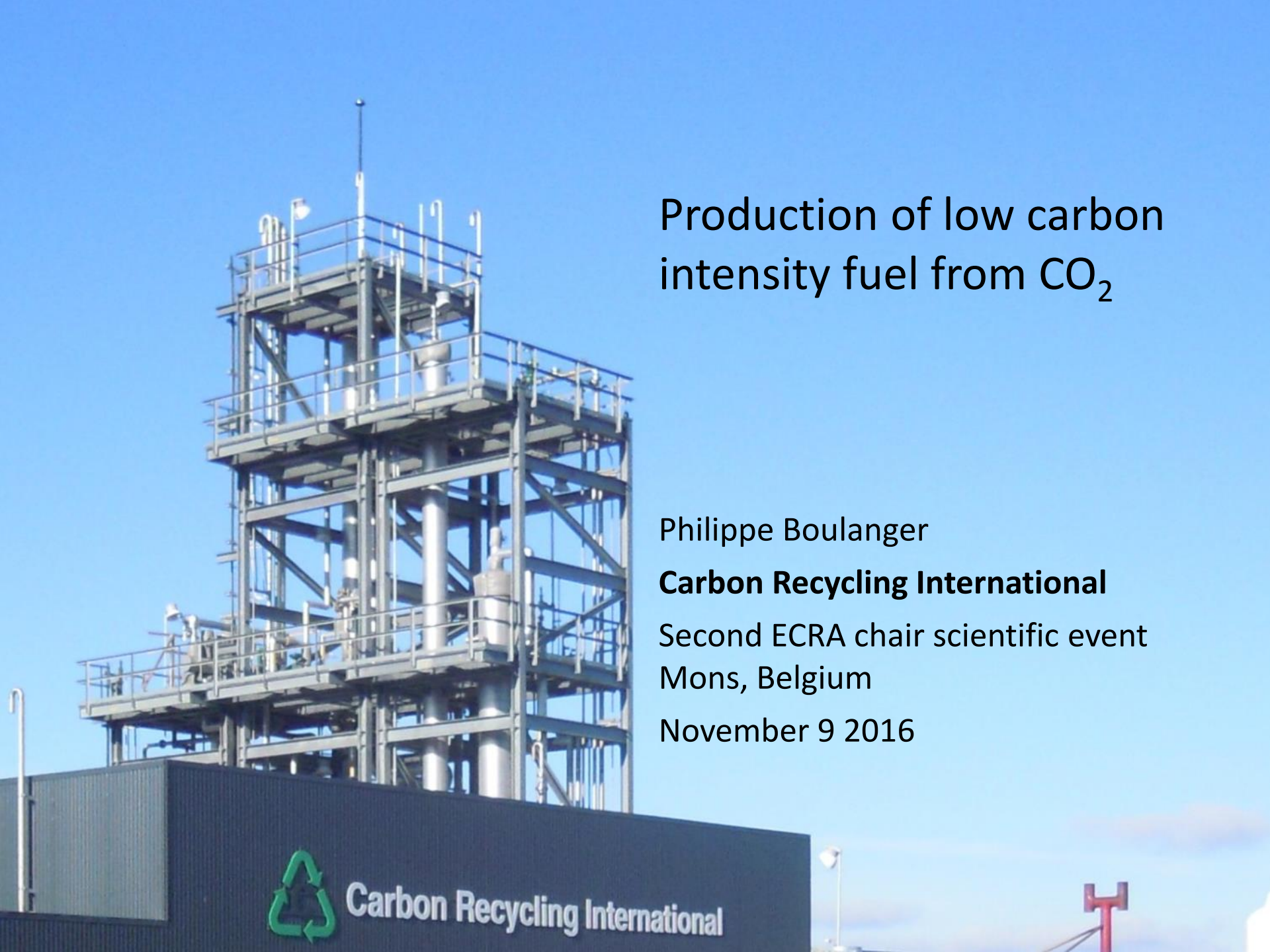


Production of low carbon intensity fuel from CO_2

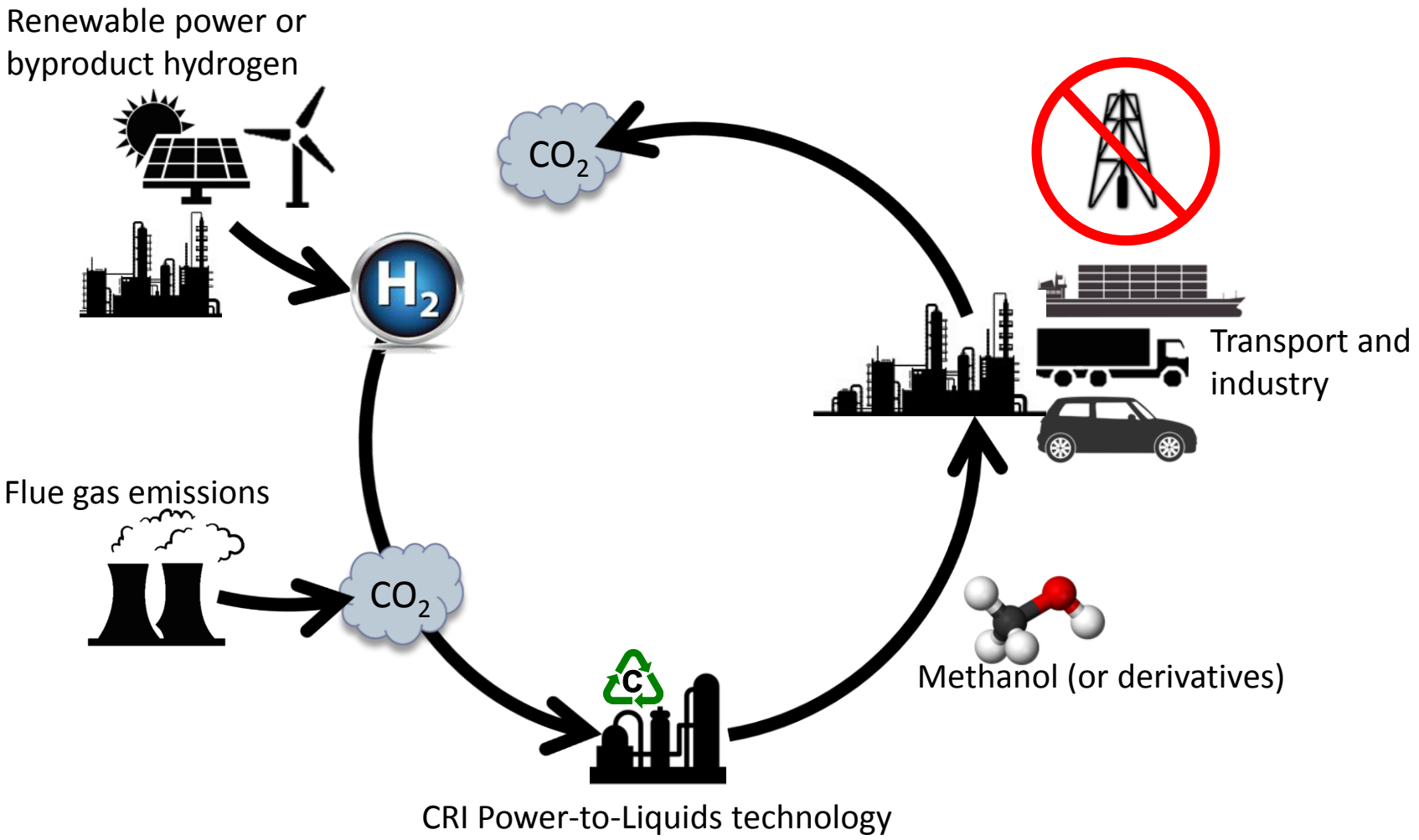
Philippe Boulanger

Carbon Recycling International

Second ECRA chair scientific event
Mons, Belgium

November 9 2016

Low carbon intensity methanol: liquid energy carrier enabling sustainable transport



CRI: an Icelandic Innovation Company

Technology, IP, and international brand recognition

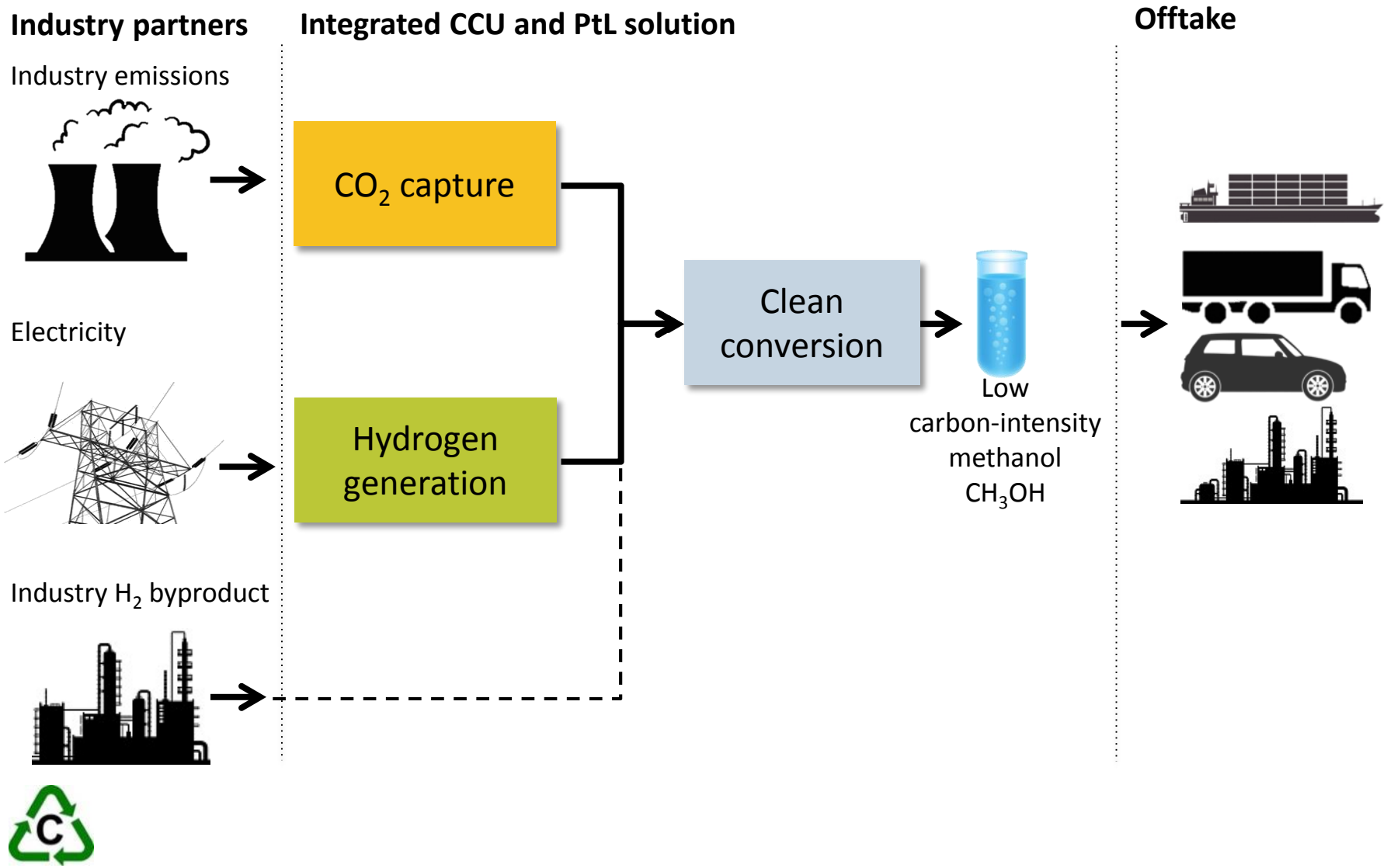
- A pioneer in technology for CCU methanol / power to methanol
- Practicing MW scale conversion of renewable energy to hydrogen
- Practicing kt scale production of fuel from CO2 for sustainable transport

2006	2007	2009	2010	2012	2013	2014	2015	2016
Company founded	Pilot plant built Patents filed	Equity infusion from Icelandic investors	Constructing demo plant	Demo plant launched at 1,300 t/yr	Renewable methanol product goes to market with sustainability certificate ISCC	Demo plant expanded to 4,000 t/yr Methanex invests 1st Horizon 2020 project in Europe	GEELY Geely invests Go to market in China	2nd Horizon 2020 project in Europe

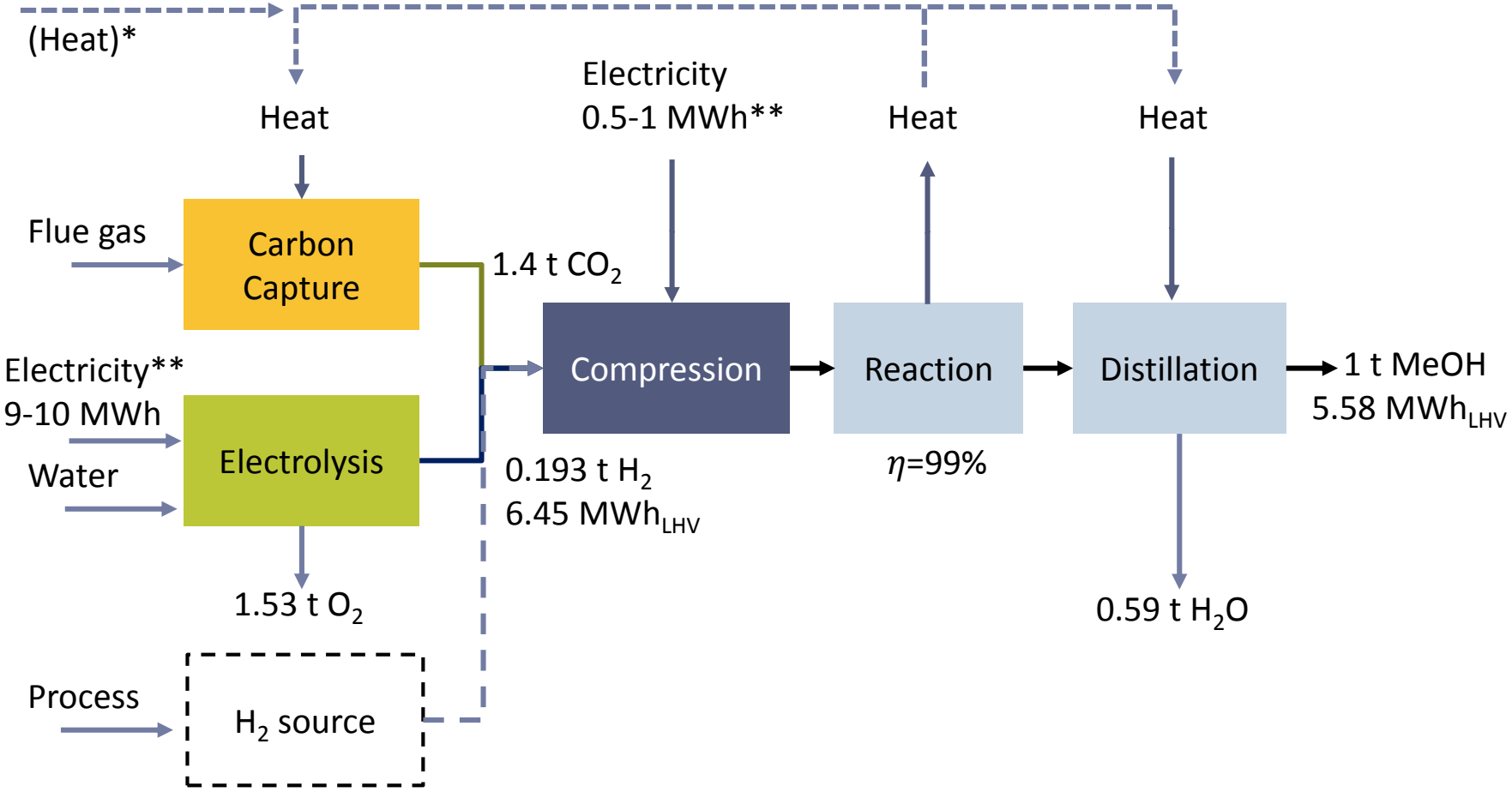
CRI first of its kind Power-to-Liquids facility in Iceland

Pilot: 2009 **Industrial scale commissioning:** 2012 **Capacity expansion:** 2015
CCU: 5,600 t/yr CO_2
Production capacity: 4,000 t/yr renewable methanol
Energy source: Icelandic grid mix (70% hydro, 30% geothermal)
Offtake: Automotive fuels (Iceland, Sweden, Netherlands)

CRI's Power-to-Methanol integrated solution

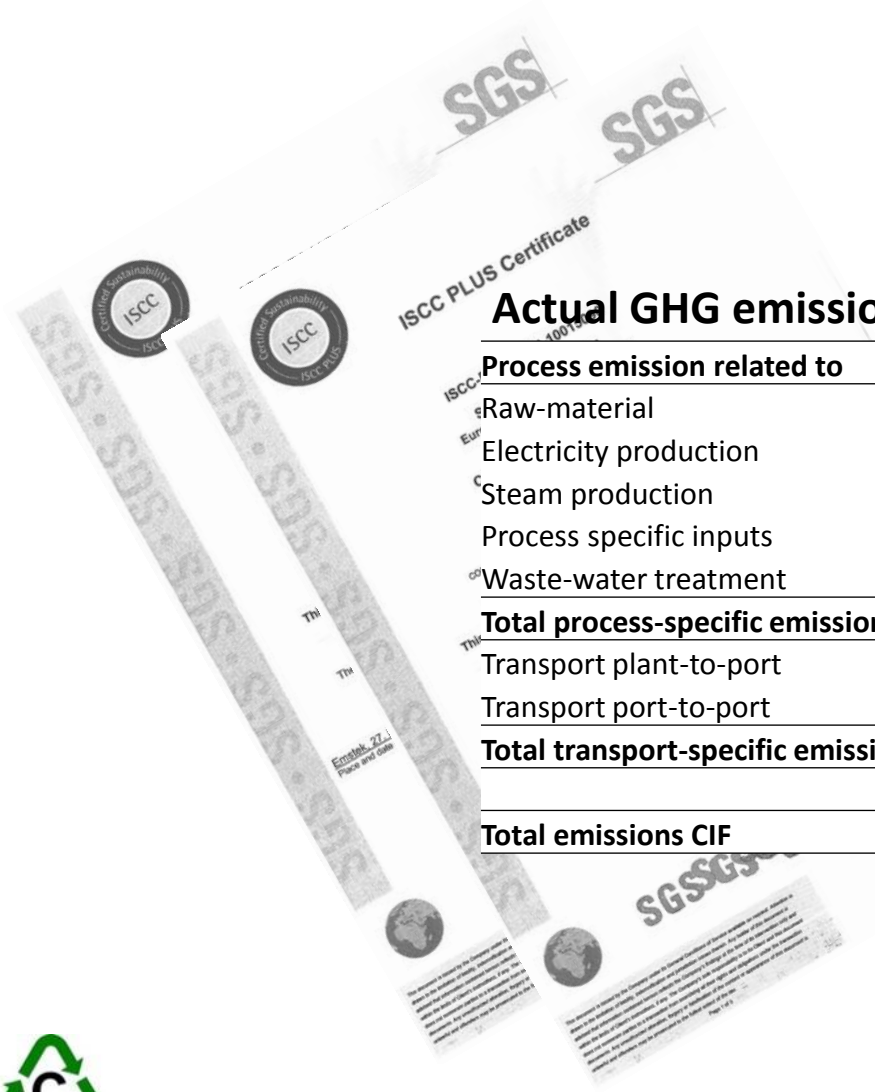


Power-to-methanol mass energy balance and efficiency



*Heat balance depends on configuration **Depends on electrolyzer technology

First renewable transport fuel from non-biological sources with ISCC+ certification of sustainability

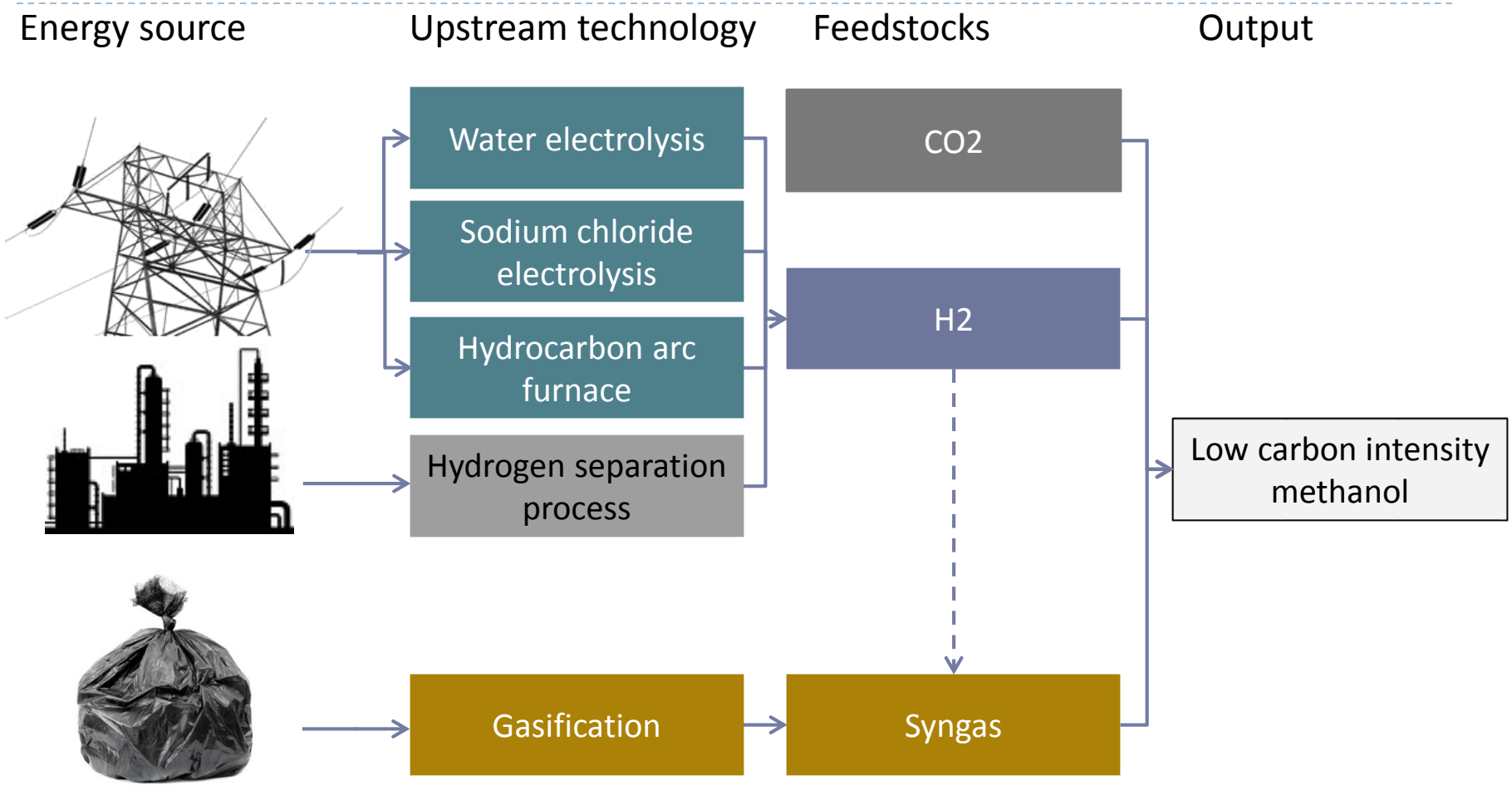


Actual GHG emission values using ISCC EU GHG module*

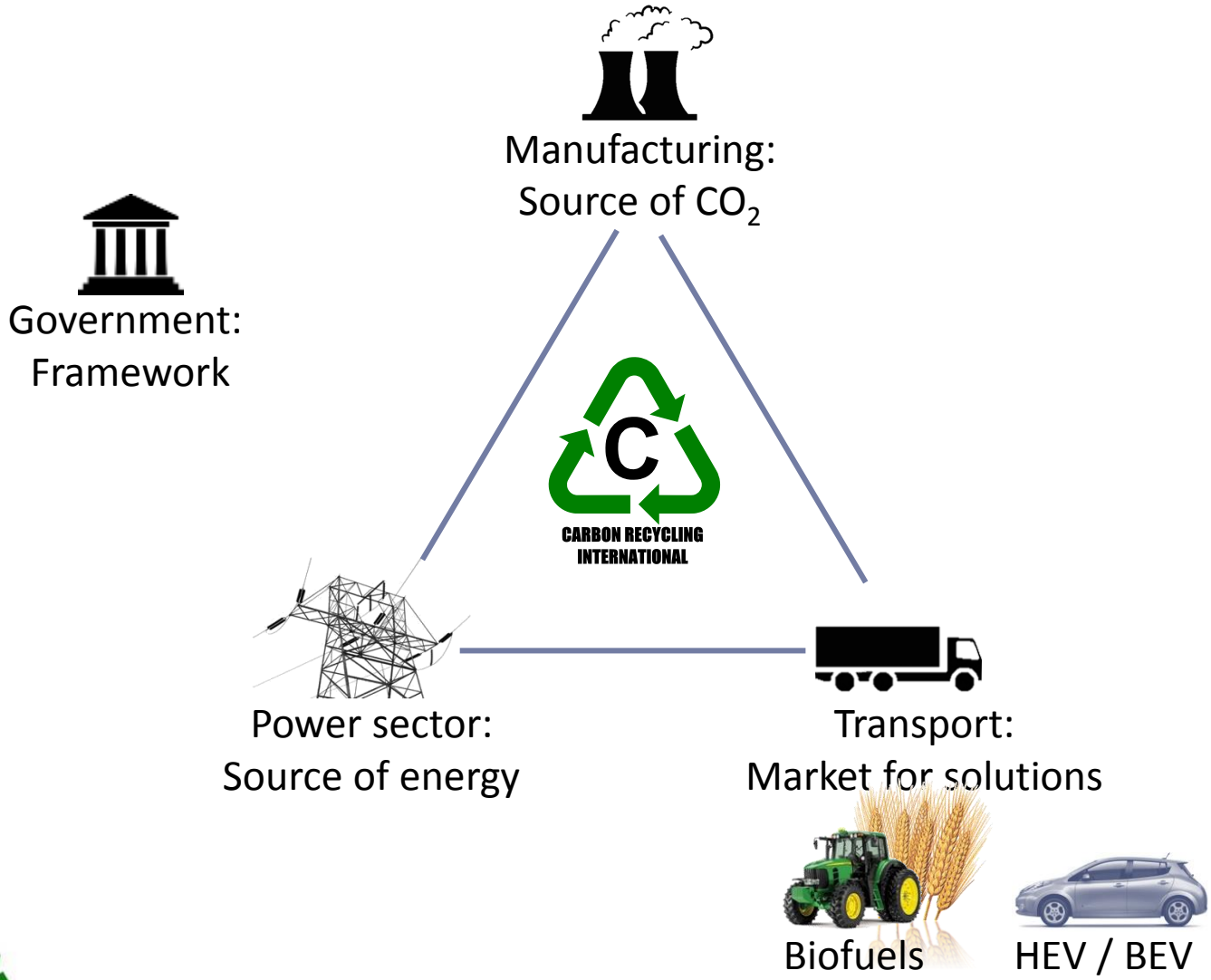
Process emission related to	kgCO2e/t RM	gCO2e/MJ RM
Raw-material	0.00	0.00
Electricity production	141.52	7.08
Steam production	6.76	0.34
Process specific inputs	1.30	0.06
Waste-water treatment	0.25	0.01
Total process-specific emissions:	**149.82**	**7.49**
Transport plant-to-port	5.97	0.30
Transport port-to-port	22.00	1.10
Total transport-specific emissions	**27.97**	**1.40**
Total emissions CIF	**177.79**	**8.89**

***Based on EU directive 2009/30/EC (FQD)**

Potential low carbon intensity production processes

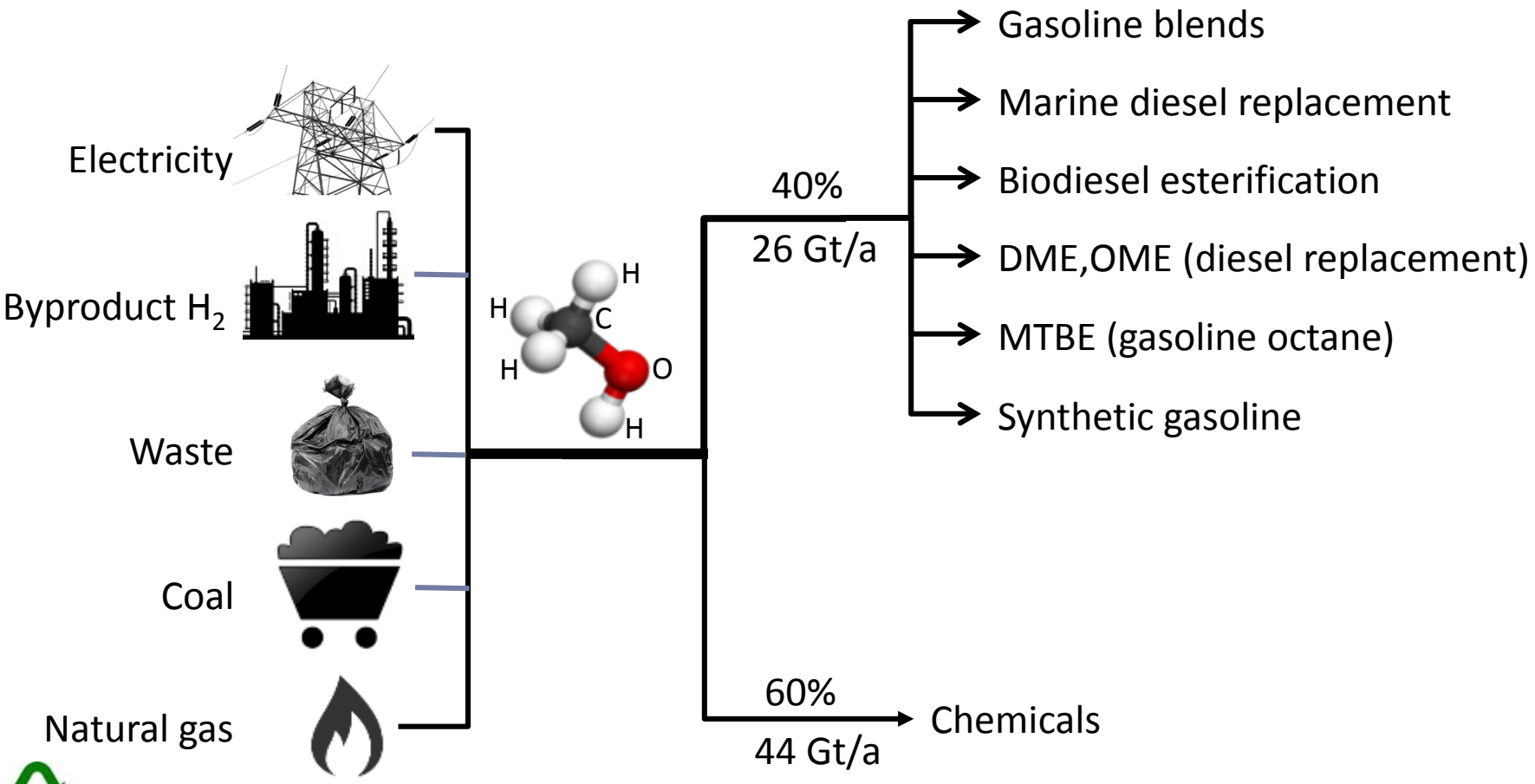


A new business model for sustainable liquid fuel



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 NOx, suits higher compression ratio



Current “new” uses for methanol as fuel

Geely Emgrand 7 M100 vehicle fleet test in Iceland

Production vehicles from Chinese automaker Geely with traditional spark-plug ignited IC engine which runs on 100% methanol

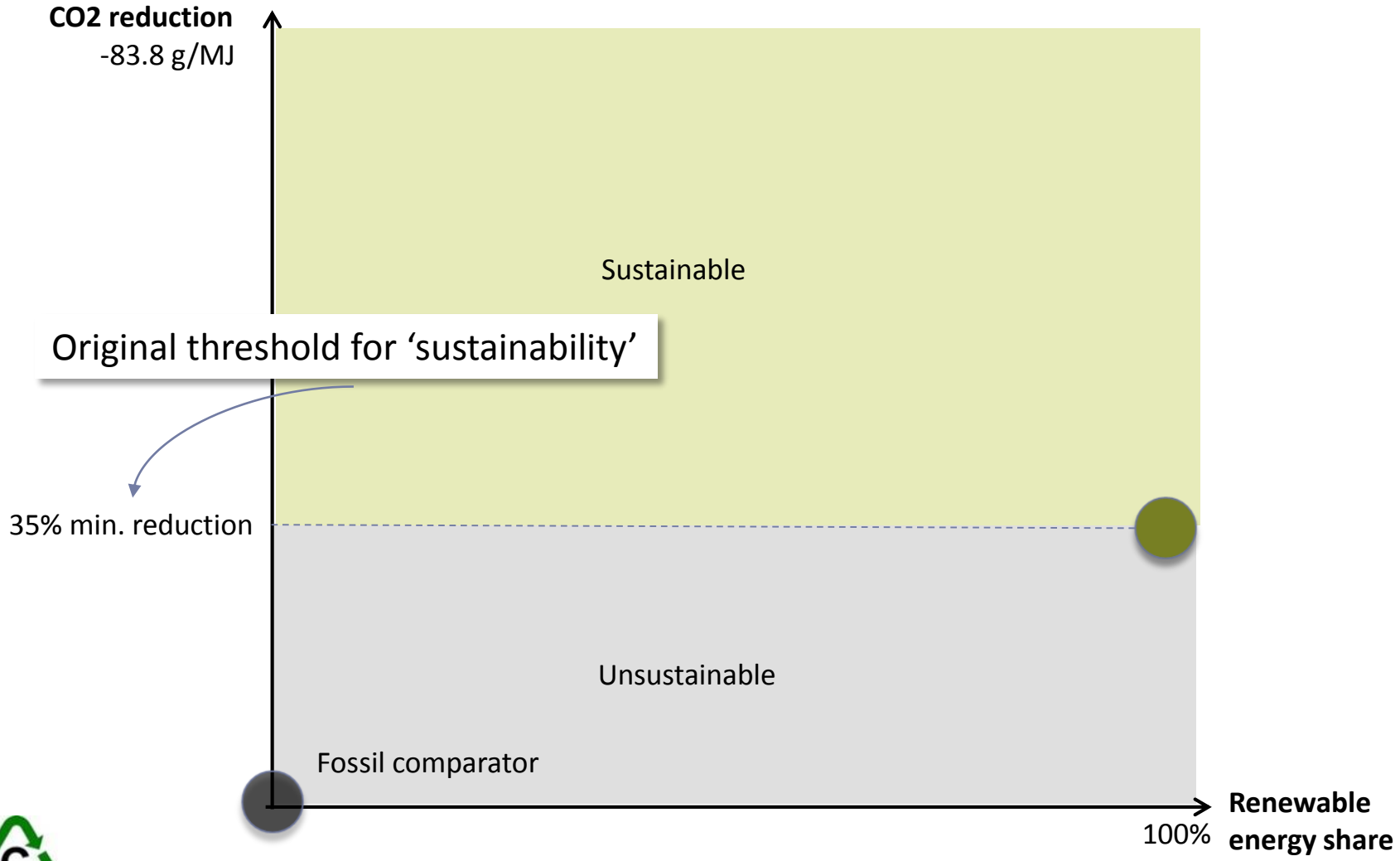
Stena Line converts first passenger ferry to methanol

Production engines from Wartsillä which can run on diesel or methanol. Method to fulfill SECA rules on low sulphur emissions.

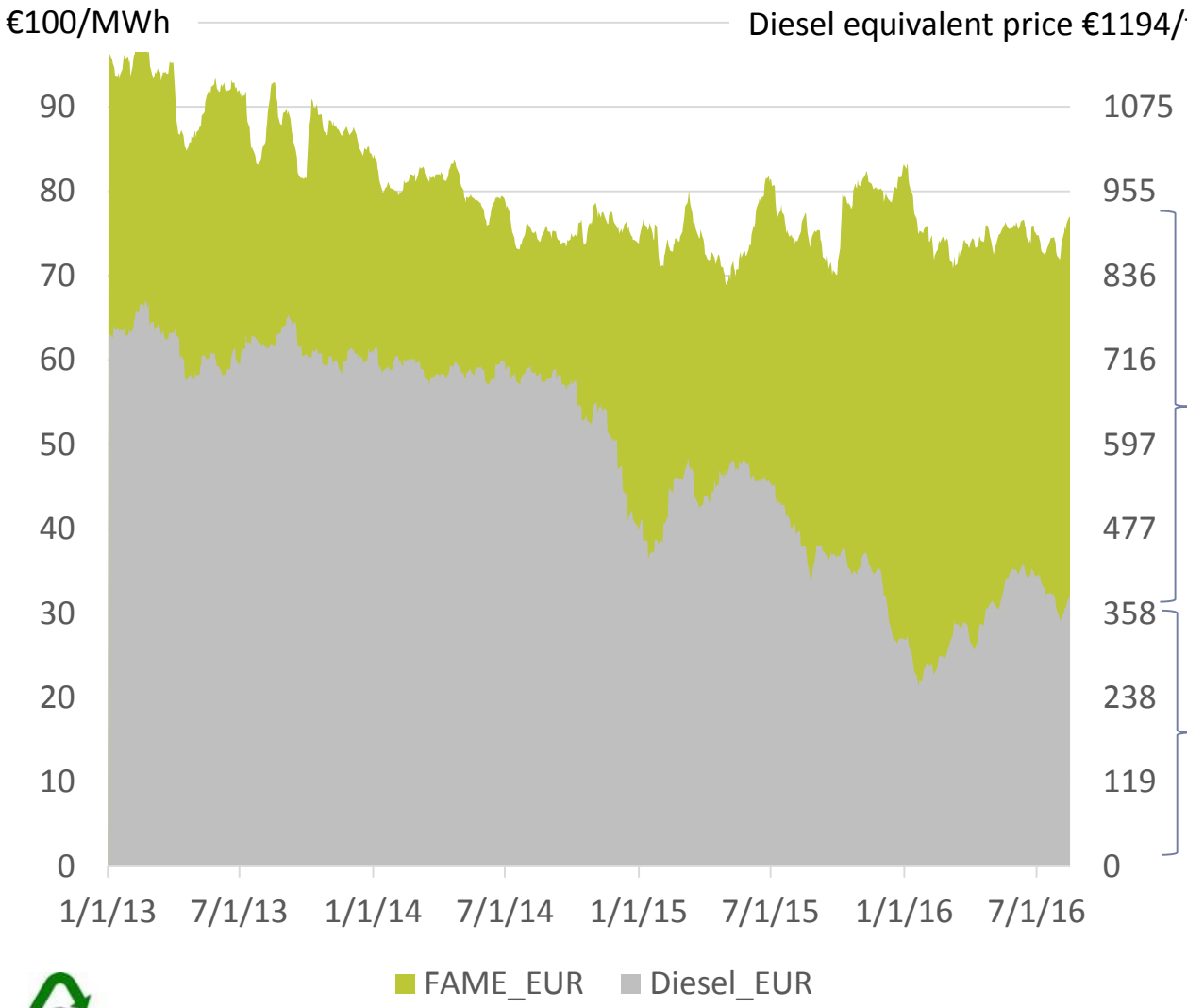
Danish oil company OK distributes M100 to fuel cell vehicles

Fuel cell manufacturer Serenergy retrofits production EVs for test purposes with fuel cells running on methanol.

EU framework mixes two metrics: CO_2 reduction per unit energy and overall share of renewable energy



Determination of market value of ‘ton of CO2 reduced’



Price biodiesel

Value of t CO_2 saved:

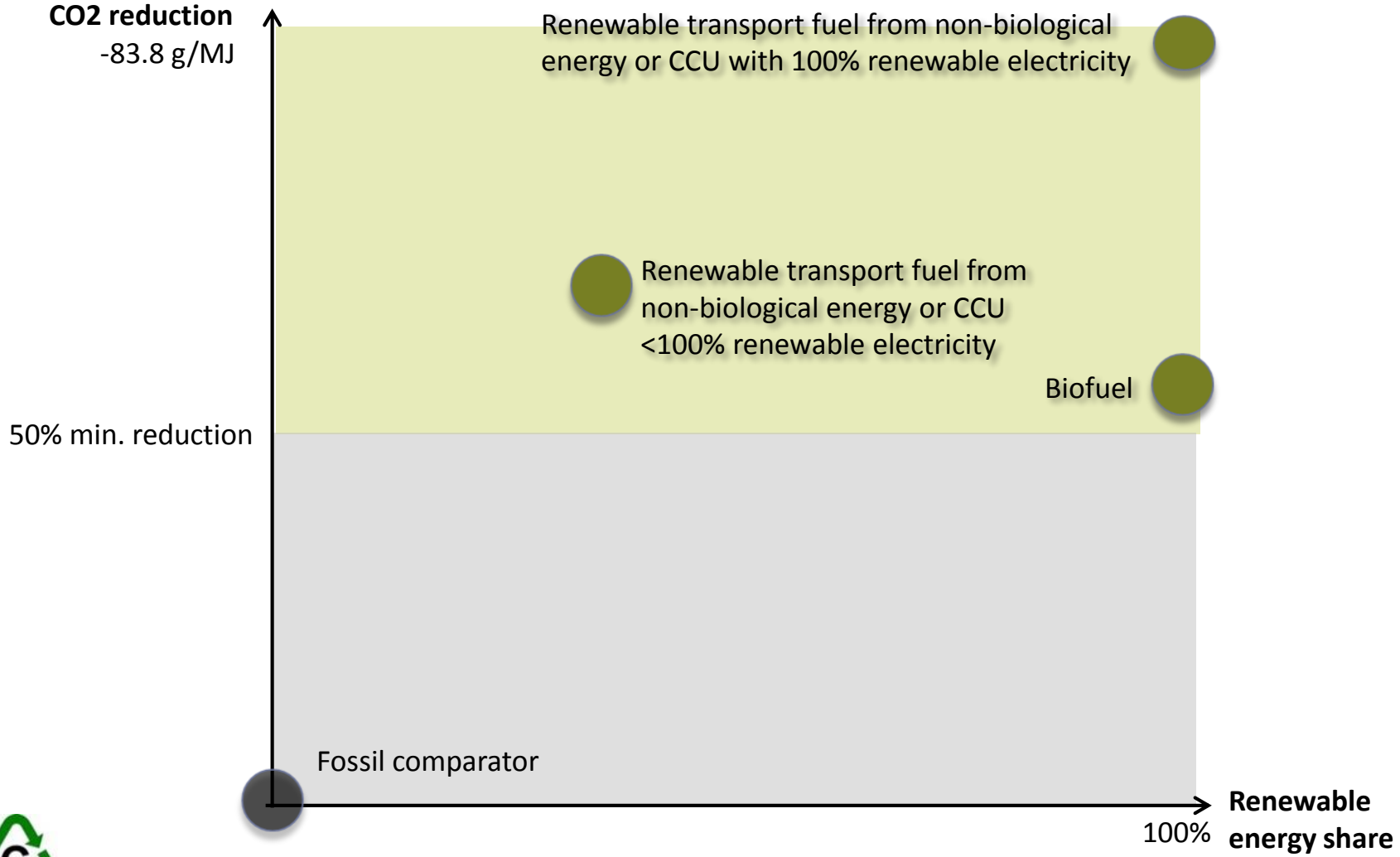
$$\frac{\text{Price biodiesel} - \text{Price diesel}}{1.98\ \dagger}$$

E.g.: $\frac{918 - 381}{1.98} = 270/tCO_2$

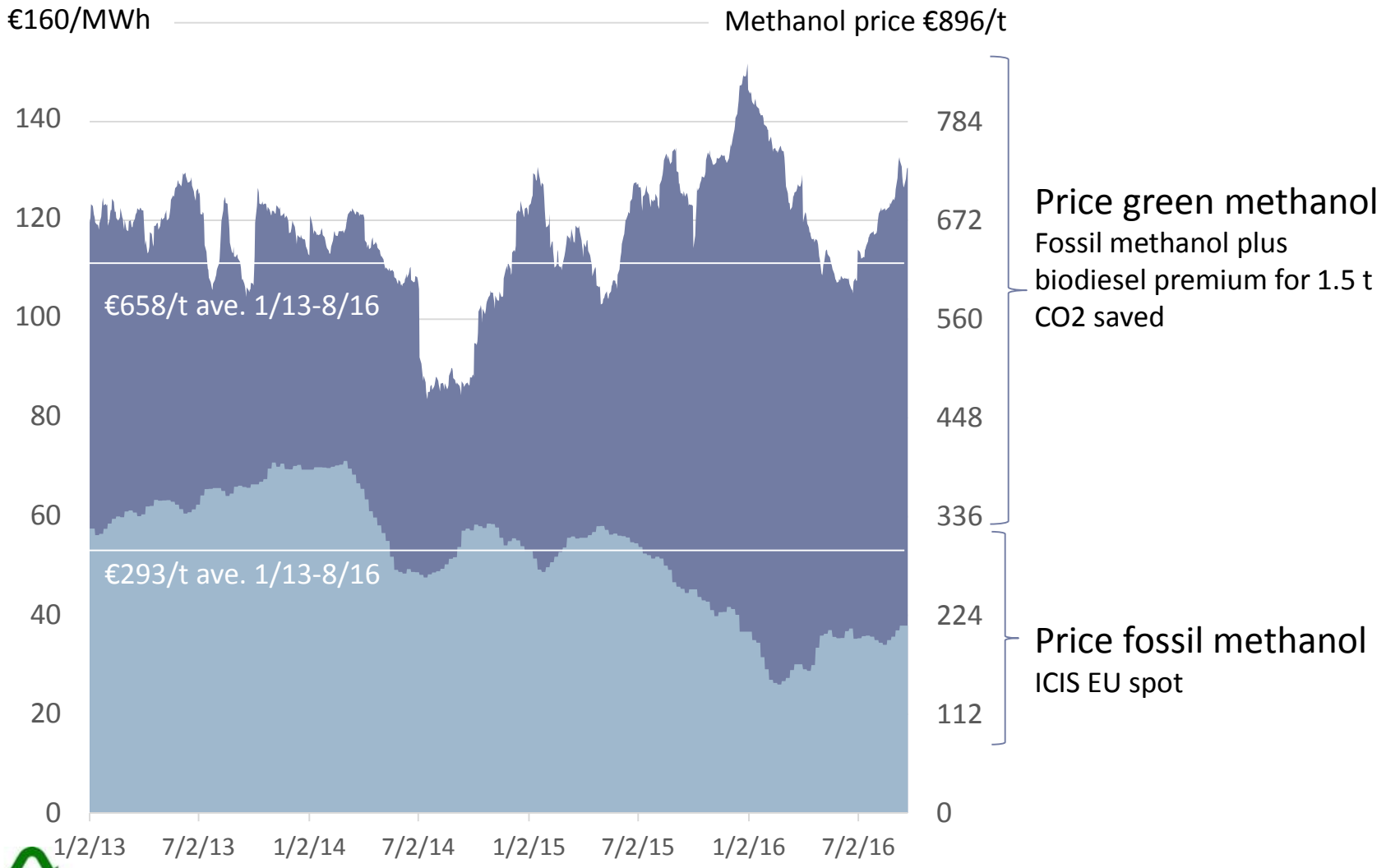
Price diesel

† 1.98 = 55% × 302 kgCO2/MWh × 11.9
i.e. offset × diesel emissions/MWh × MWh/t

Now two new types of renewable fuels taken into account: CCU fuels and non-bio renewable fuels (annex 9 part A, directive 2015/1513 dated 9/9/2015)

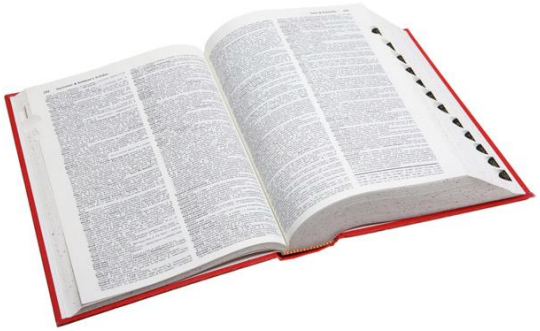


Determination of market value of renewable methanol



EU policy actions and impact for carbon emission valorization

Inclusive terminology

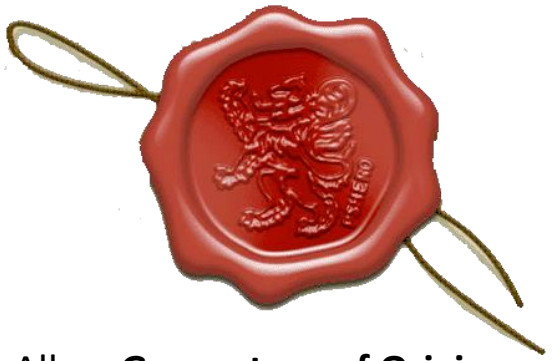


Clear definition of **renewable gaseous or liquid fuel of non-biological origin** and **CCU fuels**

Sustainability criteria

Clear sustainability criteria and methodology to verify their GHG footprint.
Single CO2 savings metric

Guarantees of Origin



Allow **Guarantees of Origin** for energy to meet national targets in the transport sector

Expected Impact

More transparent and predictable business model for fuel producers and investors

Simplification of regulatory framework and implementation across industries

Source of several million tons of low carbon intensity fuels
Higher efficiency and value for by-product gas and stranded energy
Offsets costs of carbon capture

Summary

- Current RED finally includes non-bio renewable fuels and CCU fuels

Non-bio renewable fuels can play a vital role as a scalable and sustainable solution

- Level playing field is a necessary condition for the development and qualification of advanced fuels

- PtL technology demonstrated at scale and ready to deploy in Europe

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