

CLM

Cluster Lombardo della Mobilità
Lombardy Mobility Cluster



POLITECNICO
MILANO 1863

Avvento dei veicoli 'green'

Aspetti scientifici e contingenze

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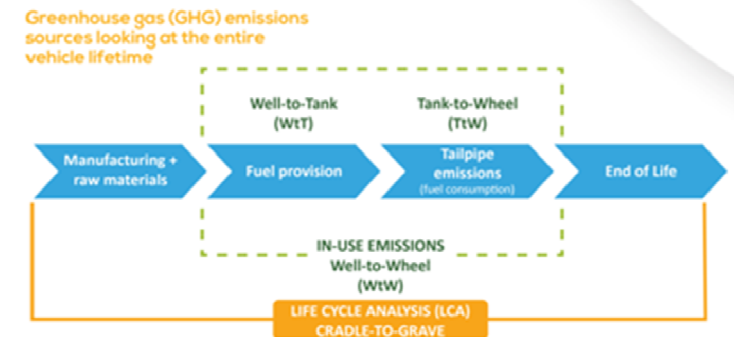
18 maggio 2021

- **Automotive industry figures and HEVs EVs penetration**

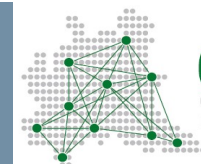


Outline

- Automotive industry figures and HEVs EVs penetration
- Comparing different technologies scientifically



- **Automotive industry figures and HEVs EVs penetration**
- **Comparing different technologies scientifically**
- **The problem of Lightweight Electric Vehicle**

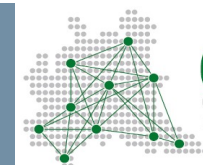


- **Automotive industry figures and HEVs EVs penetration**
- **Comparing different technologies scientifically**
- **The problem of Lightweight Electric Vehicle**
- **Alternative fuels**

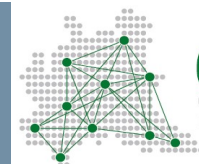


Outline

- **Automotive industry figures and HEVs EVs penetration**
- **Comparing different technologies scientifically**
- **The problem of Lightweight Electric Vehicle**
- **Alternative fuels**
- **Geopolitical problems**



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- **The problem of Lightweight Electric Vehicle**
- **Alternative fuels**
- **Geopolitical problems**
- **Conclusions**



Automotive Industry figures: fundamental facts for discussing about automotive issues



2018: nearly 80 mln road vehicles produced yearly in the world

2019: EU automotive: jobs for 13.3 million people

2019: automotive: 5% of the EU's GDP

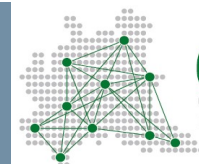
2019: 50 billion € yearly invested for R&I in EU on automotive



Why EVs are not spread ?



1. **Industry not ready / Suppliers less ready than OEMs**
2. **Cost (customer, society, OEMs)**
3. **Relatively poor performance (range, heating)**
4. **Recharging system/infrastructure**
5. **Regulation (Homologation, traffic policy ...)**



Integration of product and process for manufacturing electric motors of road vehicles

Inproves

REALIZZATO CON IL SOSTEGNO DI



UNIONE EUROPEA
Fondo europeo di sviluppo regionale



Regione
Lombardia



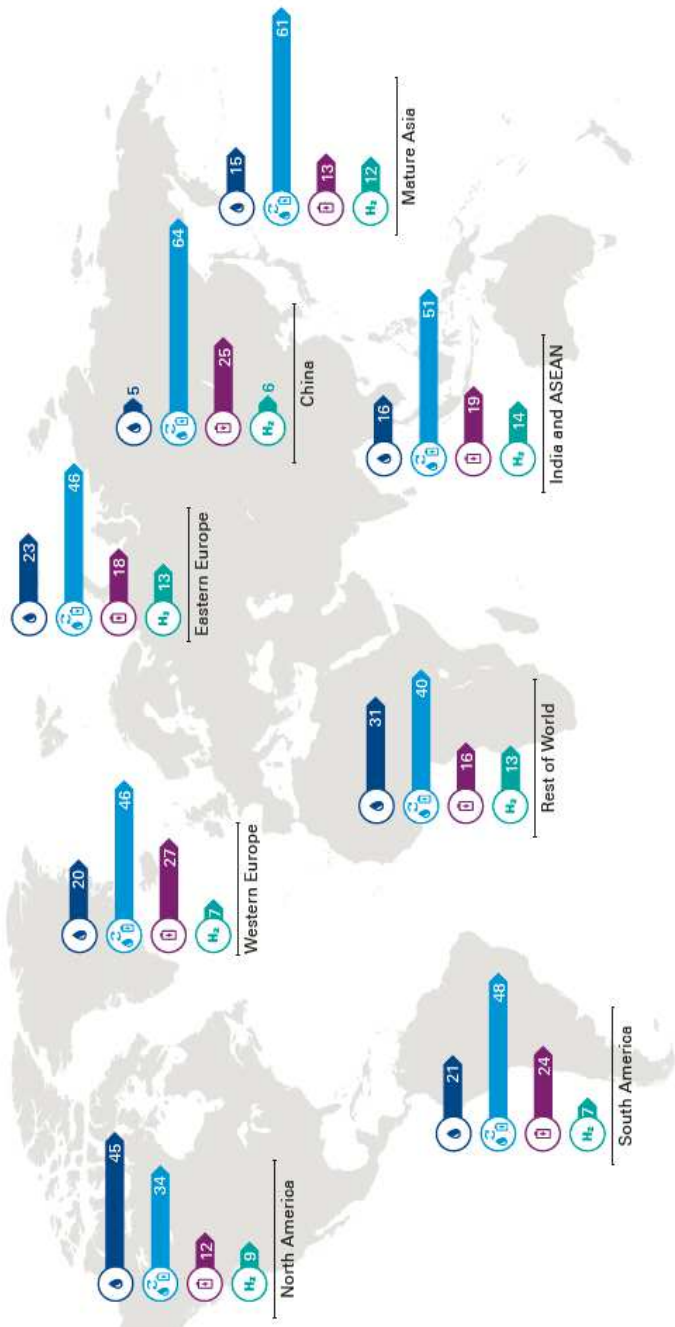
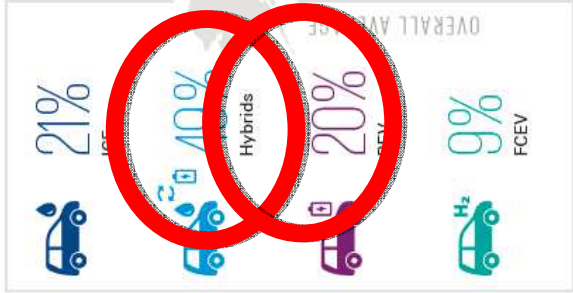
POR FESR 2014-2020 / INNOVAZIONE E COMPETITIVITÀ



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CONSUMER
Which powertrain technology would you choose if you were to buy a car over the next 5 years?

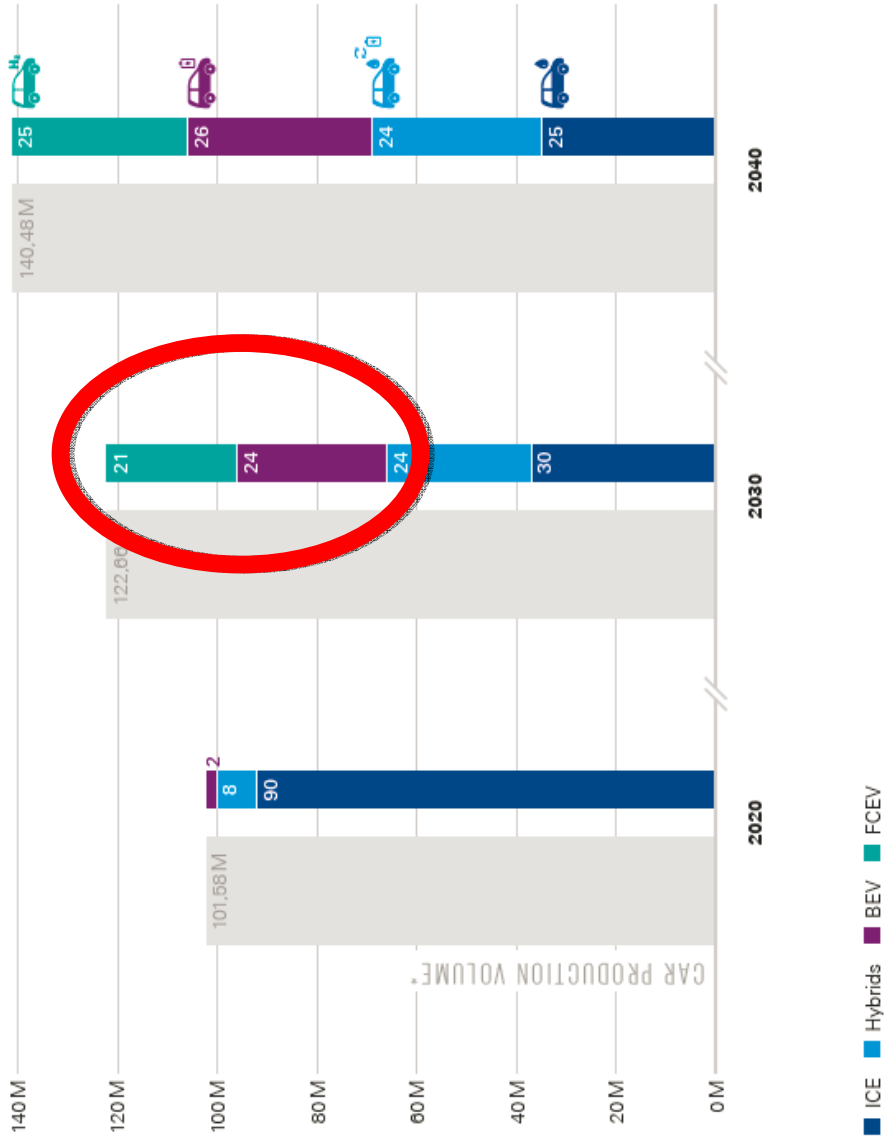


ICE Hybrids BEV FCEV



EXECUTIVE

What is your opinion on the share between ICE, PHEV, BEV and FCEV in 2020, 2030 and 2040?



Green vehicles and Green House Gas (GHG)

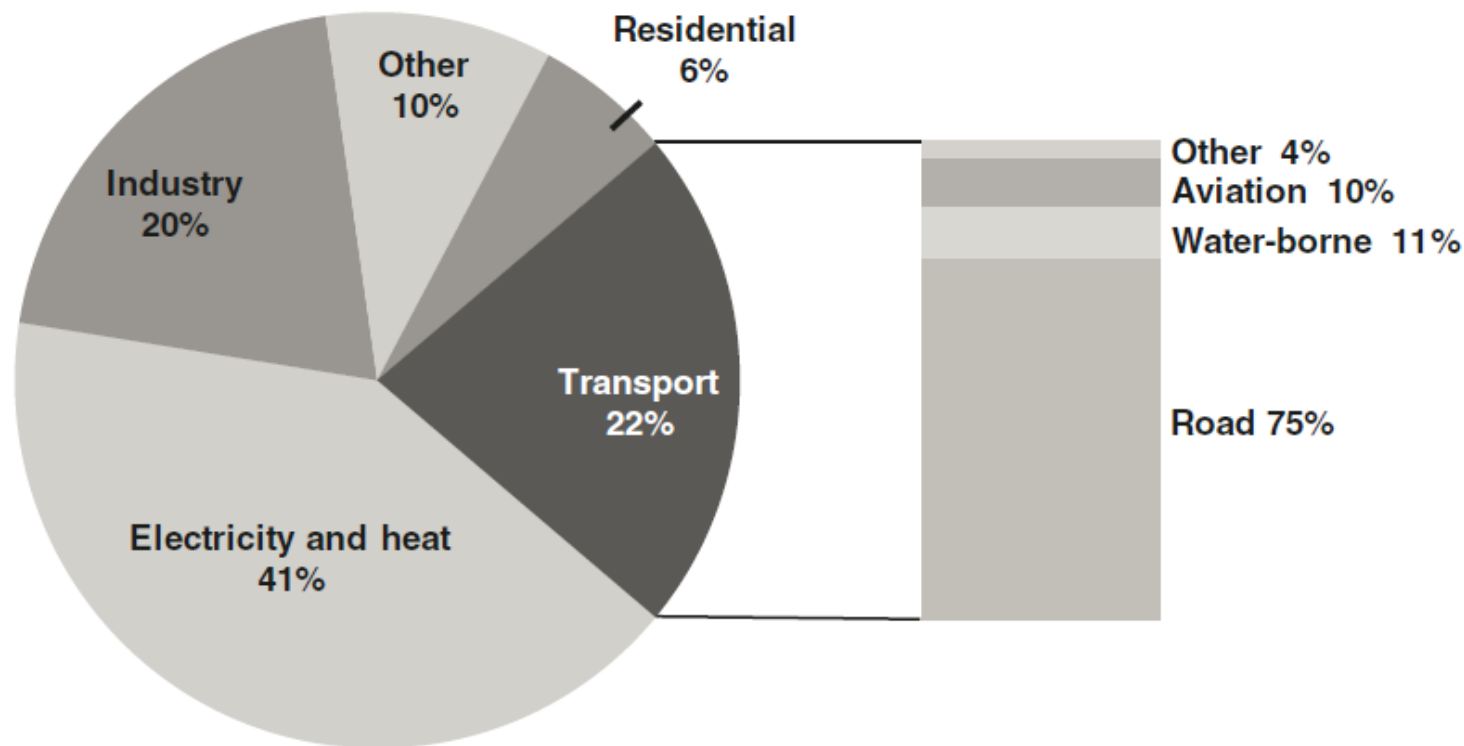
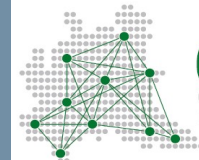


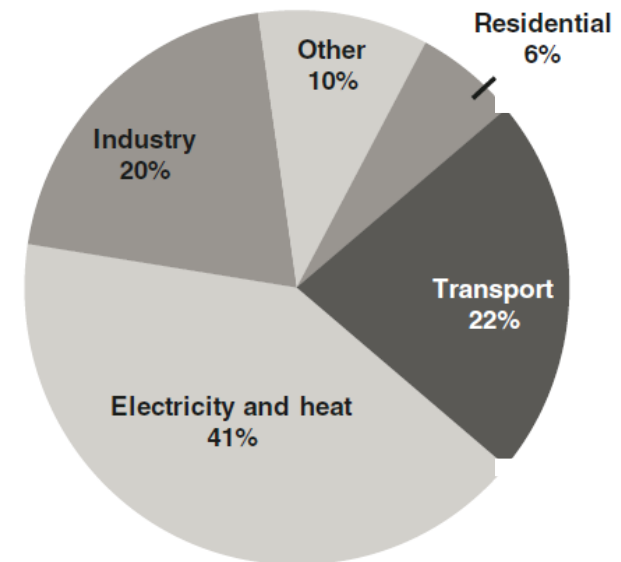
Fig. 1.2 Anthropogenic greenhouse gas emissions by sector in 2010 [data from IEA (2012)]

P. Egede, *Environmental Assessment of Lightweight Electric Vehicles*, Springer, 2017

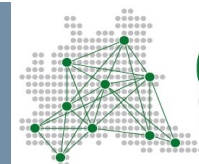


Electric Vehicles (EVs) justified by environment protection

- **Electric Vehicles (EVs) environmental impact**
 - during industry production
 - during electricity production

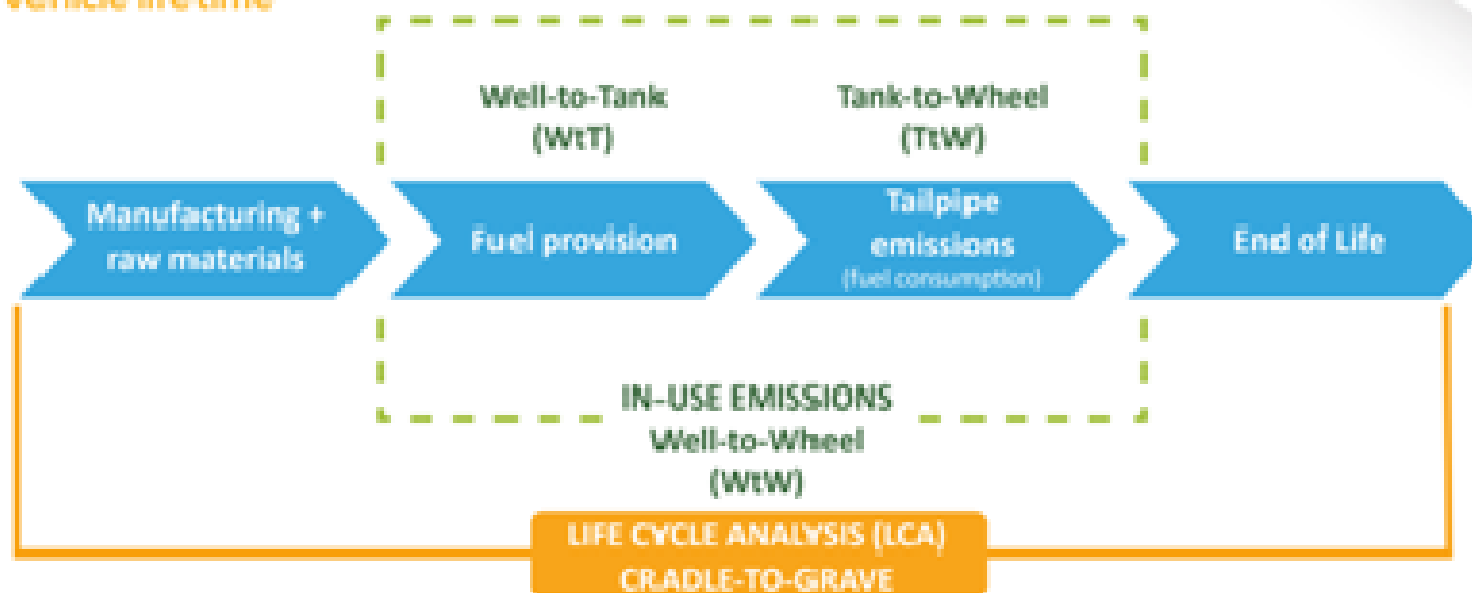


...HOW ASSESSING ENVIRONMENT PROTECTION SCIENTIFICALLY?

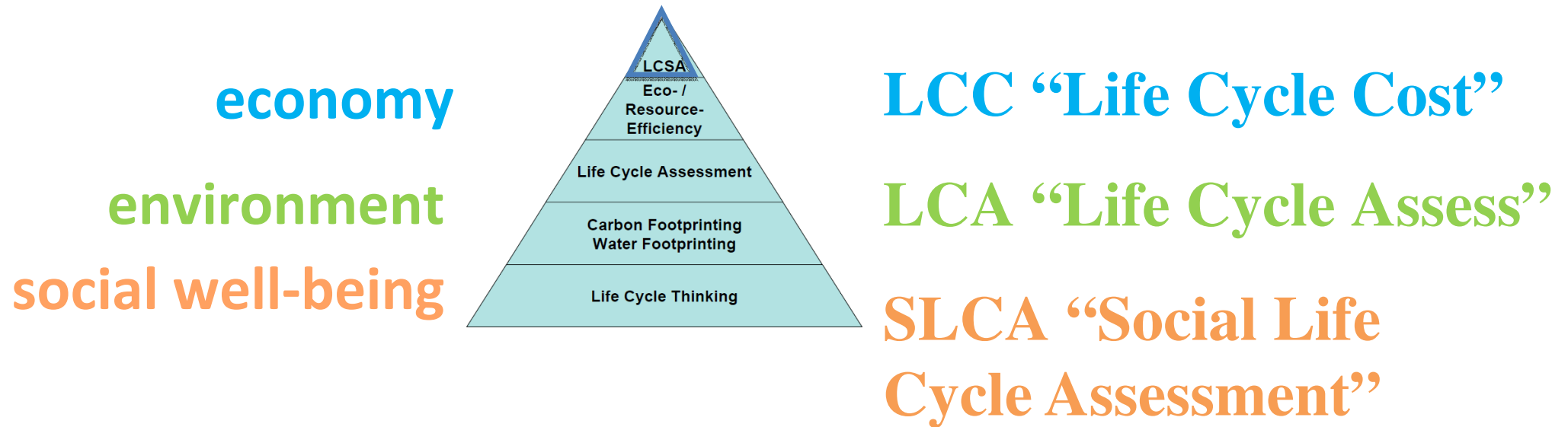


Well-to-wheel, cradle to grave

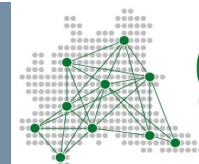
Greenhouse gas (GHG) emissions sources looking at the entire vehicle lifetime



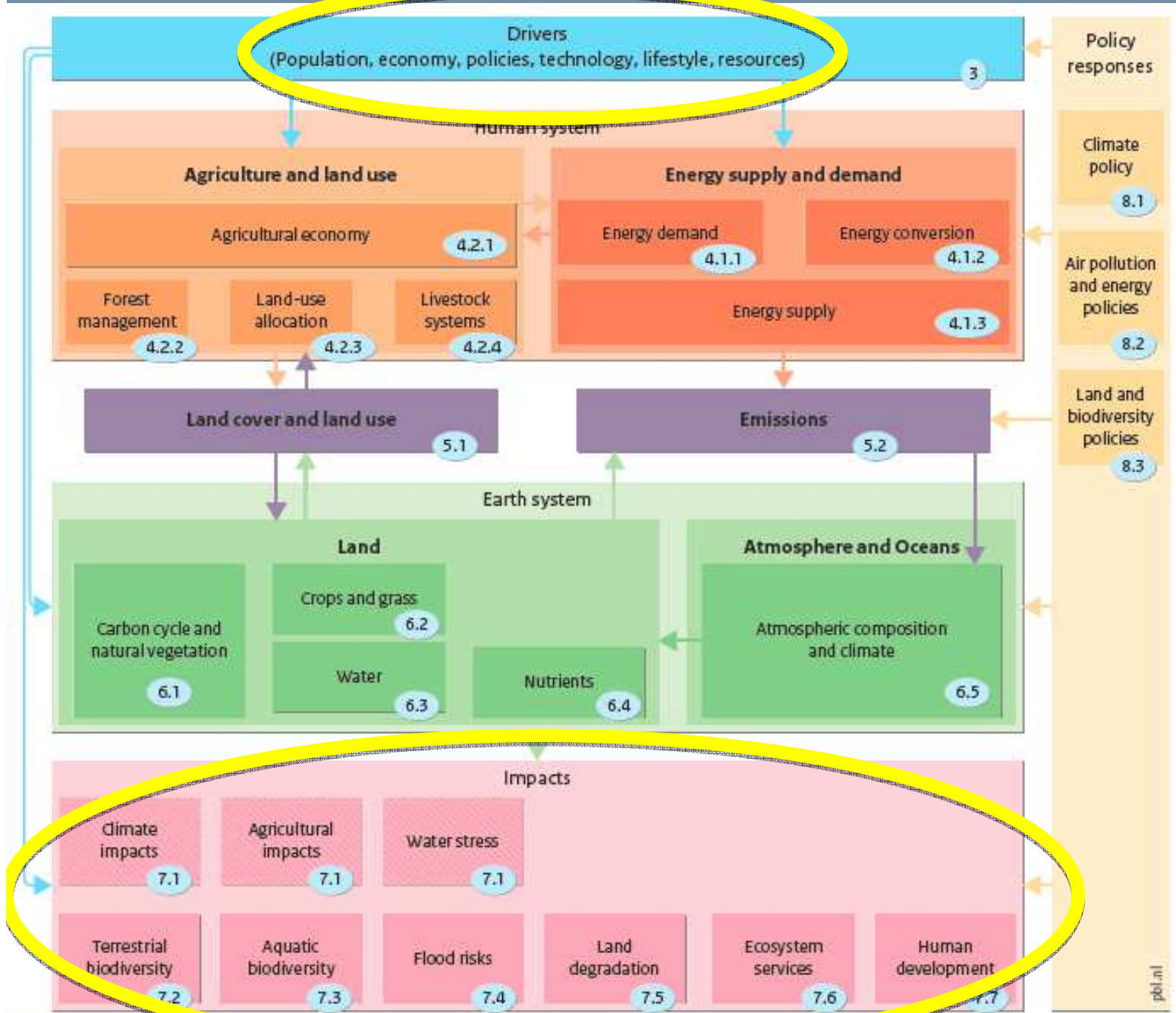
Life Cycle Sustainability Assessment



LCSA = LCC + LCA + SLCA
“Life Cycle Sustainability Assessment”



LCA - Scientific assessment of EVs environmental footprint

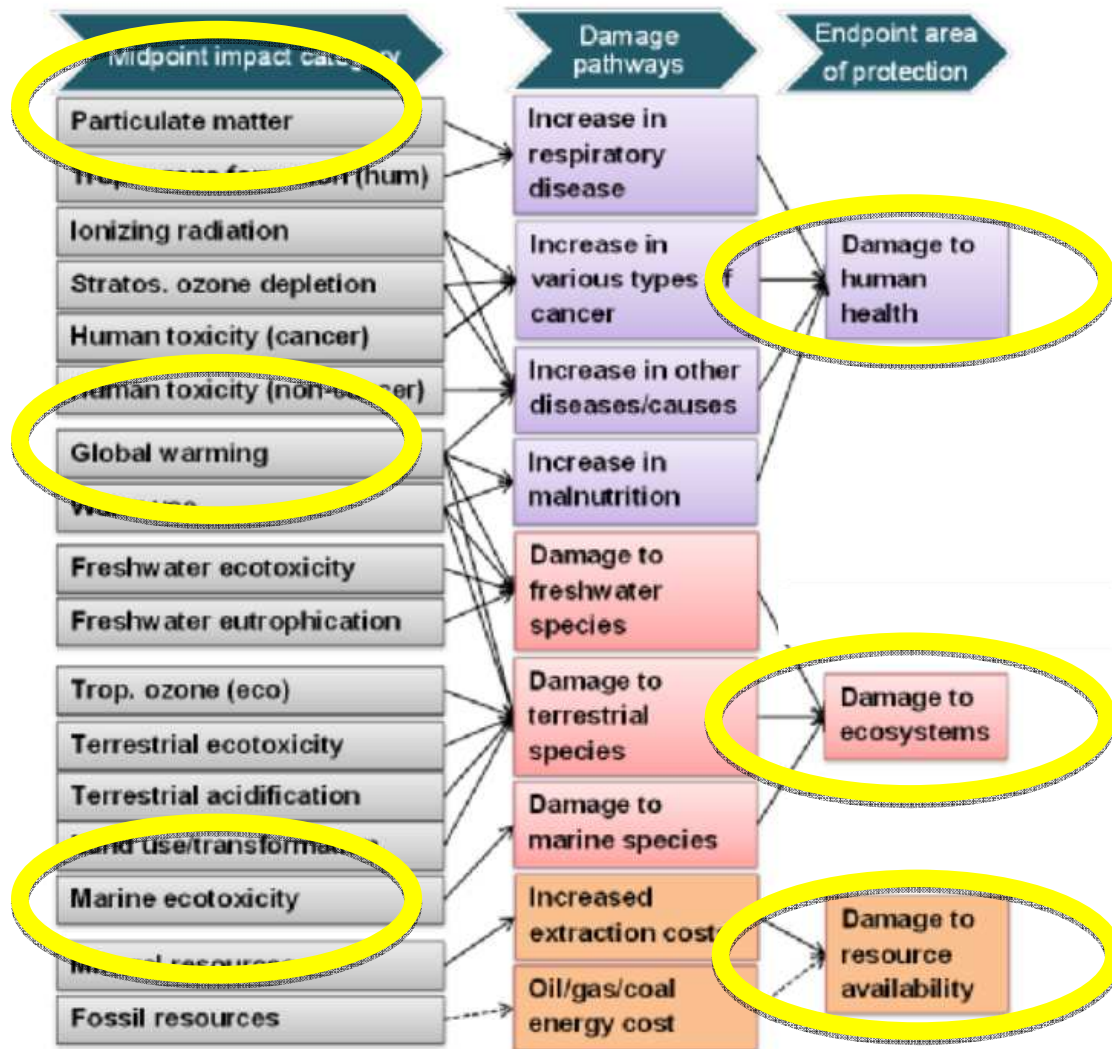


Netherlands
Environmental
Assessment Agency

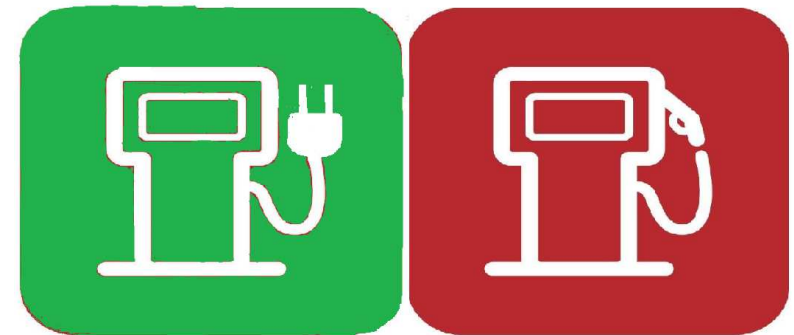
Integrated Model to Assess the Global Environment (IMAGE)

https://www.pbl.nl/sites/default/files/downloads/pbl-2014-integrated_assessment_of_global_environmental_change_with_image30_735.pdf

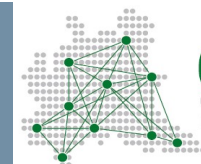
LCA - Scientific assessment of EVs environmental footprint: 17 indices for impact



ReCiPe (database)



National Institute for Public Health and the Environment
 Ministry of Health, Welfare and Sport
 The Netherlands



Scientific assessment of EVs environmental footprint: LIFE CYCLE ASSESSMENT (LCA)



ACEA

European
Automobile
Manufacturers
Association

1997



1998



2001



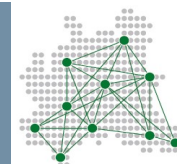
2011



2015



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Life Cycle Assessment: ISO and EU Commission

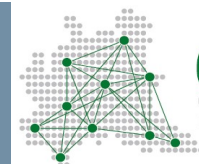


- ISO 14040:2006 Life cycle assessment—Principles and framework.
- ISO 14044:2006 Life cycle assessment—Requirements and guidelines.
- ISO/TR 14047:2012 Life cycle assessment—Illustrative examples on how to apply ISO 14044 to impact assessment situations.
- ISO/TS 14048:2002 Life cycle assessment—Data documentation format.
- ISO/TR 14049:2012 Life cycle assessment—Illustrative examples on how to apply ISO 14044 to goal and scope definition and inventory analysis.



- **International reference Life Cycle Data system ILCD by IRC – EU Commission**

<https://eplca.jrc.ec.europa.eu/ilcd.html>



Life Cycle Assessment: EVs vs ICEV (gasoline)

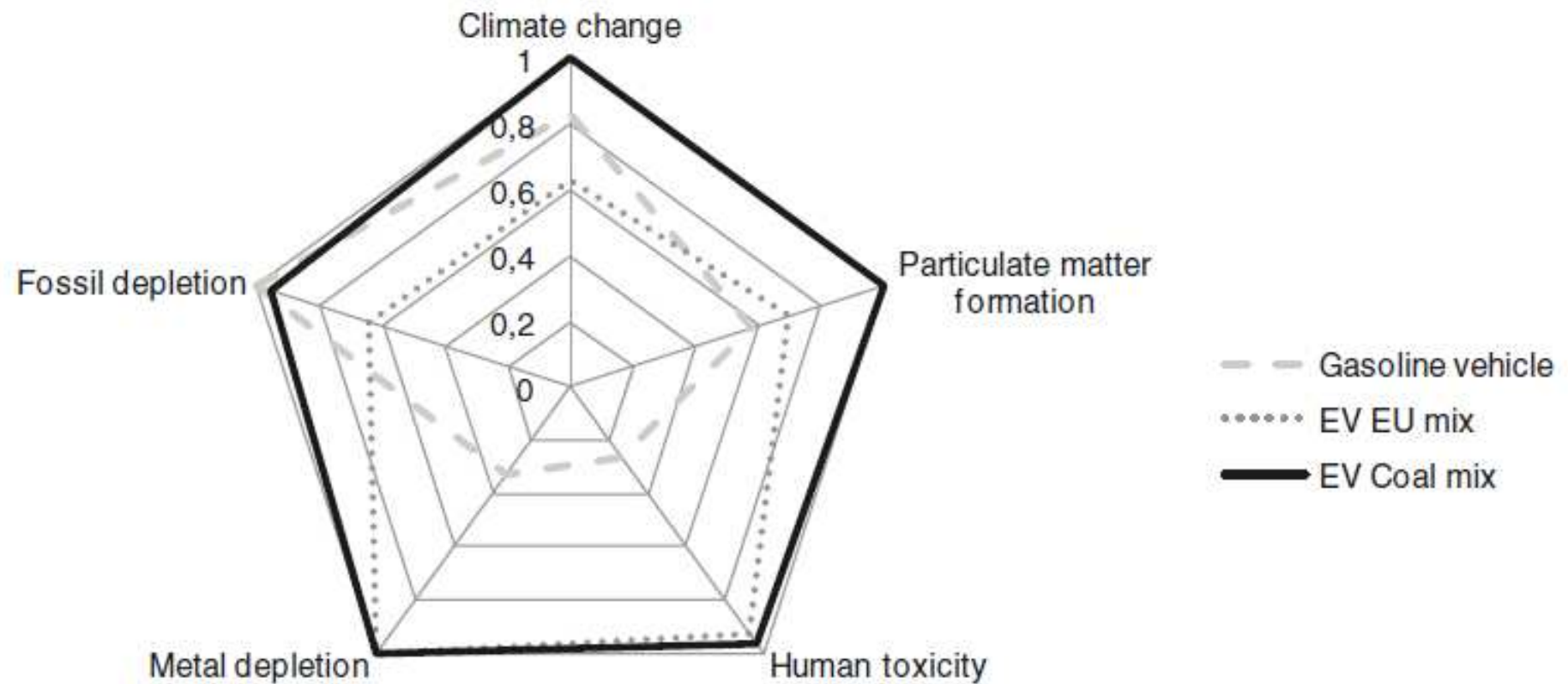


Fig. 4.13 Radar chart for the comparison of vehicles in five different impact categories; values taken from Hawkins et al. (2013)



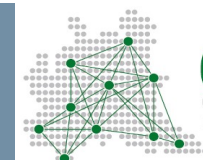
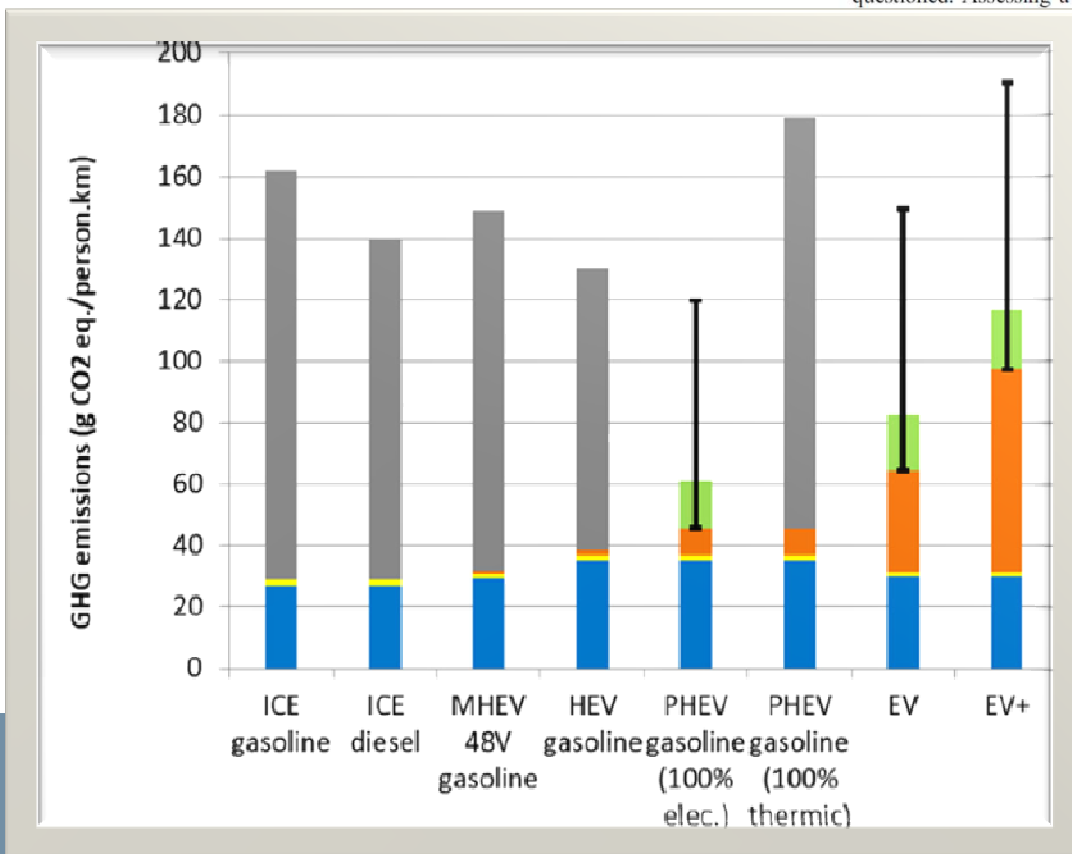
Comparative environmental life cycle assessment of several powertrain types for cars and buses in France for two driving cycles: “worldwide harmonized light vehicle test procedure” cycle and urban cycle

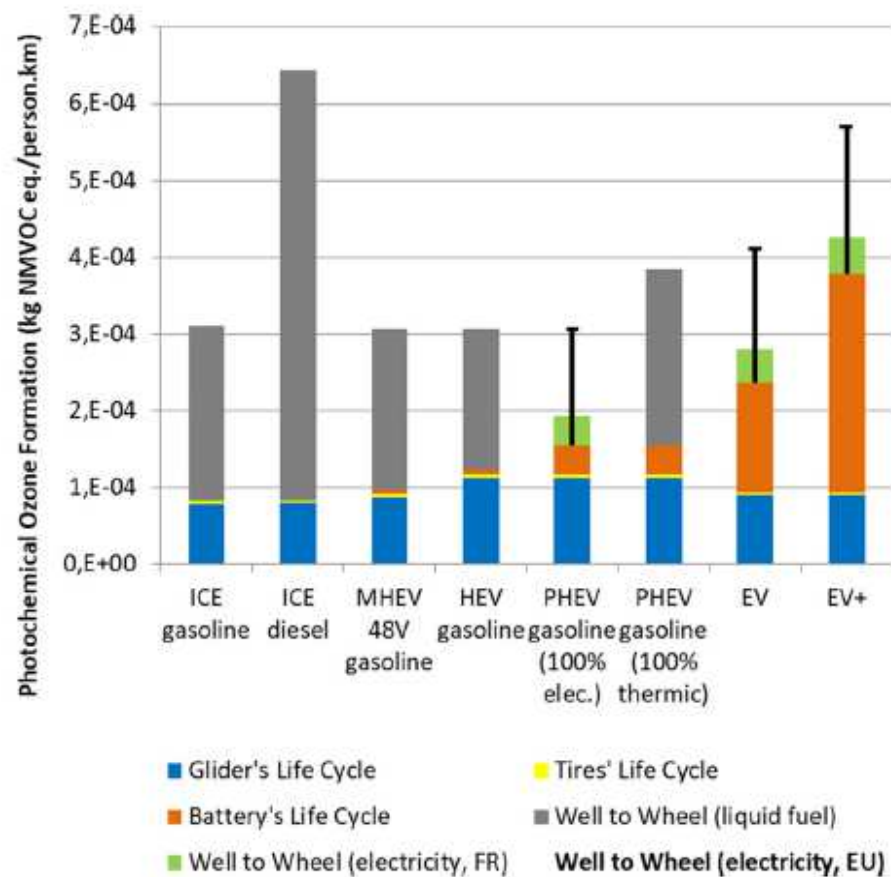
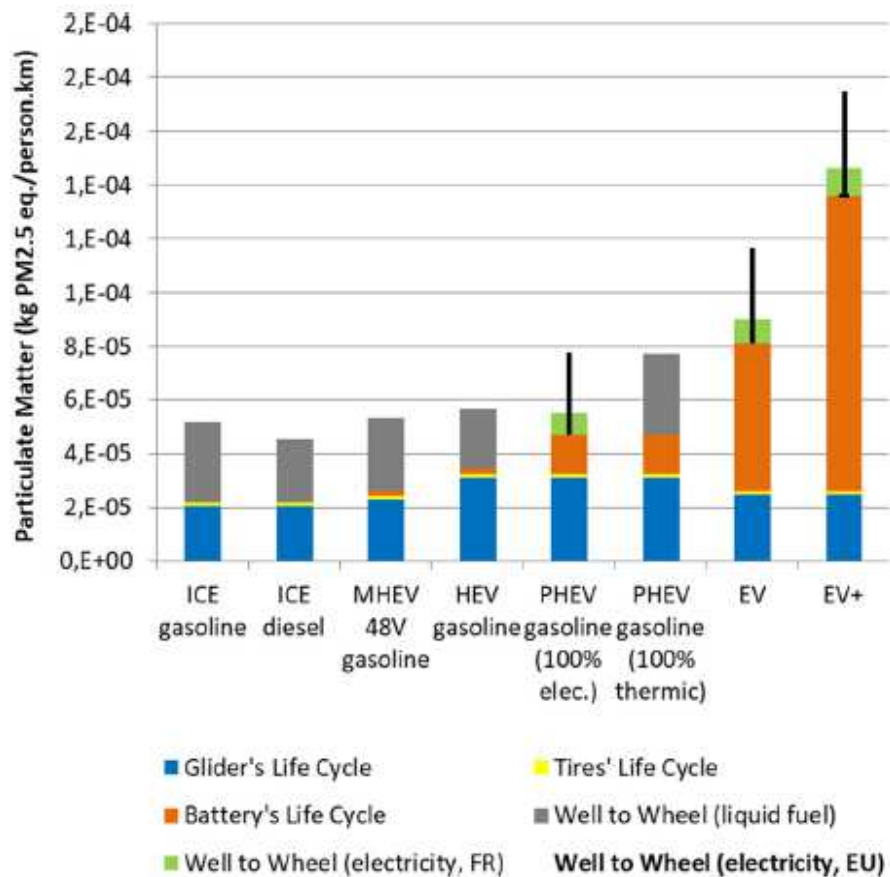
Anne Bouter¹ · Emmanuel Hache^{1,2} · Cyprien Ternel¹ · Sandra Beauchet¹

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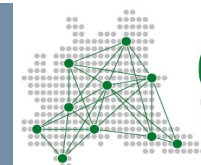
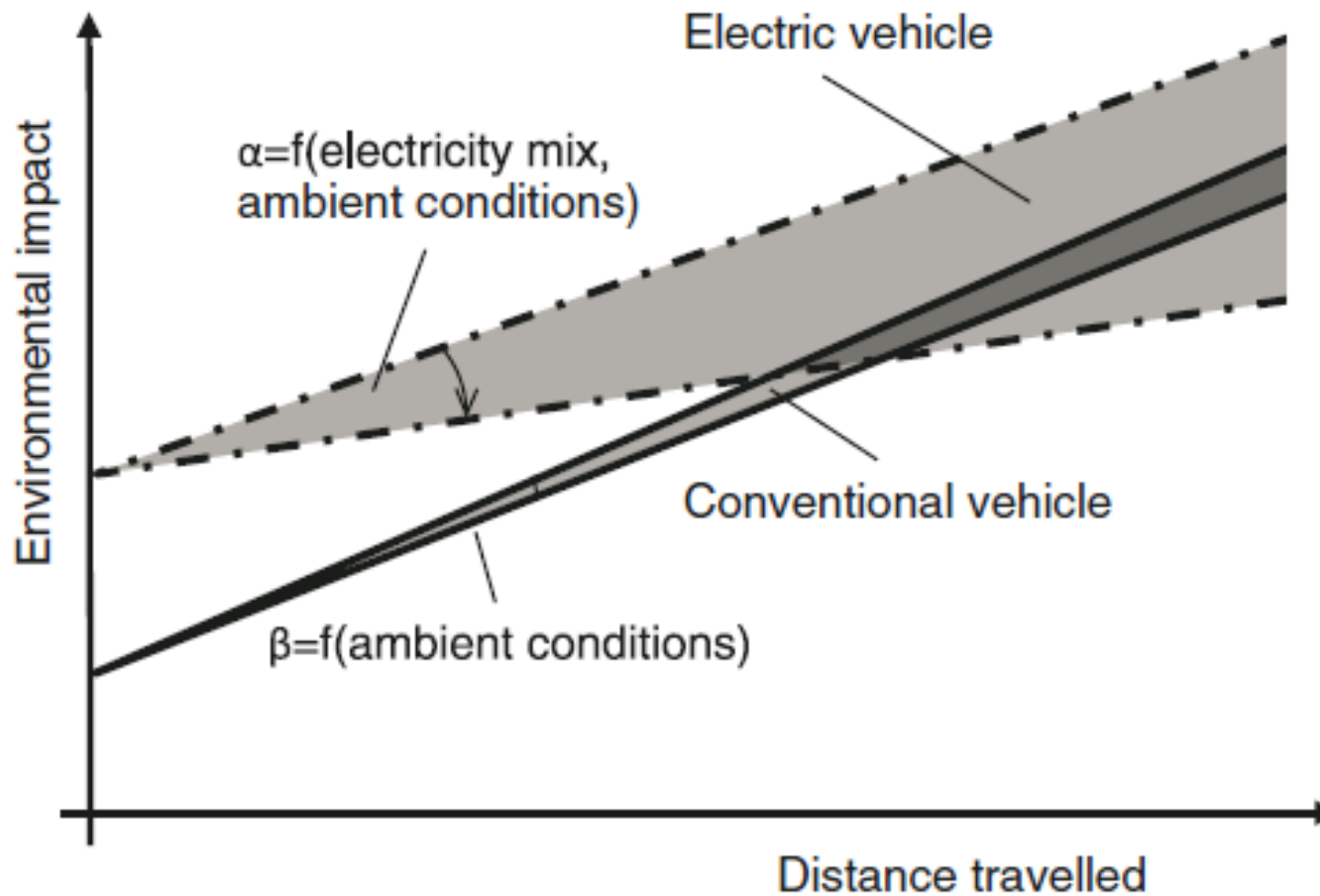
Abstract

Purpose Environmental assessments in the transportation sector are often lacking in transparency and completeness. In this article, the environmental trade-offs in road passenger transportation between conventional vehicles and electrified vehicles are compared, using life cycle assessment (LCA) methodology. Hence, the relevance of a massive electrification approach can be questioned. Assessing a set of current midsize passenger cars and buses allows for investigation of potential environmental

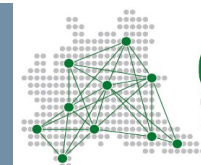
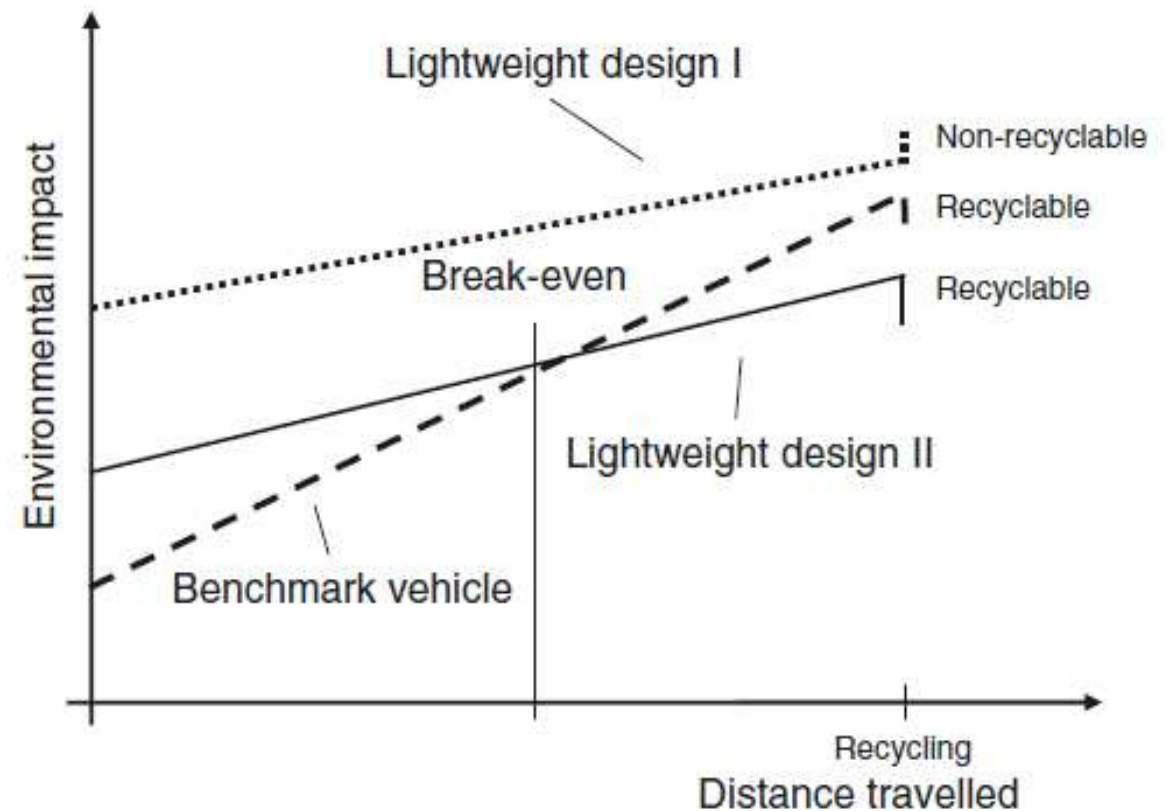
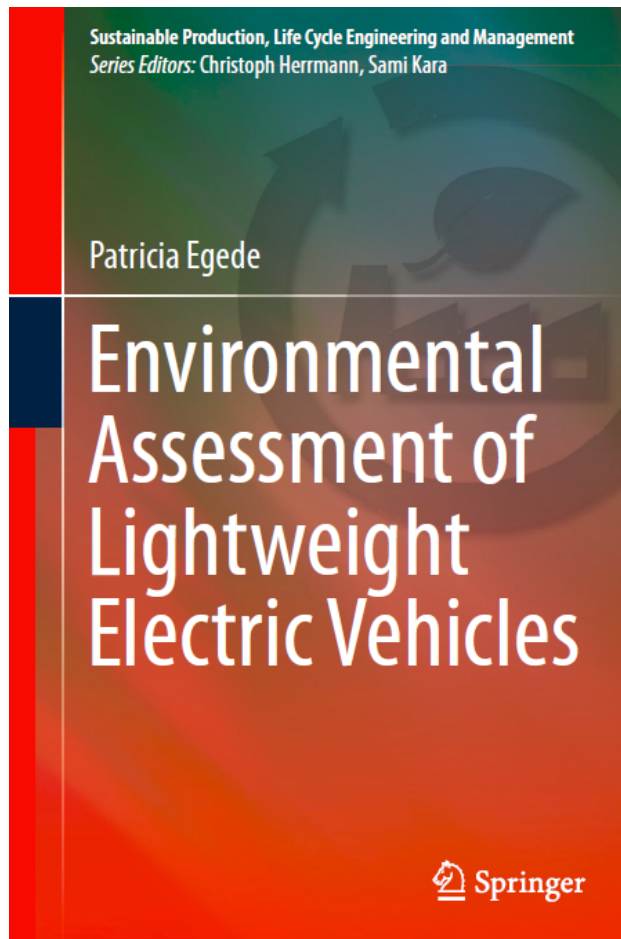




Life Cycle Assessment: EVs vs ICEV

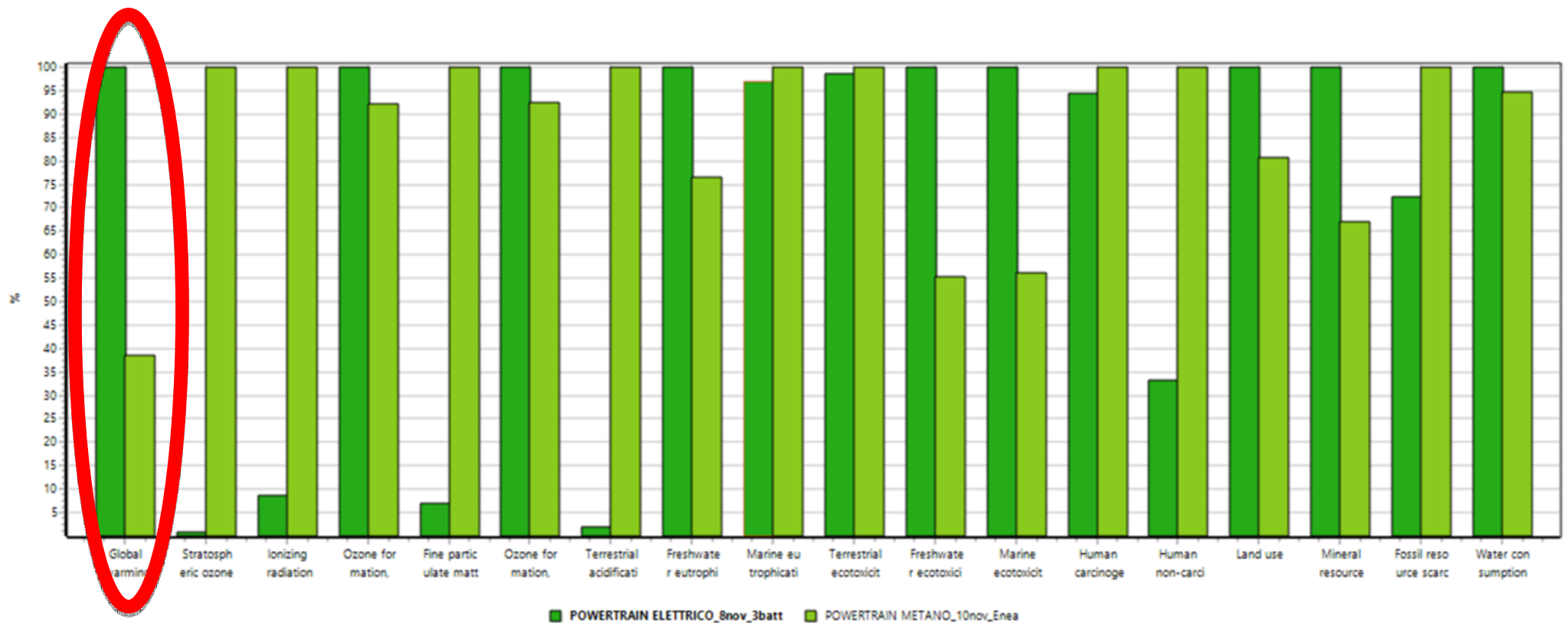


The problem of Lightweight Electric Vehicle

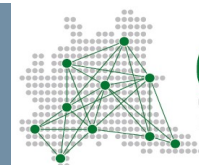


Alternative fuels: biomethane

Electric bus vs Biomethane fuelled bus



Confronto di 1 p 'POWERTRAIN ELETTRICO_8nov_3batt' con 1 p 'POWERTRAIN METANO_10nov_Enea': Metodo: ReCiPe 2016 Midpoint (H) V1.03 / World (2010) H / Caratterizzazione



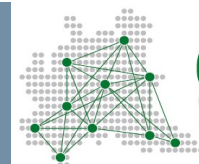
Geopolitical problems



- Much of the rare earths (Nd, Sm..) under monopole
- Massive battery production



- NL: from 2030 no more IC engines sold



Conclusion

- **Evs or HEVs will surely penetrate the market, delay due to industry processes**
- **Scientific assessment of EVs performance is made by Life Cycle Assessment which is a cumbersome process**
- **Lightweight Electric Vehicle should be designed very wisely**
- **Biomethane good for GHG, Italy very strong globally**
- **Geopolitical problems to be faced possibly in the future**

