Lund methanol day

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- PhD in hydrogen engines, 2005, Ghent University
- Currently 50% Assoc. Prof. at Lund University (SE)
  and 50% Assoc. Prof. at Ghent University (BE)
- Supervising 10 PhD students, 1 on hydrogen as engine fuel,
  2 on dual fuel gas engines, 3 on biofuels, and 4 on methanol
- Expertise: internal combustion engines, focus on alternative/renewable fuels:
  methanol (since 2009), ethanol, hydrogen (since 1999), straight vegetable oils,
  animal fats, biodiesel, alcohol blends, ...

- Coordinator of EU H2020 project FASTWATER

- ... and your moderator for the day!

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Setting the scene

DEFOSSILIZING, SECTORS JOINING FORCES

THE CHALLENGE

100 M barrels of oil per day

vs. chemicals production
e.g. methanol production
capacity of 3 M barrels /d

THE CHALLENGE

100 M barrels of oil per day

e.g. H_2 production 4.5 M barrels /d (energy equiv.)

A future sustainable (energy) society

- Plenty of renewable energy: solar, wind, bio etc. can cover our needs
  - E.g. solar: 1,5 10^{12} barrels oil equivalent per day (15.000 x current oil use)
  - But gigantic challenge to scale them up
  - And renewables are intermittent and not equally distributed around the globe
  - Thus, need for large scale energy buffers, likely also energy imports
  - Most economic way to store and distribute large amounts of energy: fuels
    - » Fuels built from renewables – either from bio, “down” into usable fuels;
    - » Or from green electricity “from the ground up”,
      starting with hydrogen and synthesizing fuels from “green molecules”

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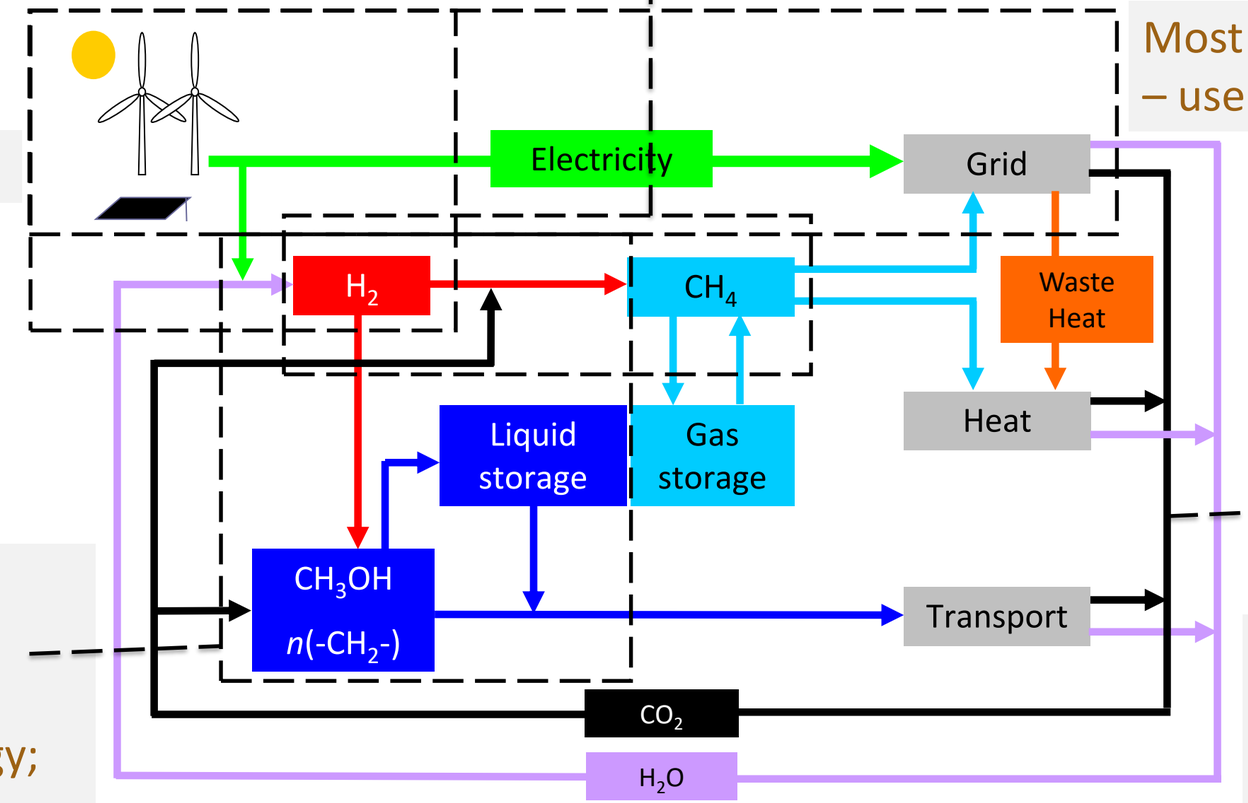
An integrated system

Hydrogen to buffer renewables
Balance electricity grid
Methanation / e-gas: increase energy density
Make use of existing gas grids

Most efficient route
– use whenever possible → electrify

Electrolysis



Carbon capture a necessity for this to work long-term.

When energy density needs require liquid fuels: methanol synthesis or Fischer-Tropsch;
Balance seasons, import energy;
Serve transport needs

Or should/can we avoid carbon? Ammonia?
Battery-electric; fuel cells; sustainable combustion engines? ...?

R. J. Pearson et al. ‘‘Energy storage via carbon-neutral fuels made from CO2, water, and renewable energy,’’ Proc. IEEE, vol. 100, no. 2, pp. 440–460, Feb. 2012.

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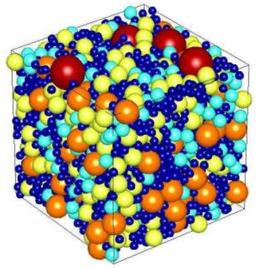
Narrowing down the options...
Energy carrier and drive for (heavy) transportation?

Must be:

- **Sustainable**
  - Closed cycle for energy carrier and powertrain materials

- **Scalable**
  - Use abundantly available resources (avoid scarce materials)
  - Affordable



- **Storable**
  - High energy and power density... Makes life *simple*

→ Need for renewable, **liquid** fuels

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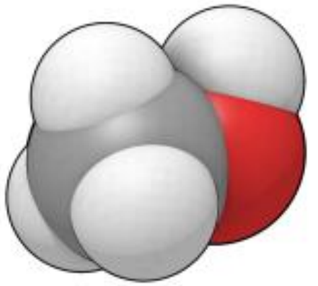
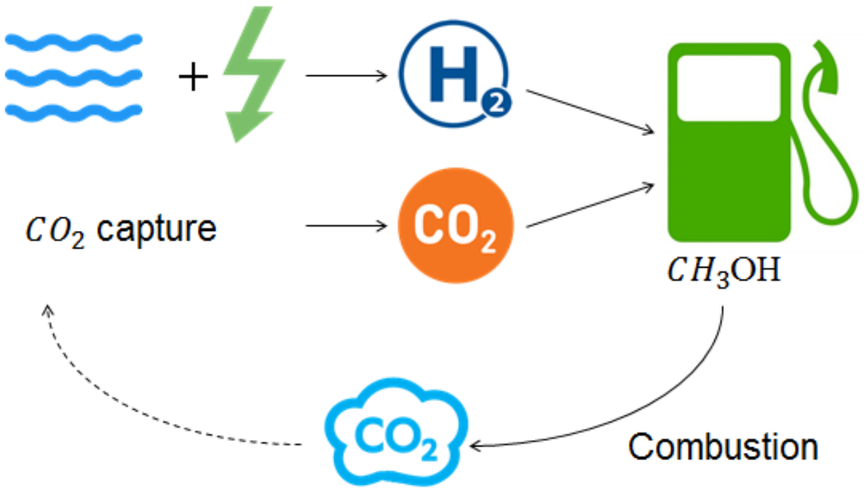
Case: methanol



- Can be produced in different ways
  - Biomass, fossil fuels
  - Synthesize using renewable energy: $H_2 + CO/CO_2 \rightarrow CH_3OH$
- Liquid
  - Most simple hydrogen carrier that is liquid at atmospheric conditions
    - » Simplicity desired: maximize production efficiency (well-to-tank)
  - Cheap tanks, cheap distribution
  - Evolution of infrastructure possible, retrofitting possible
  - Great fuel: high efficiency, ultralow emissions
    - » High efficiency desired: maximize conversion efficiency (tank-to-wheel/propeller)



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Methanol gaining traction

- Power sector: liquid hydrogen carrier → economically attractive versus alternatives, to store and distribute large amounts of energy
- Chemical sector: chemical building block, methanol-to-olefins (MTO)
- Transportation sector: liquid – acceptable energy density for many applications
  - Shipping:
    started looking into methanol when new pollutant emission regulations loomed
    - » IMO Tier 3: looking for economically most feasible ways of cutting SO_X and NO_X
    - » Gradually, search for alternatives widened in scope:
      how to cut CO_2 emissions from shipping too?
    - » Several initiatives investigating methanol as fuel for shipping now
      - BEST-energy; Green Maritime Methanol; Uthörn II; ...
      - FASTWATER...

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Introducing FASTWATER

FAST TRACK TO CLEAN AND CARBON-NEUTRAL **WATER**BORNE TRANSPORT

FASTWATER

FAST Track to Clean and Carbon-Neutral WATERborne Transport

Project description

FAST Track to Clean and Carbon-Neutral WATERborne Transport through Gradual Introduction of Methanol Fuel: Developing and Demonstrating an Evolutionary Pathway for Methanol Technology and Take-up

The project has received funding from the European's Horizon 2020 research and innovation programme (Contract No.:860251)

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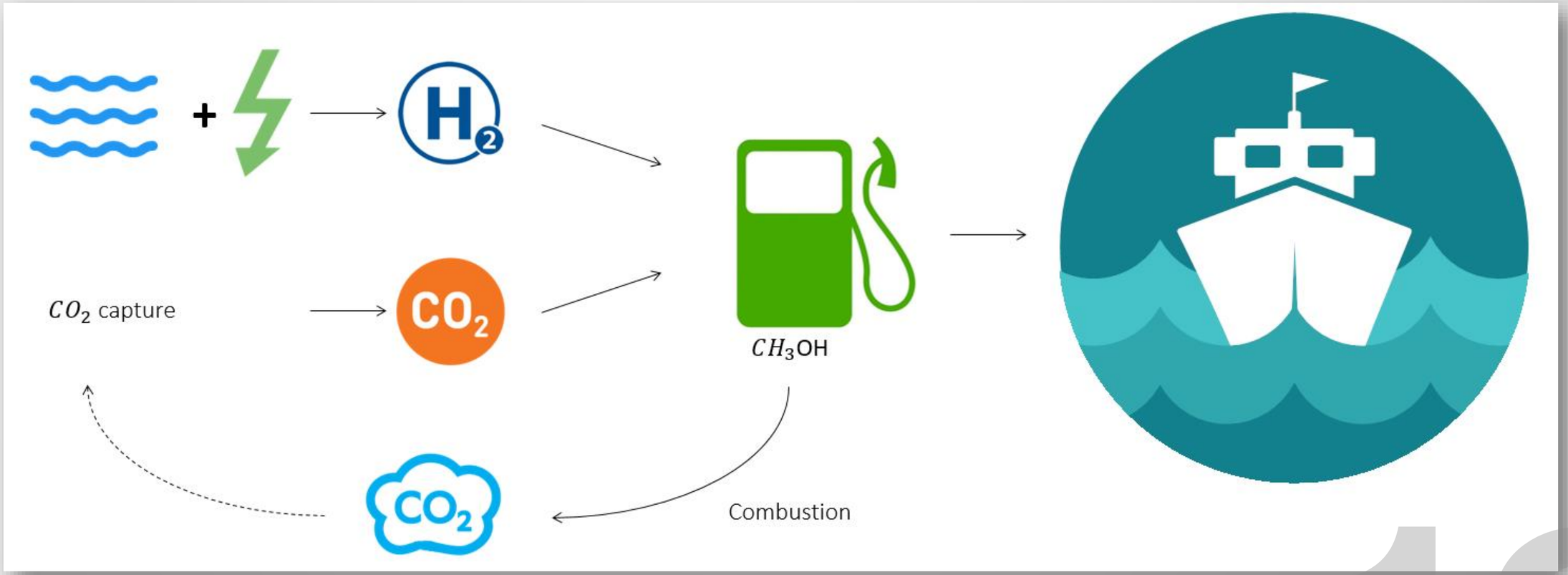
Project core idea



Challenges to be tackled by the project

- Four-stroke methanol engines, and retrofits of marine engines to methanol operation, not commercially available
  - i.e. power range 100 kW – 10 MW
- No demonstration of the full chain of renewable methanol production to ships sailing on it
  - Production – distribution – bunkering – sailing
- Rules and regulations not mature yet
  - Need practice, on different vessel types, need to be challenged if required

- 4y project, started June 1st, 14 partners, 6.4 M€ (5 M€ EU funding)

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How are we going to address them?

- Medium speed dual-fuel engines (2 MW demo engines, 1 – 4 MW commercial offering)
- High speed MD95 engine (400 kW demo engine, 150 – 450 kW commercial offering)
- High speed dual-fuel engine retrofit (200 kW demo engine)
- Dual-fuel retrofit kit for 200 kW – 4 MW engines

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How are we going to address them?

- Harbour tug, medium speed engines, 2 x 2 MW, Antwerp, BE
- River cruise vessel design, DE
- Pilot boat, high speed engine 400 kW, Oxelösund, SE
- Coast guard vessel, high speed engine 200 kW, Athens, GR

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Partners

Covering the value chain

- Universities and research institutes
- Engine manufacturers and equipment suppliers
- Fuel supplier and distributor
- Naval architects and consultancies
- Shipyards
- Classification society
- Fleet owners
- Port authority / administrations

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Advisory board

Advice on exploitation, increase project exposure, identify early movers, push adoption of recommended guidelines

- Renewable methanol producers
- Ship owners
- Authorities
- Propulsion technology manufacturers / engineering consultancies / R&D

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Project outcomes benefiting other initiatives

- High and medium speed methanol engines commercially available
- Engine retrofit kit commercially available
- Real life demonstrators that can be visited to get a hands-on feel for practical applications
- Tested training material for crew and on-shore personnel
- Simplified rules and regulations
- Renewable methanol supply chains
- Business plans to support investment decisions

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