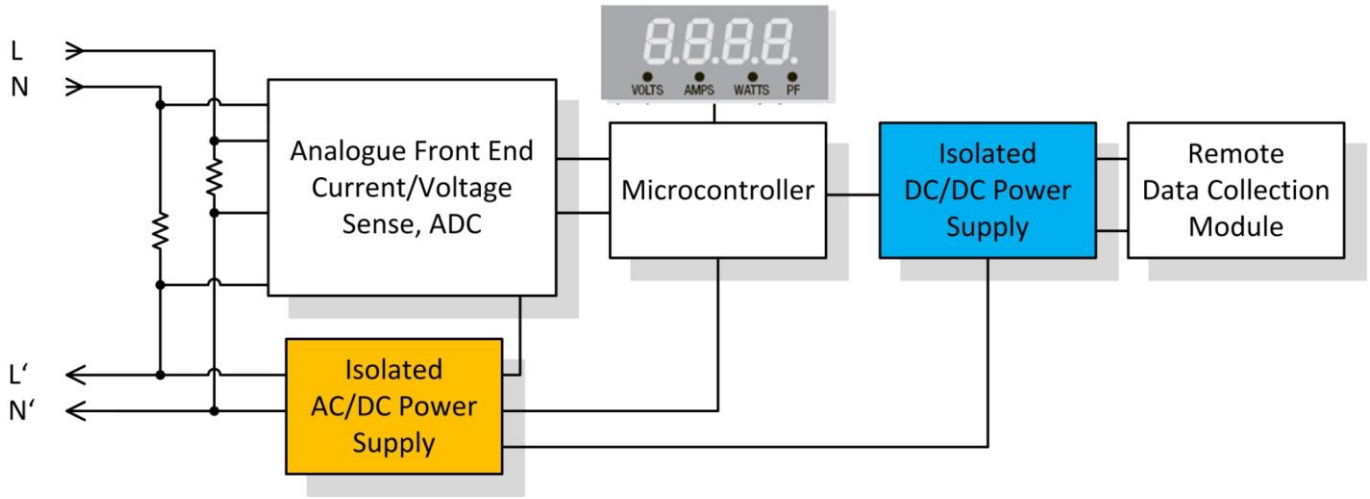
Main advantages of a Smart grid:

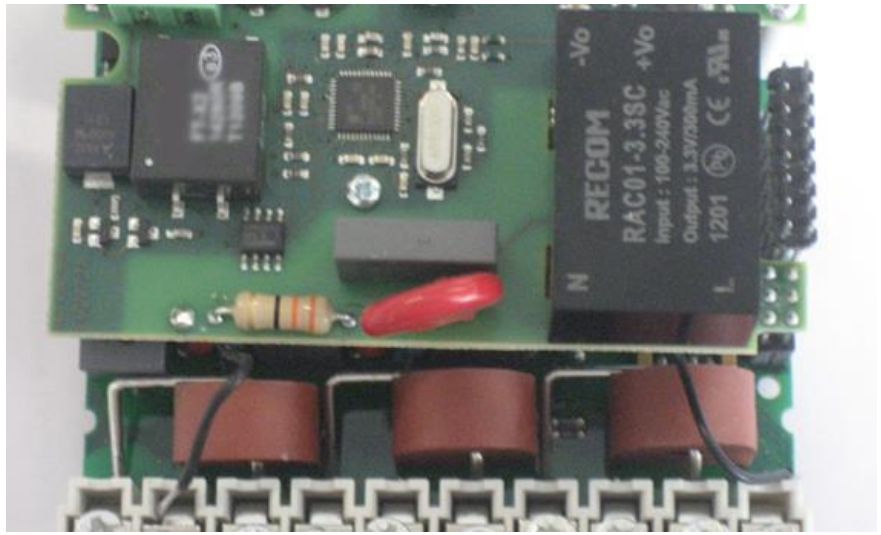
- Balance energy production/demand
- Store excess energy
- Reduce maintenance cost
- Monitor usage and stability
- Low latency, high bandwidth data networks



Smart Grid Hierarchy:
HAN = Home Area Network
FAN = Field Area Network
WAN = Wide Area Network

HAN Smart Meter





RAC01-SC	1W, 80-264V AC input, 1.3“ x 0.8“, 30mW in standby, Class B EMC filter built in
RAC01-SGB	1W, 80-264V AC input, 1.3“ x 0.8“, 150mW in standby, lower cost

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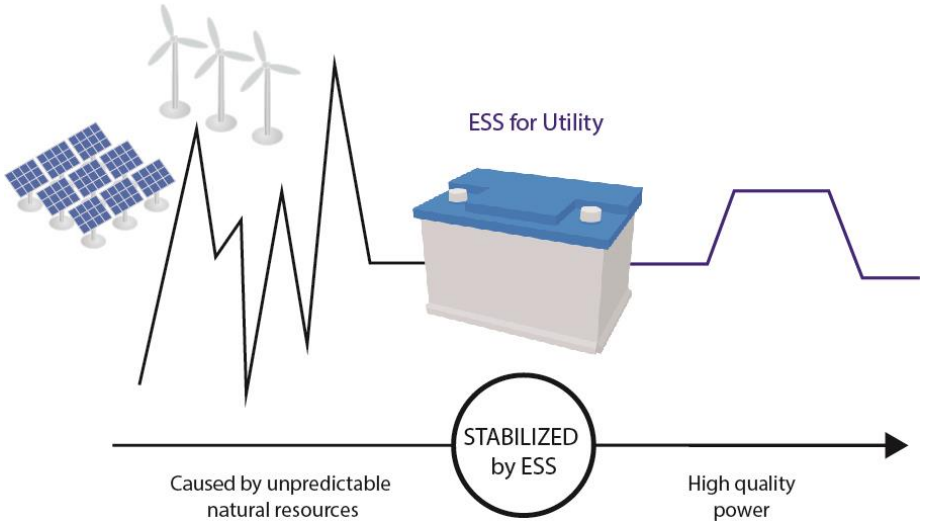
FAN BMS

Substation Voltage Stabilisation:

- Energy Storage System (ESS) improves power quality
- Typically 110V / 1-to-3kAh batteries
- Battery Management System (BMS) monitors and controls charge/discharge cycles – powered from the 110V supply.



RP12-AR	12W, 36-160V DC input, 1“ x 1“
RP20-FR	20W, 43-160V DC input, 1“ x 2“
RP40-FR	40W, 43-160V DC input, 1“ x 2“

Wind Turbines

Wind turbines are tall structures, usually positioned in exposed locations and are particularly susceptive to lightning strikes.

Lightning strikes accounted for 80% of wind farm insurance claims *(Wind Engineering, Vol 40,No. 1, Feb 2016)*

One commercial wind farm reported the 85% of their down time was lightning-damage related (*ibid*)

The company *Energieerzeugungswerke Helgoland GmbH* was forced to shut down their wind farm permanently after suffering more than 500k€ lightning strike damage in only 3 years as no-one would insure them. (https://www.nachi.org/wind-turbines-lightning.htm)

Source: Ron Wiseman

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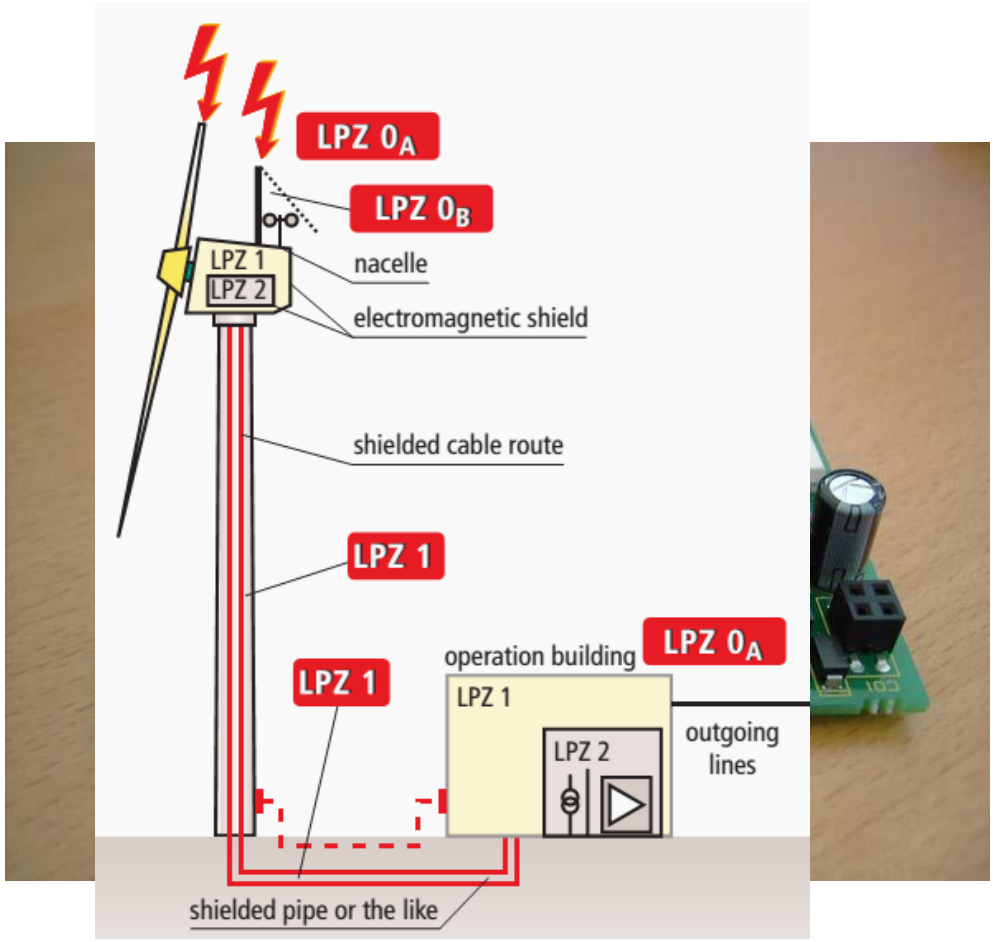
Wind Turbines

Besides physical damage to the blades, nacelle and generator: „*by far the most common is damage to the control system (electronics)*“ US National Fire Protection Association.

Solution is to fit protective grounding…
…and to isolate all signal and power paths with
opto-couplers, transformers and isolated DC/DC converters.

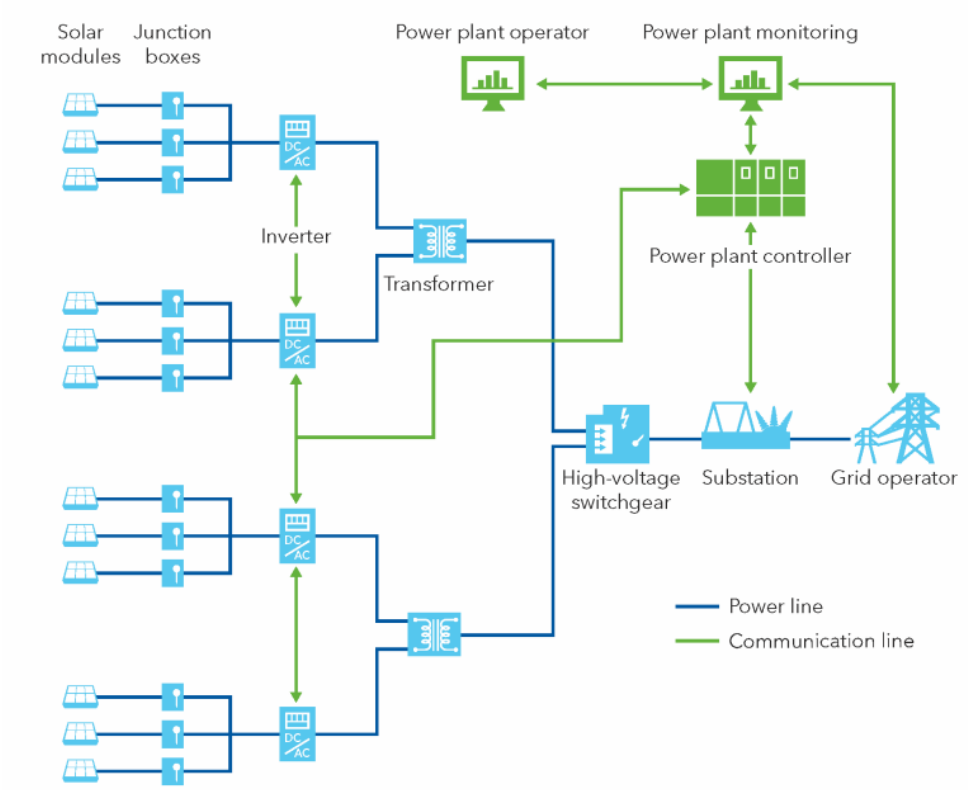
RK-xxxxS/H6	6.4kV DC isolation in SIP7
RxxPxx/R	8kV DC reinforced isolation in SIP8
RHV3-xxxxS/R20	20kV DC reinforced isolation in SIP16



Solar Farms

Solar panel farms use a large number of photovoltaic panels to generate electricity from a few 100 kW_{ac} up to utility scale (>4 MW_{ac}). (In 2027, Australia hopes to complete a 10 GW solar farm)

Source: Verogy



The DC output of the solar panel strings are synchronised with the AC mains using DC junction boxes/switchboards and DC/AC inverters.

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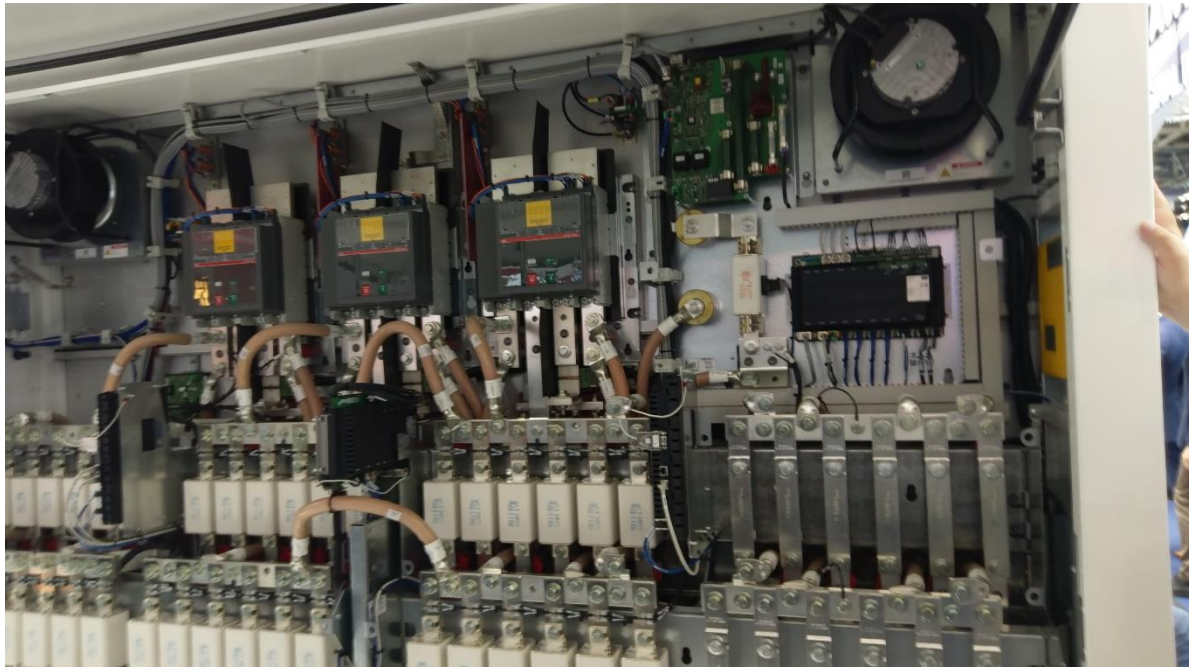
Solar Farms

The DC bus voltage is typically 800-1000V DC, with newer farms running at 1200V DC, so high voltage, very wide input range, isolated DC/DC converters are needed to power the DC switchboard monitoring and communication equipment.

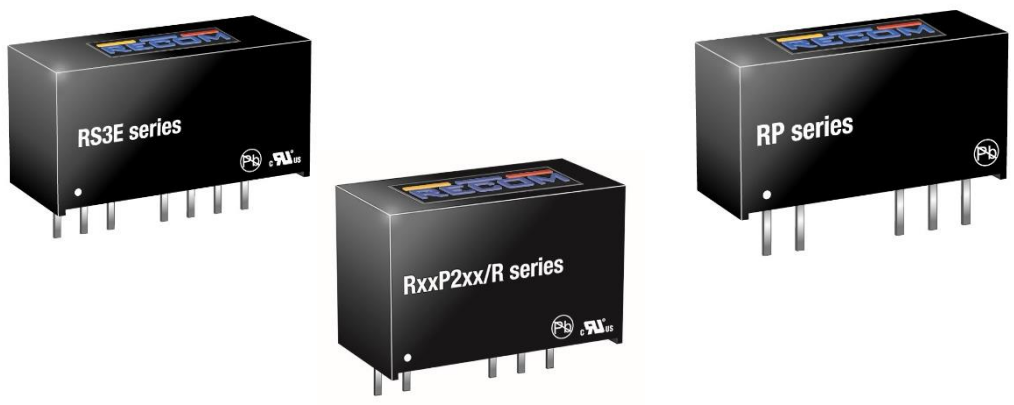


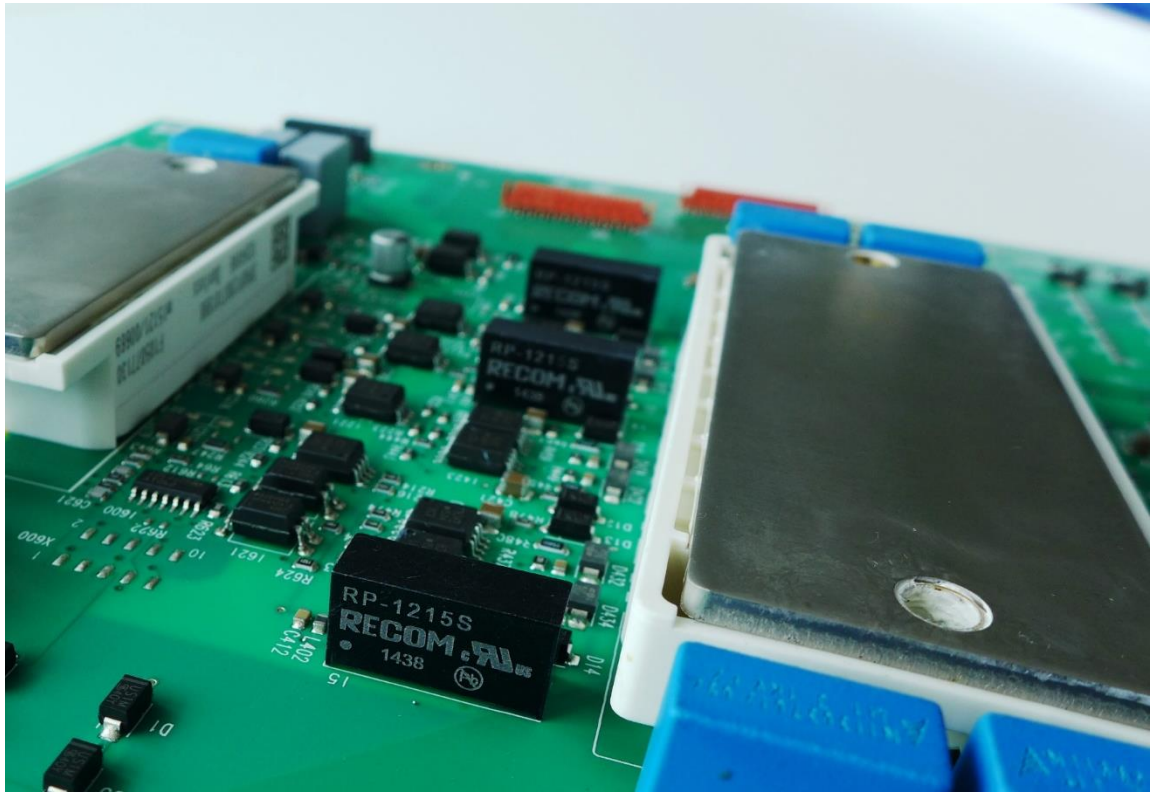
RPV30-DK (custom)	30W, 200-1700V DC input, dual independent isolated outputs

Solar Farms

Smaller scale AC inverters (e.g. Fronius, Kaco, Solar Edge, SEPSA) use multiple isolated DC/DC converters for the high side gate drivers and to isolate the control bus-interfaces.

RS3E	3kVDC isolation in SIP8, regulated
RP-xxxx	5.2kVDC basic isolation in SIP7 (pot core)
RxxP21503D/R	6.4kVDC reinforced isolation in SIP8





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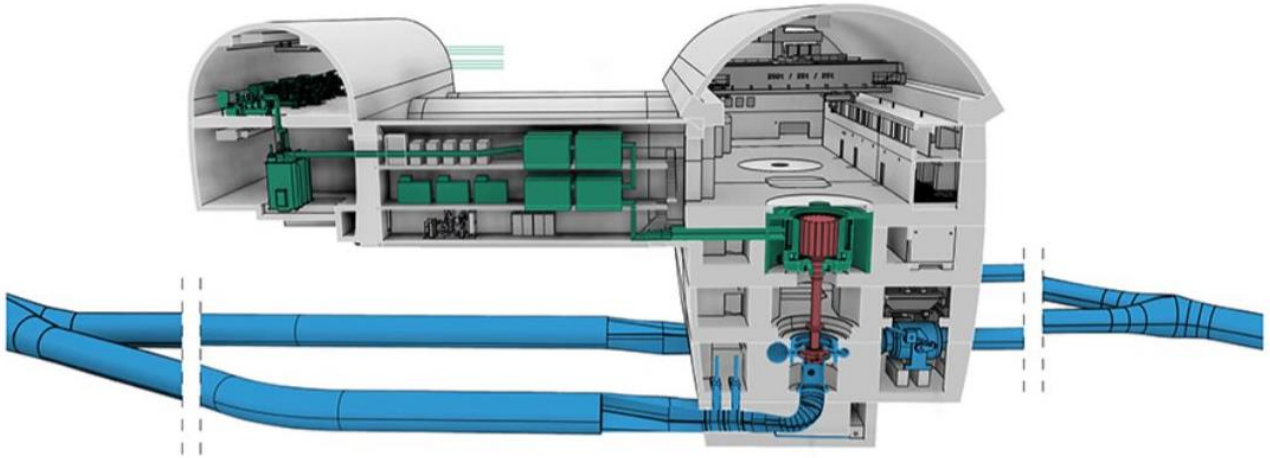
Hydroelectric

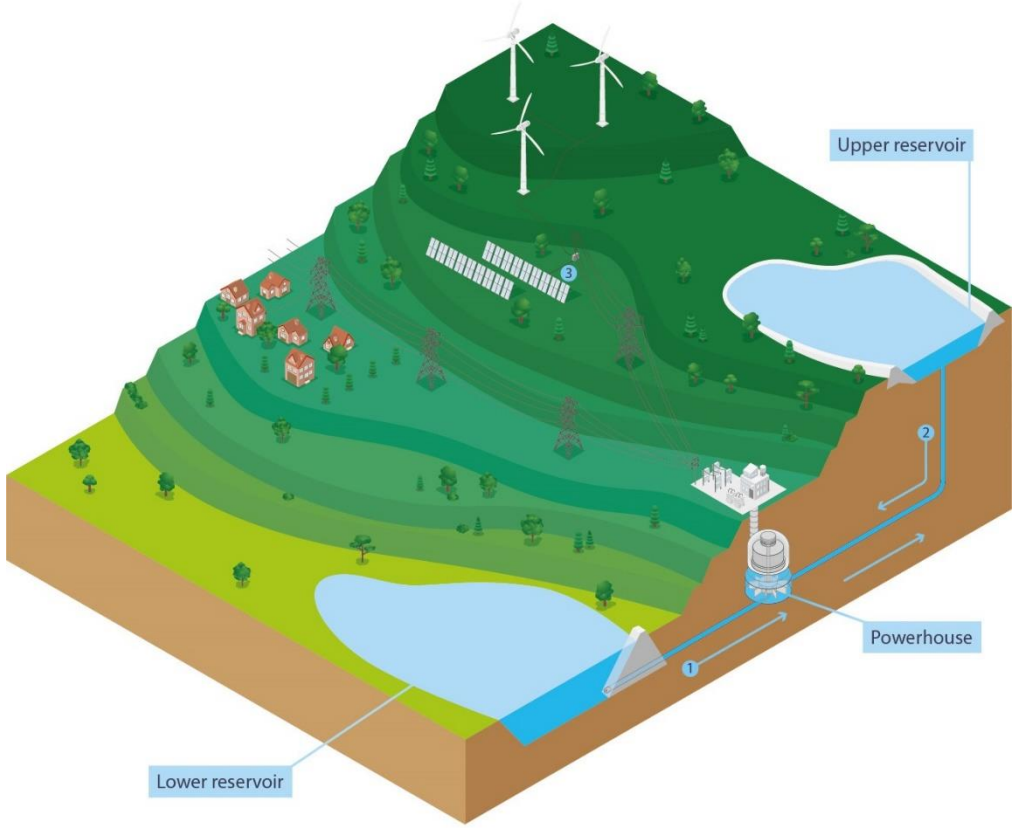
Water power is one of the oldest forms of energy and the first renewable source of electrical power (1882)

Austria has over 14GW of hydoelectric power production, delivering some 56% of the national supply.

8.4GW are pumped storage plants (e.g. Kühtai in Tyrol)



Source: Waterpowermagazine.com



Source: https://www.hydropower.org/factsheets/pumped-storage

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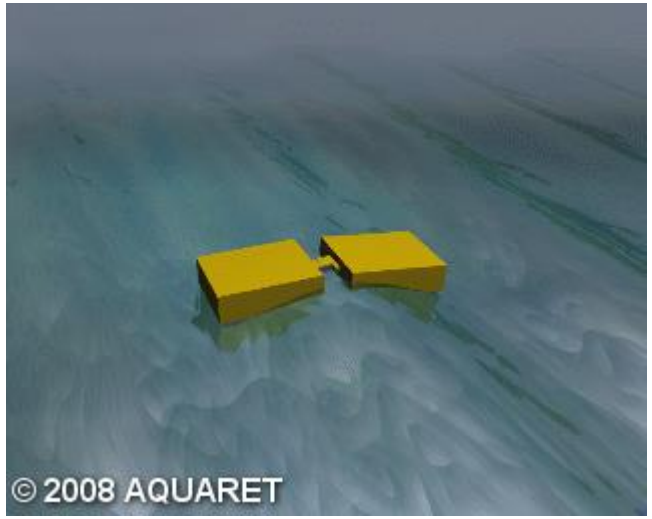
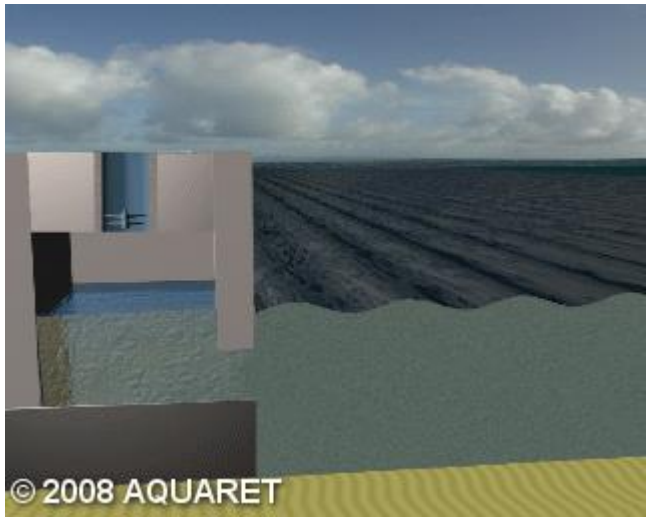
Hydroelectric

Outside of Austria, countries with coastlines can use Wave Energy Converters (WEC) to harness „The Liquid Grid“

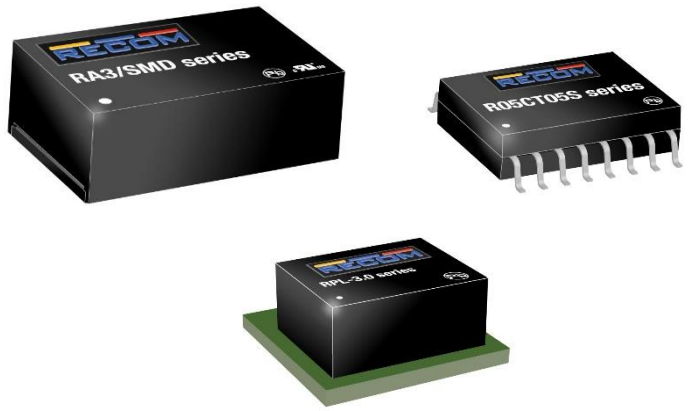


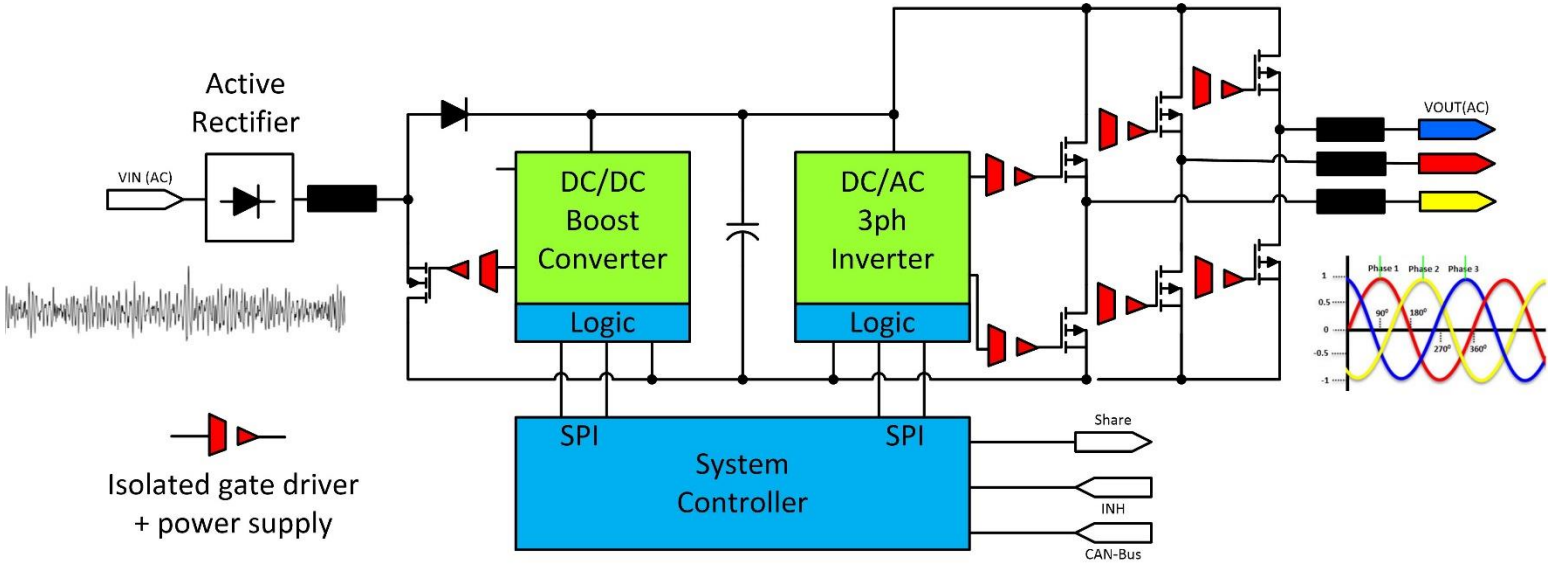


Source: Theliquidgrid.com

Hydroelectric

Output from WEC generators is AC, but highly erratic,therefore AC ➡ DC ➡ AC converters are needed:

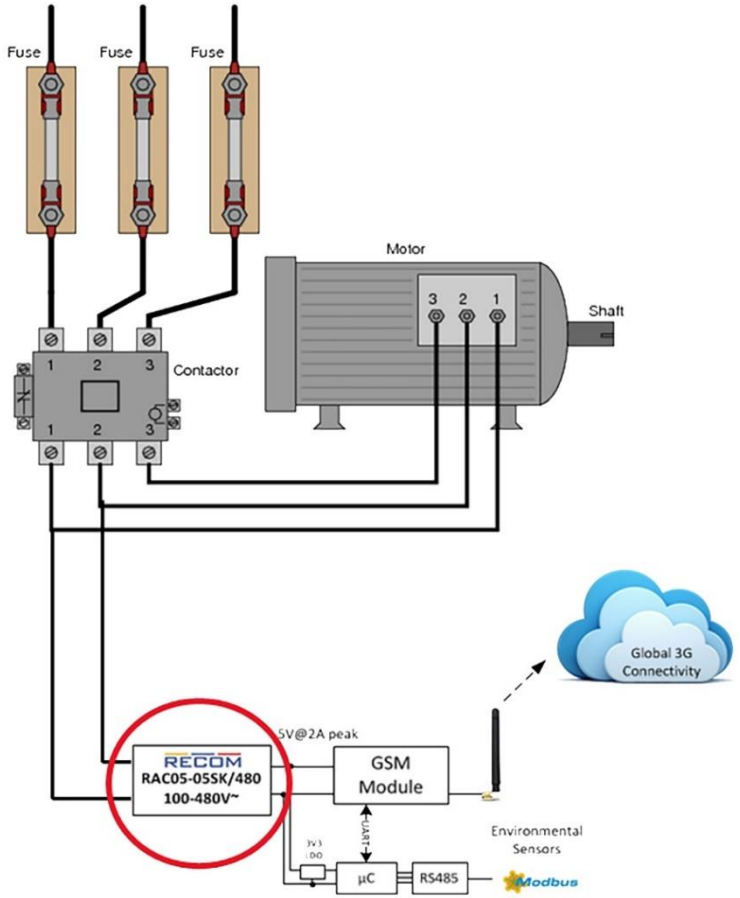




RA3-xx2005D/SMD	3W, 5.2kVDC isolation in SMD, +20/-5V
RxxCTxx	0.5W, 5kVAC reinforced isolation
RPL-3.0	3A POL in 10 pad LGA (3mm² footprint)

Hydroelectric

Such complex systems also rely heavily on the SCADA (Supervisory Control And Data Acquisition) structure



Source: Andritz

RAC05-SK/480	85-538V AC input, OVCIII 5.4kV AC isolation in 2“x1“ case.
RAC05-SK/277	85-305V AC input, OVCIII 4.2kV AC isolation in 1.2“x1“ case.

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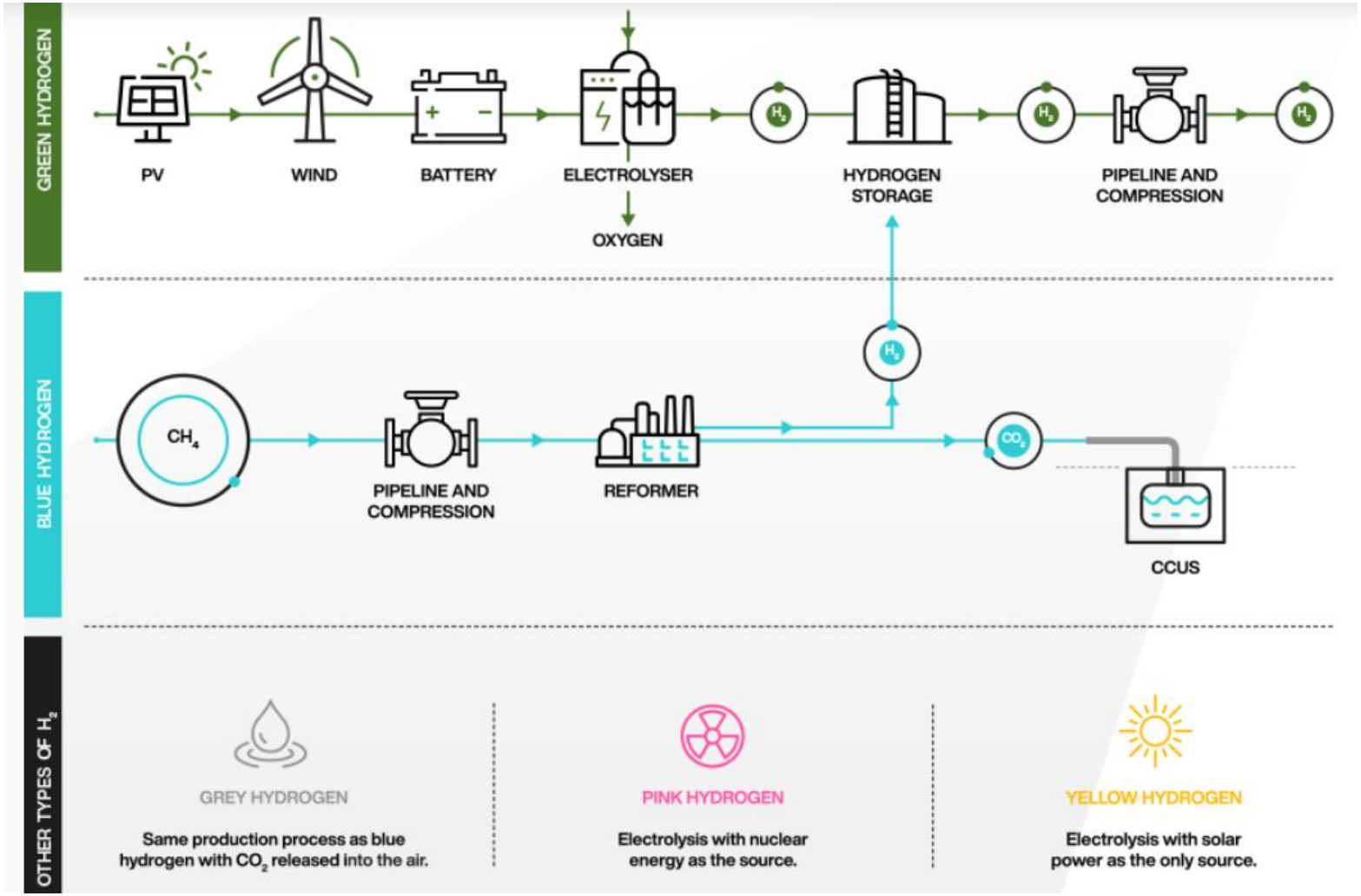
Hydrogen



Green Hydrogen comes from the electrolysis of water useing renewable energy sources to power the process.

Blue Hydrogen comes from the steam reformation of natural gas which splits the Methane (CH_4) into H_2 and CO_2, which is then stored underground.

Grey Hydrogen is the same as Blue Hydrogen, but some or all of the CO_2 is released into the atmosphere

Pink or **Yellow Hydrogen** is the same as Green Hydrogen but using Nuclear or Solar power for the electrolysis.

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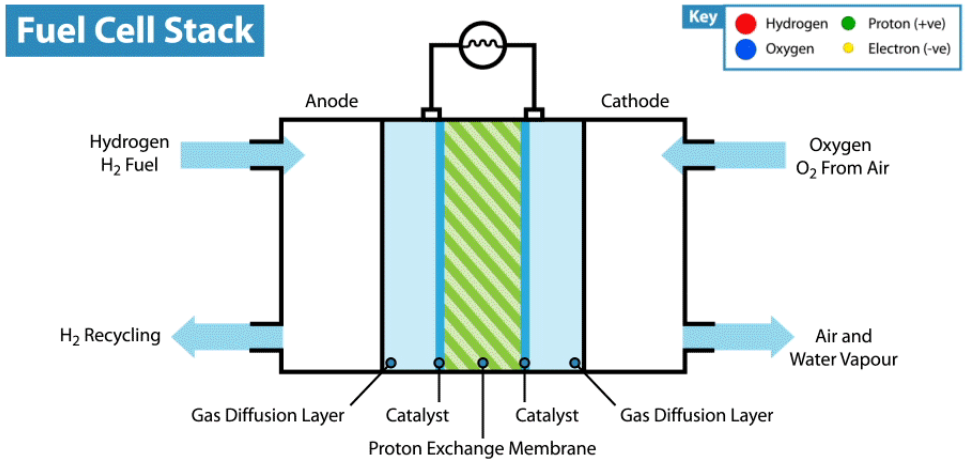
Hydrogen

Stationary fuel cell power systems provide decentralised or emergency power, or can be used as ZE grid-independent generators.

Typical stationary generator capacity is 25-70kW



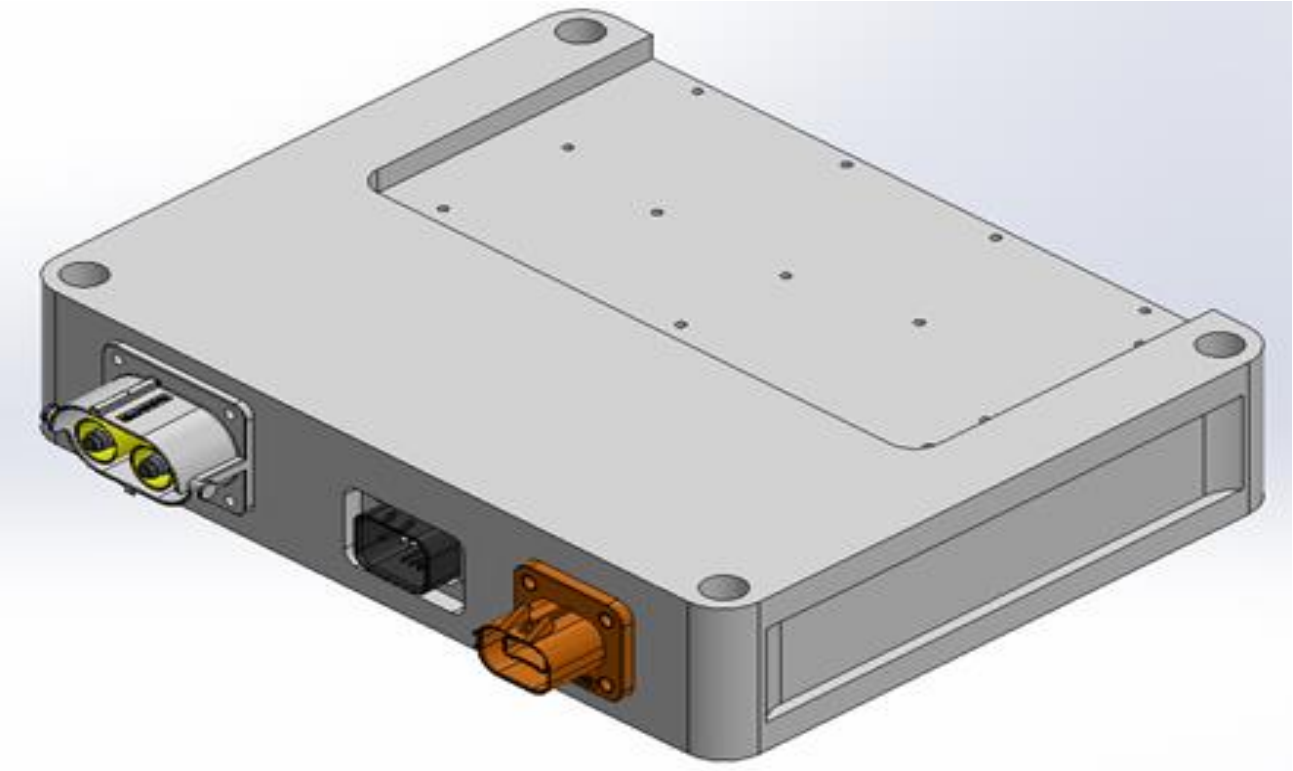
Quelle: https://www.intelligent-energy.com/static/img/animations/fuel_cell_stack.gif

Source: Wikipedia

Hydrogen

(RECOM product under development)
10-75 kW DC/DC, scalable

- Vin = 25-280VDC @ 500A max
- Vout = 200-800 VDC
- >97% efficiency
- Reverse polarity + surge protection built-in
- MPP tracking
- Active current sharing
- Liquid cooled baseplate

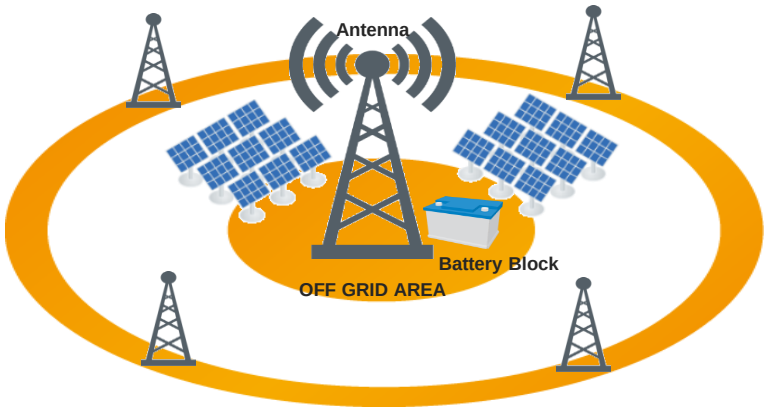


Off-Grid

Zero emission off-grid power generation

- PV/Wind/Battery combi-systems

IPS xxxx	3000VA inverter (1Ph 230V AC)



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Off-Grid

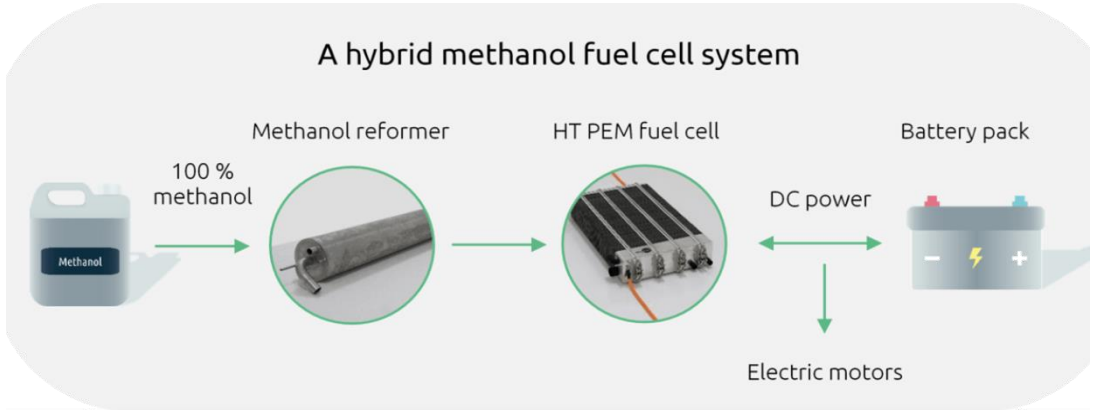
Hybrid Methanol Fuel Cell Systems (30x energy density of lead acid batteries)

Stand-alone refrigeration units for trailers

Zero Emission off-grid power generation

- Military, mining, construction
- Emergency supply (telecoms)
- PV/Battery/FC combi-systems

Source: McConnell Transport



Source: SFC Energy

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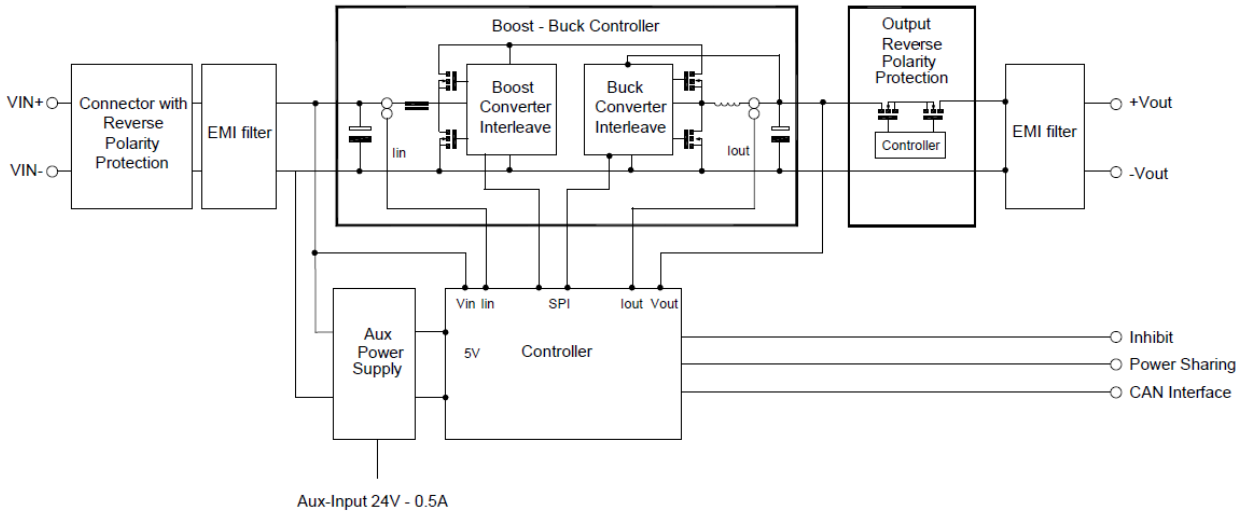
Off-Grid

7 kW **SD7008-X-48-2**

- Vin = 48V (30-70VDC) @ 220A max
- Vout = 48V (36-60VDC adj.) @ 190A max
- Buck/Boost with >97% efficiency
- Reverse polarity + surge protection
- MPP tracking (Solar or Fuel Cell)
- Liquid cooled baseplate
- CAN-bus interface

4.8 kW **SD4008-X-24**

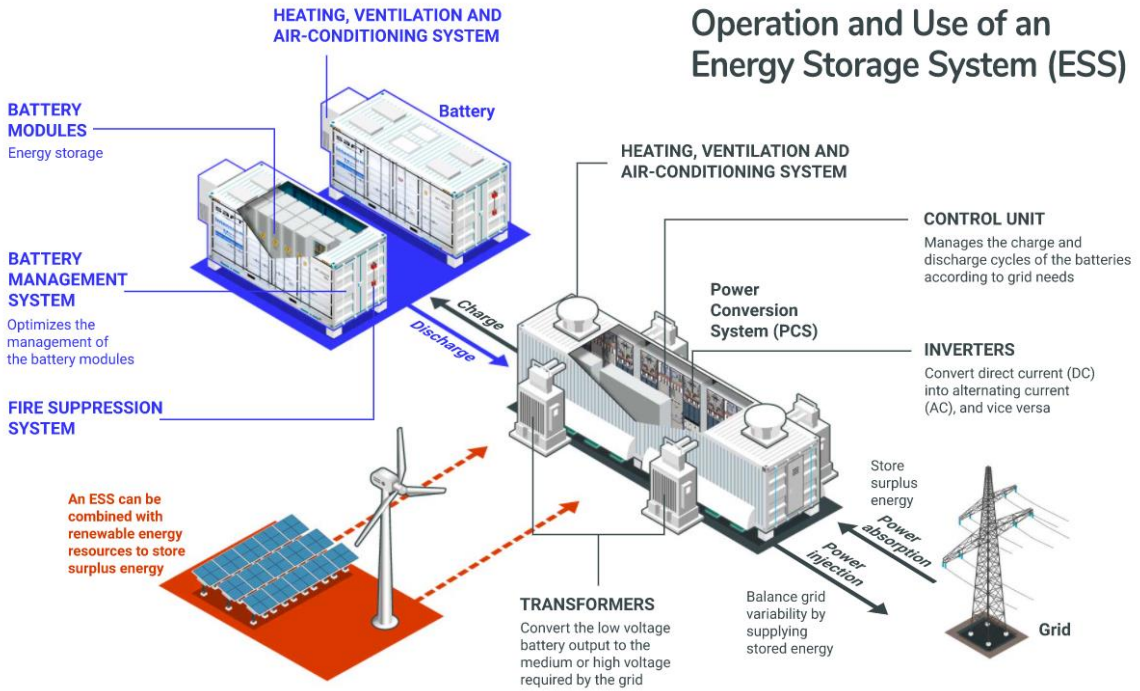
- Vin = 36V (18-54VDC) @ 200A max
- Vout = 20-56VDC adj.
- (24V @ 185A max / 48V @ 110A max
- Buck/Boost with >95% efficiency
- Reverse polarity + surge protection
- MPP tracking (Solar or Fuel Cell)
- Baseplate cooled (fanless)
- Analogue or digital control



Energy Storage

Energy Storage Systems

- Li-Ion Batteries
- Redox Flow Batteries
- Sodium Batteries



Source: SAFTbatteries

Source: REGlobal

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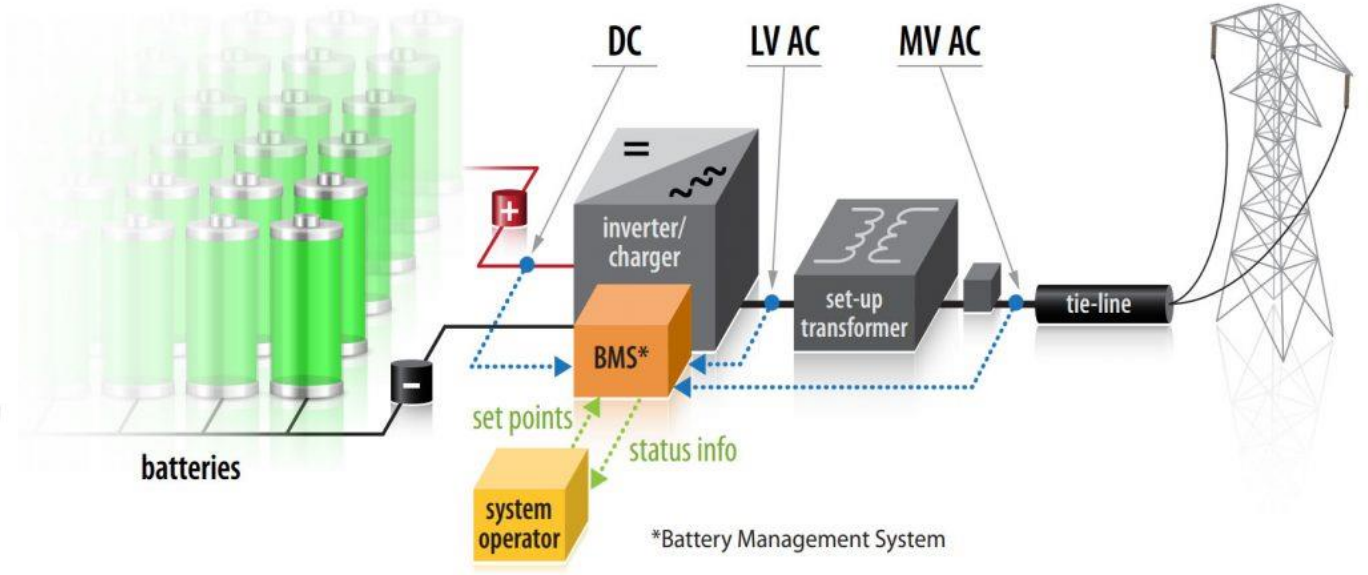
Energy Storage

Battery Management Systems

- Maintain cell Safe operating area (SOA)
- State of Charge (SoC)
- State of Health (SoH)



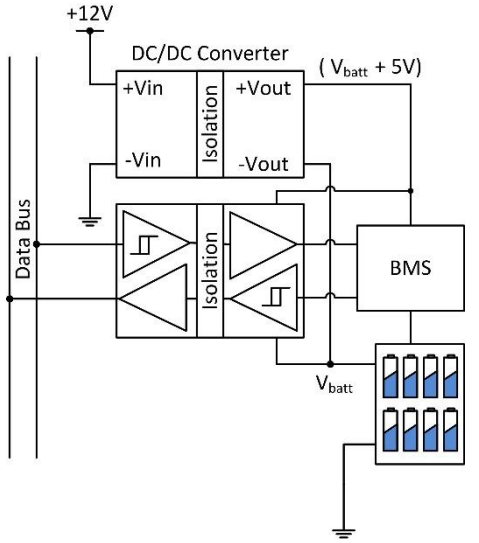
Source: OSMbattery

SA5000	5kW cascadeable battery charger

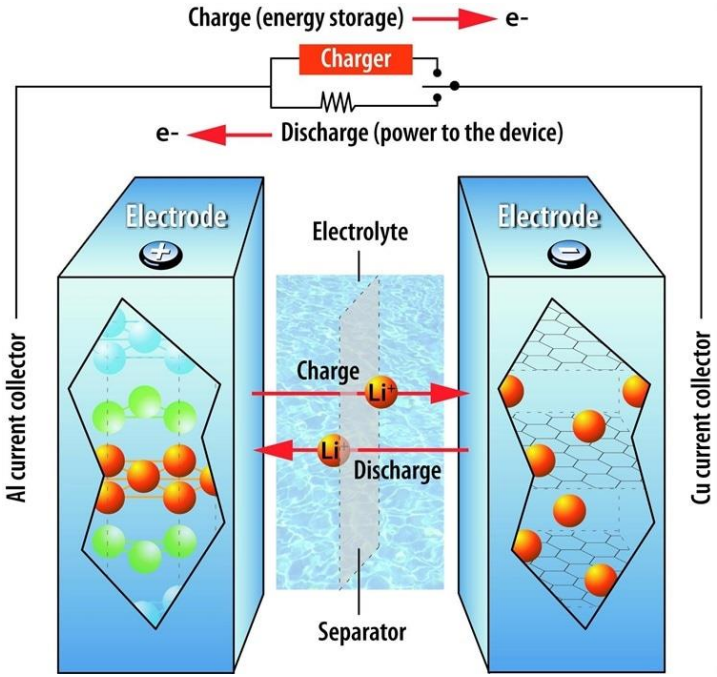
Energy Storage

Battery Conditioning

- Bidirectional battery balancing (1.45 - 11kW)
- Controlled charge/discharge rates to maximise cell capacity and conteract aging effects
- Reconditioning battery packs after deep discharge (deintercalation)

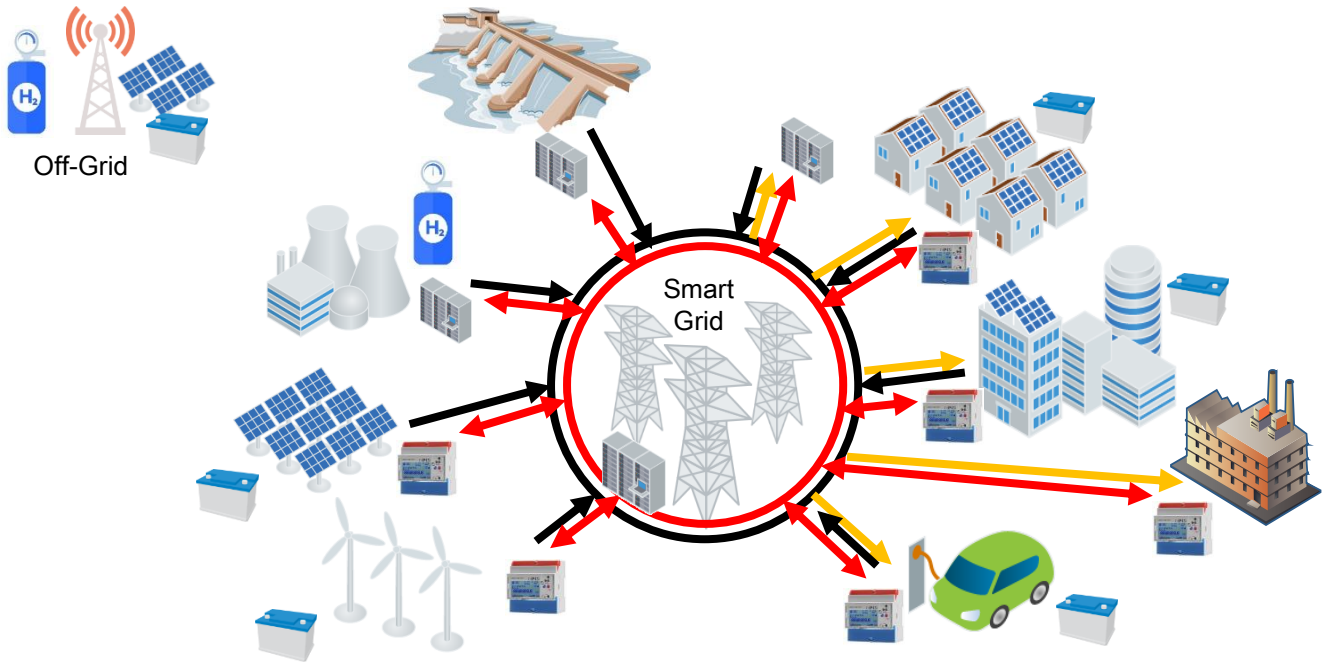


RxxCTExx	1W iso. in SOIC16 SMD, -40°C to 125°C
MA11000	11kW bidirectional battery balancer



Source: Argonne National Laboratory

Conclusion



RECOM and Renewable Energy Systems

RECOM is involved in every component of the smart grid, from low power DC/DC converters used to isolate battery management or wind turbines systems. through to low standby consumption AC/DC modules for smart meters, EV chargers and PV inverters, to kilowatt converters for off-grid, hydrogen and ESS systems.

For more information on individual solutions contact Axel Stangl at Rutronik or RECOM direct.

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