Renewable and decarbonised gas: which role in the EU integrated energy system?

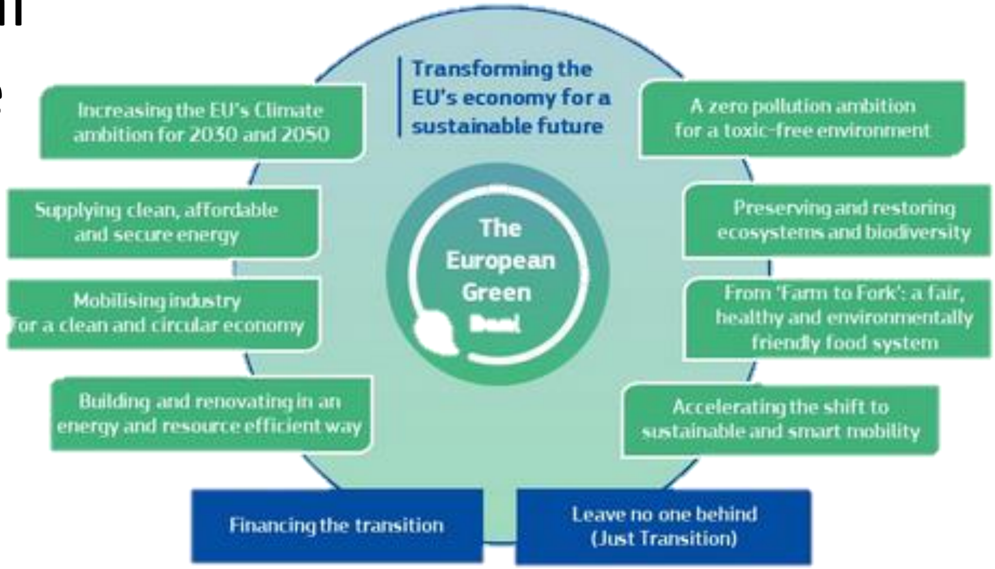
Ilaria Conti, Head of FSR Gas

Outline

1. **The EU vision for Integrated Energy Systems**
2. Renewable and decarbonised gases: definition and role
3. Making it to the market: some challenges

EU Green Deal and climate targets

- The European Green Deal sets the target of climate neutrality by 2050.
- EU Green Deal's objectives go beyond climate change or environmental policy as they address decarbonisation of the entire EU economy.

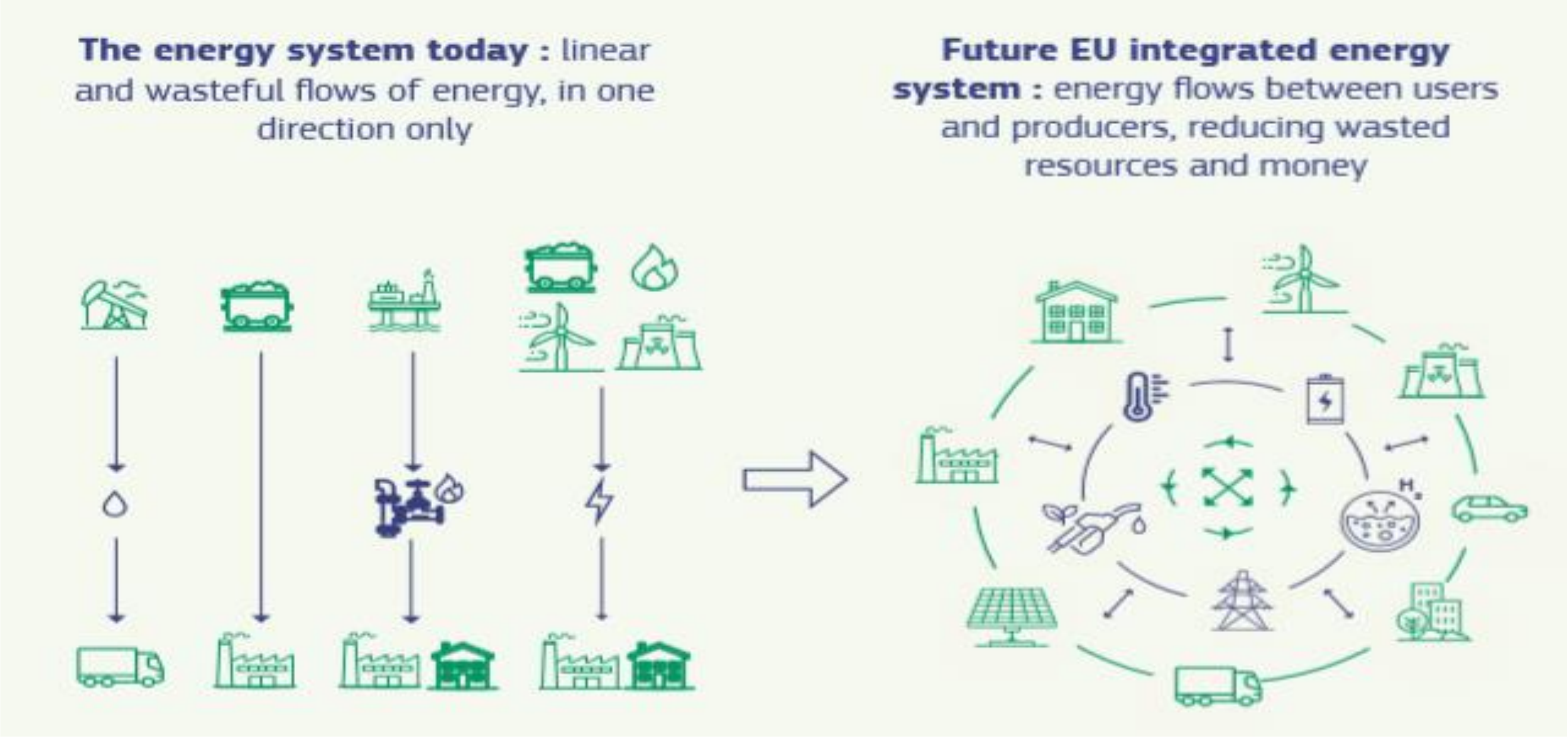


EU climate targets for 2030

- 55% CO2 emissions cut (SoU proposal)
- 32% gross final RES energy consumption*
- 32,5% energy efficiency

The ESI Strategy

Energy System integration is
«the coordinated planning and operation of the energy system 'as a whole', across multiple energy carriers, infrastructures and consumption sectors».



Source: EU Commission's Strategy for Energy System Integration, July 2020

The six pillars of the ESI Strategy

1

A more **circular and energy efficient** energy system

2

More **electrification** of consumption, based on renewables

3

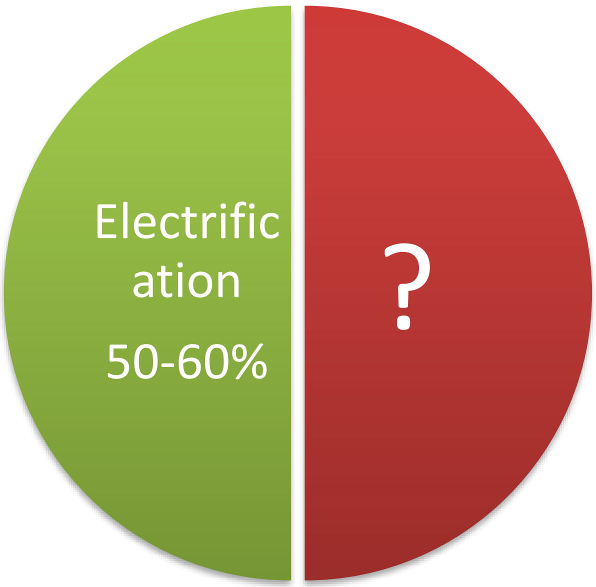
Renewable and low carbon fuels (incl. hydrogen) in hard-to-abate sectors

+

- **Consumers** can choose the best clean option for their needs
- **Infrastructure** is planned in an integrated way, looking jointly at gas, electricity, heat and hydrogen
- **Digitalisation** fully enables a smarter system

« Green gases »: the other half of the pie

EU Commission's LT strategic vision: deep decarbonisation of the economy requires 50% electrification or more, up to 60% by 2050



Zero-carbon economy by 2050

Role of gas → support to decarbonisation

- Smaller volumes
- Natural gas as a «back up» (storage, LNG-to-X, etc)
- Clean molecules (Green gas): biogas, biomethane, synthetic methane, Hydrogen
- Sector coupling/integration between gas and electricity is essential to achieve deep decarbonisation by 2050

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‘Green gases’ not defined (yet) in regulation

- **REDII (art. 2(1)) defines ‘renewable energy’ as:**

(1) ‘energy from renewable sources’ or ‘renewable energy’ means energy from renewable non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas;

- **REDII (art. 2(28)) defines ‘biogas’ as:**

(28) ‘biogas’ means gaseous fuels produced from biomass;

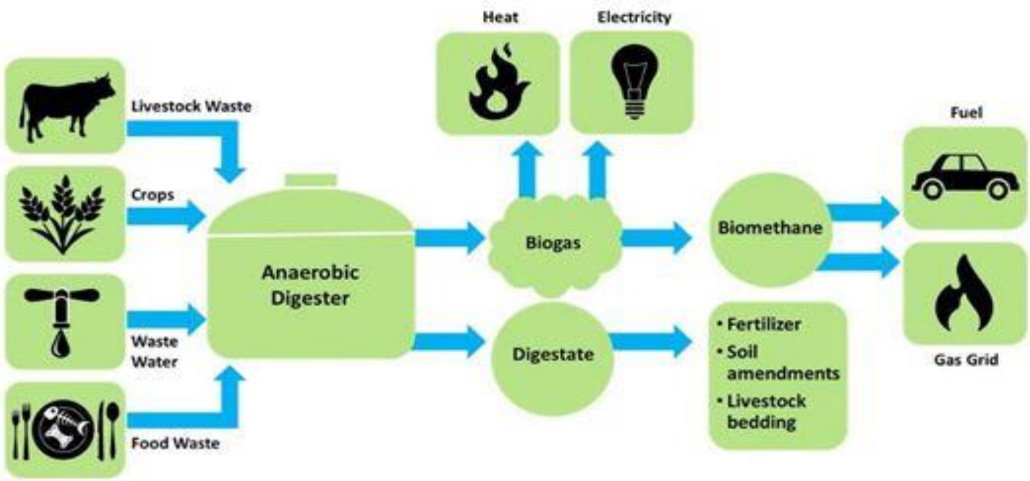
- **REDII does not introduce definitions of other renewable gases such as biomethane and hydrogen, although they are both mentioned in the Recitals (Recital 59)**

(59) Guarantees of origin which are currently in place for renewable electricity should be extended to cover renewable gas. Extending the guarantees of origin system to energy from non-renewable sources should be an option for Member States. This would provide a consistent means of proving to final customers the origin of renewable gas such as biomethane and would facilitate greater cross-border trade in such gas. It would also enable the creation of guarantees of origin for other renewable gas such as hydrogen.

Two broad categories of “green gas”

“Renewable gases”	Decarbonised or low-carbon gases
Gas of organic* origin or produced utilising renewable** sources (biomass, water, renewable electricity***)	Gas molecules of fossil origin which underwent a decarbonisation process (i.e. removal of CO2)****

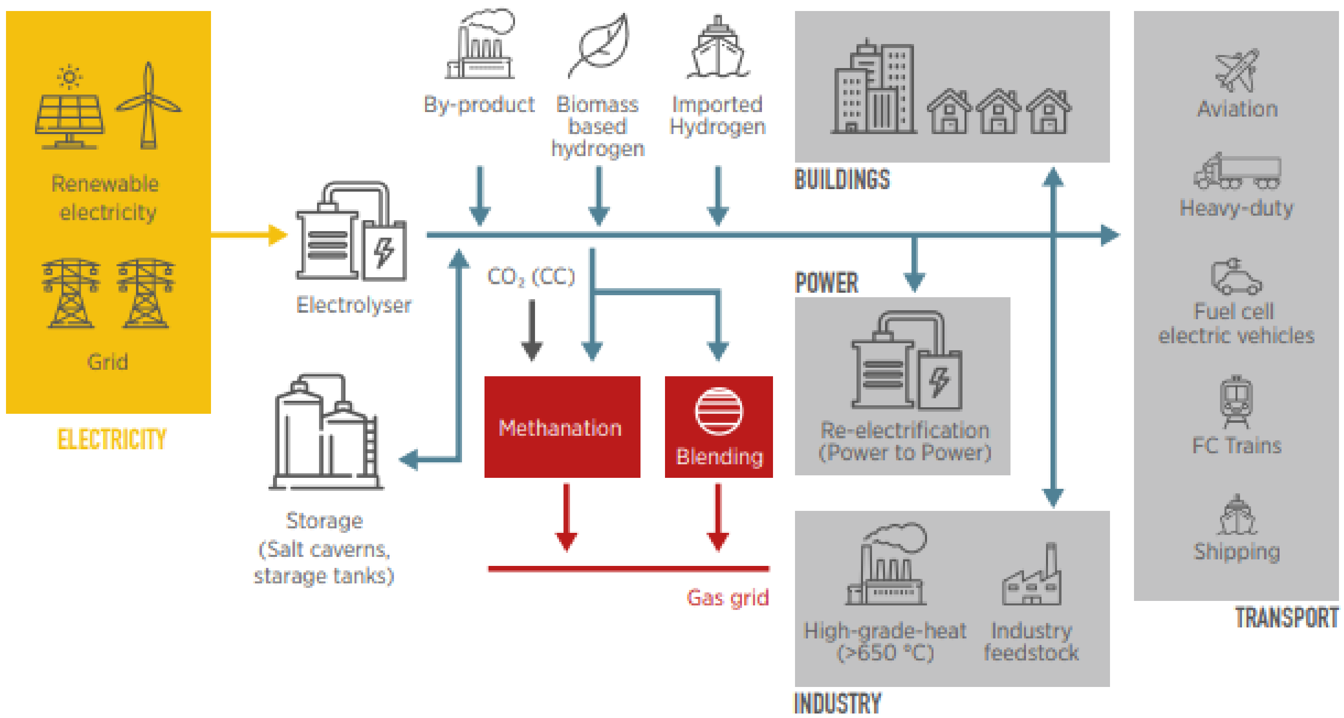
Biomethane can be produced through various processes and starting from different feedstock



Above: Anaerobic digestion process. Source: Environmental and Energy Study Institute, 2017

Below: Thermal gasification process. Source: Navigant, 2019.

Green hydrogen and synthetic methane can be produced via power-to-gas



Source: IRENA, 2018

What (gas) are we talking about?

- The same type of gas can be obtained through several processes and starting from different origin
- Gas obtained from non-fossil origin is not always CO2 free
- 3 identical molecules of Hydrogen can be obtained from
  - Biomass (100% non-fossil) with GHG emissions
  - Gas with (almost) no GHG emissions
  - Coal, with GHG emissions
- Synthetic gas includes CH4 but it can be made starting from 100% renewable hydrogen and no GHG

Product standardisation is key in trading!

What (gas) are we talking about? Hydrogen, but…

- **Green H2** – gas produced from renewable resources such as solar PV, wind, hydropower.
- **Blue H2** – low-carbon gas produced by thermochemical conversion of fossil fuels with carbon capture use and storage (CCUS).
- **Grey H2** – gas produced via Steam Methane Reforming (a thermochemical conversion of fossil fuels) without the capture of CO2.
- **Turquoise H2** – gas produced via pyrolysis via renewable electricity and no CO2 emissions.
- **Yellow H2/Pink H2 -** gas produced via pyrolysis or electrolysis using nuclear electricity

The need for a Taxonomy of “green gas”

- Taxonomy (*τάξις*, tàxis, order and *νόμος*, nòmos, rule) = the *discipline of classification*

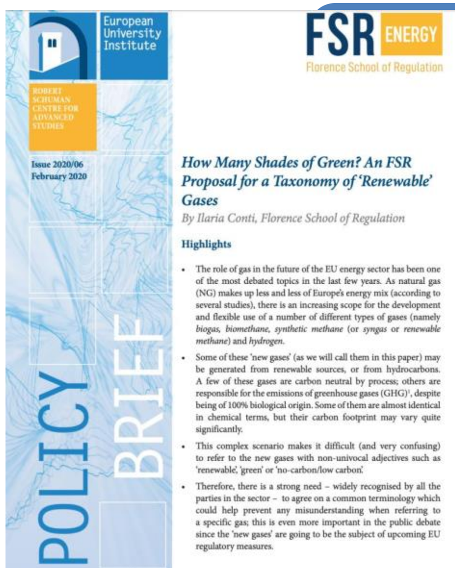
- **Research focus**

Which gases?

Which parameters?

ch methodology?

- **Scope***:*



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FSR ENERGY

Florence School of Regulation

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POLICY BRIEF

How Many Shades of Green? An FSR Proposal for a Taxonomy of ‘Renewable’ Gases

By Ilaria Conti, Florence School of Regulation

Highlights

- The role of gas in the future of the EU energy sector has been one of the most debated topics in the last few years. As natural gas (NG) makes up less and less of Europe's energy mix (according to several studies), there is an increasing scope for the development and flexible use of a number of different types of gases (namely *biogas, biomethane, synthetic methane* (or *syngas* or *renewable methane*) and *hydrogen*.
- Some of these 'new gases' (as we will call them in this paper) may be generated from renewable sources, or from hydrocarbons. A few of these gases are carbon neutral by process; others are responsible for the emissions of greenhouse gases (GHG)[1], despite being of 100% biological origin. Some of them are almost identical in chemical terms, but their carbon footprint may vary quite significantly.
- This complex scenario makes it difficult (and very confusing) to refer to the new gases with non-univocal adjectives such as 'renewable', 'green' or 'no-carbon/low carbon'.
- Therefore, there is a strong need – widely recognised by all the parties in the sector – to agree on a common terminology which could help prevent any misunderstanding when referring to a specific gas; this is even more important in the public debate since the 'new gases' are going to be the subject of upcoming EU regulatory measures.

ng a common language
cribe reality

ghlight the essential
atures of each gas

Attribute (environmental, commercial, financial) value

FSR Gas Taxonomy proposal: defining and classifying gas(es)

1. **Object:** Biogas, biomethane, synthetic methane, hydrogen
2. Two key **parameters** to define a type of gas:

GREEN VALUE

Origin
(Non fossil/fossil)
+
GHG emissions
(Offset / non offset)

USABILITY

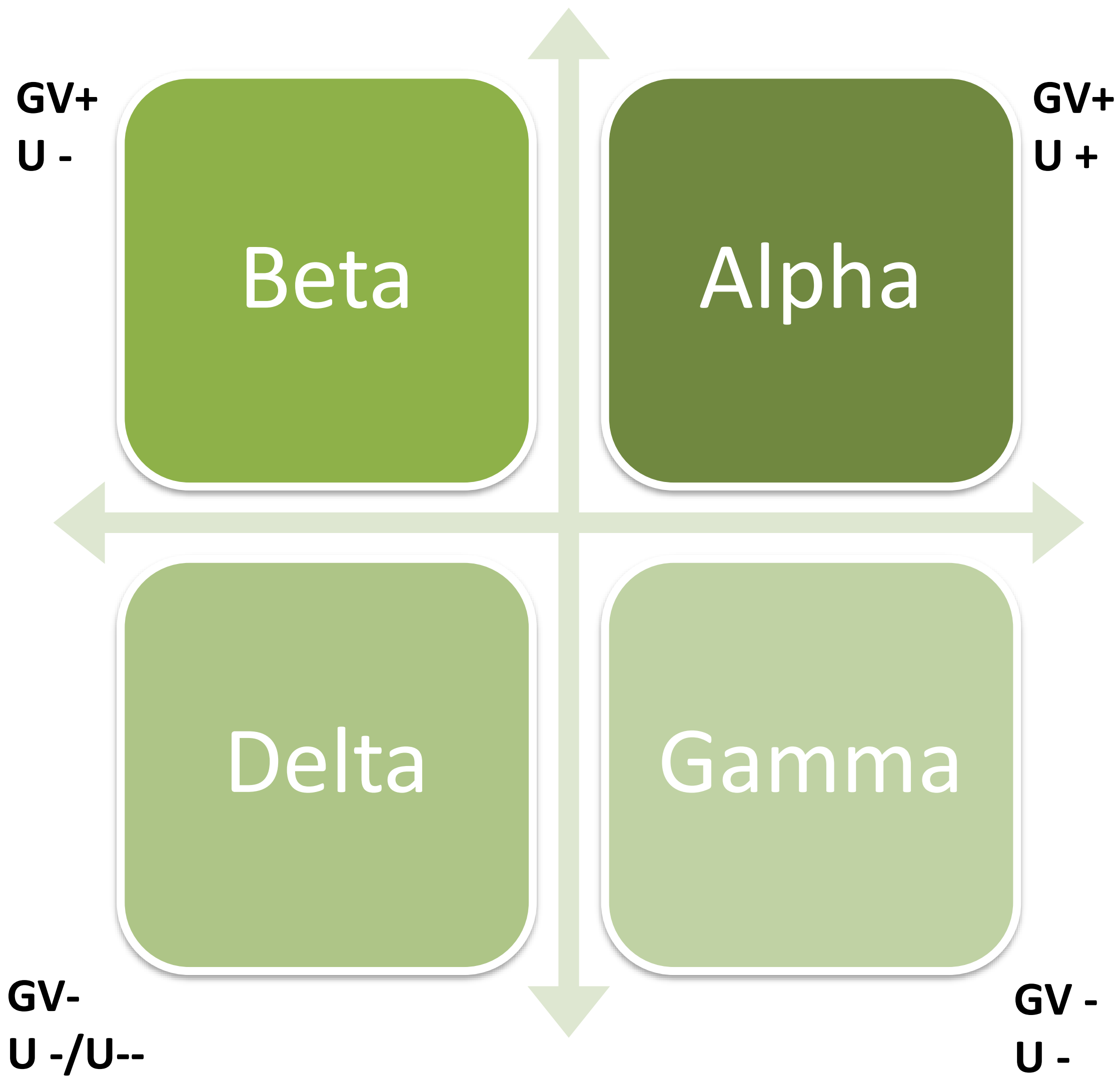
Compatibility with existing infrastructure
(Fully compatible/ Transformation needed)

3. Methodology: a binary code to attribute values

	BINARY VALUE	0	1
GREEN VALUE	ORIGIN	NON FOSSIL	FOSSIL
GREEN VALUE	LIFECYCLE GHG EMISSIONS	OFFSET	NON OFFSET
	USABILITY	FULLY COMPATIBLE	TRANSFORMATION NEEDED

PROCESS	GAS	GREEN VALUE		USABILITY	SCORE
		ORIGIN	GHG offset		
Anaerobic digestion / gasification	**Biogas**	0	1	0	**GV1, U0**
	Biomethane	0	1	0	**GV1, U0**
Methanation of green H2 + atm CO2	**Synthetic methane**	0	0 / (-1)	0	**GV0, U0**
Methanation of green H2 + NON atm CO2		0	1	0	**GV1, U0**
Electrolysis	**«Green» H2**	0	0	1	**GV0, U1**
Pyrolysis/gasification of natural biomass		0	0	1	**GV0, U1**
Photo catalysis		0	0	1	**GV0, U1**
Pyrolysis of gas	**«Blue» H2**	1	0	1	**GV1, U1**
SMR with CCUS		1	0	1	**GV1, U1**
Pyrolysis of coal	**«Grey» H2**	1	1	1	**GV1, U1**
SMR without CCUS		1	1	1	**GV1, U1**

Taxonomy proposal for new gases



Alpha: **000, 010,**(100)
Beta: **001**
Gamma: 101 (011)
Delta: 111

Results

TYPE OF GAS	
ALPHA **(high/very high GV, high U)**	**Biogas, biomethane,** **Synthetic methane** from ‘green H2’ via ATM CO2, Synthetic methane from ‘green H2’ via non ATM CO2
BETA **(high GV, low U)**	**«Green H2»** via pyrolysis of natural biomass, electrolysis or photo catalysis
GAMMA **(low GV, low U)**	**«Blue H2»** via pyrolysis of gas OR via SMR with CCS
DELTA **(very low GV, low U)**	**«Grey H2»**, produced via pyrolysis of coal or via SMR without CCS

(Some) results

- All the Alpha gases, having 0 usability, can be mixed among themselves hence be transported/traded as homogeneous product
- Alpha + Natural Gas (NG) is a homogenous mixture with 0 usability
- Beta, Gamma and Delta gases can be mixed with NG. Usability might vary depending on their percentage and on the type of infrastructure used.
- With technology and infrastructure evolution, gases might change category (ex. Green H2 become an Alpha gas)
- Regulators’ choice whether to favour source or process or usability.

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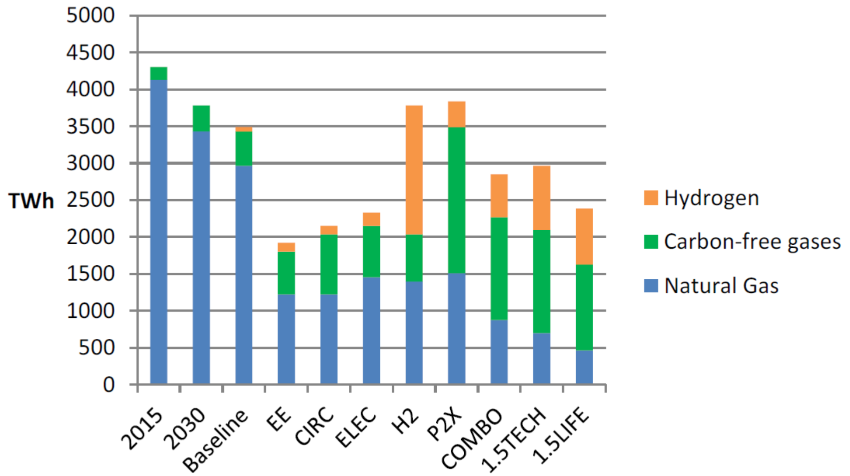
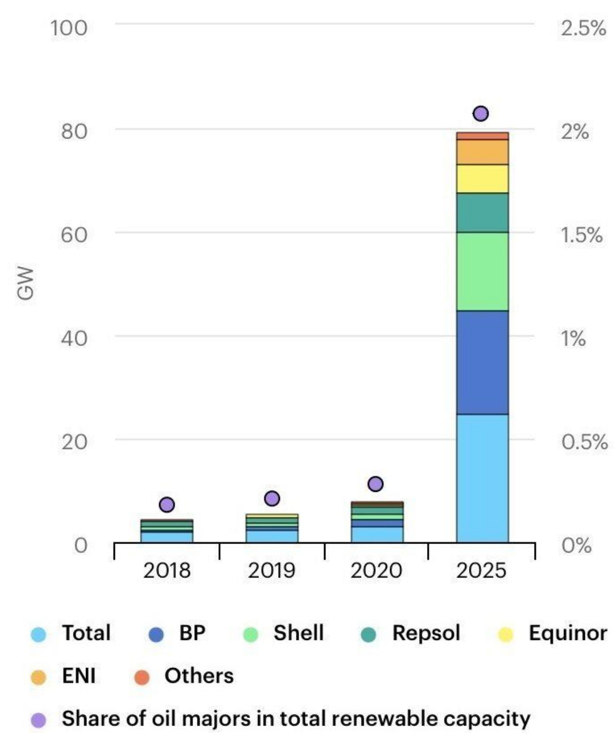
Renewable and low-carbon gases in the path to 2050

Several scenarios and projections see an important role for renewable gases in the path to 2030 and 2050



Installed and contracted renewable capacity by major oil and gas companies, 2018-2025

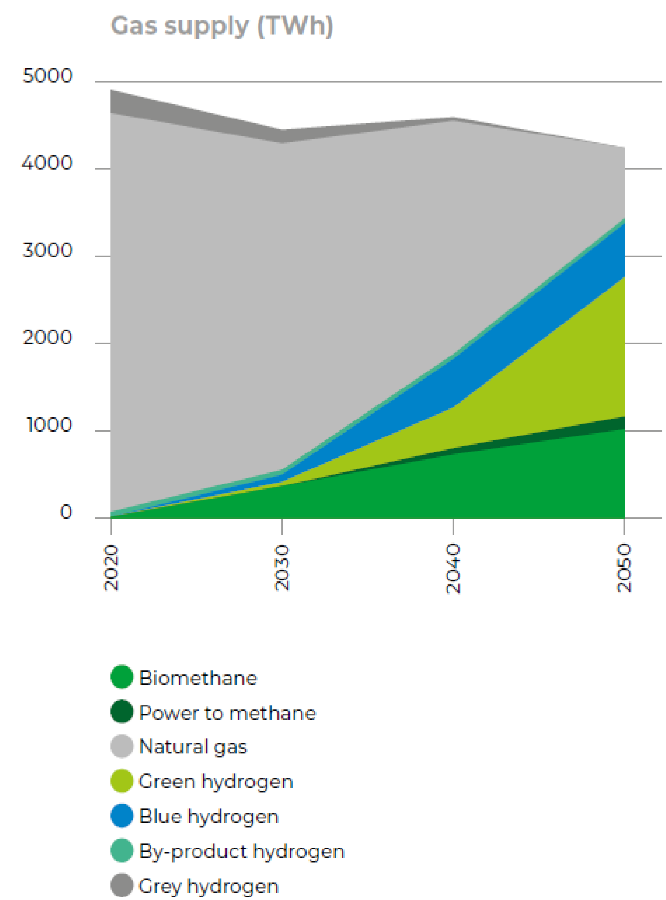


Source: EU Commission's Long-Term Strategy and OIES

Targets for green gases are ambitious…

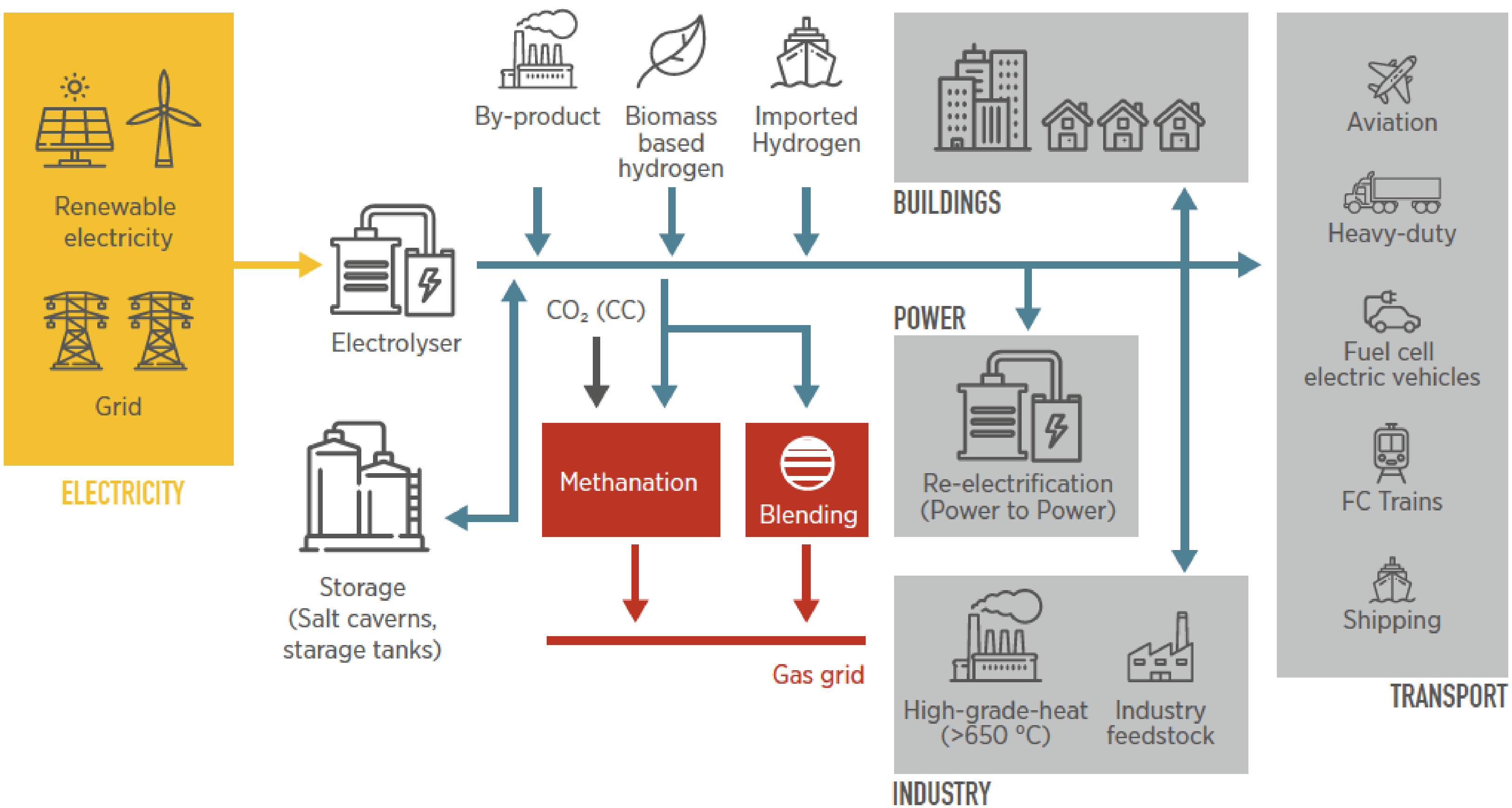
Type of Gas	Today	2030	2050
Biomethane Biogas	19 TWh (2bcm eq) 170 TWh (16bcm)	370 TWh	1020 TWh
Hydrogen (blue+green)	339 TWh (almost 100% grey)	1710 TWh	1600 TWh green H2 600 TWh blue H2

Source: **Gas for Climate study** (April 2020) – 'Optimised gas' scenario



"EU Climate policies that led to a record-speed decarbonisation of electricity production are not designed to decarbonise gas".
Gas for Climate Study, April 2020

Power-to-gas



Source: IRENA, 2018

Power-to-gas: a Sector Integration enabler

Pros:	Challenges
• P2G technology is flexible and therefore suitable for the variable electric infeed. • Provision of seasonal flexibility and storage, building on existing gas network and underground storage. • It's a versatile technology, synthetic gases can be used for industrial processes and heating and thus help to decarbonise other sectors. • Can help reducing RES curtailment • Produces 'green H2', provided that the electricity used is 100% from RES sources	• Only small P2G plants are in operation (up to 10 MW) and the production of synthetic gases is currently expensive. • Electrolysis manufacturing capacity needs to develop for the upscaling challenges. Electrolyser needs 4000-5000 h/year operation to be cost-effective • Blending: in UK and Belgium, network limit for hydrogen is 0,1%. In Germany 10% and in NL 12%.

…Need to incentivise clean molecules?

- 4 types of support schemes currently in place*:
  - Feed-in Tariffs (FITs)
  - Feed-in Premiums (FIPs)
  - Green Certificates (GCs) and
  - Investment Grants

All on renewable **electricity**

*CEER Report on RES Support Schemes in EU, Dec 2018

- **Very limited support is currently in place for green *gas***

Only few exceptions:

FR → binding mandate for 10% biomethane to be transported in the French grid

IT →biomethane subsidy scheme to support 1 bcm of biomethane in transport by 2022

DK→ incentives to build biogas plants

Several challenges for "green gases"

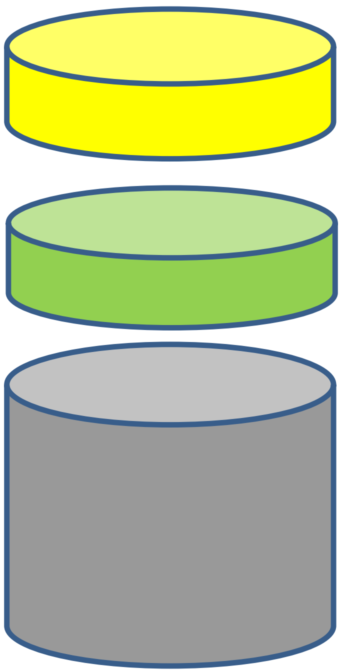
At technical level:

- **Scalability**: from MW to GW
- **Operation**: separate routes or blending?

At policy & regulation level

- **Market design**: a separate market? gas quality? targets? incentives? GOs?
- **Infrastructure**: a EU or regional hydrogen network? Safety rules? Blending limits?
- **Regulation and Governance**: Taxonomy; Sticking to existing rules and 'roles', or need for a 'Regulatory sandbox?'

A complex market, made of several layers



- Technical layer : conversion to get a specific commodity (CH_4 or H_2)
- Climate layer : value of renewable or low-carbon
- Market layer : value of energy content (kWh)

FSR & Sector coupling/integration

- Working on the topic **since 2017**
- FSR is **knowledge partner of DG ENER** in the Madrid Forum, with the task to facilitate and enlarge the debate on sector coupling and its most challenging issues.
- Online debates, training, research on:
  - Taxonomy
  - Readiness of gas infrastructure
  - Guarantees of Origin
  - Power-to-gas
  - Decarbonisation scenarios

More at https://fsr.eui.eu

Thank you for your attention!

Ilaria Conti
Florence School of Regulation
Head of FSR Gas

European University Institute
Ilaria.Conti@eui.eu

Classification based only on Green Value

Green by Origin

- Biogas
- Biomethane
- Synthetic methane
- Green H2

Green by Process

- Green H2
- Synthetic methane + air captured CO2
- Blue H2

Green by Origin AND Process:
Synthetic methane + air captured CO2

Non-green:
Grey Hydrogen