



## Potential for Pyrolysis in the Marine market

*WBA Webinar: Pyrolysis Oil markets and global supply*

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# Our GoodFuels DNA

Advanced sustainable fuel is the best option for reducing the carbon footprint of the following transport segments:

*Aviation*



*Shipping*



*Heavy road & Rail*

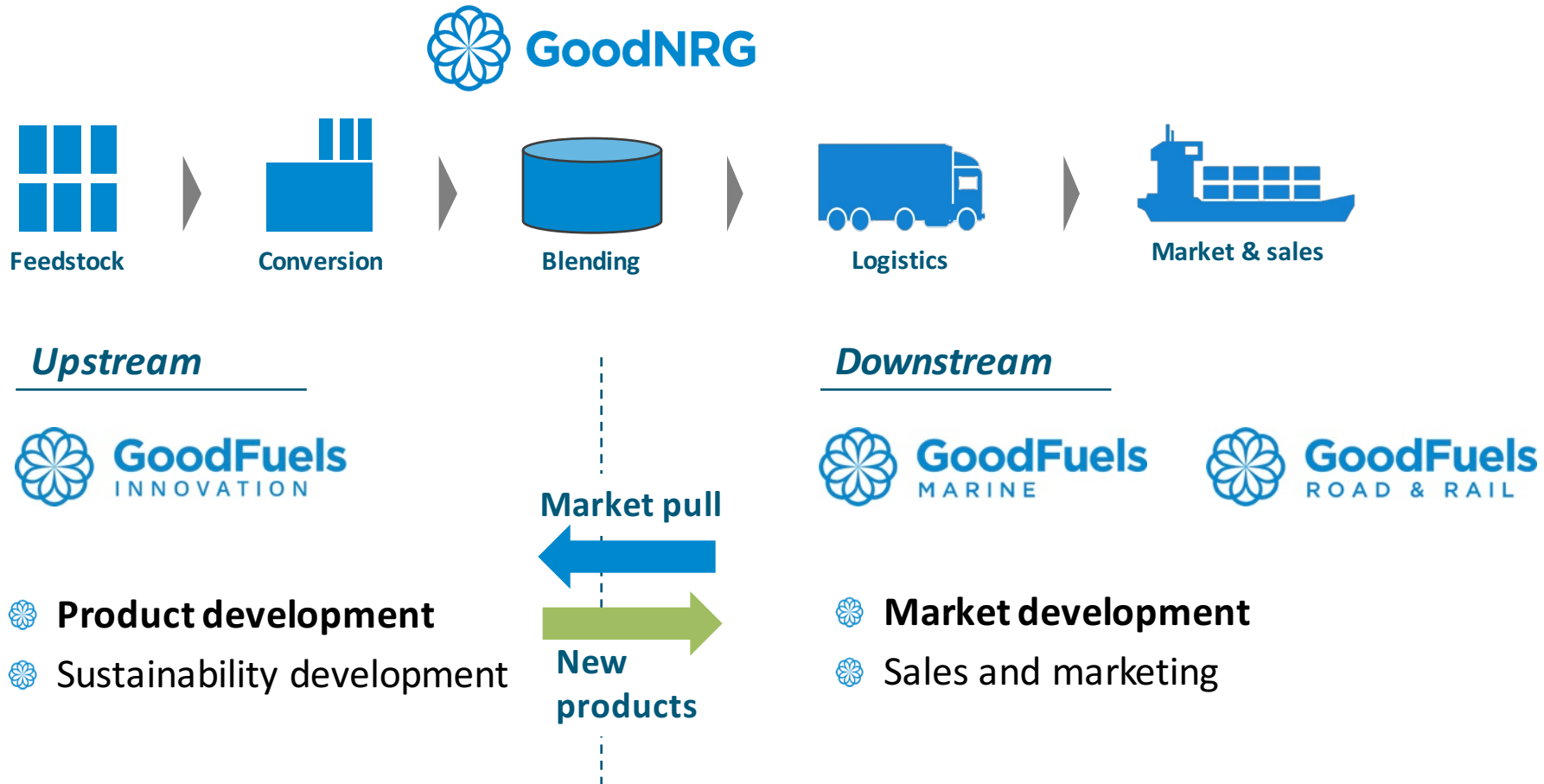


**NGO's support** the fact that for these sectors, **sustainable biofuels** are the best option for **reducing the carbon footprint** significantly



# The GoodNRG Group

Downstream we focus on market development & sales, upstream our focus is on product development



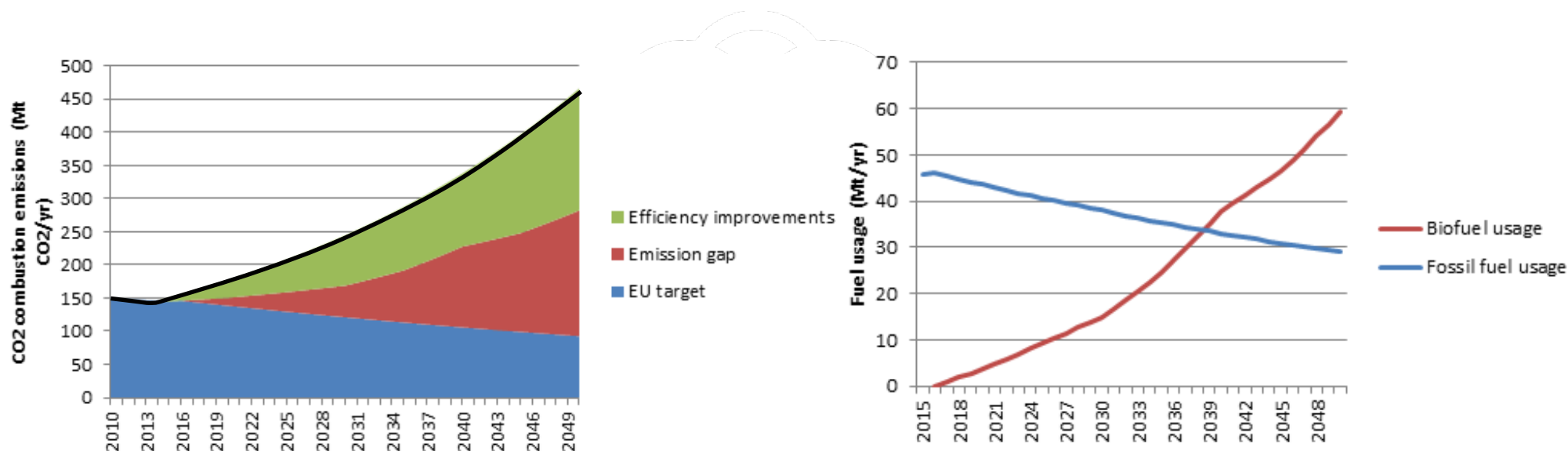


## Marine biofuel market



# European GHG targets and low-carbon fuel requirement

To meet EU targets, Europe will need 60 Mtonne of low-carbon marine fuel in 2050



## Inputs

- ❁ **Base case scenario:** Emission factors fossil fuel mix developing according to IMO low-LNG scenario
- ❁ **Biofuels combustion emissions:** 0 gCO<sub>2</sub>/MJ, (Source: Kyoto protocol)
- ❁ **European emissions share:** 19% 2010 -> 13% 2050 (Source EU/IMO projection)
- ❁ **EU target:** 50% GHG reduction vs 2005 levels (Source: *The Commission's 2011 White Paper on transport*)

# Global vs Local drivers for marine biofuel market

Whilst global regulation is slow to be developed, some markets have already introduced favourable regulations enabling the introduction of low-carbon marine fuels

## Global

### IMO

- Efficiency measures: EEDI & SEEMP
- IMO's definitive **GHG strategy** in **2023**



### EU

- MRV regulation starting in 2018
- Potentially including shipping in **EU-ETS** in 2021



## Local

### RED extension

- Inclusion of shipping in **RED** scheme



### Procurement: Waterworks

- In **tenders** for government contracts in **waterworks** CO<sub>2</sub> reduction is given a value



### Ship rating schemes

- Sweden has adopted the **Clean Shipping Index** as basis for their fairway and port duties



### Procurement: Public transport

- New ferry contracts have to **reduce** their carbon footprint by **25%**



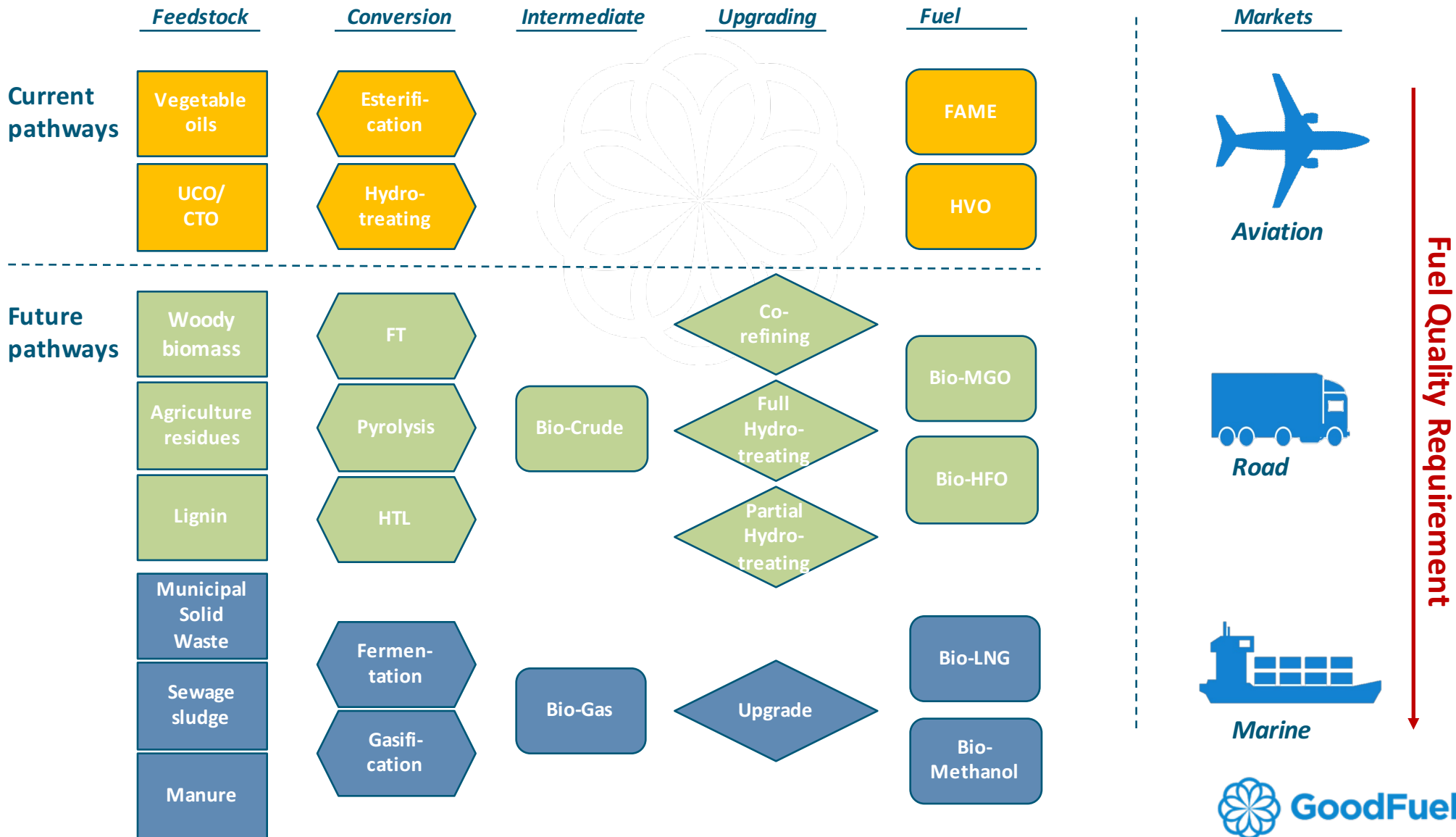


## Potential for Pyrolysis



# Technology development

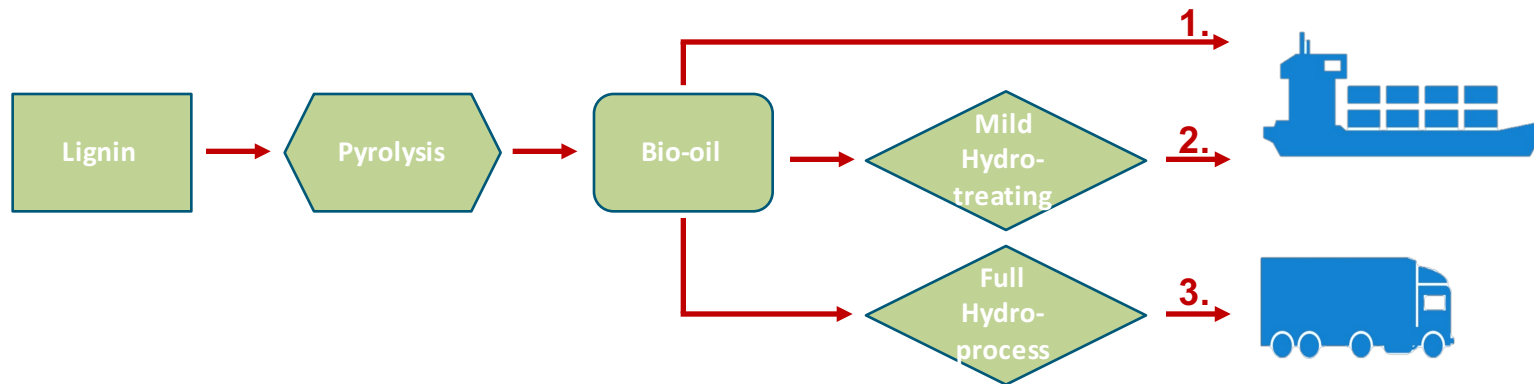
Each feedstock requires specific conversion and upgrading, leading to many possible pathways. The marine market offers a lower entrance quality option.





# Case study: Lignin pyrolysis and upgrading

The marine market shows significant advantages over other markets for bio-crude valorisation



## 3 routes for pyrolysis products

1. Direct blending of bio-crude into marine fuel
2. Partial upgrading to marine quality
3. Full upgrading to road/aviation quality

## Advantages marine vs road/aviation

- ⌘ Lower H<sub>2</sub> requirement for upgrading
- ⌘ Lower GHG footprint of end-product
- ⌘ Higher yield
- ⌘ Lower CAPEX and OPEX

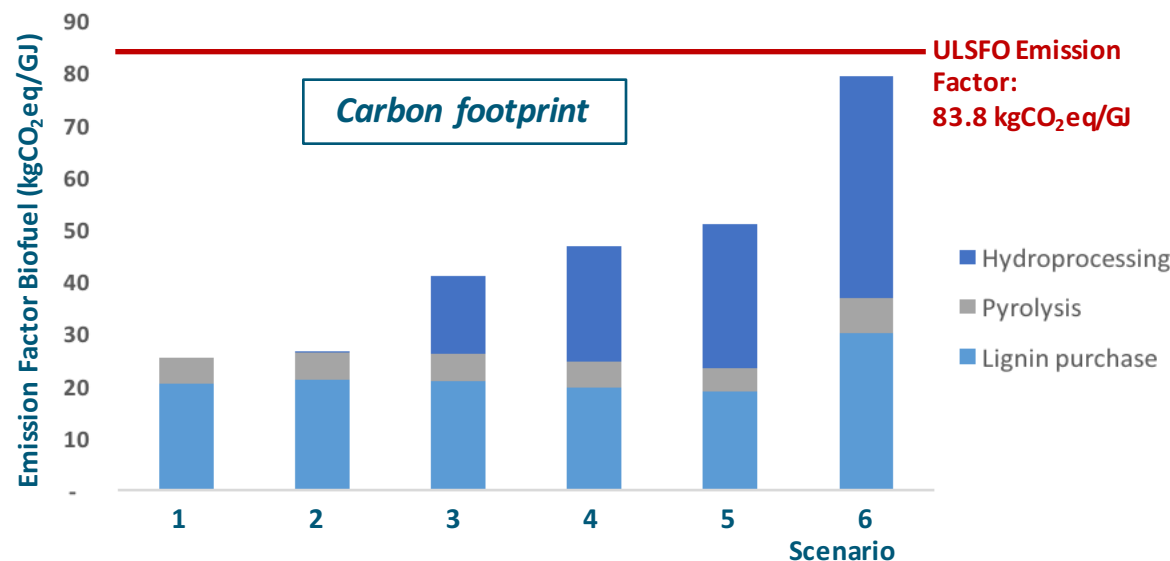
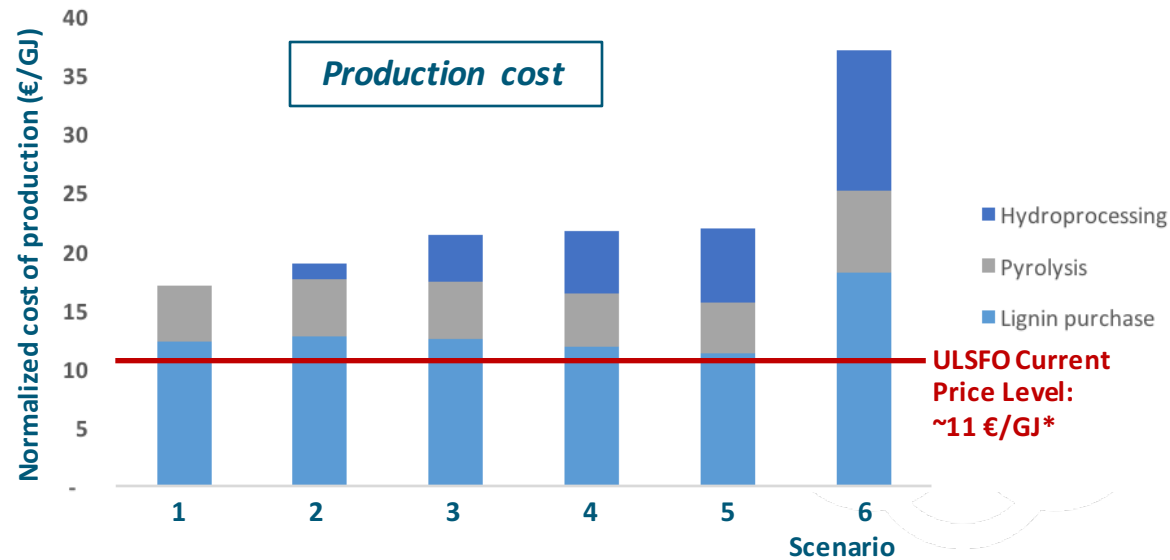
## Case study for Biobased Delta Zuid-Holland

- ⌘ Fast Pyrolysis of lignin fraction from a biorefinery running on woodchips
- ⌘ Location: Port of Rotterdam
- ⌘ Natural gas used to replace lignin energy
- ⌘ Bio-oil upgrading options:
  1. No upgrading
  2. Mild hydrotreatment with variable deoxygenation -> Marine fuel
  3. Full hydrotreatment and hydrocracking -> Automotive fuel



# Results: Lignin pyrolysis and upgrading

Minimizing upgrading requirement leads to optimal financial and environmental performance



## Scenarios

Scenario	Hydro-treatment	Hydro-cracking	Residual oxygen %
1	No	No	30%
2	Mild	No	30%
3	Mild	No	20%
4	Mild	No	10%
5	Mild	No	0%
6	Full	Yes	0%

## Lessons learned

- Minimal upgrading leads to optimal techno-economic and environmental performance

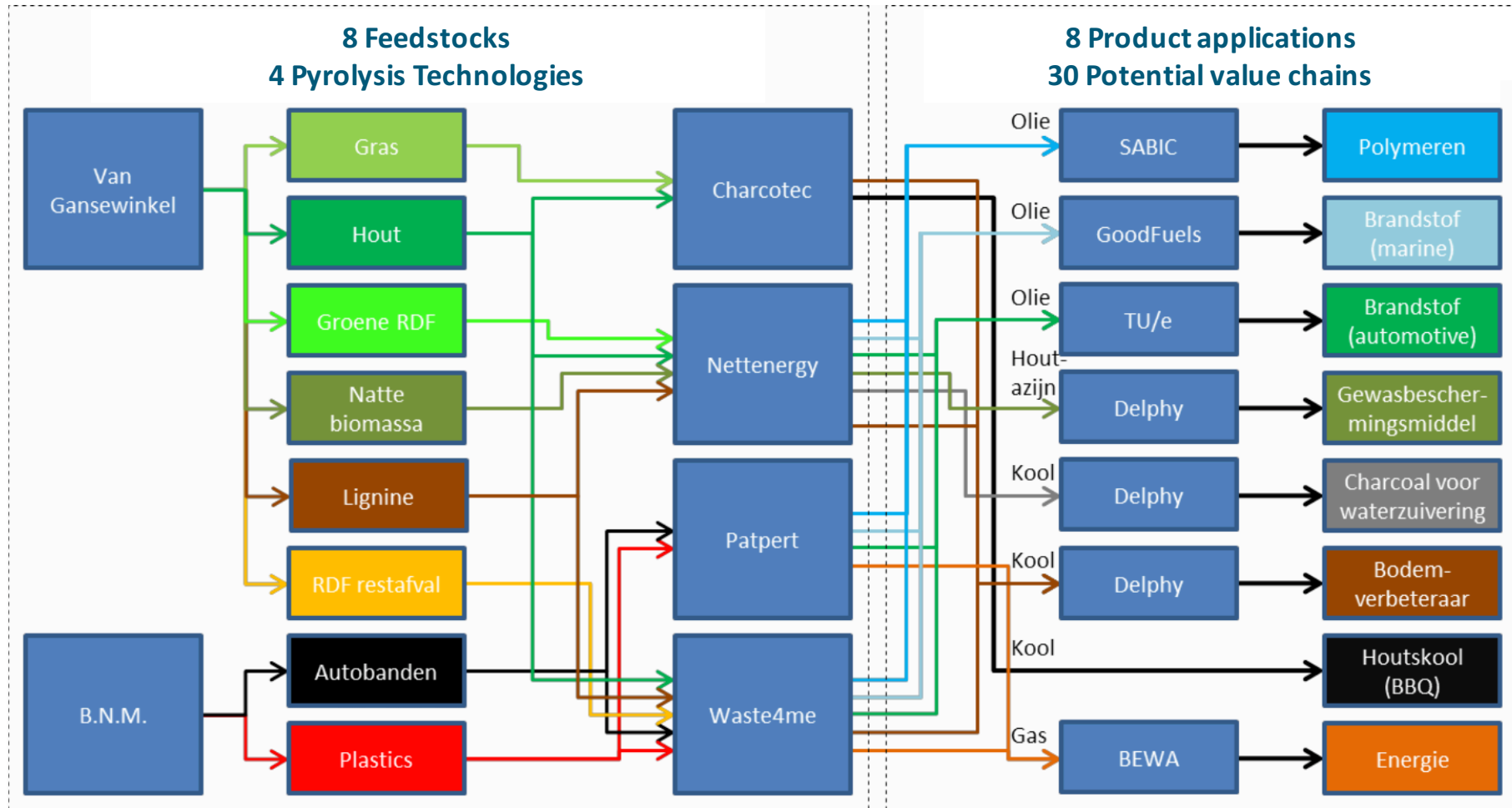
- ❁ Shipping needs enormous amounts of low-carbon fuels for a sustainable future
- ❁ Although global regulations are slow to be implemented, local conditions are already creating markets for low-carbon marine fuels
- ❁ Pyrolysis fuels for marine application show significant advantages over other markets, both economically and environmentally
- ❁ To develop these fuels, Cooperation with relevant fuel standard setting bodies is needed (ISO/CIMAC)



**Let's start!**

# GoodFuels is part of the Pyrolysis cluster Moerdijk

EC-funded project with 4 pilot plants, 8 feedstock options, creating 30 value chains





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