

Generator Service

Air-Cooled Footprint Generator

Tailor-made generator replacement concept

Generators operated for several decades can require extensive reconstruction measures due to normal aging of the main components, e.g. rotor and stator winding insulation.

After a certain age or degree of wear, careful consideration should be given to whether further investments in the generator are still profitable in the long term or whether a complete replacement is a more economic and viable option. Increased time and effort spent on maintenance and repair measures, outdated technology and materials, spare part procurement issues, as well as signs of aging and damage can all be strong arguments in favor of investing in a replacement solution.

Siemens has responded to these demands by introducing the Footprint™ generator concept offering a replacement of older, high maintenance water-, hydrogen- or aircooled generators by state-of-the-art air-cooled Siemens generators. Replacement hereby means design fitting according to existing foundation and interfaces to minimize reconstruction efforts.

Siemens offers custom-fit replacements of generators with an increased rated output power up to more than 370 MVA* based on an extended and proven air-cooled generator design.

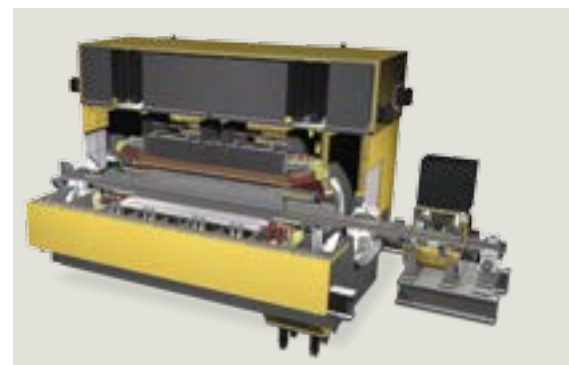
Our solution

In a joint effort, you and Siemens can find the best solution for your power plant by performing a comprehensive cost-benefit analysis. Siemens can then advise you of its recommendations whether to modernize or replace your generator.

In case of purchasing a new machine, the generator can either be replaced at a major overhaul, or the replacement generator can be individually adapted and implemented as a separate measure.

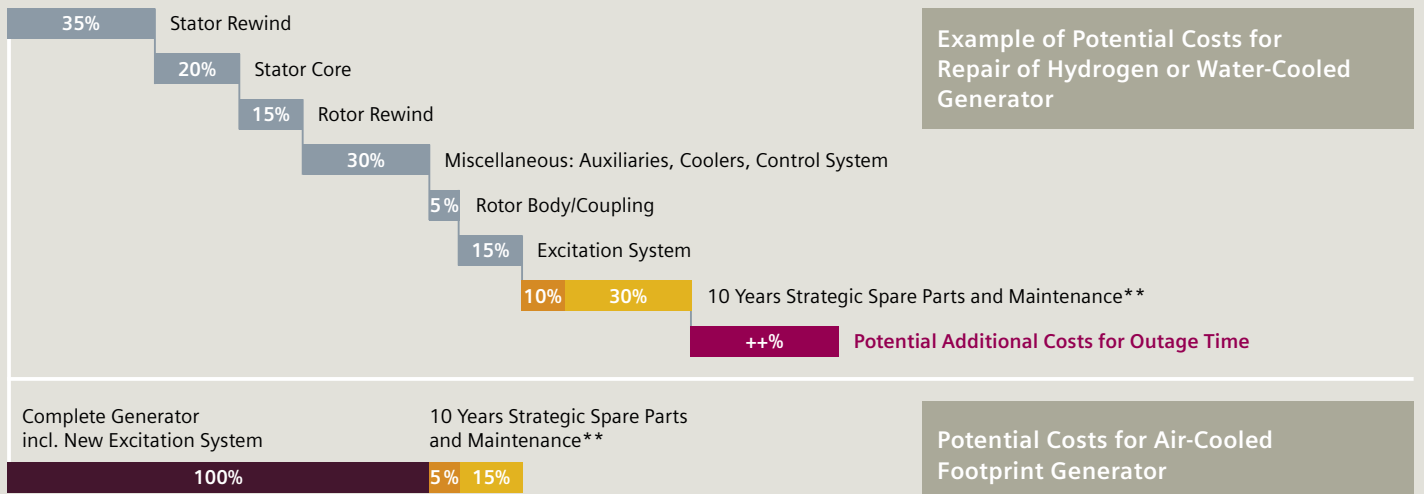
The implementation of the Footprint generator concept can lead to significant time and cost reductions in comparison to repair of an existing hydrogen (H₂) or water (H₂O)-cooled generator.

Prior to replacing the generator, Siemens performs a comprehensive and detailed analysis which can be supported by means of an on-site three-dimensional measurement for non-OEM units. History, current maintenance status, technical records and dimensional data as well as electrical parameters, such as power rating, efficiency, power factor, reactances and rated voltage are taken into consideration for the purpose of this analysis.



Footprint generator adapted to existing foundation

*at cooling gas temperature of 40° C according to IEC 60034



Example cost comparison of Footprint replacement vs. refurbishment of hydrogen or water-cooled generator (for information only – actual experience may vary)

Features

Siemens Footprint generators can be used in various types of power plants and configurations. They reach power ratings of up to more than 370 MVA and are designed for up to 10,000 start/stop cycles and according to IEC 60034 or GOST 533-2000 standard.

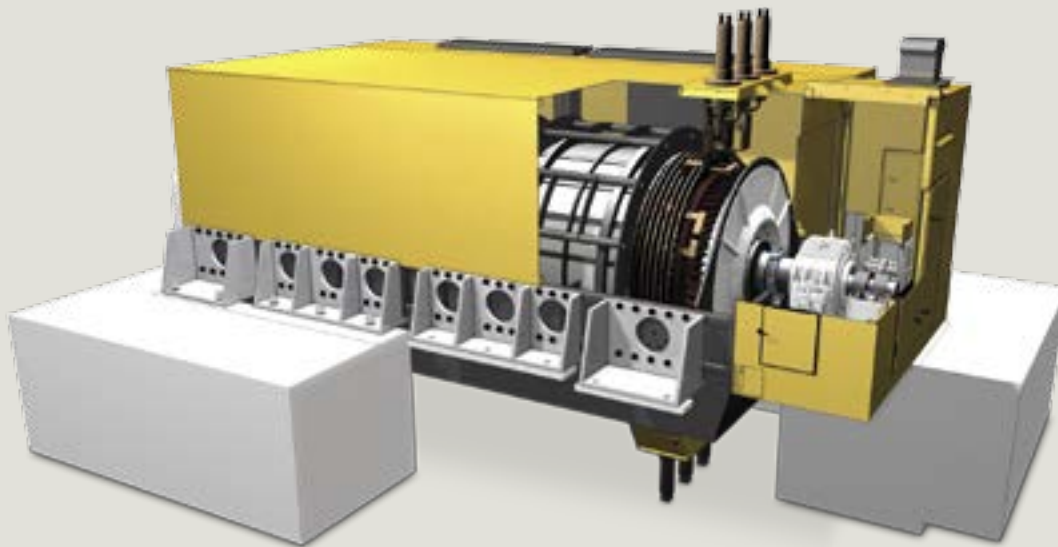
Due to its modular design concept, the air-cooled Footprint generator can be tailored to fit into the existing plant configuration. This concept can allow for an efficient and individual adaptation of the new generator to local site conditions and has already been successfully in use for years.

The existing foundation and electrical connections can remain in use and the axial shaft center height maintained.

Furthermore, the amount of existing high-maintenance auxiliaries can be reduced if an aging water- or hydro-cooled generator is replaced by an air-cooled machine, thus eliminating the need to replace or service this auxiliary equipment.

	Hydrogen-/Water-Cooling	Air-Cooling	Benefits of Air-Cooling
Auxiliaries	<ul style="list-style-type: none"> Multiple different systems such as seal oil, gas supply, water system, exhaust system 	<ul style="list-style-type: none"> No such auxiliary systems 	<ul style="list-style-type: none"> Lower overall investment
Generator Design	<ul style="list-style-type: none"> H₂ seal Pressure vessel similar design Water-cooled stator bars 	<ul style="list-style-type: none"> Design to purpose: air 	<ul style="list-style-type: none"> Lower overall investment
Reliability	<ul style="list-style-type: none"> Multiple active systems 	<ul style="list-style-type: none"> Active systems reduced to one cooling system 	<ul style="list-style-type: none"> Reduction in complexity can improve reliability
Operational Costs	<ul style="list-style-type: none"> H₂ consumption Filter consumption Purge gas consumption More systems, therefore, more maintenance required Special features needed for safe H₂ handling 	<ul style="list-style-type: none"> Lower maintenance by use of GVPI as pulling of rotor during a major overhaul may not be required 	<ul style="list-style-type: none"> Typically less maintenance and life cycle costs No special features needed for H₂ considerations

Potential benefits of air-cooled generators vs. aging generators with H₂/H₂O cooling



Customized Footprint generator with lateral cooler

Siemens Footprint generators include the following design features:

Patented rotor cooling system

The optimal distribution of the cooling air in connection with an optimal heat transfer in the rotor winding leads to a more uniform temperature distribution in the rotor, which in turn can increase efficiency.

Patented outer corona protection system

The multiple-layer outer corona protection of the stator winding is designed for a more reliable and durable insulation system.

Proven MICALASTIC® stator insulation

The proven epoxy-mica insulation system in global vacuum pressure impregnation technology (GVPI) can enable reliable stator operation, even at some extreme temperatures and under some adverse ambient conditions while keeping the scope of required maintenance low.

Optimized vibration behavior

The design of the stator end winding has been optimized to help minimize vibration levels during operation and damage to the insulating components.

Adapted excitation system

The excitation system can be offered as a static or brushless system, depending on customer requirements. In the case of generator replacement it is recommended to replace the existing exciter by a state-of-the-art design, lower-maintenance brushless excitation system.

Solid base frame

The frame of the replacement generator can be adapted to many existing foundations. It can be supplied in a completely assembled state which can lead to a significant reduction of installation time in the field.

Flexible cooling system

Various cooling system configurations are available for the Footprint generator: A totally enclosed water-to-air cooling system (TEWAC), a direct open air cooling system (OAC) with air supplied through a filter or a totally enclosed air-to-air cooling system (TEAAC). The cooling system can be positioned flexibly (e.g. on the top or lateral) – depending on site conditions.

Flexible position of generator leads

The generator lead box can be designed as a side, top or bottom-mounted assembly.

Flexible bearing designs

Multiple bearing designs available supporting adaption of machine length and different oil interface positioning.

Country	Frequency	Prior Generator OEM	Rated Output (MVA)
USA	60 Hz	Alstom	240
Czech Republic	50 Hz	Skoda	235.30
Finland	50 Hz	BBC	208.59
France	50 Hz	Jeumont-Schneider	200
South Africa	50 Hz	AEG	139
South Africa	50 Hz	Alstom	139
Taiwan	60 Hz	Brush	106.30
Taiwan	60 Hz	GEC Alsthom	73.80
Germany	50 Hz	KWU	55
Germany	50 Hz	Siemens-Schuckert	32
Taiwan	60 Hz	AEG/LDW	25
South Korea	60 Hz	LDW	18.04

Examples of executed Footprint generator projects

Your benefits

Siemens' tailor-made generator replacement concept can offer the following advantages:

- Opportunity to increase the efficiency of your power plant
- World-class generator efficiency up to 98.8%
- Higher rated power possible in many cases
- Foundation is typically not changed.
- 3D measurement possible for non-OEM replacements
- Outage time can be determined more precisely and can, in certain cases, be significantly shorter than for a partial modernization.
- Risk of finding unexpected signs of aging or damage in the existing generator, and the associated costs, can be reduced.
- Potential of a longer generator service life
- Operating and maintenance costs can be reduced in many cases.

If you decide on a new air-cooled Footprint generator, you can benefit from:

- Latest Siemens technology
- Potential reduction of scheduled maintenance outage duration of up to 40% at an average for air-cooled compared to hydrogen-cooled generators
- Increased reliability due to less auxiliaries
- More reliable spare parts supply
- Comprehensive and customized service contracts
- Continuous updates about further product developments, maintenance and upgrades

References

More than 1,000 Siemens air-cooled generators are already in operation worldwide.

The Footprint generator concept has been successfully implemented in several power plants regardless of the original manufacturer (see examples).

More detailed information on the Siemens Footprint generator concept is available in our Footprint generator animation.

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