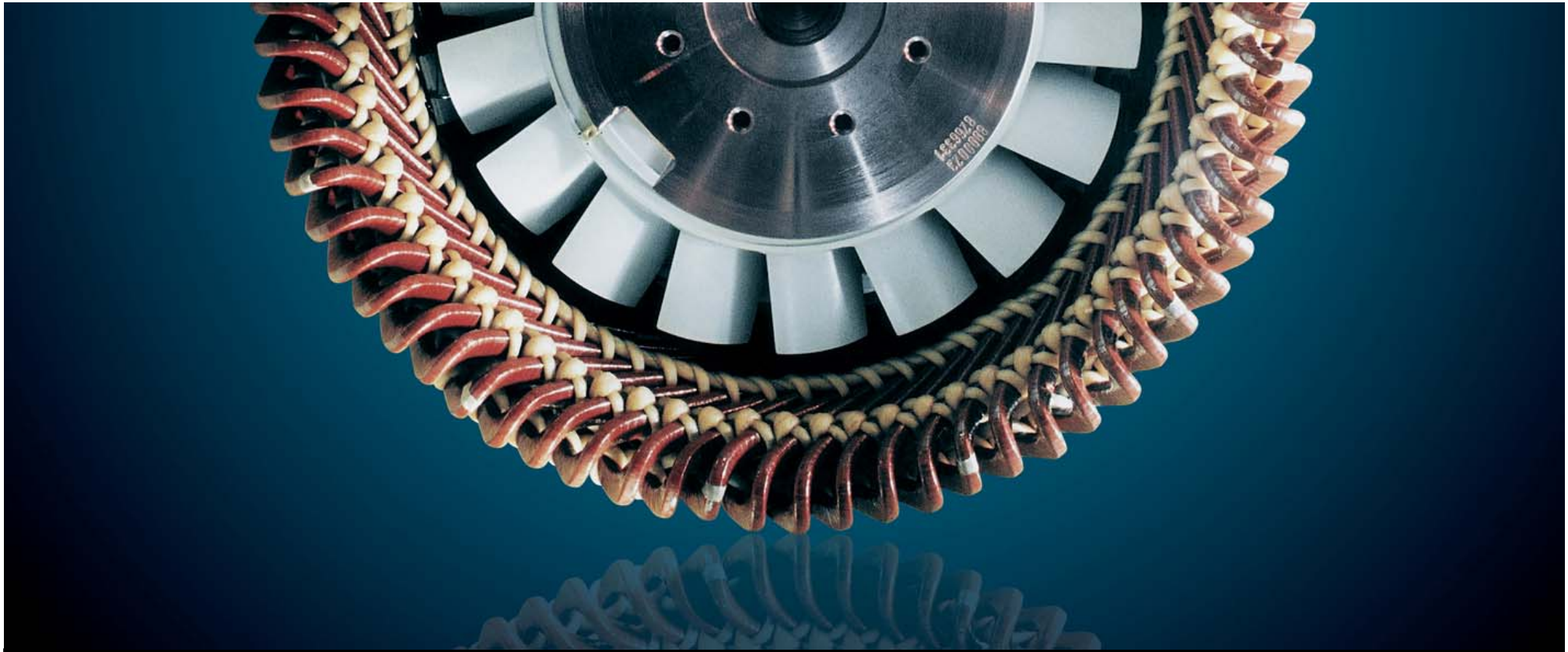


Kenneth Kullinger 2009-03-23

High-megawatt Electric Drive Motors

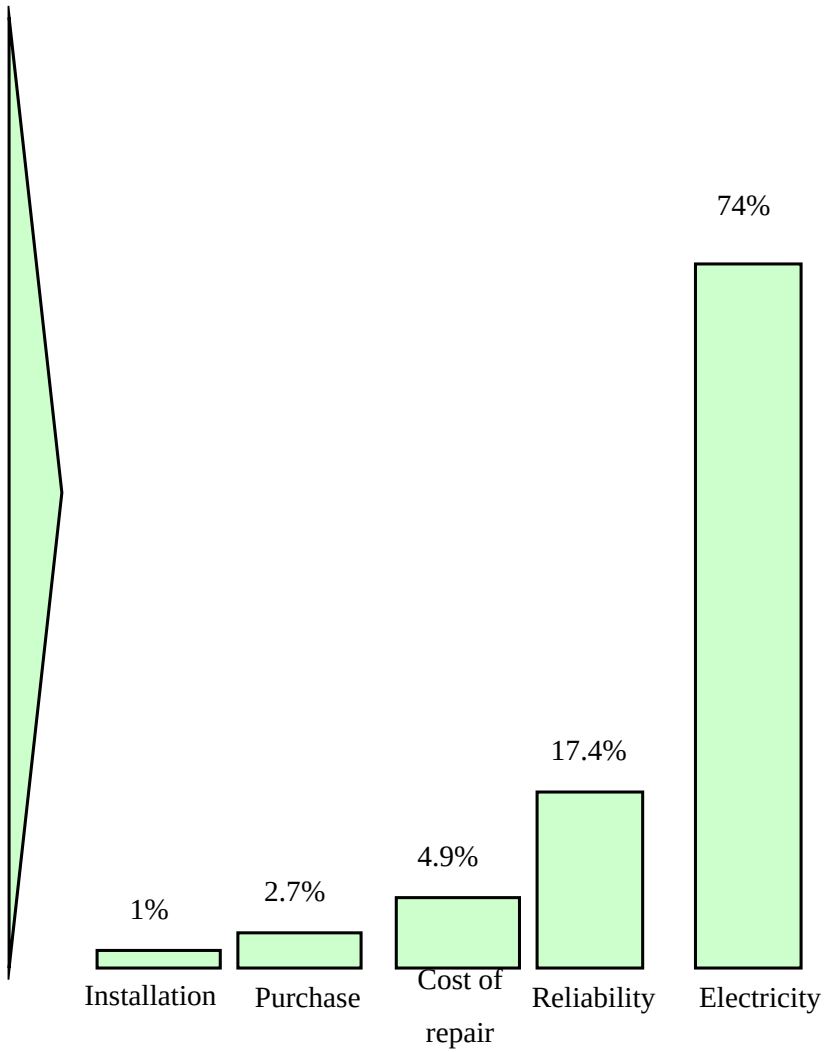
High-megawatt Electric Drive Motors
Presentation Content

- Total cost of operation
- Large synchronous motors
- Starting methods
- High-megawatt compressor drives
- Very High Voltage motors
- References
- Summary

Total cost of operation (TCO)*

TCO includes:

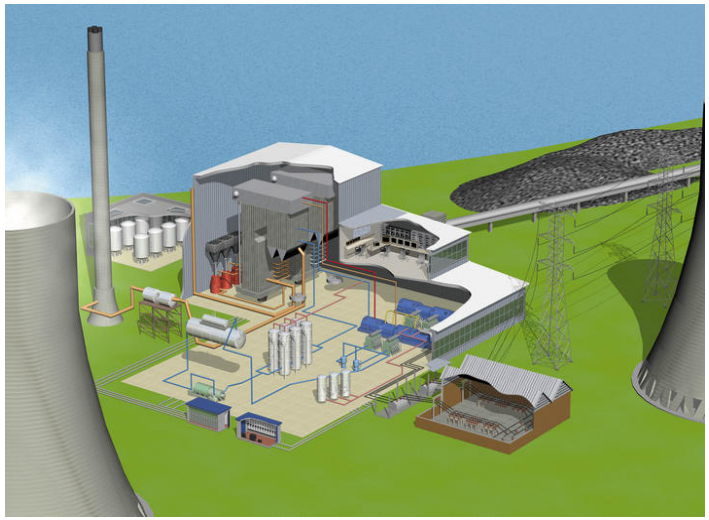
- Purchase price
- Specifications
- Transportation
- Storage
- QA
- Reliability
- Electricity
- Repairs
- Administration
- Inventory
- etc

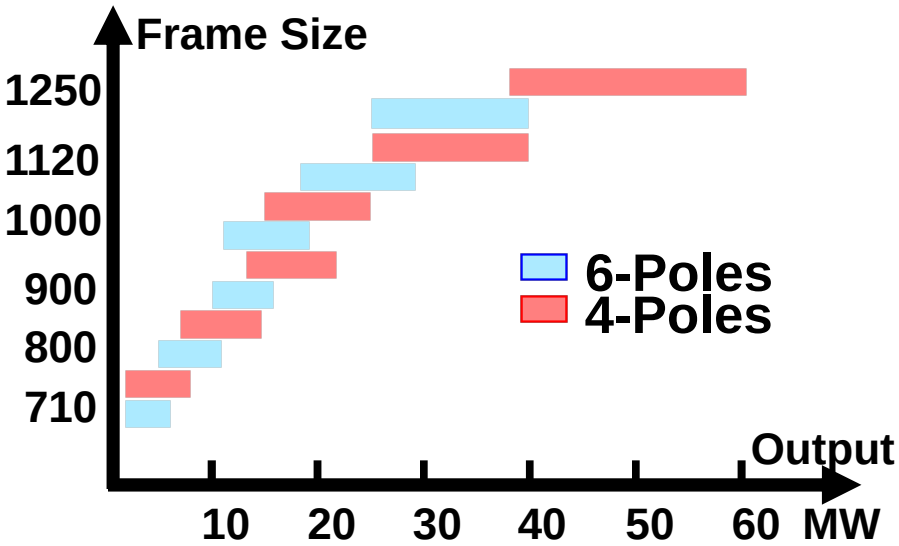


*Information provided by Machinemonitor based on survey of 6000 machines

Large Synchronous Motors

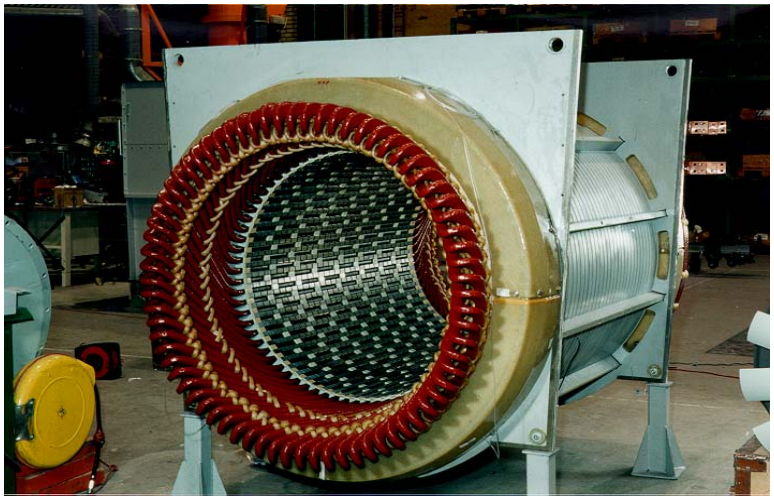
- 4-6 pole synchronous compressor motors
- 10 - 60 MW
- 3-150kV
- Efficiency >98%
- Direct on line or VSD/VFD applications

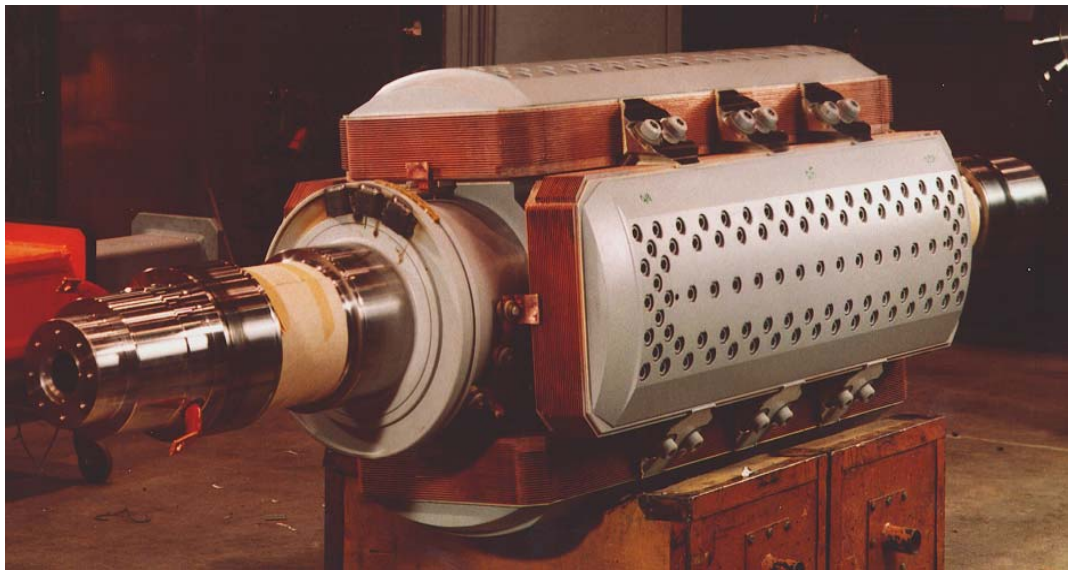




Synchronous Motor Concept

- Features
  - High efficiency
  - Low inrush current
  - Variable power factor
- Rotor design characteristics
  - Salient solid rotor
  - Forged shaft for heavy duty service
  - Brushless exciter



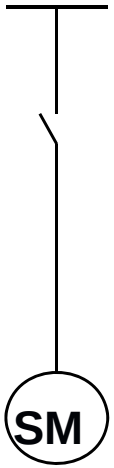


Considerations when Selecting Starting Method

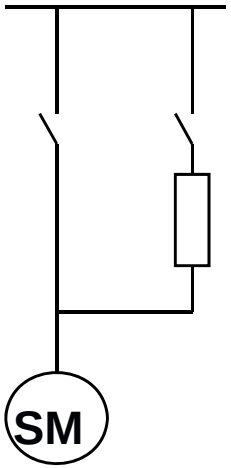
- Short circuit capacity on the network
- Maximum allowed voltage drop on the terminals during start
- Minimum starting torque to give a safe acceleration and synchronization for synchronous motors
- Maximum starting torque not to exceed the allowed shaft torque during start

Starting Methods:

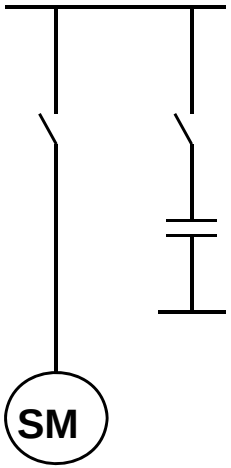
Direct on line starting



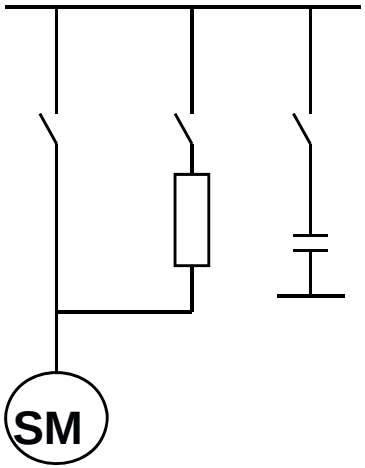
Reactor starting



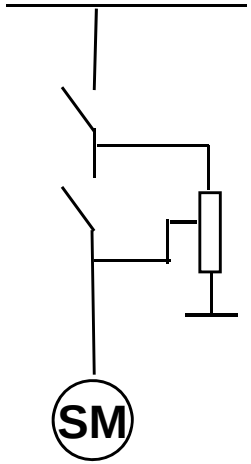
Capacitor starting

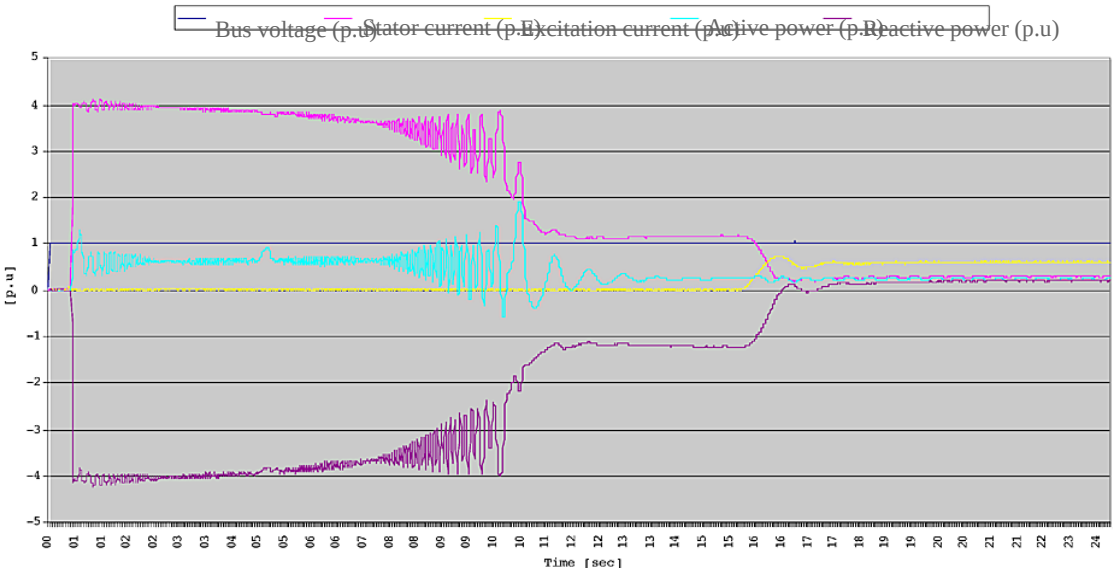


Reactor + capacitor starting

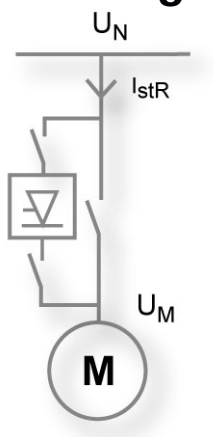


Transformer starting





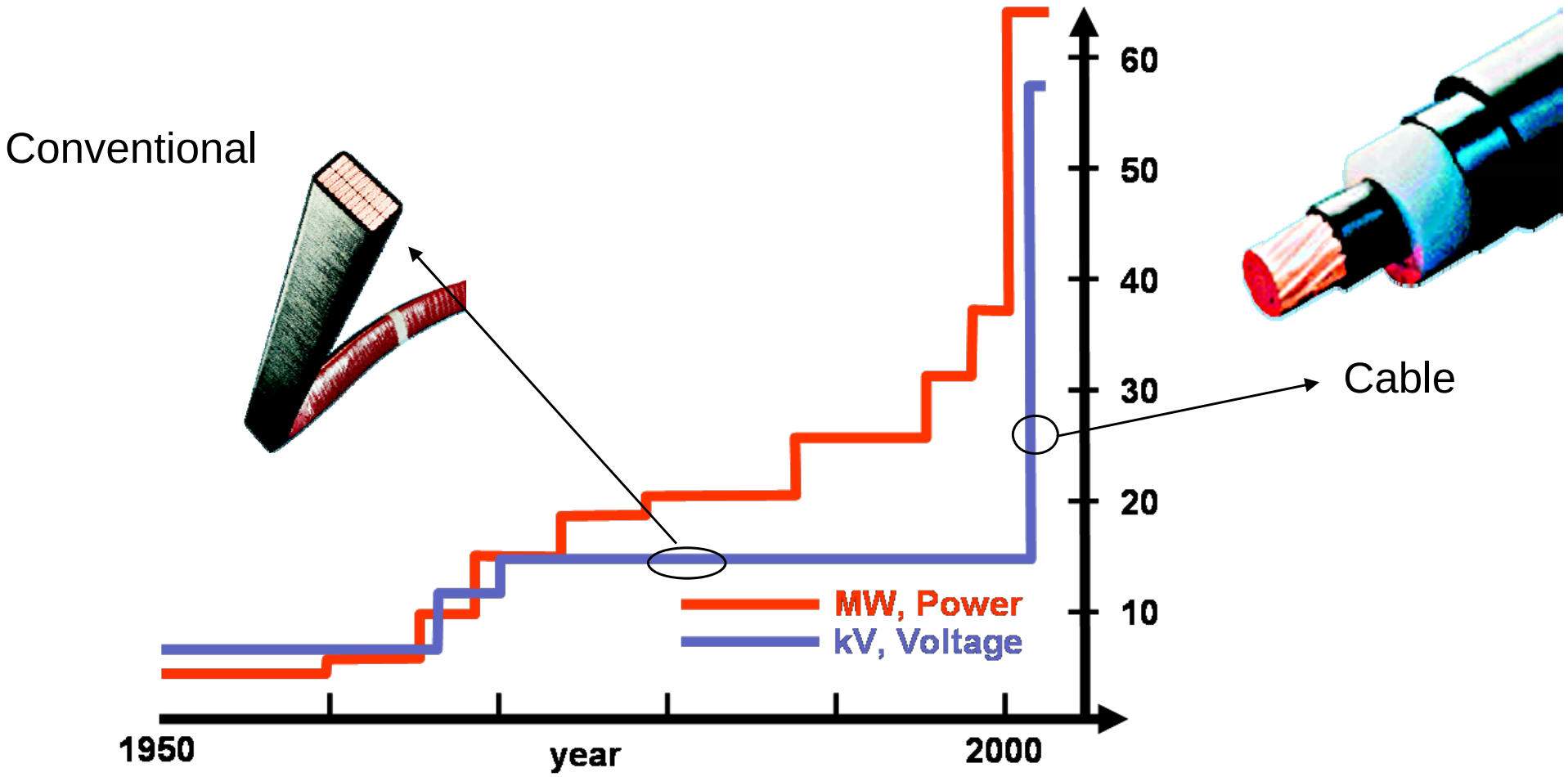
Frequency controlled starting



High-megawatt Compressor Motors

- +40 years experience driving large compressors
- Adaptable for harsh environments Hot, Cold, Hazardous Area
- Water cooled or Air cooled
- Suitable for multiple compressor applications Gas injection, Pipeline, Air separation, Gas oil separation etc.
- Pf control for weak network

Very High Voltage Machines



VHV Synchronous Machines - AMT

- Connection
  - Direct to high voltage grid
  - Variable speed with HVDC – light converter supply
- An innovation creating a brand new motor concept
  - Motorformer™ : 5 - 50 MW
  - 20 - 70 kV
- Eliminates the need for a transformer
- Higher total efficiency
- Less space than conventional installation

References

A selection of compressor motors >30MW.

Customer	No	User country	Starting	MW	Industry	Delivery
Linde	2	UAE	Soft start	59	Air Separation	2010
Air Liquide	2	South Africa	Soft start	55	Air Separation	2001
Statoil	2	Norway	HVDC	44	COG	2008
Wuhan steel works	3	China	Soft start	42	Metal (Blower)	2003
Linde	2	UAE	Soft start	40	Air Separation	2010
JSW	3	India	Soft start	40	Metal (Blower)	2007
Air Liquide	1	Italy	Soft start	40	Air Separation	2008
NIGC	2	Saudi Arabia	Soft start	35	COG	2003
BP	2	Azerbadjan	DOL	33	COG	2002
In Salah	2	Algeria	VSD	12	CO2	2001

Summary

- Synchronous 4-6 pole high-megawatt motors are commonly used for large compressors in air separation and various gas compression applications
- Highest installed power reference is 59 MW
- SM motors are a proven reliable compressor drive technology
- High efficiency is key to total cost optimization
- Very high voltage is a new technology opportunity

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