

MARINE

Compact and efficient energy conversion

Integrate any load and source on any ship with the iE Convert range



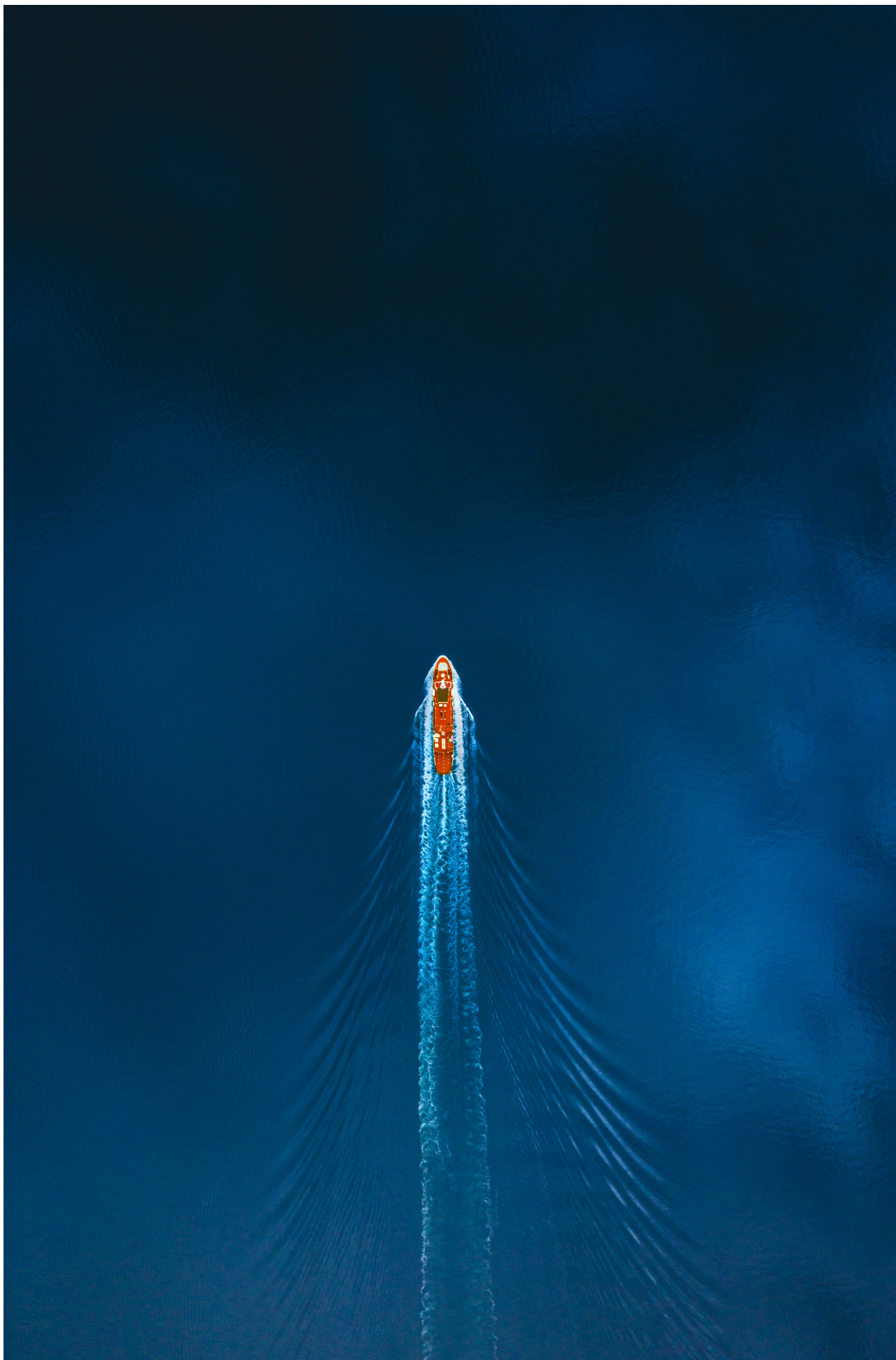
Improve
Tomorrow

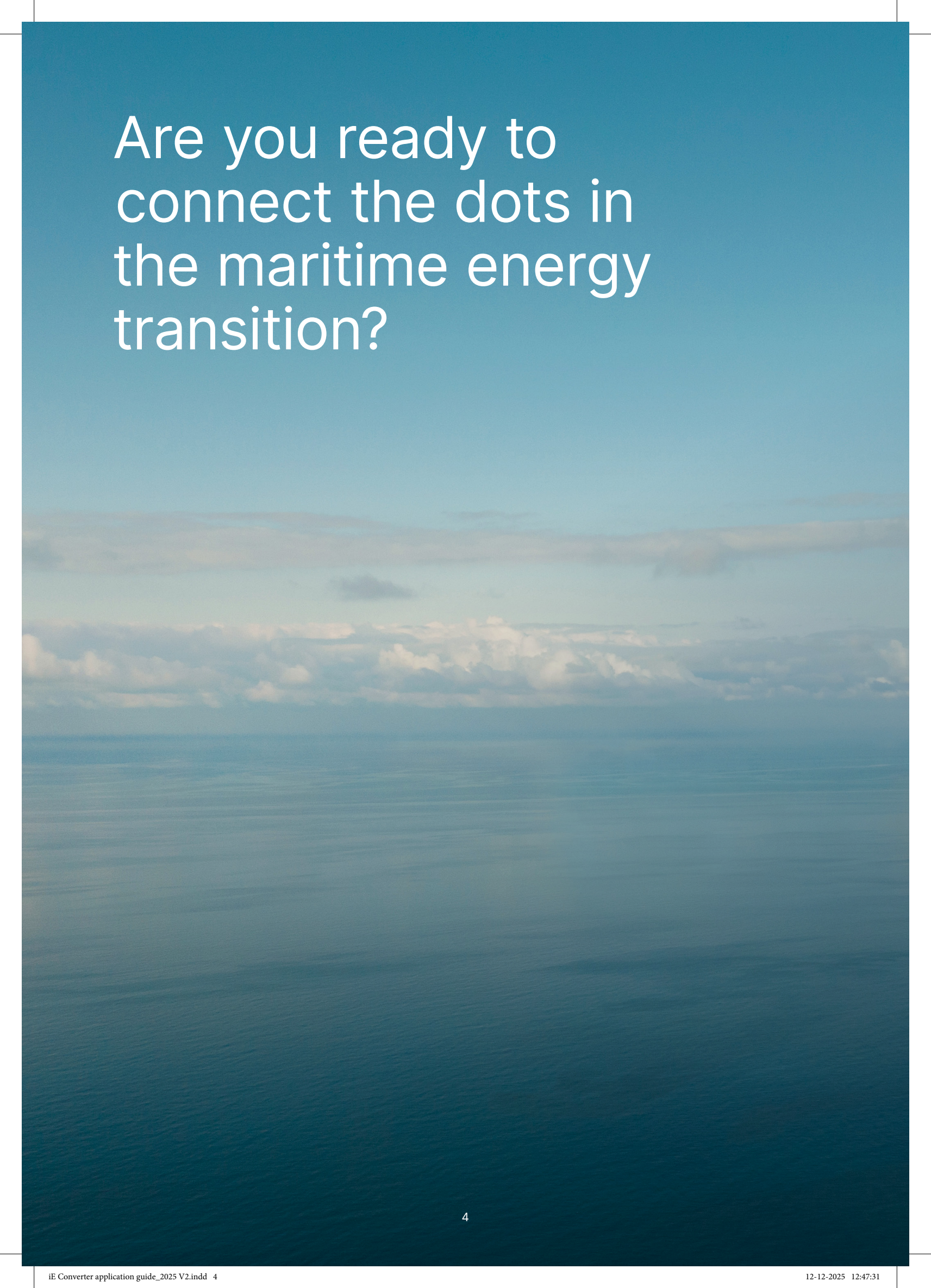
APPLICATION GUIDE




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Are you ready to
connect the dots in
the maritime energy
transition?



All over the world, the maritime industry is moving to reduce its climate impact by cutting carbon emissions from ships. Designers, shipbuilders, and owners are installing batteries, shore power connections, and fuel cells on new and existing vessels, and finding other ways to improve energy efficiency and reduce emissions in port and at sea.

One major challenge in the combination of renewables, storage, and fossil energy sources is that sources and loads often use different voltages, frequencies, and current types. This makes it difficult to combine them into systems that ensure uninterrupted power and consistently safe operation.

This combination is exactly what the DEIF iE Convert range

helps you achieve, from flexible shore connection solutions and efficient electric propulsion to fuel cell solutions with built-in galvanic isolation. The DEIF iE Convert offers best-in-class efficiency, great flexibility, a very compact footprint, and control options that can include cybersecurity and control redundancy if needed. And with DEIF's complete range of devices for supervision, measurement, control, automation, and protection, you can get everything you need to build an energy solution customised to your exact requirements.

We help you connect the dots between all loads and sources on any ship so you can reap efficiency benefits and reduce carbon emissions. This application guide shows how you can do it.

What is the iE Convert range?

Electricity from any source
for any purpose on any ship

The DEIF iE Convert range is a series of power converters that handles a wide range of conversion tasks. You can use the devices as inverters, rectifiers, frequency converters, buck/boost converters, and transformers to convert electricity from any source for any purpose on any ship.

Compact and efficient

The compact iE Convert range delivers high performance because it is based on silicon carbide (SiC) semiconductor MOSFET technology instead of silicon IGBTs. This gives the iE Convert range much higher switching frequencies, and the ability to withstand much higher temperatures, than comparable silicon IGBT designs.

Wide capacity range

With the iE Convert, you can cover any capacity requirement from 60 kVA to 6 MVA: You can combine up to eight iE Convert devices of the same size to get the performance you need. They are bi-directional, giving you great flexibility in your applications, and each device comes as a fully integrated, liquid-cooled module that you can quickly integrate in your solution.

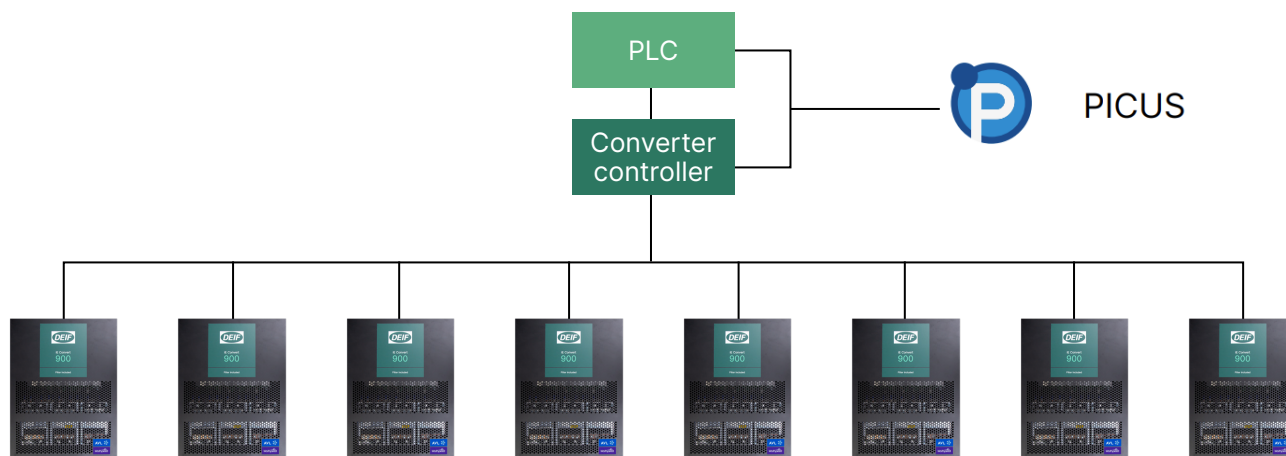
Built-in filters and galvanic isolation

All iE Convert modules come with the necessary filters built in so additional filters will only rarely be necessary. In addition, you can specify iE Convert DC//DC converters with built-in galvanic isolation, making them ideal for integrating fuel cells and for other applications where you need to isolate electrical equipment.

Key iE Convert specs

- Power losses: <1%
- Switching frequency: upto 100kHz
- Capacity: 60 kVA to 6MVA

Explore detailed
specs, approvals,
and certifications



iE Convert Variants	Capacity (KVA)	Size (H*D*W)cm			Volum (liters)	Weight (kg)
AC/DC, DC/AC drive, DC/DC	125	48	48	12	27	40
AC/DC, DC/AC drive, DC/DC	500	92	25	70	161	150
AC/DC, DC/AC drive, DC/DC	900	92	35	70	225	200
DC//DC GI	60 & 125	40	55	27	59	60
DC//DC GI	500	127	25	70	222	200

Silicon carbide (SiC) is ...

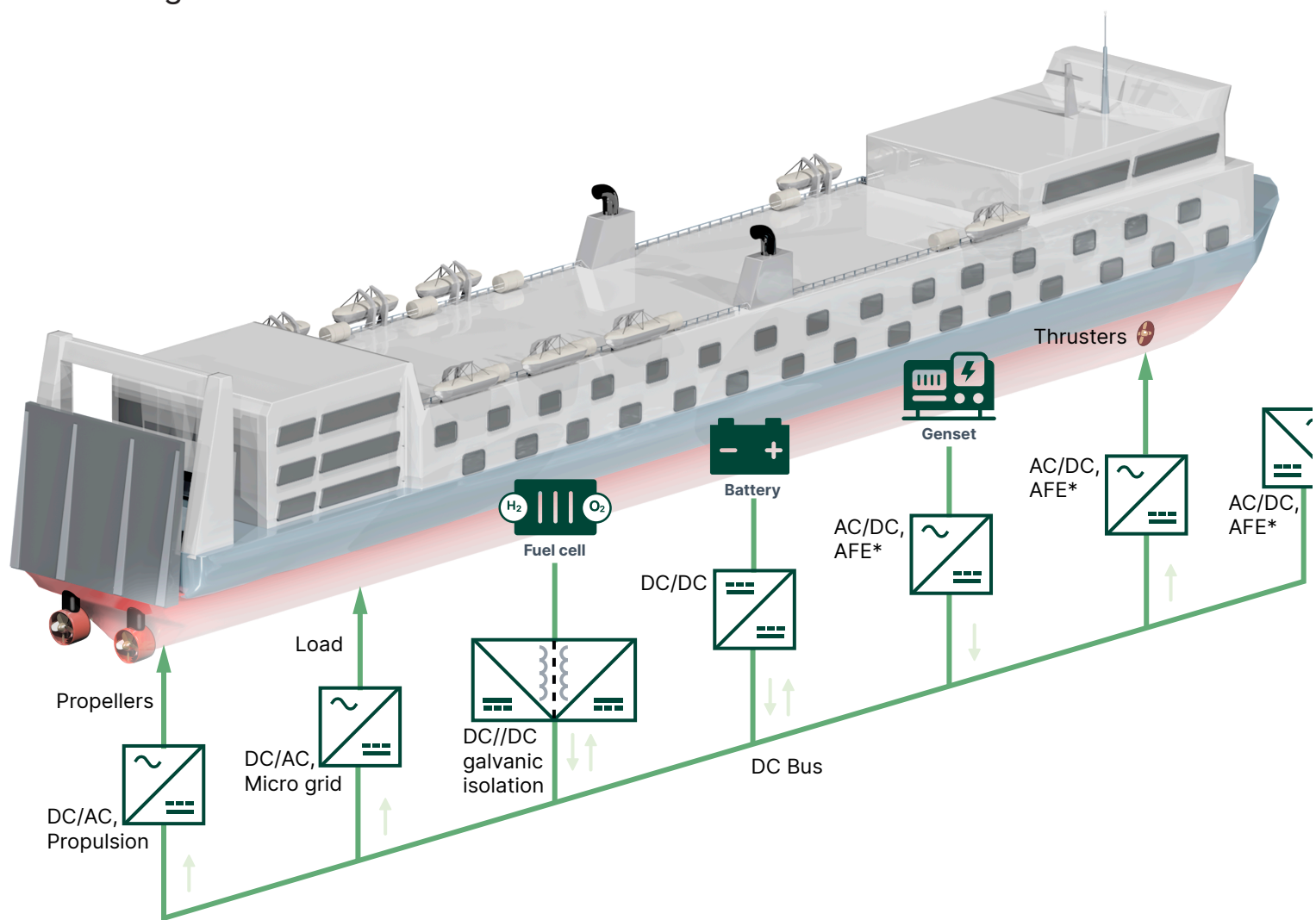
... a chemical compound which contains silicon and carbon. When used as a semiconductor, it can enable fast switching and reduce switching losses.

Combining the best with the best

The iE Convert range combines the technology, manufacturing, and application expertise of DEIF and our partners AVL (a world-leading mobility technology company) and Wolfspeed (a market leader in the worldwide adoption of silicon carbide technologies).

Key benefits of the iE Convert range

Helping you overcome key challenges in marine electrification



* Active Front End



FLEXIBLE

You can design solutions that work anywhere

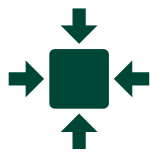
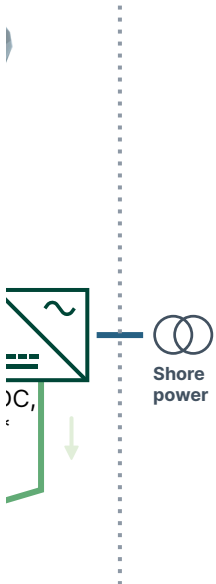
The bidirectional iE Convert will work with AC and DC and a wide range of input voltages and frequencies. It will operate from -20 to +60 degrees celsius, making it ideal for matching energy requirements on ships all over the world, no matter how they are built, or where they are bound.



EFFICIENT

You get maximum efficiency at system level

iE Convert devices can achieve high switching frequencies that transform electrical energy very efficiently with little energy lost as heat. You can achieve this high efficiency at different load levels and maximise output, minimise cooling, and drive down energy consumption.



COMPACT

You can save space and weight

An iE Convert gives you 60% more space in your switchboard. It weighs only 30 to 40% of a typical IGBT design, and you will rarely need external filters to condition output energy to meet grid regulations or equipment requirements – all of which is great news when your solution needs to fit in a confined space.



SAFE & SECURE

You can protect vessels, equipment, and crews

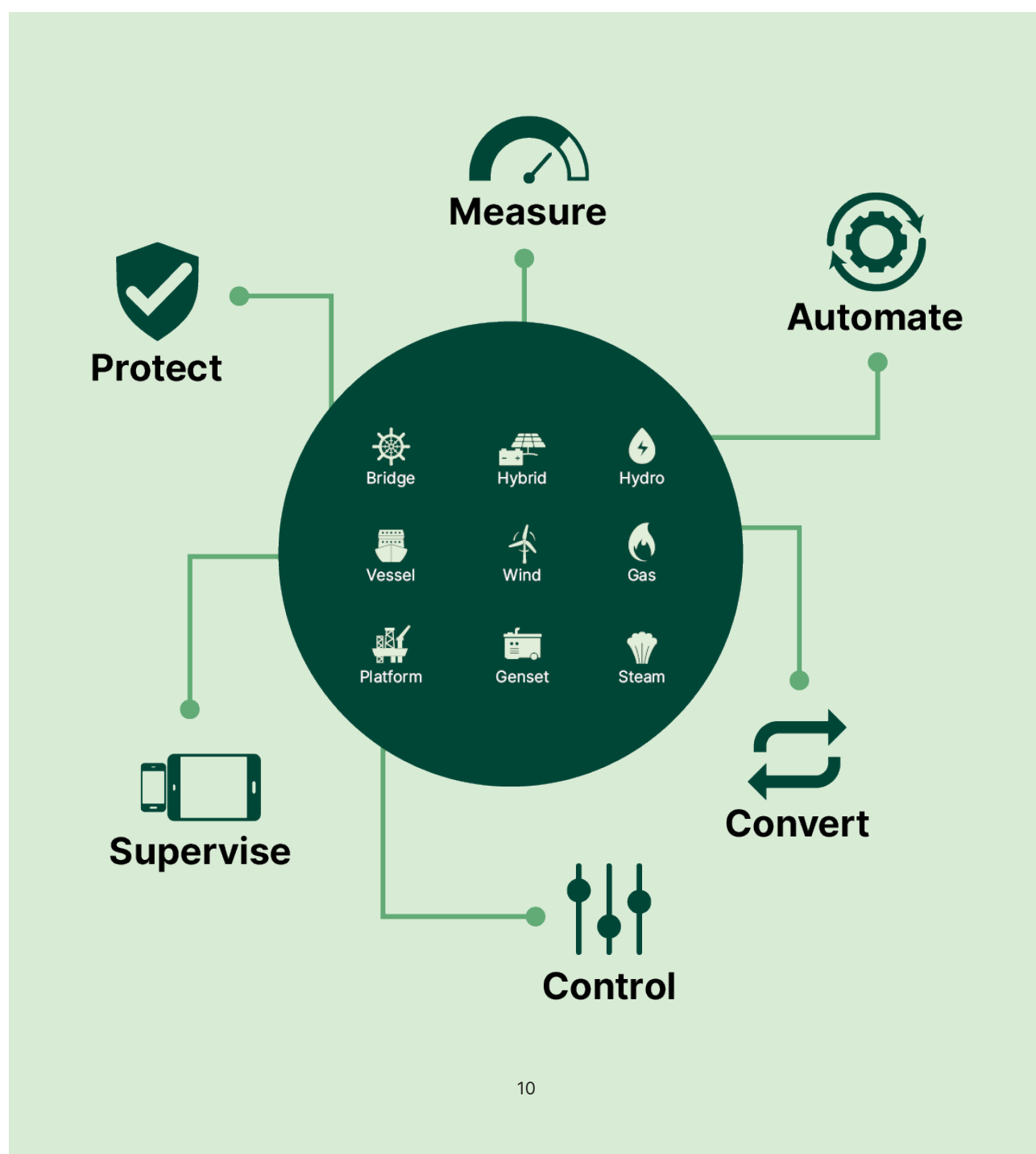
The built-in filters and galvanic isolation of the iE Convert help you protect sensitive equipment from stray currents and keep systems stable. And we offer application controllers which provide advanced cybersecurity features that have been DNV certified for compliance with IACS UR E27.

Why DEIF?

Build the ecosystem you need with DEIF

DEIF can supply all the devices you need for your energy control and conversion solution. From converters, interfaces, and meters to controllers, automation PLCs, and protection relays, we have what you need to design and build an ecosystem that fulfils your exact requirements.

When you do business with us, you benefit from decades of experience with energy control. We know that good advice, rapid support, efficient logistics, and working with a solid partner are as important as reliable devices when you are looking to design future-proof solutions.





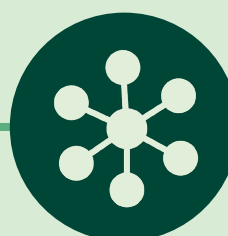
From product offerings and solution designs to annual reports and the latest company news, you can learn much more about us.

Four great reasons to work with DEIF

DEIF devices help you get the job done. Here are some of the key benefits that make it happen.

Your global one-stop solution partner:

DEIF offers everything you need to design a complete energy control solution, from cybersecure controllers and meters to after-sales support. And you can easily place your orders online or through our subsidiaries, distributors, and sales partners worldwide.



On-time delivery and global support:

With DEIF, you get your devices on time. We can meet your volume demands, no matter where you need your devices, and we ship standard products in less than seven days. Globally, 98% of all our deliveries are on time, and we offer flexible and fast on-site service and support all over the world.





Proven reliability in tough conditions:

Our devices are known for reliability, and the iE Convert is no exception. We test all our products to ensure they will always keep working, even in extreme temperatures and high humidity, and during powerful vibrations or electromagnetic disturbances.



Test Facility

Expert training and free online content:

Our regional DEIF Academy training centres offer hands-on expert training so you can make the most of your DEIF devices. And [deif.com](https://www.deif.com) offers free case studies, blog posts, webinars, application guides, and more on topics ranging from successful applications to industry trends.



Propeller and thruster control with DC/AC AFE drive

Accurate and energy-efficient electric propulsion control

You can use an iE Convert configured as a variable-speed DC/AC drive to control electric propellers and thrusters. The compact iE Convert saves valuable space, leaving more room for other equipment and giving you the freedom to design the hybrid propulsion solution you need and achieve accurate and reliable control of propellers and thrusters on any type of ship.

Electric propellers and thrusters are energy-efficient, respond quickly and accurately to control changes on the bridge, and generate little noise and few vibrations on board. As a result, you can save fuel, optimise manoeuvrability, and increase crew and passenger comfort. And because propulsion power can come from a wide range of energy sources, electric propulsion lends itself to flexible hybrid and fully electric vessel designs.

Efficient and accurate control

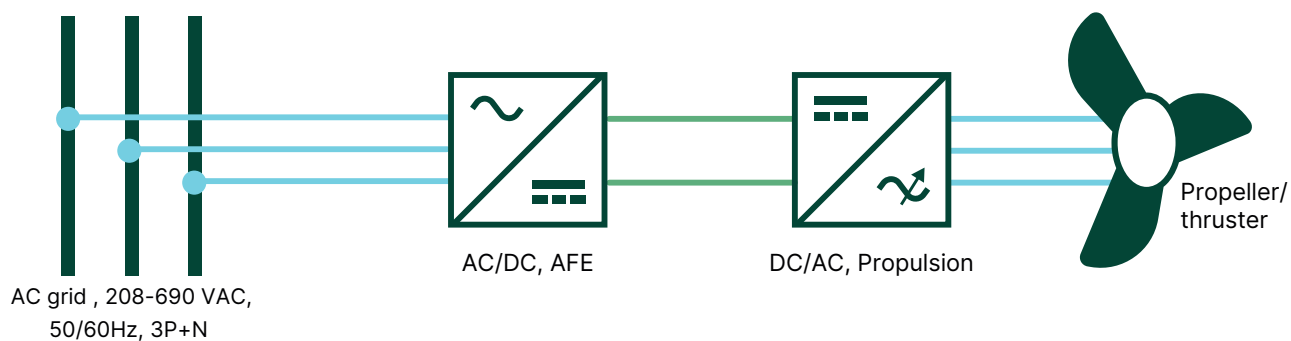
The iE Convert drive instantly regulates the AC voltage and frequency supply to the motors so the ship reacts quickly to course and speed changes. On ships with azimuth thrusters, you can use an iE Convert to control the motors regulating thruster angle, providing accurate and quick course corrections.

In both cases, the AC power from the iE Convert drive is virtually free of harmonics and other electrical disturbances, protecting the motor and contributing to reliable and accurate motor control.

Flexible hybrid solutions

The drive can supply AC propulsion power directly from a BESS or fuel cell, or from a DC bus. If the ship has an AC bus, simply install an iE Convert AC/DC converter in front of the DC/AC drive.

Our DC/AC drive is an active front end (AFE) design which lets you recover braking energy from the propeller or thruster, return it to the source, and increase system efficiency by reducing the need for energy generation on board. You can also use the iE Convert to integrate a shaft generator and design PTO, PTI, and PTH solutions. For more information, [see page 16](#).



Nominal capacity(kVA)	Max. DC voltage	DC link voltages (VDC)			AC line voltages (VAC)		
		Nominal	Min. Operating	Max. Operating	Min. Operating	Max. Operating	Frequency
125, 500,900 or multiples up to 8	950VDC	800	150	850	0	520	upto 4kHz (current derating after 400Hz)
500,900 or multiples up to 8	1350VDC	1100	350	1200	0	806	
125 or multiples up to 8	1500VDC	1350	350	1500	0	806	



Other relevant products

DEIF complements the iE Convert PCS with a full range of products to build your own energy management solutions.

Integration of shaft generators with DC/AC or AC/DC converter

Flexible hybrid energy solutions
for propulsion and more

You can use an iE Convert configured as a frequency converter, DC/AC converter, or AC/DC converter to easily integrate a shaft generator in the onboard propulsion and overall energy system. By doing so, you get additional options for routing energy where the crew needs it and design features such as power take-out, power take-in, and power take-home (PTO/PTI/PTH).

A shaft generator is a great way of improving energy efficiency on board any type of ship. It reduces the need for auxiliary generators by converting mechanical energy from the propeller shaft to electrical energy that can be fed to the ship's AC, DC, or combination grid. And if the main engine fails, or the crew needs extra propulsion power for a short time, it can drive or boost the main propeller and thrusters by converting electrical energy from auxiliary gensets, batteries, or fuel cells to mechanical energy. In all of these cases, the iE Convert helps you easily integrate the shaft generator in the ship's propulsion and energy system.

Facilitating PTO, PTI, and PTH designs

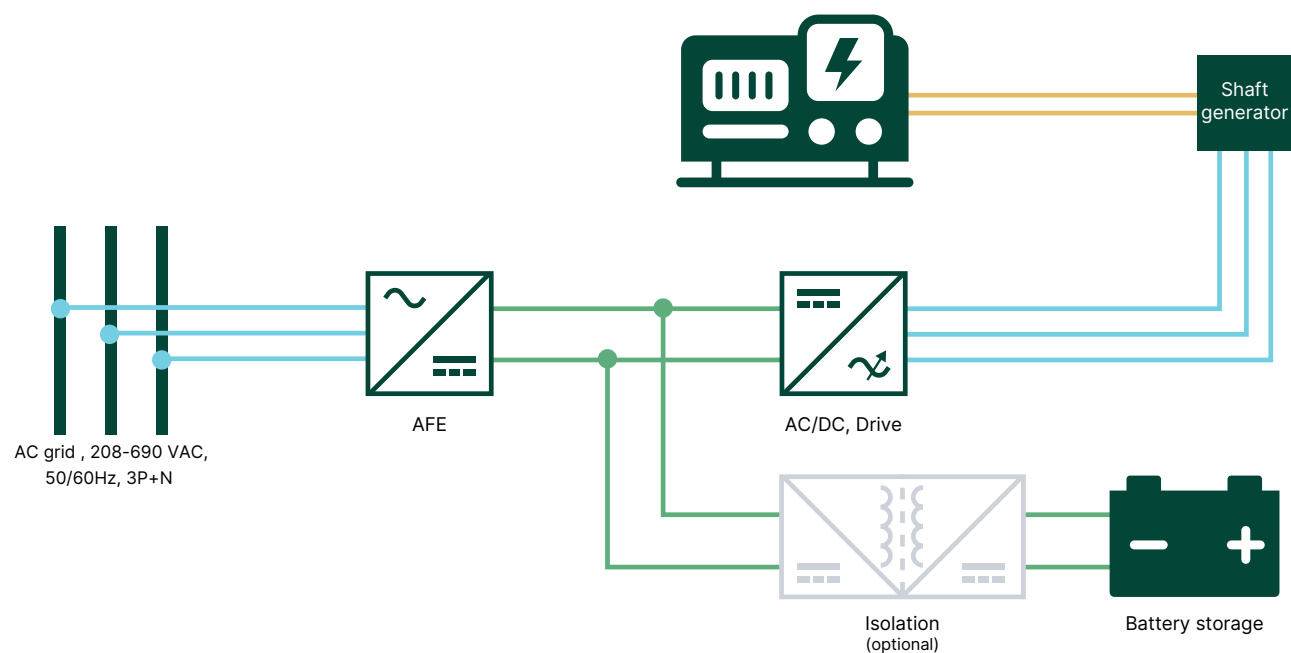
In power take-out applications with variable-speed propeller shafts, you can use the iE Convert to convert the voltage and frequency from the shaft generator to ensure a steady supply to the grid. Similarly,

you can feed electrical thrusters or other equipment through an iE Convert that ensures they get the voltage and frequency they were designed for.

The iE Convert also lets you design PTI and PTH solutions that power the propeller wholly or in part using electrical energy from onboard batteries, fuel cells, or auxiliary generators. The converter ensures that the shaft generator gets the input power it needs and gets the crew safely home.

Protects sensitive equipment

The iE Convert can handle both DC and AC shaft generators, converting the output or input energy as needed to ensure the required energy is present. The energy supplied by the iE Convert is virtually free of electrical disturbances, protecting sensitive equipment on board.



Other relevant products

DEIF complements the iE Convert PCS with a full range of products to build your own energymanagement solutions.

Shore power connection with galvanic isolation

Accurate and energy-efficient electric propulsion control

You can use the DEIF iE Convert to design a solution that converts a wide range of AC or DC supply voltages and frequencies to the values needed on board. With the iE Convert, you save valuable space, and you can specify your devices with built-in galvanic isolation that helps protect the ship from power fluctuations.

Shore power (also known as shore supply, cold ironing, and alternative maritime power (AMP)) lets you run all onboard systems on grid power when the ship is docked, letting you shut down engines and generators and greatly reduce emissions in the port area.

As it helps reduce air pollution and climate impact, shore connection technology is steadily becoming common – and mandatory – in ports all over the world, but since voltages and frequencies vary globally, ships need to be fitted with onboard converter solutions.

Protection through galvanic isolation

You can design the solution you need with iE Convert AC/DC and DC/AC converters on either side of a DC//DC converter with galvanic isolation. This protects the ship and its sensitive electronic equipment from power quality issues. With a galvanically isolated iE Convert, power fluctuations and surges will not affect the ship.

The iE Convert can handle a wide range of supply voltages and frequencies, allowing the crew to use it in any port of call worldwide. You can design shore connection solutions for 1 and 3-phase AC shore power.

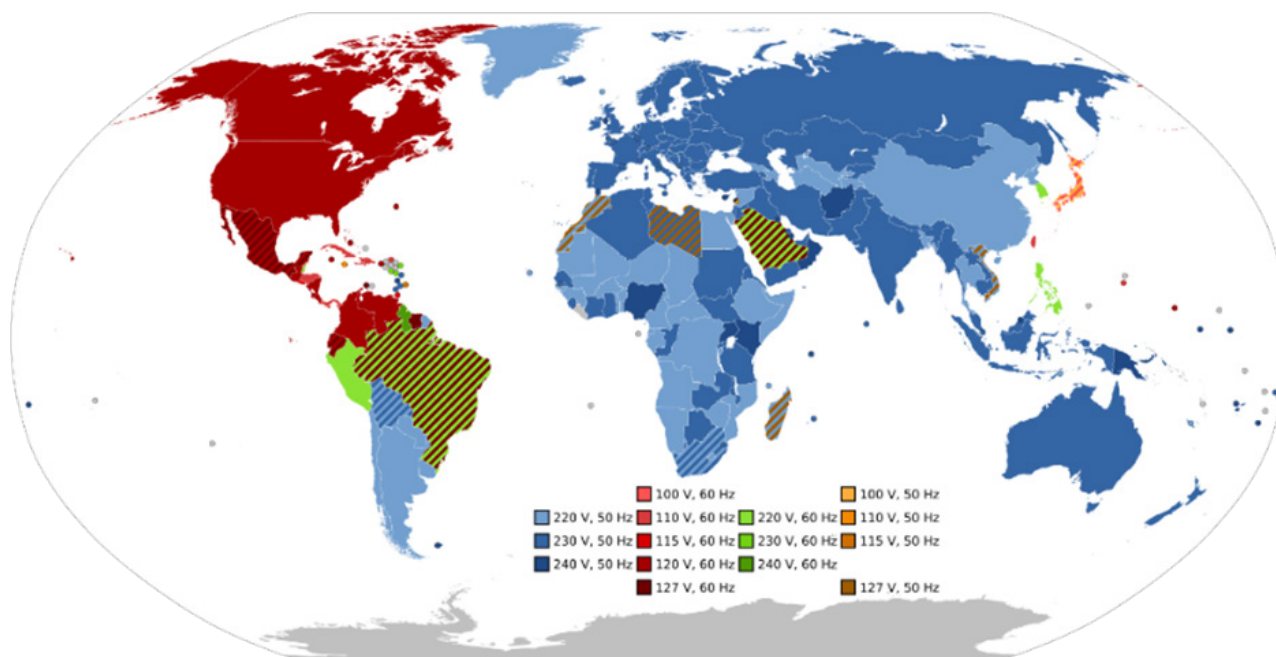
Efficient, flexible, and space-saving

The space-saving iE Convert devices eliminate the need for an additional transformer, and they significantly reduce the weight of your solution.

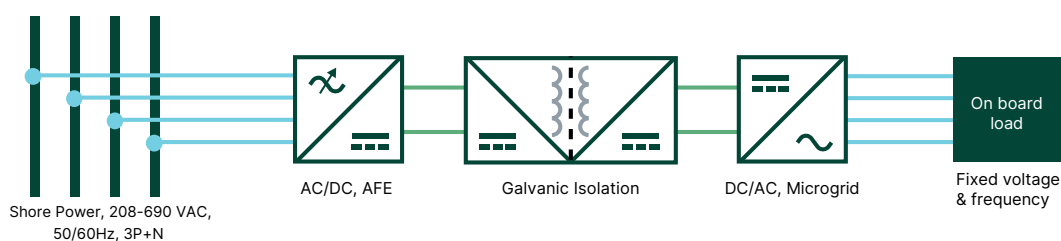
They are also suitable for other combinations of shore power and vessel currents, helping you use MW-scale shore power systems based on batteries: The iE Convert can convert DC shore power to AC for an onboard AC busbar or regulate voltage to match an onboard DC busbar. And it can convert AC shore power to DC if the vessel has a DC busbar.

Other relevant products

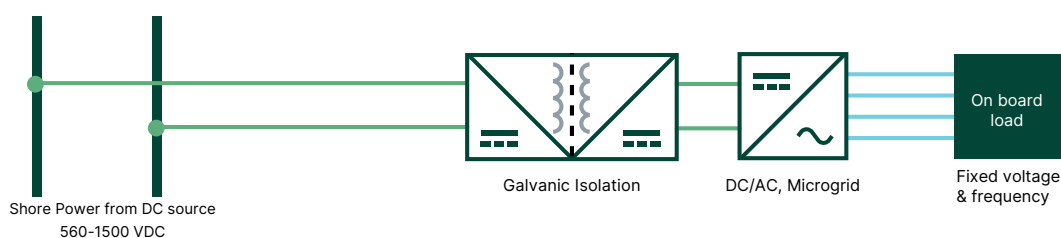
DEIF complements the iE Convert PCS with a full range of products to build your own energy management solutions.



Shore connection from 3P+N, 1P+N connection



Shore power from DC source



Nominal capacity(kVA)	Max. DC voltage	DC link voltages (VDC)			AC line voltages (VAC)		
		Nominal	Min. Operating	Max. Operating	Min. Operating	Max. Operating	Frequency
125, 500,900 or multiples up to 8	950VDC	800	150	850	208	520	upto 400Hz
500,900 or multiples up to 8	1350VDC	1100	350	1200	300	690	
125 or multiples up to 8	1500VDC	1350	350	1500	300	690	

Fuel cell integration with DC//DC converter

Safe zero-emission power solution with galvanic isolation

You can use a DEIF iE Convert DC//DC converter with built-in galvanic isolation to integrate a fuel cell in the ship's energy system to lower emissions. You can boost fuel cell voltage to match that of the busbar whilst protecting both the fuel cell and busbar from power quality issues. The iE Convert offers features that make it ideal for maritime fuel cell applications.

Fuel cells provide instant low-emission power on ships, making them an ideal solution for providing quick power boosts or steady propulsion power in marine protected areas (MPAs).

However, integrating them on board requires efficient isolation and conversion: They are highly susceptible to faults on the busbar. A slight variation in the power supplied from a connected battery, for example, can damage the fuel cell. Also, they can generate stray currents that need to be isolated from the rest of the ship's electrical system.

Galvanic isolation and efficient conversion

The DEIF iE Convert DC//DC converter regulates the fuel cell voltage to match the busbar voltage. On ships with DC busbars, you can install the iE Convert between fuel cell and busbar; on ships with AC busbars, you can use it to supply regulated voltage for a second iE Convert unit configured as a DC/AC converter.

The built-in galvanic isolation of the DC//DC converter ensures that both the fuel cell and the rest of the electrical system are

protected from faults that could otherwise result in equipment damage.

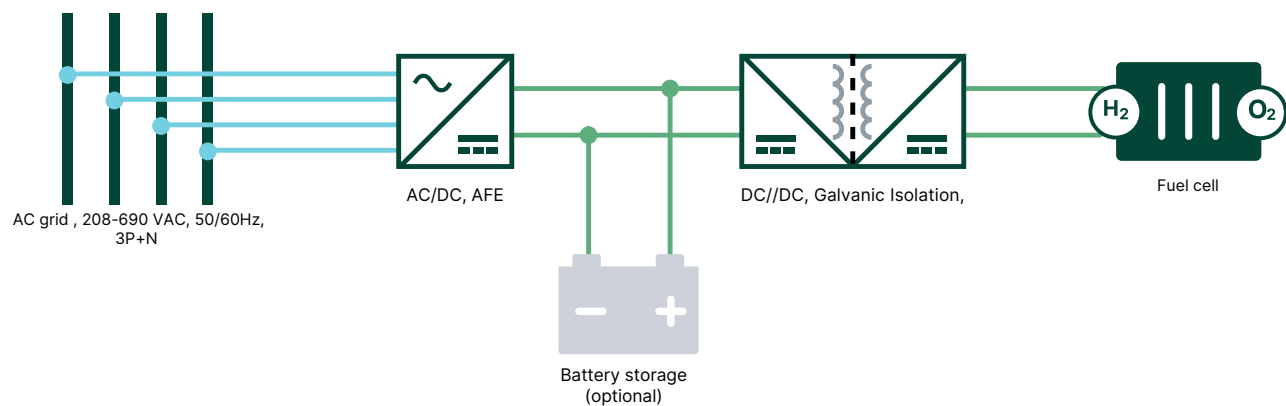
Ideal for fuel cell applications

The iE Convert comes with several features that make it ideal for fuel cell applications. Its pre-charge circuit pre-charges the booster input voltage. Its load-dump capabilities allow the fuel cell to be loaded while starting, while limiting the voltage. And while the fuel cell is stopping, you can use the converter's load-dump capabilities to limit the input voltage.

Other relevant products

DEIF complements the iE Convert PCS with range of products to build your own energy management solutions.





Nominal capacity(kVA)	DC link voltages (VDC)			DC line voltages (VDC)	
	Nominal	Min. Operating	Max. Operating	Min. Operating	Max. Operating
60kW or multiples up to 4	600	900	500	1000	1100
125kW or multiples up to 4	600	900	500	1000	1100
500kW or multiples up to 4	750	700	800	1250	1420



BESS charging and discharging with buck-boost DC/DC converter

Improved energy efficiency with bi-directional energy transformation

You can use an iE Convert as a buck-boost DC/DC converter to shift the voltage level of all electricity flowing in both directions between the DC busbar and the BESS – or as a DC/AC converter if the vessel has an AC busbar. By integrating the iE Convert with an external power management controller, you can design application-specific battery control solutions that provide several benefits on board for both hybrid and fully electric vessels.

Battery energy storage systems (BESS) play a major role in improving energy efficiency and reducing vessel emissions. On hybrid ships with fossil-fuelled engines, they can provide instant spinning reserve/UPS functionality, carry out peak shaving to absorb loads, and provide zero-emission propulsion in marine protected areas (MPAs). On fully electric vessels, they can provide the power for shorter crossings. In either case, they facilitate low or zero-emission operation that helps crews reduce emissions at sea, while docking, and in port.

The key to efficient onboard power

By installing the bidirectional and highly flexible iE Convert between your BESS and the busbar, you ensure that electricity is continuously converted as needed. Voltage from the busbar is stepped down for charging the BESS and up when discharging to the busbar. And you can convert energy

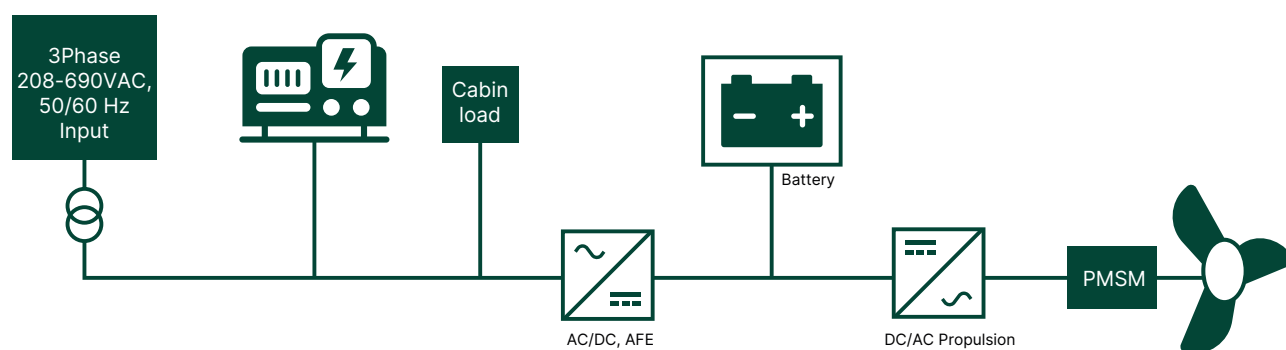
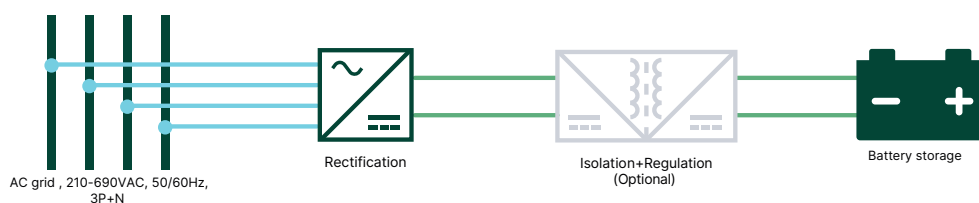
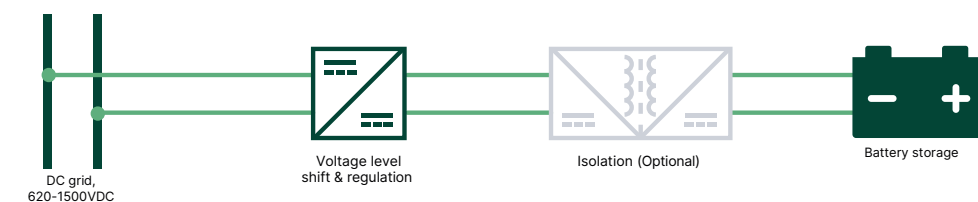
between AC and DC as needed, for example if the ship has an AC busbar.

The iE Convert also supports other applications, for example connecting the BESS directly to propulsion on small vessels.

Additional control and protection

You can integrate the iE Convert with an external battery controller, for example a DEIF iE 250 Marine, to control the energy flow in and out of the BESS according to the set points defined. You can configure the solution to charge the battery from excess engine power in low-load situations at sea, or discharge to the busbar as needed to cover demand surges.

You can specify an iE Convert DC//DC converter with built-in galvanic isolation to provide additional protection for sensitive equipment on board.



Nominal capacity(kVA)	Max. DC voltage	DC link voltages (VDC)			DC line voltages (VDC)	
		Nominal	Min. Operating	Max. Operating	Min. Operating	Max. Operating
125, 500,900 or multiples up to 8	950VDC	800	150	850	100	800
500,900 or multiples up to 8	1350VDC	1100	350	1200	300	1150
125 or multiples up to 8	1500VDC	1350	350	1500	300	1450

Other relevant products

DEIF complements the iE Convert PCS with a full range of products to build your own energy management solutions.

Other marine energy applications

Flexible integration of any source
and load on any busbar



With the iE Convert, energy can go anywhere on your ship: You can configure an iE Convert to handle conversion efficiently and reliably, no matter if you need to go from AC to DC or vice versa, or if you need to step the input voltage/frequency up or down. The space-saving converter range lets you design solutions for confined spaces.

In an age of increasing maritime electrification, you need to be able to connect the dots and help energy go anywhere on board. The DEIF iE Convert range of efficient, compact, flexible, and secure power converters helps you design the electrical systems you need, even when sources and loads run on different types of electricity.

Application examples

You can configure iE Convert devices to

- power AC hotel loads and deck equipment from a DC bus, or connect DC power sources and loads to an AC bus

- provide soft starter functionality to gradually ramp up the power supply for onboard equipment
- control hydraulic rudders by providing stepless hydraulic pump control

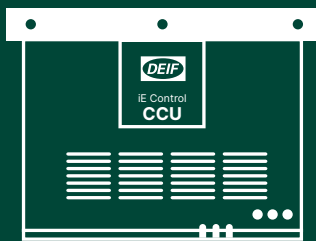
You can integrate the iE Convert with an external controller, for example a DEIF iE Marine series controller, to accurately define the energy control strategies you need on the ship and execute them reliably and consistently.

Other relevant products

DEIF complements the iE Convert PCS with a full range of products to build your own energy management solutions.

Control and integration

Integrate your iE Convert solution in your systems



Dedicated controller

iE Convert module needs a “converter controller” for basic unit configuration and operation. It is possible to connect 8 converter modules of same size (either 125 or 500 or 900). By doing so, you can control them at once and achieve higher capacity through paralleling and synchronising the power blocks. It is also possible to run up to two applications (Propulsion / Grid forming / Grid following/ battery charge etc) with one converter controller. Additionally, you can configure converter controller to achieve redundancy when needed.

Converter controller has seamless connectivity to DEIF marine controllers and PLC (see next page) to add extra features like power/energy management, cyber security and user specific customization. You can also connect to the dedicated iE Convert Controller to a third-party control device or PLC or SCADA system.

Whether you are working on newbuild or retrofit projects, your power converter solutions must fit into a wider context, not least as regards control. We offer a

complete range of intelligent, flexible, and adaptable control devices so you can build the solution you need.



Cybersecurity first

When you control your iE Convert using a DEIF iE 250 Marine or iE 350 Marine controller, you get cybersecurity that keeps your system running reliably and securely, even if it is subjected to attacks by hackers or other malicious parties.

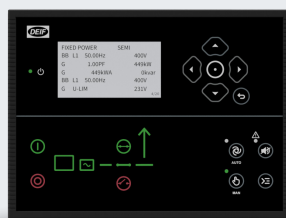
This resilience is the result of several features: All users must sign in to use the controller. The system will only accept software updates that come directly from DEIF. And the controller will keep running even if attackers try to take it down with a denial of service attack.

All the devices you need

DEIF offers a complete range of devices and accessories for your power converter application and other marine energy solutions. Get a quick overview below and read more on deif.com.

Controllers

From simple to advanced applications, and from calm lakes to the high seas, our flexible, secure, and powerful application controllers and PLCs help you manage any maritime energy solution.



iE 150 Marine

Cost-effective and simple controller for coastal vessels and river boats



iE 250 Marine

Flexible and secure controller for oceangoing vessels



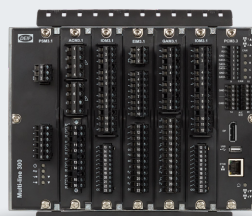
iE 350 Marine

Advanced modular controller for complex applications



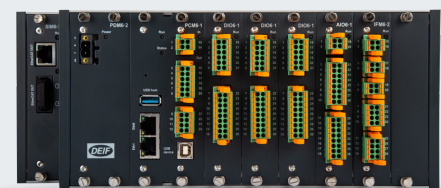
iE 250 PLC

Versatile and modular intelligent energy programmable controller



iE 350 PLC

Programmable automation controller with built-in 3-phase measurement



iE 650 PLC

Extremely robust programmable automation controller with EtherCAT based I/O

Interfaces

Available with 7" to 21" screens, our AGI 400 series of rugged touch displays lets you monitor and control any DEIF and third-party controller via standard communication protocols.



AGI 400 series

Advanced graphical interface

Protection relays

Combine protection, control, and measurements with our fast-acting and efficient MVR-200 series of protection relays for medium and high voltage applications.



MVR-200 series

Medium Voltage Relay

Bridge instruments

From inclinometers and rudder angle systems to thruster monitoring and wind sensors, our range of analogue and digital bridge instruments provide the overview the crew needs in any situation.

Switchboard equipment

Give crews complete control at the switchboard with our wide range of analogue meters, transducers, multi-instruments, current transformers, and more.

An aerial photograph of a lush green forest. The forest is dense with various types of trees, including tall evergreens and deciduous trees with lighter green foliage. A rocky shoreline runs along the right side of the image, with many dark, smooth stones of various sizes. To the right of the shoreline is a body of water with a light blue-green hue. The text "Improve Tomorrow" is overlaid in large, white, sans-serif font on the left side of the image.

Improve Tomorrow



Adapting to change through forward-thinking innovation has been a hallmark of DEIF since we went into business in 1933. That attitude has served our customers and ourselves well over the years, and although very much has changed over the course of more than nine decades, our approach has stayed the same.

Our commitment to setting standards remains the same. Our insistence on high quality and supreme reliability remains the same. And so does our firm belief in close and honest long-term collaborations. We truly believe that businesses, authorities, and society at large can achieve great things when we join forces for a higher goal.

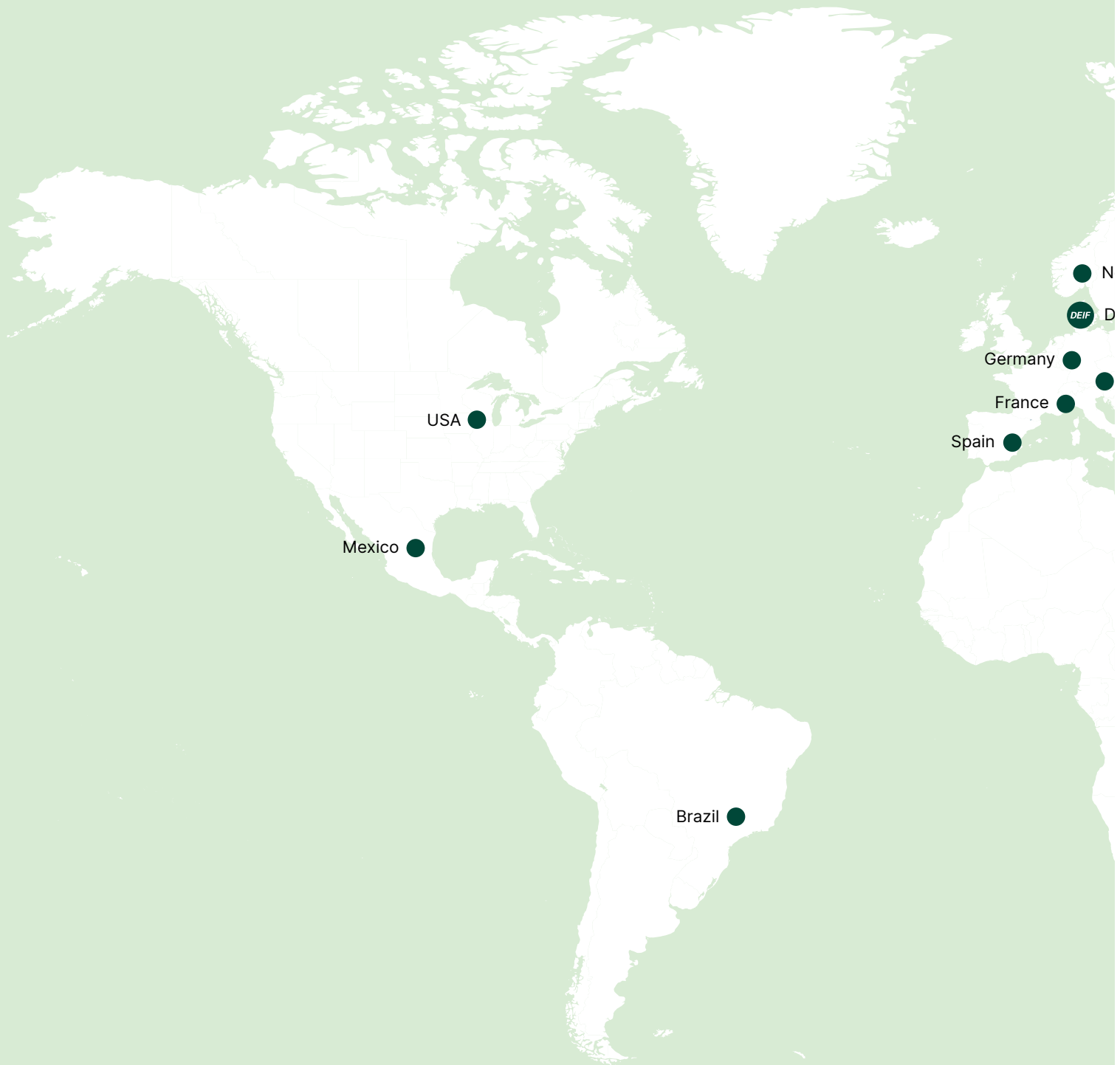
In many ways, our power converters are the perfect

example of that approach. They are a case of high performance and great flexibility. Of always putting safety and reliability first. Of restless innovation and great results achieved through constructive partnerships. And of an unrelenting drive to reduce emissions and contribute to a cleaner environment.

The energy sector is in transition, affected by the need to move from fossil fuels to renewable sources. With our range of power converters, and our strong cooperation with key stakeholders, we are once again adapting to change. We are raising the bar of what's possible in energy control to help our customers and partners prosper. To enter new territories and enable new solutions. And above all: to **Improve Tomorrow.**

DEIF subsidiaries worldwide

DEIF A/S is a Danish family owned company with several subsidiaries and service partners all over the world. To contact DEIF subsidiaries, click below.



Contact sales





Improve
Tomorrow

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