



# Wagenborg towards 2050

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Minimization

$$\frac{m_{fuel}}{ton.nm}$$

Transport  
efficiency







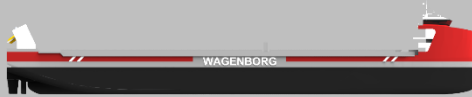
Sources:

- IMO – MEPC.304(72)
- TNO – Richard Smokers


- Decrease carbon intensity of international shipping:
  1. Design: EEDI framework
  2. Operation:  $\frac{g_{CO_2}}{ton.nm}$  2008  $\left\{ \begin{array}{l} -40\% \longrightarrow 2030 \\ -70\% \longrightarrow 2050 \end{array} \right.$
- Cost/revenues



$$\frac{gCO_2}{ton.nm} = \frac{\overset{\text{①}}{\overset{-40\% \rightarrow 2030}{MJ}}}{ton.nm} \times \frac{\overset{\text{②}}{\overset{-70\% \rightarrow 2050}{gCO_2}}}{MJ}$$



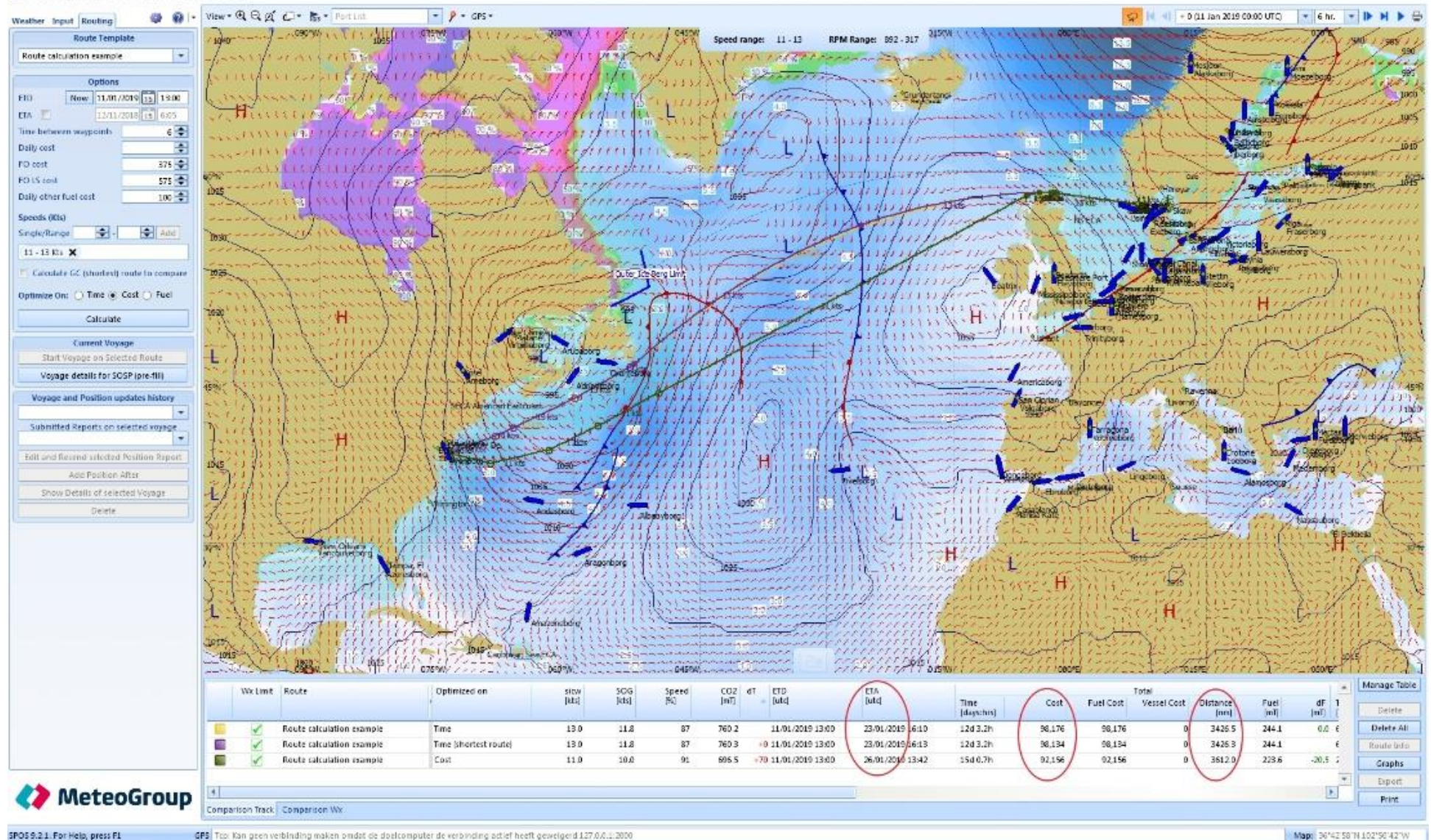
Design + operational  
efficiency



Carbon intensity  
energy carrier



SPOS 9 Wagenborg - SPOS 9 Office IT - [No active voyage]





## Energy convertor

Technology Readiness Levels (TRL)

TRL9 **Operations**

TRL8 **Active Commissioning**

TRL7 **Inactive Commissioning**

TRL6 **Large Scale**

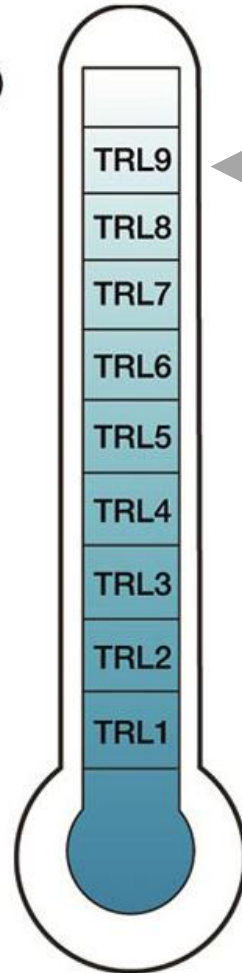
TRL5 **Pilot Scale**

TRL4 **Bench Scale Research**

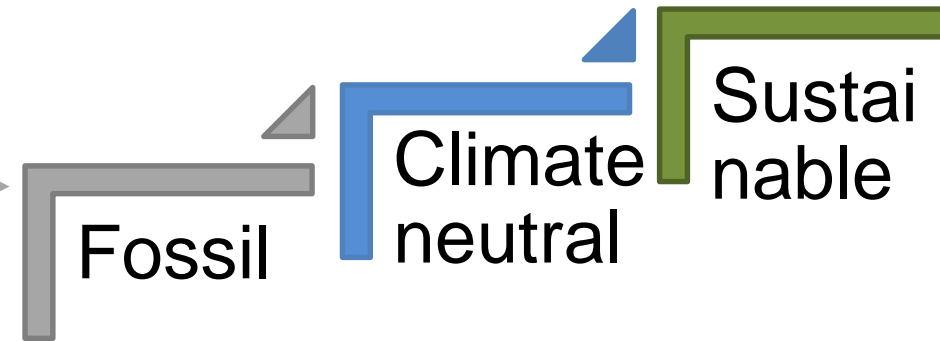
TRL3 **Proof of Concept**

TRL2 **Invention and Research**

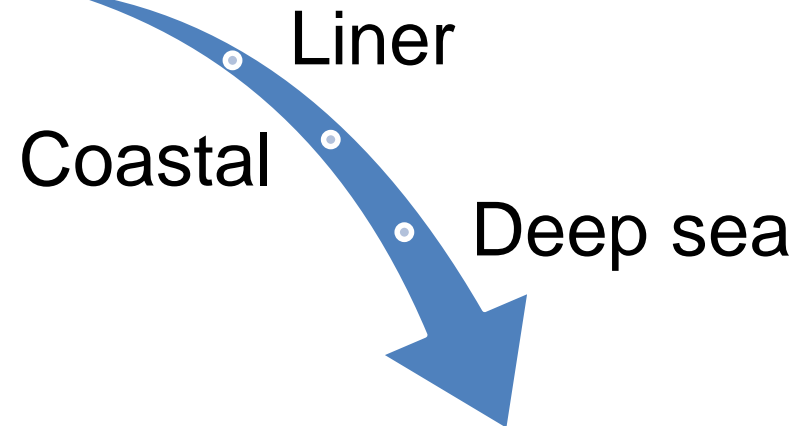
TRL1 **Basic principles**



## Energy carrier



## Implementation sequence



2050: Sustainable shipping

—40%  
—→ 2030 Operational + improved design

—70%  
—→ 2050 Sustainable energy carrier

Regulations, technology and economics are key.





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