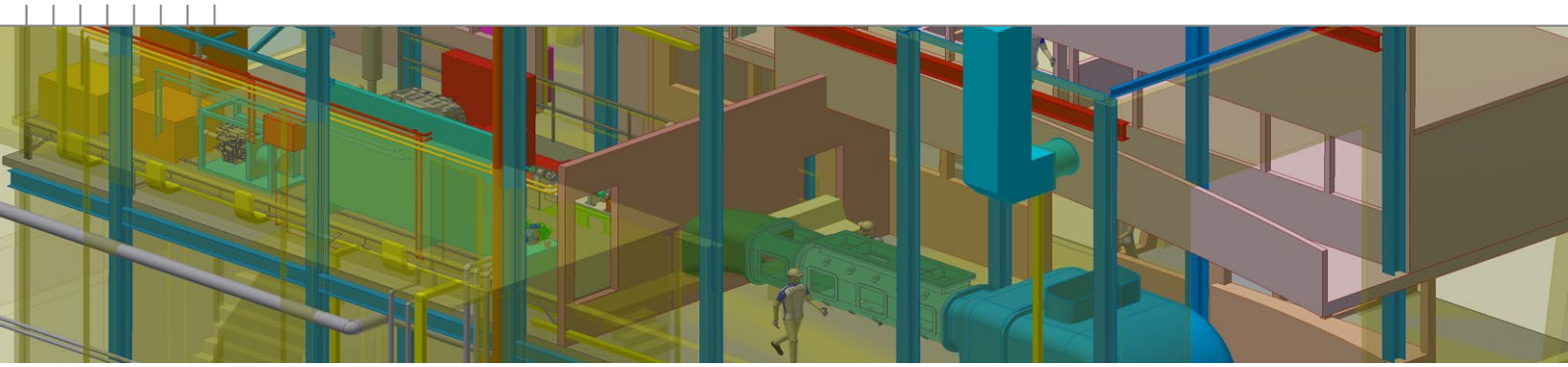


Technology selection using SPEC

In the technology selection phase the Ships Power and Energy Concepts (SPEC) tool is used to define the most suitable technology for ships' power and energy systems.

Ship Power & Energy Concepts

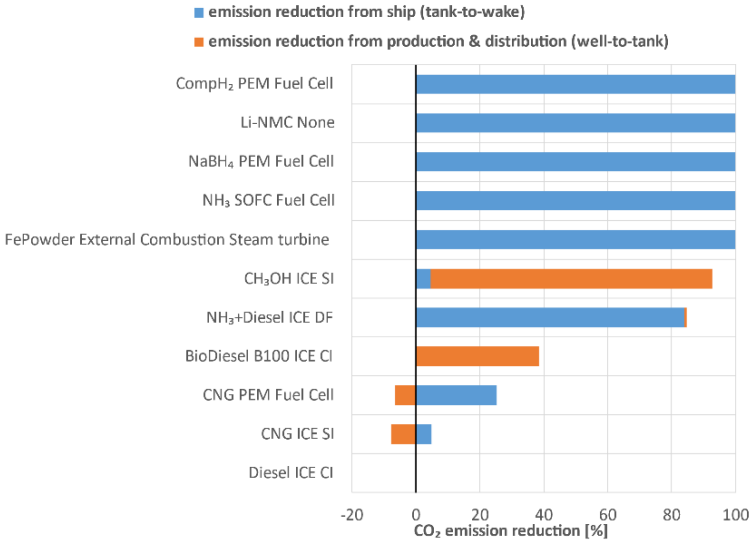
At MARIN the Marine Power Systems Design follows the stages:

- Operational analysis
- Technology selection
- Functional system design
- System dimensioning
- Ship arrangement concept

You want to be ready for the emission free shipping of the future. This requires vessel designs that incorporate integration of new energy and power systems onboard. But which technology to choose?

Comparing power and energy technologies is a difficult task: Published information is fragmented, technologies appear ready but can be experimental and their efficiency only represents part of the ships' power system. Compared to traditional fuels, alternative energy-carriers have several different properties that are to be taken into account:

- Energy density (weight and volume)
- Power density (weight and volume)
- Capital and operational cost
- Technical and societal readiness levels
- Energy efficiency
- Greenhouse gas & pollutant emissions



At MARIN we created a way to take all these aspects into account by using a multi criteria approach. This approach can be used in the very early design stage to give direction and to put focus only on interesting sustainable technologies to work out further. This approach is consolidated in the SPEC tool.

The output of SPEC is an independent and operations based ranking of a wide selection of technologies. The SPEC algorithms do not establish a winner technology on its own. The process is an exploration, which takes into account the ship (design) owner's preferences and requirements.

What benefits do SPEC based services from MARIN offer to decision makers in ship design?

- An overview of alternative solutions and their properties, vendor-independent and considering the complete optimized system.
- Insight in the consequences of design choices and priorities for the operation and the size and lay-out of the ship.
- Clear information enabling a responsible choice for the suitable power concept for specific operations.

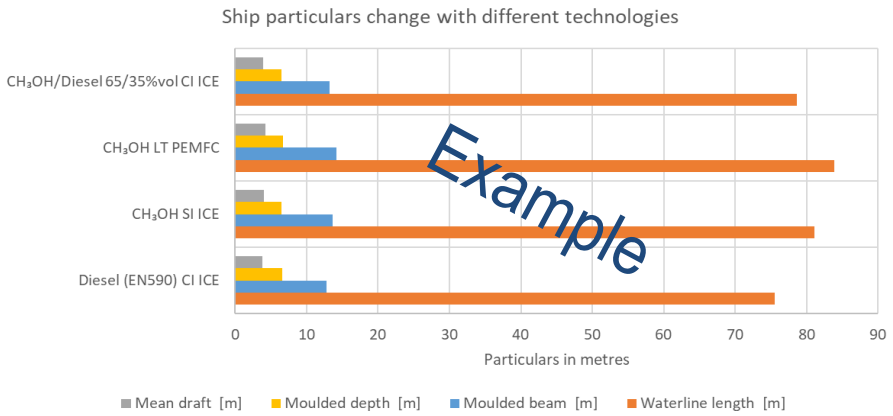
The data used by SPEC is freely accessible on the Sustainable Power portal, which was developed by MARIN and ESSF (European Sustainable Shipping Forum). The database is focused on greenhouse gas emissions and system and production efficiency. This and all kind of other relevant data, can be accessed through the Data Table. Interested? Visit https://sustainablepower.application.marin.nl.

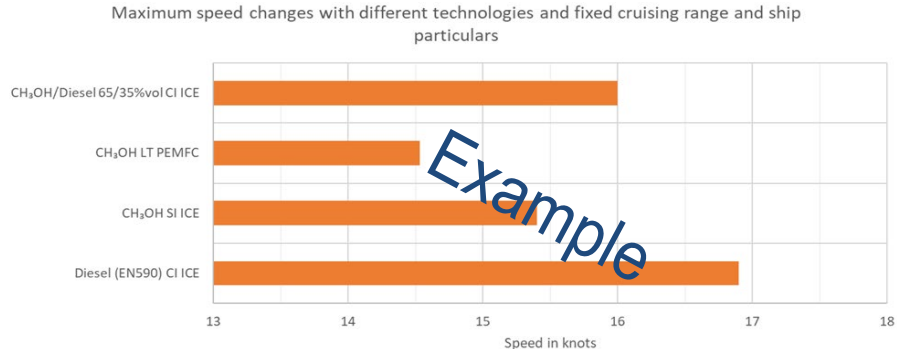
For more information contact MARIN:
Department Ships
T + 31 317 49 34 72
E info@marin.nl

In a second round of iteration a design case analysis is performed. Here a selected number of technologies are assessed in the context of a numerical ship design. Specific design space constraints are relaxed to explore alternative designs and requirements, see table below for an overview.
The design case analyses the effects on:

- Ship particulars
- Effective endurance / autonomous range
- Payload
- Maximum speed

Each of the above is a design case with specific constraints. Different technologies can be compared with the same constraints, as seen in the figures below for respectively Ship Particulars and Maximum Speed.





Typical SPEC Design Case results: how does the ship design or the operation change given certain constraints?

Project timeline when emission requirements are same for all operations:

	Input	Output	Runtime
1. Pre-selection	Max. power (propulsion + auxiliary), average power (propulsion + auxiliary), endurance, TRL, emission req.	For each technology the SPEC data[1]. Includes charts to represent the data.	1 week
2. Ranking	Weighing factors for prioritising technology	Ranking of technology with charts.	1 week
3. Design case for 4 technologies, 2 design cases.	Selected technologies from ranking/pre-selection, auxiliary power, ship design[1]	Ship dimensions, displacement, for each technology the SPEC data[1]. Includes charts to represent the data	1 week
Report		A report with the results and conclusions of the analysis	2 weeks

1 *Coefficients (number of propellers, CB, weight factor lightship, displacement, hold capacity, payload, L/B ratio, FB/T ratio, D/T ratio).*