Fuel Life Cycle Analysis for Different Types of Vehicles in the Canary Islands

Concurrent Session 37: Mobility and CO2

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Introduction

Energy Transition:

- Climate and environmental challenges require an urgent and ambitious response.
- Renewables and Energy Storage assume the role of “game-changers” in energy transition.
- Land Transportation transformation towards electromobility is unstoppable over the world.

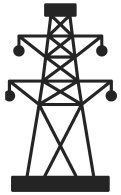
Energy Policies:

- The European Union is committed to achieving climate neutrality by 2050.
- The National Integrated Energy and Climate Plan (PNIEC) 2021-2030 is published by the Spanish Government.
- The Canary Islands (Spain) is committed to decarbonize the archipelago by 2040.

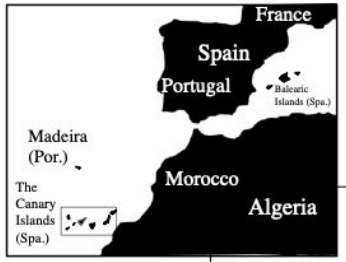
Introduction - the Canary Island Energy Context

97% of External Oil Dependence

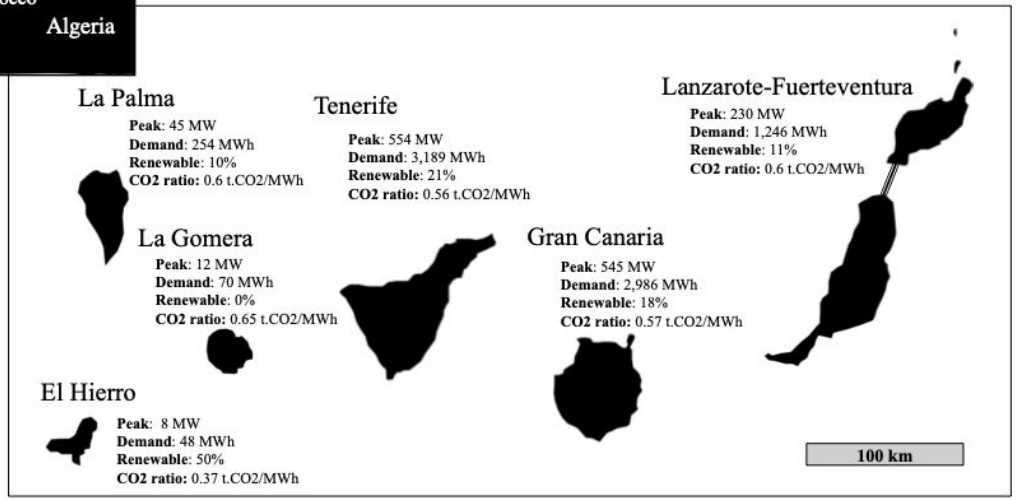
40% of total emission in transport sector



Electricity sector is a 20% of total final energy consumption



The Canary Islands Electric Systems (2020)



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Introduction - Motivation

OR

Objective

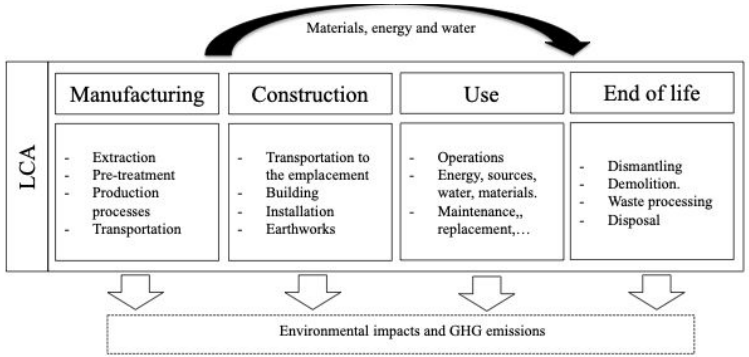
"Evaluate different light-duty vehicles' power-train technologies in terms of energy consumption and GHG emissions from the well to the wheels in the Canary Islands context"

Methods - Well to Wheels Overview

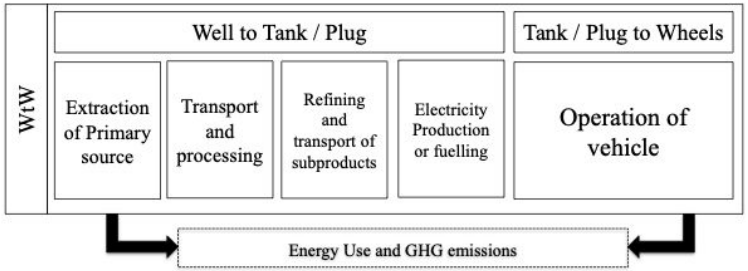
Hawkings et al. (2013)... “it is counterproductive to promote BEVs in areas where electricity is primarily produced from lignite, coal, or even heavy oil combustion”

M. Sivak and B. Schoettle (2018)... “Countries, such us India, China, USA and most African Countries, that use oil or coal as major energy sources in the electricity mix harm the benefits of BEVs as emissions mitigator ”

JRC, 2020, the PEV while electric propulsion on the vehicle is efficient, the overall energy use and GHG emissions depend critically on the source of the electricity used.



a) Life Cycle Assessment (LCA) methodology scheme

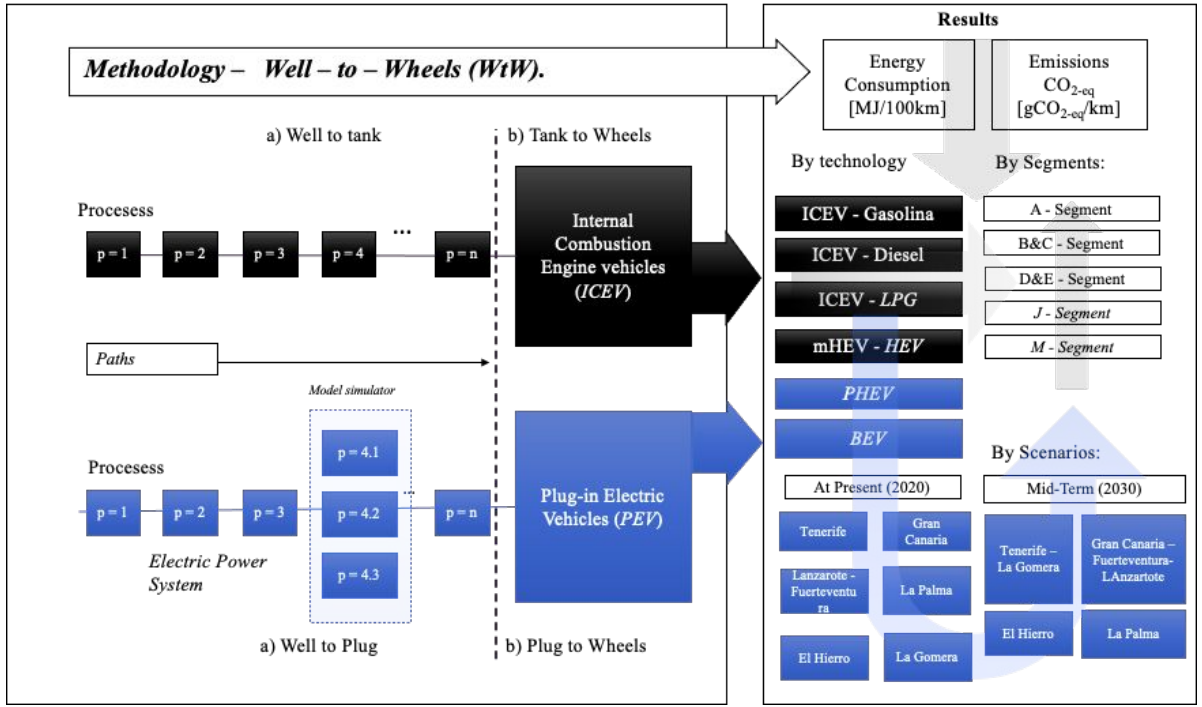


b) Well to Wheels (WtW) methodology Scheme

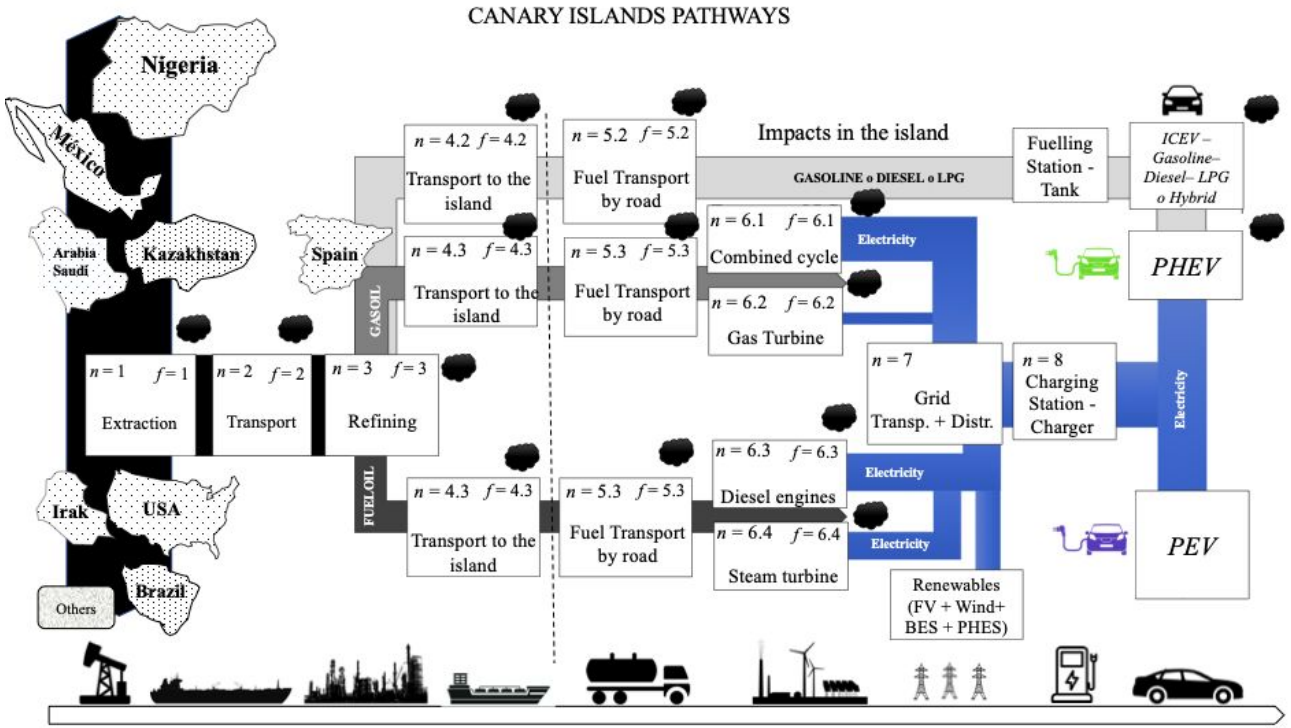
Methods - Well to Wheels

Internal combustion Engine Vehicles (ICEVs)

Plug-in Electric Vehicles (PEVs)



Methods - Well to Wheels



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Methods - WtW modelling

WtW - Energy Consumption::

“The energy spent from the energy fuel source well to the wheels of the vehicle to cover a certain distance” - Measured in [MJ/100km]

$$WtW_{energy\ consumption} = \left(\sum_{n=1}^{n}\left(1 + WtT_{n\ ,Total\ expended\ enegy}\right)\right) \cdot TtW_{car\ consumption}$$

WtW - GHG Emissions:

“The sum of GHG emissions derived from the exploitation, transformations and transportation of energy fuel sources from the well to the car added to the car tailpipe emissions when it covers a certain distance” - Measured in [g.$CO_{2\text{-eq}}$/100km]

$$WtW_{GHG\ emissions} = \left(\sum_{f=1}^{f}\left(1 + ntW_{f}\right) \cdot WtT_{GHG,f}\right) + TtW_{GHG\ emissions}$$

Methods - Light-duty Vehicles Inventory

Database features:

- Almost 46,460 newly light-duty vehicles registered in the Canary Islands collected (more than 80% of the total registrations from private car users).
- Sales from january 2019 to december 2020.
- Data mining from real newly registrations, counting sales according to Brand, Model, Power (CV or KW), Variant, Segment, Type of Fuel, Type of Power-Train.

Technical data:

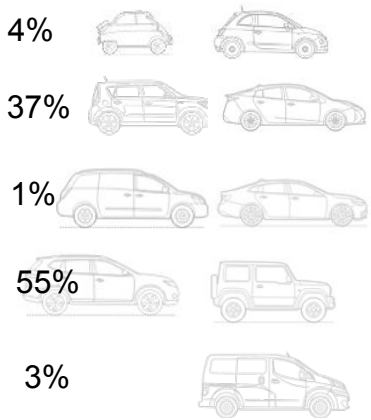
- WLTP consumption cycle. Low, Medium, high & very high speed consumptions.
- Island users mobility routines (35% Urban, 30% extra-urban, 30% highway and 5% high performance.
- 5 groups of segments created.
- Up to seven powertrain configuration/technologies considered.

Results - Tank to Wheels and Plug to Wheels

A	Energy Consumption [MJ / 100km]
(A)	Emissions [g.CO2 / km]

Sample Share by Powertrain technologies (%) 85% 4% 1% 3% 6% >1% 1%

Sample Share by Segments (%)



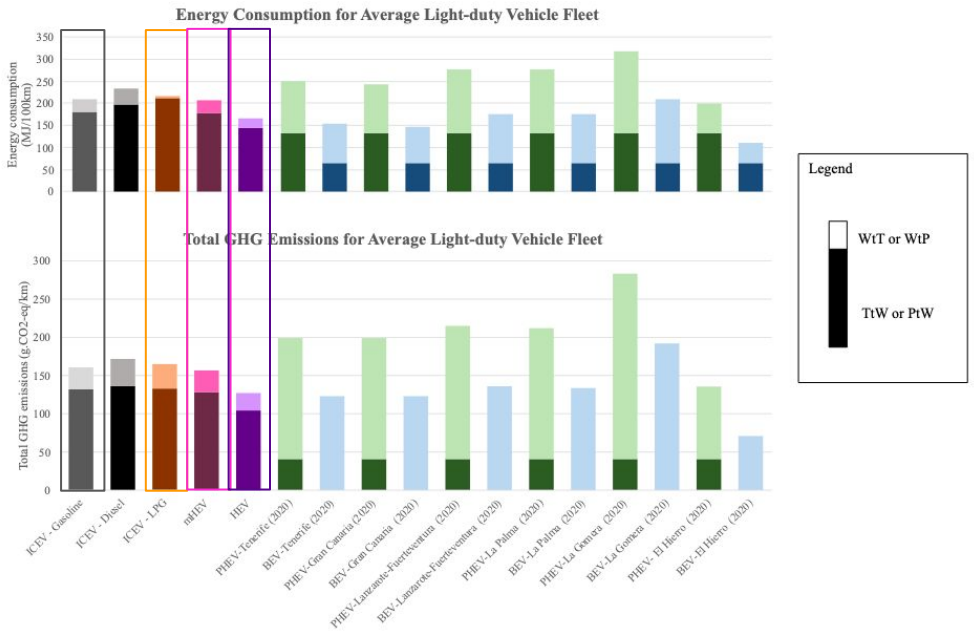
Power-train Tecnology	ICEV - Gasoline	ICEV - Diesel	ICEV - LPG	mHEV	HEV	PHEVs	BEV & REEV
Average fleet	**182.1 (131.9)**	**197.4 (136.3)**	**212.5 (133.0)**	**179.4 (128.3)**	**144.1 (104.3)**	**133.2 (40.7)**	**64.55 (0)**
A - Segment: Micro-cars and Urban Cars	162.4 (117.6)	-	227.5 (142.3)	149.5 (108.3)	140.3 (101.6)	-	59.9 (0)
B & C- Segment: Subcompacts, Compacts and Mid-Size.	170.9 (123.6)	162.2 (112.0)	207.8 (130.0)	157.4 (113.9)	132.8 (96.2)	110.5 (26.5)	63.7 (0)
D & E - Segment: Large cars and family cars.	190.0 (137.6)	175.2 (121.0)	212.8 (133.2)	184.1 (131.1)	182.9 (132.4)	116.7 (38.3)	60.6 (0)
J-Segment: AllRoad cars, Crossovers and SUVs	191.6 (138.8)	213.1 (147.1)	209.9 (131.3)	190.4 (135.6)	144.4 (104.4)	135.9 (41,4)	66.6 (0)
M-Segment: Multi-purpose vans, cargo vans and mini vans.	178.8 (129.5)	209.9 (144.9)	249.7 (156.3)	-	230.1 (158.9)	-	92.8 (0)

129 g.CO2/km Average in Canary Islands

121 g.CO2/km Average in Spain

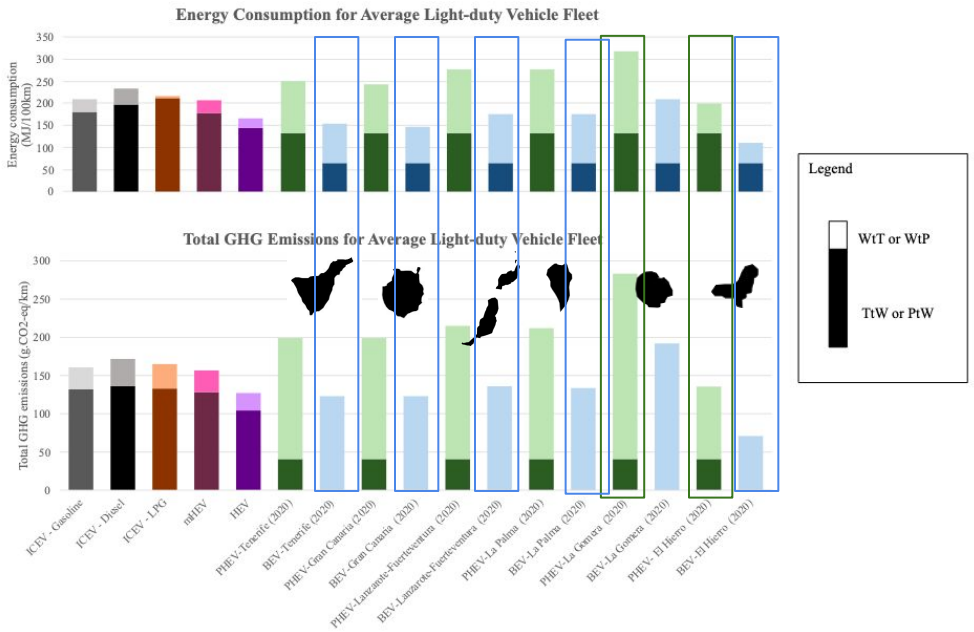
123 g.CO2/km Average in Europe

Results - WtW for 2020 scenarios in the Canary Islands



- **Gasoline** fleet seems to be in average the less pollute and less consumption solution for ICEVs
- **LPG** is better solution for mobility with vehicles of the D&E and J segments than diesel or gasoline
- **Mid-Hybridization** just reduce a 3% the average GHG emissions compared to gasoline..
- **Full - Hybridization** is key to reduce significantly both WtW energy consumption and GHG emissions.

Results - WtW for 2020 scenarios in the Canary Islands



- In general, for 2020 scenarios, **PHEVs** is not and efficient solution for all island, except El Hierro.
- The worst case scenario is on La Gomera for **PHEVs**, that depends on 100% on diesel oil for electricity generation.
- Spite of 16% of renewable sources in average in Canaries, **BEVs,** in general show better results both energy efficiency and emissions for all systems, except La Gomera.
- **BEVs** in El Hierro island reduces almost a half of emissions and energy efficiency in comparison to the **HEVs**.

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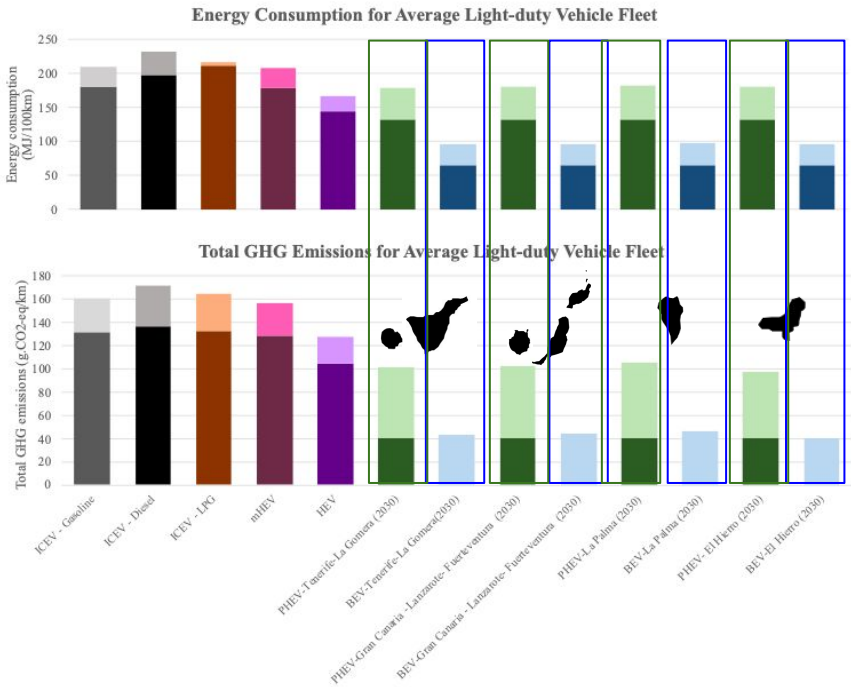
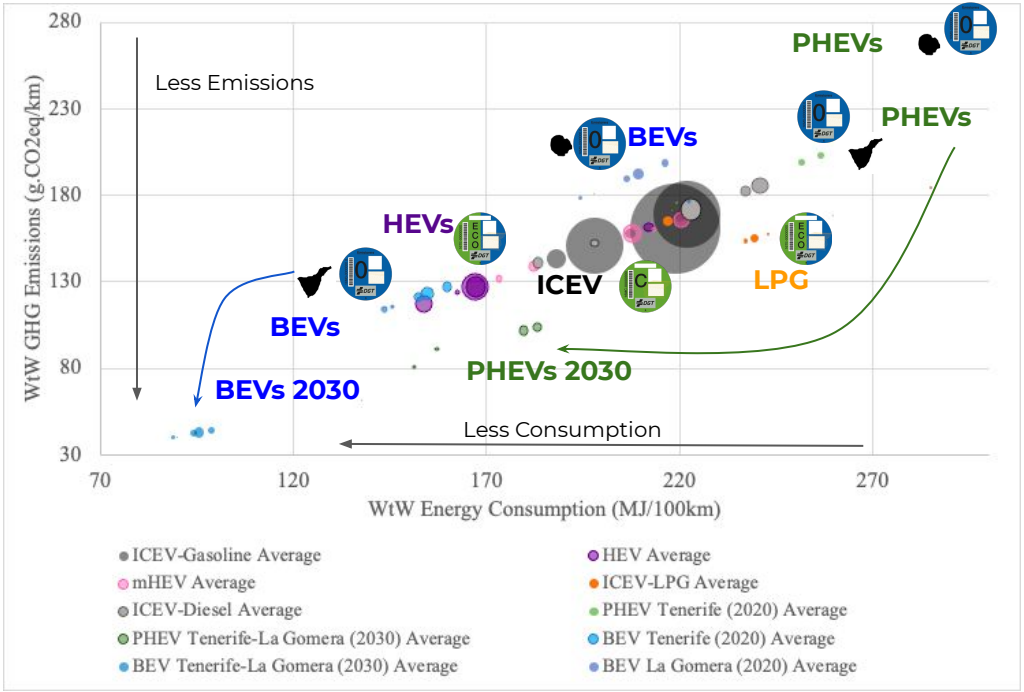
Results - WtW for 2030 future scenarios



- For ICEV, the is not capacity to improve their emissions and efficiency in future scenarios (2020 fleet).
- Conversely, for PEVs (**PHEVs** and **BEVs**) with the electricity mix transition towards decarbonization, the figures for the impacts on WtP process improves considerably.
- For **PHEVs** in terms of energy consumption are nearly **HEVs** but reduce their emissions in all systems respect conventional cars.
- For **BEVs**, the reduction of total emissions is neary 73% respect gasoline cars.,

Discussion and Policy Implications



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National Labeling for Energy Consumption in Spain:


BEVs and PHEVs


HEVs, MHEVs and LPG


Euro 6 Diesel and Gasoline


Old Diesel and gasoline

PLAN MOVES III:


From 4,500 € to 7,000€ for private users and 9,000 € for companies (BEVs)


From 2,500 € to 5,000€ for private users on PHEVs.

Canary Islands Government Incentives:

- 0% taxes on purchase for…


BEVs and PHEVs


MHEVs and HEVs with less than 110g.CO2/km, and LPG

Conclusions

- The Canaries as similar island regions in the world, depends highly from fossil fuels.
- **Policies** in this areas towards alternative mobility requires an special consideration due to the special fuel cycle from the well to the vehicles.
- Spite of high dependence on fossil fuels an average of 17% from renewables makes **BEVs** the better alternative for light-duty vehicles.
- **PHEVs** should not be promoted until at least 50% renewable mix is achieved.
- **HEVs** plays a key role in short-term to reduce the emissions and the consumption of ICEV cars.
- The rise and popularity of **SUV** segment becomes a huge problem in the islands, increasing the average emission of the fleet year per year.
- **Zero** and **Eco-Labeling** for should be reviewed in the Canary Islands in terms of car segment or direct and indirect emissions in order to promote the most potential technologies to cope with climate goals..

Thanks for your Attention

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MEDI Marco Estratégico de Desarrollo Insular

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