Gearless Conveyor Drives – A Step Towards Greater Sustainability and Carbon Footprint Reduction

SME Society for Mining, Metallurgy & Exploration | MINEXCHANGE
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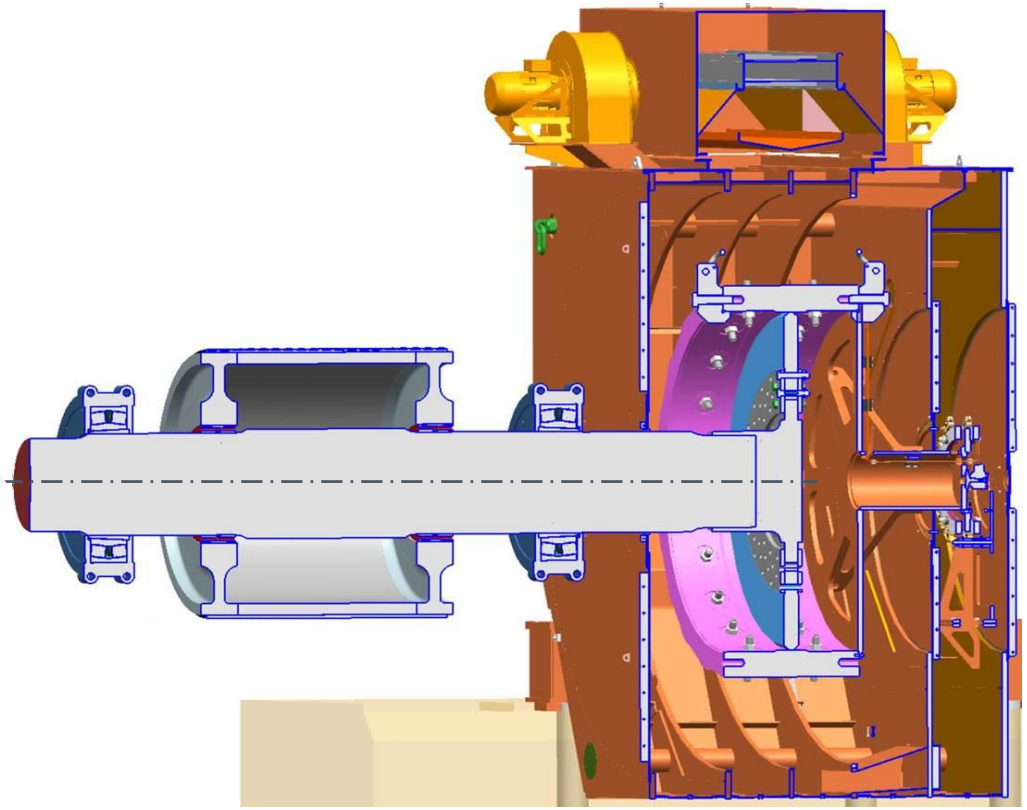
Current Situation and Challenges – Gearless Drive Systems are part of the answer

Classic Challenges

- Deeper mines, decreasing ore grades
- Mines located at remote areas
- Highest Efficiency
- Health & Safety

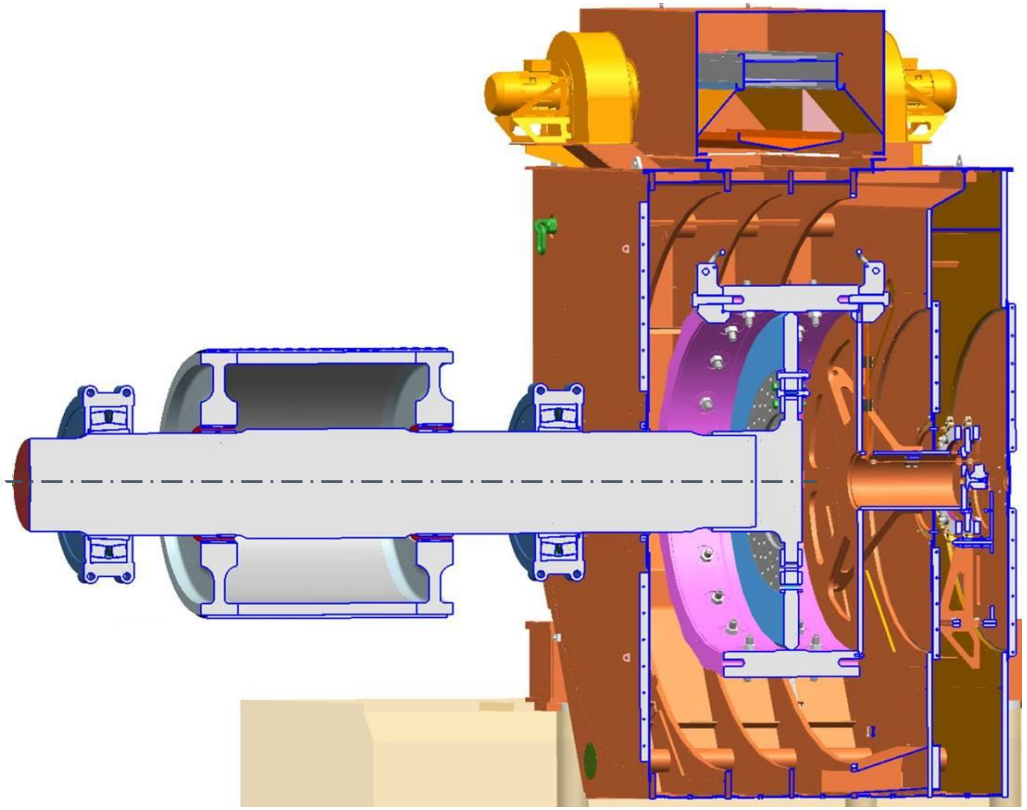
“Latest” Challenges

- Public Attention, Industry in Focus of Discussions
- Reduction of CO_2 emissions
- Sustainability
- Strongly Increasing Demand of Resources



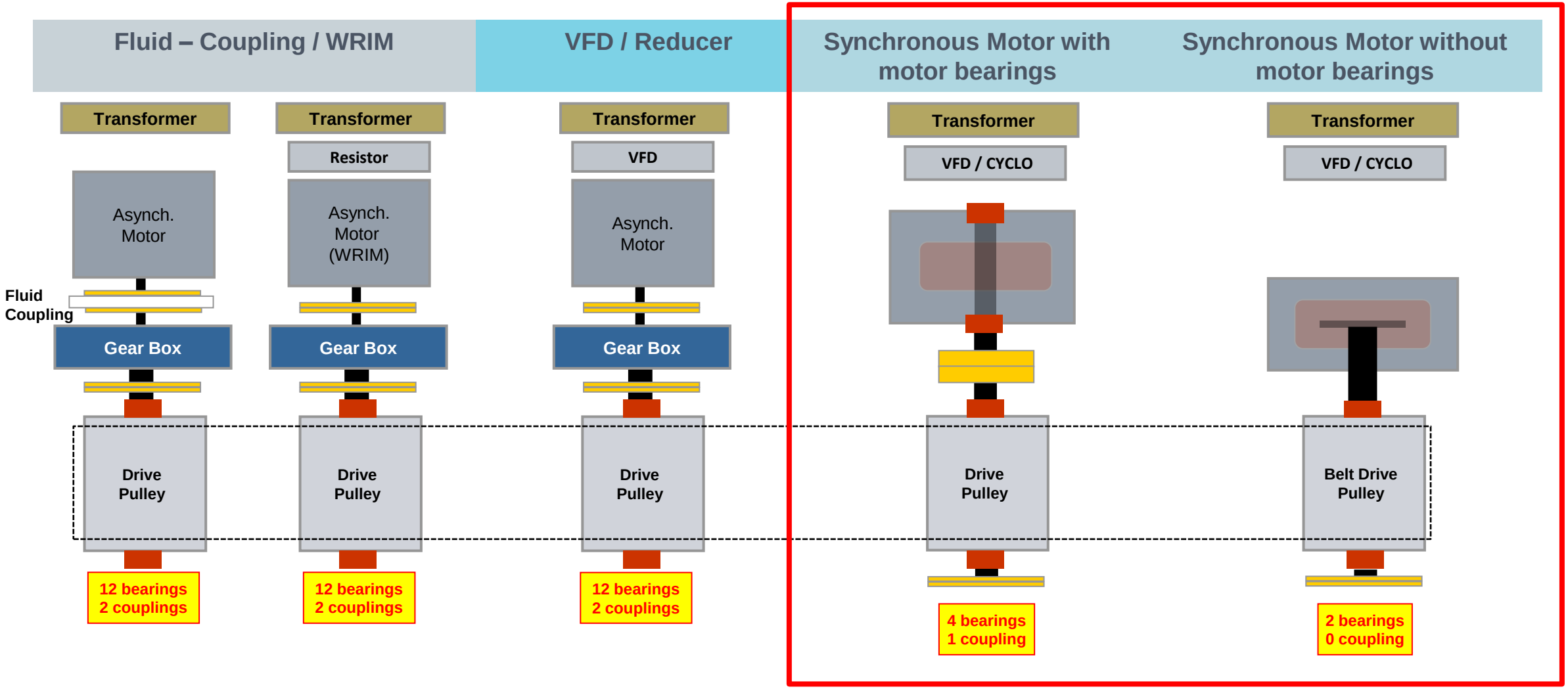
Current Situation and Challenges – Gearless Drive Systems are part of the answer

- Serving the requirement of larger and longer conveying systems
- Complying with highest power requirements
- Matching manufacturer’s abilities to produce stronger belts
- Increasing efficiency
- Reducing environmental impact



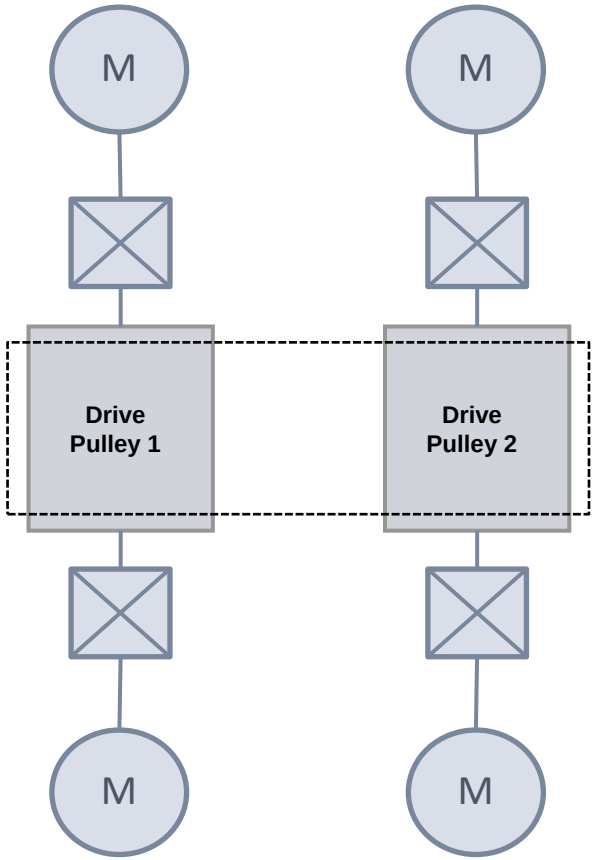
Gearless Drive Systems for Conveyors

Comparison with Other Drive Configurations



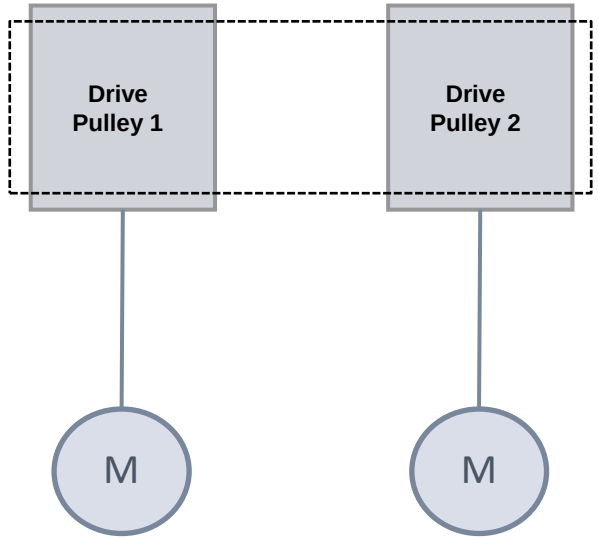
Example: Drive Station with Four Drives

Drive System Configuration



- 4 x Motor High Speed
- 4 x VFD
- 4 x Gearbox
- 4 x Feeder MV-SWG

44 bearings
8 couplings



- 2 x Motor Low Speed
- 2 x VFD / CYCLO
- 2 x Feeder MV-SWG

4 bearings
0 couplings

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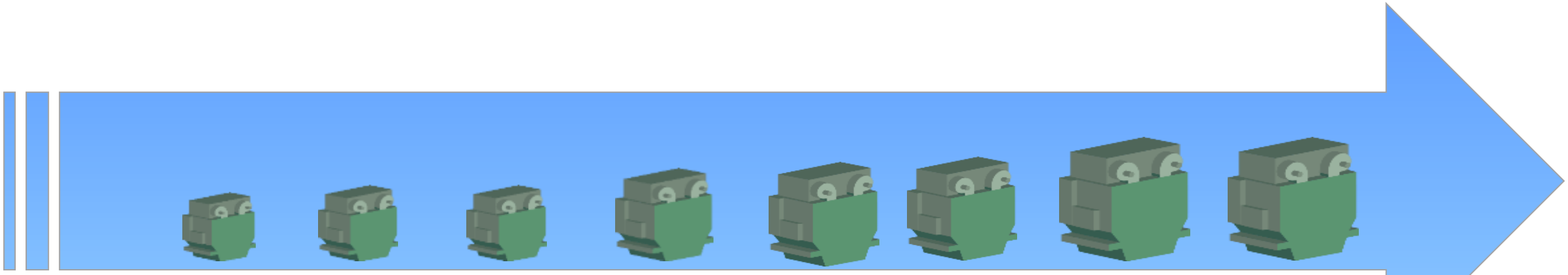
Gearless Conveyor Drive Projects

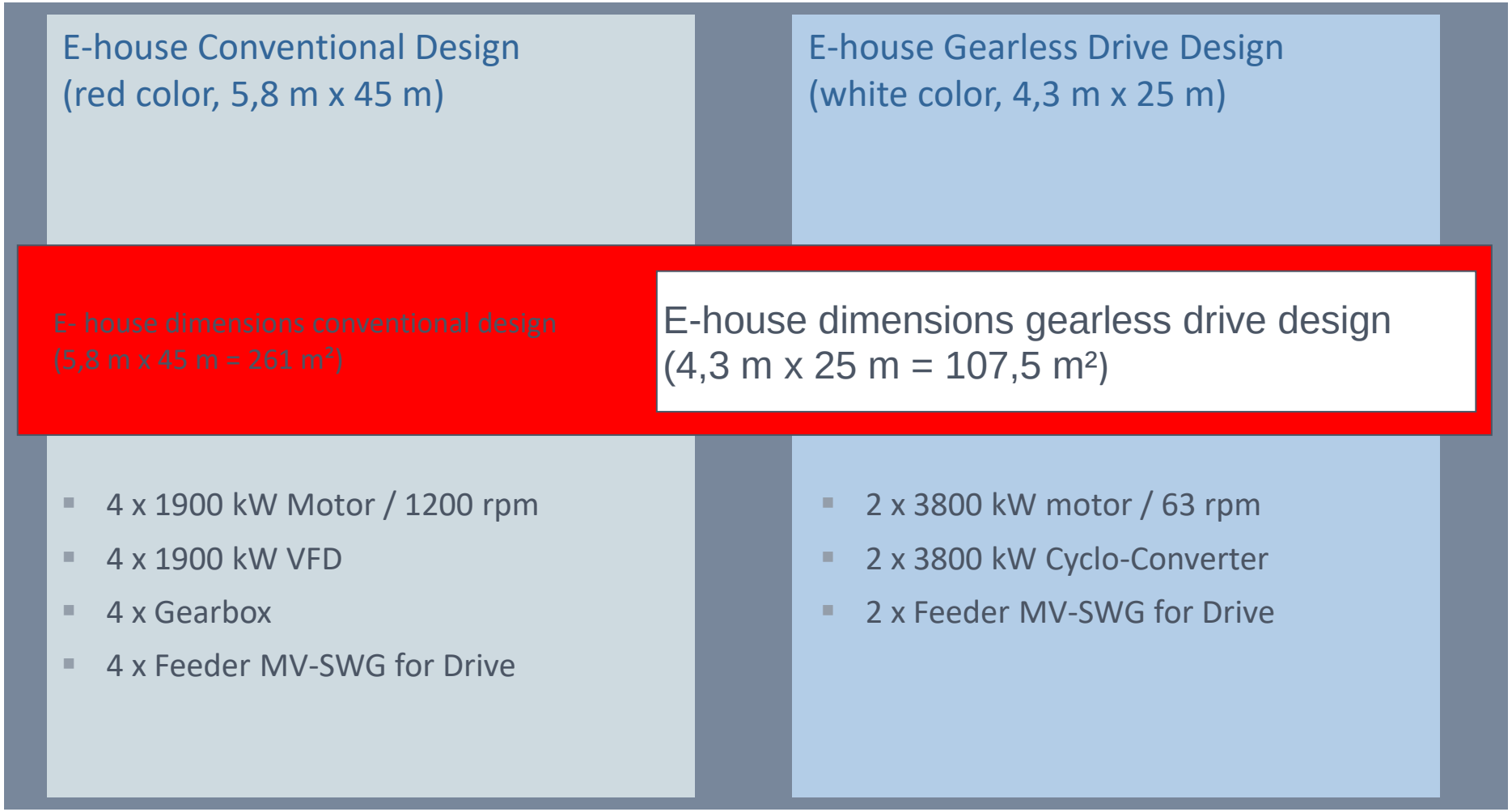
References



	Antapaccay	Prosper Haniel	Las Bambas	Escondida OGP1	Quellaveco	Oyu Tolgoi	Julong	Cuajone
Country	Peru	Germany	Peru	Chile	Peru	Mongolia	Tibet, China	Peru
Site Elevation	4,100m	60m	4,000m	3,050m	3,700m	1,200m	5,000m	3,500m
Installed Power	2 x 3,800 kW	2 x 3,200 kW	4 x 4,400 kW	5 x 5,000kW	2 x 5,500kW	8 x 5,500kW	2 x 6,000kW	2 x 6,000kW
Year	2012	1985	2015	2015	2021	2022	2022	2017
Nominal Torque	**576kNm**	**631kNm**	**637kNm**	**774kNm**	**783kNm**	**942kNm**	**1023kNm**	**1042kNm**
Nominal Speed	63rpm	47rpm	66rpm	62,5rpm	67,1rpm	57rpm	56rpm	55rpm

Example: Antappacay – Drive Station with Four Drives 1900kW

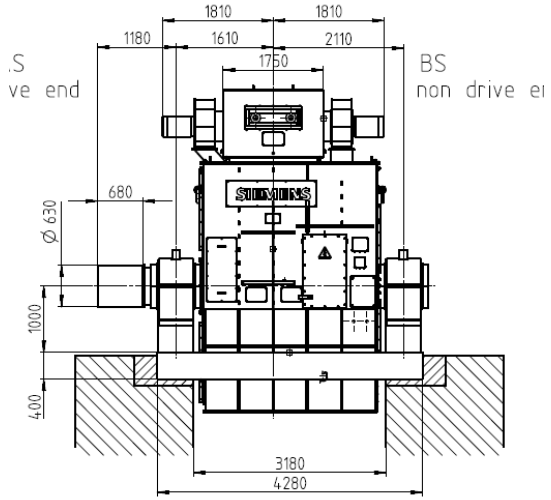
Impact on E-House Footprint



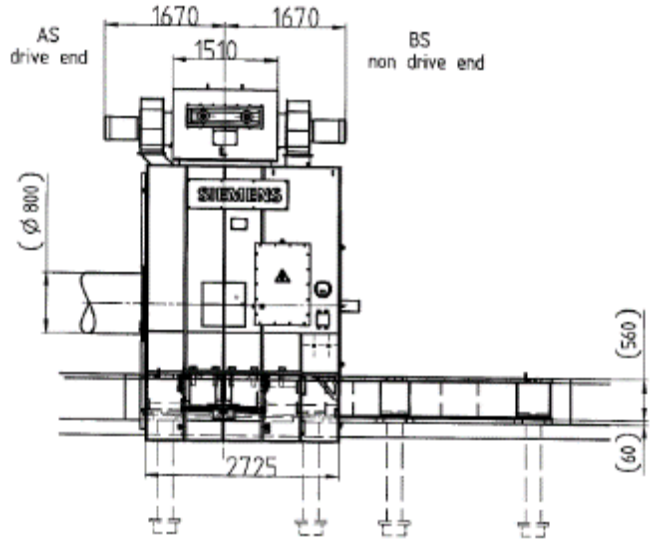
Example: Escondida OGP1

10km Overland Conveyor System with 4 Flights (1x2x 5MW & 3x1x 5MW gearless drives)

- First time single gearless drive on conveyor flight
- Case study between 10 x 2500kW (conventional) vs 5x 5000kW (gearless)
- Case study between motor with bearing and without bearing



5,000 kW // Weight: 97 t



5,000 kW // Weight: 58 t

Example: Escondida OGP1

5 Gearless Drives vs. 10 Conventional Drives (2,500 kW), 25,000kW Installed Power – Efficiency Comparison

	Conventional Drive System w/ Reducer		Gearless Drive Station w/o Reducer	
	Induction Motor & VFD		Separate Excited Synchronous Motor & Cyclo-Converter	
Installed Power	4 x 2,500kW		2 x 5,000kW	
Equipment	Efficiency [%]	Losses [kW]	Efficiency [%]	Losses [kW]
Converter Transformer	99.3	70	99.2	140
Excitation Transformer & Rectifier	n/a		(97.6)	16
Converter	97.3	270	99.2	100
Gearbox & Oil System	96.0	400	n/a	n/a
Motor	96.5	350	95.6	440
Motor Cooling System	n/a			
Total	**89.1**	**1090**	**93.0**	**696.0**

Example: Escondida OGP1

5 Gearless Drives vs. 10 Conventional Drives (2,500 kW), 25,000kW Installed Power – Savings and Reductions

Availability

⇒ Reduced loss of production

⇒ $\text{savings}[\text{USD/a}] = \frac{loss[USD]}{h} * \frac{down\ time[h]}{a}$

Efficiency

⇒ 3.9% higher efficiency

⇒ $\text{savings}[\text{kWh}] = eff.\ increase[\%] * total\ power\ demand[kW] * operating\ time\ per\ year[h]$

⇒ E.g., ≈6,800,000 kWh ≈2,770 (1) tons in CO_2 reduction / year
≈1,108,000l crude oil

Maintenance

⇒ Savings in reducer maintenance work:
no oil storage and handling, no workforce, etc.

Reliability Calculation (4 x 2500 kW reducers)

			Assumed max. Rel.	99.99%	Operating time [h/a]	7000
		Bearing	Couplings	Reliability [%]	Risk [%]	Down Time [h/a]
Conventional	IM	44	8	99.48	0.52	36
Gearless	SM	4	0	99.96	0.04	3

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(1) Considering 2019 German energy mix (0.408 kg CO2 per KWh)

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Customized Cooling System: Antapaccay and Las Bambas Overland Conveyor Systems

2 Projects, Same Frame Size Motor, Two Different Power Ratings

Antapaccay Dry Cooler

Las Bambas Chiller

	Antapaccay	Las Bambas
Installed Power	2 x 3.8MW	2 x 4.4MW
Cooling Unit Type	Dry Cooler	Chiller
Forerun Temperature[°C]	32	20

Customized Cooling System: Cuajone Overland Conveyor System

Elimination of HVAC Units from E-House Cooling

- E-house Cooling by Air / Water Heat Exchanger
- Air / Water heat exchanger ties into closed loop circuit of motor cooling system (dry cooler)

- Simplified Cooling Concept
- No Compressors
- Robust System

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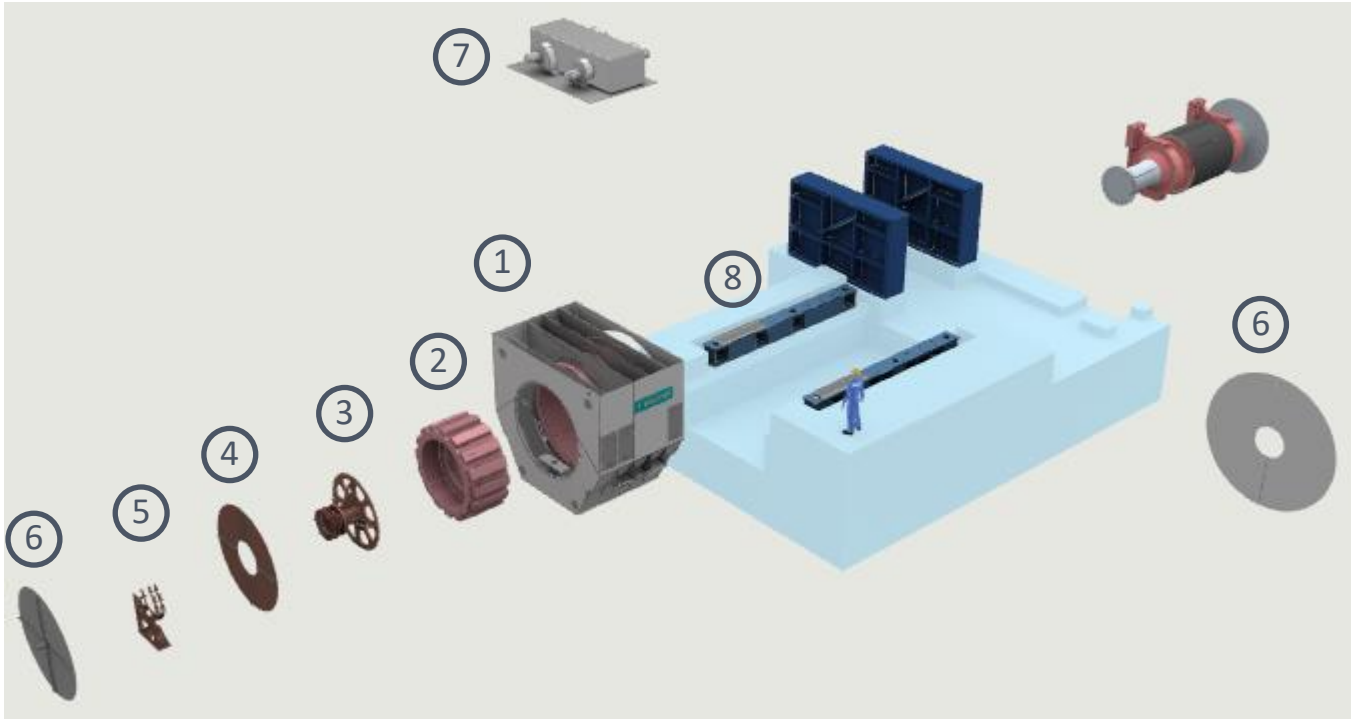
Gearless Drive Systems: A Flexible Solution for Most Requirements

Reducing Footprint, Even for Transportation

- The motor is delivered in parts
- Heaviest part to lift is the stator
- The parts are smaller than the assembled motor, which is an advantage for transport, especially through tunnels,
  e.g., at Oyu Tolgoi the motor had to fit in a mine hoist cage
- Still, the motor is easy to assemble

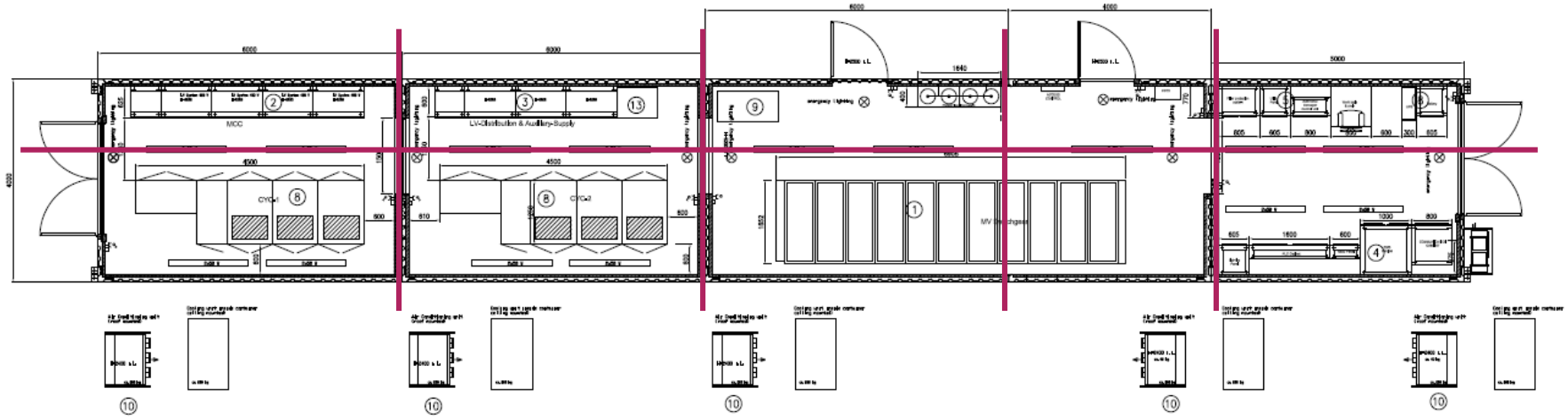


1 Stator
2 Rotor
3 Slip Ring
4 Intermediate Wall
5 Brush Holder
6 Outside Wall
7 Air Baffle Cover
8 Sole Plates

Gearless Drive Systems: A Flexible Solution for Most Requirements

Reducing Footprint, Even for Transportation

- The E-House can be designed with splits
- Number and size of the modules is flexible
- Easy installation by use of ISO-corners to bolt the modules together, no welding required
- E.g., at Oyu Tolgoi the modules have been transported in the cage of the mine hoist, as well



Building Split

Option:
Terminal boxes for connection at building splits for faster reconnection at site

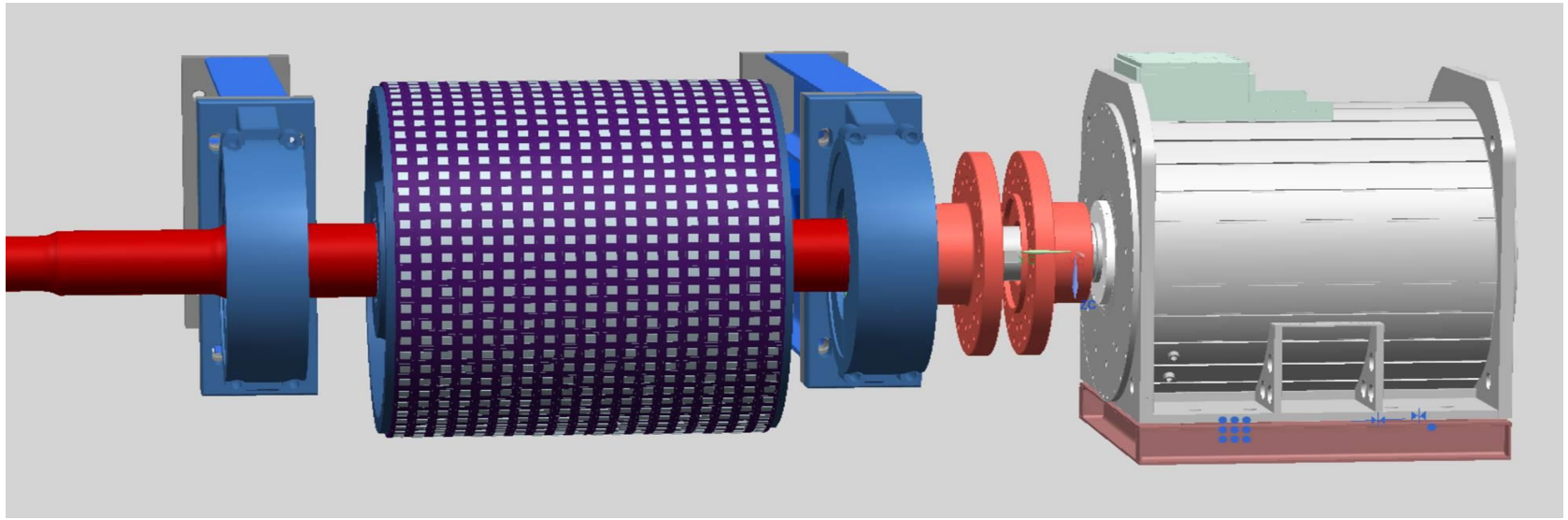
Gearless Drive Systems: A Flexible Solution for Most Requirements

High Overload Capability

- One-Drive-Out Scenario:
  Emptying the belt with one out of two drives, overload factors realized up to 190% (Las Bambas, Antapaccay), Oyu Tolgoi: 170%, up to 5.5min
- Braking scenarios for downhill conveyors:
  Julong: 170% for 70s
- Maximum overload factor ≈2,7 without mechanical design changes

Gearless Drive Systems: The Next Step

Permanent Magnet Motors



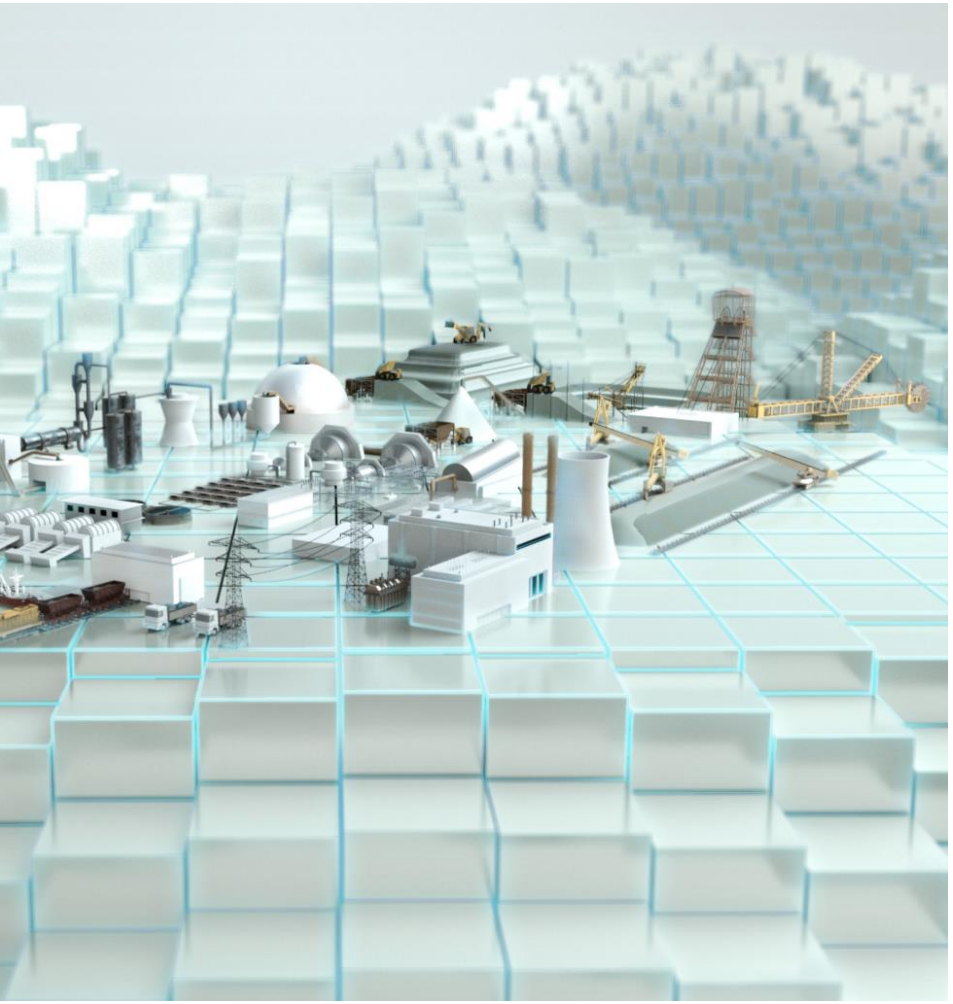
- Same basic concept as Gearless Drive with Separate Excited Synchronous Motor, but motor always with proprietary bearings
- Higher motor efficiency by not requiring external excitation
- Very interesting option in the range of 800-1000kW
- For higher ratings e.g., 2000kW PMM is approx. 30% more expensive

Wrap Up: Gearless Drive Systems for Conveyors

Sustainability is part of the solution, by

- **providing a flexible system which can be adapted to most requirements**
- **having a smaller footprint and a simplified layout / configuration**
- **increasing efficiency and availability**
  →reduction of maintenance efforts
  → reduction of emissions
- **eliminating vibrations, reducing noise and the necessity of handling reducer oil**
  → reduction of direct environmental impact
- **Containing fewer pieces of equipment and needing fewer spare parts**
  → less production and storage of parts

Thank you for your participation!



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