



# The Journey to 2050

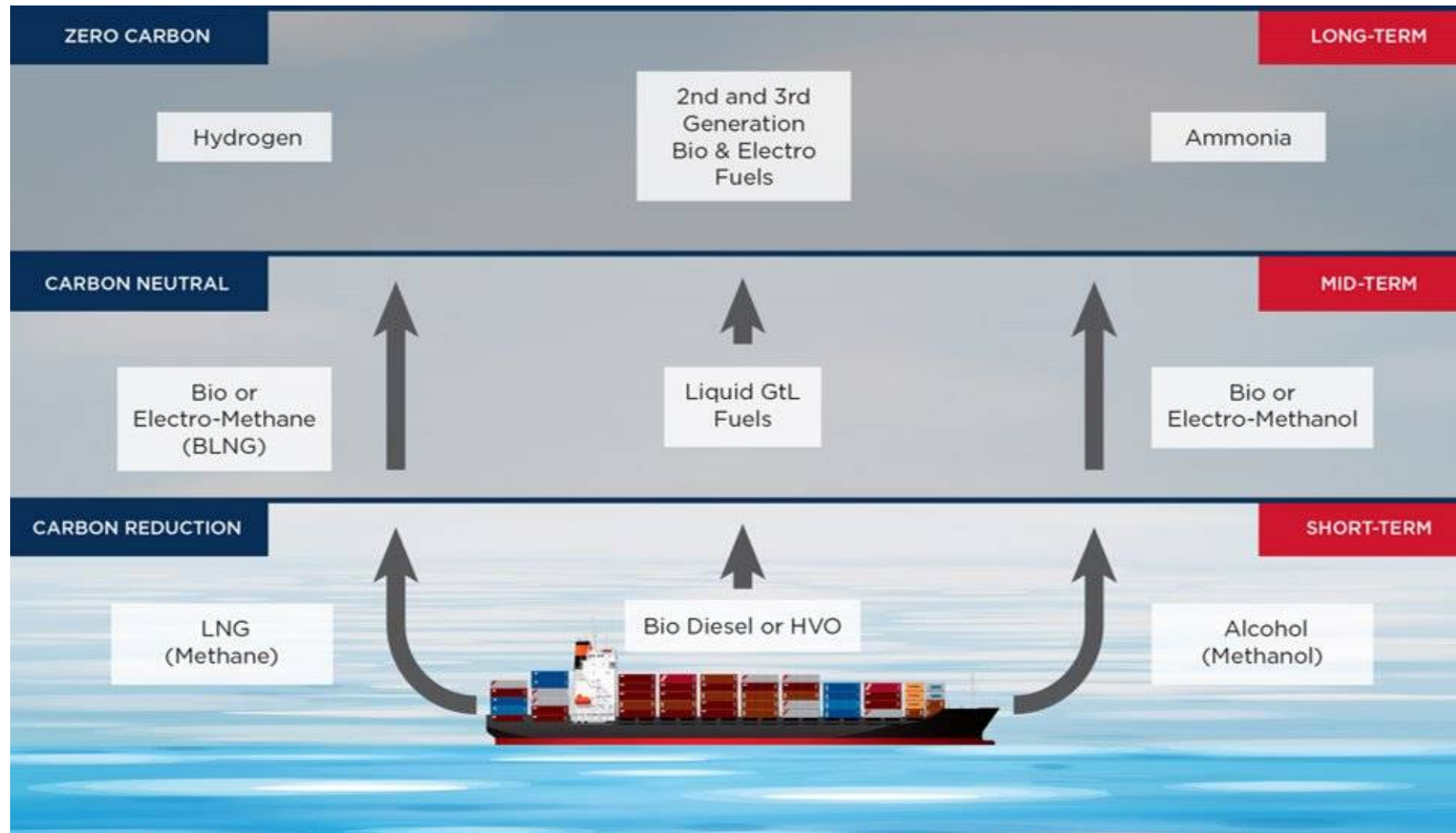
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# Fuel Pathways



# Fuel Types

| Fuel Type                 | Infrastructure                                                                      | Security of Supply                                                                    | Energy Density                                                                        | CO2                                                                                                                                                                                                   | SOx                                                                                   | Safety                                                                                |
|---------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Heavy Fuel Oil            |    |    |    |                                                                                                                    |    |    |
| Marine Diesel             |    |    |    |                                                                                                                    |    |    |
| LNG                       |    |    |    |                                                                                                                    |    |    |
| LPG                       |    |    |    |                                                                                                                    |    |    |
| Methanol (from Methane)   |    |    |    |                                                                                                                    |    |    |
| Methanol (from biomass)   |    |    |    |                                                                                                                    |    |    |
| Ammonia (from methane)    |    |    |    |                                                                                                                    |    |    |
| Ammonia (from renewable)  |    |    |    |                                                                                                                    |    |    |
| Hydrogen (from methane)   |   |   |   |                                                                                                                   |   |   |
| Hydrogen (from renewable) |  |  |  |                                                                                                                  |  |  |
| Biofuels                  |  |  |  |  <sup>1</sup>  <sup>2</sup> |  |  |

**Notes:**

- **Infrastructure** refers to existing bunkering infrastructure or facilities that can be adapted to support bunkering (e.g. import/export terminals)
- **Security of supply** refers to the availability of sufficient global production to meet significant demand from the marine sector for bunkers
- **Energy density** refers to the volumetric energy content of the fuel and on-board storage requirements
- **CO<sub>2</sub> and SO<sub>x</sub>** refers to impact on emissions
- **Safety** refers to handling, storage and consumption risks

# Technology Maturity Rates

| Component                   | Feature                                         | Potential Saving | Technology Readiness Level |
|-----------------------------|-------------------------------------------------|------------------|----------------------------|
| 1. Hull Design              | Lightweight materials<br>Hull coatings          | 2-5%             | 1-9                        |
|                             | Hull air lubrication system                     | 4-5%             | 9                          |
|                             | Ballast water reduction                         | 3-8%             | 3-6                        |
|                             | Hull form optimization<br>Energy saving devices | 5-15%            | 9                          |
| 2. Power and Propulsion     | Hybrid power/propulsion                         | 3-8%             | 7-9                        |
|                             | Power system/machinery optimization             |                  |                            |
|                             | Power system/machinery optimization             |                  |                            |
|                             | Waste heat recovery                             |                  |                            |
| 3. Alternative Fuels/Energy | Wind<br>Solar power                             | 2-12%            | 3-9                        |
|                             | LNG<br>LPG                                      | 20%              | 9                          |
|                             | Bio-Methanol<br>Bio-Ammonia                     | 75%              | 6-9                        |
|                             | Electric (non-renewable/renewable)              | 8-95%            | 7                          |
| 4. Operations               | Cold ironing                                    | 4%               | 9                          |
|                             | Speed/voyage optimization                       | 5-7%             | 9                          |

# Pathway to 2050

## Alternative Fuels and Energy Sources



- LNG
- LPG/Ethane
- Methanol (Regional)
- Biofuels (Regional)
- Biofuels (Global)
- Ammonia
- Hydrogen

## Technology Improvements



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

## Operational Efficiency

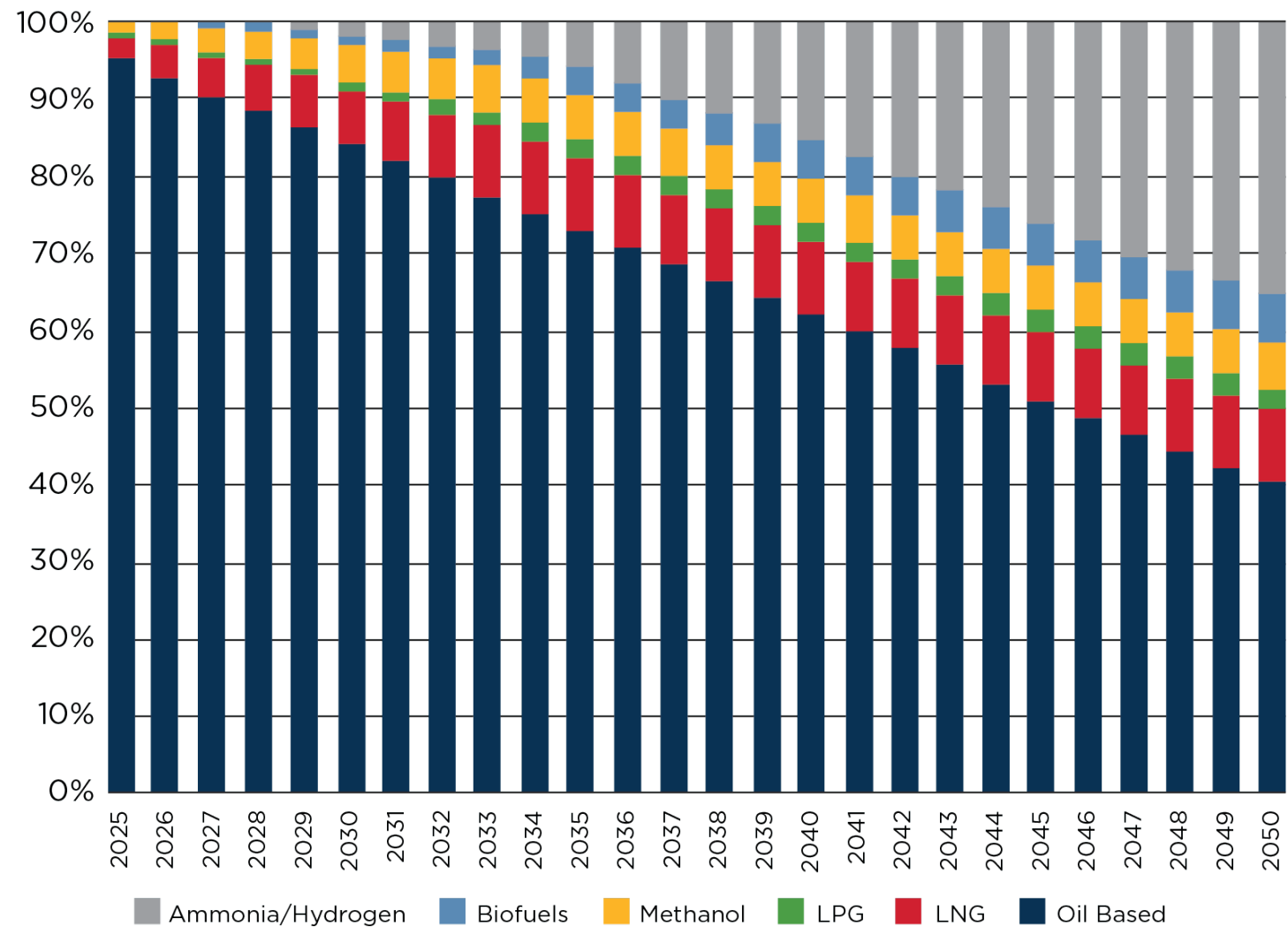


- Weather Routing
- New Charter Arrangements
- Speed Optimization
- Just in Time Shipping
- Vessel Performance Reporting
- Smart Vessel/ Improved Reliability
- Fleet Interactive Performance/ Optimization

2050

Pathway to 2050

# Fuel Forecast



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# Talent Equation Transformation

**Age + Experience + Skills + Training = Talent**





# Talent Equation Transformation

**((New Technology + Rate of Change of Technology) + People) + Learning = Talent**







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# Thank You

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