Examining the possibilities of battery powered car ferries

Electric potential

The combination of ABB's recent advances in marine electrical systems and the on-going improvement of battery technologies is opening up fresh possibilities for all-electric vessels. This case study plots the potential for an electric powered, zero emissions car ferry.

Over that last five years, ABB has developed an electrical system platform that enables the simple integration of energy storage media, such as batteries, into vessel power systems. At the same time the increasing sophistication, availability and performance of battery technologies has enhanced their potential, pushing them closer to a wide-scale adoption within marine power systems.

These two factors combine to make battery powered car ferries a viable alternative to diesel powered units, even for locations where the available power from shore is limited and charging times are short. Such systems are fully scalable and have strong potential for vessels with transit times of up to at least 25-30 minutes. In this scenario there would be little or no need for alterations to vessel timetables.

Ferry facts

This case study focuses on a ferry with a capacity limit of 300 passengers and around 110 cars. It has a diesel-mechanical propulsion system, with power output of 2 x 750 kW, is 100m in length and utilises a service speed of 12 knots. The ferry operates continuously through the night. It spends three minutes quayside in the early morning, five minutes during the day and 15 minutes at night.

The graphs in Figure 1 illustrate the power demand across a standard journey. Transit times are 15 minutes for most of the day except for early morning, when power is increased to reduce the journey to just 12 minutes. This requires a higher demand from the batteries. Charging facilities can be found at both ends of the route, with 400kW of power available.

The following sections describe the main characteristics of a fully electric version of the above vessel.

All electric system details

The onboard DC grid system platform forms the basis of the vessel's power system. The nature of DC battery power allows for an efficient flow, and easy control, of power.

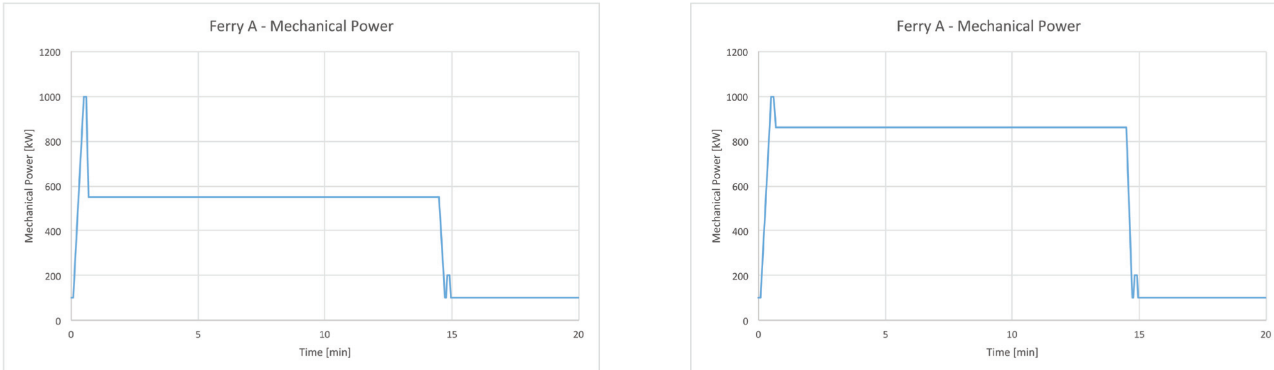

Figure 1: (Left) Power consumption during 15 minute transit. (Right) Power consumption during 12 minute transit

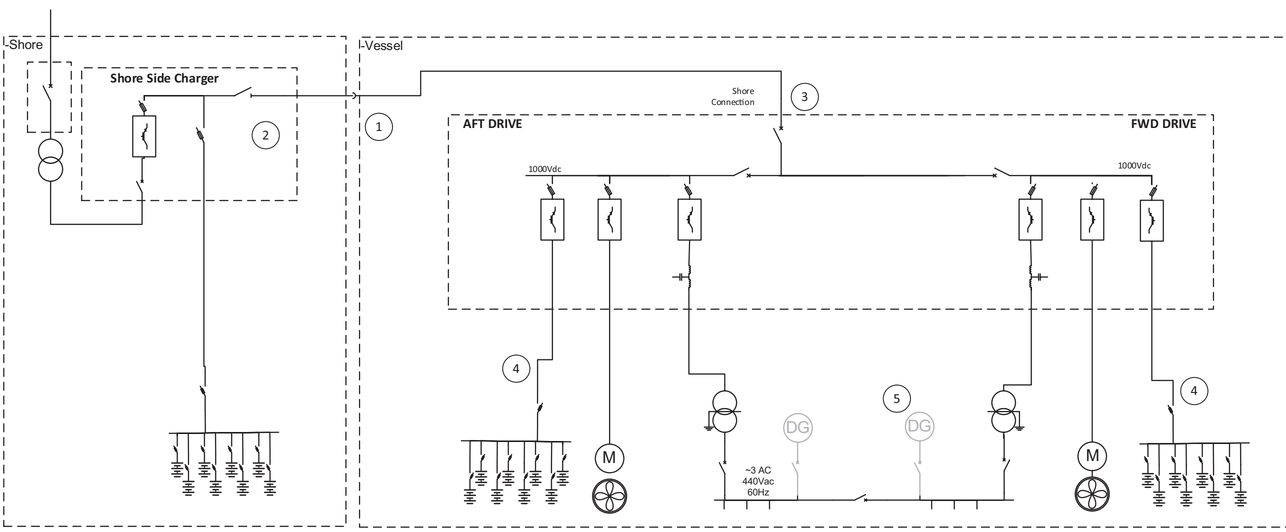

Figure 2: Conceptual drawing of shore and vessel hybrid power system

1. Vessel's onboard power system.

2. Charging station on shore: The voltage is rectified and transferred to the vessel using DC voltage. A battery of 500kWh is used to buffer energy from the grid. The principal two reasons for this are: A) Energy transfer can be significantly increased without increasing power drawn from the grid. This means that the size of the battery onboard can be decreased, mitigating the impact of short charging times. B) The energy-buffering capability of the battery means that the charging station can draw a more constant power from the network.

3. Shore connection: the vessel is automatically connected to the charging station within 15 seconds of arrival. This is done without operator input. Capacity is 2400kW. An auto-mooring device can be used to reduce consumption in harbour, but this is not a requirement.

4. Multiple parallel batteries are used to reach the necessary battery size of 1000kWh. This gives the added benefit of redundancy should one system fail.

5. Auxiliary generator sets can be fitted to supplement battery power during fault situations.

The graphs below show how the onboard battery's charge develops through the course of the day. The early morning period of higher transit speeds and shorter charging duration is shown to start a little after 5am, continuing to around 7am.

The charging station on shore draws an average power of 200kW from the grid and peaks at around 350kW. When connected to the vessel, the charging station, utilising the buffered energy in the battery, can deliver up to 2.4MW worth of power to the ferry.

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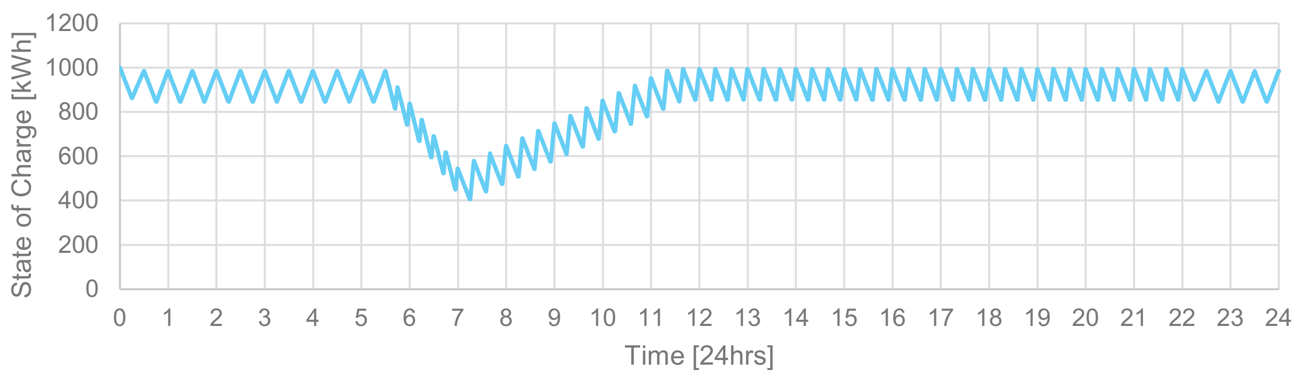

Figure 3: State of charge of the vessel's onboard battery

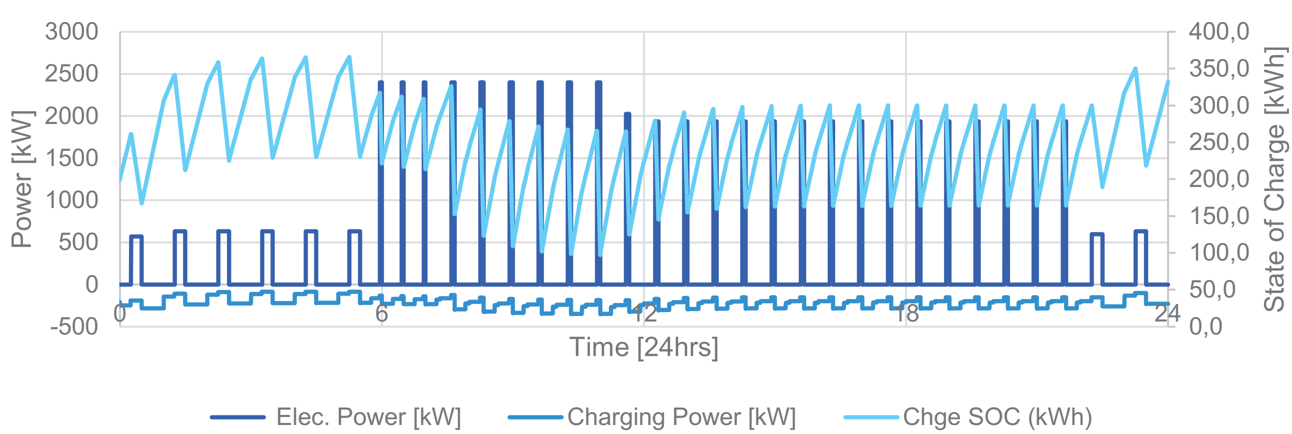

Figure 4: Key parameters of one of the two charging stations