Reliable electrification for naval ships

CNE – FARNBOROUGH 2025

By CEO and founder of STADT GROUP – Mr. Hallvard Slettevoll

Thank you for the opportunity to present our technology here at CNE. We are looking for sustainable new solutions for how to power naval ships.

We think that reliability is maybe the most important thing. Of course, it should be as sustainable and green as possible in the world we are living in. And we try to find the best energy sources, of course.

And that is what we are working with daily at STADT. We have 40 years of experience in this field, and that is what I will guide you through, how we see this situation. As I said, reliability and turning the ships greener is a focus for us.

The reliable electric way

But there are some key drivers in the markets now that calls for electrification. As we see, for instance, now from Japan, introducing the electric rail guns. And the laser weapons are increasing in power from different sources.

FUTURE PROOF ELECTRIFICATION

There are multiple reasons for electrification now. Both from the environmental thinking, reliability point of view, and redundancy. And also to power the weapons in combination with propulsion. These systems can work hand in hand, ensuring that power is available when and where it's needed. All energy is electric, and you can use it as you like at any moment.

This was not possible in the previous ships where most of the energy was locked into mechanical solutions. That will not be a very wise thing to do now in the coming years.

And we are looking in the longer perspective. Building ships now, that should last for 40 years. Electric power should be there from the beginning. And we see the trend is quite clear that many nations, like Singapore, is going this way with full electrification. And other nations like the U.S., Britain, Norway, Denmark, and so on, are moving the same way.

New weapons call for electric power

And again, weapons are of course a key issue. They will need a tremendous amount of electric energy as it now evolves.

WE FOUND HIDDEN “GEMS”

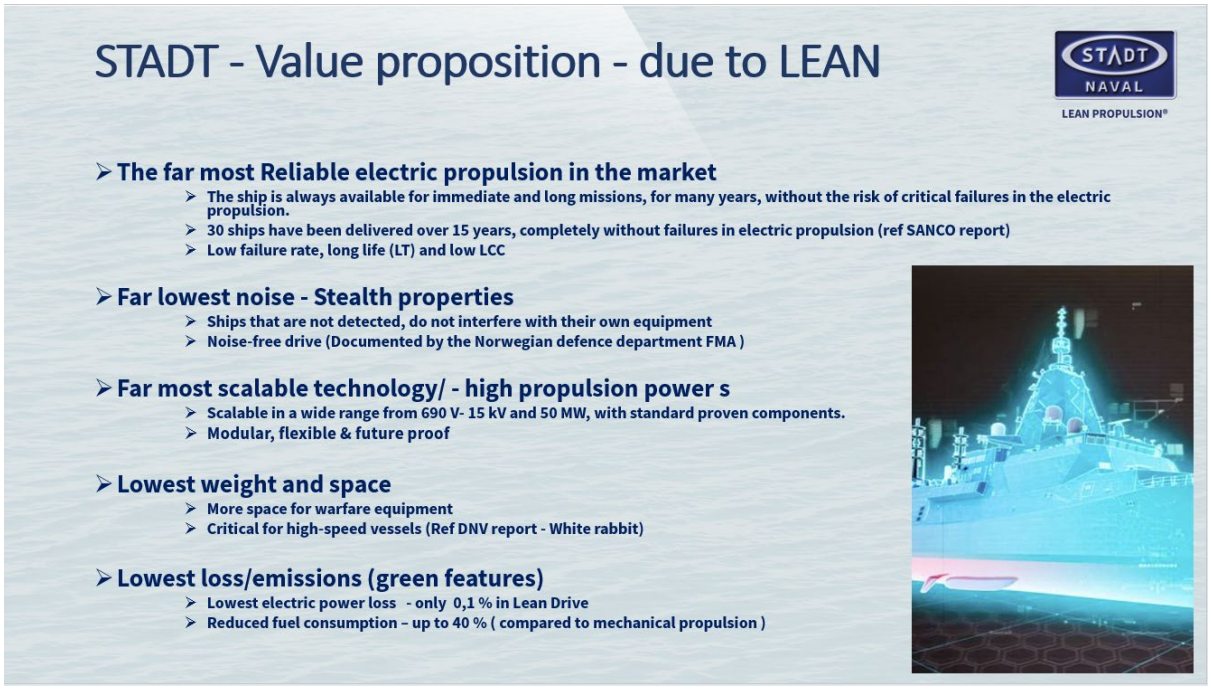
Well, STADT has this long experience of developing these kinds of solutions. And some years ago, we turned our way around and looked in a new direction of how we could create a more sustainable and reliable electric propulsion. And we found some hidden GEMS on this journey.

The Lean thinking is inspired by Toyota, so that we are removing unnecessarities in our technology. And this gave us some tremendous benefits, which we discovered, as we say, as the hidden gems. So, we, as Toyota say, we do not jump to use the latest and greatest, so to say. Our primary focus is on reliability.

Lean Propulsion ® - designed by STADT

We try to use well-proven elements where they have shown to work well over the years. And combine that with new technologies where necessary. In this way, we have created a solution of extreme reliability, extremely high efficiency, compact solution with low underwater radiated noise, no EMI, and many critical parameters which will benefit the naval ship and commercial ship as well.

STADT – Value proposition



Again, reliability is a key issue. What we also found as a gem is that this technology is completely noise free when it comes to electromagnetic interference (EMI). That is very hard to obtain.

We have a patented solution for that, and it is implemented now on 30 naval ships and commercial ships. It is an extremely scalable technology. Some technologies are scalable, some technologies are not scalable. By coincidence, this is an extremely scalable technology, both downwards and upwards. We can power any naval ships with proven elements. This is very important.

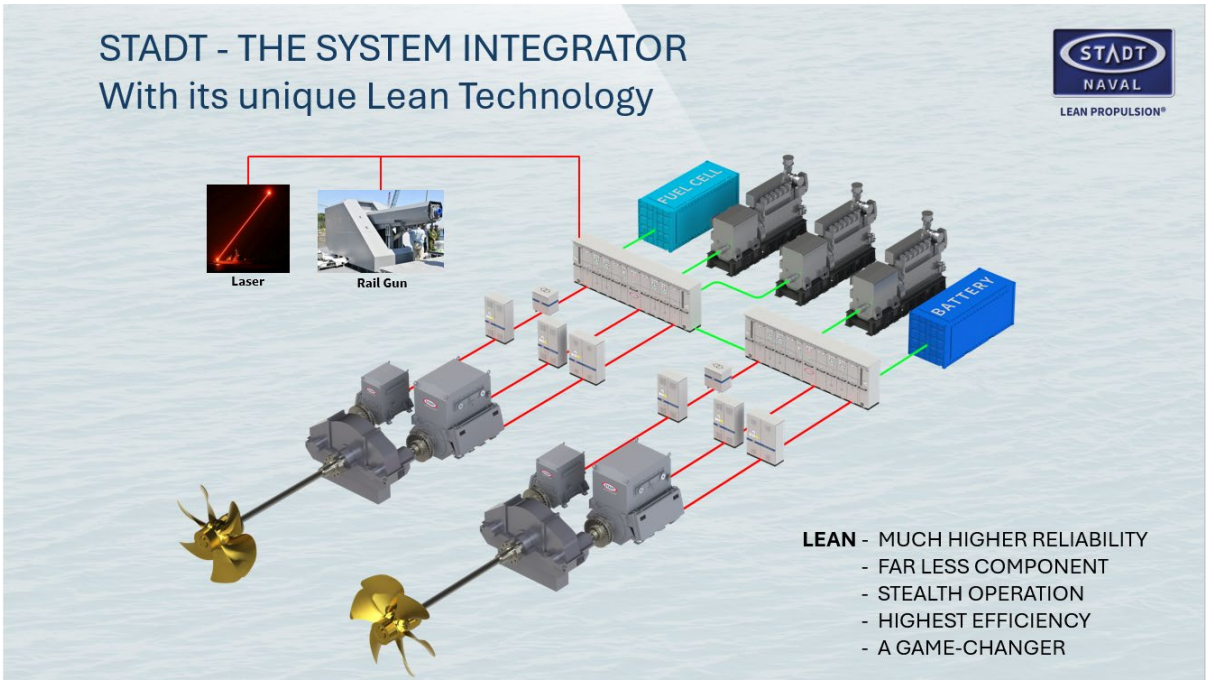
We are ready for that. It is not just something we have in the laboratory. It is something real based on well proven elements and integration.

We have seen a tremendous reduction in weight and size with this technology compared to our competitors. It could be up to 100 tons on a frigate, for instance, in weight savings. When it comes to losses and efficiency, that is fine, but it should never be the first point of the specification, so to speak. We have 0.1 % losses only in our product. That's the lowest ever possible to obtain. It can not be less.

Simplicity is the ultimate sophistication

LEAN is a strange thing. It gives you actually more. Less gives more. It's a contradiction, of course, but this is where we are. We are a challenger to the big players in electrification.

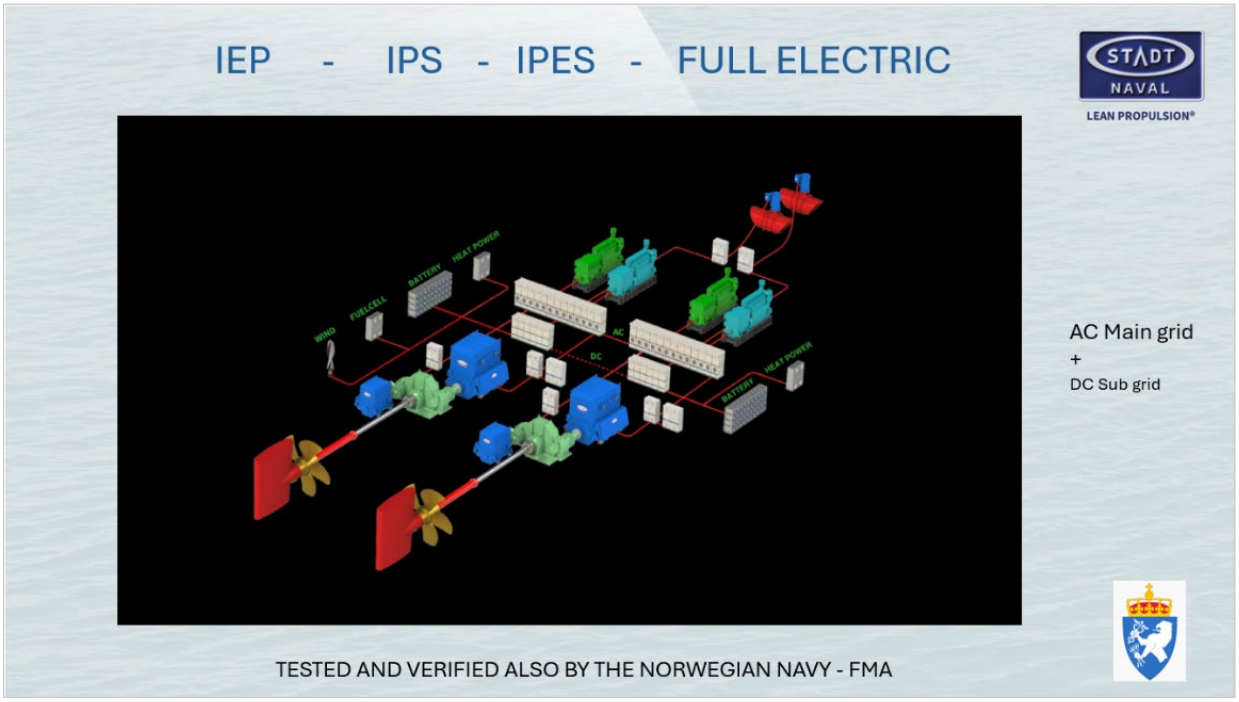
STADT – a system integrator



We are also a system integrator with a lot of experience. We are designers of energy and propulsion solutions.
From the generators or batteries or fuel cells, how they are combined, how they will bring electric energy into the switchboard system, for instance. We work with AC as the main

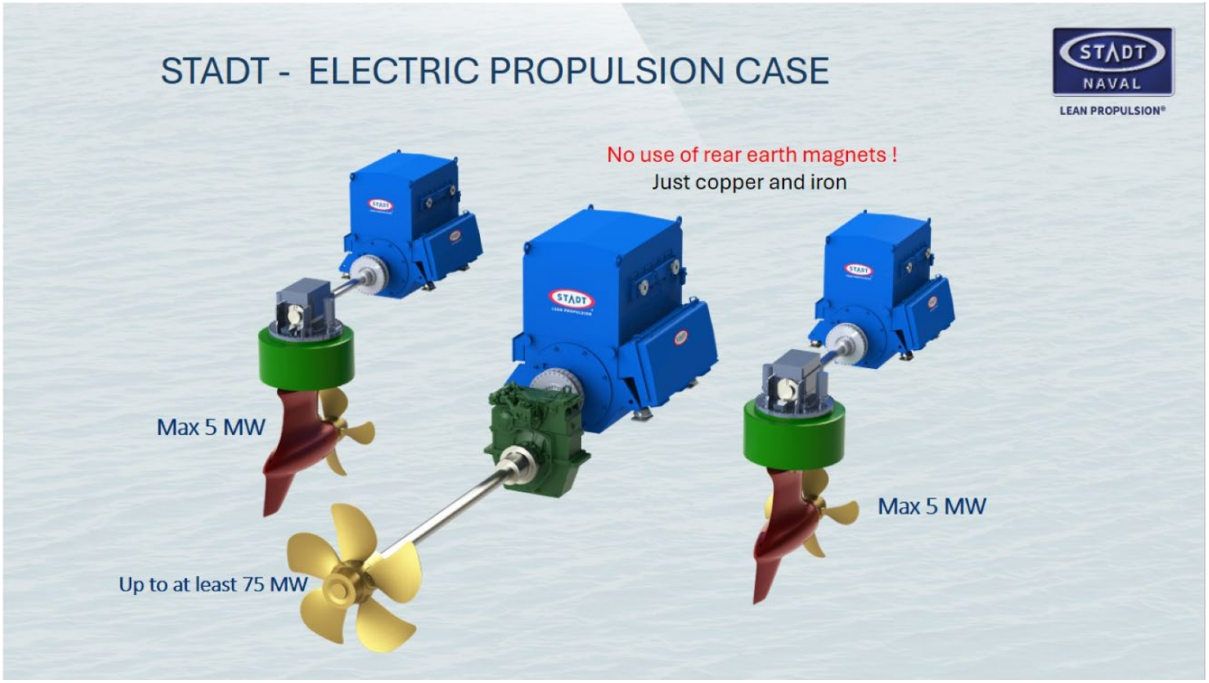
power, - because we believe in AC. Because all generators in the world are actually AC - all of them. There is no DC generator to talk about. The same with propulsion motors. There are no DC propulsion motors to talk about today, all of them are AC. We keep to the AC as the well-proven running horse. You could say that we are a game changer in this way of electrification, definitely.

IEP – IPS – IPES – Full electric – AC



We are combining AC with DC because we also see that *some few users* will require DC. But keep in mind that going from AC to DC is very simple. You only need one component, and that's a solid-state diode. Then you have DC from AC. But going the other way around is very complicated, and it will create a lot of electromagnetic interference and complexity. We have many reasons to select AC first of all - as also other companies are pointing to. When it comes to high power, at least, AC is the winning horse.

STADT – Electric propulsion case



Our technology is also evaluated by the Norwegian Ministry of Defense, and they have found our statements of uniqueness to be correct and validated.

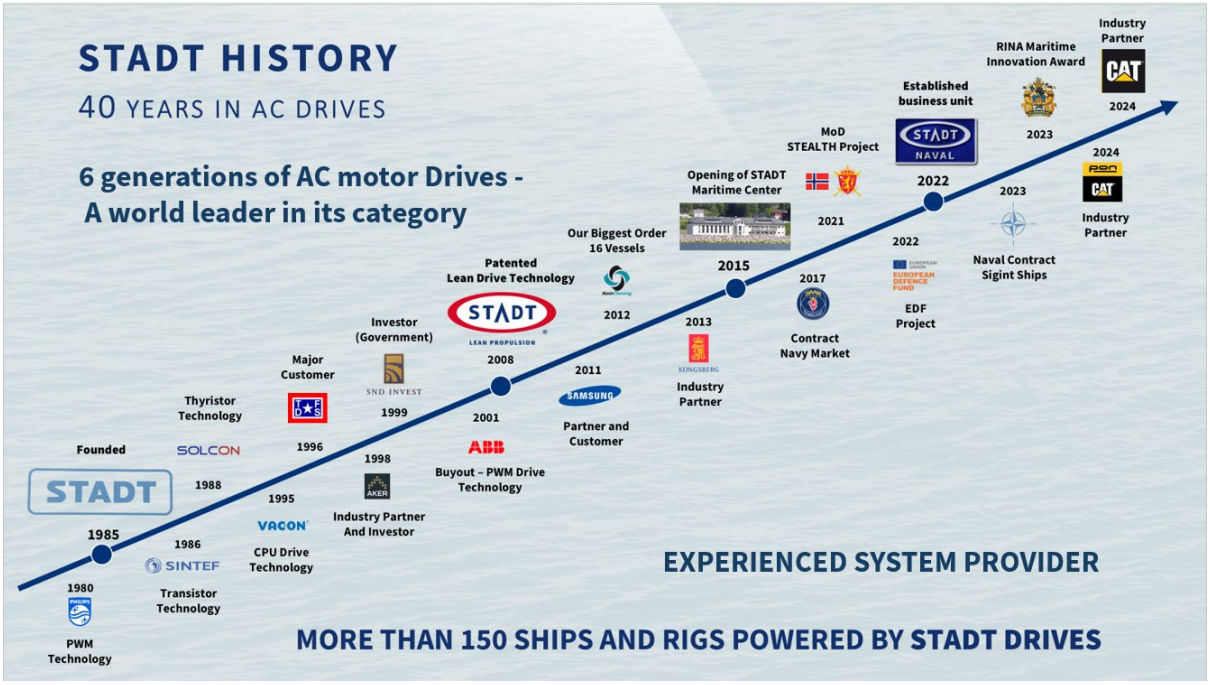
This is now implemented on several naval ships in Europe. The figure over here shows a typical display of how electrification is done in real life. There are some boundaries which are important to be aware of.

Like talking about shaft lines, like talking about azimuths, they have limitations. They are not available in any power, and that is important to think about when you are designing a new concept. Azimuths are limited to approximately 5 Megawatts in the marketplace, while shaft lines is more or less unlimited, so to speak, in power. They have been built up to 75 Megawatts. And there are multiple market players who can do that, both in Asia, in America and in Europe. There is a highly competitive market when it comes to shaft lines.

Powering a ship with shaft lines will always be possible, in any power. And you can have multiple of those, of course. One or two or three or even a combination with azimuths is also possible. Like you see here in the figure.

We use induction motors and *avoid rear earth materials*. This is particularly important from a geopolitical perspective today. We are only using copper and iron. Very easy to get, easy to manufacture and no limitations from products from China, for instance. We have multiple partners who make the motors for us, based on our specifications.

THE STADT GROUP HISTORY :



This shows our long history of innovation. And I think we are a good example that innovation comes from the smaller SMBs. We are an SMB in Norway.

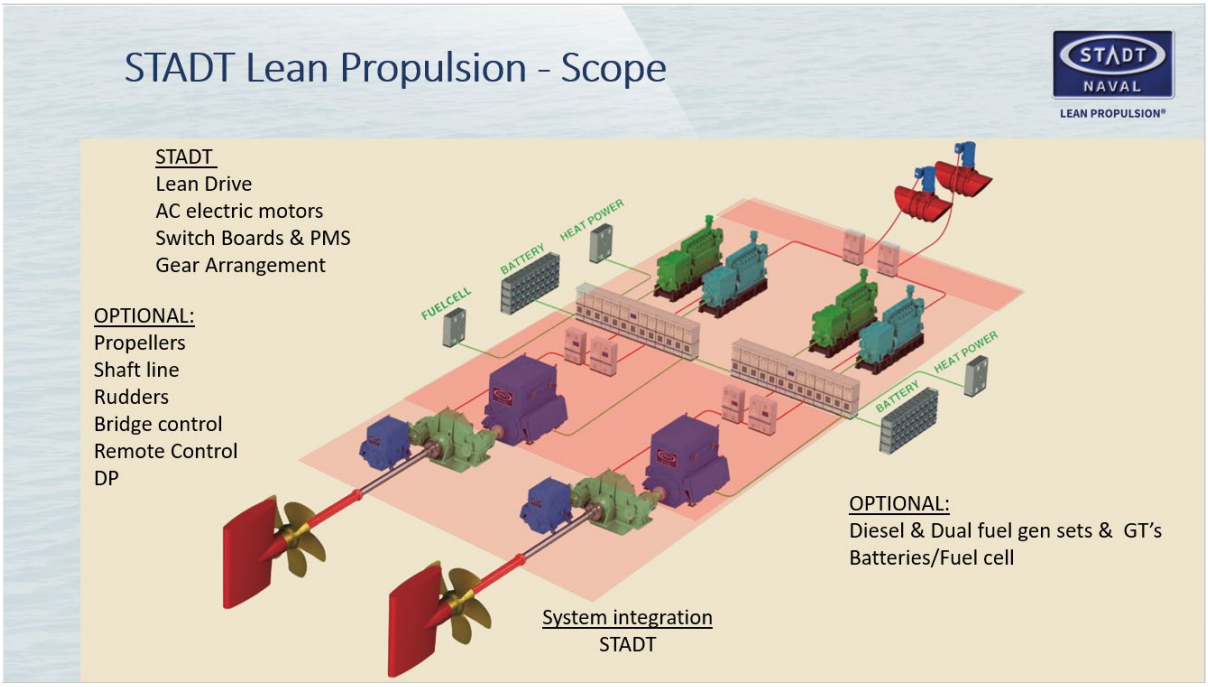
STADT is a family-owned company, but we cooperate with the bigger partners. Like Samsung in Korea, Kongsberg, Saab, Caterpillar, etc. We can cooperate with anyone.

This is our 40 years of history and we have the anniversary these days. And I'm the founder of the company. Starting my career in Philips in the 1980s where I got the idea about the AC drive business.

We have been a world leader in how to develop AC drives. And some of the technology we sold out in 2001 to one of our competitors. And then we started on the LEAN journey after that.

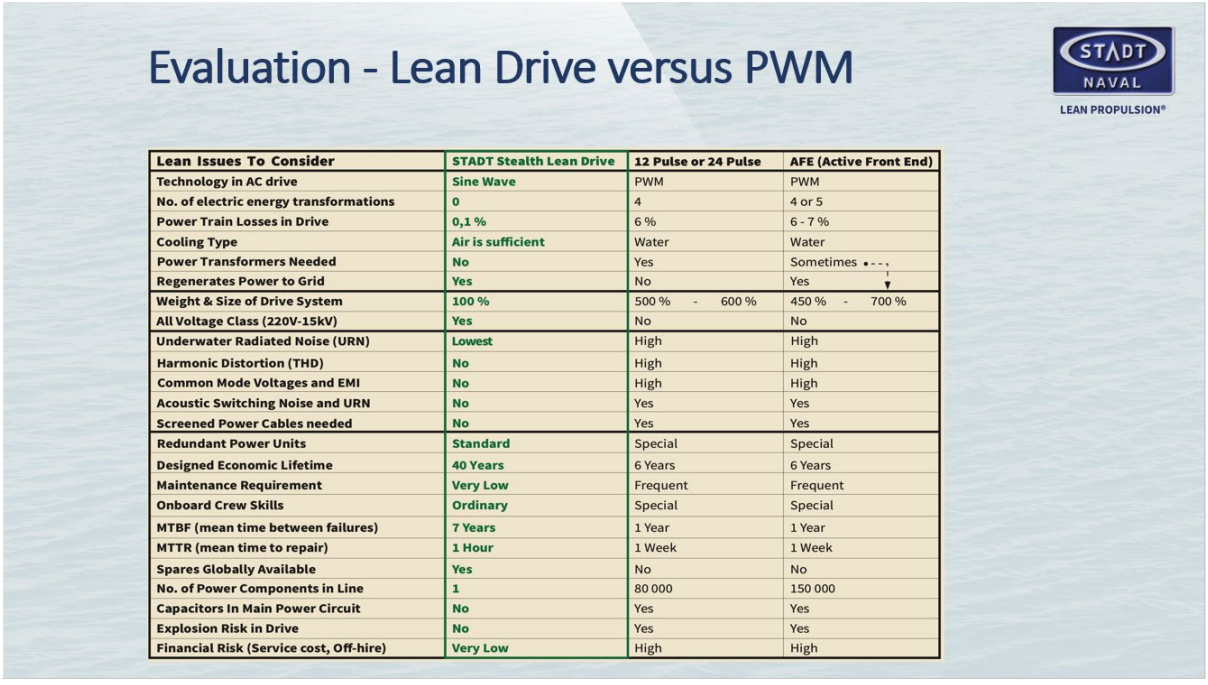
And then we went in a very different direction to what we now have been talking about, Lean Propulsion®. That's where we are, our 6th generation AC Drive.

STADT Lean Propulsion - Scope



This is a typical arrangement how a full electric ship might look like and how we can provide both the solution and integration. And we cooperate with well-known partners on how to make this a reality.

Evaluation – Lean Drive vs PWM



Lean Issues To Consider	STADT Stealth Lean Drive	12 Pulse or 24 Pulse	AFE (Active Front End)
Technology in AC drive	Sine Wave	PWM	PWM
No. of electric energy transformations	0	4	4 or 5
Power Train Losses in Drive	0,1 %	6 %	6 - 7 %
Cooling Type	Air is sufficient	Water	Water
Power Transformers Needed	No	Yes	Sometimes
Regenerates Power to Grid	Yes	No	Yes
Weight & Size of Drive System	100 %	500 % - 600 %	450 % - 700 %
All Voltage Class (220V-15kV)	Yes	No	No
Underwater Radiated Noise (URN)	Lowest	High	High
Harmonic Distortion (THD)	No	High	High
Common Mode Voltages and EMI	No	High	High
Acoustic Switching Noise and URN	No	Yes	Yes
Screened Power Cables needed	No	Yes	Yes
Redundant Power Units	Standard	Special	Special
Designed Economic Lifetime	40 Years	6 Years	6 Years
Maintenance Requirement	Very Low	Frequent	Frequent
Onboard Crew Skills	Ordinary	Special	Special
MTBF (mean time between failures)	7 Years	1 Year	1 Year
MTTR (mean time to repair)	1 Hour	1 Week	1 Week
Spares Globally Available	Yes	No	No
No. of Power Components in Line	1	80 000	150 000
Capacitors In Main Power Circuit	No	Yes	Yes
Explosion Risk in Drive	No	Yes	Yes
Financial Risk (Service cost, Off-hire)	Very Low	High	High

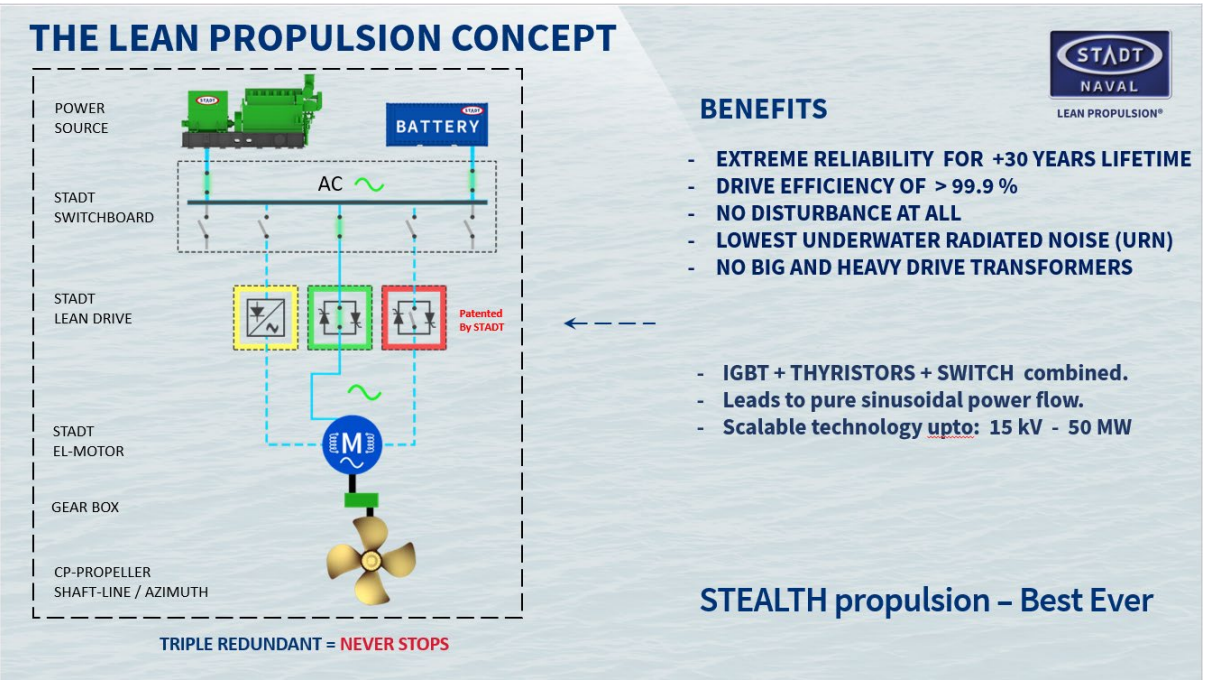
There are so many differences between our Lean technology and our competitors. I will not go into all the details, but they are here listed up.

Maybe the bottom of the line is the most important one. That is the risk of implementing new technology, so to say. In our case, *the risk is very low* and very well documented.

Extremely well documented. We have ships now have been sailing with this technology for *17 years* worldwide without a single moment of being off higher, so to speak. That is an extremely good track record.

And there is a reason behind that. There are theoretical reasons why it is like that in the technology we are using. But it is also proven by reality.

The STADT Lean Propulsion Concept - benefits



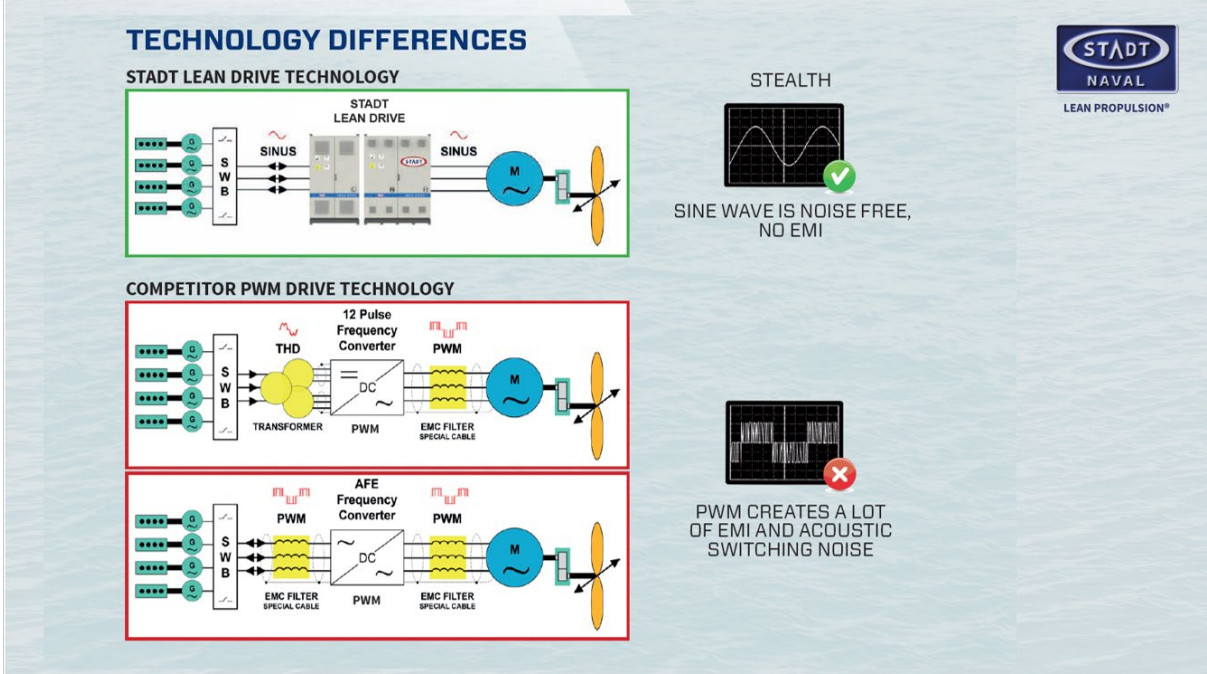
One important part of our technology is that we are combining different technologies in parallel. And if some of it should fail for some reason, there is always something in parallel to it that will kick in immediately and *make sure that the propeller never stops*. This is a main objective for us, that the propeller should never stop.

We are born and grown up in Norway, neighboring the harshest ocean. And we know the risk of being out on a ship if a propeller should stop. It is so critical. And this is one of the major things. And that is why we emphasize the importance of reliability. And for a naval ship, you must be sure that you can send it out on a mission and it comes back without using a tug. Too often we have seen that. And maybe even in particular on electric projects. We have a different, much more reliable solution to offer.

We can go in any power, in any voltage, up to 15 kV. And we don't need big transformers, for instance. We can do it with such a high voltage transformer free.

That is one of the reasons why we save a lot of space and weight in our solution.

Significant technology differences

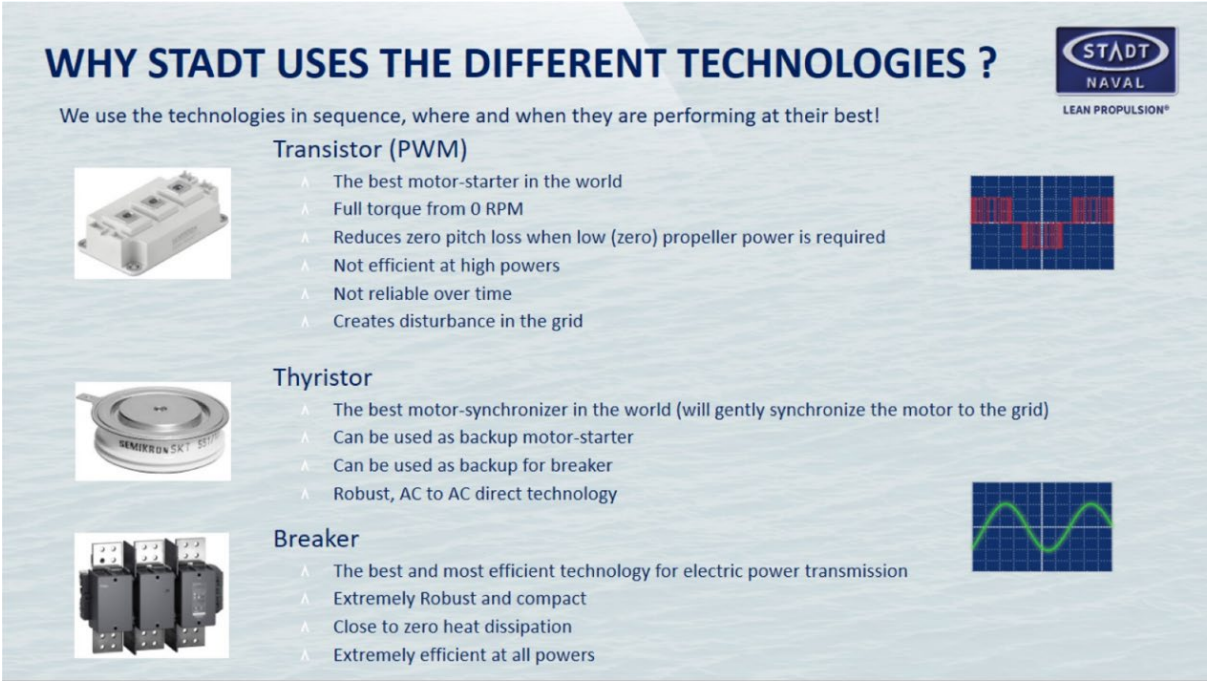


SINUS vs PWM

This is a comparison again about our sinusoidal technology compared to the PWM (pulse width modulation). That is a little bit at the core of the difference between us and our competitors.

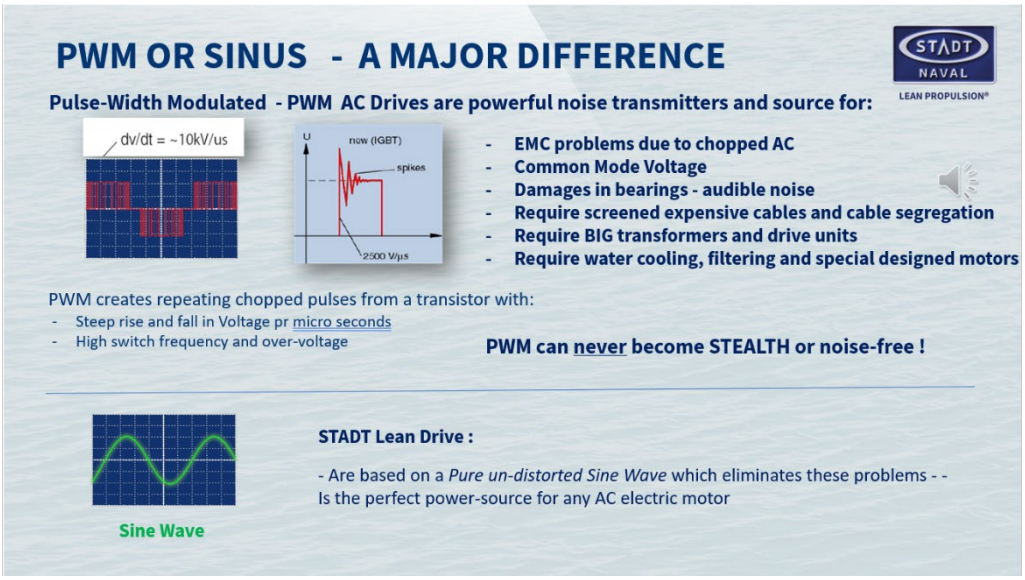
Or where we were in the past. Because we were also world leader in PWM product developments in the 90s, for instance. That means we know that technology very well from inside. And can compare very well.

Why STADT implements the different technologies?



We are combining transistor technology with thyristors and breakers. In a symbiosis, you could say. To obtain the qualities we are aiming for.

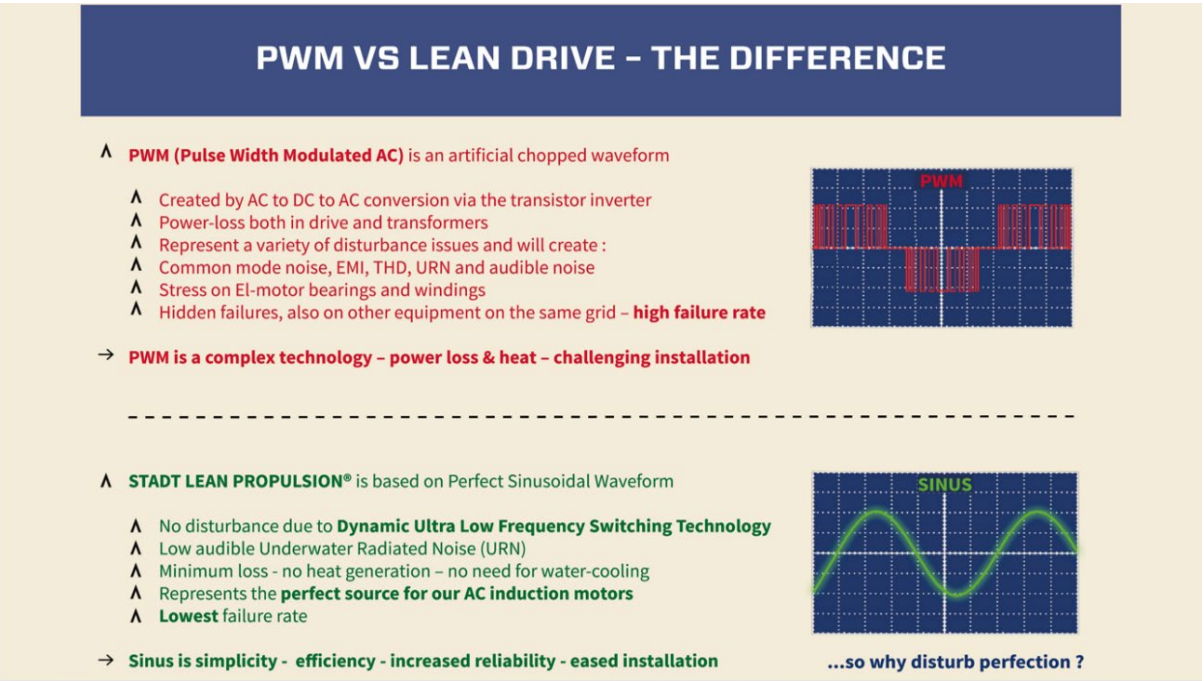
PWM or Sinus – a major difference



Here we are into the details of the IGBTs high frequency switching and so on. And the core of the challenges seen in those PWM drives.

With high dv/dt, high switching frequencies, etc. If you have a sinusoidal solution, those problems disappear. Period. You don't have to think about it. That's a big difference. And STADT with our patent technology, are the only ones to offer such technology.

PWM vs Lean Drive – the difference

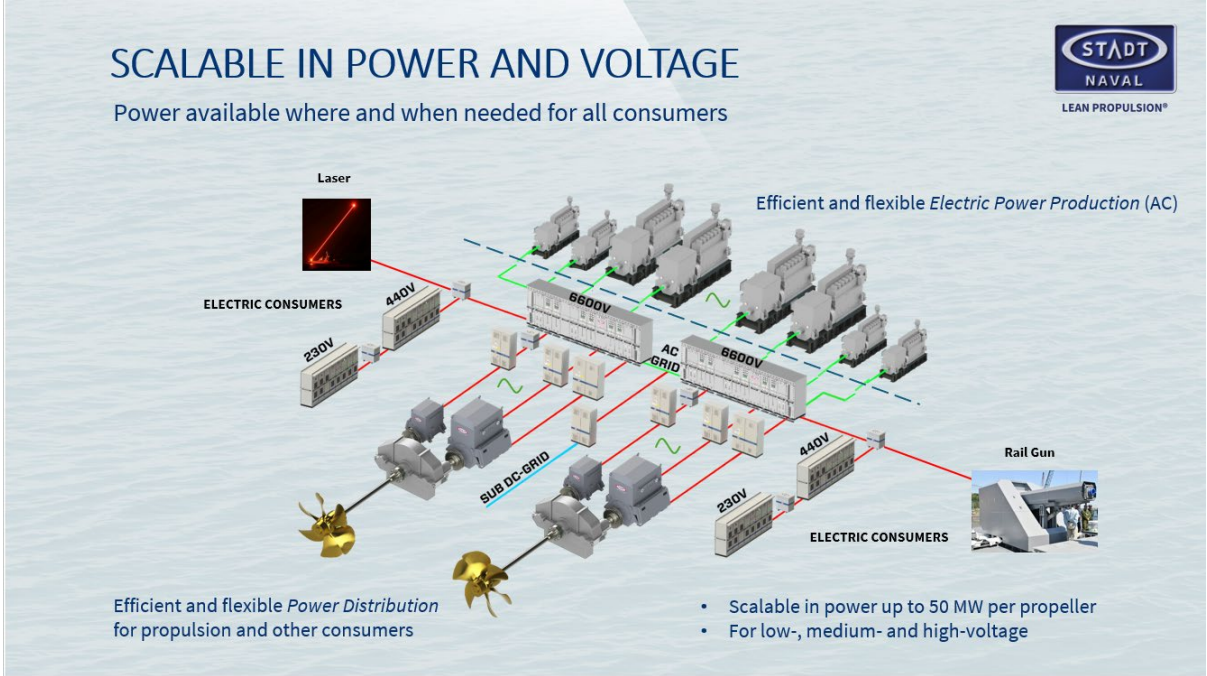


This is a little bit about the same. I will not go into all the details. Because here you should be a doctor or engineer to see all the differences.

But we have been working with these things over the 40 years - we know exactly where the bottleneck lies. And I don't think I will go further today.

But of course, we are ready to discuss this with you anytime.

Scalable in power and voltage

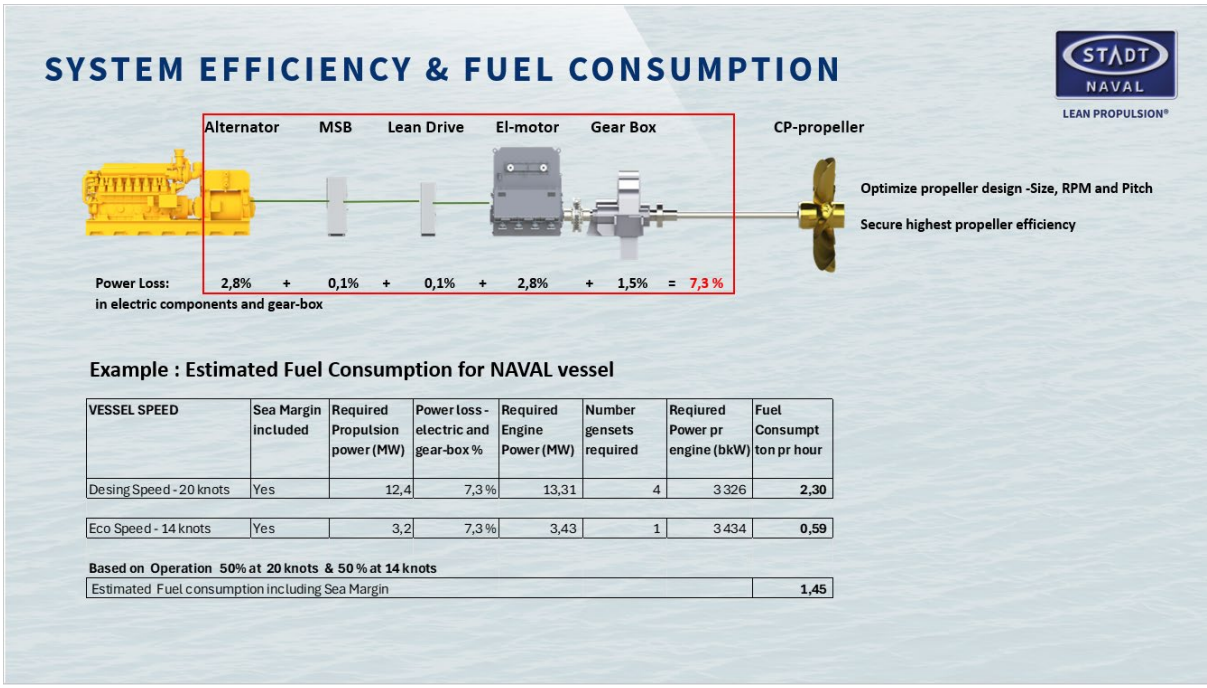


Here we see a combination of a high-power solution with 6600 V AC.

And a sub grid of DC. As we said, it's easy to generate a sub grid of DC for the new weapon system, etc. Anytime.

We can feed a transformer. We can feed a motor. We can feed anything with AC. It's a well-proven technology. It's available components everywhere. That is not the case with DC.

System efficiency & fuel consumption. Example



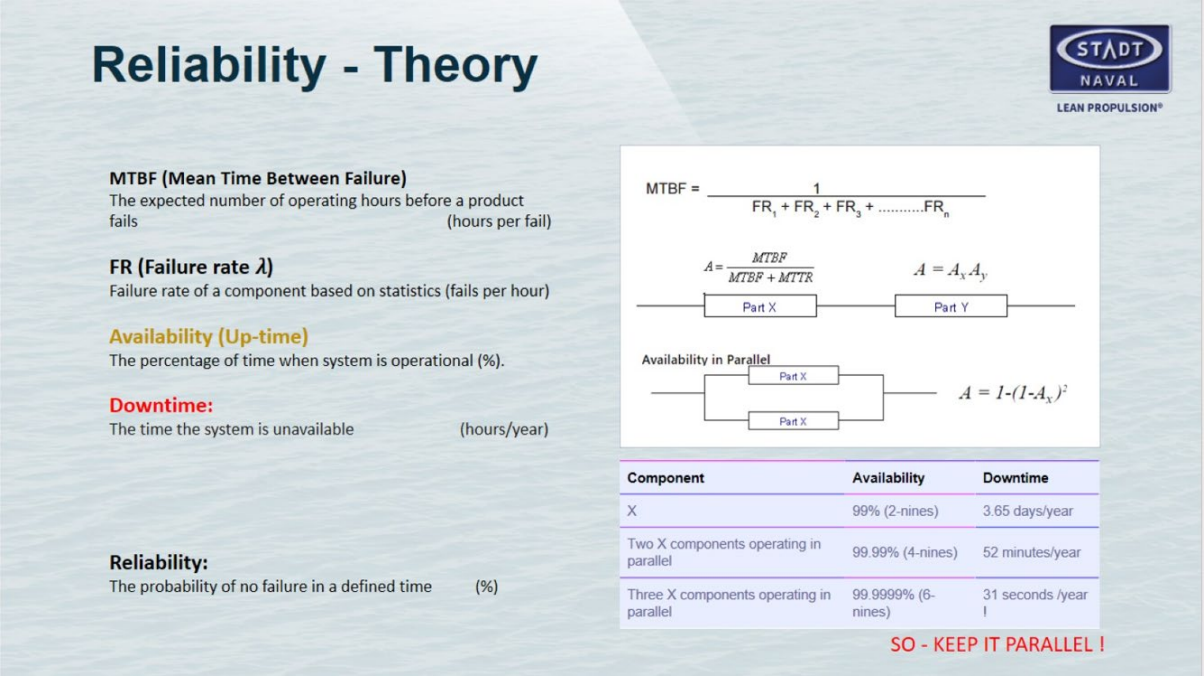
This shows the system efficiency in our solution.

From generation of power to propeller. We believe in internal combustion engines. Feeding them with any power from diesel to methanol to anything you can imagine. We don't care. But diesel is today a winning horse for naval ships. And of course, we should use the energy very efficiently to save what we can.

But the operational point, I guess, is the key thing. And now we are in a hurry to build more vessels. We must go and use what we have and what we know works well.

And diesel is a good alternative when you run it in a diesel-electric way, for instance, where the efficiency is improved a lot. Also, with diesel. So, as you see from here, we have very low losses in the transmission line. It is not possible to have less losses.

Reliability - Theory



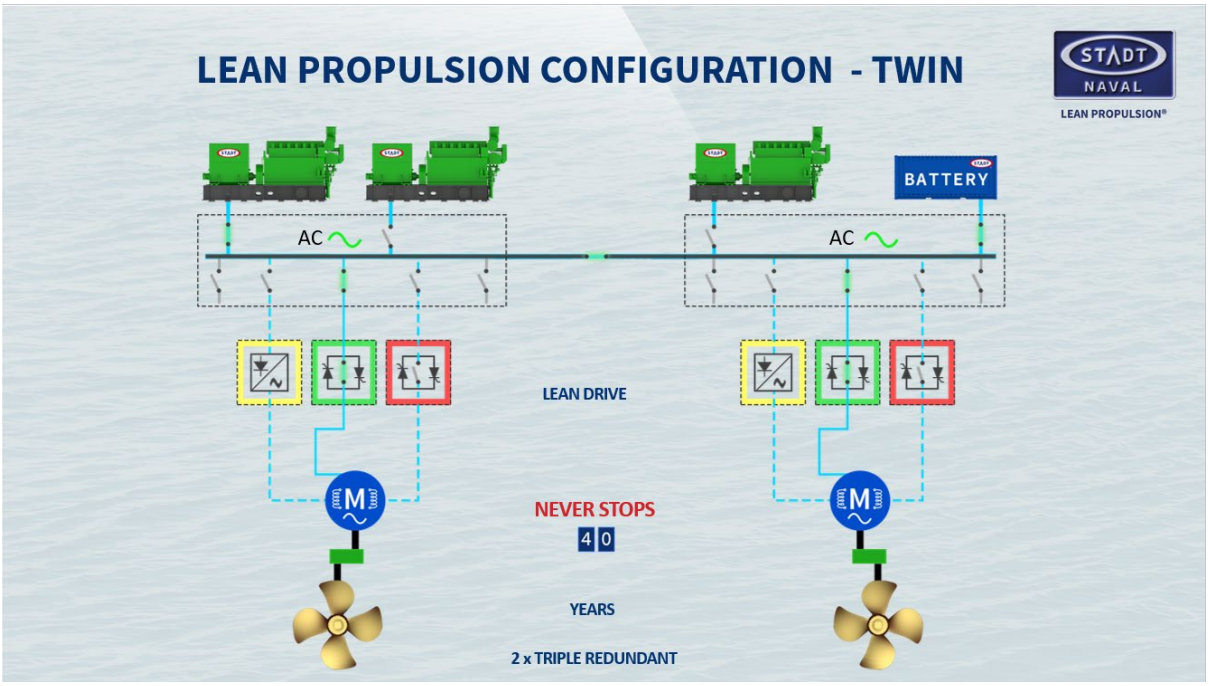
Here we are talking about reliability and why we have such high reliability. It's because instead of a long chain of serial-connected components, we go in parallel.

This makes *a huge difference in reliability* from a theoretical point of view. And this is also what we have demonstrated over 17 years of real operations – it just works.

We have calculated the difference in our drives' reliability compared to complex technologies such as PWM and found that the difference could be in the range of millions of times better. It's such a high figure that it's, of course, a little shameful to talk about it because the difference is so tremendously big when you calculate it.

There are clear reasons why we see this high reliability in the STADT systems.

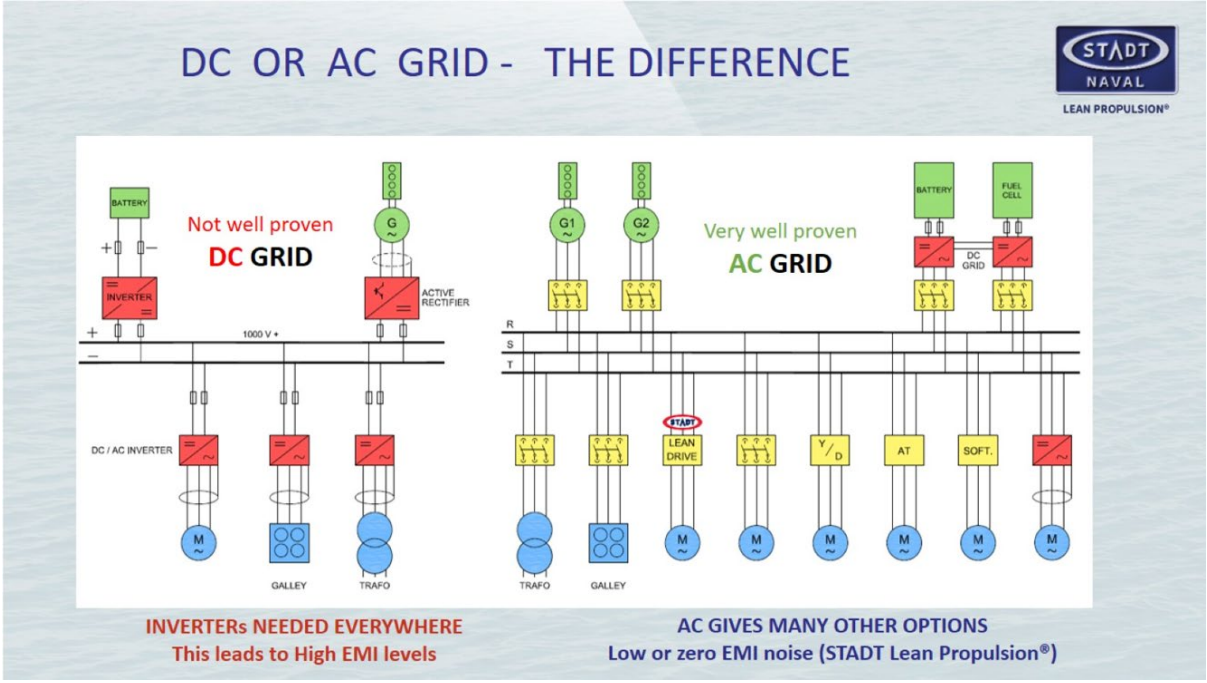
Lean Propulsion® configuration - Twin



And here we see it again. When you have two propellers, you have six times the redundancy for the ship on the transmission line.

This is, of course, what you should have and what will be sufficient. And such a ship will never stop.

The AC grid vs the DC grid



Here is a little bit about the DC-AC type of discussions.
And in short cut, I would say that with an AC grid, you have so many options of using different kinds of good technologies, while with DC, you only have one option, and that is inverters. That is good for those companies that live from making inverters, but it's not good for the customer. And this will be a noise transmitter.

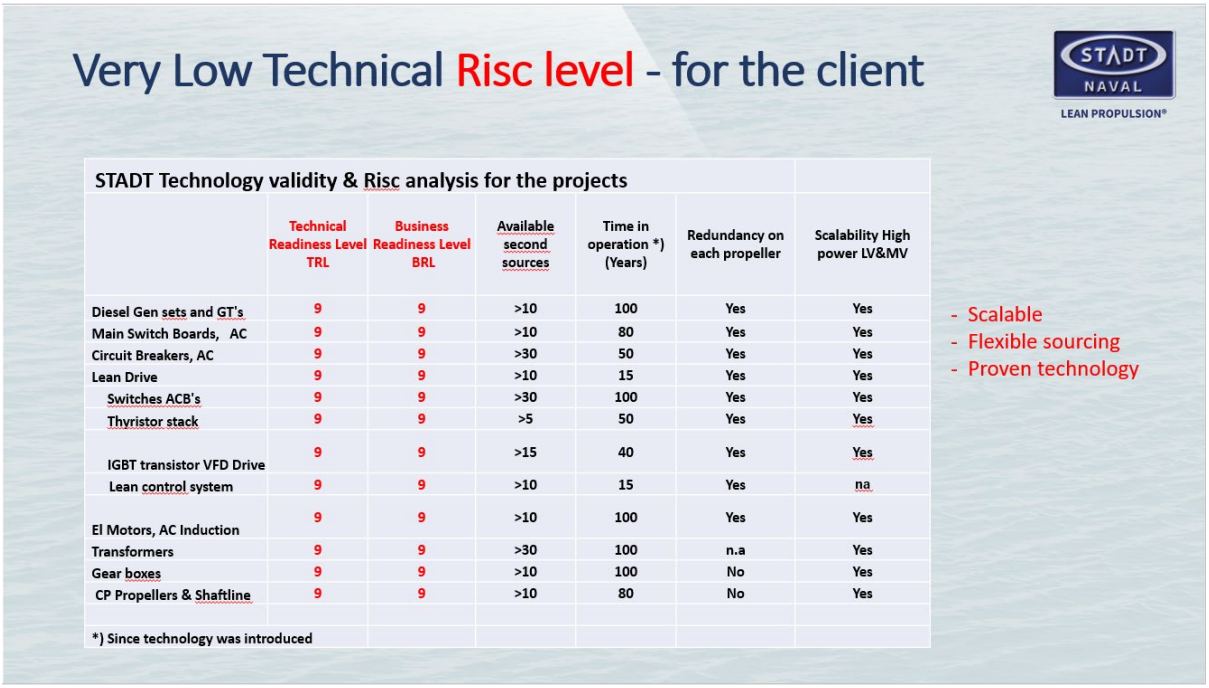
A DC grid can never be stealth or noise free. Never. Not possible.

There are no good arguments for talking DC grid. 1,000-Volt DC cannot be used for anything on board a ship directly. *Nothing.*

Because the generators are AC, electric motors are AC, you cannot run a transformer with the DC, as we see here, the red dots. Everywhere around the ship, full of inverters and transistor technology. That will create a lot of EMI and complexity and costs.

So, the choice:

RISK mitigation in shipping:



Looking into our Lean drive technology, we have looked also at the TRL and VRL type of levels, on all the issues in the propulsion chain, so to say. And we have found that what we are doing has the highest levels on *all* elements through the system, from the generators, switchboards, AC motors, etc.

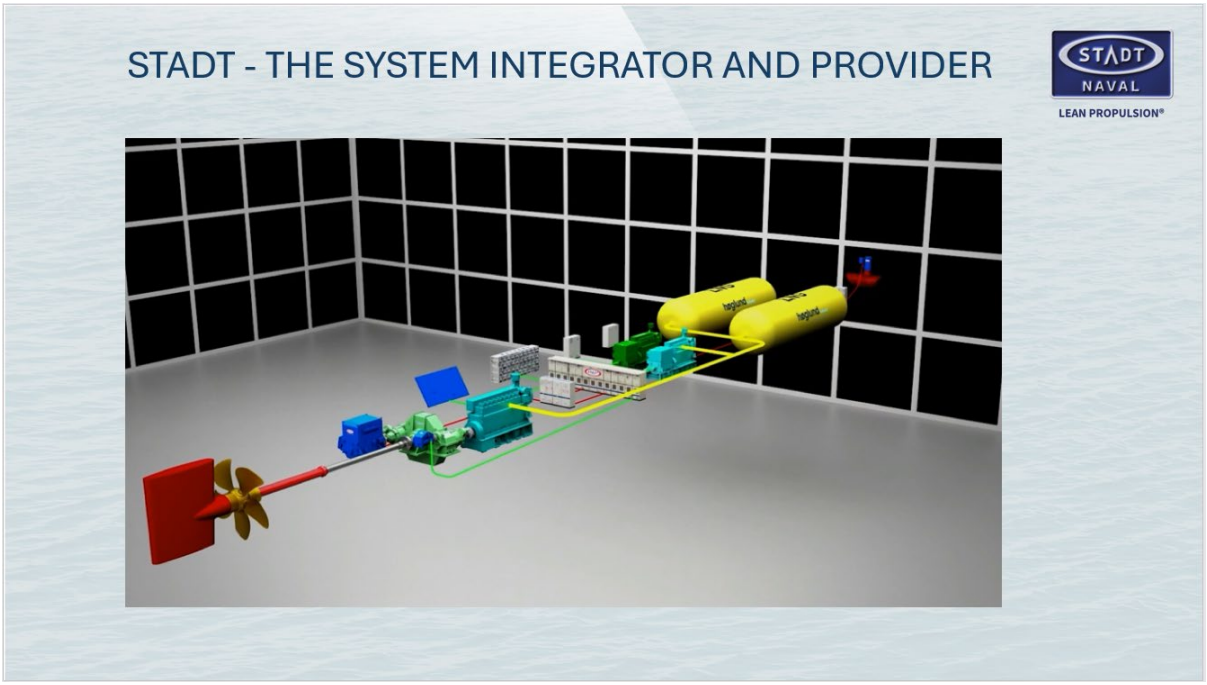
It's well-proven elements that have shown to work over years. And this is very important in our understanding. And it's also scalable.

We have flexible sources, not single sources, which is very often the case with complex technology. You have one source, and you even need to have the right batch number of those components. And then you are in the hands of the supplier.

How long? How many years? How big is this batch? You are not in that type of discussion with our technology. This is very, very important.

How would such Risk diagram look like for other competing technology – we may wonder?

STADT – your system integrator and solution provider



This is simulation of the energy system, how we work with digital twins.

For instance, we have just been through an EDF program where this was the issue with simulation and modeling of energy and propulsion systems.

New electronic weapons

The lasers, they are picking up in power. We are talking now about lasers in the range of megawatts with maybe 5, 6, 7 Megawatts of power need coming on the horizon.

And of course, we must look in the medium and long-term future here. We are not talking about what is today. We must think 5, 10, 15 years ahead of us.

What will be developed? What will be available? And of course, even I didn't believe in the railgun, but now the Japanese is implementing it. I think they will make it. Railguns will need a hell of a lot of electric power.

This is some of the projects we have done together with SAAB, which is one of our key customers. Three ships so far. One is already sailing. The two next is under commissioning in Poland.

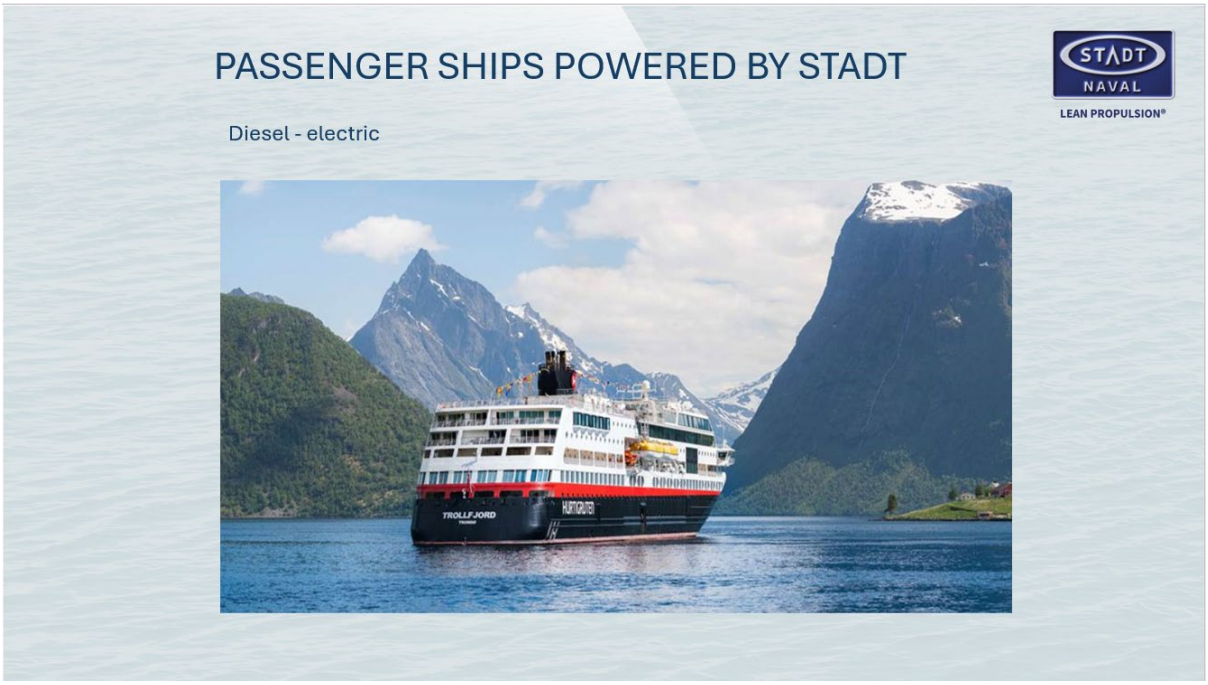
This is a signal intelligence ship. It is a very sensitive operation. And of course, our stealth technology is the superior solution for that.

Research ships sailing flawlessly – for over 17 years

This is one of the ships with a TRL-9 level, as we say, operating 17 years flawlessly, two of them working worldwide in research, seabed exploration.

This is from the generator room in this research.

Passenger ships powered by STADT – Trollfjord and Midnatsol



So, the AC grid is very important for us - be careful about the DC grid arguments. They are very vague and not very realistic.

The STADT test facilities in Norway

STADT projects in Poland


STADT
LEAN PROPULSION
WIND
SOLAR
BATTERY
WASTE HEAT REC.
FUELCELL
AC
AC
The Royal Institution of Naval Architects
STADT received the RINA Maritime Innovation Award for it's AC grid and Drive architecture
LET US DESIGN YOUR NEW SUSTAINABLE PROPULSION SOLUTION
STADT - AN INNOVATIVE SUPPLIER AND SYSTEMINTEGRATOR OF ELECTRIC PROPULSION FOR COMMERCIAL AND NAVAL VESSELS – INSTALLED IN OVER 150 VESSELS AND OPERATING SUCCESSFULLY ALL OVER THE WORLD.
> STEALTH silence - no interference - no acoustic noise
> HIGHLY EFFICIENT – close to zero power loss (0,1%) in Lean drive
> LOW WEIGHT AND SPACE CONSUMPTION - more space for cargo
> RELIABLE – over the lifetime of any vessel – proven low maintenance costs
> Ready for ZERO EMISSION operation
STADT NAVAL
WWW.STADT.NO