



Future developments of engines.

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Introduction

Over the years engineer’s have been experimenting, implementing improvements to supporting climate change. This era has had the most significant impact in terms of going green, you may think, but its quite the contrary. Future engine developments has been at its most pivotal state as they are trying to implement that all Internal combustion engine productions must be **abolished** by 2030, is it possible?

Key concepts

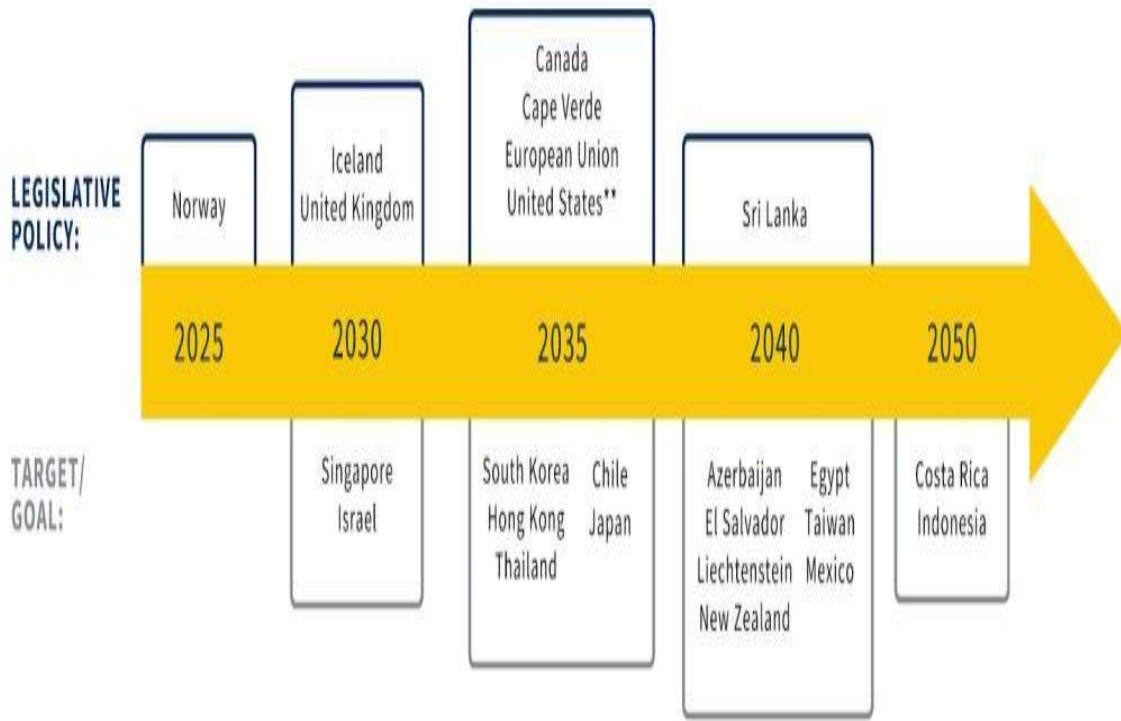
As we approach an era that is pro active in going green and are trying to reduce carbon footprints, some **innovations** that are going towards the right directions are:

- **Full electric vehicles**
- **Hybrid vehicles**
- **Synthetic fuels**
- **Hydrogen combustion engines**

Unfortunately, the way materials are dug up for these innovation such as electric vehicles, for their battery, hybrids, for their motor. Still utilizes machinery that produces a significant amount of carbon, contributing to further carbon pollution. Examples of dug up materials used in EV’s:

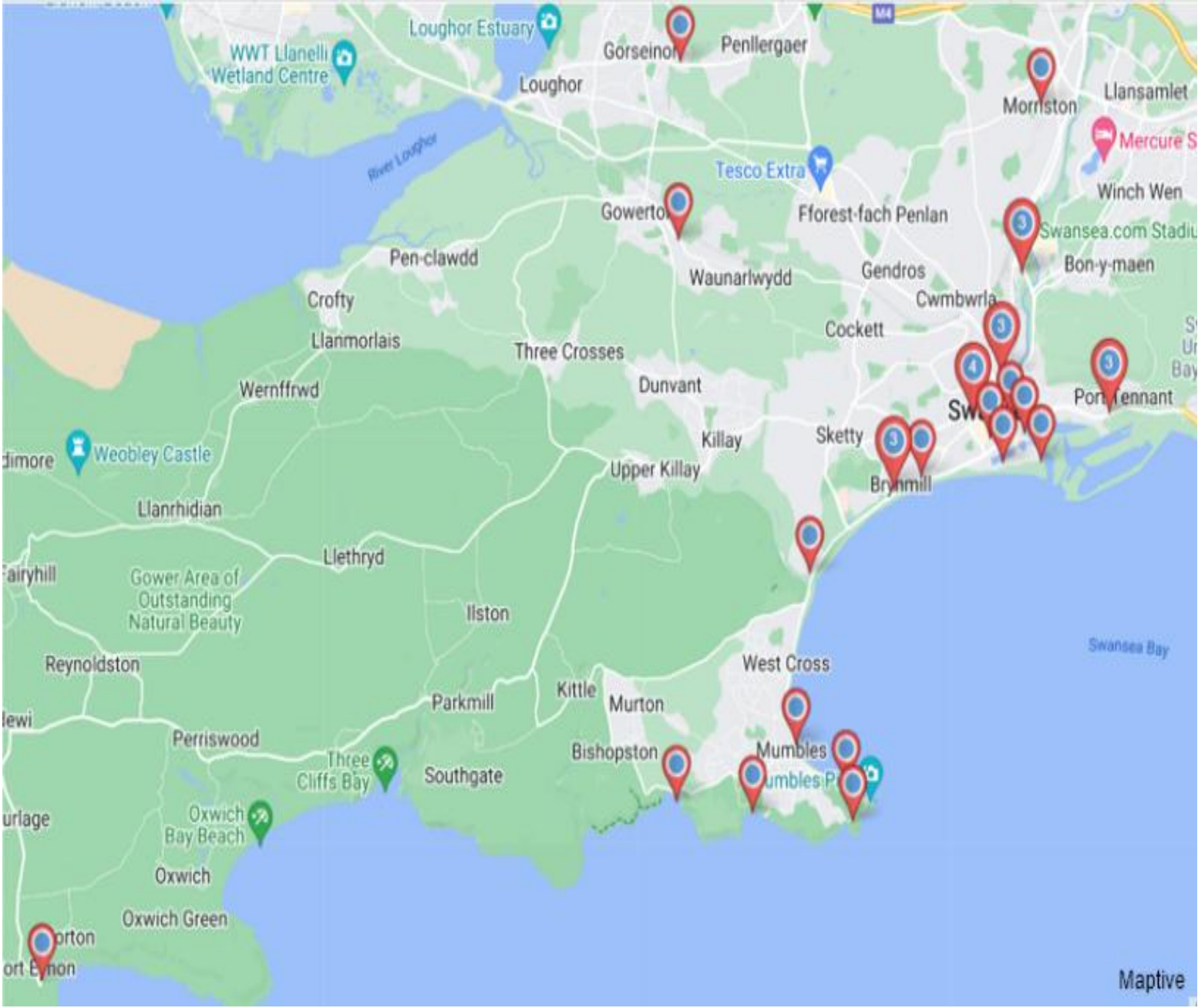
- **Lithium (heart of Electric vehicles)**
- **Copper for wiring and motors**
- **Graphite**
- **Cobalt**

Phase Outs for Sales of Internal Combustion Engine Vehicles (4-wheel passenger)*



Timeline of countries (globally) and their designated ban of Internal Combustion Engine production. Image sourced from Páez, D. (2023, March 7th). [1]

Top 10 countries with the highest carbon footprints
Image sourced from Mckay, B. (2024, August 27th). [2]



Example of an area(Swansea) with a sparse amount of charging points. Image sourced from Swansea Council [3]

Negatives of Full electric and Hybrid vehicles.

Full Electric vehicles:

- **Range anxiety** - Driver’s are often filled with worry when travelling long journey, they would have to plan out their route for the journey.
- **Inconsistent charging ports** – Not many are found in rural areas compared to urban

Hybrid vehicles:

- Battery degrades overtime therefore hybrid vehicles still becomes reliant on an Internal combustion engine. Added factor is an increase of fuel consumption as the battery and motor becomes deadweight

Euro emission standards

An enforced regulation for vehicle emissions, the sole purpose of the regulation is to reduce harmful pollutants and to improve the air quality thus engineers must adhere to the regulations that is set. Examples of harmful pollutants

- Nitrogen oxides
- Carbon monoxide
- Hydrocarbons
- Particulate matter

NO _x (g/km)	0.97*	0.50/0.90*	0.15/0.50	0.08/0.25	0.06/0.18	0.06/0.08	0.06
PM (g/km)	0.14	0.08	0.05	0.025	0.005	0.005	0.0045
PN ₂₃ (#/km)					6x10 ¹¹	6x10 ¹¹	6x10 ¹¹

	Euro 1 (1992) CO HC + NO _x PM (D)	Euro 2 (1996)	Euro 3 (2000) NO _x added	Euro 4 (2005)	Euro 5 (2009) PM (GDI) PN (D)	Euro 6 (2014) PN (GDI) Test updates: NEDC to WLTC RDE introduced	Euro 7 LD (2025) Technology neutral PN ₁₀ added Wide RDE	NO _x 84% reduction (Euro 3-7) CO 82% reduction (Euro 1-7) PM 96% reduction (Euro 1-7)
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	1990	2000	2010	2020	2030
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	Euro I (1992) CO, HC, NO _x , PM	Euro II (1996) Limits power-neutral	Euro III (2000) Transient test added Smoke added	Euro IV (2005)	Euro V (2008)	Euro VI (2013) PN added Test updates: Steady-state test updated Transient test updated	Euro 7 HD (2027) Technology neutral PN ₁₀ added Wide RDE conditions	NO _x 99% reduction (Euro I - 7) CO 97% reduction (Euro I - 7) HC 96% reduction (Euro I - 7) PM 95% reduction (Euro I - 7)
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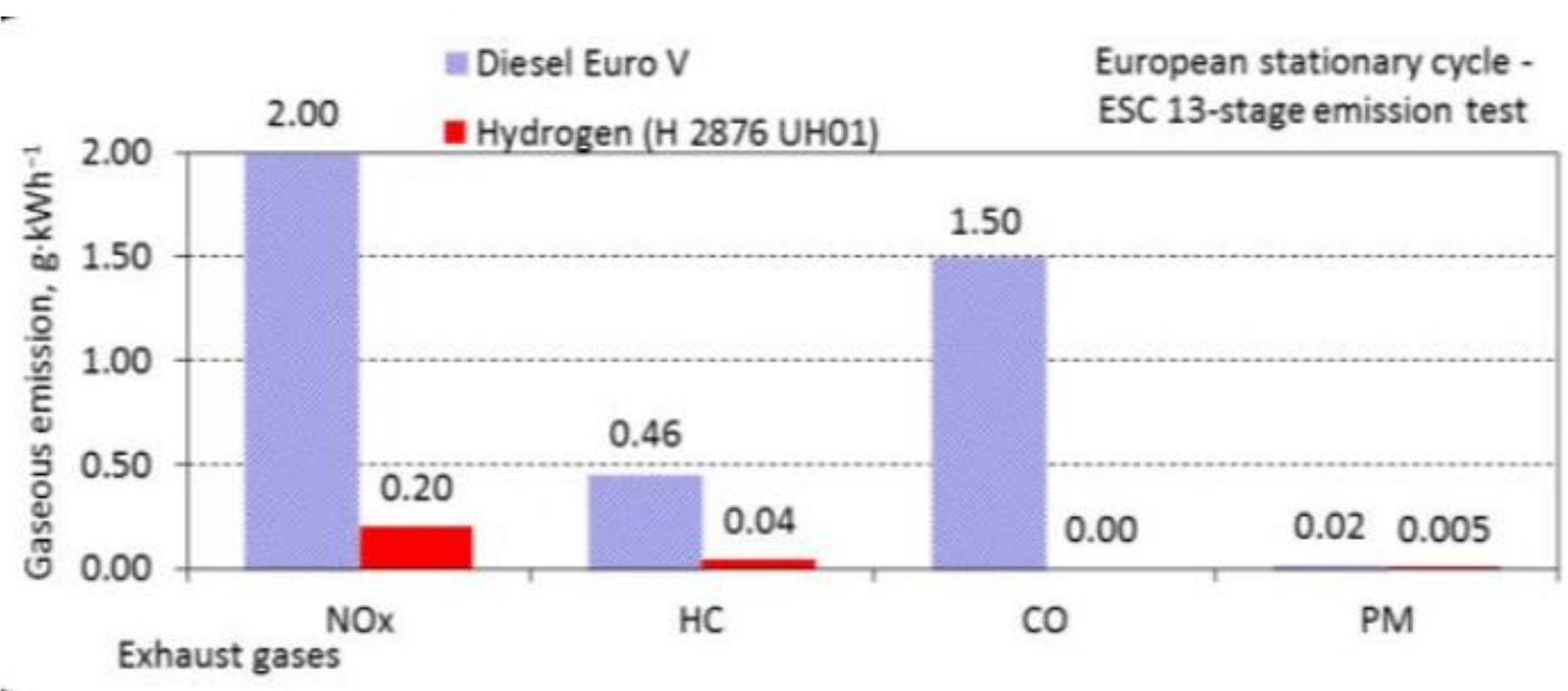
NO _x (g/kWh)	8.0	7.0	5.0	3.5	2.0	0.4	0.09
PM (g/kWh)	0.36	0.25	0.10	0.02	0.02	0.01	0.008
PN ₂₃ (#/kWh)						6x10 ¹¹	2x10 ¹¹

(D) = Diesel | HC = Hydrocarbons | PM = Particulate Mass | NO_x = Nitrogen Oxides | CO = Carbon Monoxide | (GDI) = Gasoline Direct Injection | PN₂₃ = Particulate Number (minimum particle size 23 nm) | *Includes HC

Evolution of Euro regulations, timeline. Sourced from Lubrizol360.com “Euro 7 The Evolution of Emission legislation in Europe”.[4]

Hydrogen engines

A pivotal innovation that can achieve zero carbon emission as it only produces mostly water vapour as the byproduct. This innovation meets the governments regulation for a cleaner environment reducing health implications.



Exhaust emission comparison. Sourced from ResearchGate Milojević, S.(2016, June)[5]

References

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