A tall, multi-tiered industrial distillation column with metal railings and pipes, set against a clear blue sky. The column is part of a larger industrial facility, with a dark building visible at the bottom left.

Power-to-Methanol: Green transport fuel, renewable energy storage and grid balancing service

Philippe Boulanger

Director of Business Development

Using bioenergy for energy storage and to
balance the grid

Brussels November 9 2015

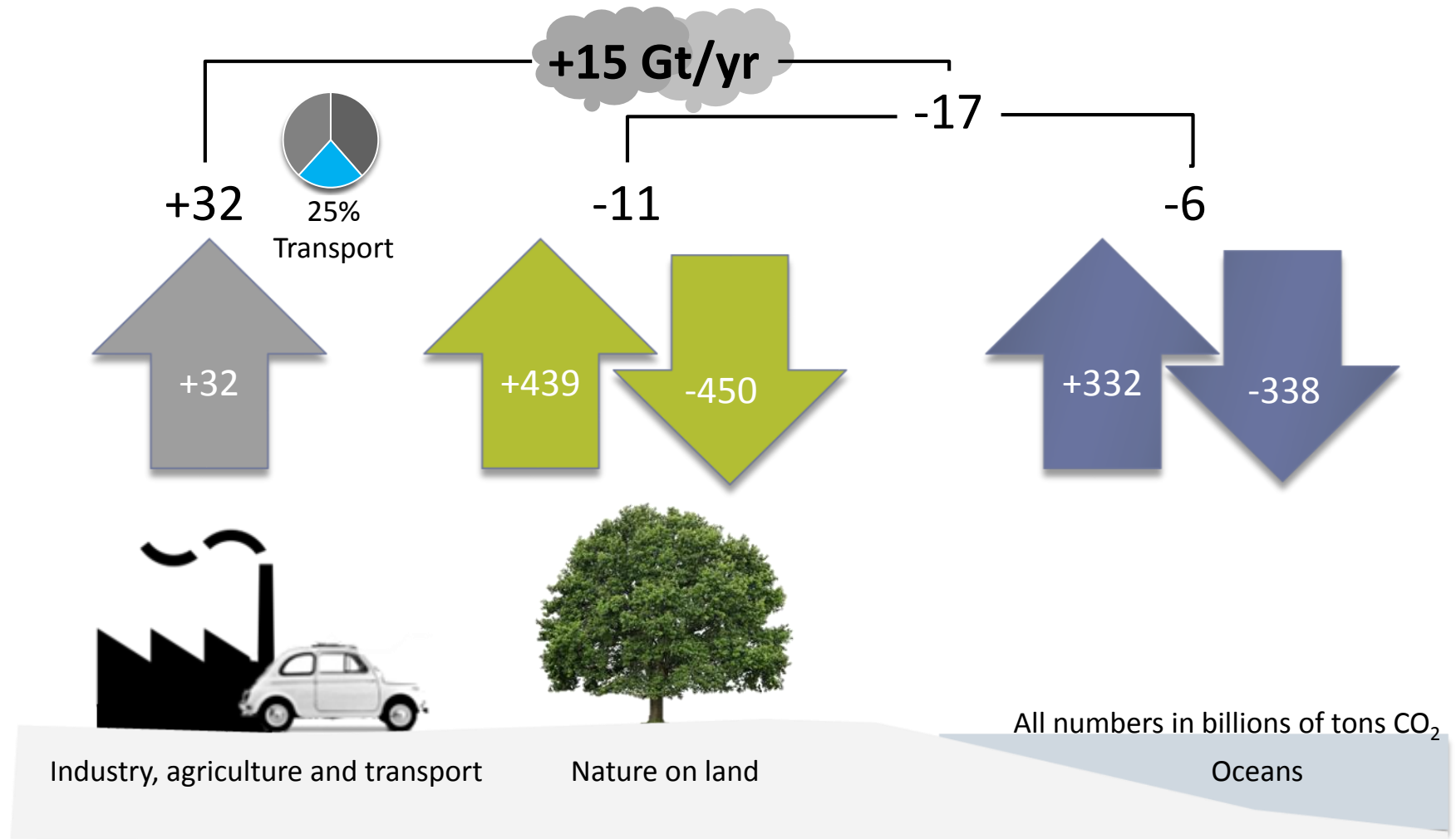


Carbon Recycling International



Our imperative

Global GHG impact from human and natural activity



Source: UN IPCC / IEA

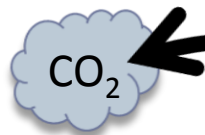
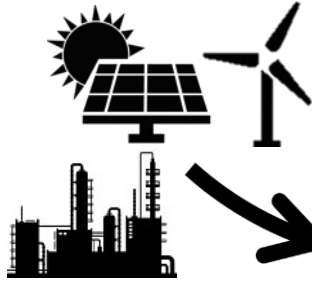




Our Contribution

CRI mission: producing Low carbon intensity methanol as energy carrier in a circular economy

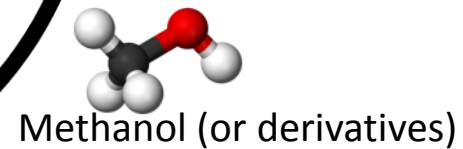
Renewable power or
byproduct hydrogen



Flue gas emissions



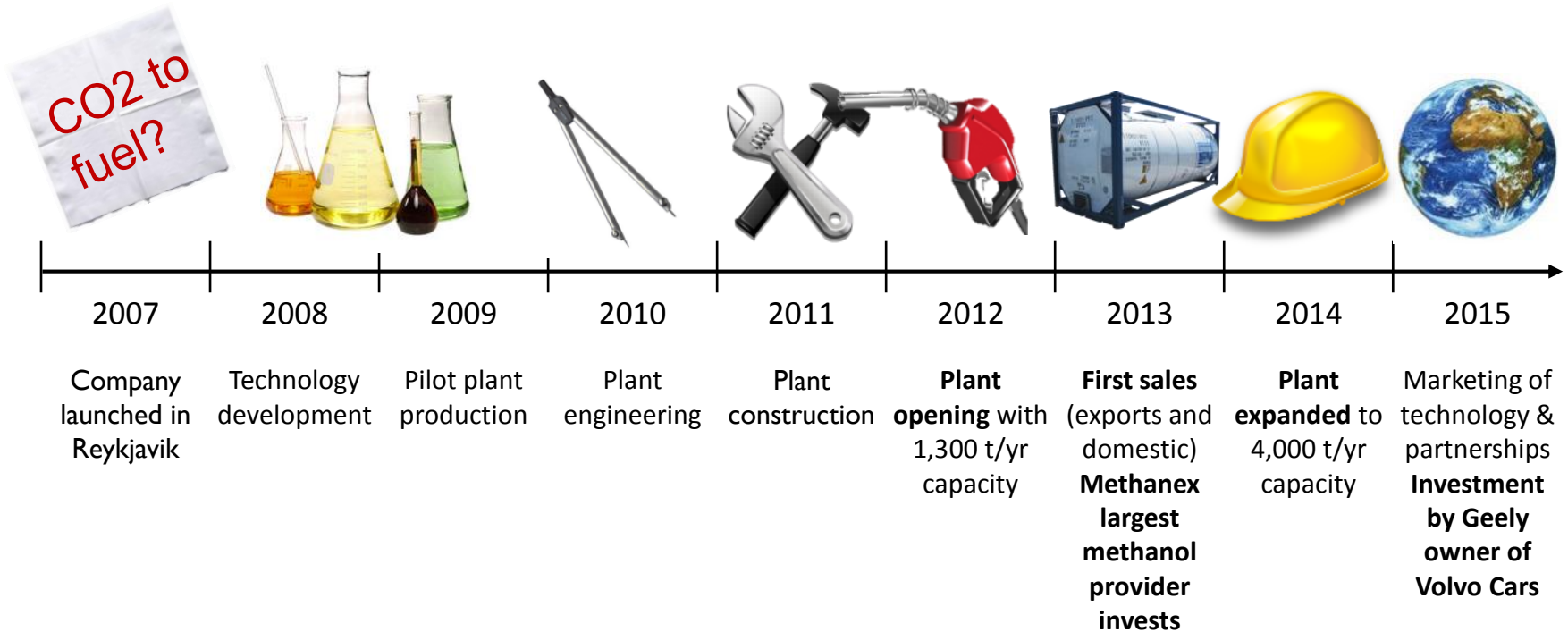
CRI Power-to-Liquids technology



Transport and
industry



Brief history of CRI



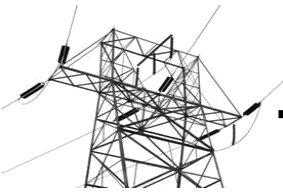
CRI's Power-to-Liquids platform

Industry partners

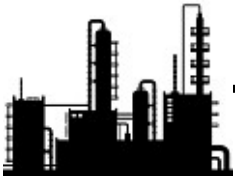
Industry emissions



Electricity



Industry H₂ byproduct



CRI integrated CCU and PtL solution

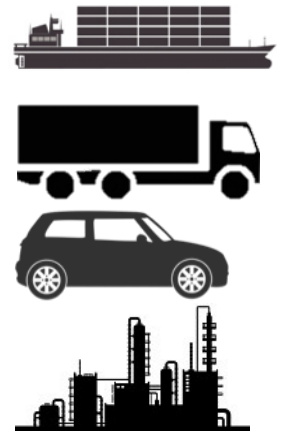
CO₂ Capture

Hydrogen
Generation

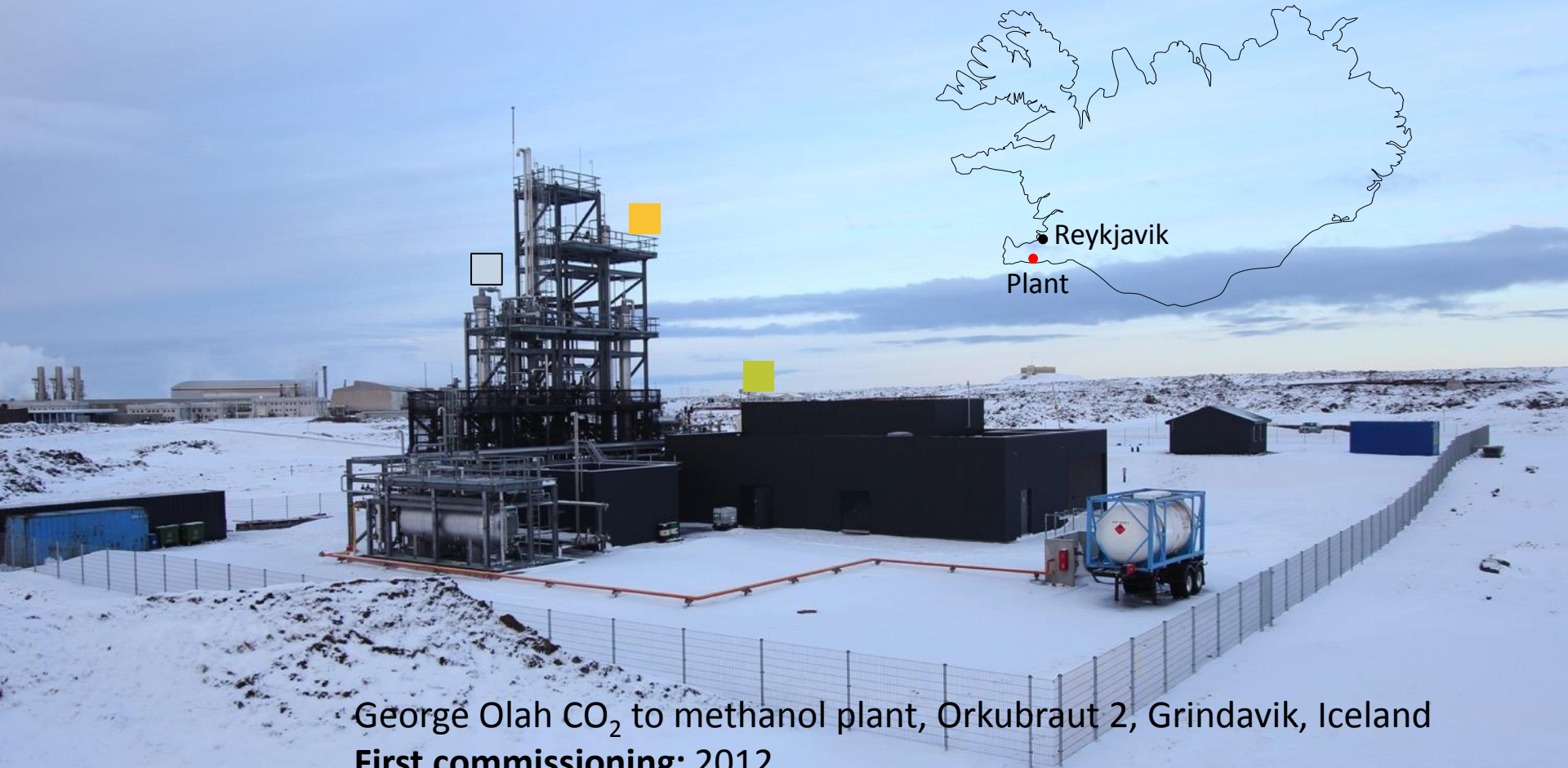
Clean
Conversion

Low
carbon-intensity
methanol
CH₃OH

Offtake



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



George Olah CO₂ to methanol plant, Orkubraut 2, Grindavik, Iceland

First commissioning: 2012

Capacity expansion: 2015

CCU throughput: 5,600 t/yr CO₂

Electrolyzer capacity: 800 t/yr H₂ (1200 Nm³/hr)

Production capacity: 4,000 t/yr methanol

Project at Steag Lünen coal-power plant, Germany

Input: 1 MW electric + 500 t/yr CO₂

Output: 400 t/yr methanol

Capacity: 1 t/day

MethCO₂ Horizon 2020 (€8.6/m)

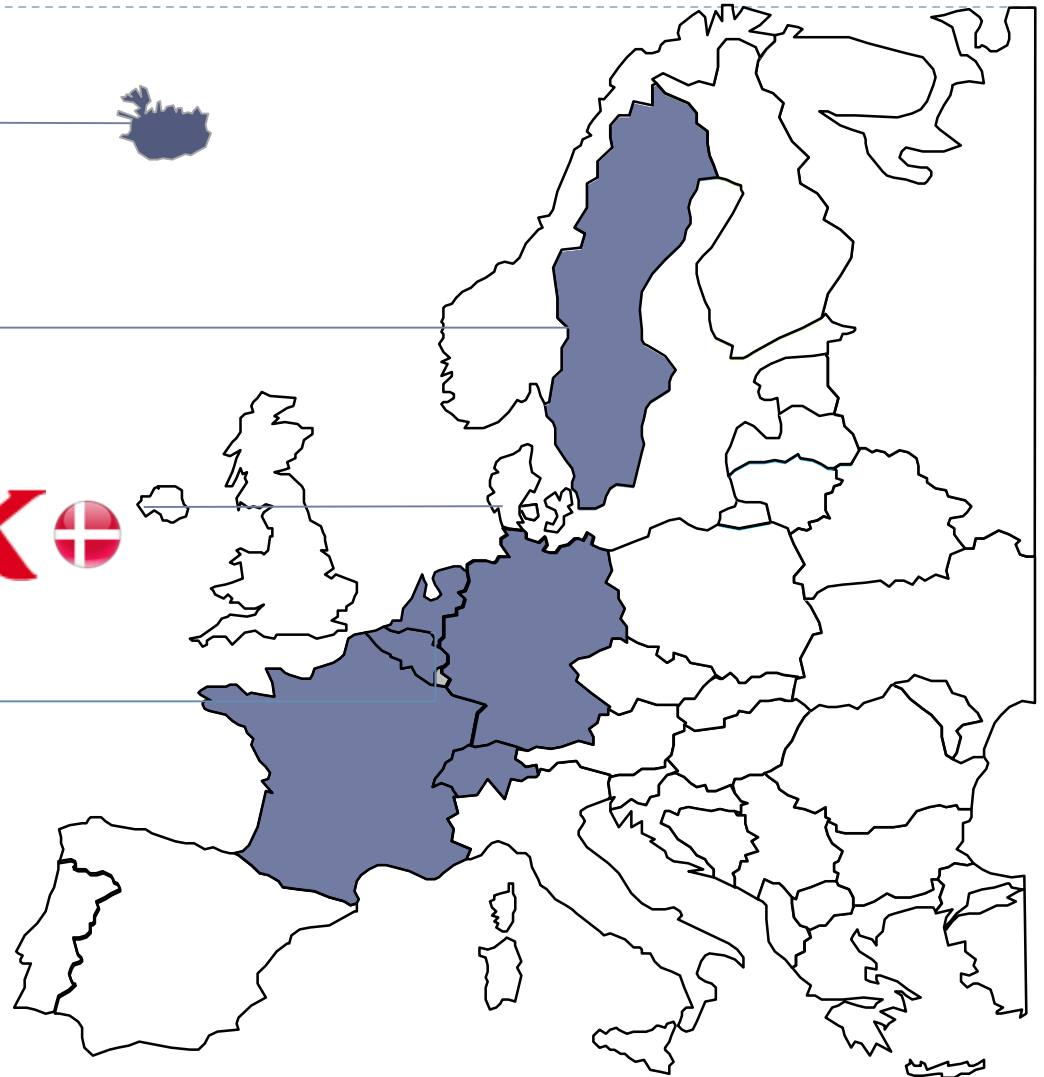
Collaboration with STEAG, MHPSE,
Hydrogenics and EU universities

CO₂ capture

Hydrogen production
Clean conversion

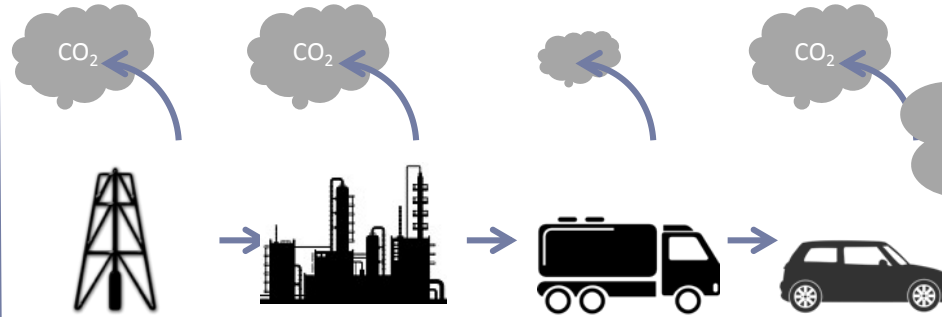
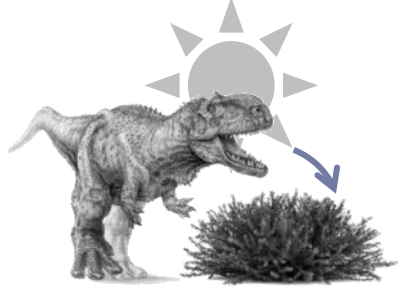


Customers



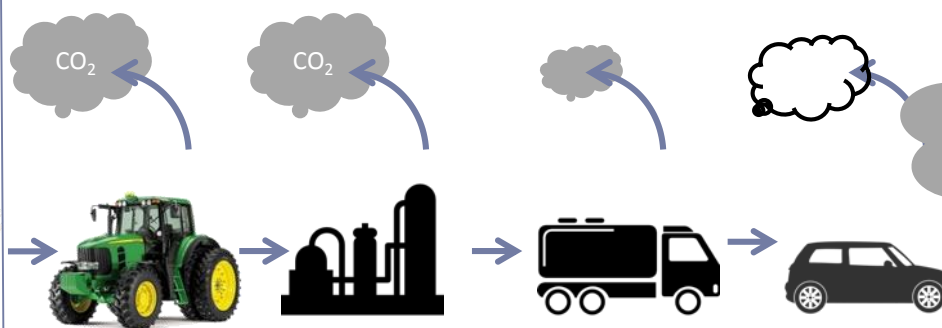
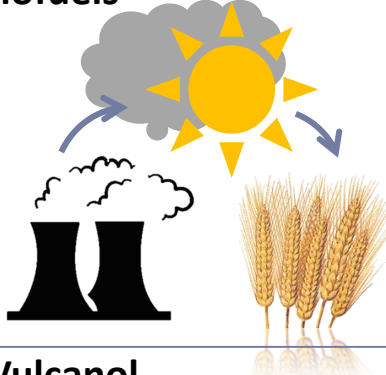
Framework to compare CO₂ life cycle emissions of fuels

Gasoline & diesel



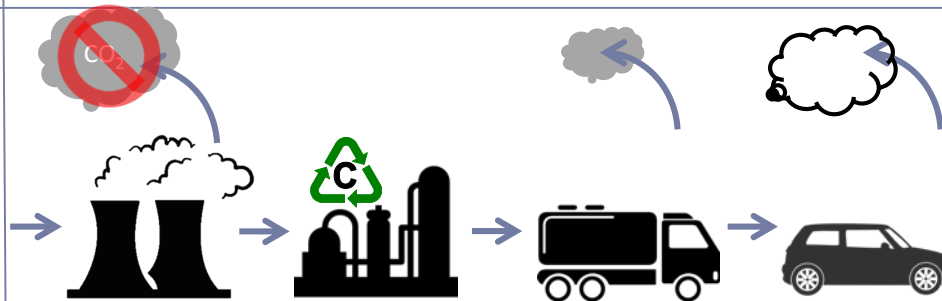
=84 gCO₂/MJ

Biofuels



=33-54 gCO₂/MJ

Vulcanol



1-8 gCO₂/MJ



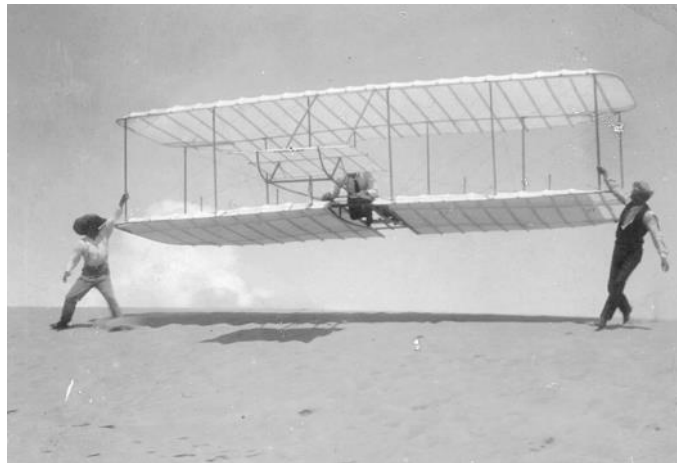
First PtL plant with ISCC+ certification of sustainability

Actual GHG emission values using ISCC EU GHG module*

	kgCO ₂ e/t RM	gCO ₂ e/MJ RM LHV
Emissions related to raw-material:	0	0
Emissions of electricity production (grid)	134	6.71
Emissions of steam production	4	0.22
Emissions of process specific inputs:	4	0.21
Emissions of waste water treatment:	1	0.06
Total process-specific emissions:	143	7.2
Plant-to-port (50 km by road)	7	0.34
Port-to-port (2000 km container ship)	20	1.00
Total transport-specific emissions	27	1.3
Total emissions CIF Rotterdam	170	8.5
Compared to reference value of 83.8 gCO₂e/MJ fossil		>90% reduction

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

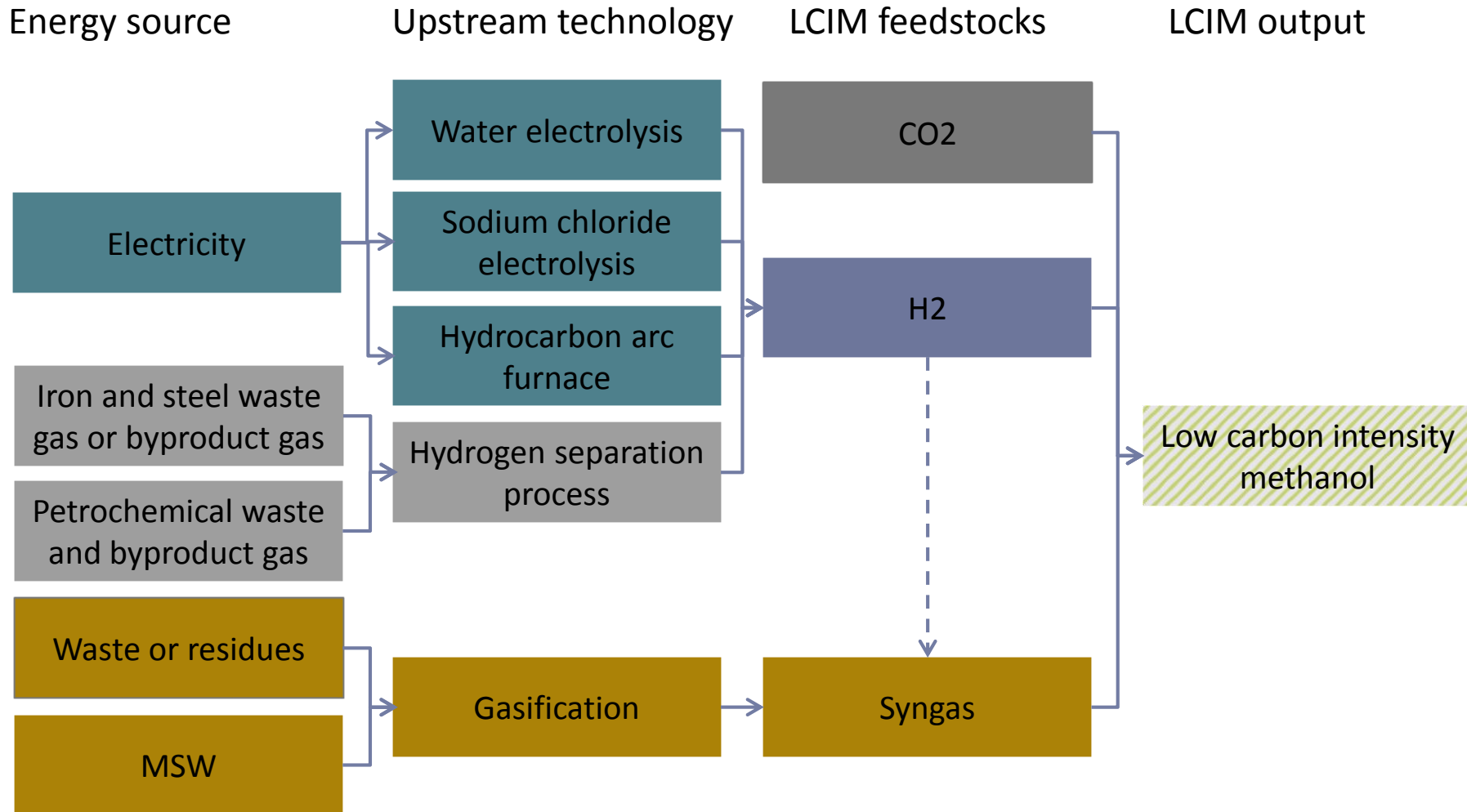




Towards a sustainable business:

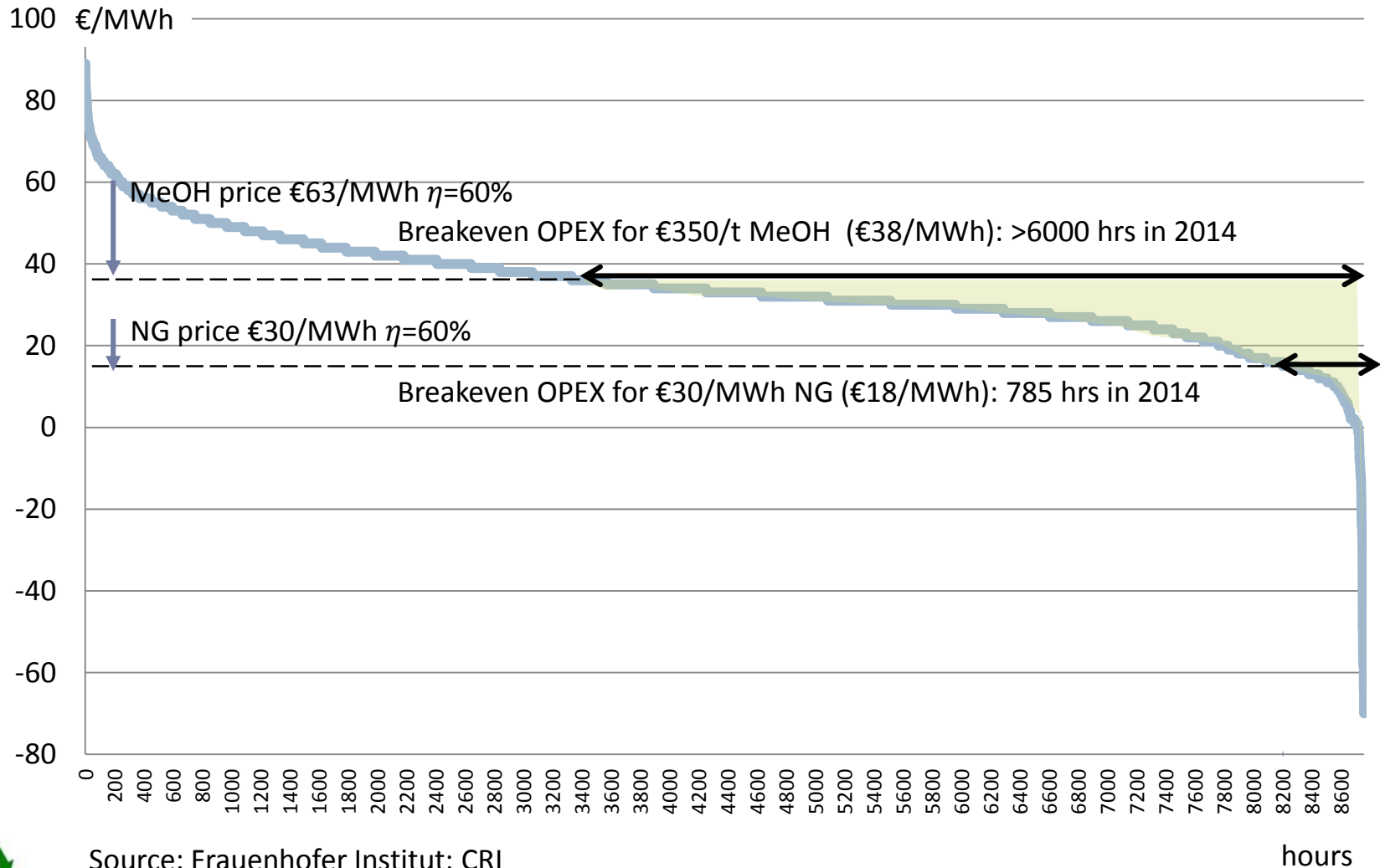
- Advanced renewable fuel production
- Energy storage services
- Grid balancing services

Low Carbon Intensity Methanol production processes



Power-to-methanol production using German grid spot prices reaches breakeven on OPEX 70% of the time

German day ahead spot power price Jan 1 – Dec 31 2014



Source: Fraunhofer Institut; CRI



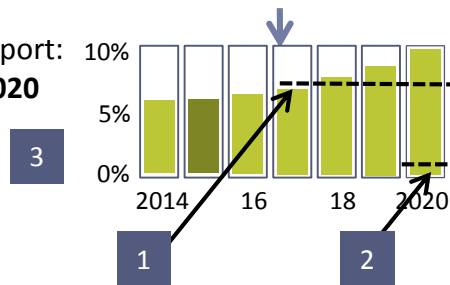
EU fuel regulatory framework: moving from agricultural policy to sustainability focus



EU 2009: 20% GHG reduction/20% efficiency improvement/20% renewable share)

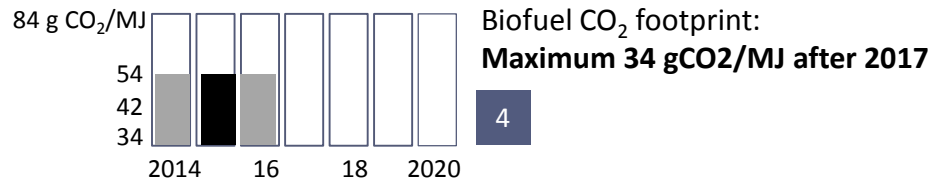
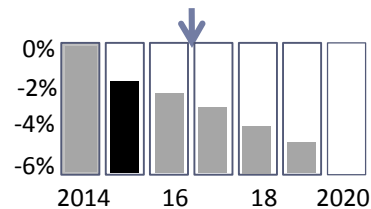
Renewable Energy Directive (2009/28; RED)

Renewable energy in transport:
10% minimum share by 2020



Fuel Quality Directive (2009/30; FQD)

CO₂ footprint of all fuel:
Minimum 6% reduction by 2020



2015 ILUC amendment (to RED and FQD)

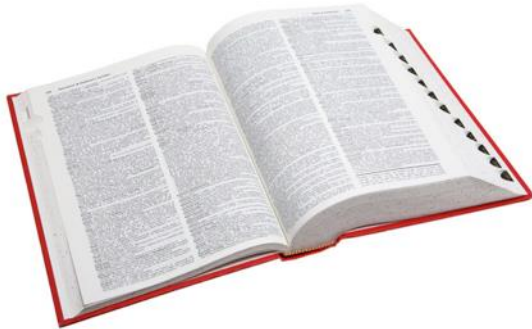
- 1 Maximum 7% from crop based fuel
- 2 Minimum 0.5% from advanced fuel
- 3 Double counting energy from advanced fuels
- 4 CO₂ release because of land use change reported

Transposed by EEA Member States before July 2017



The three pillars of EU policy for renewable transport fuels of non-biological origin

Inclusive terminology



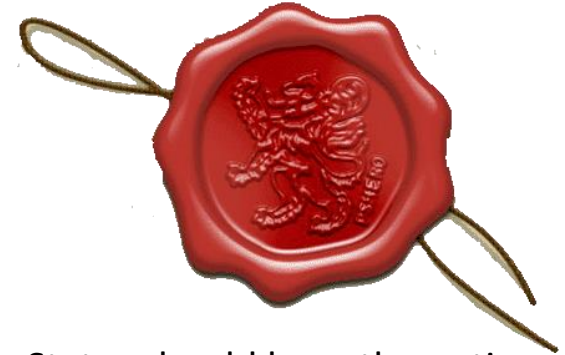
Define the term **renewable gaseous or liquid fuel of non-biological origin**

Sustainability criteria



Provide **sustainability criteria and a methodology to verify the green-house gas footprint**

Guarantees of Origin



States should have the option to use **Guarantees of Origin** for energy to meet transport target

We urge the Council, Parliament and Commission to implement policy which allows us to power transport with low carbon intensity fuels from renewable energy today



cri.is



etogas.com



eu.mhps.com



nel-hydrogen.com



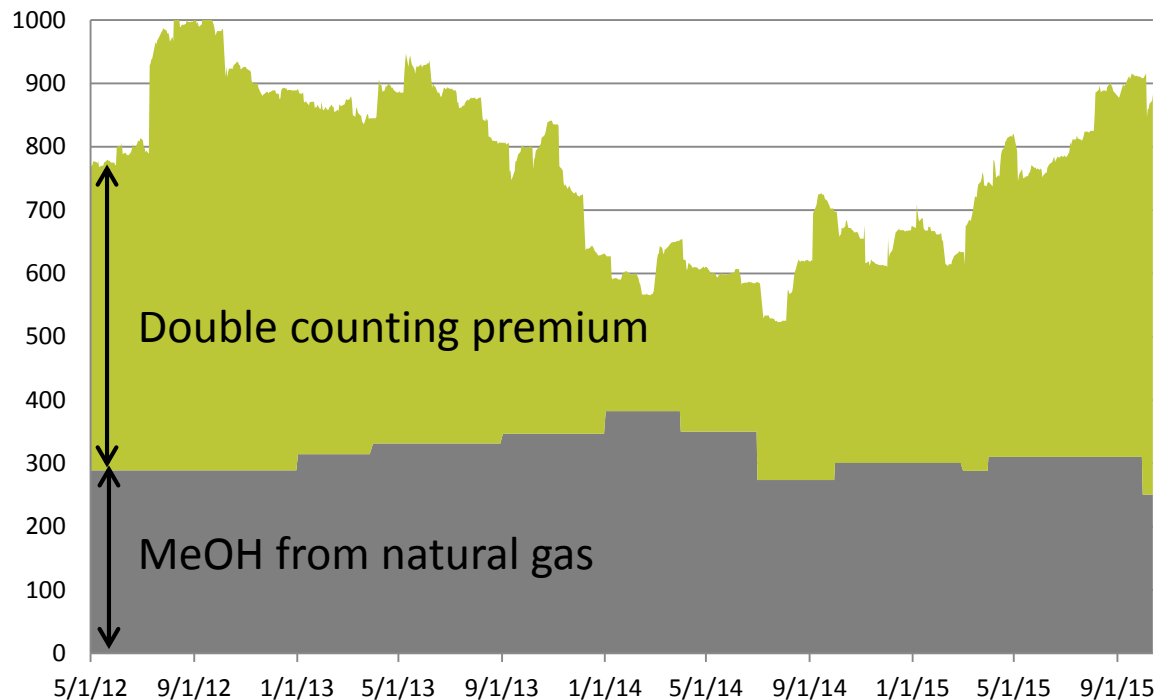
hydrogenics.com



argos.nl

Market value of renewable methanol in Europe

Market prices (€/mt)



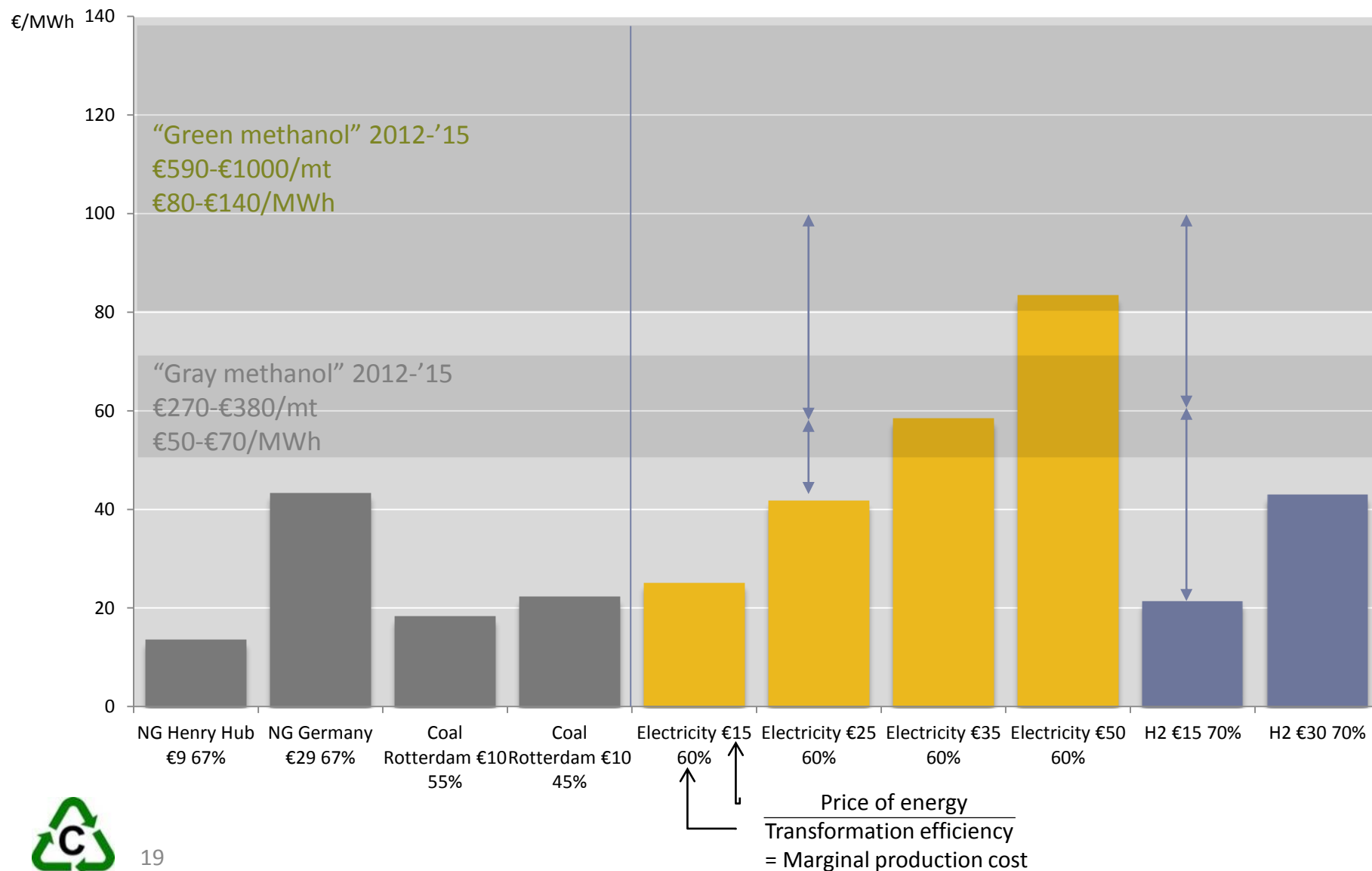
Market premia

Vulcanol

Bioethanol



Marginal cost of production vs. methanol market value

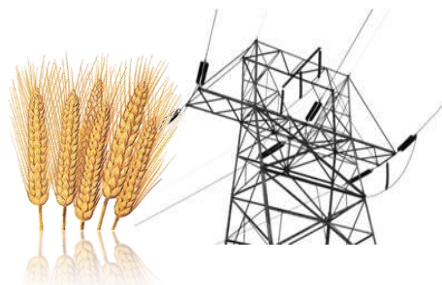


Summary



- Current RED finally provides roadmap to non-bio renewable fuels and CCU fuels

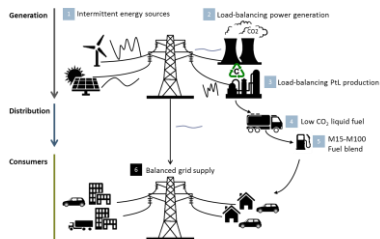
- Power to Fuel will play vital role as a scalable and sustainable solution



- PtL technology demonstrated at scale and addresses upstream and downstream issues



- By providing energy storage and grid balancing services PtL is a sustainable business platform



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