

Recycling CO<sub>2</sub> into low carbon intensity methanol: enabling sustainable transport

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**Carbon Recycling International**

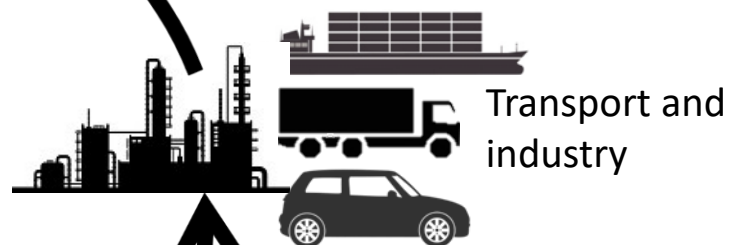
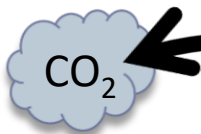
2<sup>nd</sup> CO<sub>2</sub> Reuse Seminar, October 2016



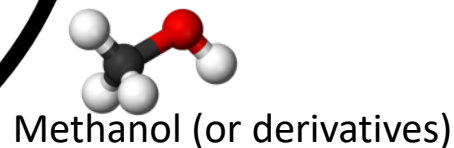
Carbon Recycling International

# Low carbon intensity methanol: liquid energy carrier enabling sustainable transport

Renewable power or byproduct hydrogen



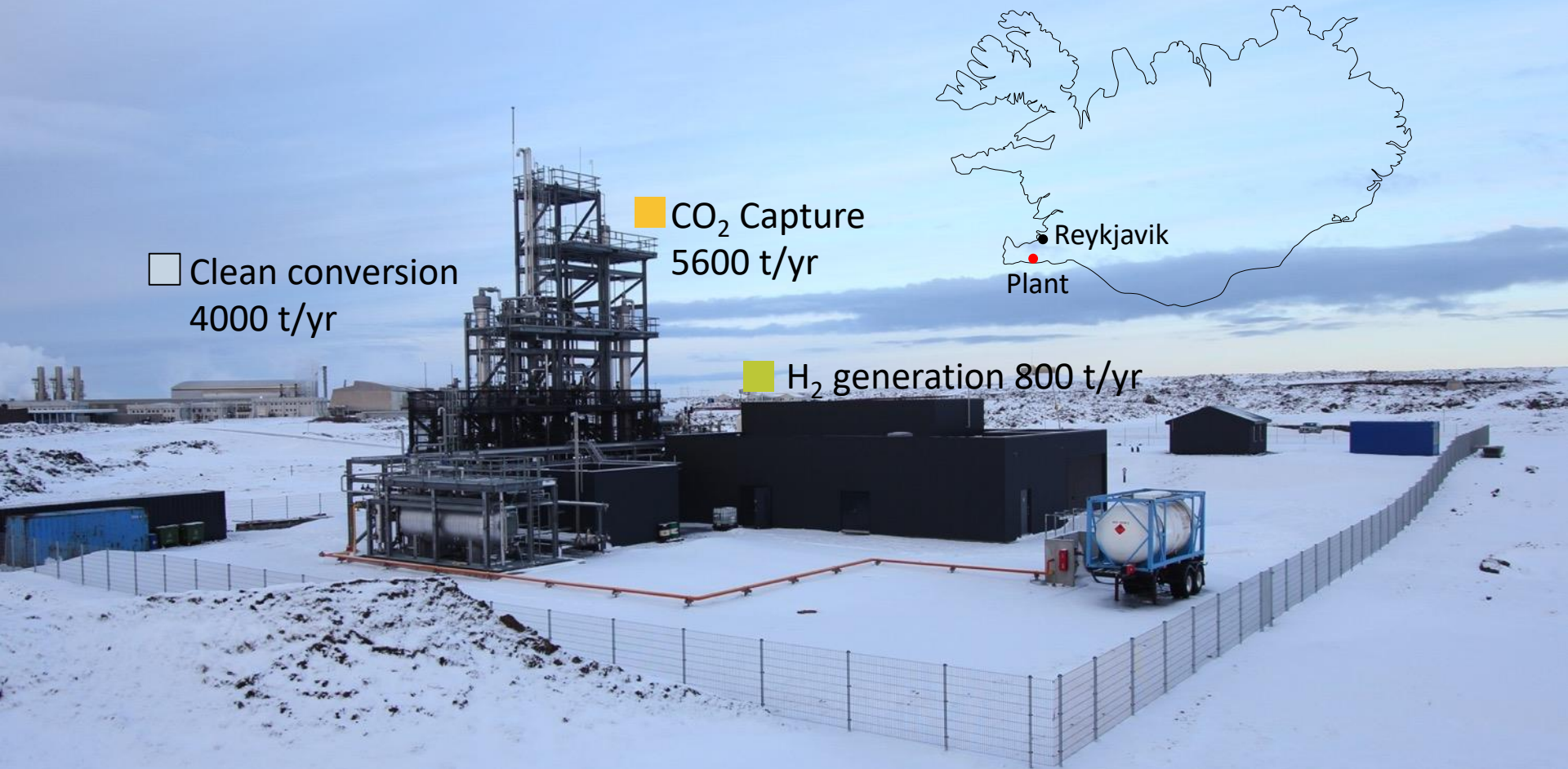
Flue gas emissions



CRI Power-to-Liquids technology



# CRI first of its kind Power-to-Liquids facility in Iceland



George Olah CO<sub>2</sub>-to-methanol plant, Grindavik, Iceland  
**First commissioning: 2012**  
**Capacity expansion: 2015**

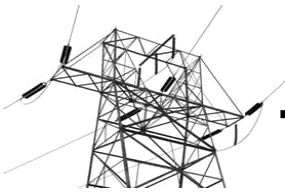
# CRI's Power-to-Methanol integrated solution

## Industry partners

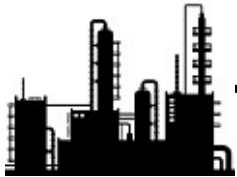
Industry emissions



Electricity



Industry H<sub>2</sub> byproduct



## Integrated CCU and PtL solution

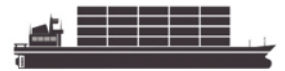
CO<sub>2</sub> capture

Hydrogen generation

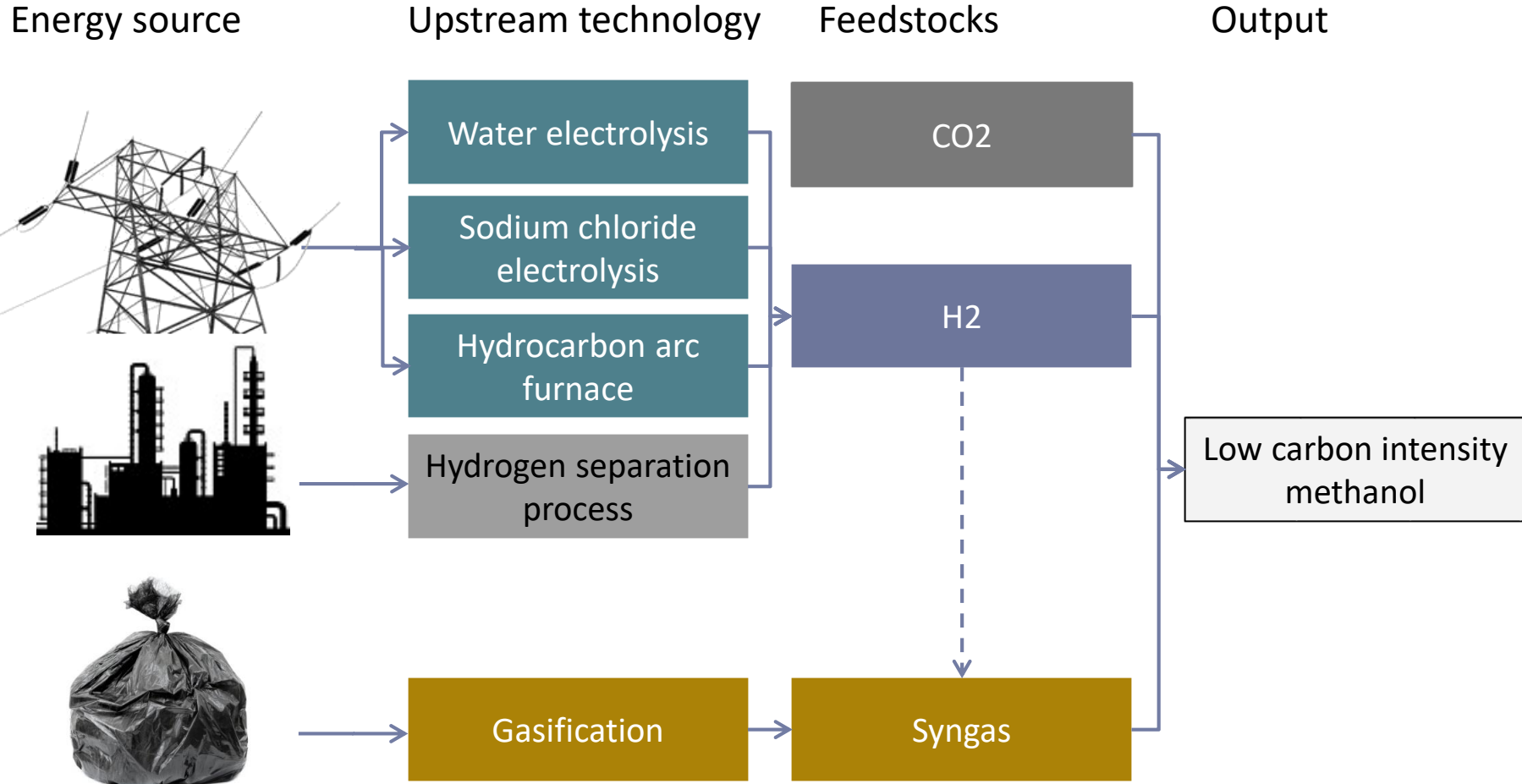
Clean conversion

Low  
carbon-intensity  
methanol  
CH<sub>3</sub>OH

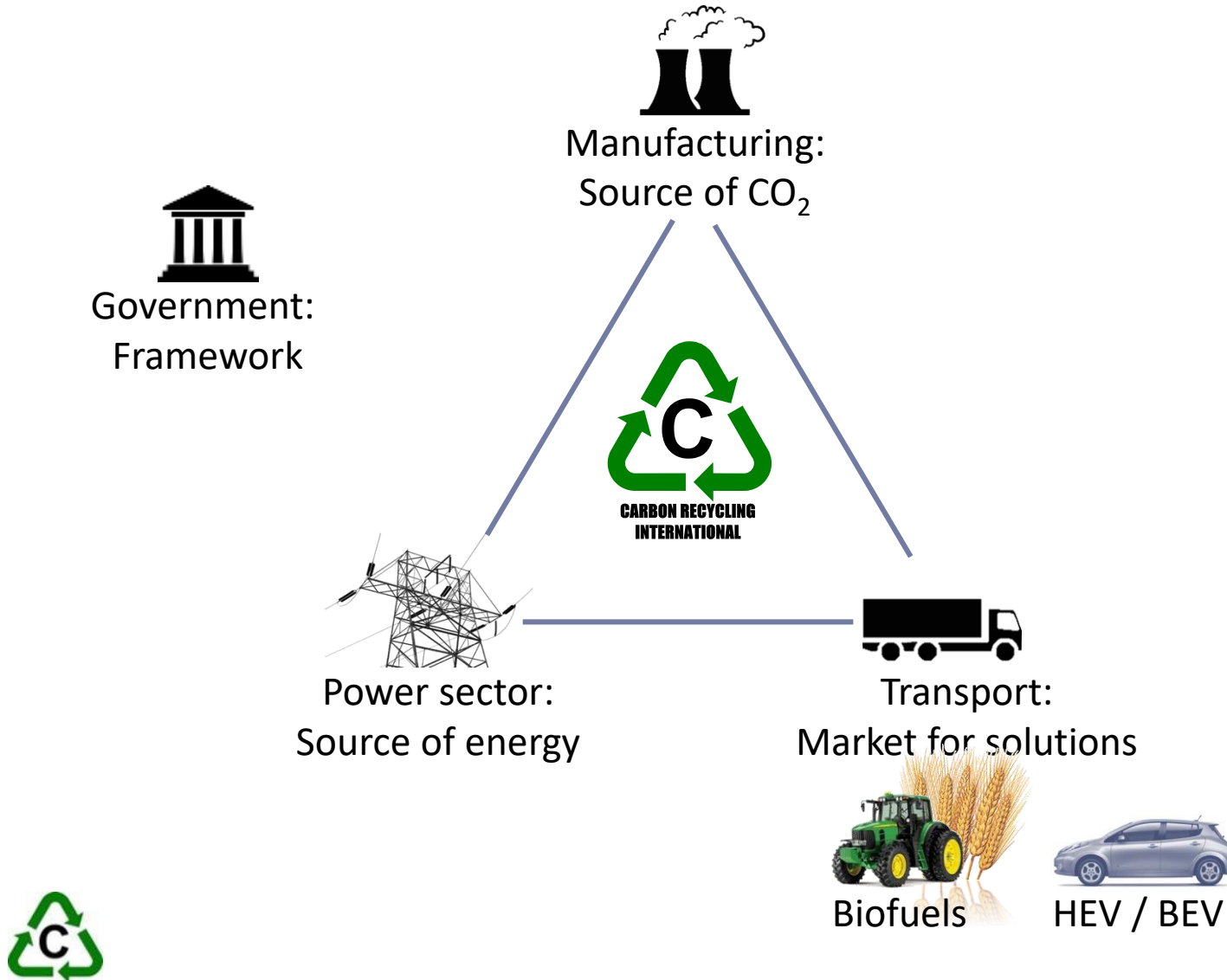
## Offtake



# Low Carbon Intensity Methanol production processes

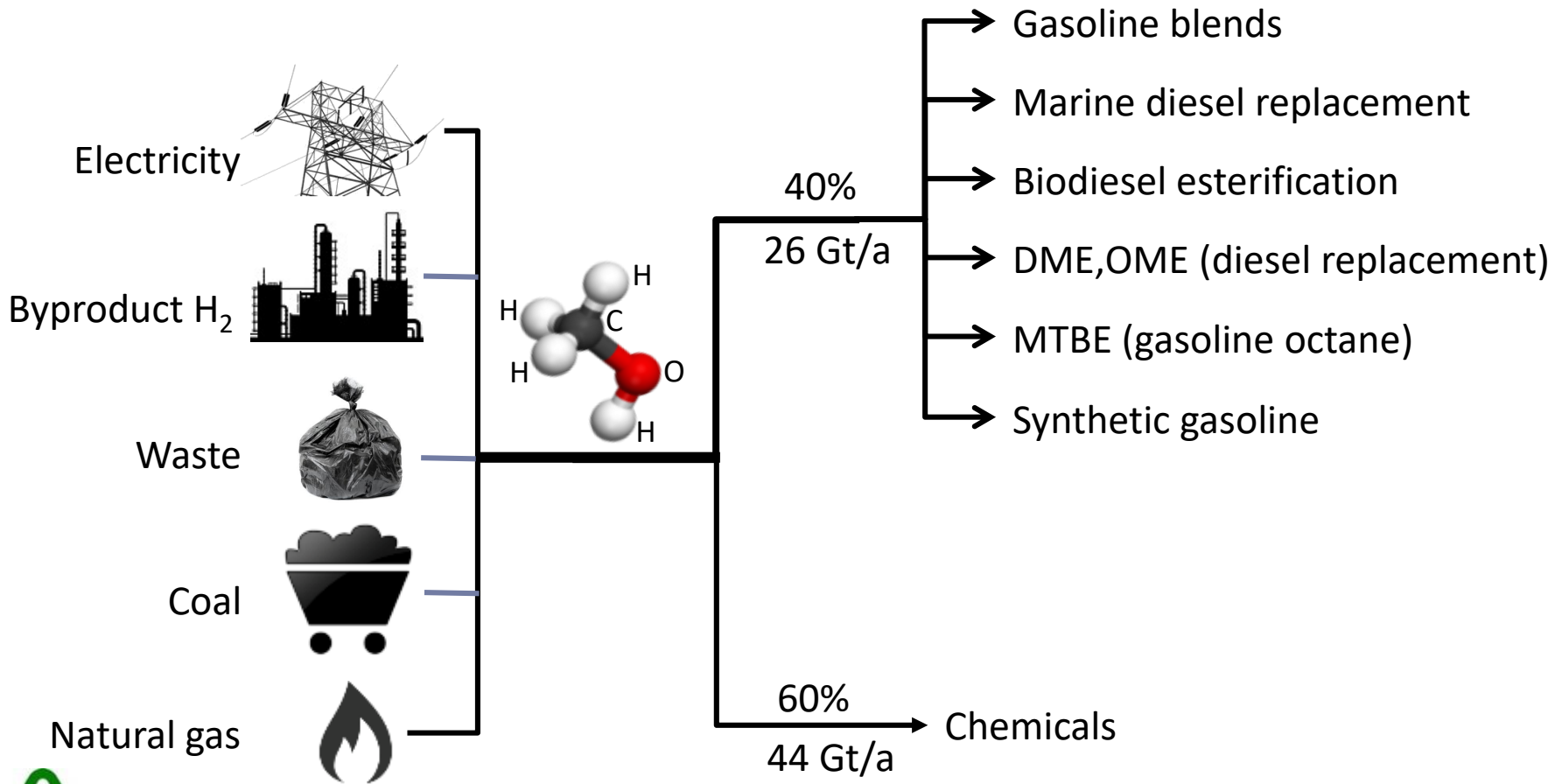


# A new business model for sustainable liquid fuel



# Methanol: the versatile hydrocarbon

As fuel can be seen as “liquid hydrogen”, has no C-C bonds and thus burns cleanly (no PM emissions), produces no ozone, no sulfur, low NO<sub>x</sub>, suits higher compression ratio



# Methanol fuel in ships and fuel cells

Passenger ferry in Scandinavia using methanol as low-sulphur alternative



Methanol from CRI used in Denmark for electric vehicles with fuel cells





# Methanol fuel in cars and trucks

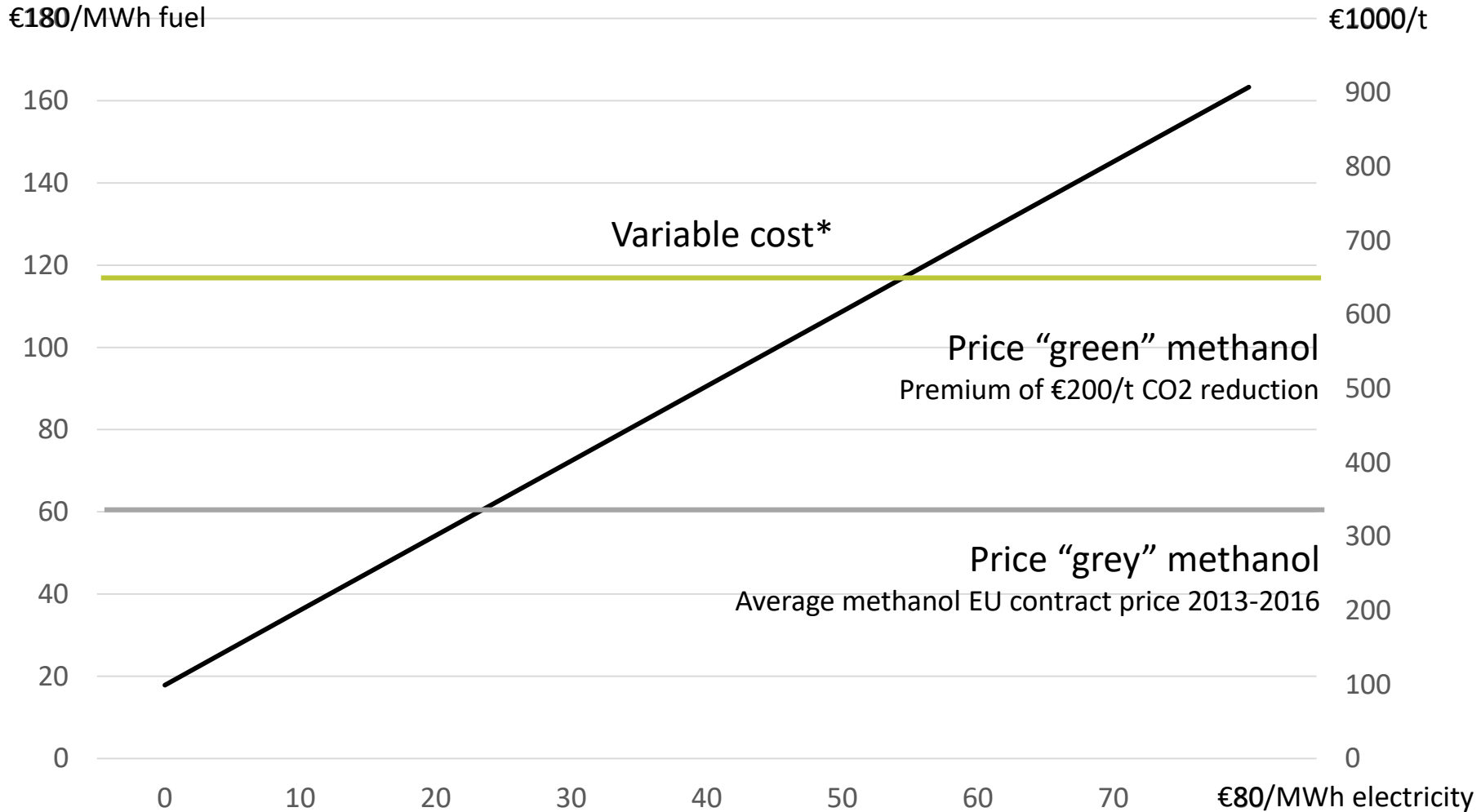
Volvo Trucks ready to offer DME trucks and Ford testing DME in small cars



CRI and Geely collaborating to fleet test M100 vehicles in Iceland



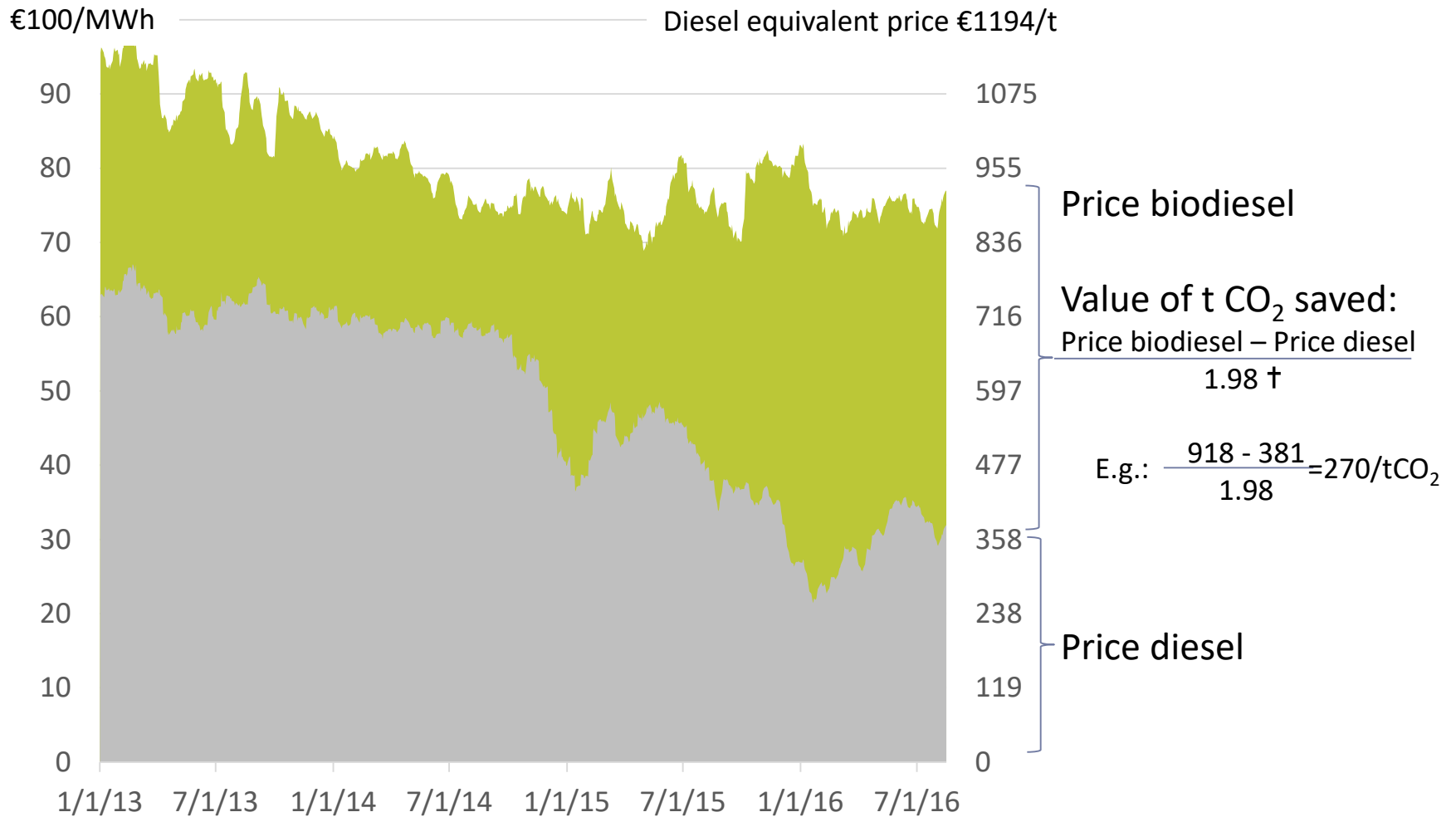
# Stylized economics of production from electricity



\*Including energy, consumables and labor



# Determination of market value of 'ton of CO2 reduced'



† 1.98 = 55% × 302 gCO<sub>2</sub>/MWh × 11.9  
i.e. offset × diesel emissions/MWh × MWh/t



# The French “PPE” provides a unique development opportunity

- Power to Liquids Fuels are recognized at EU level as advanced renewable fuels: annex 9 part A, directive 2015/1513 dated 9/9/2015 mentions:
  - (r) Renewable liquid and gaseous transport fuels of non-biological origin.
  - (s) Carbon capture and utilisation for transport purposes, if the energy source is renewable in accordance with point (a) of the second paragraph of Article 2.
- The draft “Décret PPE” that was published for public consultation until 15/10/2015 sets ambitious targets for advanced fuels:

	2018	2023
Filière essence	1,6%	3,4%
Filière gazole	1%	2,3%

Methanol from CO2 reuse should be explicitly considered in all the regulatory texts referred to advanced fuel support



# Summary

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- Low carbon intensity liquid fuel from electricity (nuclear or renewable)
- Compatible with current infrastructure and engines; lower cost of transition
- Production technology is already mature and can be implemented economically
- The French “PPE” provides a unique development opportunity

