
# Ammonia in the fuel mix towards 2050

## DNV GL Energy Transition Outlook 2019

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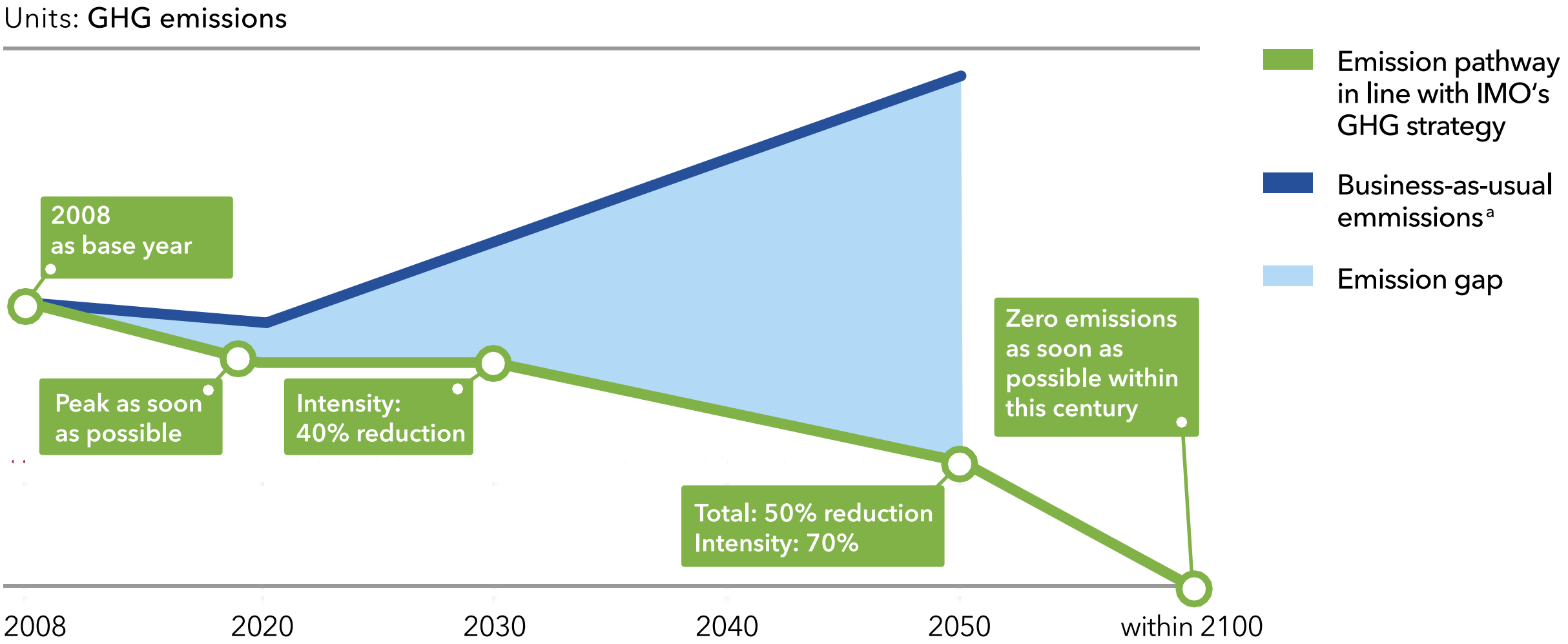
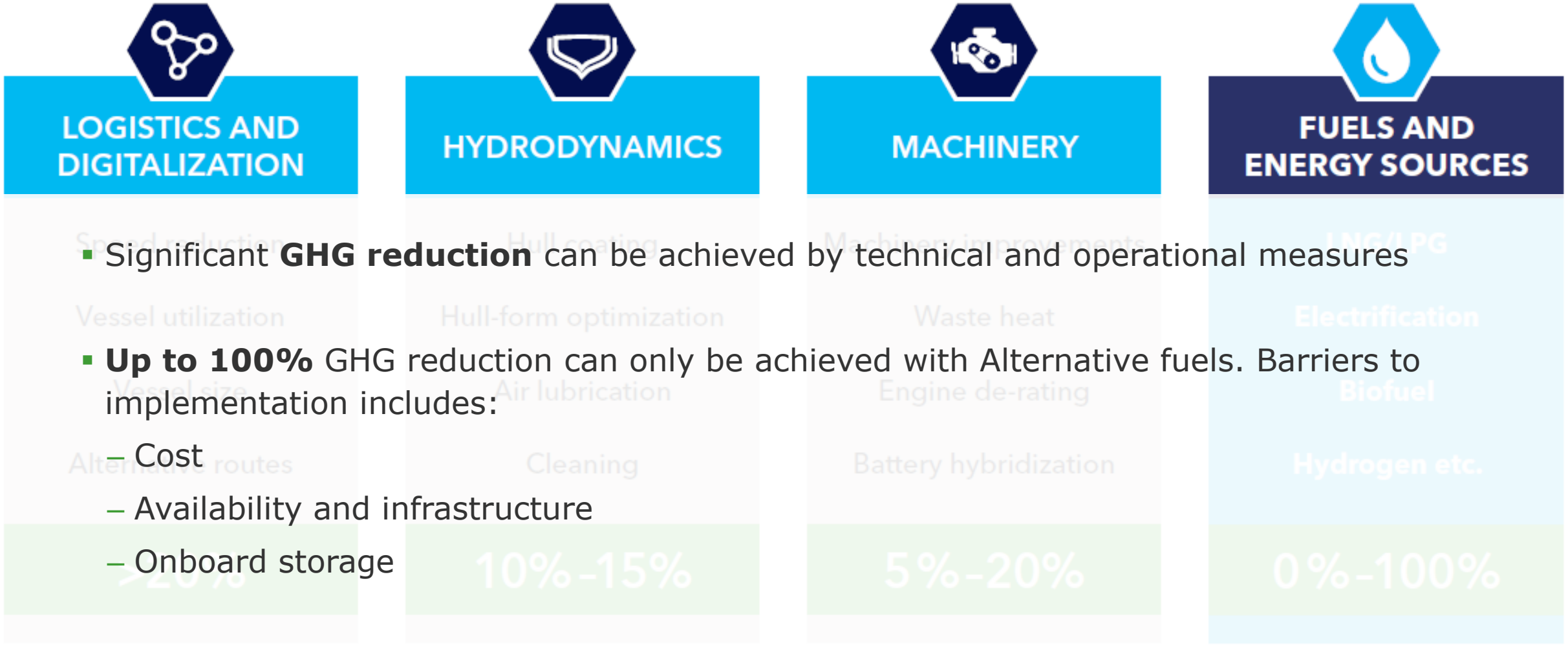
# MARITIME FORECAST TO 2050

## Energy Transition Outlook 2019

# The foundation for the outlook is the IMO GHG strategy



# Decarbonization options for shipping

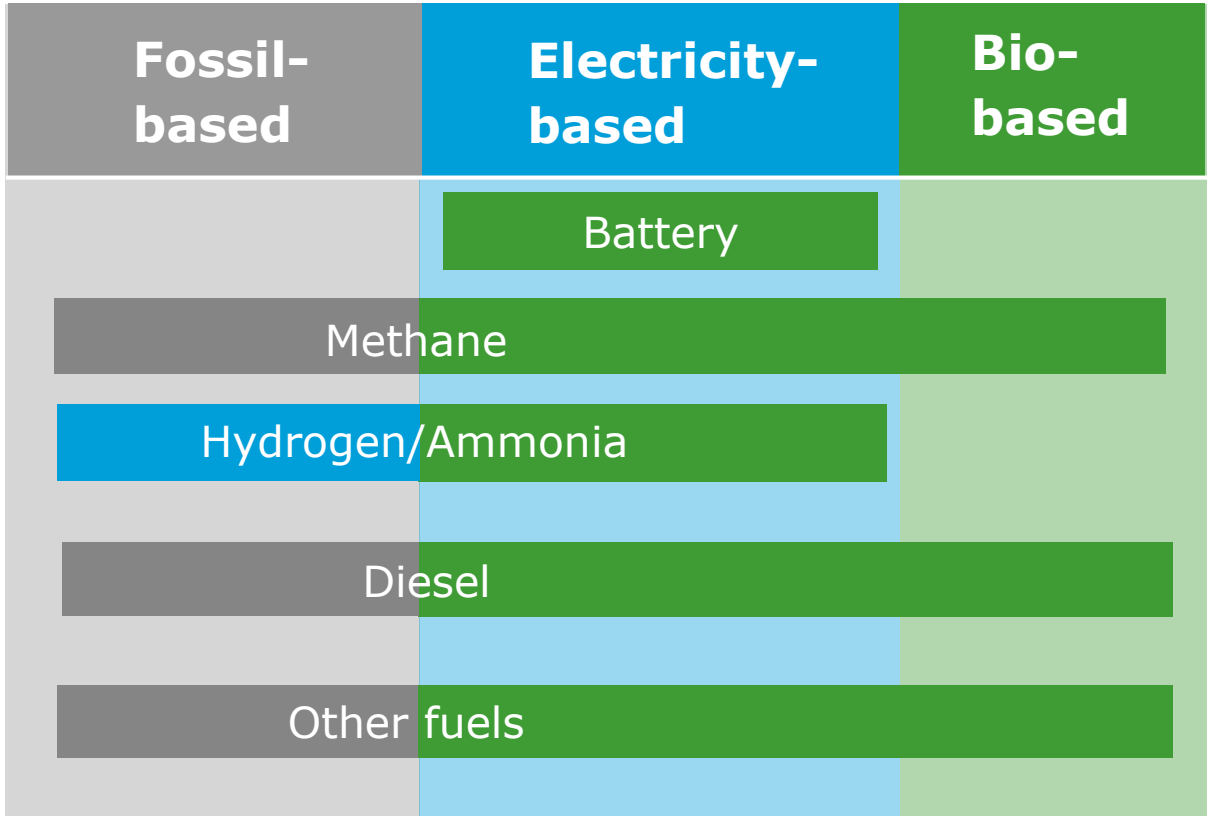



- Significant **GHG reduction** can be achieved by technical and operational measures
- **Up to 100%** GHG reduction can only be achieved with Alternative fuels. Barriers to implementation includes:
  - Cost
  - Availability and infrastructure
  - Onboard storage

# Decarbonization options for shipping - alternative fuels and energy sources

**Three** main "family types" of fuels, categorized based on energy source.

- Similar fuels can originate from different energy sources, but lifecycle emissions and cost vary greatly
- A given energy converter (e.g. combustion engine) may apply many alternative fuels

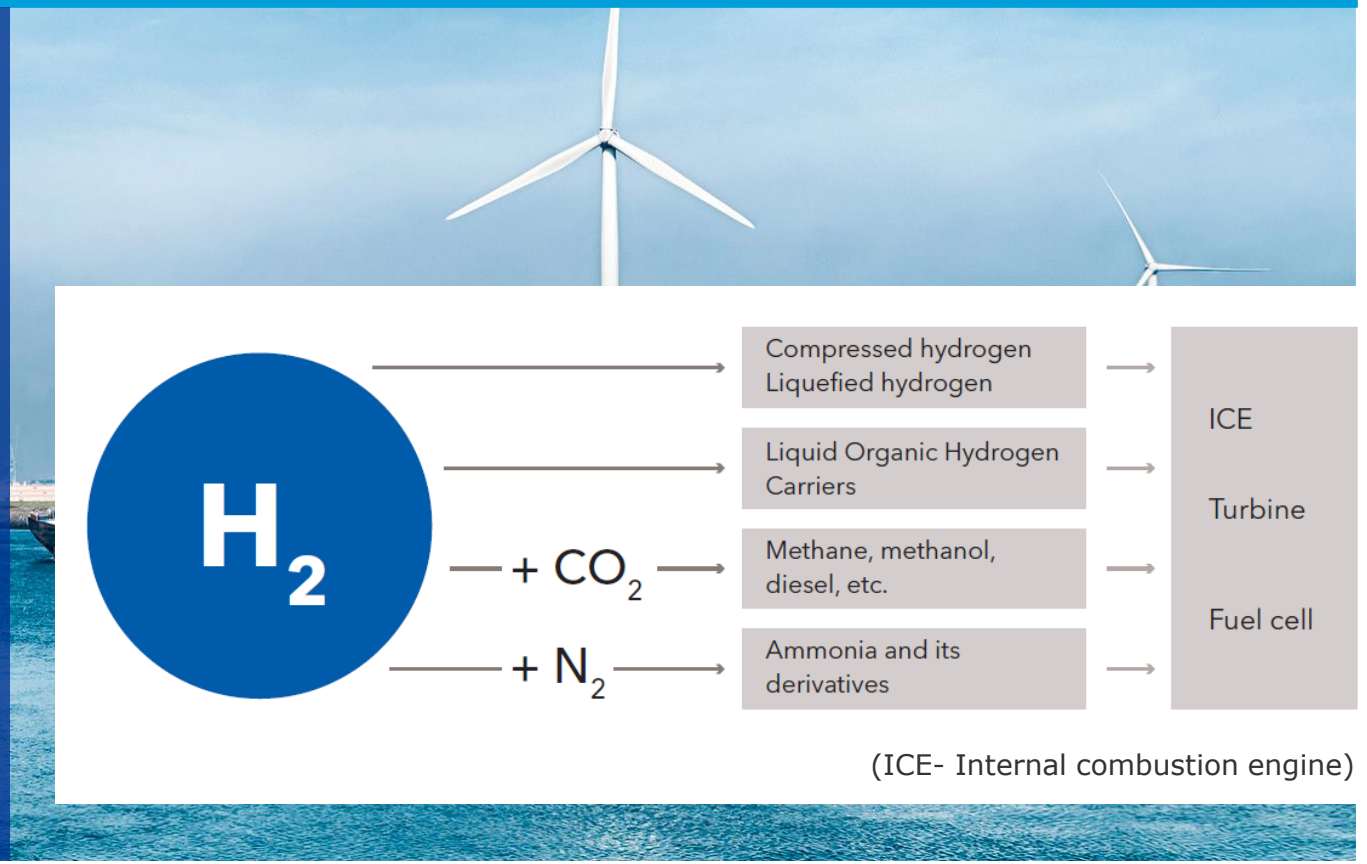



Source: Maritime Forecast to 2050, DNV GL 2019

# Electricity-based fuels

## Renewable **electricity** in batteries is energy efficient and carbon free

- **Hydrogen** ($H_2$) is a carbon-free alternative energy carrier produced from:
  - Electrolysis using electricity from renewables or nuclear (i.e. "green" $H_2$)
  - Reforming natural gas with CCS (i.e. "blue" $H_2$)
- Carbon neutral fuels can also be produced from renewable **electricity and $H_2$** (electrofuels):
  - Diesel, methane and methanol (from combining $H_2$ and $CO_2$)
  - Ammonia (from combining $H_2$ and nitrogen)

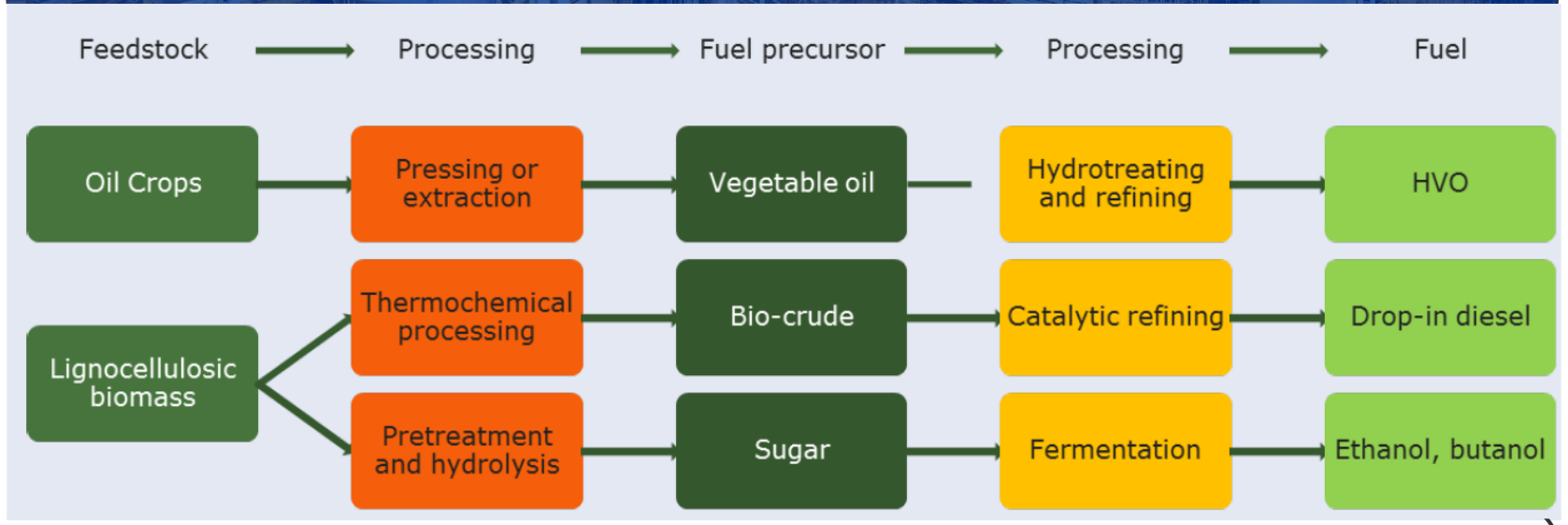



(ICE- Internal combustion engine)

# Biofuels start to gain traction in the market

- **Biofuels**
  - has carbon emissions at the stack, but the emission is considered as being part of the natural carbon cycle
  - exist in gas-phase and liquid-phase
  - can be **blended** with conventional fuels or
  - used as **drop-in** fuels fully substituting conventional fossil fuels
  - challenges relate to price and sustainable production in sufficient volumes

**Marine biofuel production technologies**




(IEA, 2017)

# Other fuel options

## LPG

- 2017: no activity
- 2019:
  - 4 LPG carriers - retrofits
  - 7 new LPG carriers ordered

**DNV GL just published Class Rules for LPG as a fuel**

## Methanol

- 1 passenger vessel
- 7 methanol tankers
- 5 new methanol tankers orderd
- Main challenge: fuel cost

**DNV GL has Low Flashpoint Liquid fuel rules that address methanol since 2013**

## Hydrogen

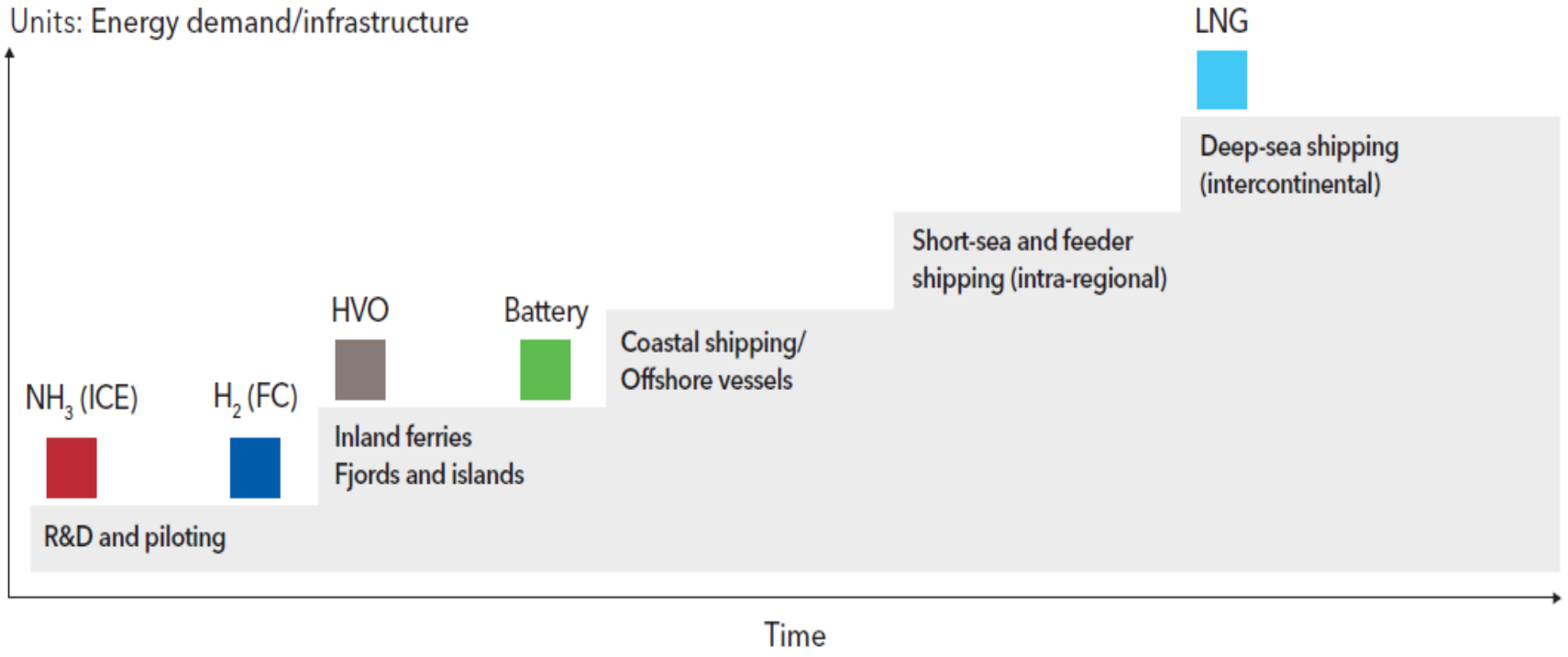
- 2 Passenger ferries ordered
- Main challenges:
  - CapEx
  - Fuel cost
  - Storage space
- Mainly for short-sea shipping

## Ammonia

- Can be used in internal combustion engines
- Suitable for deep sea shipping
- Easy to store
- Main challenge: very toxic and corrosive
- Ammonia tankers already interested

**DNV GL working with industry partners for removing barriers both for hydrogen and ammonia**

# Alternative fuels must evolve over time to increase marked penetration

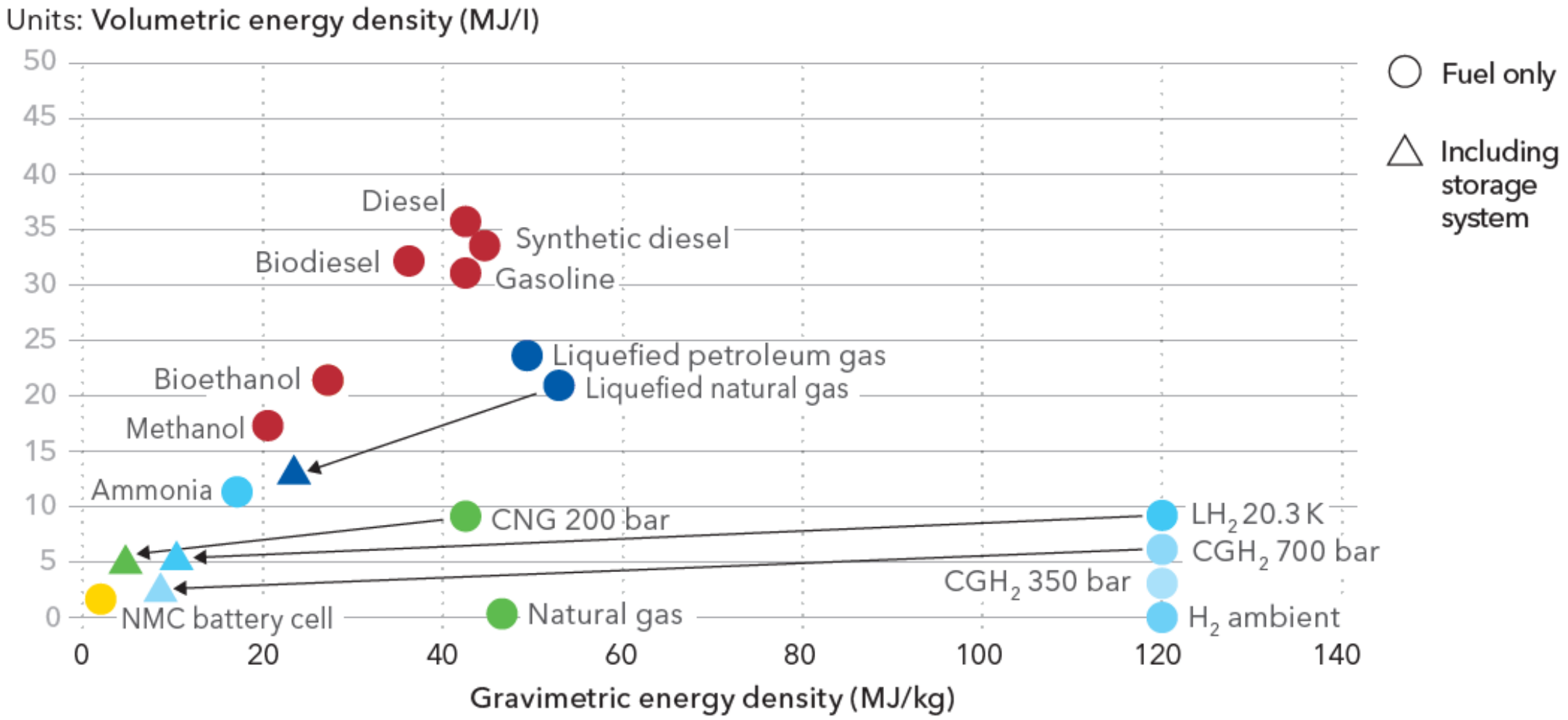



Gradual steps allow for:
- **maturing** of technology
- scaling of supply and **infrastructure**

Not all the options have the potential to reach the deep-sea stage, mainly due to limited energy density

It took LNG around 20 years to climb all steps. To reach the IMO targets, carbon-neutral fuels must mature faster!

# Alternative fuels will require more space on board (approximate values)

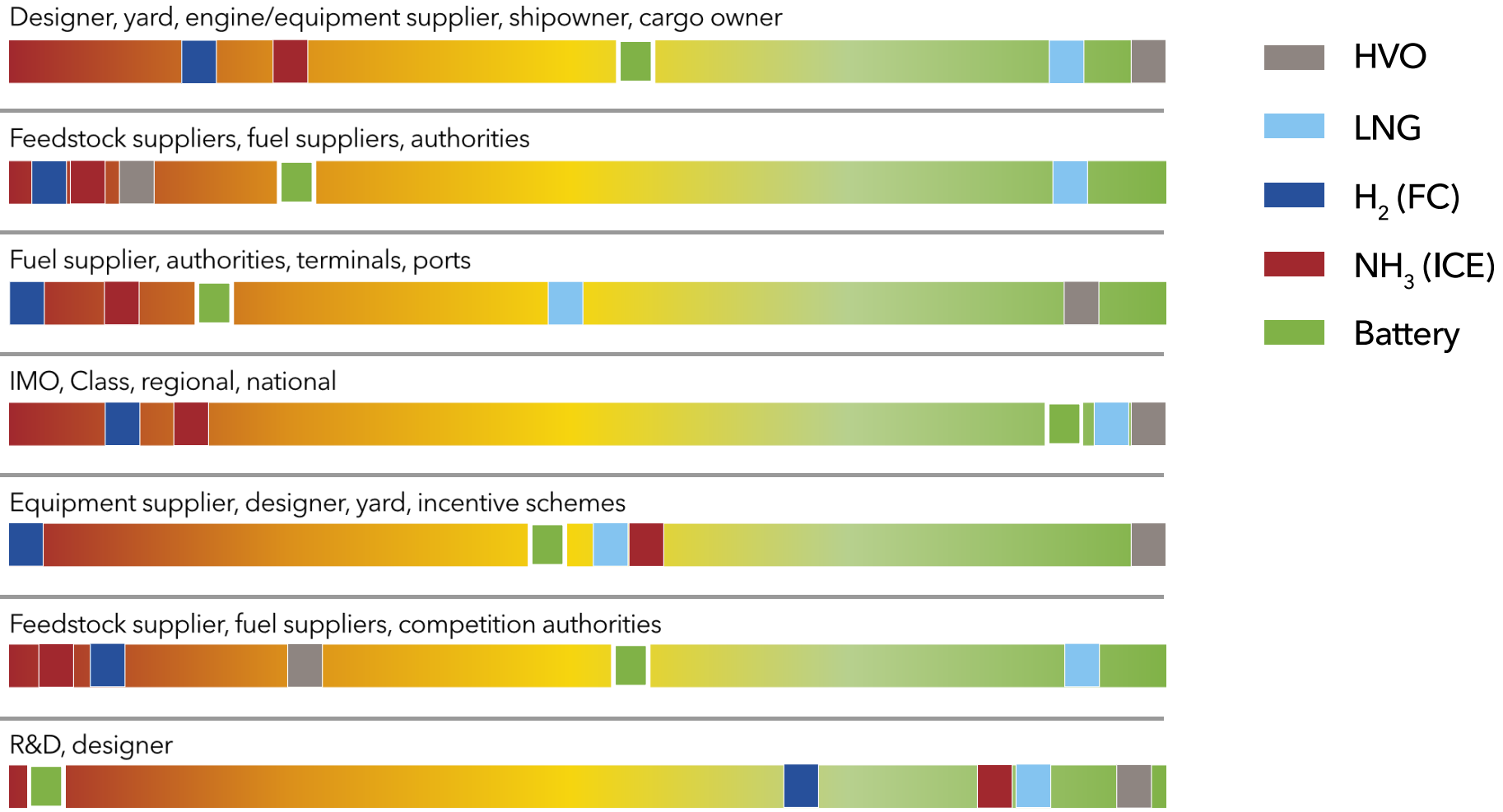


# The Alternative Fuel Barrier Dashboard: Indicative status of key barriers for selected alternative fuels

Barriers exists on many levels for different fuels.

Adoption of alternative fuels depend on

- demand from charters/cargo owners,
- proactive regulators,
- procurement policies and
- incentive schemes and international cooperation



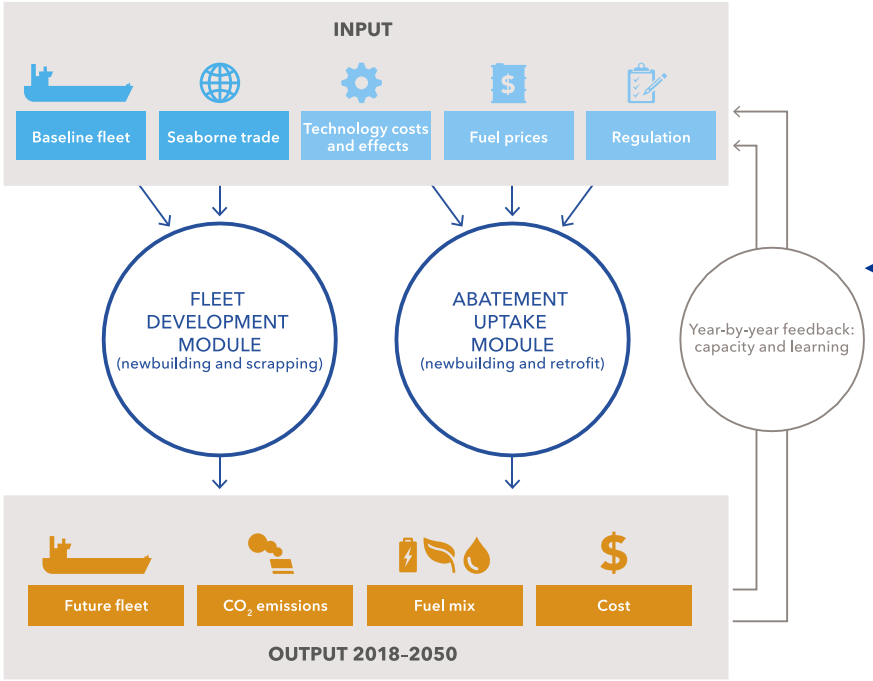
# Pathway Model; We explore the impact of specific GHG regulations

## Regulatory input to the model: Three different policy designs

**1** What would happen if **no further decarbonization policies** are put in place?

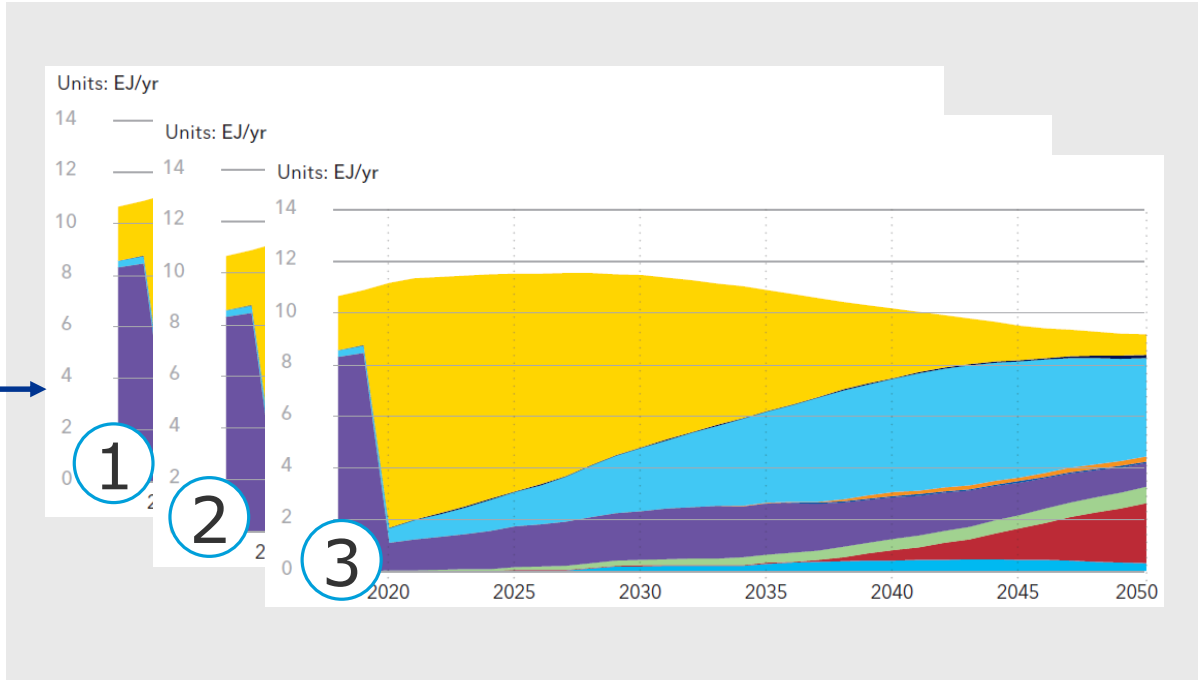
**2** What is the effect of stricter **operational requirements?**

**3** What if main focus is on stricter **design requirements**?



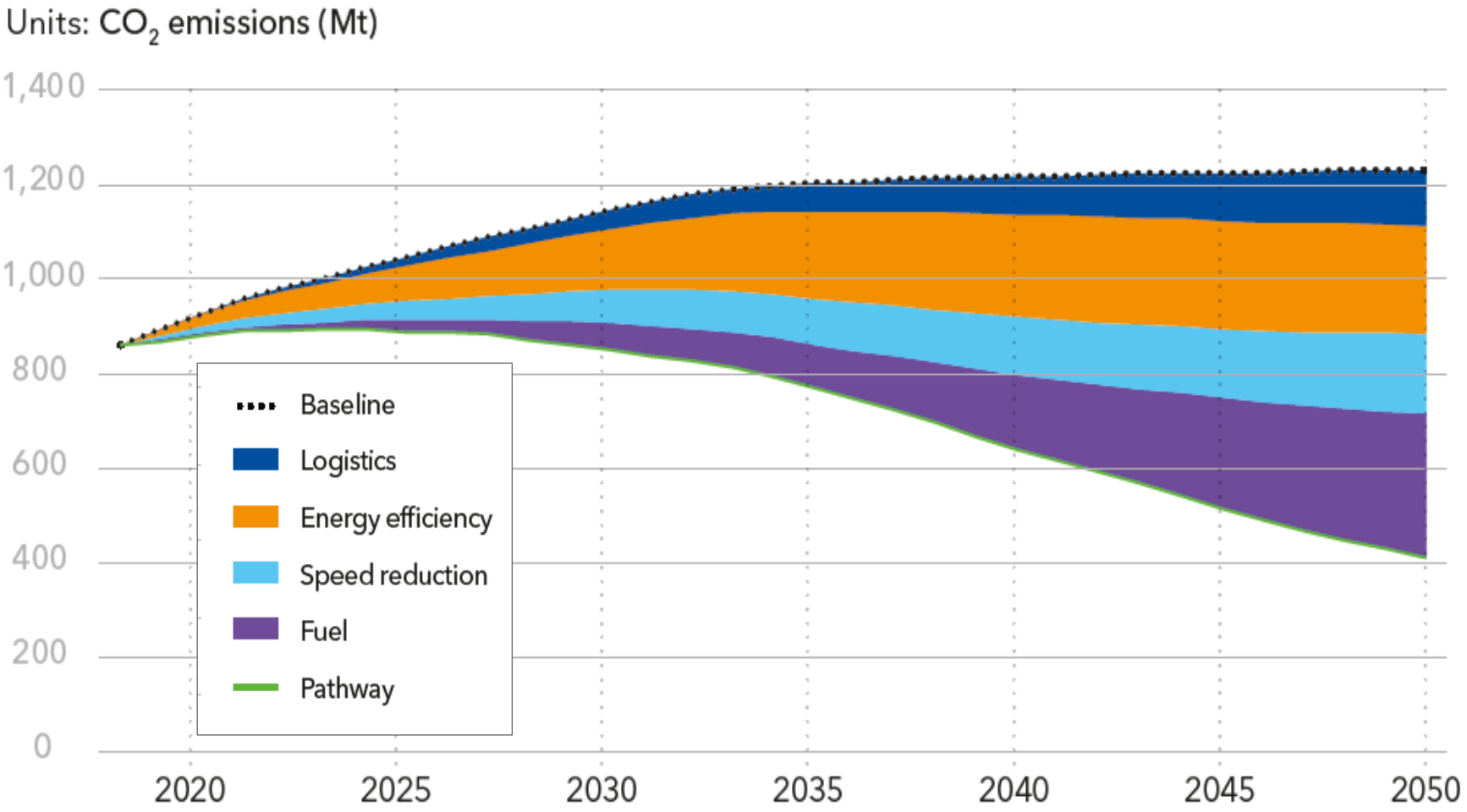

**Model**

**Output**



# $CO_2$ emissions towards 2050 in the 'Design requirements' pathway

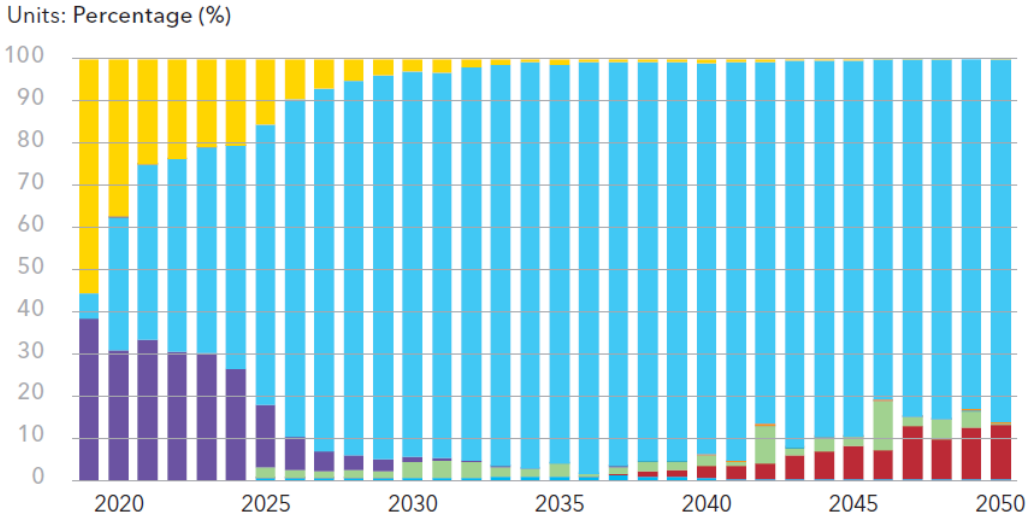
- Both the **design** and **operational** focused regulatory pathways fulfill the IMO ambitions:
  - New fuels, alongside energy efficiency, will play a key role.
  - Carbon-neutral fuels need to supply 30%–40% of the total energy in 2050.
- The "Current policy" pathway **is not** fulfilling the IMO ambitions.

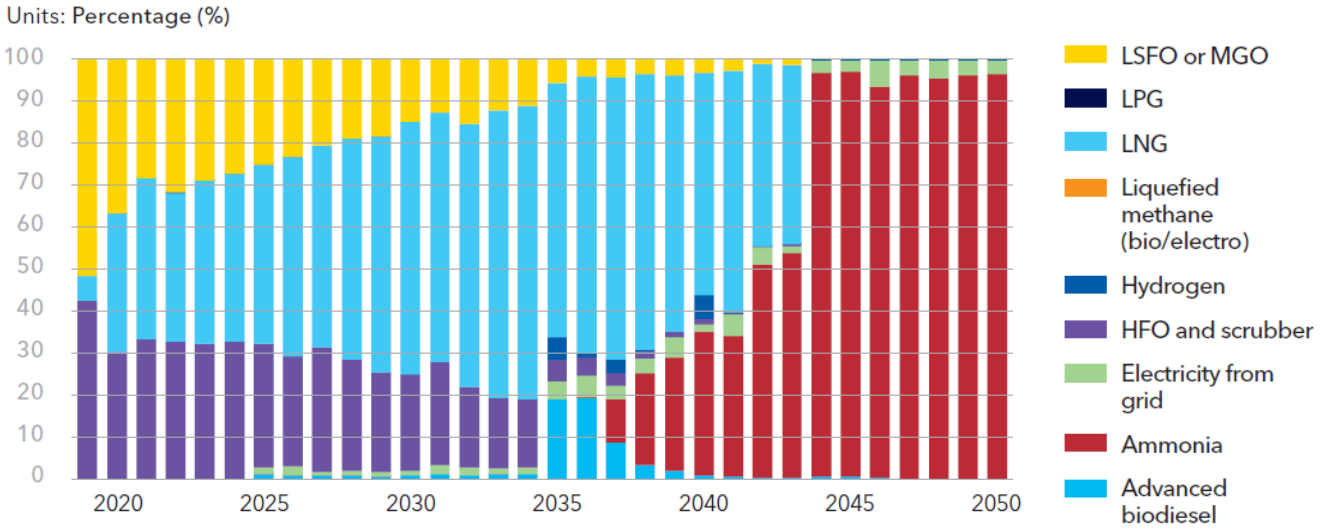


# Several ways to meet the IMO targets - policy matters

Focusing on **operational requirements**, the uptake of alternative fuel for newbuilding's is more gradual

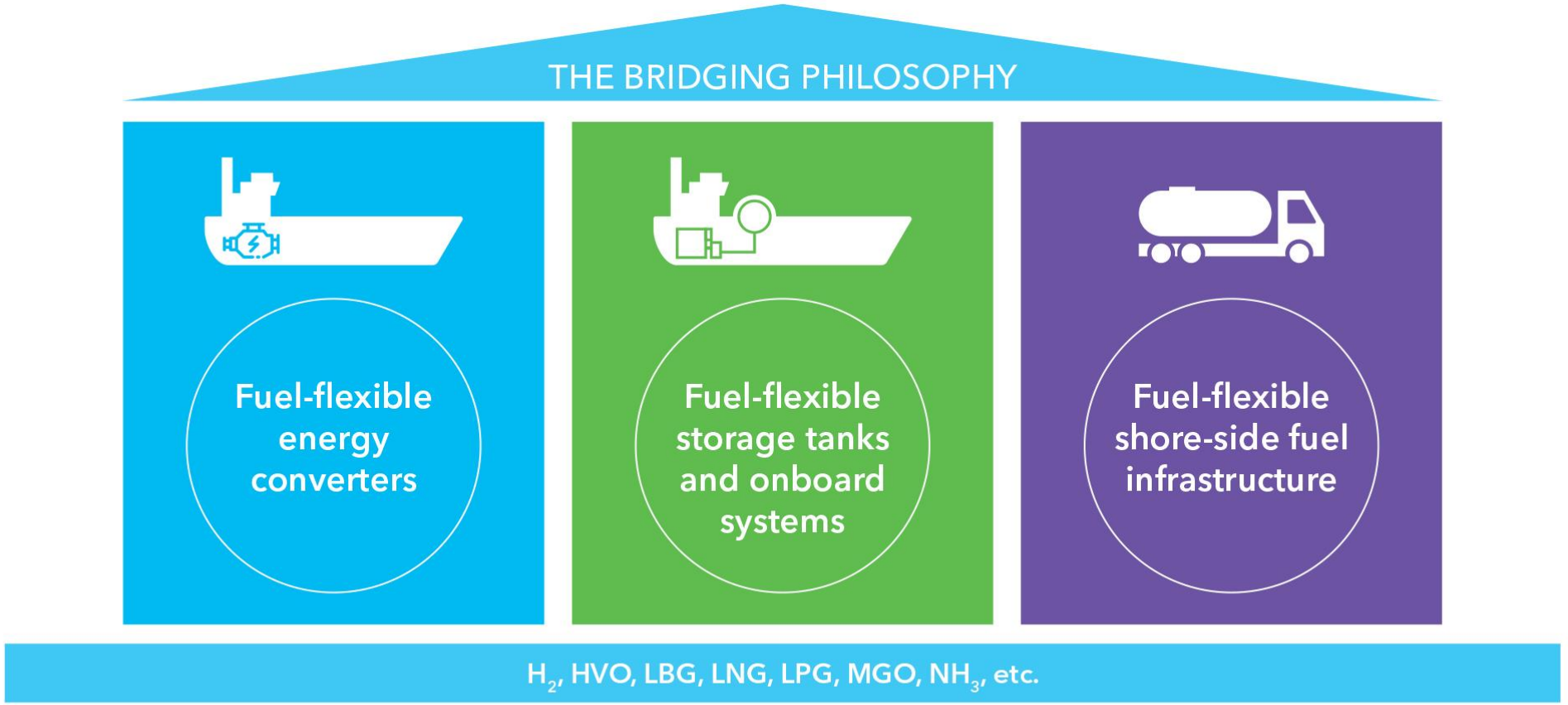
If main focus is on **design requirements**, the shift in fuel and fuel-converter technology on newbuildings is very abrupt




LNG play an important role – transition to carbon neutral fuels will be needed

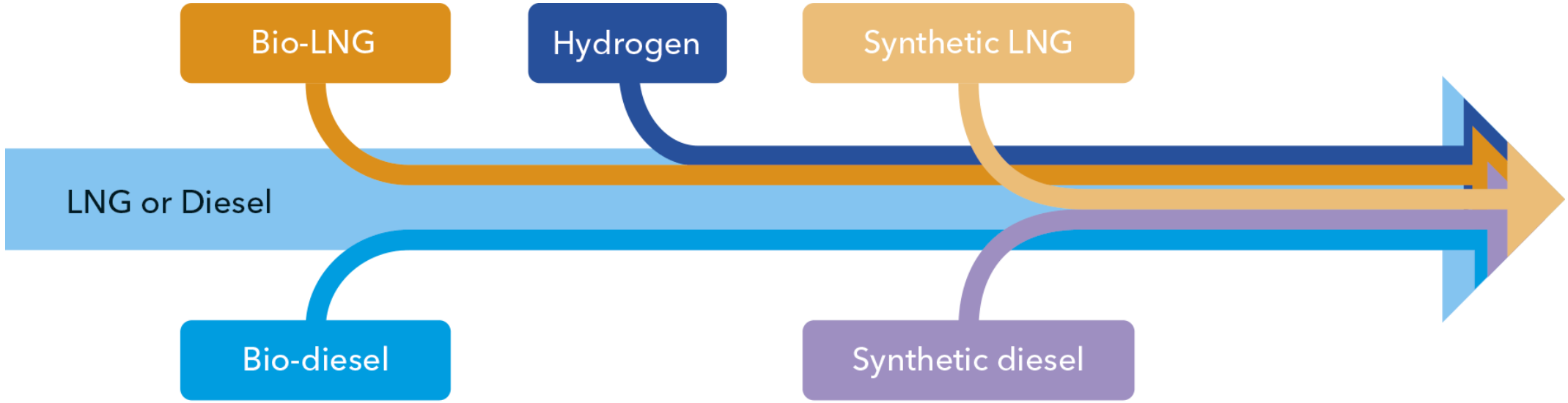
# The three pillars of the bridging philosophy




$H_2$, hydrogen; HVO, hydrotreated vegetable oil; LBG, liquid biogas; LNG, liquefied natural gas
LPG, liquefied petroleum gas; MGO, marine gas oil; $NH_3$, ammonia

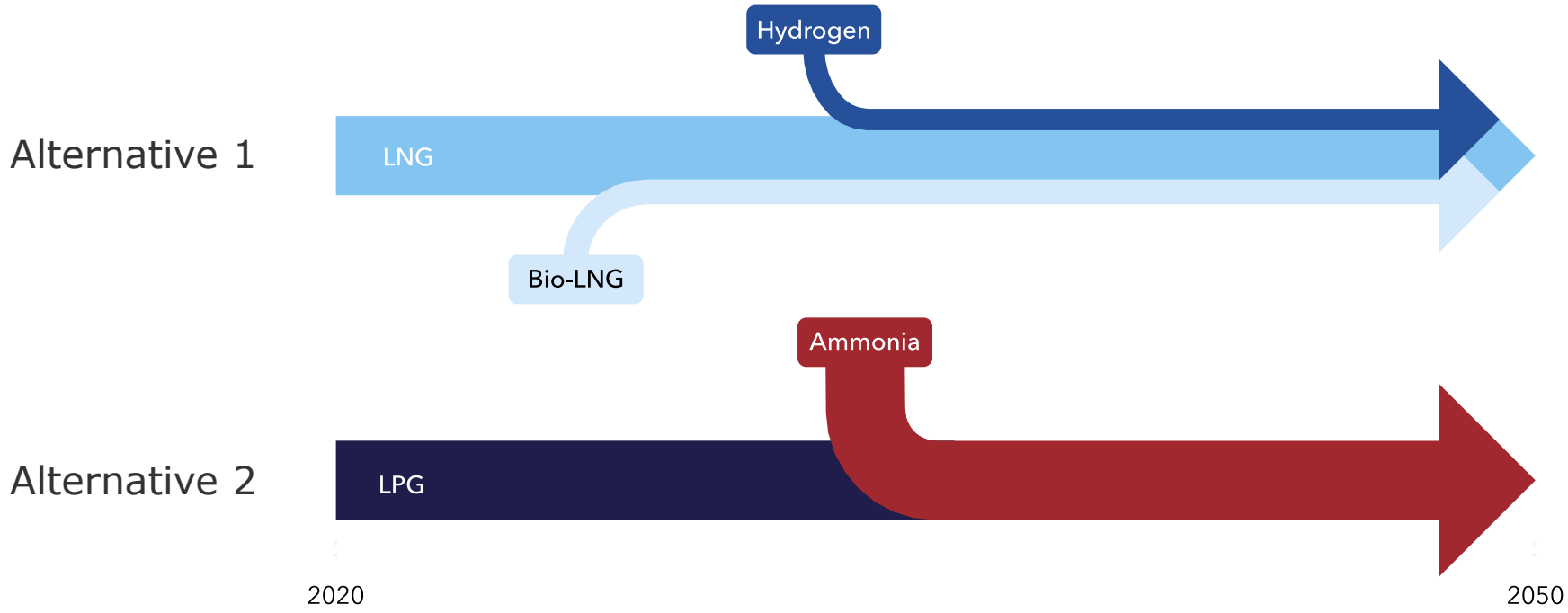
# Fuel flexibility and bridging technologies - the three pillars


**Bridging** technologies can facilitate the transition from traditional fuels, via fuels with lower-carbon footprints, to carbon-neutral fuels



# Fuel flexibility and bridging technologies

- can facilitate the transition from traditional fuel, via fuels with lower-carbon footprints, to carbon-neutral fuels
- require limited investments and modifications along the way



# Key findings

- Shipping decarbonization is a must
- Uptake of alternative fuels is picking up, but needs a breakthrough to the large ocean going ships

- In addition to LNG, carbon-neutral fuels will be needed towards 2050
- Bridging technologies and fuel flexibility can smoothen the transition from traditional fuels

- Ships should be future proof in a changing environment, securing competitiveness and mitigating the carbon risk
- We have provided tools to support policy makers, ship owners and other stakeholders