How can Asia advance adoption of hybrid, electric and fuel cell technologies?

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Q&A Summary

**MS** | Ma Shiao, BOS Offshore & Marine
**II** | Dr. Imran Ibrahim, DNV GL – Maritime Advisory
**SK** | Dr Sanjay C Kuttan, Singapore Maritime Institute
**JD** | Jon Diller, Spear Power Systems
Consider a hybrid system on an ocean-going vessel where the battery is only used to relieve the engines from the dynamic load. What power % should be considered? What energy storage shall be considered? What is the order of magnitude of added cost, mass and volume per kW or KWh for the "add on" hybrid system?

II | You could refer to this study to get some insights to the question. https://www.dnvgl.com/news/man-energy-solutions-corvus-energy-and-dnv-gl-present-results-of-hycas-study-on-hybrid-power-generation-150069

JD | The battery is an important part of a peak shaving system and I think you'll find that having it as an asset provides several benefits beyond its primary purpose. To get the best answers I would talk to your propulsion or electrical system integrator, and if you don't sense a lot of experience and creativity consider broadening your reach a bit. Lots of further comments and questions available if you like!

MS | It is one of the reasons why BOS wants to develop a mathematical model of the hybrid electric system to get insights.
Jon: Lithium-ion batteries will be a poor solution for medium to long-range plug-in vessels. What are your thoughts?

II | Indeed the volumetric energy density for batteries is quite low compared to other fuel types.

JD | All electric propulsion (regardless of the energy storage medium) is a real challenge for long range vessels the way we think of them today. Batteries don't obey Moore’s law and even if they had an order of magnitude improvement in energy density they won't replace fossil fuels -- which means we need to think differently about how and what we propel across the water. The IMO is driving really innovative thinking and we're proud to play a role in many of the more creative solutions being put forward.

MS | Lithium-Ion batteries are still good for hybrid electric systems to make medium to long range ships 'greener' although they may not be zero emission yet.
We are concerned about cell to cell propagation testing and dedicated exhaust vents to channel any thermal runway gases completely separate from the battery room. Can you comment?

II | You can refer to the type approval guidelines for Lithium Batteries here https://rules.dnvgl.com/docs/pdf/DNVGL/CP/2015-12/DNVGL-CP-0418.pdf. There's a portion on cell to cell propagation.

SK | Battery safety is well studied and lots of effort is being taken to ensure safety. DNV GL and others have done studies on battery safety and this is an important an ongoing research topic.

JD | Your concern is valid, and it is reasonable to demand that your battery supplier limit cell to cell propagation to a single cell group. I'd be pleased to provide a detailed introduction to battery safety at your convenience.

When will hybrid electric be further adopted by tugs and harbour vessels in Asia? Which nations will be first?

II | Singapore seems to be leading in this

SK | Further to Jon's inputs Taiwan also has e-ferries

JD | Right now, in Singapore and Japan! We feel that Korea is close behind.
The electrical knowledge of on board crew will need to expand and more training may be needed. Can you comment?

II | Agreed

SK | Agree and most owner operators have indentified this a key enbler for electrification

JD | Absolutely; while lithium ion batteries require pleasantly little maintenence and a good system integrator makes things pretty transparent to the crew, excellence in onboard marine engineering demands a lot of knowledge sharing from the battery supplier and electrical system integrator. With some of the multi-MWh (really big) systems we're delivering in the near future, we will support multi-week training events for scores of crew members.

MS | Crews will need to be familiar with the various operation modes of the hybrid system. Some knowledge on LVDC /MVDC, batteries, power converters will be good.
Operation profile is key to design the power system and selection of battery for a hybrid vessel. Can you comment?

II | Yes. Operational Profile and Machinery Specification, understanding load profiles of the system when in operation

SK | Agree and we are pursuing this at the R&D level to develop design models to address this at an early stage effectively.

JD | That's very insightful; exactly the manner of use of the thing drives the nature of the thing. The more you know about how the battery will be loaded, the more precisely you can specify the battery, and the more value you'll get. An electrical integrator with extensive experience in propulsion loads can be really helpful.

MS | Yes. Operation Profile is the key. It has to be defined in a way that support the design and optimisation of hybrid vessel.
**DNV GL:** What is the autonomy level of the Autonomous vessels mentioned in your presentation?

**II |** Level 2

**What are the greatest challenges to integrating energy storage into hybrid propulsion on a workboat/ferry?**

**II |** Feasibility, Space, Safety

**SK |** Space, power, energy management

**JD |** Funding is generally the first obstacle, and takes the most time to overcome. Working out the battery space with the architect, yard, and class is an activity that depends on excellent collaboration, experience, and knowledge.

**MS |** Space and weight constraint and lack of choices in class type approved ESS
Spear : Do you have a plan to establish battery manufacturing facilities in Europe? I think local supply and support are major factors in front of electric vessels

SK | Economics of manufacturing is also important when it comes to siting

JD | We are opening a facility in Brussels; we agree strongly regarding the importance of locality.

When solid state batteries become widely available around 2030 what do expect them to cost

II | Battery prices are likely to fall with time.

JD | There is a very extensive set of variables to consider -- solid state won't be capable of everything today's LIBs do; it will be higher in inherent safety, which presents opportunities for cost savings; and we don't know how useful it will be to larger markets that make its economies of scale appropriate to the marine market's needs. It's easy to say something glib like "about half," but a more nuanced discussion is warranted.
Is there a study on the environmental costs / externalities from building and disposing the batteries in respect to their total life cycle?


JD | There are excellent studies attendant to the automotive industry. Googling 'life cycle environmental impact lithium ion' produces good results; starting with Majeau-Bettez et al's 2011 paper "Life Cycle Environmental Assessment of Lithium-Ion and Nickel Metal Hydride Batteries for Plug-In Hybrid and Battery Electric Vehicles" is a great starting point.

How suitable are hybrid electric vessels for India?

II | Very suitable. A lot of features within that support short sea operations

JD | Very -- India's has tons of inland waterways and short sea opportunities to benefit.