

MAN Energy Solutions
Future in the making




















Power Generation Solutions



Member of the Volkswagen Group

MAN Energy Solutions is part of a brand family



| Volumen | Premium | Super Premium | Truck & Bus |
|--|---|---|---|
| VW  | Audi  | Porsche  | MAN Truck & Bus  |
| Skoda  | Lamborghini  | Bentley  | Scania  |
| Seat  | Ducati  | Bugatti  | Power Engineering   |
| VWN  Nutzfahrzeuge | | | RIO  |
| MOIA  | Financial Services | | |
| |  | | |

MAN Energy Solutions

A world-class product portfolio

Engines & Marine Systems



Power Plants



Turbomachinery



Aftersales MAN PrimeServ



Our Design and Production Network

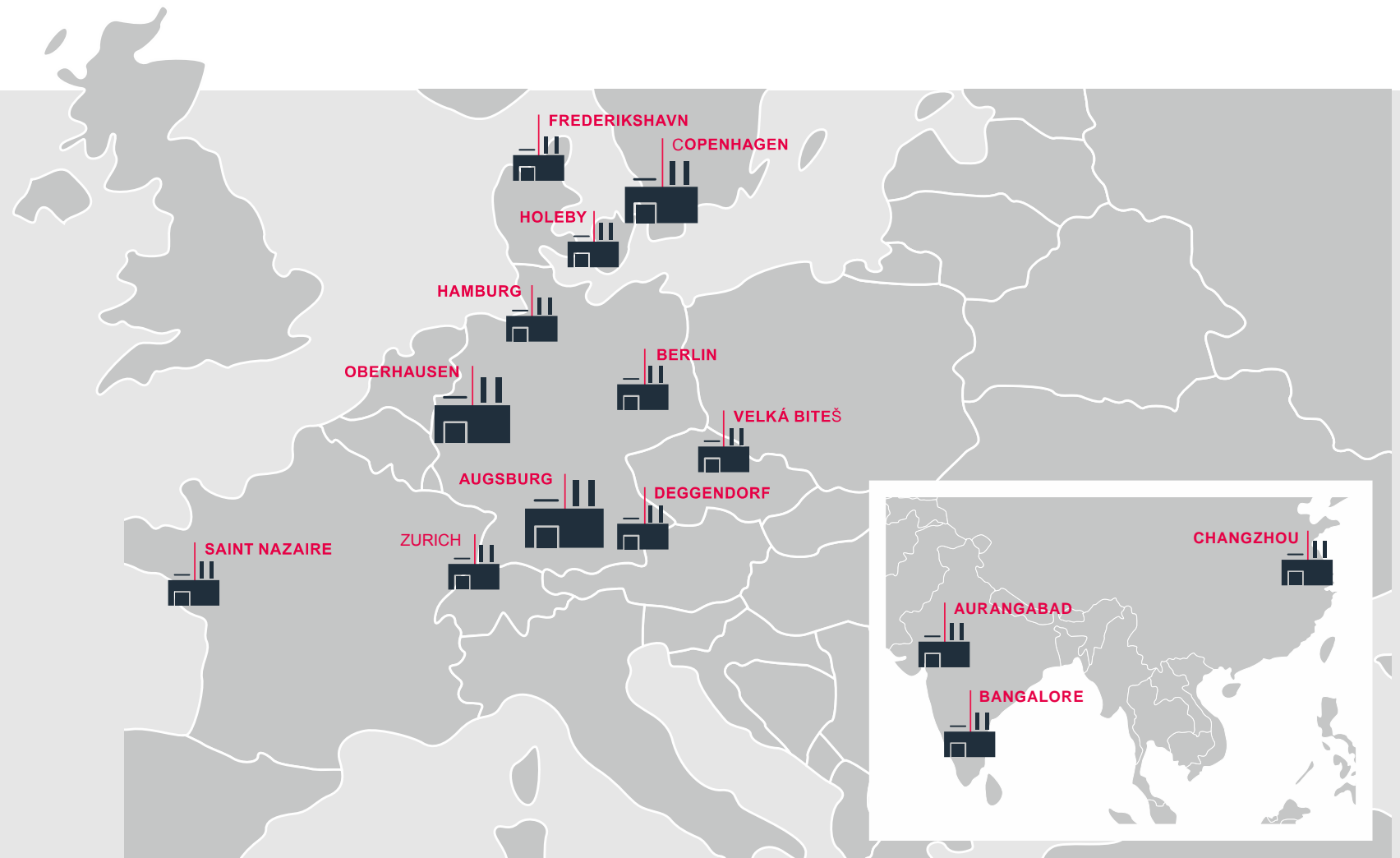
Sites across Europe and Asia

11

Production sites
in Europe

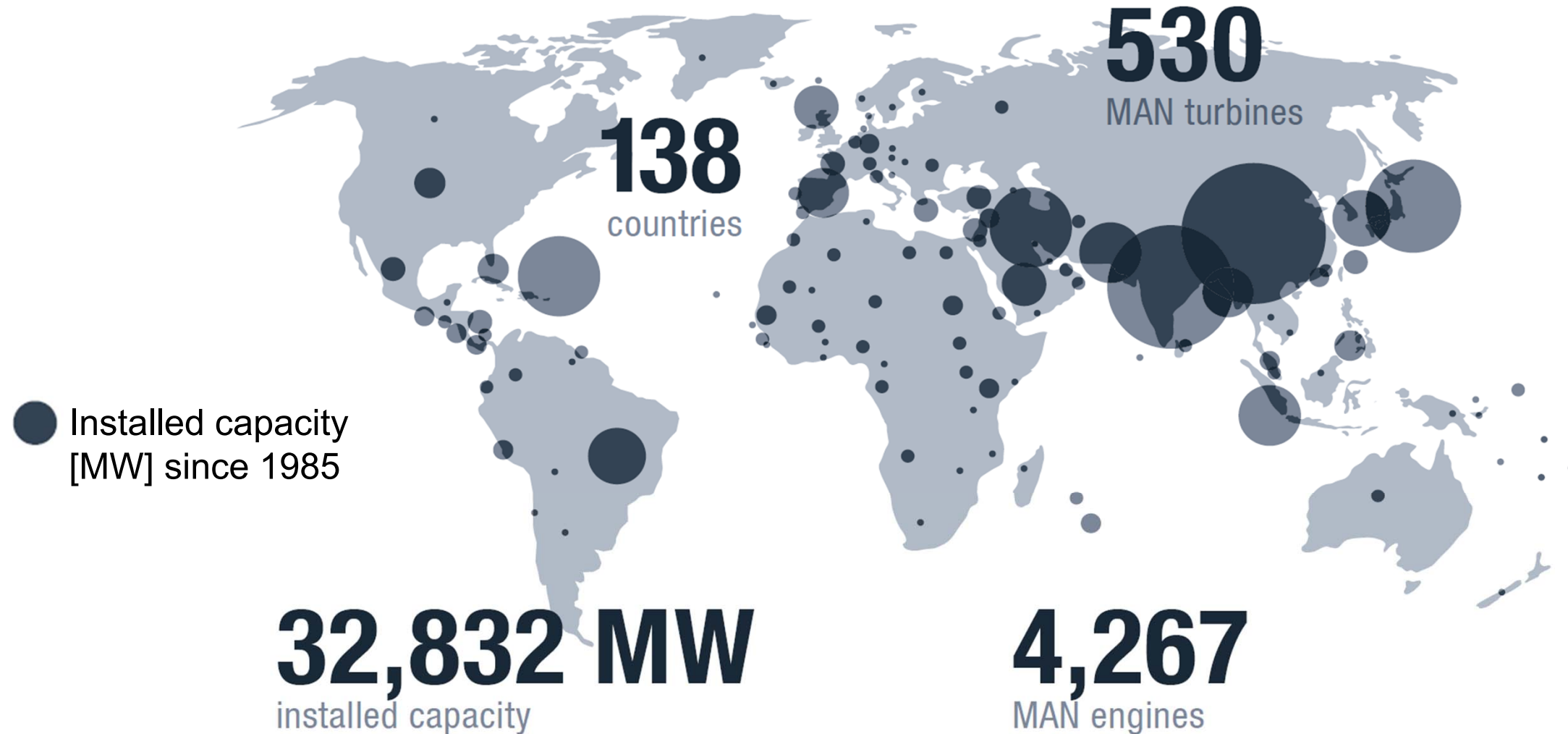
3

Production sites
in Asia



Power Solutions – Global Overview

References since 1985



The electricity delivered by MAN engines installed since 1985 is able to satisfy the electricity demand of 63,4 million households*

*Average electricity consumption per electrified household 3353 kWh/a with 8,000 operating hours per annum.

Our Goal

Paving the Way to Sustainable Energy Generation

We offer our customers sustainable power solutions from a single source – combining thermal power plants, renewables and energy storage solutions. Smart energy management systems integrate the energy sources that are most environmentally friendly and also most economical.

Generating Sustainable Power

Reliable and efficient solutions and products for power generation

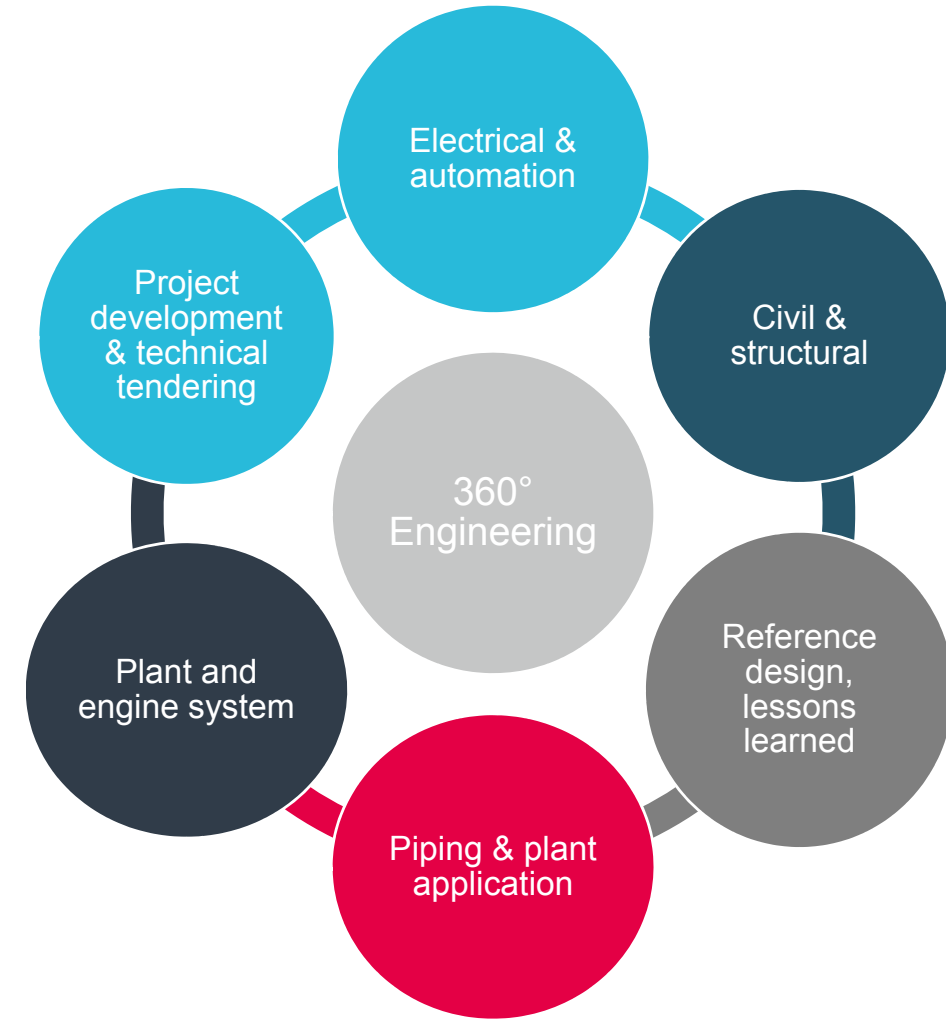
- Thermal power plants based on gas- and liquid-fired engines or turbines, and highly efficient CHP solutions
- Hybrid power plants
- Mid-to-large scale energy storage systems
- PtX (syngas) production
- LNG to power solution
- Biomass, CSP, geothermal
- Energy management system
- EPC power plant solutions, 360° engineering, modular, fast realization time
- Services: energy consulting, project development, financial services, operation, and maintenance services



Power Plant Solutions

Engineering competence

- **Concept:** The **system**, electrical, safety, environmental and civil **design** comes **from one source** and includes: concept design, basic design and detailed design
- **Application:** A **global team of engineers continuously** strives to generate innovative solutions to **improve the power plant reference design** with regard to reliability, cost-efficiency and modularity, but also to design tailor-made power plant solutions for your project



MAN Energy Solutions
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Thermal Power Plants



MAN Power

Diesel and gas power plants

- Diesel, gas and dual-fuel engines from 625 kW to 68,000 kW
- Gas and steam turbines from 1 MW to 160 MW
- Diesel and gas power plants up to 500 MW
- Base-load, peaking, CHP, hybrid and LNG power solutions
- Excellent fuel flexibility: diesel, heavy fuel oil, biofuels, gas, dual fuel
- Expandable modular concepts
- Exhaust gas treatment systems
- Operation & maintenance (complete services)
- Retrofit of existing power plants for fuel change, higher efficiency, and exhaust gas cleaning



MAN ES Portfolio

Benefits engine based power plants (I)

Different applications

- Continuous base load power generation
- Captive power & heat (industry)
- Flexible power & heat (regulatory energy market)

Various requirements

- High power density (low CAPEX)
- Very efficient (low OPEX)
- Clean emissions
- Extreme ambient conditions:
 - + High ambient air temperatures ($> 50^{\circ}\text{C}$)
 - + High site elevations ($> 3,000\text{ m}$)

Flexibility in operation

- From 0 to full load in < 60 seconds (in standby mode)
- Instant load steps manageable



MAN ES Portfolio

Benefits engine based power plants (II)

Immunity to harsh ambient conditions

- No or moderate derating at extreme temperatures & altitudes

Highest efficiency

- Highest efficiency in full and in part load of single units
- Highest plant part load efficiency (modular plant system)

Ease of maintenance & no aging effects

- Long TBO* periods and short downtimes of units
- No downtime of complete power plant
- No derating caused by aging effects

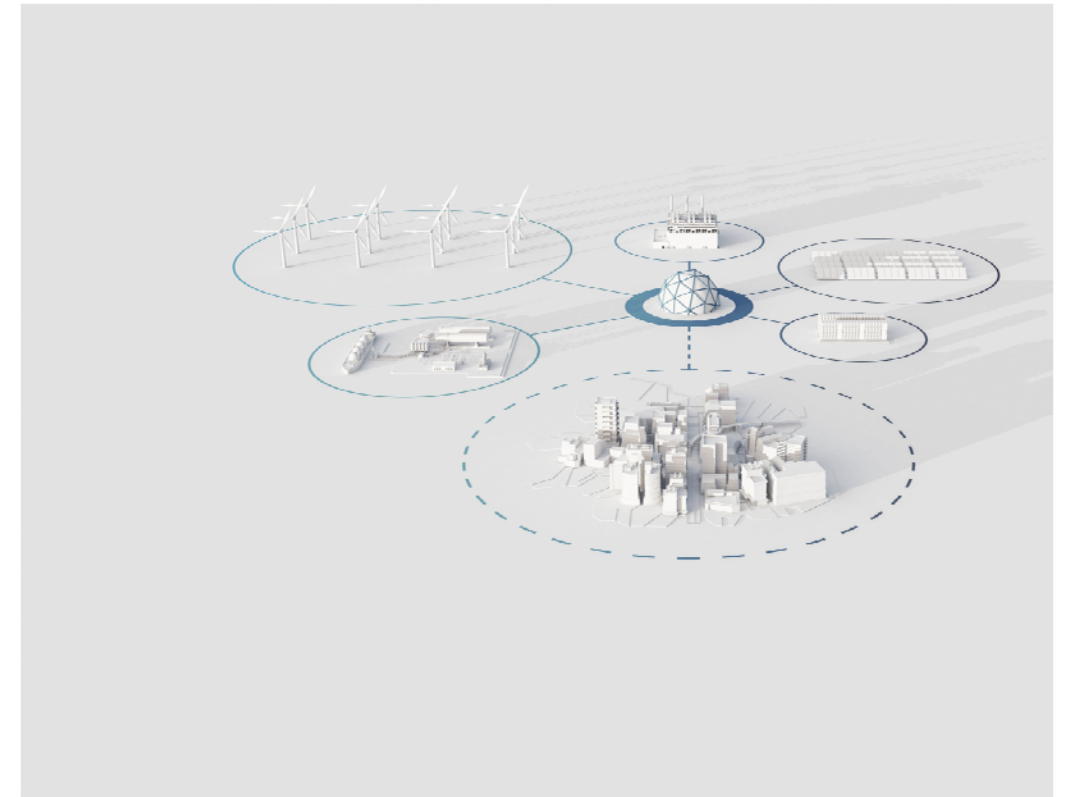
* Time Between Overhauls



Hybrid Power Solutions

Key facts

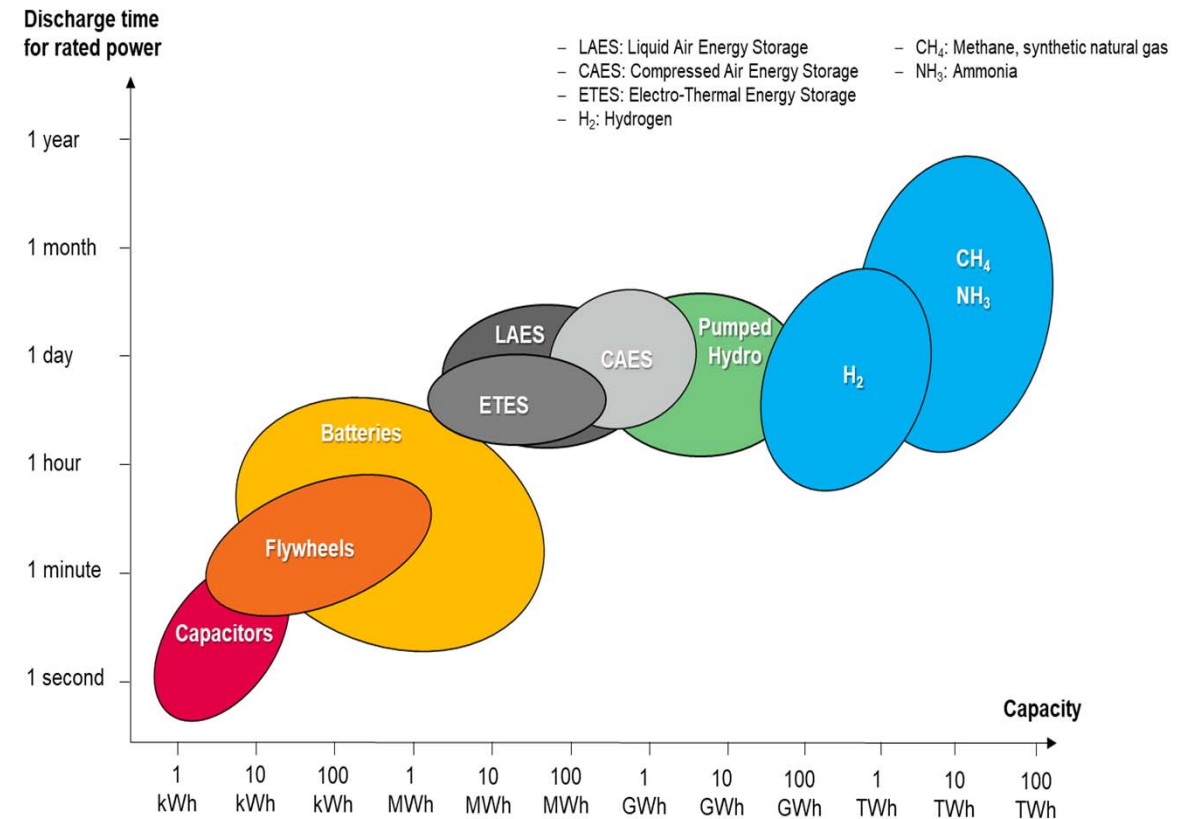
- Reduction of CO₂ emissions and fuel saving by combining RES, storage, and thermal generation
- Leverage of RES utilization to reduce energy production cost
- Securing availability & grid stability by using battery energy storage (BESS) for operating reserve, frequency control, and supporting the engine dynamics



Energy Storage Solutions

Key facts

- The power systems are facing fundamentally new challenges due to the increase of renewables
- Storage systems can provide **multiple services** for the energy system
- **Storage creating value** along the entire value chain of the power system
- MAN ES supporting its customers with multiple **storage technologies for different requirements**



Power to Gas Solution

Key facts

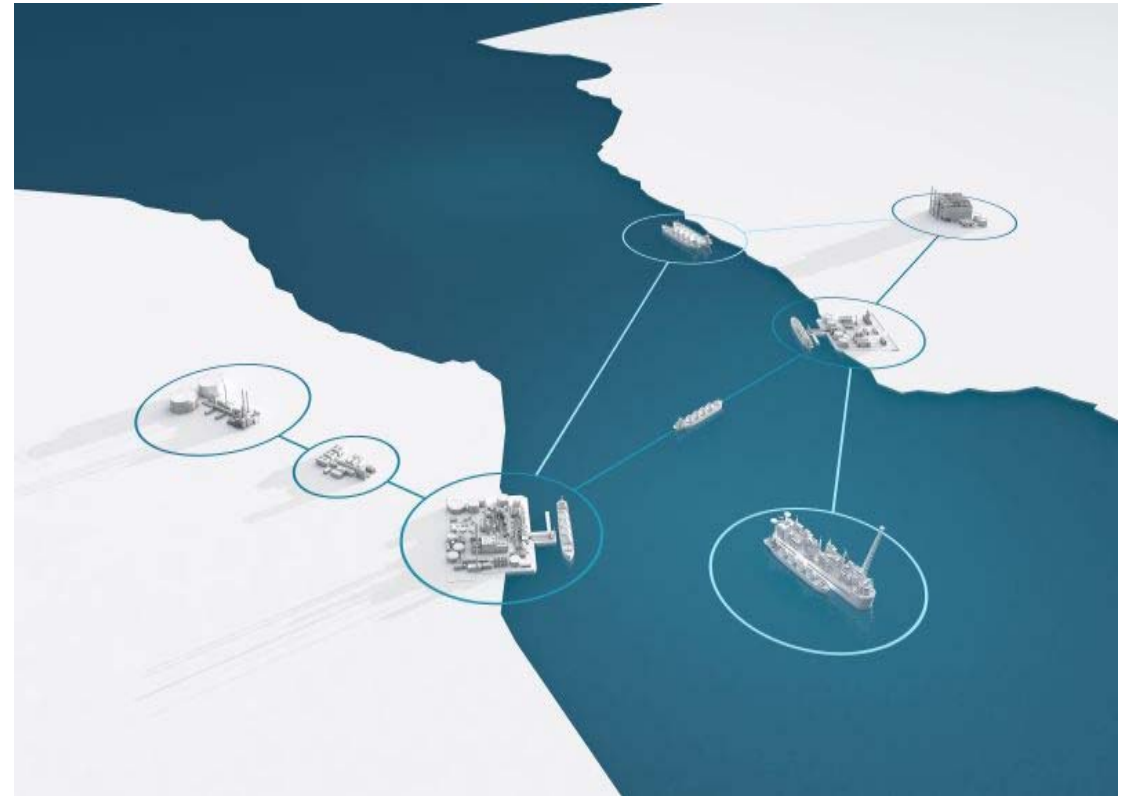
- Converting renewable energy into synthetic fuels
- Long-term storage of excessive renewable energy
- CO₂ neutral e- and gas-Mobility
- CO₂ neutral power generation



LNG to Power Solution

Key facts

- LNG / natural gas is the **cleanest fossil fuel** and an alternative supporting decarbonisation
- Potential **fuel cost saving** due to decoupling LNG from the oil price
- LNG system **competence in-house**
- EPC – LNG to Power Solutions **out of one hand**



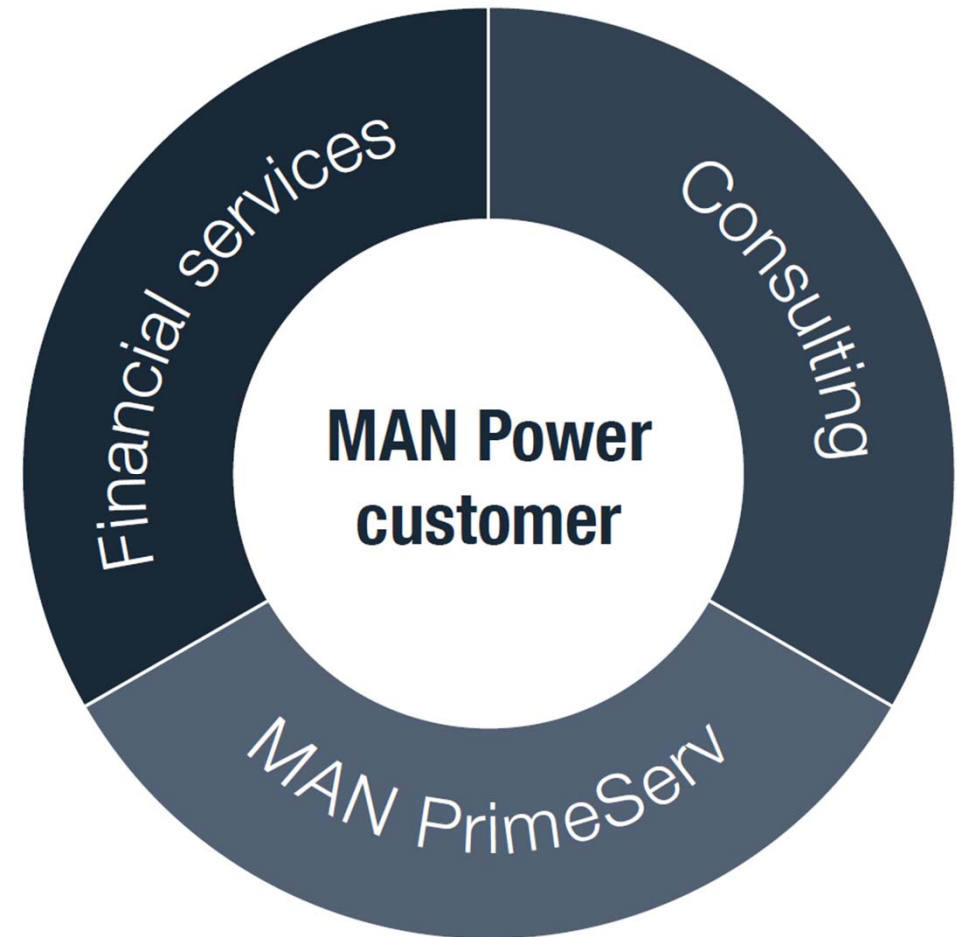
Power Services



MAN Power Service

Understanding customers' needs and expectations

- Power plant projects are capital-intensive and have a high demand for consultancy throughout their entire lifetime
- Early project development, financing support, and technical consulting are key building blocks for complete solutions from one source
- Our consultant role does not end after plant take-over, but is continued by our brand label MAN PrimeServ with high quality aftersales support for our complete product portfolio



MAN Energy Solutions Reference Project

IPP Participation using the example of Atlas

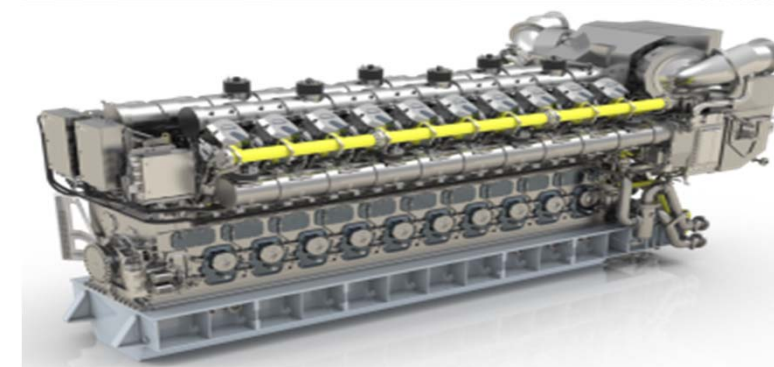
| | |
|----------------------|---|
| Customer: | Atlas Power (SPC + MAN Equity) |
| Application: | Base load power plant, Engine Combined Cycle |
| Location: | Lahore, Pakistan |
| No. and engine type: | 11 x 18V48/60 + 1 x steam turbine |
| Plant output: | 225 MW |
| Fuel: | HFO |
| Order commencement: | 11/2007 |
| MAN's work scope: | EPC |
| Feature: | O&M contract for 10 years |



MAN Diesel & Turbo Reference Project

VW Braunschweig

| | |
|----------------------|---|
| Customer: | Volkswagen |
| Application: | Combined Heat and Power for Industry & grid |
| Location: | Brunswick, Germany |
| No. and engine type: | 1 x 20V35/44G |
| Plant output: | 10 MW _{el} & 9 MW _{th} |
| Fuel: | Natural Gas |
| Order commencement: | 12/2012 |
| MAN's work scope: | EPC |



Reference Project VW Brunswick/Germany

1 x 20V35/44G Combined Heat & Power (CHP)

Case

- VW Group has to reduce CO₂ emission by 40%.
- Modernization of the existing factory heating plant,
 - to ensure factory heat supply and
 - to participate at the German Ancillary Services and the VW accounting grid.

Solution

- Replacement of existing hot water boilers by 2 new boilers
- Installation of one MAN 35/44G gas engine and integration into factory heating system

Technical data

- 1 x 20V35/44G engine, with 10,4 MW_{el} and 9,24 MW_{th}
- η_{el} = approx. 45 % / approx. η_{tot} = 85 % (0% tolerance)
- Hot water production: 159 t/h (65°C/115°C)
- CO₂ emission in CHP mode: 238 g/kWh
- Emission limits as per German standard: “TA Luft”

Benefit

- Reduction of the “CO₂ Foot print emission” per car unit
- Extension and improvement of the factory heating syst.
- Additional earnings by selling ancillary power to grid



Proyecto Gibraltar

3 x 14V51/60G + 3 x 14V51/60DF

| | |
|----------------------|---------------------------------|
| Customer: | Government of Gibraltar |
| Contractor: | Bouygues |
| Application: | Utility |
| Location: | Gibraltar |
| No. and engine type: | 3 x 14V51/60G 3 x 14V51/60DF |
| Plant output: | 84 MW |
| Fuel: | Gas / Dual Fuel (Gas, Diesel) |
| Order: | 2014 |
| Commercial operation | 2016 |
| MAN's work scope: | Gensets, mechanical auxiliaries |



Planta Dual

Owen Springs, Australia

| Project Overview | |
|----------------------|--|
| Customer: | Power and Water Corporation |
| Application: | Base load power plant |
| Location: | Owen Springs, Alice Springs, Australia |
| No. and engine type: | 3 x 12V 51/60DF |
| Plant output: | 34 MW |
| Fuel: | Gas from national gas grid |
| Contract award: | July 2008 |
| Construction period: | 11 months, commissioning June 2010 |
| MAN's work scope: | EPC |



Planta en Ciclo Combinado

Thika, Kenya

Project Overview

- Project :
EPC Consortium
- MAN's scope of supply:
5x 18V48/60 HFO engine (80MW)
+ DCC incl. steam turbine (7MW),
engineering, piping, mechanical & control Aux,
supervision & commissioning, tests
- Location:
Thika (approx. 40km NE Nairobi), Kenya
- Key dates:
Contract signature: 09.06.2011
Financial closure: 11.10.2012
Interim TOC (5x Engines): 18.08.2013
Full TOC (Steam Turbine): 07.03.2014



Thika Power Limited is developing an 87MW diesel power plant in Thika, Kenya, under a 20-year Build Own Operate agreement with Kenya Power.

The plant consists of 5 Engines from MAN Diesel that run on Heavy Fuel Oil. The project will be financed through sponsors equity, along with a long term senior A loan package by IFC (World Bank Group), ABSA Capital (affiliated with Barclays) and the African Development Bank. MAN Diesel(Germany) and Matelec Group(Lebanon) are responsible for the Engineering Procurement and Construction(EPC) contract.

Below is the pdf to the Environmental and Social Impact Assessment (ESIA) performed by ERM (Environmental Resources Management) for the power plant project:



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Hybrid Plants

Wind Diesel Project - Benchmark for an Island Grid

**MAN medium sped diesel engine power plant
approx. 14 MW**

12 wind turbines approx. 11MW

3MW battery bank

The world's largest wind and diesel power plant in Bonaire supplies up to 25 MW environmentally friendly energy for the island's 15,000 inhabitants.

Disclaimer

All data provided in this document is non-binding.

This data serves informational purposes only and is especially not guaranteed in any way.

Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.

Thank you!

