The Green and Blue Ammonia Value Chain

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Black & Veatch’s Capabilities

- Renewable Power
- Hydrogen
- Ammonia
- Terminals
- LNG, including Bunkering
- Natural Gas Processing
- Carbon Capture

ENR 2021 Rankings

Top Design Firms
- #1 Solar Power
- #2 Power
- #2 Fossil Fuel
- #3 Offshore and Underwater Facilities
- #7 Water Services
- #9 Refineries and Petrochemical Plants
- #11 Top 50 Designer in International Markets
- #13 Top 500 Design Firms
- #17 Petroleum

Top Contractors
- #8 Power
- #15 Top 50 Contractors Working Abroad
- #20 Petroleum
Substantial infrastructure will be required to support ammonia marine fuel at the Port of Singapore
Ammonia Value Chain - Commercialization

Renewable (Wind) → Green Hydrogen Plant → Green Ammonia Plant → Storage and Export Facilities → Import and Storage Facility

Renewable (Solar) → Green Hydrogen Plant → Flue Gas Carbon Capture → Blue Hydrogen Plant → Blue Ammonia Plant → Storage and Export Facilities

Natural Gas → Blue Hydrogen Plant → Blue Ammonia Plant → Storage and Export Facilities

Ammonia Transport – Truck, Rail, Pipeline

Ammonia Carriers

Ammonia-fueled Vessel

Ammonia Bunkering Vessels

Fully Commercial  Still being Developed  Early Development
Ammonia Value Chain – TIC Cost & Schedule

**Conventional Ammonia (grey)**
- 5,000 TPD ~ $1.8 to 2.4 B, 44 to 48 months

**Green Ammonia**
- 5,000 MTPD ~ $3.2 to 4.1 B, 44 to 48 months

**Blue Ammonia**
- 5,000 MTPD ~ $2 to 2.6 B, 44 to 48 months
Ammonia Value Chain – TIC Cost & Schedule

3 GW
Renewable (Wind)
Onshore Wind ~ $4.1 B, 36 months
Offshore Wind ~ $9.6 B, 48 months
Renewable (Solar)
Solar ~ $2.7 B, 34 months
Natural Gas

Green Hydrogen Plant
Green Ammonia Plant
Storage and Export Facilities

Import and Storage Facility
Ammonia Carriers
Ammonia-fueled Vessel
Ammonia Bunkering Vessels

Storage and Export Facilities
150,000 MT ~ $120 M, 36 months

Blue Hydrogen Plant
Blue Ammonia Plant
Carbon Capture
Green/Blue Ammonia in Singapore

- Green/Blue ammonia infrastructure investment will be substantial
  - New renewable power
  - New ammonia plants
  - Ammonia transport (pipeline, truck, rail)
  - Ammonia import/export
  - Ammonia vessels (transport, bunkering, ammonia-fueled)

For 30% replacement of Port of Singapore fuels – 27.5 Million MTPA required
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