

MAN's Solution Offering for FutureEnergy A/S

Overview

June 2020



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MAN Energy Solutions Business Areas

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Overview

Marine



Energy & Storage



Oil & Gas / Process Industry



Aftersales MAN PrimeServ



Business Activity - New Solutions

→ Power-to-X, Hydrogen/Elektrolysis, Hybrid solutions, LNG-to-Power, MOSAS, ETES, CSP

Key Figures

15,000 employees worldwide (2020)

3.1 bn € revenue (2018)

Member of the Volkswagen Group

MAN Energy Solutions is part of a brand family

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Automotive Division

Passenger Cars Business Area

VW



Audi



Skoda



Seat



Bentley



Porsche



Others

Commercial Vehicles Business Area

VWN



Scania



MAN
Truck & Bus



Power Engineering Business Area

MAN
Energy Solutions



Financial Services Division

Dealer and customer financing
Leasing
Direct bank
Insurance
Fleet management
Mobility offerings

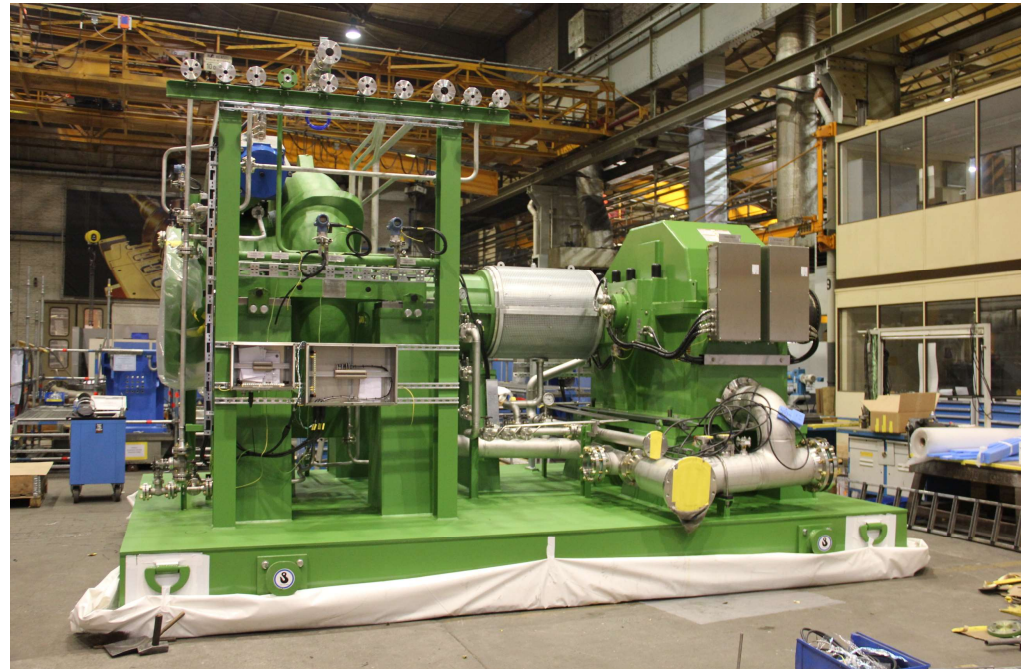
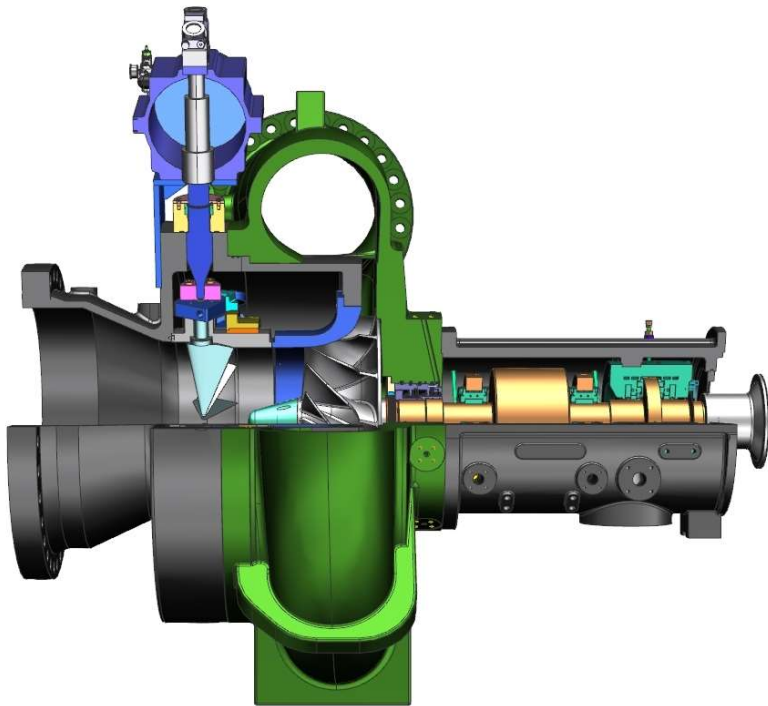
CO2 Compressor for Carbon Capture and Sequestration

2



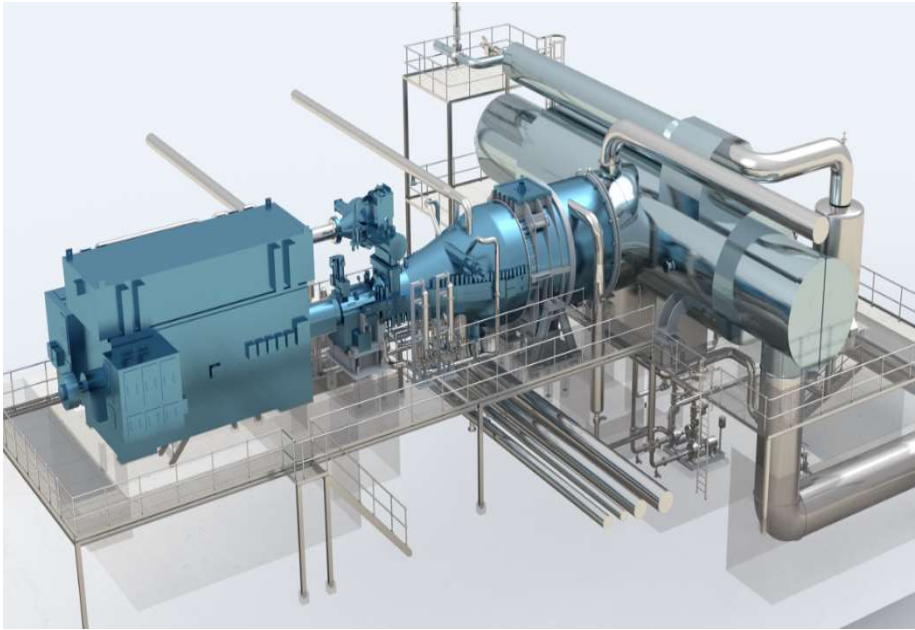
Heatpump Compressor

3



Steam Turbines

4



MAN PtX for carbon-neutral synthetic fuel production and long term energy storage

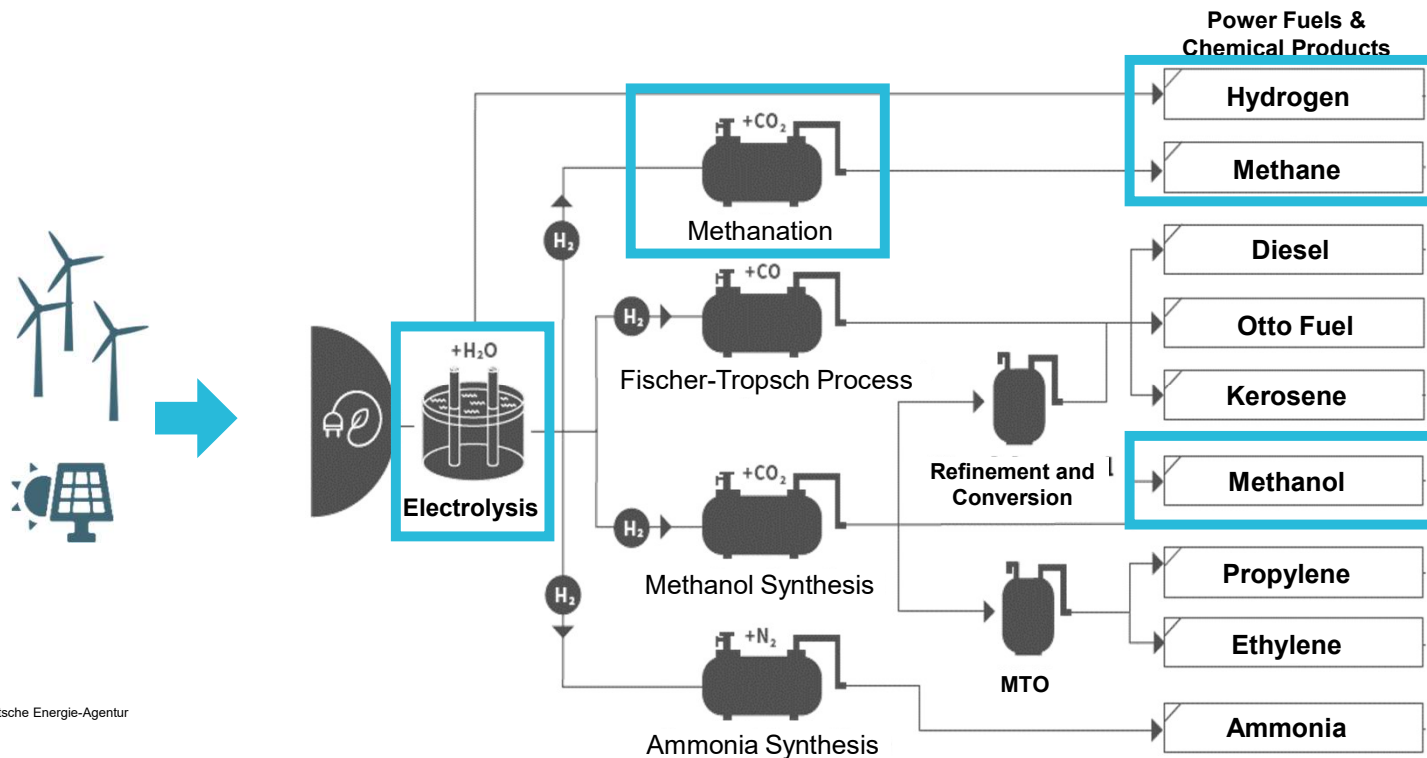


- **Renewable electricity is converted into carbon-neutral synthetic fuels** which can be stored and later used in mobility, electricity, heat
- Decarbonization of all sectors with existing assets, available today
- Solution for CO₂-neutral mobility, such as marine and long-haul trucking
- Proven MAN Energy Solutions technology: Audi eGas plant operational since 2013

MAN focusing on several Power-to-X processes with the highest market potential in the mid term

Overview: PtX processes (exemplaric)

 Main focus areas of MAN ES



Source: DENA – Deutsche Energie-Agentur

Use Case: Production of synthetic fuels with 50 MW MAN Power to Gas plant

A 50 MW P2G plant produces at 8,000 h/a...



21.250.000 m³ SNG

Enough to provide CO₂ neutral fuel for...



19,800 cars¹

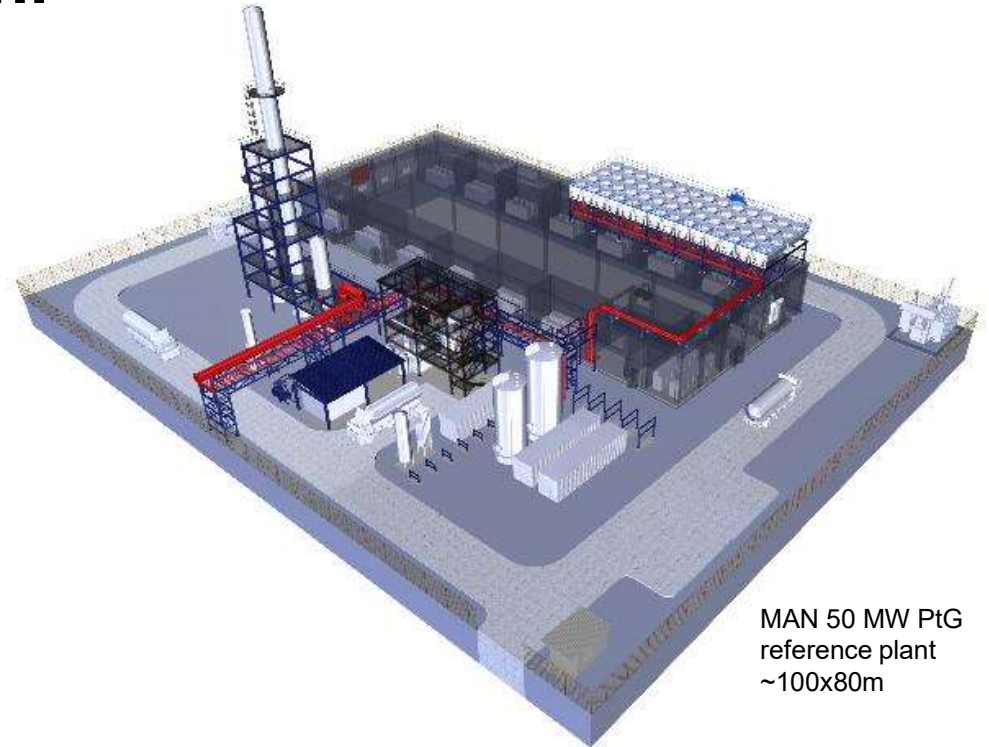


470 buses²



2 car carriers³

¹15,000 km/a; 5 kg/100km; ²60,000 km/a; 52,7 kg/100km; ³Transport capacity: ~4500 vehicles, 7 roundtrips per year



MAN 50 MW PtG
reference plant
~100x80m

**MAN provides full EPC for PtX plants
incl. operations & maintenance**

MAN Power-to-SNG customer reference in Werlte

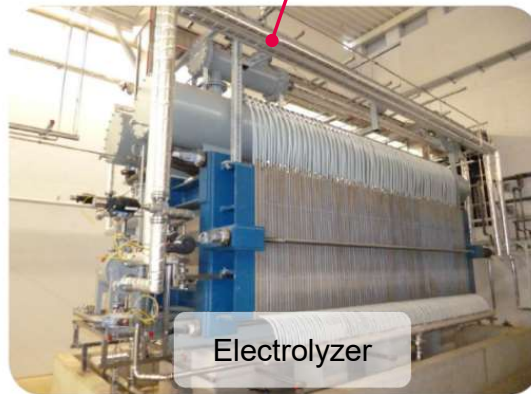
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Methanation
System



Biogas plant



Electrolyzer

Key facts:

- 6 MW power input for alkaline Electrolysis
- SNG used as e-fuel for Audi customers
- Methanation reactor by MAN Deggendorf

➔ Plant In commercial operation since 2013

Picture source: Audi

MAN ES & H-Tec Systems – PEM electrolyzers

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Product Overview

ELECTROLYSIS STACKS



Series-S30 stacks (1 to 5 kW)

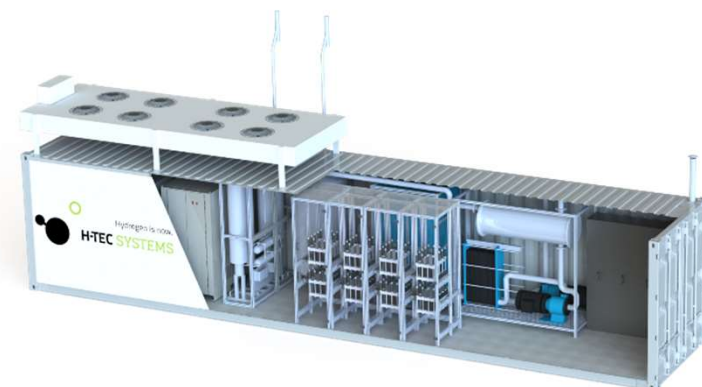
H-TEC SYSTEMS Series-S electrolyser stacks

- Nominal power from 1 kW to 100kW
- High power density
- Low transformation costs
- High efficiency
- Suited for integrated solutions

ELECTROLYSERS - READY. SET. SUPPLY.



ME 100/350 (225kW, 100kg H₂/day)



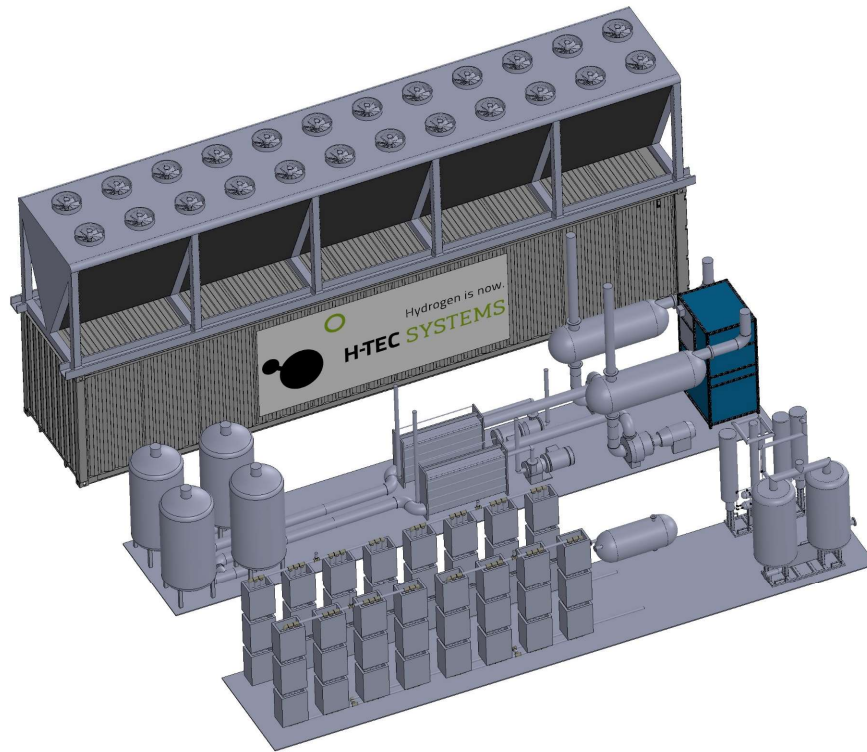
ME450/1400 (1 MW, 450kg H₂/day)

H-TEC SYSTEMS Series-ME electrolyzers

- Compact design in an ISO container
- Capable of dynamic part load operation to enable grid balancing services
- High conversion efficiency (74%), additional heat integration
- 5.0 hydrogen quality suitable for refuelling applications
- Readily available product for effective sector integration solutions

MAN ES & H-Tec Systems – Electrolysers

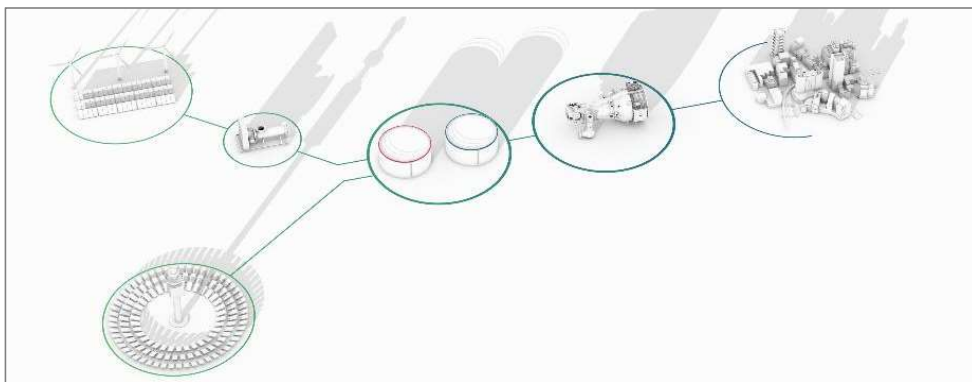
Product Overview



Key parameter of the 10 MW Electrolyser

- Based on proprietary stack technology
- Nominal energy consumption: 10 MW – base for modular concept for 20...100 MW and more
- H₂- production: 2100 Nm³/h resp. 4500kg/d
- Very high efficiency of 74%
- Perfectly suited for the integration into industrial PtX plants
- Available for commissioning in 2023

MAN Molten Salt Energy Storage (MOSAS)



- **Technology:** Renewables are used to generate heat directly or via a electrical heat exchanger. The thermal energy is stored in molten salt and later used to produce steam for power generation when needed.
- **Power & capacity**
 - Industrial installations starting from ~25 MW, reaching multiple 100 MW for large scale installations
 - Very large capacities (1 GWh+) possible

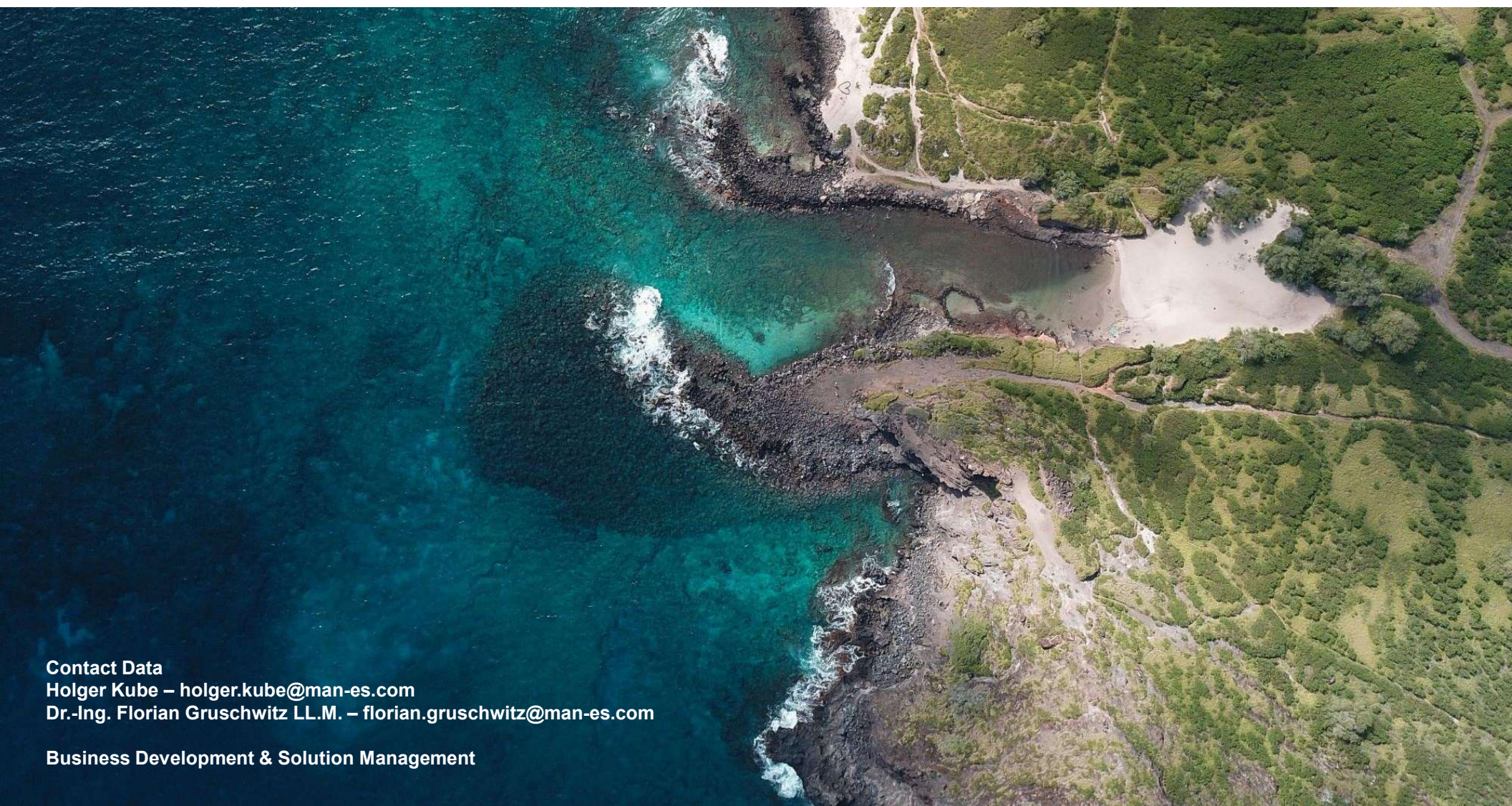
Applications

High power and medium to long duration applications

- Retrofit of conventional plants, e.g., coal-fired power plants
- Concentrated solar power: dispatchable renewable generation
- Energy recovery in industrial processes

Key benefits

- **Usable in several applications**
 - Stand alone or retrofit of thermal plants
 - CSP
 - Industrial energy management & optimization
- **Peak shaving** of volatile renewables through conversion into heat and reconversion on demand into electricity
- MAN with **long-term experience of using molten salt** as a heat transfer medium in the chemical industry
- MAN provides the **molten salt system as a complete solution** including EPC for CSP



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Business Development & Solution Management

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