

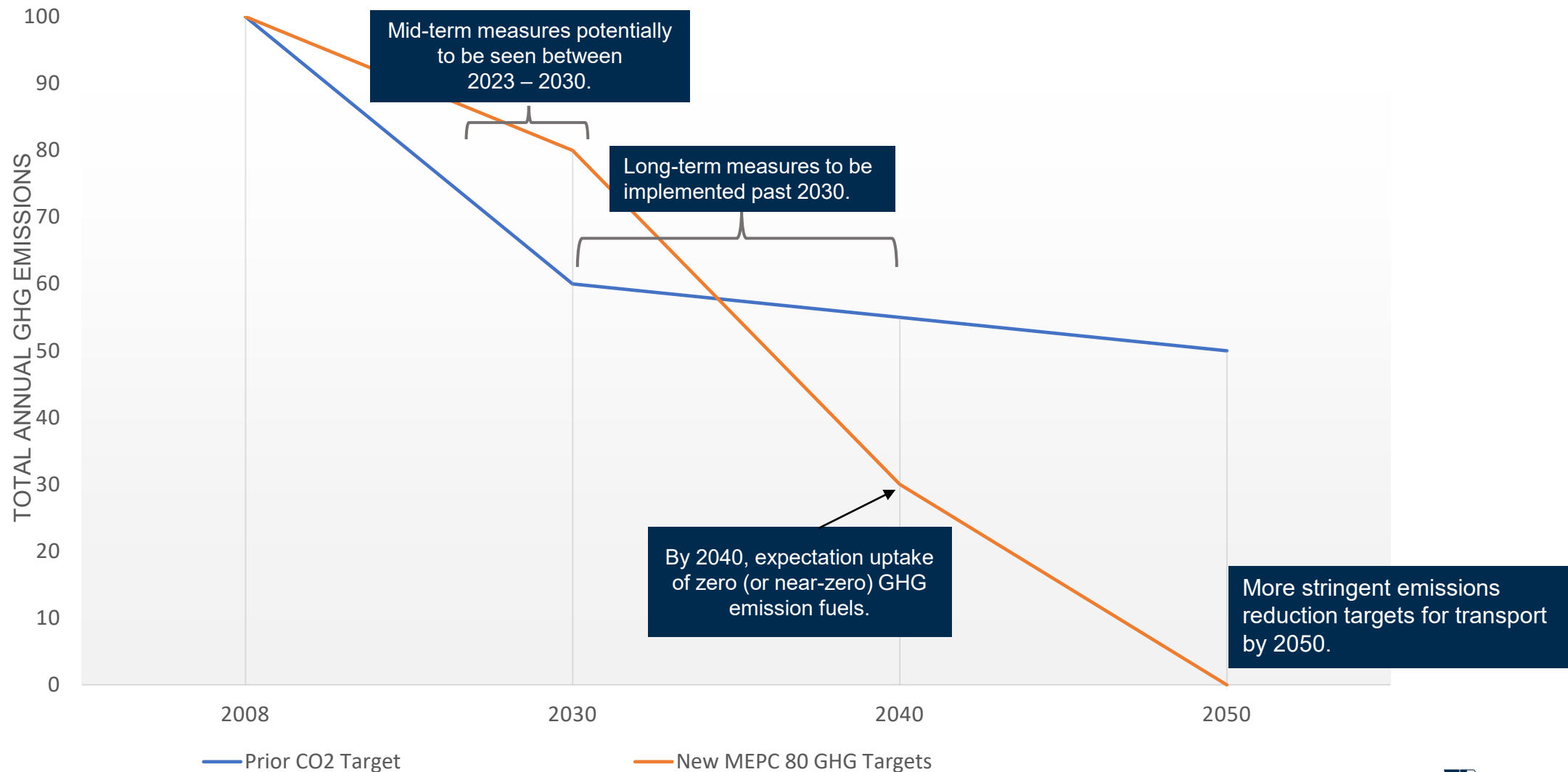
Nuclear Power in the Maritime Decarbonization

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Impact of MEPC 80

Well-to-wake focus on MEPC 80 is driving increased interest in adopting nuclear solutions



Decarbonization Solutions

Alternative Fuels and Energy Sources



LNG	Hydrogen		
LPG/Ethane		Ammonia	
Methanol			
Biofuels			
			Nuclear

Technology Improvements



Air Lubrication	Improved Hull & ESD Options		Wind/Solar
Hybrid	Fuel Cells	Electric Propulsion	
Cold Ironing		Carbon Capture (Shore/Side)	

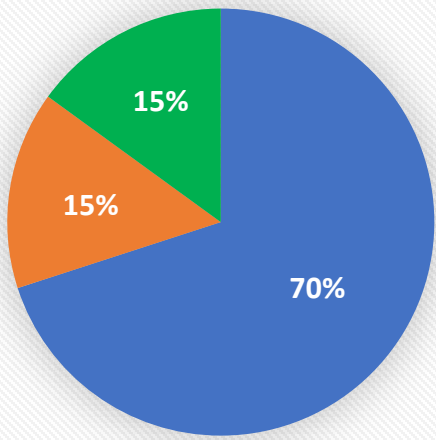
Operational Efficiency



Weather Routing		New Charter Arrangements	
Speed Optimization		Just in Time Shipping	
Vessel Performance Reporting	Smart Vessel / Improved Reliability	Fleet Interactive Performance / Optimization	



Decarbonization Solutions



- Alternative Fuels
- Technology Improvements
- Operational Efficiency

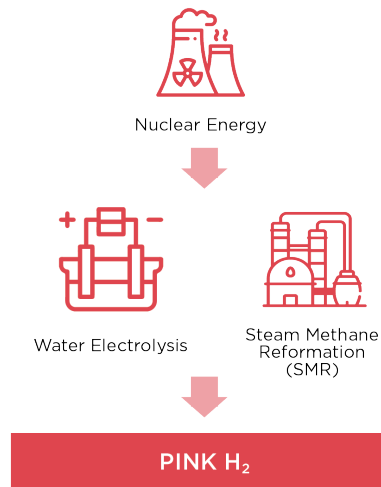


Nuclear — Maritime Use Cases



Near Shore Nuclear Power

- Floating power barge for grid electricity
- Suitable for arrays of microreactors or small modular reactors
- Supporting Port Electrification
- Offshore Facilities



Nuclear Generated Fuels

- Included in MEPC 80's mid-and long-term reduction targets
- Strong opportunity for competitive fuels
- Not widely developed



Nuclear-Electric Propulsion

- Reactors fitted for high power
- Zero-carbon switch
- Reduce or eliminate bunkering

History of Nuclear in Maritime

- United States
 - 1940: Research on marine nuclear propulsion
 - 1953: 1st naval test reactor, Mark 1
 - 1955: 1st nuclear submarine, USS Nautilus
 - 1962: U.S. Navy 26 nuclear submarines, 30 under construction
 - 1959: 1st nuclear-powered merchant vessel, N.S. Savannah
- USSR/Russia
 - 1955: 1st Soviet nuclear submarine, K-3 Leninsky Komsomol
 - 1957: 1st nuclear icebreaker, Lenin
 - Current: Ice Breaker fleet



NS (Nuclear Ship) Savannah, enroute to the World's Fair in Seattle, 1962 Credit: US Government - NARA

Current Military Use of Nuclear Power

US Navy	• Submarines (Attack, Ballistic/ Guided Missile) • Aircraft Carriers
Russian Navy	• Submarines (Attack, Ballistic/ Cruise Missile) • Battlecruiser
China	• Submarines (Attack, Ballistic)
British Navy	• Submarines (Attack, Ballistic)
France	• Submarines (Attack, Ballistic) • Aircraft Carrier
Indian Navy	• Submarine

Commercial Nuclear Challenges

Safety



- Zero GHG emissions.
- Replacement rather than refueling.
- Long fuel cycles.

Regulatory



- International (IAEA, IMO).
- Flag State.
- Coastal State.

Operational



- Nuclear maintenance at shipyards.
- Terminal considerations.
- Crew training requirements.
- End of life considerations.

Commercial/Social



- Capex requirements for construction.
- Trade location limitations.
- Public perception and acceptance.
- Public/private partnerships.

Thank You

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