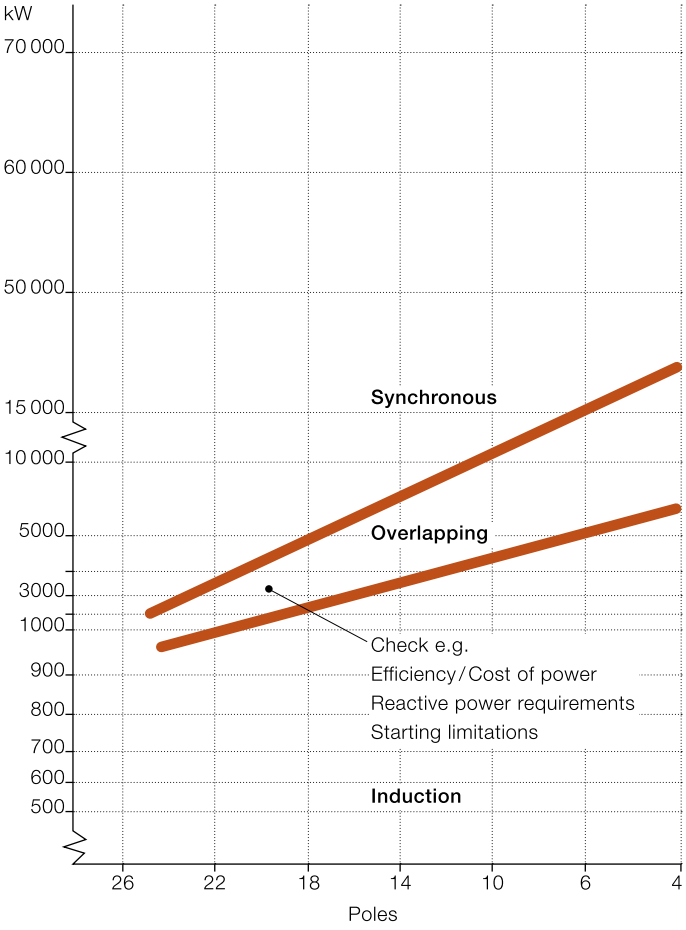
Technical note
Induction versus synchronous: how to select the right type of motor

ABB manufacturers a comprehensive range of induction and synchronous motors rated up to 60 MW.



Selection based on the speed-power ratio

In many applications, the requested speed-power ratio provides enough determination of which motor should be used. As a preliminary guideline, the diagram on the left hand side can be used. It must however be noted that the limit between induction and synchronous motors varies heavily due to the unique assumptions in each case. When in the overlapping area, certain parameters need to be looked into before the final selection is made. Below, these are described in more detail.

Efficiency, CO_2-omission and lifetime cost

The initial investment cost is higher for a synchronous motor but its higher efficiency and better reactive power performance mean that, depending on active and reactive energy prices, CO_2-omission, the overall lifetime cost is often lower than an induction motor.

Power factor and reactive power

If power factor control or reactive power compensation is needed, then a synchronous motor should be the main selection.

Network performance

In networks where high voltage drops are likely to occur, an induction motor should generally be selected to ensure stable operation during the high voltage drops. A synchronous motor can also be used but it is more sensitive to keep a stable operation. However, for both motor alternatives, certain design steps and checks need to be performed to ensure a stable operation.

In networks where a lot of inductive power is consumed, a synchronous motor is often beneficial.

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Comparison overview

Characteristics	Induction	Synchronous
Efficiency	High	Very high
Power factor (Note [1])	0.5-0.90 lagging	Possible to select (lagging - unity - leading)
Reactive power	Consumed	Note [2]
Rotor		
Rotation speed	Slower than electrical net, “slip”	Same speed as electrical net, “synchronous”
Load torque variation	Some speed variations due to load torque variations	Fixed speed, independent of load torque variations
Current in rotor	AC	DC
Magnetization	By induction	By exciter (fed from excitation panel)
Design	Laminated Squirrel cage or slipring	Salient poles - Solid (high speed) or laminated (slow speed) Brushless
Starting (slip = 1.0 p.u.)		
Current	Higher	Lower
Torque	Lower	Higher
Protection		
Motor protection	Yes	Yes + typical synchronous motor protections (e.g. out of step)

Notes:

[1] Power factor

– the power factor for an induction is always lagging and is depending on pole-numbers, the higher the pole-number, the lower the power factor
– the power factor for the synchronous is possible to design to “any value” but normally a power factor is selected in the range 1.0 - 0.8 leading, i.e. the motor produces reactive power to the net. A synchronous motor very seldom runs lagging.

[2] Reactive Power

– Lagging power factor: consumed
– Unity power factor: motor is neither consuming nor producing
– Leading power factor: produced

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