Wireless Charging

QUESTIONS & ANSWERS

Wärtsilä has developed a wireless charging system for easy transfer of power from the shore to ship, replacing the traditional cable connection method. This technology is particularly suitable for fully electric vessels using batteries which spend little time at the dock, such as ferries for example. Using the Wireless Charger, power transfer can start the moment the vessel is docked rather than having to wait until cables are connected. This means that the same energy can be supplied to the vessel over a longer time, which reduces the total power rating of the shore connection system.

Frequently asked questions

QUESTION 1:
What are the vessel applications best suited for Wärtsilä's wireless charging system?

Wireless charging is best suited for applications where a high number of charging periods per day are necessary. This is especially true in harsh marine climates, since wireless charging systems experience no contact wear and have no exposed electrical contacts. Ferries definitely fall within this category, as do tugs and other coastal vessels, depending upon their actual operational profile. More advanced applications may also benefit from the advantages of having a total separation between the primary and secondary systems. With the introduction of more automated, and even autonomous vessels, inductive charging is designed and tested to offer a completely automated procedure where no human interaction is necessary.

QUESTION 2:
What is the capacity of the Wärtsilä wireless charger?

One standard basic unit delivers 2.5MW. Landside and onboard connections are normally 690VAC, but that can be adapted with transformers and there is also the possibility for a common DC bus connection. At 690V, 2.5MW corresponds to 2500Arms three phase. The power rating of the charging system can easily be increased by using several units in parallel, or by specifying a larger unit with an increased active coil area.

QUESTION 3:
Is significant jetty infrastructure work needed, and does a high energy power supply need to be added from the grid to the jetty?

The landside equipment for a wireless charger has a rather low profile compared to other types of charging units. Depending upon the characteristics of the site and the vessel to be charged, the charging unit can be located on an existing concrete foundation or on custom designed beams. Given that charging from the landside is to be implemented, the wireless charger has the best utilization of available time of all charging methods, and correspondingly requires the lowest charging power for any given energy transfer necessary. For all types of charging, some jetty infrastructure work and high power supply is necessary.

QUESTION 4:
What power is needed on the jetty? Can existing power lines, even those found in remote community areas, be used?

Wärtsilä will provide a calculation of the energy and power needs for the vessel based on the conditions where it is being used, and together with the customer decide on the correct input to this calculation. The energy and power needed is mostly dependent upon the vessel's size, speed, sailing distance and timetable. However, with a wireless charger, the charging time can be longer than for other systems, thereby reducing the maximum power to some extent. This power reduction compared to other solutions may, in some cases, allow the use of existing power lines that have limited power capability, even without the use of local onshore batteries, (see also Q5). Should local batteries prove necessary, Wärtsilä can supply those, and in this case the system is directly DC connected to the wireless charger to give the best efficiency. Local batteries will often give better total economy than the upgrading of power lines to remote community areas.

QUESTION 5:
How do we prevent grid instability with such quick charging?

Grid instability is related to long or weak power lines, and the solution for this is to control the reactive power conditions at the site. Normally, the active power conditions are not that critical for grid stability, so the role of the battery is to reduce the peak charging power. However, with the Wärtsilä active rectifier we have developed and tested a system function that improves grid stability by supporting the reactive power. In some cases, this may stabilize the grid to the extent that local batteries are not necessary, in the same way that the wireless charger itself can contribute to this as described in the answer to the previous question. These two effects are cumulative, so they can be combined for a better overall effect.

QUESTION 6:
What about the cooling and system description?

Cooling of the systems is normally carried out using liquid cooling and local heat exchangers to air. This is a standard arrangement delivered as part of the containerized solution. It is also possible to connect to the ship and landside infrastructure, if such are available. For all projects, Wärtsilä delivers standard documentation that covers the mounting, commissioning, operations, and maintenance.

QUESTION 7:
What are the charging and heat dissipation (losses) rates, the cycles available, and the battery life?

As an example, one 2.5 MW system will fully charge a 1 MWh battery in 24 minutes. Normally, only a smaller part of the onboard battery is charged and discharged for each trip. For instance, 170 kWh of energy will be transferred in 4 minutes. It is also possible to charge with more than one 2.5 MW system at the same time, if necessary. Heat dissipation (losses) is dependent upon the actual power used for charging. Since wireless charging provides longer available charging time, a lower rate of charging power is necessary, and therefore the losses are also lower. The number of cycles and the battery life depend mostly on the ship’s operational profile.

QUESTION 8:
What are the losses and system efficiency of the wireless charging system?

A wireless charging system has very high efficiency, in the area of 95-97%. In some cases, the losses can be higher than for alternative charging systems, but where the prolonged charging time, and hence reduced charging power, of the wireless charging is optimally contributing the most (typically where charging times are low), the losses with wireless charging can be lower than for other systems. There are many factors that influence overall efficiency, and it is the total system design that normally decides this. The cost of lost energy for a system with 95% efficiency will not normally be significant.

QUESTION 9:
What are the relative motion limitations between jetty and vessel?

The wireless system is designed to function as long as the relative coverage between the primary and secondary charging coils is 75%. This means that large vertical motion during loading and unloading is allowed, and longitudinal motion somewhat less. Sideways between the two charging plates, the allowed variation is >0.35 metres. Should the ferry leave the dock quickly, there is no disconnection necessary, the system shuts down as normal.

QUESTION 10:
What are the options for locations onboard the vessel and on the jetty, in case the jetty is not configured with a side charging application? Instead of a midship location for wireless charging, can it be incorporated into the terminal vehicle ramp or other locations?

The charging plate can be arranged both amidships and towards the ends. The weight of the charging plate affects the possibility to locate it on the vehicle ramp, so in this case the size of the ferry is important.

Ferries, for example, normally dock from bow and stern and the system is well suited for this application. The standard concepts have charging plates located in one of two different locations on the ferry: close to the middle of the ferry, or close to the ramp. The charging plates in both cases are vertical, located on the side of the ship. Both are suitable for ferries docking from bow and stern, however the charging plates are on the side of the ship.

Except for small vessels, it is also possible to arrange the charging plates in a vertical orientation on the side of the ramp. However, for any item located on the ramp, access depends upon availability to the ramp area.

Most ferries will have some kind of side support when docked, where a landside unit can be suspended, using one of the two standard solutions.

QUESTION 11:
How deep does the wireless charging receiver on the side of the vessel extend into the hull?

The normal depth of a complete system is 90 cm.

QUESTION 12:
What are the average annual maintenance costs for this equipment?

There is no scheduled maintenance other than for the normal inspections of the electrical system, fans and pumps.

QUESTION 13:
What is the expected operational life of the equipment?

The equipment is designed to operate for at least 15 years and with the correct maintenance it may function even longer. Wärtsilä will support the system design for at least 15 years, after which upgrades to the system may be needed to correspond to the latest technology in the field.

QUESTION 14:
Compare the price and value with the cheaper and proven option of a plug-in connection?

All fast charging systems for vessels are still in their infancy, and operational experience is, therefore, limited. Most systems are under development. The investment cost for induction charging will be in the same range as for the currently available plug-in systems, provided that there is energy storage installed onshore and the rating is below 2.5 MW. For larger ratings, the cost differences will increase. When considering the need for energy storage onshore, this is depending upon necessary charging power vs local grid conditions. Therefore, the wireless charger can for some projects be installed without onshore energy storage where a plug charger will need onshore energy storage. The price comparison in these cases will be between wireless charger without onshore energy storage and plug charger with onshore energy storage, which gives the wireless charger a major price advantage. For projects where energy storage is not necessary for any of the options, plug-in systems may be somewhat cheaper, depending on the configuration.

QUESTION 15:
How does Wärtsilä's wireless inductive charging compare in efficiency and cost to other existing charging options?

The other charging options are the conventional plug-in and pantograph methods. Each of them comes with a set of pros and cons, the most obvious negatives being safety, wear, creepage, and the absence of weather immunity with plugs and pantographs. Comparing the cost of these systems without including a cost for maintenance, safety, and availability does not give the whole picture. Safety and availability are important differentiators with wireless charging. As regards efficiency, wireless charging is better for short charging times (5-10 minutes) where the charging time can be utilized 100%, meaning that less current is used than with a traditional system.

QUESTION 16:
Does proximity to other systems, such as navigation, automation, electromagnetic or electromotive fields, medical devices, mobile phones etc. cause any kind of interference or possible danger to the devices or personnel?

With regard to magnetic fields, and also noise, the systems have been tested by Nemko according to relevant guidelines, as described by Statens Strålevern in Norway (the Norwegian authority on radiation). These are in line with international regulations for passenger transport. The design and construction ensure that neither the devices nor personnel will be at any form of risk or disturbance.

QUESTION 17:
What about the possible effect on pacemakers? (And other health concerns, also EMF concerns, etc)

The standard chosen when designing the magnetic screen, and the testing of magnetic fields involves levels that apply to the general public/all body/all time, and this is well below that which is expected to affect persons with pacemakers and those having other EMF concerns. Recommendations from suppliers of such equipment should be followed.

QUESTION 18:
Describe shielding and its ability to contain adverse fields?

The energy transfer is made via a controlled magnetic field between the landside and onboard charging coils. Onboard the ferry, there is a screen which limits the magnetic field outside this zone, so only very low fields reach the passenger and crew zones.

QUESTION 19:
Is the wireless charging system affected by weather conditions, like rain, ice, snow, and possible ice build-up?

No, the wireless charging system is fully encapsulated, and has built-in heating and a dehumidifier. The outer surfaces of the charging plates and wiring will in normal winter conditions be free of ice and snow because of the built-in heating, which will melt the inner part of the frozen layers and cause the ice and snow to drop from the vertical charging plates.

In rare conditions, with very heavy icing where any seaside construction would ice over (and passenger traffic would hardly be possible), the ice must be removed manually from the construction or by hosing with warm water (since the wireless charger is sealed, this solution would not be a problem).

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