

H₂@PORTSSM WORKSHOP: QUESTIONS FOR DISCUSSION

Session I – U.S. Government Perspectives on Hydrogen at Ports and At-Sea Marine Applications

U.S. Department of Energy	Sunita Satyapal
U.S. Maritime Administration	Michael Carter
U.S. Environmental Protection Agency	Britney McCoy
California Air Resources Board	Leslie Goodbody

Moderator: Pete Devlin

1. What most excites you about the potential for hydrogen and fuel cell technologies in maritime applications?
2. What does the landscape for hydrogen ports look like so far? What do you consider to be the foremost challenges?
3. What actions need to be undertaken by government to ensure widespread and safe operation of hydrogen and fuel cell technologies for ports applications?
 - a. For example: are safety codes and standards effort supporting CNG/LNG a foundation for hydrogen fuel cell technologies? Why/why not?
4. What specific RD & D should government agencies be funding, if any versus the private sector? What are the priority needs?
5. How should government organizations coordinate and collaborate for the best chances of integrating hydrogen in ports?

Session II – International Government Perspectives on Hydrogen at Ports and At-Sea Marine Applications

European Commission	Robert Missen
FCH-JU	Mirela Atanasiu
Germany/NOW	Erik Schumacher
Norway/SINTEF	Steffen Moller-Holst
Japan/NEDO	Eiji Ohira

Moderator: Elizabeth Connelly

1. What issues and what kind of support has helped to bolster the status of hydrogen ports in your country/continent? What needs to be done to encourage industries?

2. What are the greatest barriers to widespread adoption of hydrogen fuel cell technologies for port and ship applications in your country/region? Which type of port and ship applications has the highest and potential wide-spread commercial use?
3. What specific RD & D should government agencies be funding, if any versus the private sector? What are the priority needs?
4. What needs to be done on a global basis to ensure hydrogen fuel cell technologies on ports are deployed most efficiently, effectively, and safely?
 - a. What groundwork has been undertaken to serve as the foundation for the safe operation of hydrogen fuel cell technologies?
 - b. What are the codes and standards that needs to be harmonized worldwide?
5. The proposed IMO target on 50% CO2 emission reduction by 2050 is expected to help the development of the low emission ship sector. To what extent will this target help development fully zero emission ships, specifically hydrogen fuel cell powered ships?

Session III – Infrastructure Stakeholders: Port Authorities Perspectives

Port of Los Angeles

Chris Cannon

Valenciaport Foundation

Mercedes de Juan

Hamburg Port Authority

Bjoern Pistol

Moderator : Charlie Myers

1. What are the biggest challenges in bringing fuel cell powered equipment and hydrogen into port terminals?
2. What are the early fuel cell port equipment applications that you would like to see developed for terminal operations?
3. What technical and performance information will port terminals need to see before they consider trials or adoption of fuel cell and hydrogen technologies?
4. Ports are faced with the challenge of motivating terminals, ships and drayage truck operators to adopt zero emission technologies. How do you see fuel cell and hydrogen technologies fitting into port strategies and what early port applications should be considered?
5. What specific RD & D should government agencies be funding, if any versus the private sector? What are the priority needs?

Session IV – Industry Perspectives: Ship Systems Developer

Golden Gate Zero Emission Marine	Joe Pratt
NCE Maritime CleanTech	Paul Helland
Wilh. Wilhelmsen Holding	Per Brinchmann

Moderator: Laurence Grand Clément

1. What in your opinion are the biggest challenges for hydrogen and fuel cell technologies in ships?
2. What specific RD & D should government agencies be funding, if any versus the private sector? What are the priority needs?
3. How would you ensure hydrogen infrastructure is adequate for ship operations?
4. What needs to be done to ensure the safe operation of hydrogen in ships?
 - a. What groundwork has been undertaken to serve as the foundation for this?
5. Is there a difference in acceptance of fossil-based versus renewable hydrogen? Is there willingness to pay more for green hydrogen?
6. Would “all-inclusive” offers covering vessels and fuel over a defined period be attractive to ships operators (the “Nikola approach” – a fixed monthly payment covering the vehicle, service, maintenance, and fuel)?

Session V – Industry Perspectives: Power Systems Developer

ABB	Klaus Vanska
BAE	Peter Brooks
General Electric	Renaud Cornu
Wärtsilä	Stefano Cantarut

Moderator : Charlie Myers

1. What in your opinion are the biggest technical and economic challenges for hydrogen and fuel cell technologies in maritime applications?
2. What specific RD & D should government agencies be funding, if any versus the private sector? What are the priority needs?
3. What needs to be done to ensure safety for hydrogen fuel cell ship operations?
 - a. What groundwork has been undertaken to serve as the foundation for the safe operation of hydrogen fuel cell technologies?
4. What are the most promising applications in terms of commercializing hydrogen fuel cell technologies for vessels? Do you see any commercialization pathways, where some

applications can be commercialized first and build the foundation for the next phase of applications?

5. How do you intend to address the system integration challenges (i.e. balance of plant, power electronics, system engineering challenges), and supply chain issues?

Session VI – Industry Perspectives: Vehicle & Fuel Cell Manufacturers

Hyster-Yale/Nuvera

Gus Block

Kenworth

Brian Lindgren

Cummins

Mahesh Kumar

Hydrogenics

Ryan Sookhoo

Ballard

Alan Mace

PowerCell Sweden

Johan Burgren

Nedstack

Roel Van de Pas

Moderator: Dimitrios Papageorgopoulos

1. What fuel cell- or hydrogen-related innovation, application or technology makes you most excited about the potential to transition to maritime transportation applications at ports or on ships?
2. What in your opinion are the biggest technical and economic challenges for hydrogen and fuel cell technologies in maritime/port applications (liquid/gas storage, refueling)?
 - a. The need for low-cost and enhanced fuel cell durability and efficiency have been identified as the main challenge for heavy-duty applications. Can you expand on these for on-ship and at-port applications? What are additional challenges for ship-board compared to land-based port applications?
 - b. Are there alternative fuels and power conversion approaches that could be considered (on-board reforming, direct liquid-fueled fuel cells)?
3. What needs to be done to ensure hydrogen fuel cells are deployed safely in maritime applications?
 - a. What groundwork has been undertaken to serve as the foundation for the safe operation of hydrogen fuel cell technologies?
4. Where is the “low hanging fruit” in terms of commercializing hydrogen fuel cell technologies at the ports or on ships? Which application has the highest penetration and potential impact in the near, mid and long term?
5. What specific RD & D should government agencies be funding, if any versus the private sector? What are the priority needs?

Session VII – Regulations, Codes and Standards

PersEE	Laurence Grand Clément
Lloyd's Register	Olav Hansen
DNV-GL	Anthony Teo
ClassNK	Koichi Nishifuji
U.S. Coast Guard (USCG)	LCDR Frank Strom

Moderator: Lionel Boillot

1. What are the codes and standards that needs to be harmonized worldwide?
2. What are the critical safety issues for hydrogen fuel cell operations on ships?
3. What components should be standardized to ensure a reliable integration of hydrogen ports technology worldwide?
4. What are the key safety, codes, and standards needs for onboard hydrogen storage and refueling?
5. What compliance methods may be used to manage safety risks (e.g. LNG safety analysis and models)?
6. What is the viability of hydrogen transport by ship? How does LH2 compare to LNG?