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Medfinansieres af Uddannelses-og Forskningsministeriet

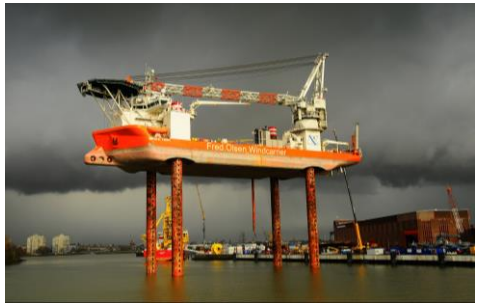
Wind Logistics Group

Greener and cleaner in offshore wind

After work / ”gå-hjem” meeting presentation by Thomas Poulsen
November 24, 2020
Online – MS Teams platform

This session – contents and timing

1	Global ocean transport	2 minutes
2	Emission reduction goals	3 minutes
3	Emission control areas	4 minutes
4	Evaluation of alternative fuels	5 minutes
5	Offshore wind hybrid pathway	6 minutes




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Marine transportation

- Seaborne transport is more than 80% of global trade by volume
- Very energy efficient means of goods transportation
  - Heavy fuel oil
  - Marine gas oil
- Close to 940 million tons of fossil CO_2/year
- 2.5% of global greenhouse gas emissions
- 15% of global NO_x emissions
- 13% of global SO_x emissions

2014 study

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International Maritime Organization

- 50% greenhouse gas reduction by 2050 (compared to 2008)
  - 40% reduction in payload-distance freight metric by 2030
  - 70% reduction in payload-distance freight metric by 2050
- Actions to achieve the goals:
  - 2018-2023:
    - ✓ Fuel assessments, technical cooperation, energy efficiency
      - National action plans
  - 2023-2030
    - ✓ Implementation program low-carbon and zero-carbon fuels
- New fuel standards (reduce sulphur content in marine fuels by 2020)

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Regional and national emission restrictions

- Emissions Control Areas (ECAs) within defined coastal boundaries
  - SECA (SO_x ECAs) to reduce sulphur oxides
  - NECA (NO_x ECAs) to reduce nitrogen oxides

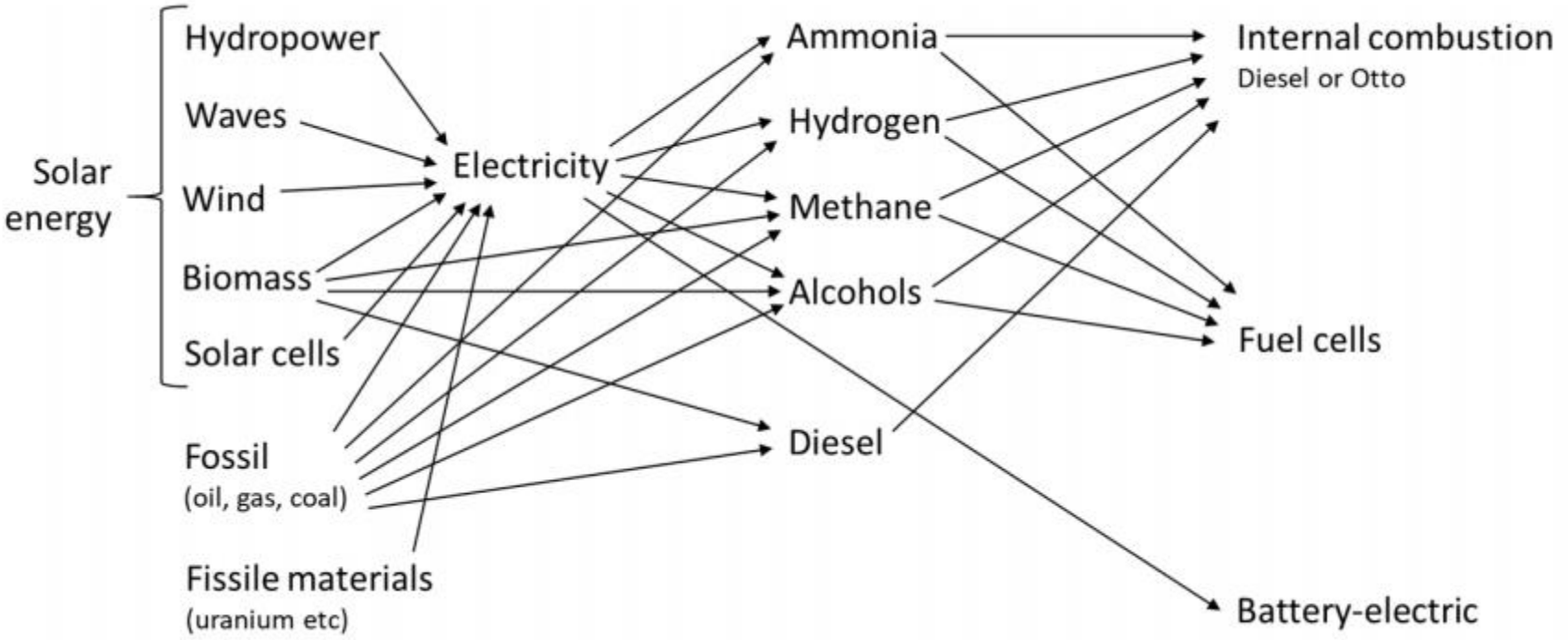


Illustration source: Danish Maritime Authority

What is fuel?

- Primary energy sources:
  - Unrefined energy sources found in nature
    - Oil, gas, coal, biomass, hydro/waves, solar, wind
- Fossil fuels:
  - Primary energy source is fossil
- Renewable fuels:
  - Primary energy source is renewable

Fuel production and energy conversion



Source: Andersson *et.al.*, 2020

Alternative fuel examples

Internal combustion engines

- Low-sulphur marine distillate oil
- Liquefied natural gas
- Liquefied biogas (organic waste)
- Fossil methanol
- Renewable methanol (short-rotation energy forest - willow)
- Hydrotreated vegetable oil (tall oil)
- Ethanol

Fuel cells

- Hydrogen

Electric engines

- Electricity

Powered by wind: Wallenius Marine example (Oceanbird)



Photo source: Wallenius Marine

Emission contral area compliance options

- On-board pollution control equipment
  - Heavy fuel oil with scrubbers
- Switch from petroleum-based fuels to cleaner fuels
  - Approx. 120 vessels operating on LNG
  - Approx. 10 vessels operating on methanol

Vessel count as of May, 2018

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Evaluation criteria

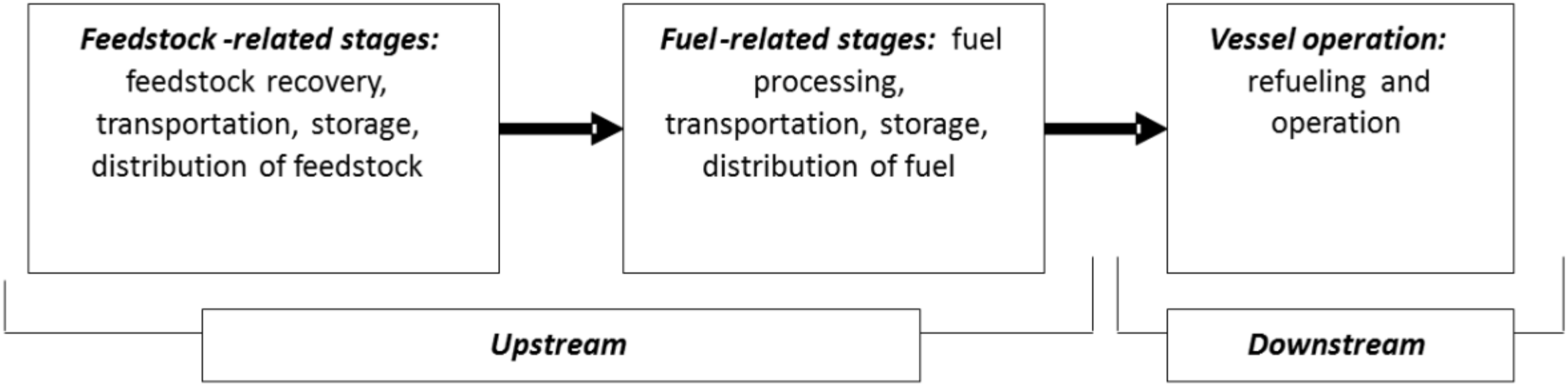
Upstream (”well-to-tank”)

- Investment cost (CapEx)
- Future fuel price
- Fuel supply reliability
- Future legislation
- Environment
- Climate change
- Health impact
- Geopolitical stability
- Ethics
- Public acceptance

Downstream (”tank-to-propeller”)

- Safety
- Technical performance
- Availability
- Cost (OpEx - operational, fuel)
- Infrastructure
- Environmental impact

Life-cycle analysis / total fuel cycle analysis



Source: Winebrake *et.al.*, 2019

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TINV project – Danish Technology Institute (Teknologisk Institut)

- Obejctive: Reduce particulate emissions and NO_x; noise reduction
- MUDP funding

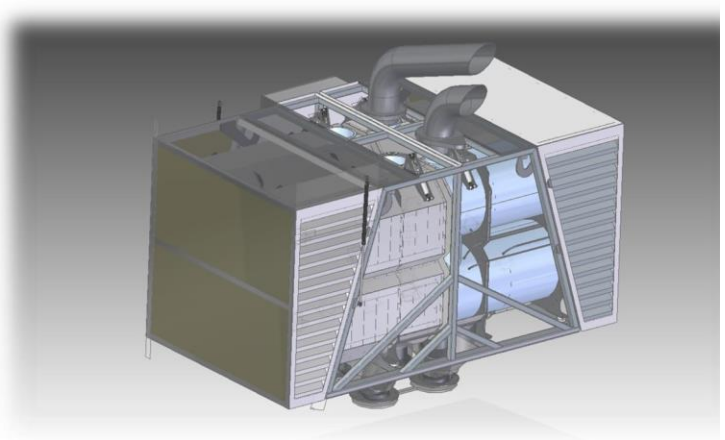
Initial results

- DPF is effective on both auxiliary and main engine (> 99% reduction of PM and PN).
- Seamless operation
- Significant noise reduction - both measured and experienced

Supplier	Tehcnology	1:1 vessel test
Exilator	Integrated diesel particulate filter	Ferry M/F Isefjord
Amminex	Diesel particulate filter/ammonium based NOx catalyst	Ferry M/F Pernille
Purefi	Diesel particulate filter/urea based NOx selective catalyst reduction	CTV World Mistral

World Mistral - in process





TEKNOLOGISK INSTITUT
PUREFI
World Marine Offshore
EXILATOR
H/R
Amminex
SUNDBUSSERNE
DanishShipping
Danish Maritime
Transportens Innovationsnetværk
Ministry of Environment and Food of Denmark
Environmental Protection Agency

Carbon Trust 2019:
CTV emissions reduction technology competition

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1. Chartwell Marine and Seaspeed Marine Consulting	1. Desktop study; diesel electric
2. CWind (Global Marine Group)	2. Prototype SES CTV; diesel electric
3. Robert Allan	3. Desktop study; methanol electric
4. Windcat and CMB Technologies	4. Prototype CTV; hydrogen diesel

Carbon Trust Offshore Wind Accelerator (OWA) partners:

EnBW, Equinor, innogy, Ørsted, RWE Renewables, ScottishPower Renewables, Shell, SSE, and Vattenfall

Sample hybrid vessels on order or in operation

Vessel type	Ship owner	Designer	Yard	Charterer	Offshore wind farm
Crew Transfer Vessel	High Speed Transfers	Chartwell Marine	Diverse Marine		
Service Operation Vessel	Bernhard Schulte Offshore		Ulstein Verft	GE Renewable Energy	Merkur
Offshore Wind Service Vessel	Acta Marine		Ulstein Verft		Deutsche Bucht
2 Crew Transfer Vessels	MHO-Co	Incat Crowther	Afai Southern Shipyard	Ørsted	Hornsea 2
SES Crew Transfer Vessel	CWind (Global Marine Group)	ESNA	Wight Shipyard Company	Ørsted	Borssele 1&2
E-class Crew Transfer Vessel	Northern Offshore Services	Northern Offshore Services	Grovfjord Mek. Verksted		







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Key take-aways

Take-aways from this presentation

1. Ocean freight is a relatively clean transport mode
2. Greenhouse gas emissions must be reduced
3. Emission control areas are being implemented
4. Compliance to new emission rules is enforced
5. On-board pollution control equipment is a solution
6. Various alternative fuels are being tested to various degrees
7. Selection criteria for alternative fuels need consideration
8. Emission life-cycle analysis of fuels could be useful
9. Wind seems to be moving along hybrid diesel-electric pathway

Thank you!

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Questions and answers!







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