marine.danfoss.com

ENGINEERING
TOMORROW

Danfoss

With **generators on board,** why supply **land-based power?**

#DanfossMarinePro

VLT® | VACON®

Meeting **emission targets**

Berthed vessels can generate their own electric power on board. So, what's the incentive for the harbor to supply shore power?

Well, it comes down to climate change and local emission reduction in the port. By connecting to shore power whilst berthed, vessels can shut down their auxiliary generators completely.

This means the air in port is free of emissions from ships' generators. Shore power supply ensures not only clean air to breathe and a noise-free environment, it also helps the port meet IMO emission targets.

You might already know shore power supply by another name: cold ironing, shore connection, shore-to-ship power, on-shore power supply, alternative maritime power, or shore side electricity (SSE).

No matter what the label, the system provides the same service: it supplies vessels with power at exactly the voltage and frequency they require, whilst berthed.

It does this by converting power from the mains supply at 50 Hz, to a 60 Hz supply which is compatible with the individual ship's grid. In some parts of the world, the conversion is from 60 Hz mains supply to 50 Hz for the ship's grid.

What makes **shore supply** so useful?

As a harbor welcoming many vessels annually, there are several good reasons to offer shore power to visiting vessels. Firstly, port authorities can reduce the emission level in the harbor since vessels can power their hotel load on shore-supplied electricity rather than running an auxiliary generator on board[1].

Shipyards which previously supplied shore power from diesel gensets can instead supply power from the mains supply, eliminating genset fuel consumption and maintenance costs[2]. And by no longer running generators on board or on shore, noise and vibrations are dramatically reduced, introducing peace and calm to the harbor. In many harbors, emission regulations and local noise limits mean that shore supply is not just a nicety.

The IMO's general emission limits, created with the aim of meeting COP24 emission targets, are even more stringent in designated emission control areas known as ECAs. Shore supply is already mandatory in US West Coast and developing in Asian countries[3].

Even without regulation, in other harbors the local port authorities shoulder the environmental responsibility and take action faster than politicians to make their contribution to reaching the COP24 goals.

For these reasons, in 2020 it is predicted that the European potential for shore supply will be as great as 3543 GWh/a, the equivalent of 800,000 tons of CO2 emissions[4]. Barcelona, Gothenburg, Marseille, Athens, Helsinki, Antwerp and Rome are all examples of port areas with high demand.

[1] A typical berthed rig at Coast Center Base in Bergen has reduced its emissions by 10-15 t daily by converting to shore power supply.

[2] By converting from diesel-powered to mains-powered shore supply, the FAYARD shipyard in Odense, Denmark achieved ROI in only two months.

[3] Shore Side Electricity, T&D Europe Task Force Harbours - Communication Package Rev 2, 24 August 2015.

[4] Potential for Shore Side Electricity in Europe, Ecofys by order of European Commission DG Climate, 2015.

What about **shore supply** in the **years ahead?**

In the future we envisage that shore supply will also support other power-hungry vessels whilst in port, for example container ships. A single refrigerated container uses approximately 5 kW power to stay cool. Scaling this up to a whole deck full, it's easy to see there is great potential for emission reduction by using shore supply to cool these reefer containers whilst berthed.

Electrification is a global megatrend where city transport, industrial processes and heating and cooling of buildings in the future will be powered by electricity generated from CO2 neutral renewable sources. This is part of the global transition of the energy sector towards fossil free energy. The global electricity generation capacity is expected to double or triple by 2050. Shore power supplies are important elements in the journey towards electrification of the transport sector.

What does a **shore supply system** look like?

Figure 1: *The shore supply system is mounted in a container and supply cables enter the ship's hull.*

Shore supply delivers power to any vessel with its own AC grid on board, be it a conventional vessel powered by fossil fuels, hybrid-powered vessel, or fully-electric battery powered vessel.

Usually the shore supply system is built into a container located on the harbor front (see Figure 1). Cables run to the ship with a connector for safe manual connection to the ship's grid.

A typical shore supply system is scaled at 1 – 2 MW, to suit the size of vessel. Generally, the vessels connecting to shore supply are ferries, supply vessels, and commercial vessels. Shore supply also caters for cruise ship hotel load during the daytime, and recharging of batteries for ferries, night or day. For example, in development of the Kai Tak Cruise Terminal in Hong Kong it was estimated that in 2015, 8% of visiting cruise ships would be equipped to connect to shore supply[5], and this capacity continues to grow with new vessels generally being prepared for shore supply. Ferry operators charging their batteries at night from a shore supply system gain the benefits of off-peak power rates – a useful extra saving[6].

[5] Feasibility Study and Preliminary Design of the On-shore Power System for the Kai Tak Cruise Terminal, EMSD, June 2015.
[6] CMAL ferries in Scotland have improved their economy by retrofitting ferries to battery power and recharging at off-peak night-time rates.

Design **considerations**

When designing a shore supply system, these are the factors to take into consideration.

On the shore side, there are restrictions on harmonics which disturb the power supply, as well as voltage and frequency, and amount of power available. The power conversion equipment must be designed to meet these restrictions and still deliver a reliable supply to the ship.

On the ship side, some of the same considerations apply: the power demand and the voltage and frequency of power supply must meet the requirements of the ship's grid. On the ship side the designer also needs to take into consideration the short circuit current feed, paralleling with diesel generator sets, synchronizing, load types and network grounding.

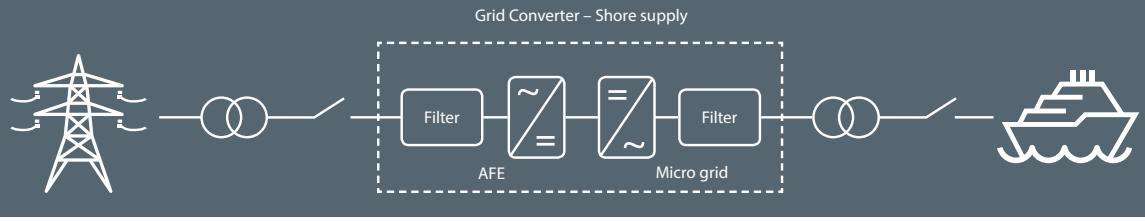

Figure 2: *Schematic diagram of shore-to-ship power supply system.*

What function does the inverter perform?

The inverter is the key component which performs the power conversion from 50 Hz land supply to the 60 Hz ship supply (or 60 Hz land supply to 50 Hz ship supply). The inverter is also responsible for ensuring synchronization with the ship's grid for seamless and unnoticeable switch to and from shore supply.

An important function of the inverter is also to ensure no harmonic disturbance. to the mains power supply when supplying the ship grids from shore supply.

Shore supply from **Danfoss Drives**

With an installed base of more than 45 MW distributed over 90 + installations in Europe, Asia, and South America, we can offer you world-class technical excellence in power conversion systems. But this is only the beginning.

When developing a shore supply system, we offer you not only extensive experience and unique product offerings. We also share our drives know-how with you during the planning, design and installation phases, to ensure the system is optimized to suit your needs exactly. Then once the system is installed we continue to provide 24/7 DrivePro® support services to ensure it runs optimally throughout its lifetime, no matter where your location around the globe.

Power conversion products

VACON® NXP Grid Converter ensures a totally smooth synchronization to the ship's grid so there is no interruption to services on board during the switchover to or from shore power. Figure 3 illustrates a shore supply system based on the VACON® NXP Grid Converter.

The modular concept of these inverters enables you to scale the system to fit the requirements exactly. To extend the capacity of the system, connect additional drives in parallel. The largest system designed to date is rated 8 MW. Active front-end variants, options and accessories are available to mitigate any potential for harmonic disturbances. These measures ensure equipment protection and no interruptions to the mains power supply.

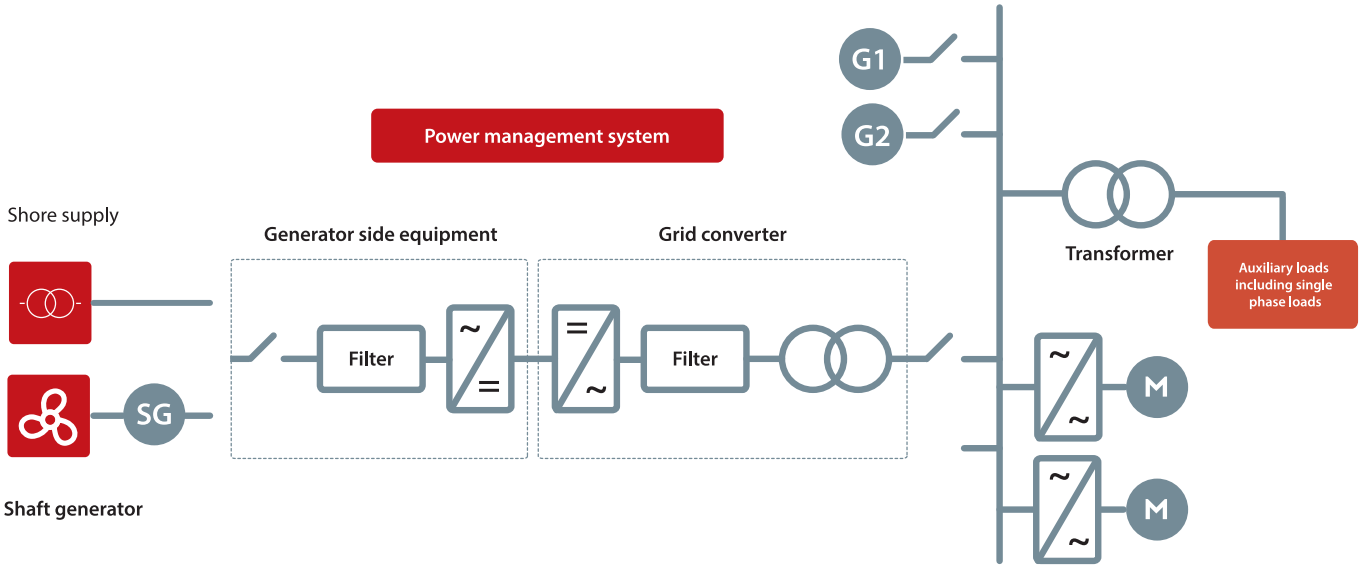

Figure 3: *Example of a power conversion configuration for a shore to ship power supply system, showing the contribution of VACON® NXP Grid Converter inverters, which are available in Active Front-end and MicroGrid variants.*

Shore supply **FAQ**

Q: Isn't the shore supply just transferring power generation by ship's diesel from the harbor to a coal power station 100 km away? The resultant emissions must be the same.

A: In all countries non-fossil fuel power generation is increasing rapidly. Often shore supplies are powered by renewable and non-fossil sources, generally to minimize distribution losses.

Q: The cost of power from the shore supply is competing against the cost of ship's diesel which is tax-free fuel on world market, so doesn't this make shore power commercially uncompetitive?

A: Power to shore supply should also be tax-free. The energy legislations in many countries such as Norway and Denmark is already moving in this direction, and this trend is accelerating.

Q: There are no standards for shore supply voltage or connector type, so as a port authority how do I know what to design for – and that my installation won't be obsolete in a few years' time?

A: Here the market demand has raced ahead of the regulators. However active standards exist, for example:

- IEC/ISO/IEEE 80005-1 Utility Connection in Ports for high-voltage systems
- IEC/PAS 80005-3 Low voltage shore connection systems-General requirements.

More standards have also emerged, for example for power supply to cruise ships. Danfoss Drives is active in sharing its experience in the standards community.

Q: Infrastructure is inadequate and access to high-voltage power is not available in my harbor, so how can I operate shore supply?

A: National transmission system operators (TSO) are increasingly considering regional power transmission optimization in development of new harbors and industrial parks. Danfoss Drives can advise on this optimization to meet the requirements of shore supply systems.

Q: My ship design is not suited to shore supply, so how can I connect?

A: We can help ship owners to retrofit the ship's electrical grid, suitable for using shore supply systems.

A better tomorrow is **driven by drives**

Danfoss Drives is a world leader in variable speed control of electric motors.
We offer you unparalleled competitive edge through quality, application-optimized products and a comprehensive range of product lifecycle services.

You can rely on us to share your goals. Striving for the best possible performance in your applications is our focus. We achieve this by providing the innovative products and application know-how required to optimize efficiency, enhance usability, and reduce complexity.

From supplying individual drive components to planning and delivering complete drive systems; our experts are ready to support you all the way.

You will find it easy to do business with us. Online, and locally in more than 50 countries, our experts are never far away, reacting fast when you need them.

You gain the benefit of decades of experience, since 1968. Our low voltage and medium-voltage AC drives are used with all major motor brands and technologies in power sizes from small to large.

Contact us

Contact your local Danfoss experts here
Learn more about shore supply here

Follow us and learn more about AC drives

VLT® | VACON®

DKDD.PM.417.A2.02