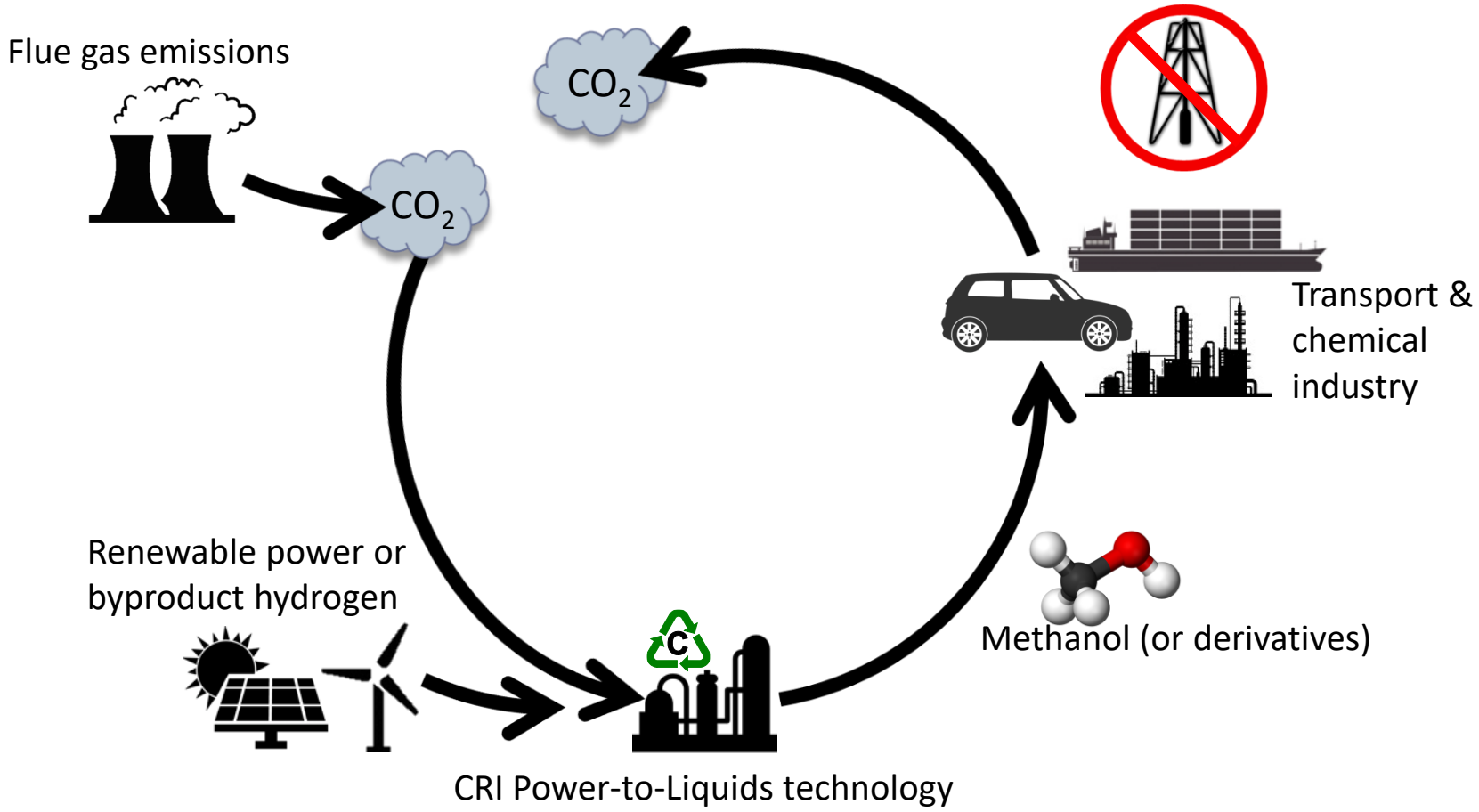
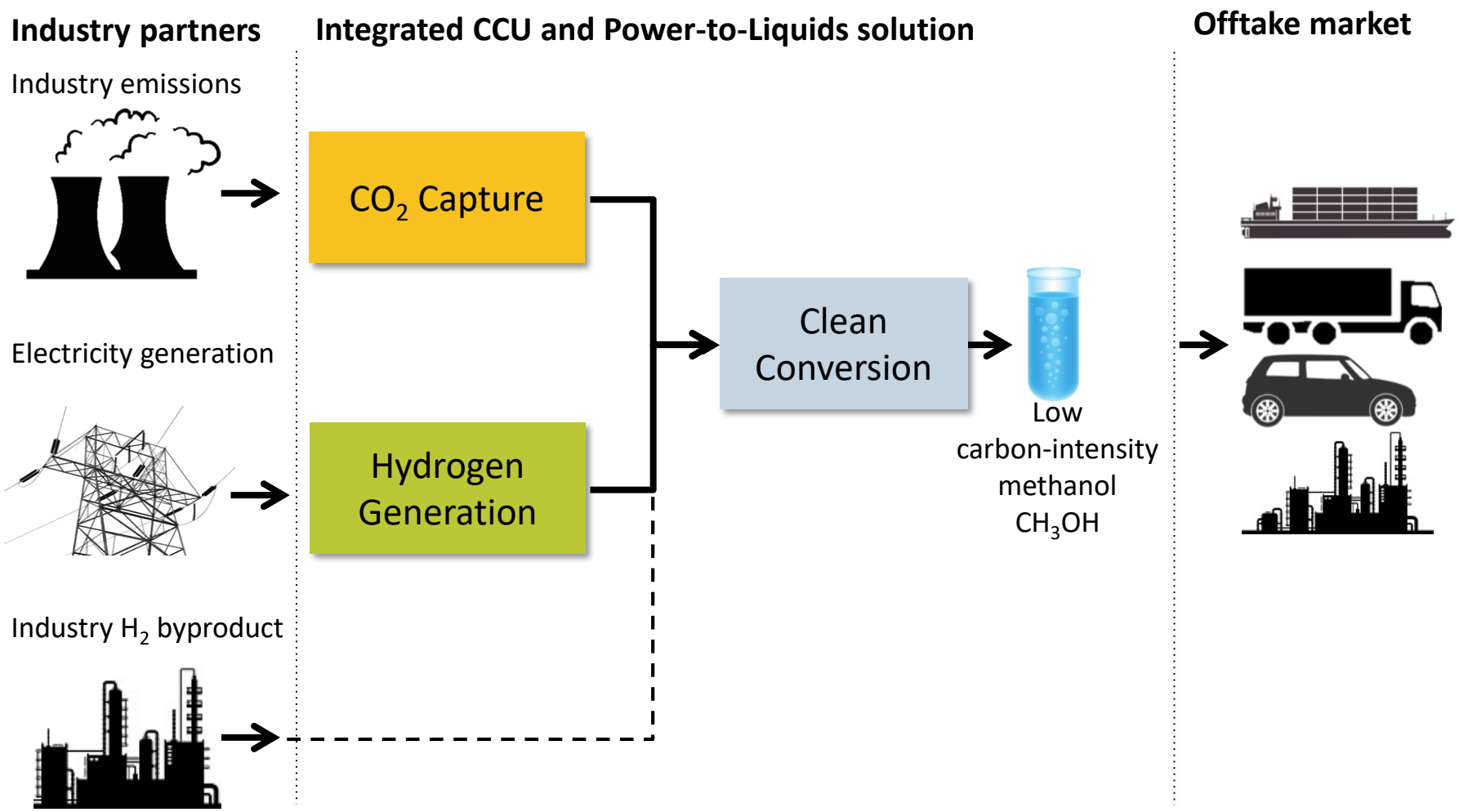
CO2-to-methanol: Nordic technology with global application

Benedikt Stefansson
Director of Business Development, CRI

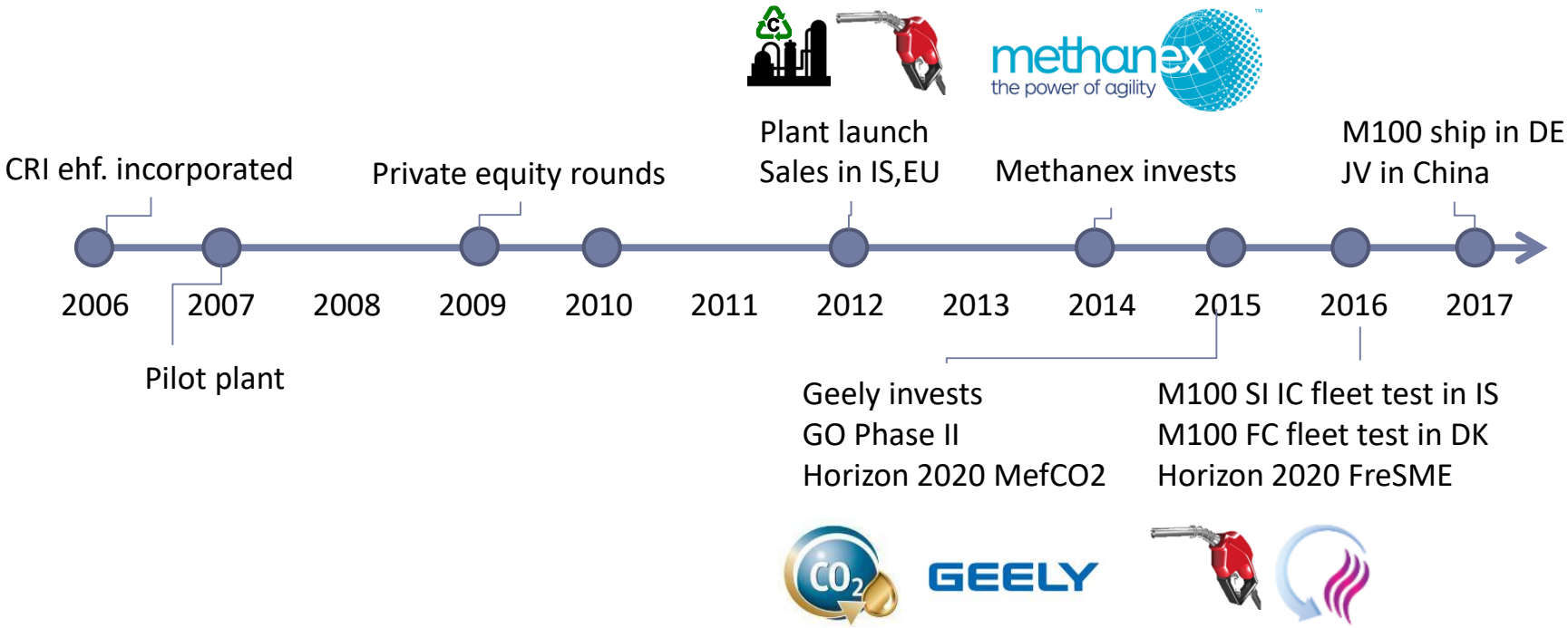
Enabling an industrial carbon cycle with low carbon intensity methanol as an energy carrier



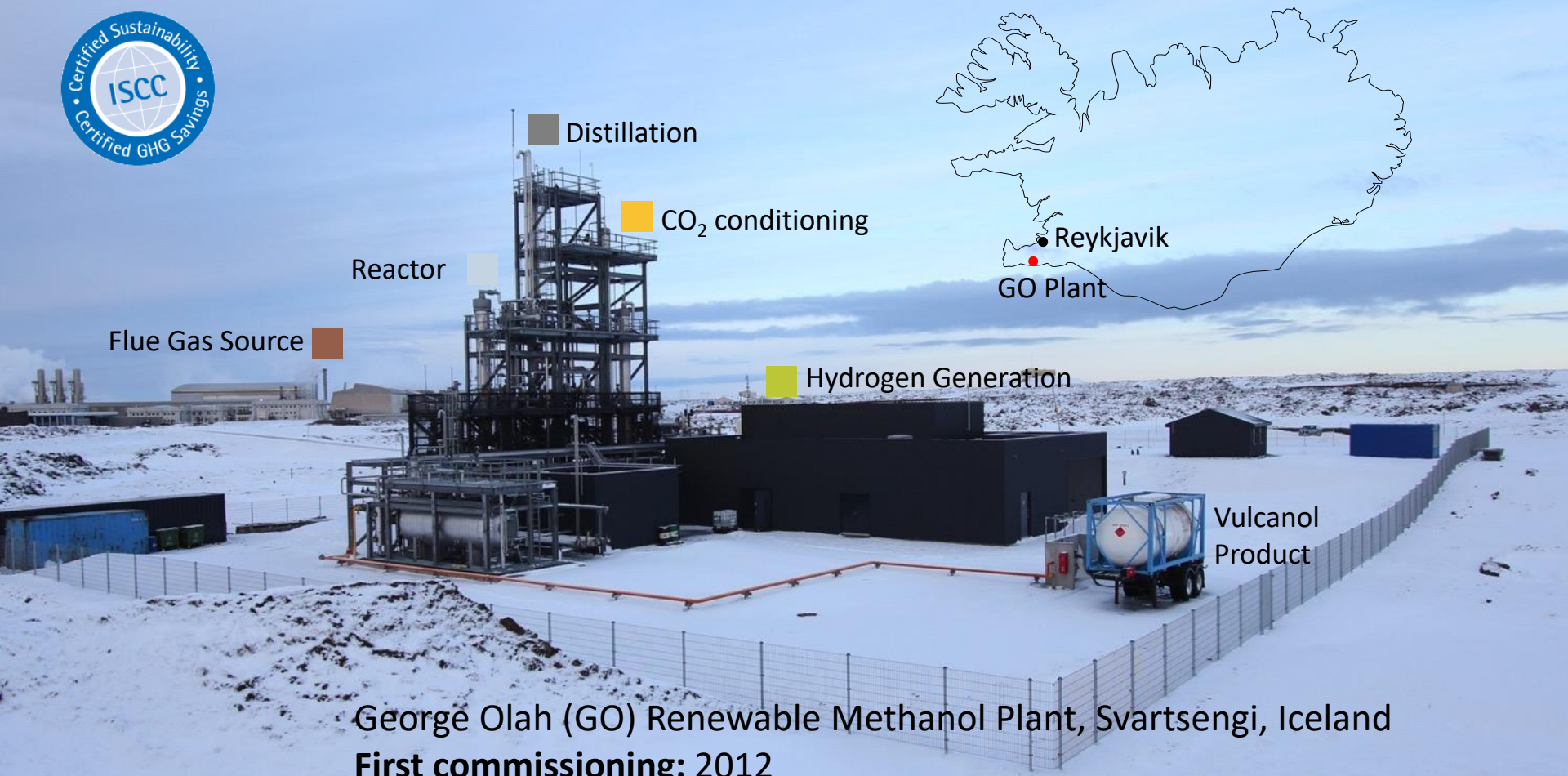
CRI's CO2-to-methanol industrial platform



Recent milestones



CRI first of its kind Emissions-to-Liquids facility in Iceland



George Olah (GO) Renewable Methanol Plant, Svartsengi, Iceland

First commissioning: 2012

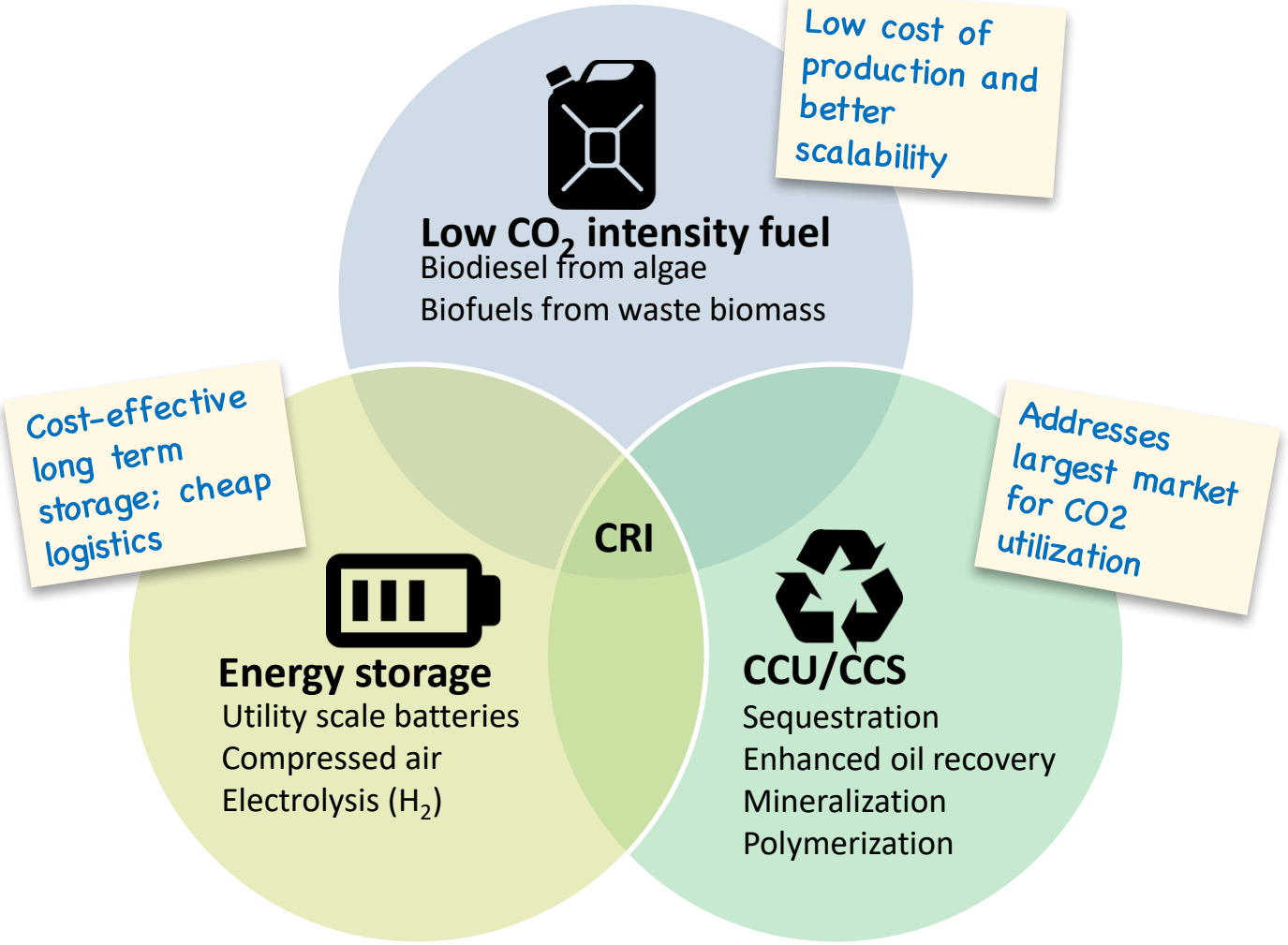
Capacity expansion: 2015

CCU throughput: 5,600 t/yr CO_2

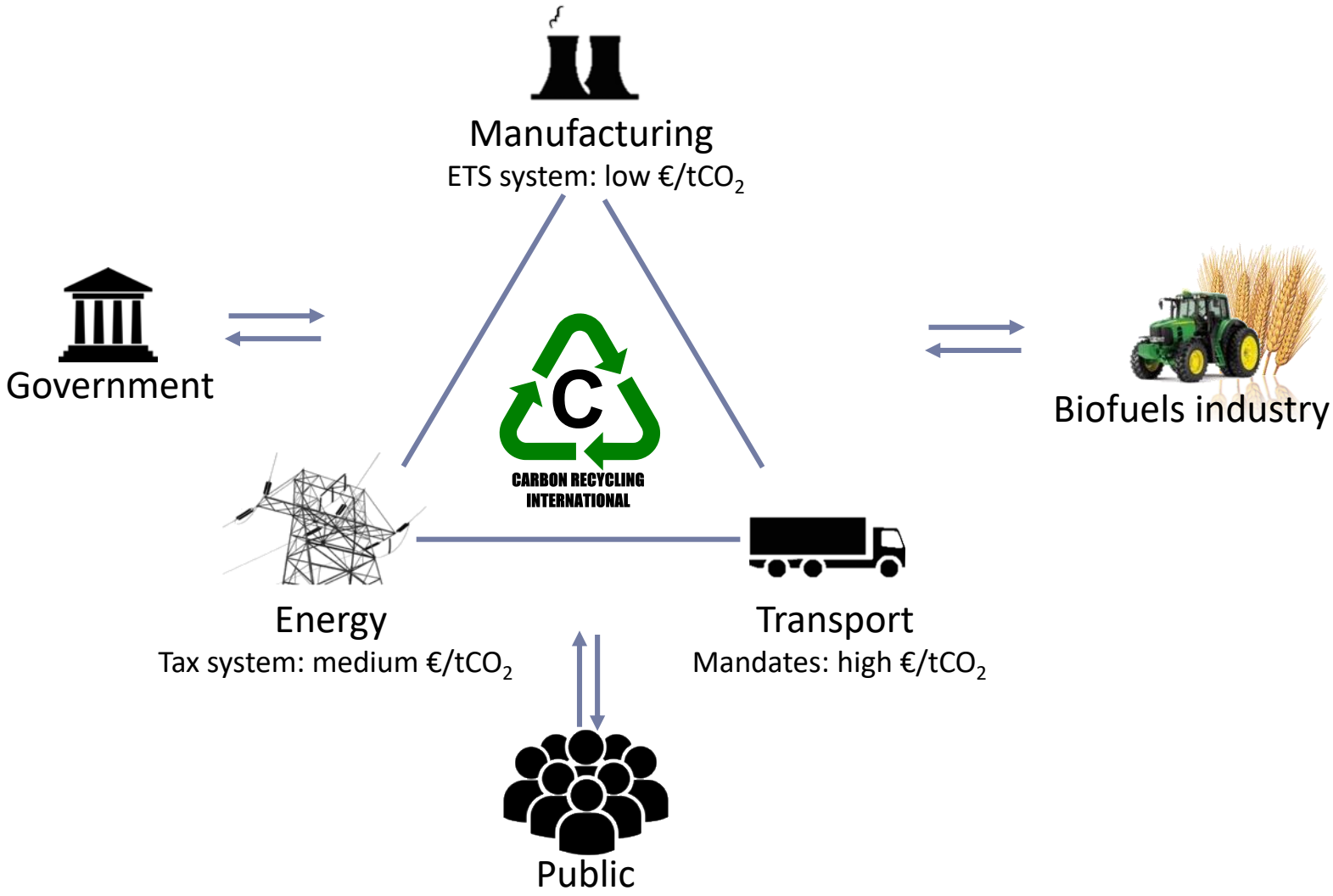
Electrolyzer capacity: 800 t/yr H_2 (1200 Nm^3/hr)

Production capacity: 4,000 t/yr methanol

CRI solution addresses three key markets



CO2-to-fuel connects 3 industries



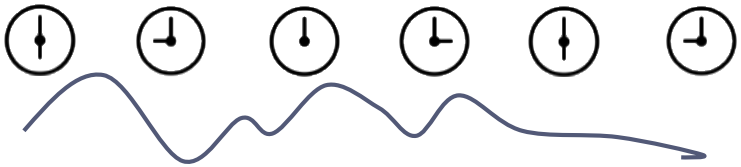
...relevant metric: efficiency of "decarbonization"

Fully electric power train faces challenges

Only a fraction of transport can be fully battery operated

2030:~30%* ~0% ~0% ~0%

Matching intermittent sources and EV charging challenging



Wind

2030:20% RES**

Challenging to ramp up sustainable battery production

500,000 = +1x world production of li-ion batteries†

14,000,000 = annual car registrations in EU-28‡

Power-to-methanol

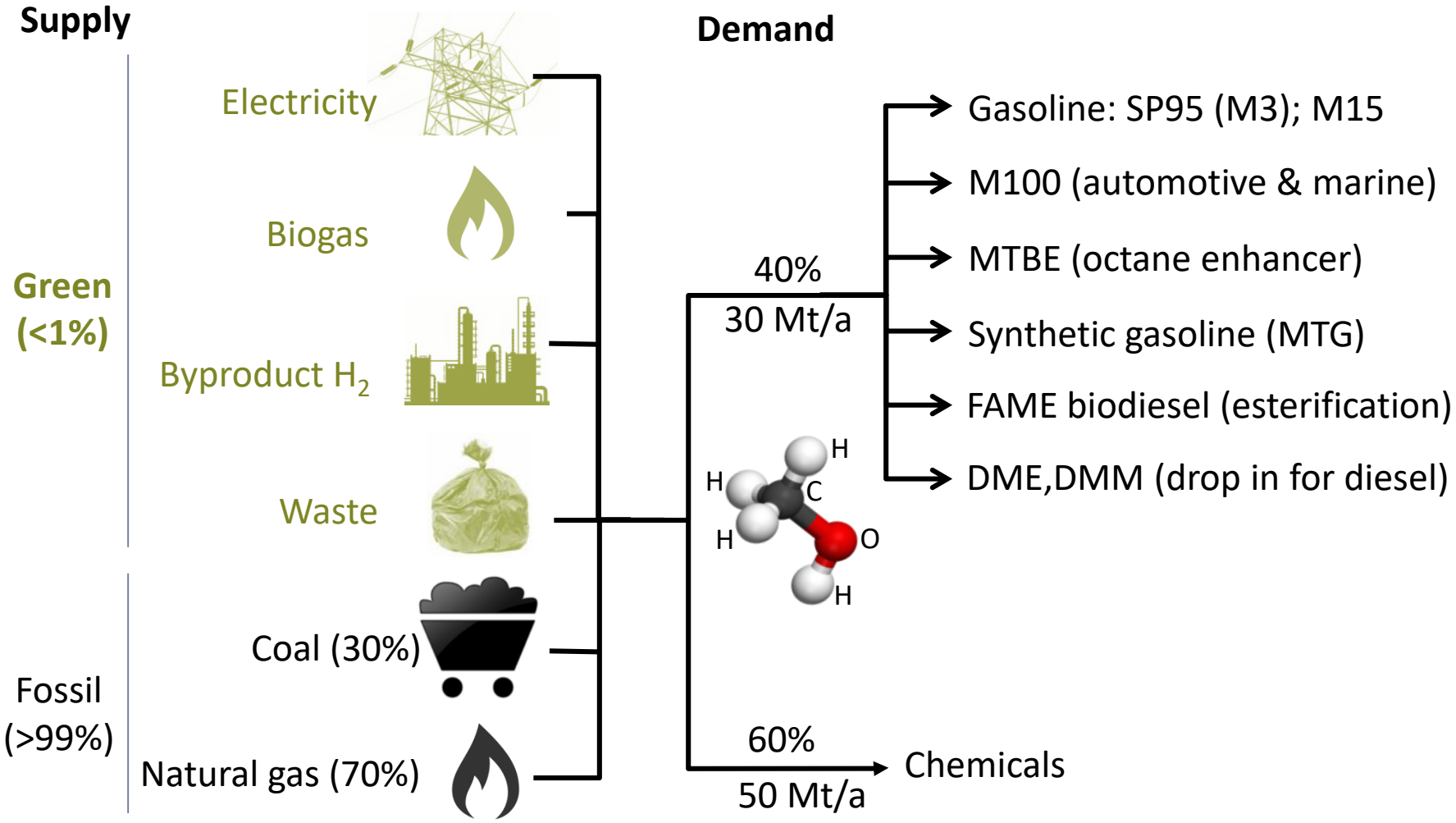
Addresses larger market
Fuel for road transport and shipping and potential feedstock for jet fuel.

Integrates with grid
Industrial production plants can make better use of electricity from non-dispatchable sources

Scalability is important
Use no rare earth metals or scarce commodities and can be readily scaled

*Bloomberg New Energy Finance **Hennings et al. Energy Policy 2013 (case of Germany) †Economist ‡ICCT

The versatile hydrocarbon



Why is methanol such an attractive green fuel option?

Energy density

Carries 2x more H_2 / litre than liquid H_2
Carries 100x more energy / volume than EV battery

IC engine efficiency

Achieves higher break thermal efficiency than gasoline or diesel
Allows cheaper and lighter materials to be used

Health risks

Less toxic than gasoline or diesel
No soot, No SO_x
Ultra-low NO_x
No ozone formation

Future scalability

Available fossil as well as green
Fits heavy duty as well as light vehicles
Compatible with IC engines as well as fuel cells

Examples of increased penetration of methanol

Automotive applications

Marine applications

Near term prospects

- Scale plants to tens of kt
- Standardized units (low CAPEX)
- Deploy in EU and China
- Meet demand for liquid sustainable fuels

Benedikt Stefansson
bs@cri.is | +354 820 6825