„greenfuel“ project

17th IERE General Meeting & Canada Forum

17th May 2017

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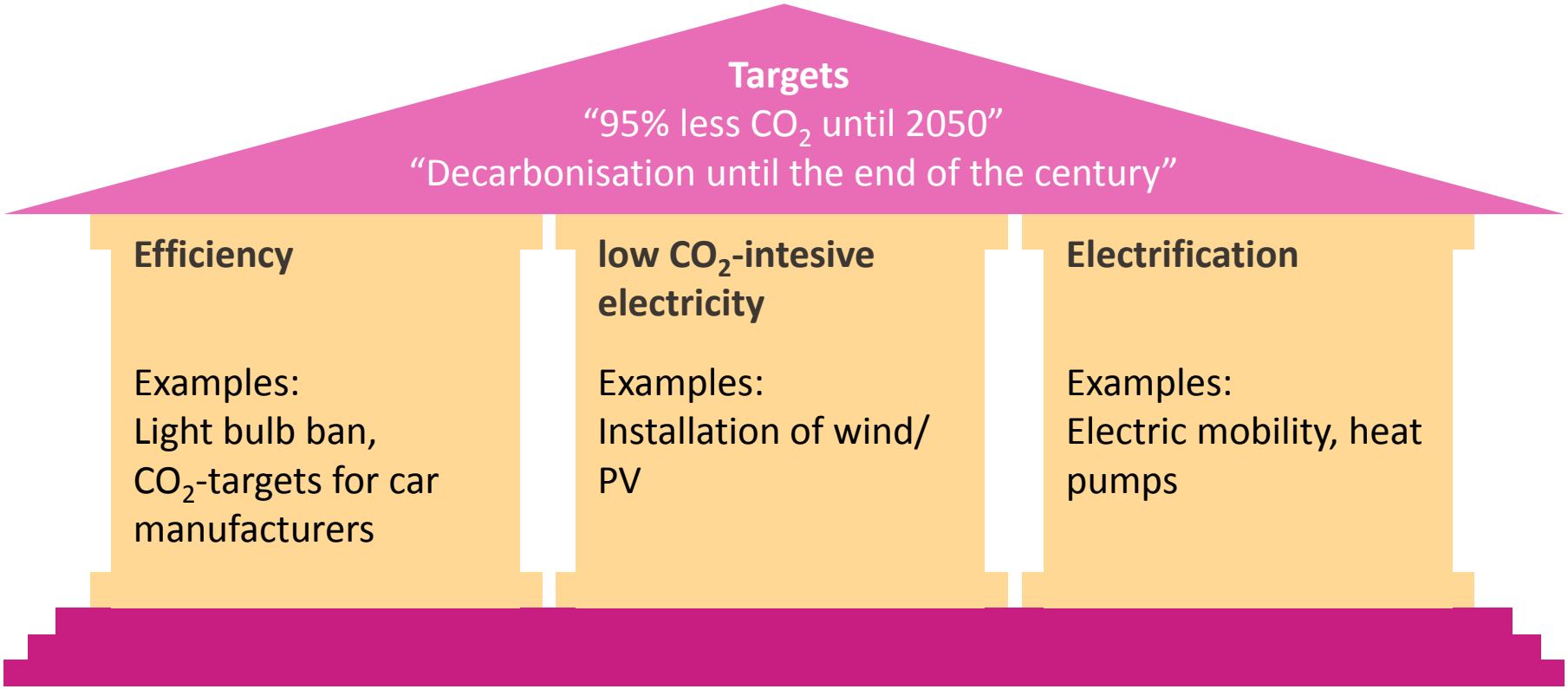
The following slides provide …

… information about:

- German CO2 emission targets
- Methanol as green energy carrier
- The R&D project „greenfuel“

Germany mainly uses three levers to reduce CO_2 emissions



But, will these levers be sufficient to reach the target? ? ? ?

German CO2 targets are only achievable with a green energy carrier

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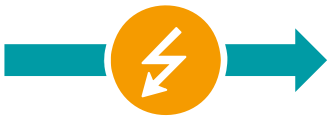
CO_2 emission reduction target of 95% is not achievable using only direct electrification

German CO_2 emissions 2050
Acceptable emissions based on 95%-target:
63 Mio. t



German CO_2 emissions 2050

Unavoidable
farming, steel & lime cement production, …)
ca. **60 Mio. t**

Long distance travel
(air, sea, heavy trucks
ca. **150 Mio. t**

Difficult to electrify. Therefore, hardly to avoid through electrification

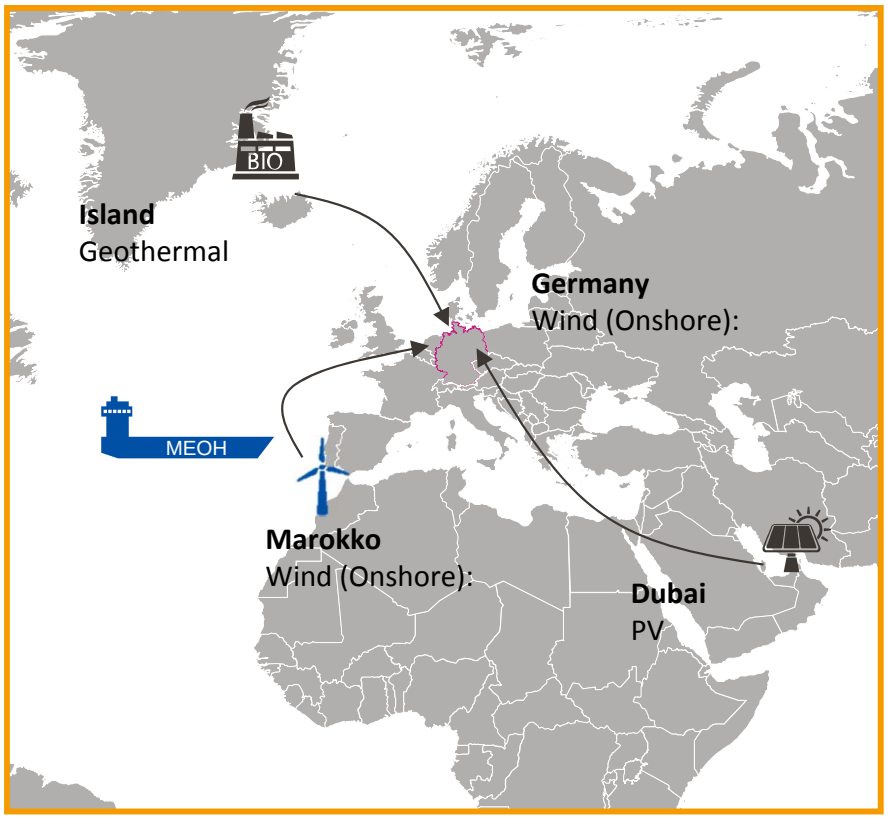
Other emissions
(cars, industry, chemistry, heat, …)
ca. **750 Mio. t**

possibly completely evitable through electrification

CO_2 emissions from long distance travel are hardly evitable by means of direct electrification. Even if all other emissions could be completely avoided, Germany would still emit to much CO_2 due to inevitable emissions (according to UBA).

Numbers in Mio. t CO_2-equivalent p.a.

Greenfuels enable a worldwide trading of renewable energy



Advantages of a global greenfuel exchange

- Low cost of production
- Higher efficiency of existing resources
- Less “not in my backyard” challenges
- Global portfolio-effects can hedge local fluctuations
- Development potential for exporting countries “win / win”

Easy handling and transport are basic requirements to take these advantages. Here **liquid energy carrier** are in **advantage** over gaseous.

There are several alternatives for green, i.e. CO2 neutral, energy carriers available

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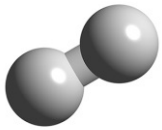
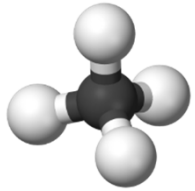
Non-exhaustive overview of potential energy carriers

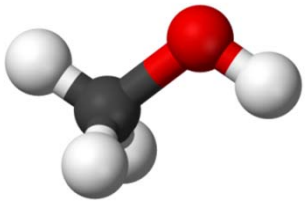
Hydrogen
(H_2)



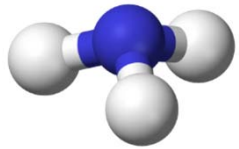
Methane
(CH_4)



Methanol
(CH_3OH)



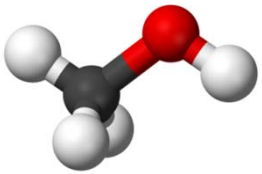
Ammonia
(NH_3)



Metallic
aluminium

Other …

Methanol as a green fuel …



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… shows very good properties for use …

Easy handling

> Methanol is liquid at ambient conditions

> Handling is similar to diesel, gasoline or fuel oil

> Methanol is blendable to conventional fuels

High energy density

> In comparison to the often discussed energy carrier hydrogen, methanol offers a high volumetric energy density

… and can reduce the CO_2 emissions from industry

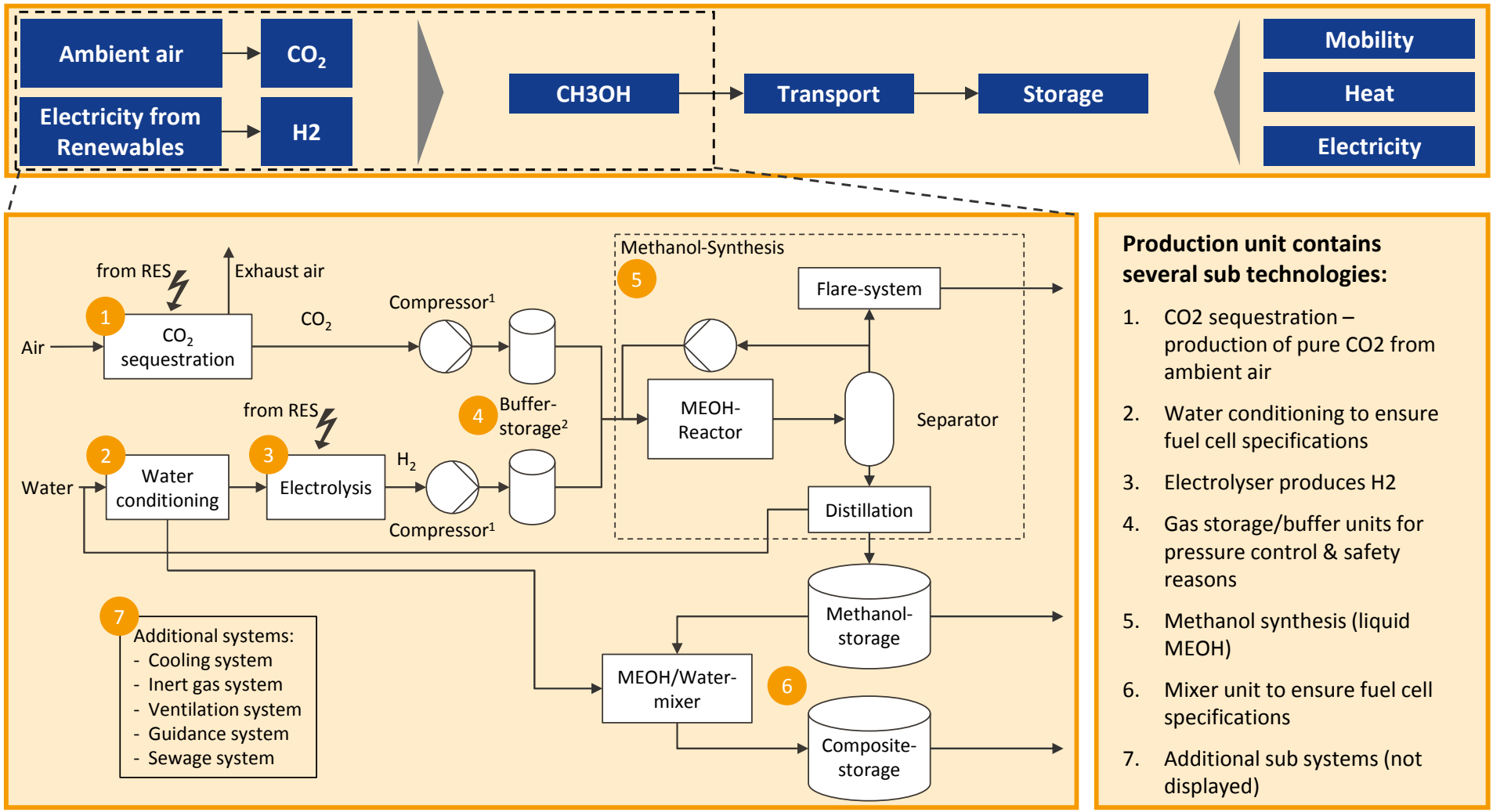
> Methanol is an important base chemical for the production of colours, solvents and plastics

> The global demand for methanol reaches 65 Mio. t, thereof approx. 7 Mio. t in Germany

> The chemical sectors uses 100.000 t of methanol per day

The use of green methanol is **not limited** to the **industry sector**. New use cases can evolve in **private households** and the **mobility sector**.

The conversion route of green methanol combines many technologies and serves sector coupling

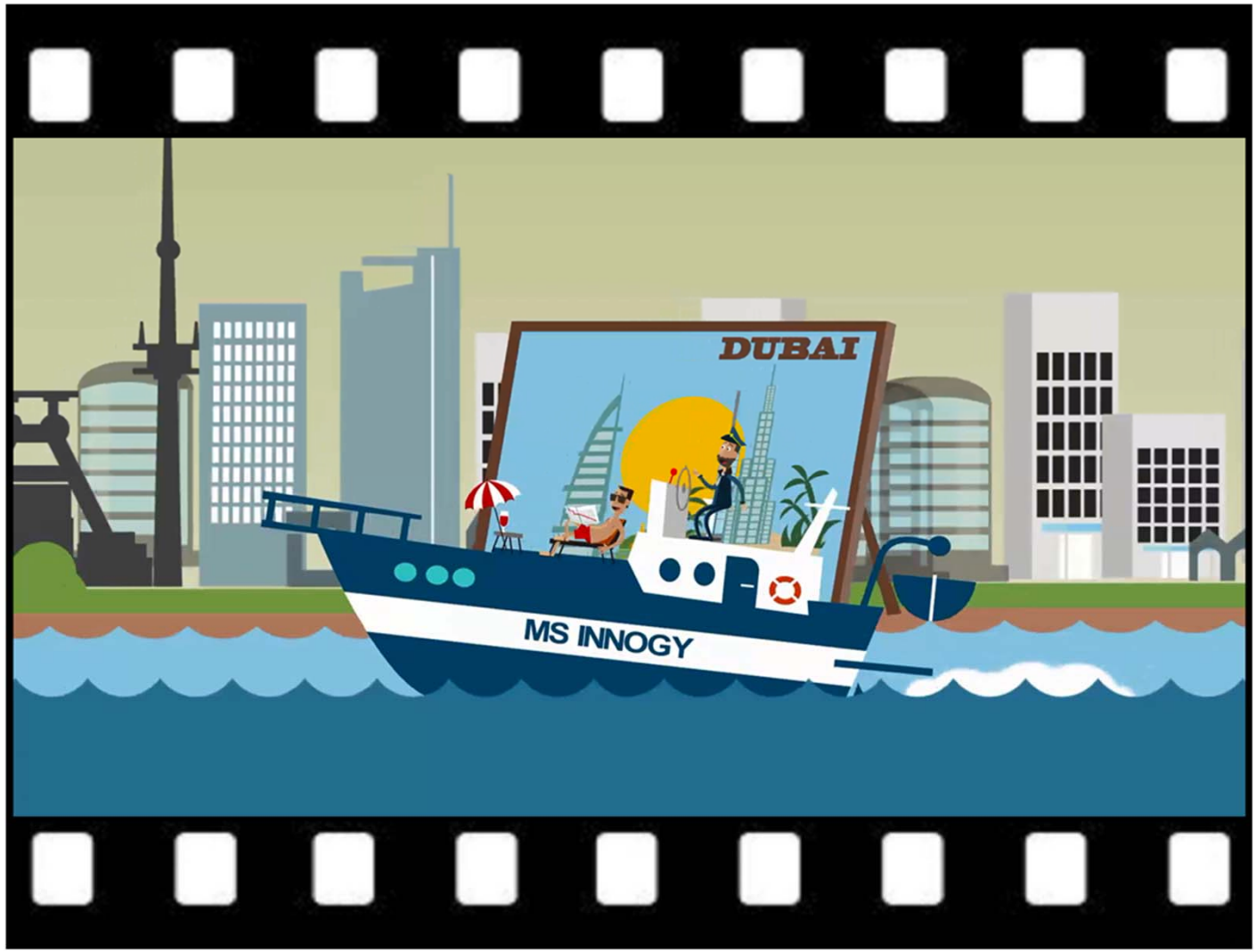


Production unit contains several sub technologies:

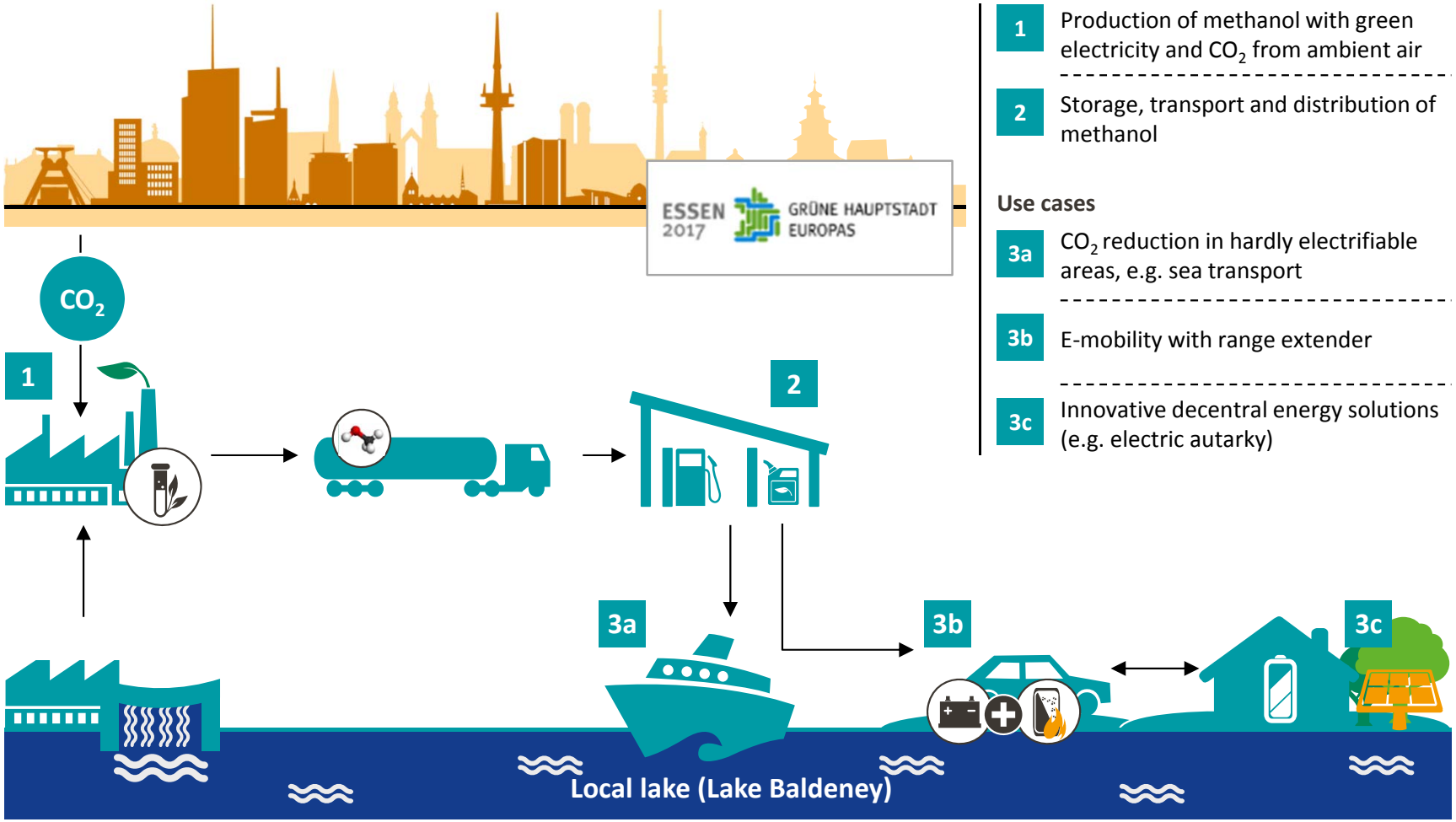
1. CO2 sequestration – production of pure CO2 from ambient air
2. Water conditioning to ensure fuel cell specifications
3. Electrolyser produces H2
4. Gas storage/buffer units for pressure control & safety reasons
5. Methanol synthesis (liquid MEOH)
6. Mixer unit to ensure fuel cell specifications
7. Additional sub systems (not displayed)

[1] eventually combined into one unit | [2] safe shutdown purpose; eventually combined into one unit

The R&D project “**greenfuel**” – a short video



The R&D project "**greenfuel**" demonstrates the entire value chain of green methanol



1 Production of methanol with green electricity and CO_2 from ambient air

2 Storage, transport and distribution of methanol

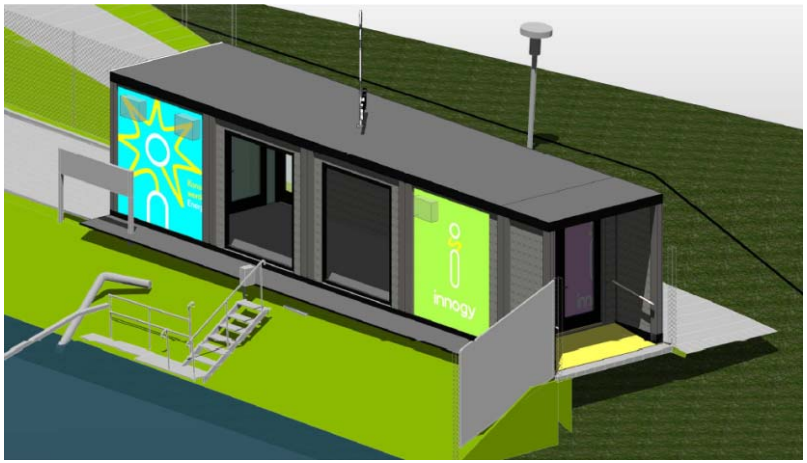
Use cases

3a CO_2 reduction in hardly electrifiable areas, e.g. sea transport

3b E-mobility with range extender

3c Innovative decentral energy solutions (e.g. electric autarky)

Production of methanol



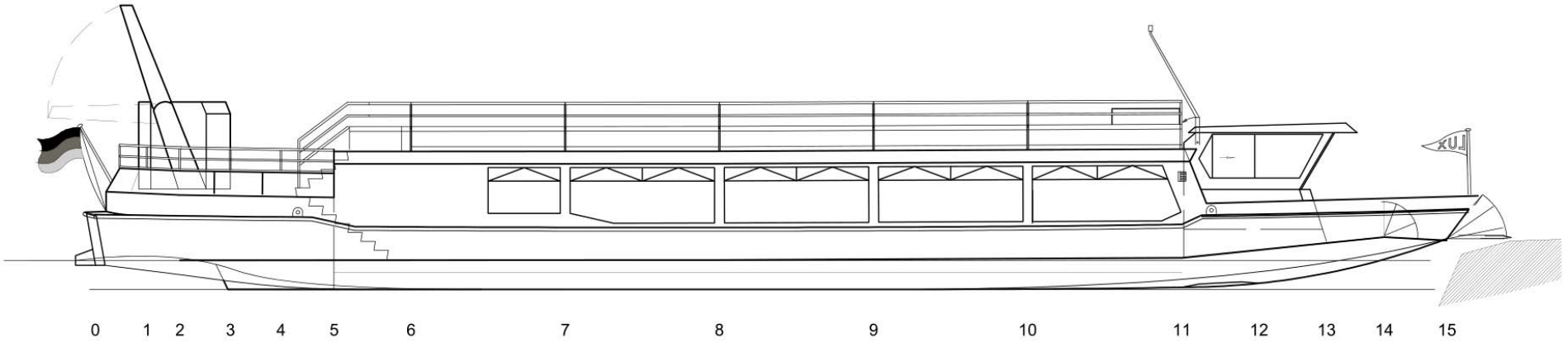
Technical specifications

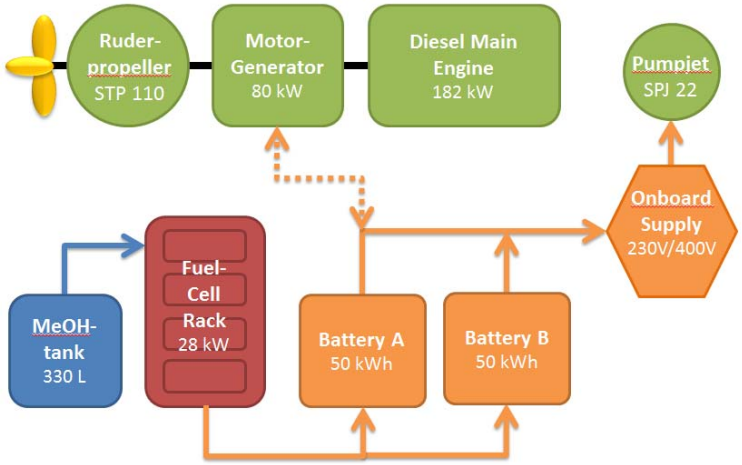
- Biocatalytical process
- Input: power, water, CO_2 from air
- 3 stage conversion from water to CO_2 to Methanol
- TRL 4-5
- Size of plant: 2x2x1 m
- Technology partner: Gensoric GmbH (Ger), Skytree (NL)

Challenges:

- Upscaling from existing Labscale
- Production and usage of active enough enzymes
- Development of enzymes (activity, costs)

MS innogy: first Methanol-fuel cell ship at lake Baldeney in Germany

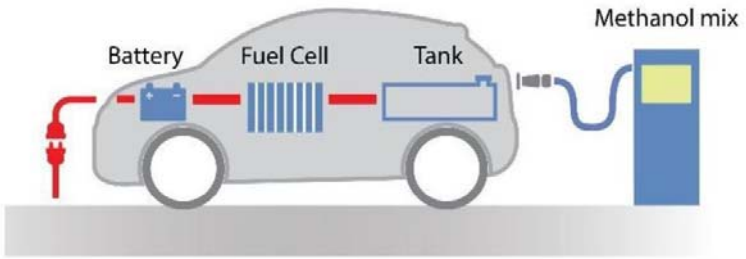




100kWh Battery // 28KW FC // 330ltr. MeOH

- Lenght: 29 m
- Width: 4.8m
- Draught: 0.65m
- Passangers: 164

Nissan eNV 200 – Rebuild for fuel cell REX*)



Technical specifications

Basis	Rebuild
7 seats	5 seats
80 kW engine	80kW engine + 5kW MeOH FC
24 kWh battery	24 kWh battery
170 km travel range	> 500km (urban)
	> 50 ltr Tank
	zero particle emission

type	current	green scenario
Diesel	132 g/km	100 g/km
Benzin	176 g/km	123 g/km
Hybrid	142 g/km	80 g/km
Batterie-elektrisch	98 g/km	2 g/km
Wasserstoff	17 8g/km	3 g/km
Methanol	83 g/km	2 g/km

REX: range extender // Source for table content: Danish department of Energy 2014

The timeline

ESSEN 2017 GRÜNE HAUPTSTADT EUROPAS
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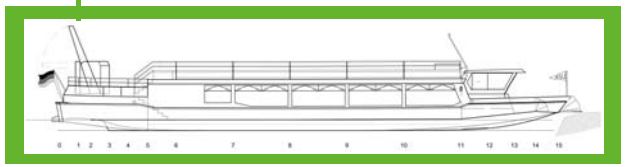
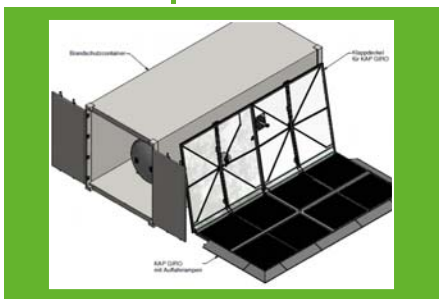
2017 **2018**





Impressions – transportation of ship to shipyard

„…by implementing the whole value chain of methanol within this R&D project we expect to generate not only a valuable contribution for the city of Essen and the “Grüne Hauptstadt Europas 2017” but also to gain a lot of know how for building a very promising business case for innogy….”

Jens Kanacher, Head of CoC Energy Systems and Storage

Thank you very much for your attention!