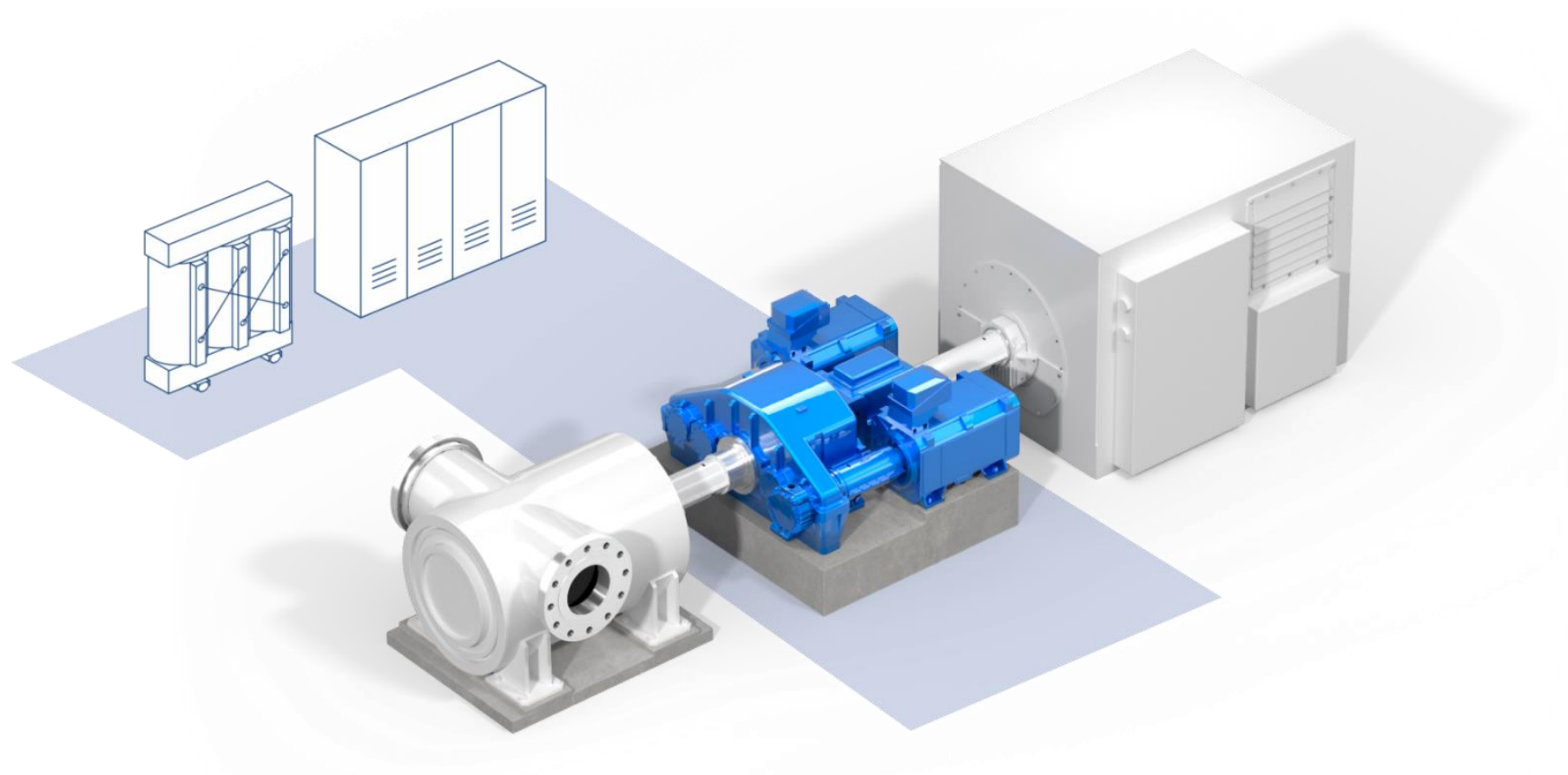


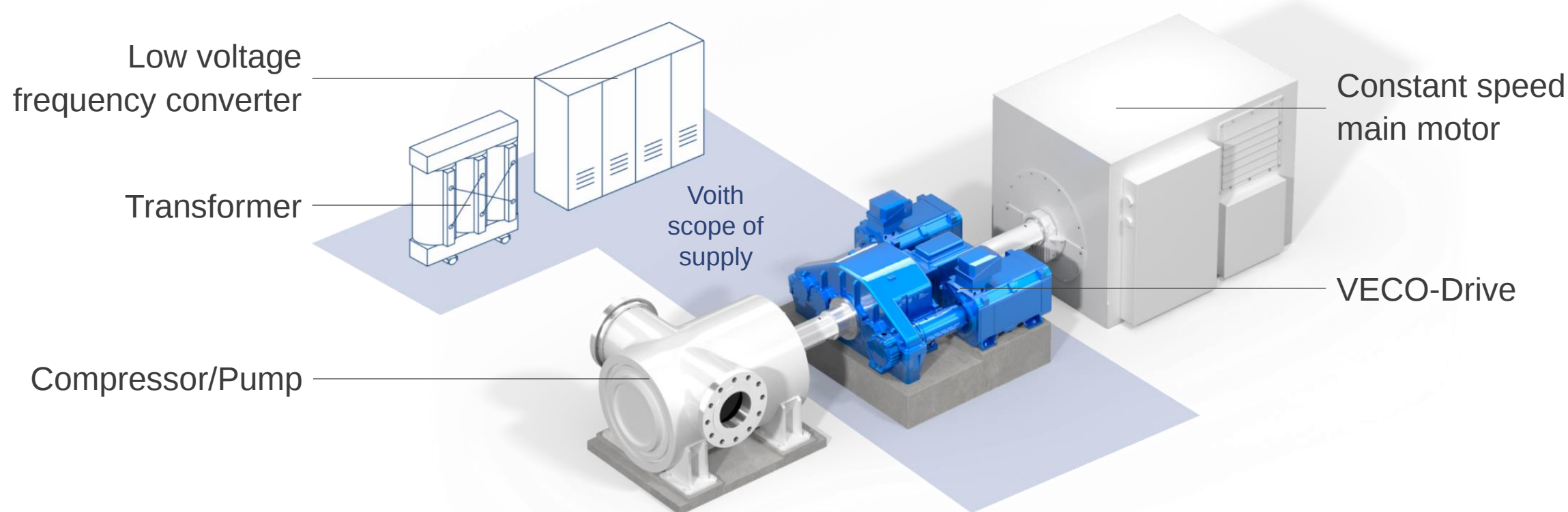
VECO-Drive, Electro-Mechanic Variable Speed Planetary Gear

February 1, 2018
Gas-Electric Partnership
Houston, TX



The VECO-Drive

Drive Train Set-Up



Technology Leader in Variable Speed Drives for Compressors & Pumps in Power and Oil & Gas

V/S Cplg



Hydrodynamic
Couplings
> 15,000 units

RK-GVSD



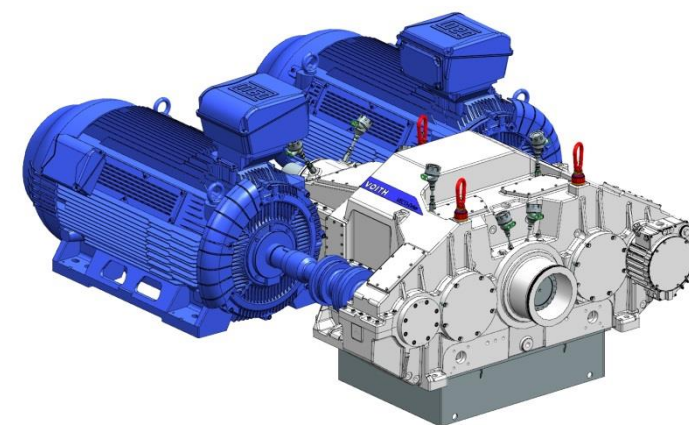
Geared
Hydrodynamic
Couplings
> 10,000 units

Vorecon



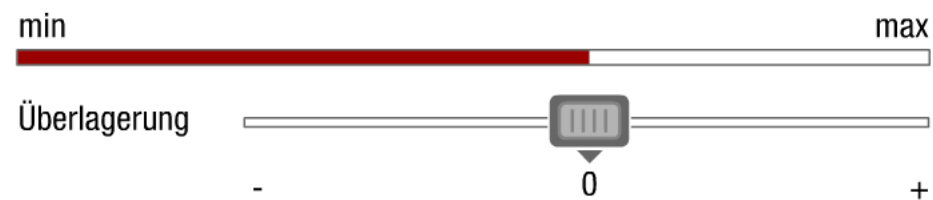
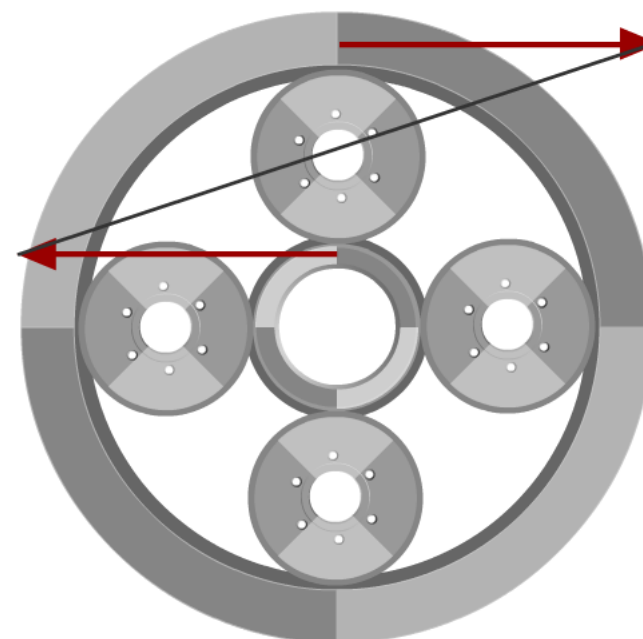
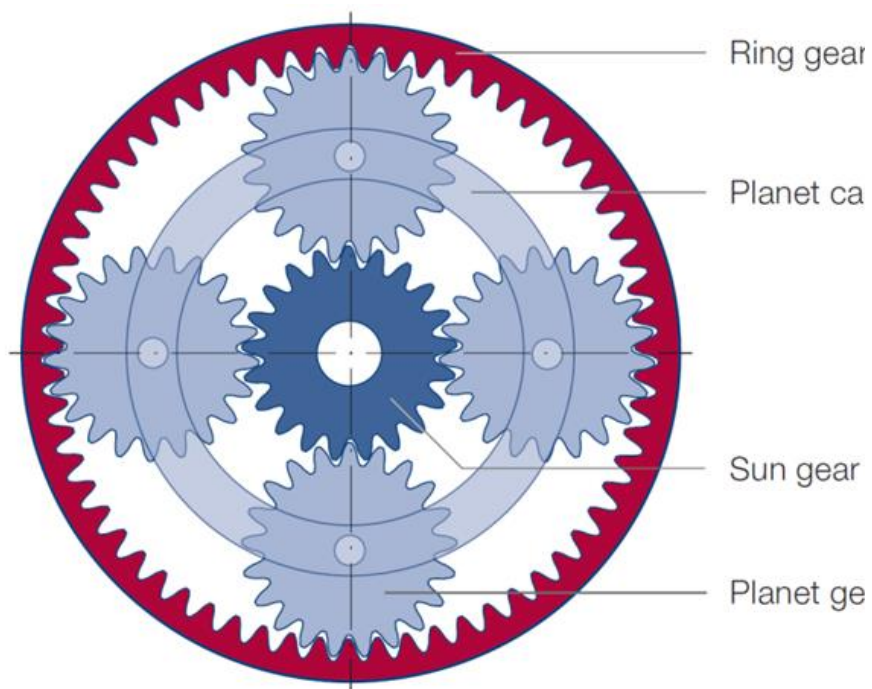
Hydrodynamic
Variable Speed
Planetary Gears
> 600 units

VECO-Drive



Electro-Mechanic
Variable Speed
Planetary Gear

The Planetary Gear Speed Control

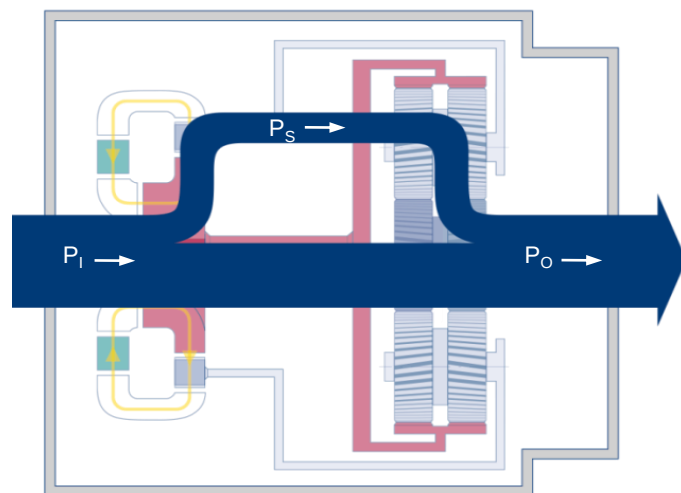


The Power Splitting DNA – Inspired by Vorecon



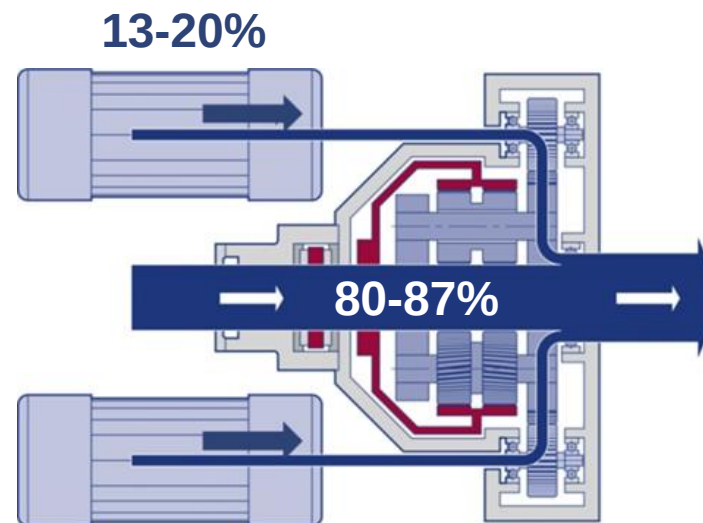
Vorecon

- variable speed planetary gear
- hydrodynamical superimposition



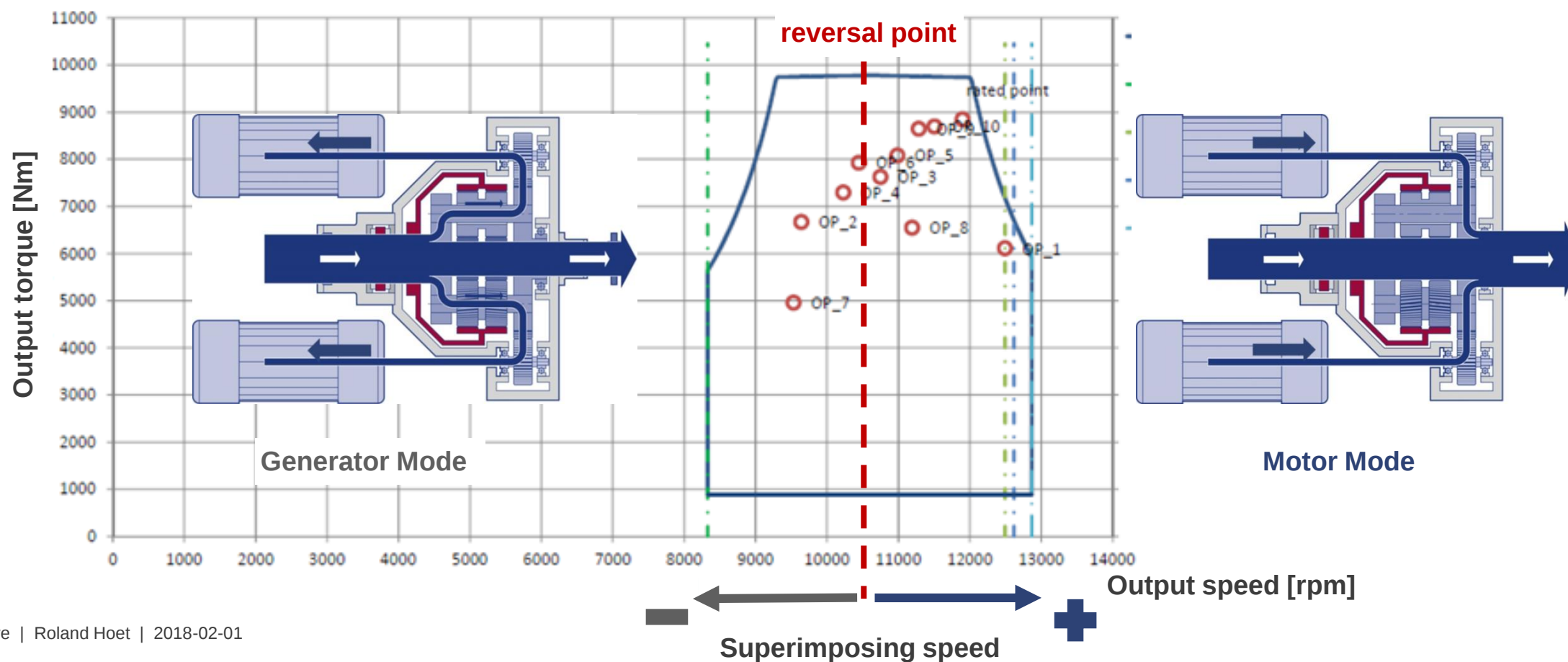
VECO Drive

- variable speed planetary gear
- electrical superimposition



VECO-Drive – Operating Map

Energy Recuperation in Generator Mode

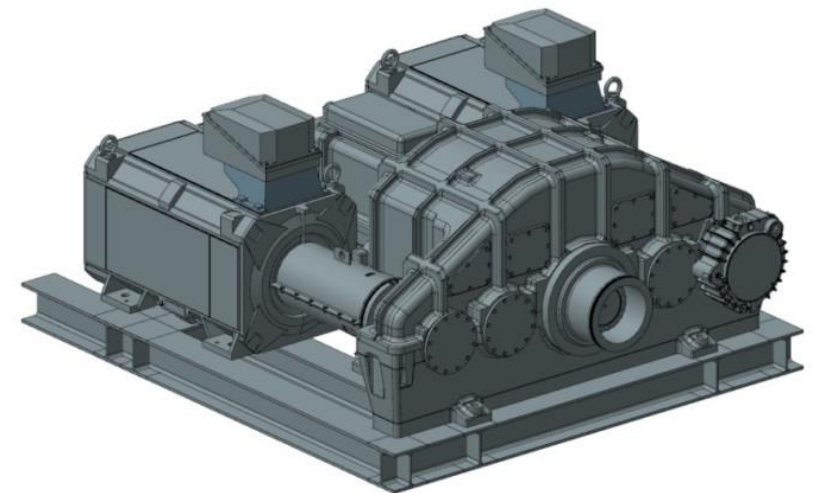


VECO-Drive – Design Specification

Modular Series Design

Rated output power	4 – 15 MW up to 20 MW on demand
Input speed	1500 or 1800 rpm
Rated output speed	5000 – 15000 rpm
Speed regulating range	70 – 105 % (compressors) 50 – 100 % (pumps)

Soft motor start (grid protection)



VECO-Drive Efficiency

Saving Operating Cost with VECO-Drive

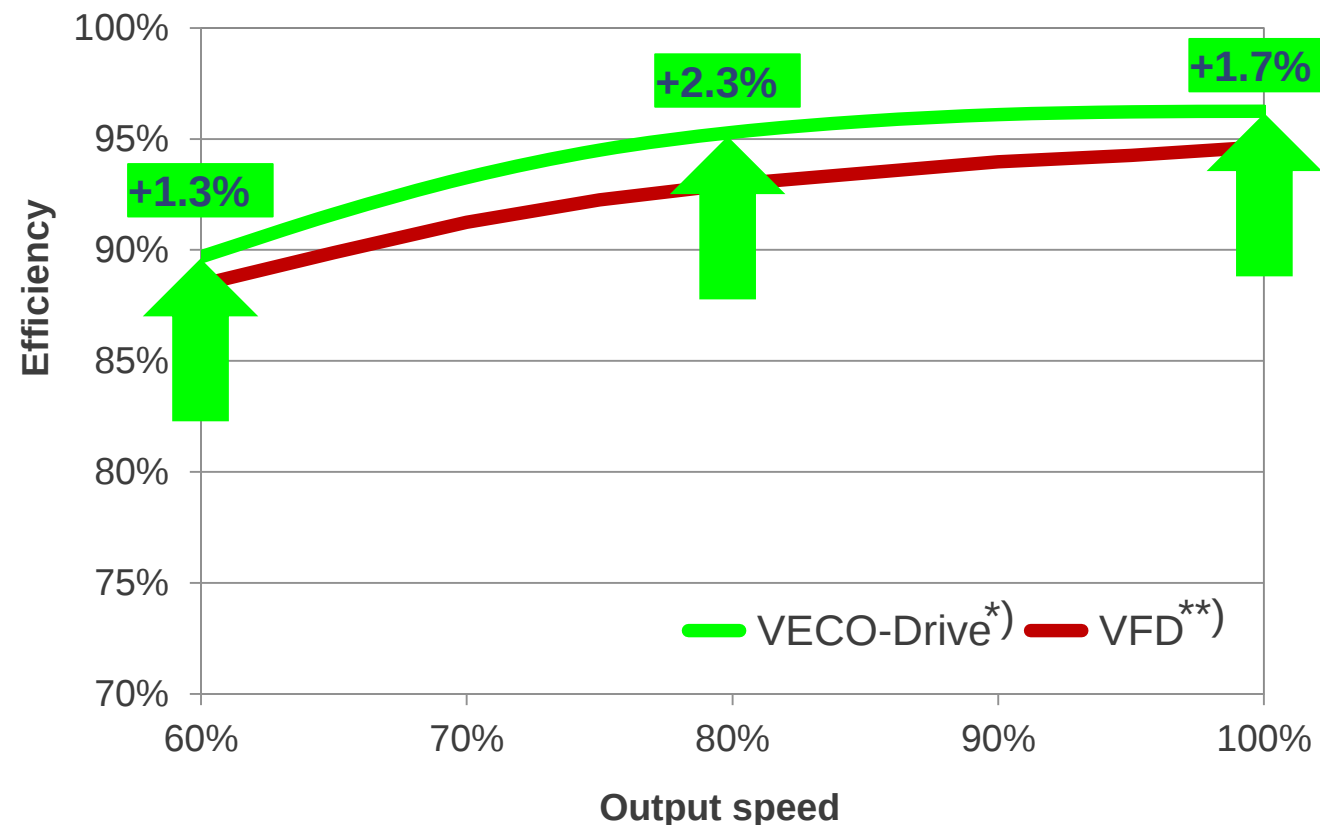
Efficiency Comparison with Full Scale VFD

*) VECO-Drive system including:

- Planetary gear
- Servo motors
- Forced cooling
- Lube oil pump
- Low voltage VFD for servo motors
- Transformer

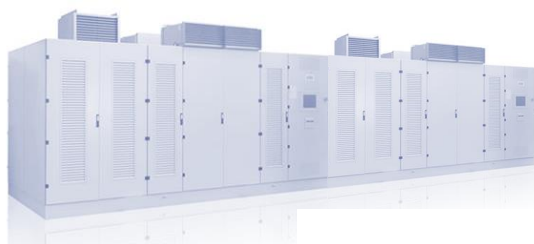
**) VFD System including:

- Parallel shaft gear
- Forced cooling
- Lube oil pump
- Full scale medium voltage VFD
- Transformer



Full Scale In-Line MV-VFD

14 MW
MV VFD

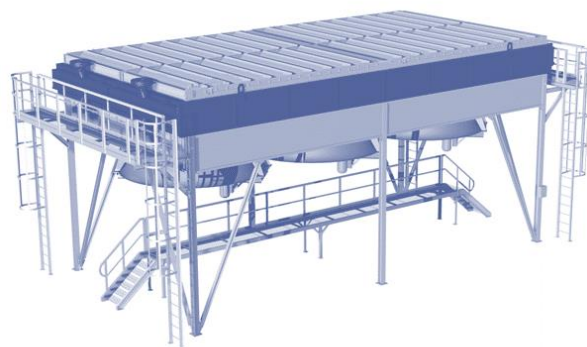


15m², 38m³
10 tons, η 97%

15 MVA
Transformer



15m², 65m³
36 tons, η 99%



Σ 44m², 142m³
82 tons, η 91.8 %

13 MW
Motor



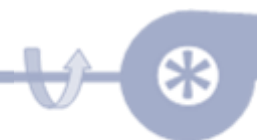
12m², 36m³
30 tons, η 97%

12.5 MW
Gear



1.6m², 2.7m³
6 tons, η 98.5%

12 MW
Compressor



Full Scale In-Line MV-VFD

Space requirements

44 m², 142 m³

82 tons^{Weight}

η 91.8 %

Drive Train Efficiency

The VECO-Drive

Space requirements

31 m², 65 m³

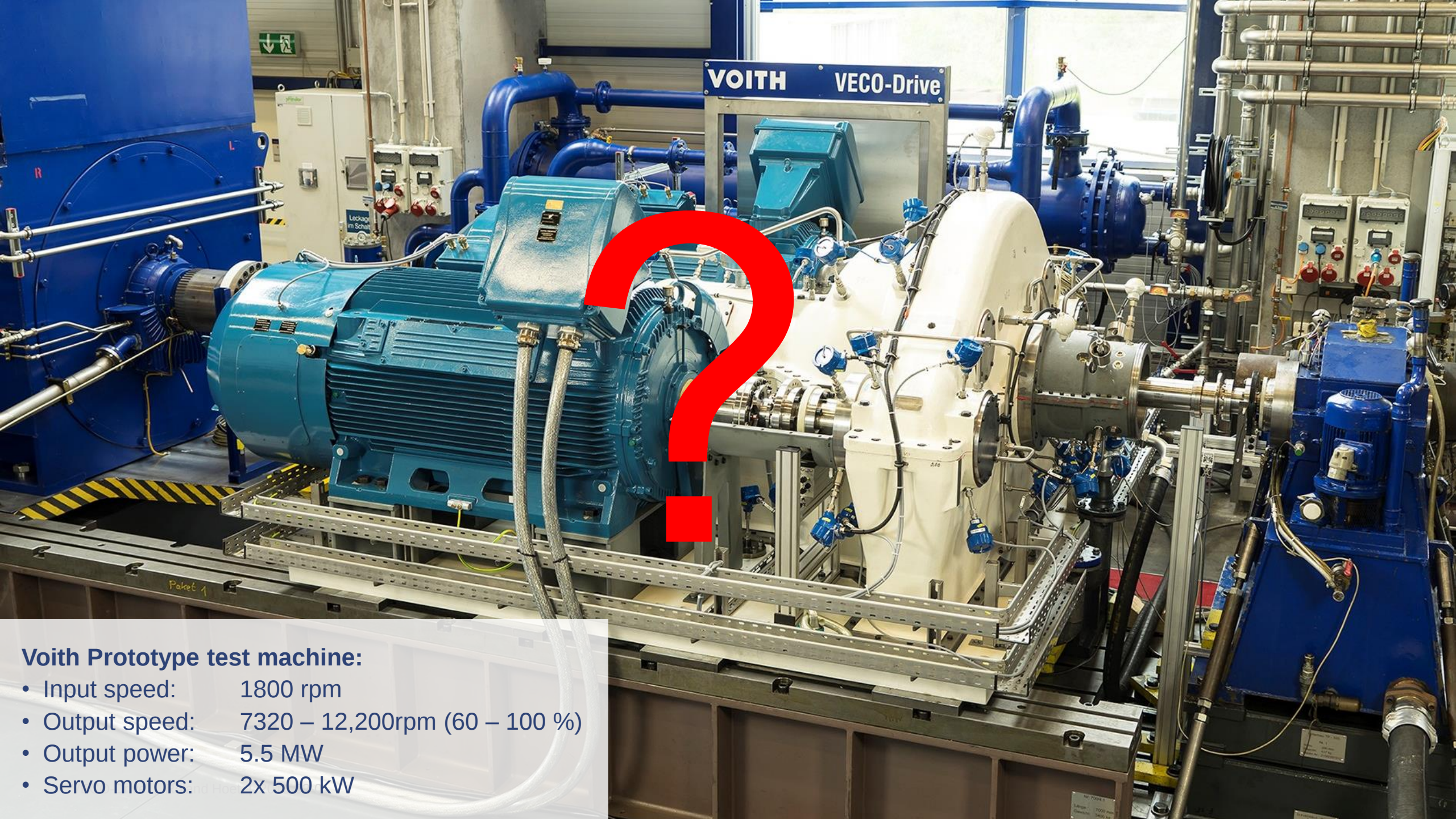
52 tons^{Weight}

η 93.5 %

Drive Train Efficiency

Additional Veco-Drive Benefits

- Installation of a lower power (air cooled possible) VFD is much less complex and easier to install and maintain
- When the VFD needs replaced in the future, you are only replacing 13-20% of the installed drive system power
- The option for a low power MV-VFD is possible for the servo-motor drives if customers prefer MV. (potentially eliminates another transformer)
- The Veco-Drive is capable of continuous “slow roll” control if required for maintenance or cooling.



Voith Prototype test machine:

- Input speed: 1800 rpm
- Output speed: 7320 – 12,200rpm (60 – 100 %)
- Output power: 5.5 MW
- Servo motors: 2x 500 kW

VOITH

Inspiring Technology
for Generations