RENEWABLE FUELS

VISION IN THE LOMBARDY AUTOMOTIVE INDUSTRY

CLM
Cluster Lombardo della Mobilità
Lombardy Mobility Cluster

PRESENTATION

GOAL

- An analysis, reflection and proposal document , which notes the current situation and outlines the possible evolution of the fuels for transport, with the aim of contributing to the "operation truth" promoted by Anfia on emissions, technologies and energy carriers.
- This document proposes and compares homogeneous data relating to the most promising renewable fuels. Such data are expected to be useful for decision-makers and are open to be integrated by all operators in the value chain. Referring to each single renewable fuel, the considered data are: the calorific value expressed in kWh for each kilogram of fuel, the vehicle emissions (during operation and during the entire life cycle), the production volumes of the fuel that are available and that will be available over the interval of time considered, the cost per kilogram, the existence of a distribution networks, current and necessary skills along the entire supply chain, legislation, and incentives for innovation, production and consumption volumes.

THESIS

- In line with the principle of technological neutrality, IC engines and renewable energy vectors - including biofuels - deserve support in view of the 2026 verification target. The employment of such fuels may immediately contribute to the decarbonisation process of the transport sector.
- The social and economic impacts of the Fit for 55 act in its current formulation are evaluated among the Automotive Regions Alliance (ARA) survey.

PRESENTATION

METHODOLOGY

- The indications contained in the notebook are, in summary, the result of the work of the Cluster's Renewable Fuels Working Group and the scientific papers cited in the text. The forecasts of the quantities of the different fuels are evaluated by the Cluster based on the knowledge and possible evolution of the Italian market and on interviews with representatives of the involved Insitutions and Associations.

MAIN LITERATURE

- Declaration on Renewable Fuels – Lombardy Mobility Cluster and Lombardy Region Government . 29/3/2022
- Lipzig declaration 17/11/22 (ARA-CORAI).
- Regulation (EU) 2023/851 of the European Parliament and of the Council of 19 April 2023 amending Regulation (EU) 2019/631 (Whereas – art11).

STEERING AND SUPPORT COMMITTEES

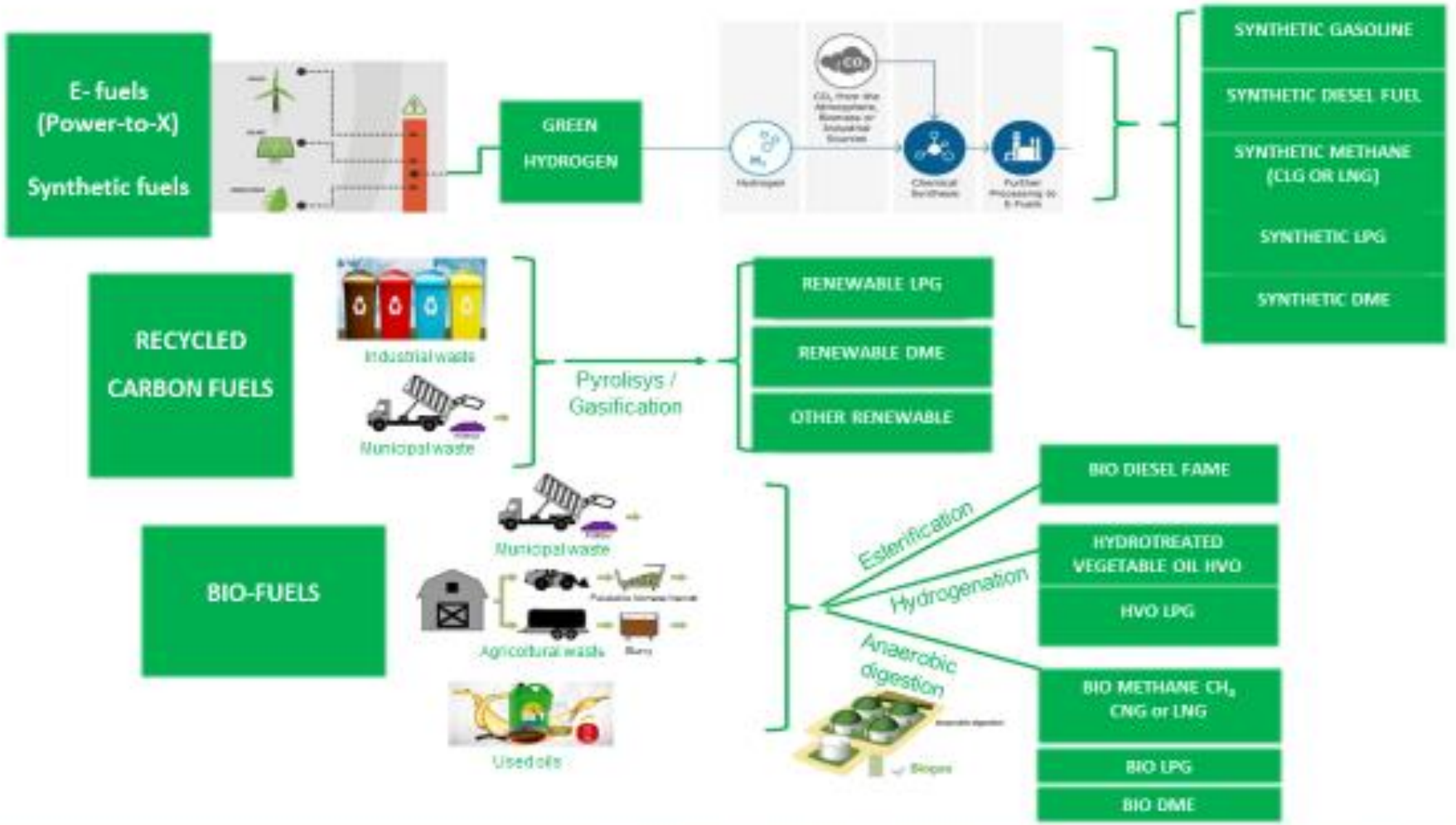
STEERING COMMITTEE

Prof. Gianpiero Mastinu – Politecnico di Milano
Prof. Angelo Onorati – Politecnico di Milano
Ing. Carlo Beatrice – CNR-STEMS
Prof. Marco Gadola – University of Brescia
Prof. Luca Gavioli – Università Cattolica del Sacro Cuore – Brescia

SUPPORT COMMITTEE:

Ing. Renato Gaudio and Ing. Piersandro Trevisan – Cluster Lombardo della Mobilità
Ing. Flavio Merigo – Assogasmetano
Dott.ssa Silvia Migliorini – Federchimica-Assogasliquidi
Ing. Giuseppina Pisaniello e Dott. Andrea Di Stefano – ENI
Prof. Carlo Visconti e Prof. Tommaso Lucchini – Politecnico di Milano
Dott.ssa Cristina Maggi e Ing. Valeria Bona – H2IT
Ing. Mariangela Merrone – Confindustria Lombardia
Ing. Dante Natali –Federmetano

Syntetic fuels and bio-fuels (simplified scheme)



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FUEL PROPERTIES

(Dir. 2018/2001/EU and Concawe Review october2019)

	Lower calorific value							Note
	Mass kg/Nm3	MJ/litre	MJ/kg	kWh/kg	Equivalent MTOE			
1 TOE						1 TOE 11.630 kWh 1 MTOE= 11.630 GWh		REF.: Ton of crude Oil Equivalent (TOE)
Gas								
1Nm³ biomethane (CNG and LNG)	0,717		47,7 MJ/kg	13,2	1,134 10^9m^3	ISO13686 ISO 16723-1&2		Biomethane covers (2022) 20% of italian demand for transport methane (considering CNG alone, the % of biomethane rises to 40%)
Ammonia			18,8 MJ/kg					Suitable for use in internal combustion engines (dual fuel with pilot flame); Various experimental applications on ship engines (Japan); Possible use as hydrogen carrier.
Liquid-Regulation								
	Kg/litre	MJ/litre	MJ/kg	kWh/kg		N°cet.	Norm	
LNG	0,43	21	47,7	13,2		ISO 13686; 23306 Sea Use; ISO 16723 -1&2		ISO 16723:1 Filling station network features– 2: Automotive Use
RAPESEED OIL PVO	0,91	34,2	37,6			39	DIN 51605	Fuels for vegetable oil compatible combustion engines - Fuel from rapeseed oil - Requirements and test methods
	Supported by Oleo100 France						EN 14214	Fatty Acid Methyl Esters - Max.7% in diesel – Issues when cold - Admitted 100% Oleo France with preheating
FAME	0,88	33	37	10,2		50-65		
1 litre HVO ENI Green diesel	0,78	34	44	12,2	0,95 10^6 t.	70-90	EN 15940	Hydrotreated Vegetable Oil – repleaceable 100% with commercial diesel. ENI refineries in Porto Marghera and Gela (process «Ecofining»)
1 litre diesel Fischer-Tropsch (e-fuel)	0,77	34	44	12,2	0,95 10^6 t.			repleaceable 100% with commercial diesel.
1litre bio methanol	0,8	16	20					⇨ esterification fatty acids (FAME)
1 litre bio ethanol	0,78	21	27					Versalis (ENI) production in Crescentino (Italy)
e-DME/DME renewable (liquid) CH_3-O_CH_3	0,67	19,0	28	5,30				Directly in diesel engines. Very low NOx, Particulate matter and CO content. Easy replacement of LPG
BioLPG	0,55	24	46	12,8		EN589		BioLPG is equivalent to LPG, same physical features. Directly in engines (blended or pure); available existing filling station network.
To compare:								
Hydrogen	0,090		120	32,7	0,356 10^6 t			
Gasoline	0,732	32	43	12,2			UNI EN 228	Ethanol content max 10% (E10)
Diesel	0,835	36	43	11,9		51	EN 590	FAME content max. 7%
LPG	0,55	24	46	12,8			EN 589	

ENERGY – REFERENCE MEASUREMENT UNIT: KWH/KG, THERMAL ENERGY RELEASED BY THE COMPLETE COMBUSTION OF 1 KG OF FUEL (CALORIFIC VALUE)

(additional measurement unit: kWh/litre - energy contained from one litre of fuel)

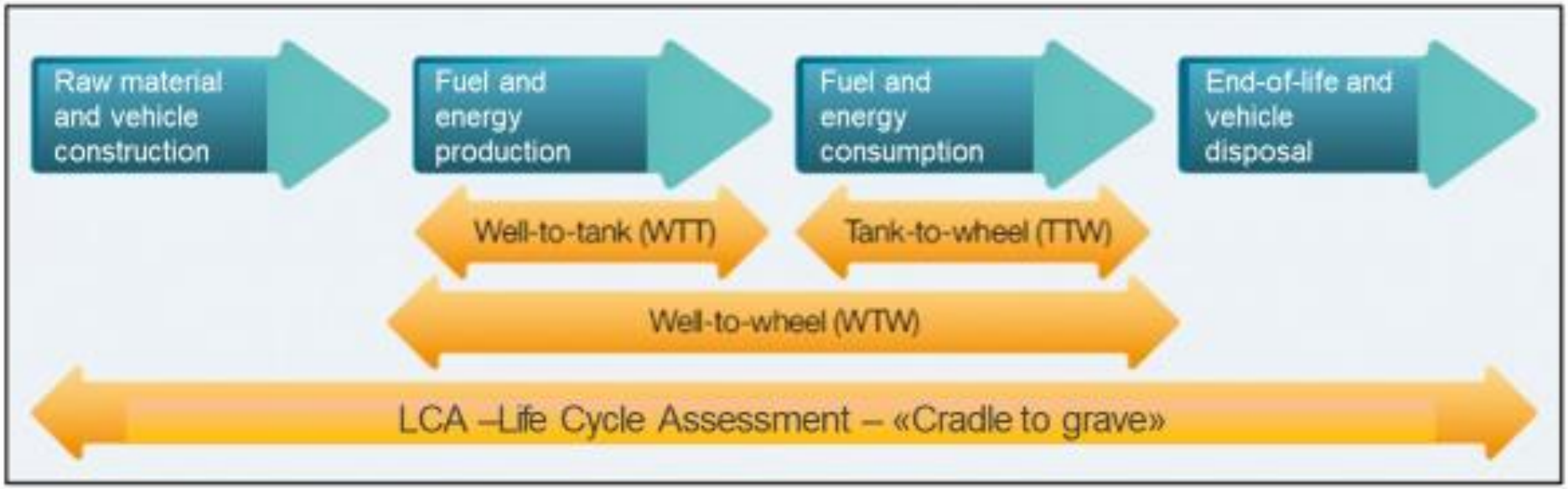
- Costs of raw materials are given in €/kWh
- For macro analyses TOE or MTOE (1 million TOE – Ton of Oil Equivalent) are used
  - «TOE» - energy contained in a ton of crude oil
  - ≈ 6 barrels = 11.630 kWh

PRODUCTION OF ENERGY AND CO_2

- **One kg of crude oil or diesel fuel** used to produce enery: **~3,17 kg di CO_2**
- **One kg of methane** produces **~2,75 kg of CO_2**
- **A human being** produces **~ 0,75 kg CO_2 per day**

- Hydrogen, when combined with oxygen, does not produce CO_2
- **Currently, 78 kWh are needed to produce 1 kg of hydrogen by classical electrolysis process** (the electrolizer must be fed by green power in order to decrease the CO_2 emission). Electrolisys process is rapidly evolving and improving.

Life cycle of a vehicle - Definitions



Source: Concawe (2018)

CONFRONTO DEI PRINCIPALI CARBURANTI RINNOVABILI A FIANCO DELL'ENERGIA ELETTRICA - GRANDEZZE CONSIDERATE	BIOMETANO/BIOLNG	bioGPL	DME rinnovabile	HVO	E-FUELS	IDROGENO
ente/associazione	*Assogasmetano*	*Federchimica-Assogasliquidi*	*Federchimica-Assogasliquidi*	*ENI*	*PoliMi*	*H2IT*
POTERE CALORIFICO (kWh/kg)	13	12,8	5,3	12,2	12,2	33,3
EMISSIONI CO2 g/km						
WTW [carburante dal pozzo alle ruote******] - valori a regime (sistema decarbonizzato)	5 [a]	6 [b]	6 [b]	8*	13 [c]	8 [a]
+ LCA [fabbricazione e demolizione veicolo] [d]	21	21	21	21	21	30
Totale emissioni [intero ciclo di vita- cradle to grave]	26	27	27	29	34	38
CONSUMI TRASPORTI ITALIA (in MTEP/ANNO)						
ATTUALE	0,55	0,044**	---	0,05***	---	---
PROIEZIONE CLM A TENDERE 2035/2050 (TOTALE 33 MTEP)	4 - 6	1,6 - 2,5	1,2 - 2	6 - 8,5	1 - 4,5****	2 - 4
CAPACITÀ PRODUZIONE COMBUSTIBILE ITALIA (in MTEP/ANNO)				(senza specifico perimetro geografico)		
ATTUALE	0,53	0,044		1.1	18 centri in avviamento	
INTERMEDIO	2,2 (2026) ÷8,8 (2030)	> 1	> 1	>3 (2025)		target perseguibile
POTENZIALE 2035	>10	> 2	> 2	> 5 (2030)	1	
POTENZIALE 2050	>15					
COSTO PRODUZIONE (€)						
ATTUALE	0,8 (€/kg)*****			1,4 – 2 €/litro*******	sperimentale	8,8 (€/kg)
POTENZIALE 2035/2050				previsto in netto calo	2,8-2,2 (€/litro) [f]	5 fino a 2 (€/kg)
DISPONIBILITÀ RETE	disponibile	disponibile	disponibile	150 stazioni (in estensione)	disponibile	previste 40 stazioni

* Renewable hydrogen and 100% Electric Renewable Energy Sources in production process.

** BioLPG is currently present as a product in the HVO production process. Therefore increase in BioLPG quantities is directly related to HVO production increase and to the development of upgraded production process of Biogas.

*** 0,3 if applicable Italian LD 122/2021 (pure fuels)

**** of which 3 MTOE relevant to gasoline+LPG

***** strongly related to waste and recycling costs and production technologies

****** medium vehicle (1300kg)

******* literature average values (tax-.exampt), depending by feedstock type and availability

COMPARISON OF RENEWABLE FUELS ALONGSIDE ELECTRIC POWER		BIOMETHANE/BIOLNG	BioLPG	Renewable DME	HVO	E-FUELS	HYDROGEN
INNOVATION							
	VOLUME INCREASE	- logistics/raw material handling (continuous cycle of production) - optimization of technological processes	Volume increase: investment to strengthen existing processes and introduce new production processes		- supply chain/logistics optimization - optimization of technological processes	development of production centres	Radical technological leap in the electrolysis process
	COST REDUCTION					decrease in hydrogen costs	
REGULATIONS FOR USE							
		existing R110	existing	blended with LPG up to 20%.	existing R110	existing	to be completed
PROFESSIONAL SKILLS							
		existing	existing	existing	existing	to be implemented	to be implemented
ECONOMIC INCENTIVES/PENALTIES							
	PRODUCTION	Biogas->Biomethane 40% grant funding 15 years incentive tariffs	- existing national obligation to use pure biofuels, which can be met by bioLPG (art. 39 Legislative Decree 199/2021) - possible increase in consumption in maritime transport (fuelEU Maritime); - possible reduction in tax rate (EU - European Tax Directive - and Italian policy evolution). - extension of ETS to road transport	- potential increase in consumption in maritime transport (fuel EU Maritime); - potential reduction in tax rate (EU - European Tax Directive - and Italian policy evolution). - extension of ETS to road transport	- existing national level obligation to use pure biofuels, which can be met by HVO, and Industrial Conversion fund (art. 39 Legislative Decree 199/2021) - potential introduction of SAF (Sustainable Aviation Fuel) release obligation on aviation transport (for further technology deployment; starting in 2025 - RefuelEU Aviation); - potential increase in consumption in maritime transport (FuelEU Maritime); - potential reduction in tax rate (EU - European Tax Directive - and Italian policy evolution). - Extension of ETS to road transport		- IPCEI (Important Projects of Common European Interests) - brownfield sites up to 100% contribution
	CONSUMPTION	- extension of ETS (emissions Trading Scheme) to road transport; - potential increase in consumption in maritime transport (fuel EU Maritime); - potential reduction in tax rate (EU - European Tax Directive - and Italian policy evolution).				- extension of ETS (emissions Trading Scheme) to road transport;	- extension of ETS (emissions Trading Scheme) to road transport;

Literature

[a] DENA – Renewable electric power

[b] JEC WtW Report issue 5 (reworking Assogasliquidi)

[c] Concawe CO Comparator User Guide

[d] "1 - Assogasmetano data - Thinkstep Carried forward to 200,000 km - conservative

[e] Report Ricardo 2020: 2020 – 2050 emission range

[f] Concawe Report 17/2022

Other: Ecoinvent / REDII Directive

Main literature

Declaration on Renewable Fuels – Lombardy Mobility Cluster and Lombardy Region Government 29/3/2022 (in italian)

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