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Rethinking Propulsion.

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A3PS

JOANNEUM RESEARCH Forschungsgesellschaft mbH

Environmental Assessment of Different Vehicle Concepts

Gerfried Jungmeier, Kurt Könighofer, Martin Beermann, Canella Lorenza, Johanna Pucker

A3PS Conference 2010, Vienna, November 19-20, 2010

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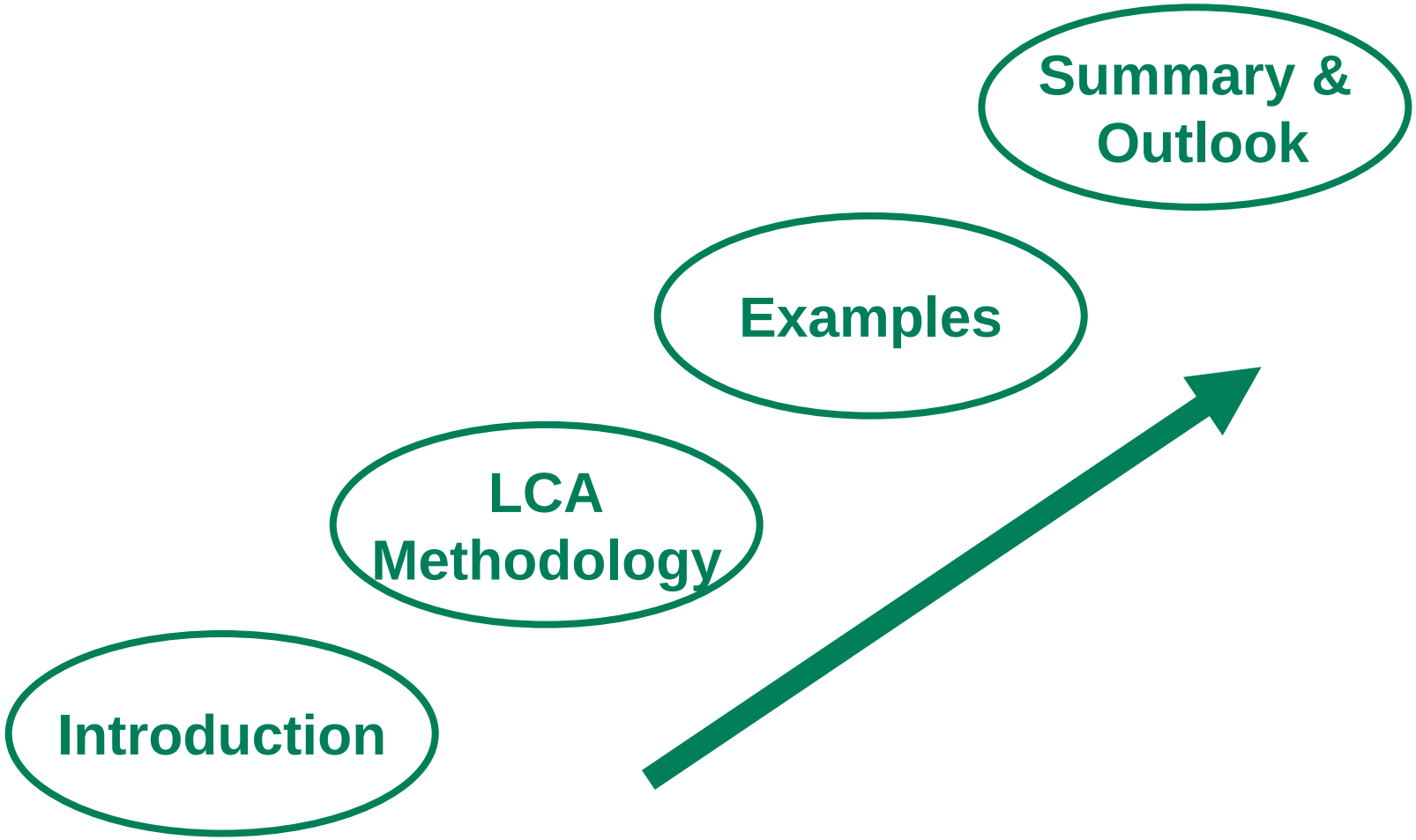
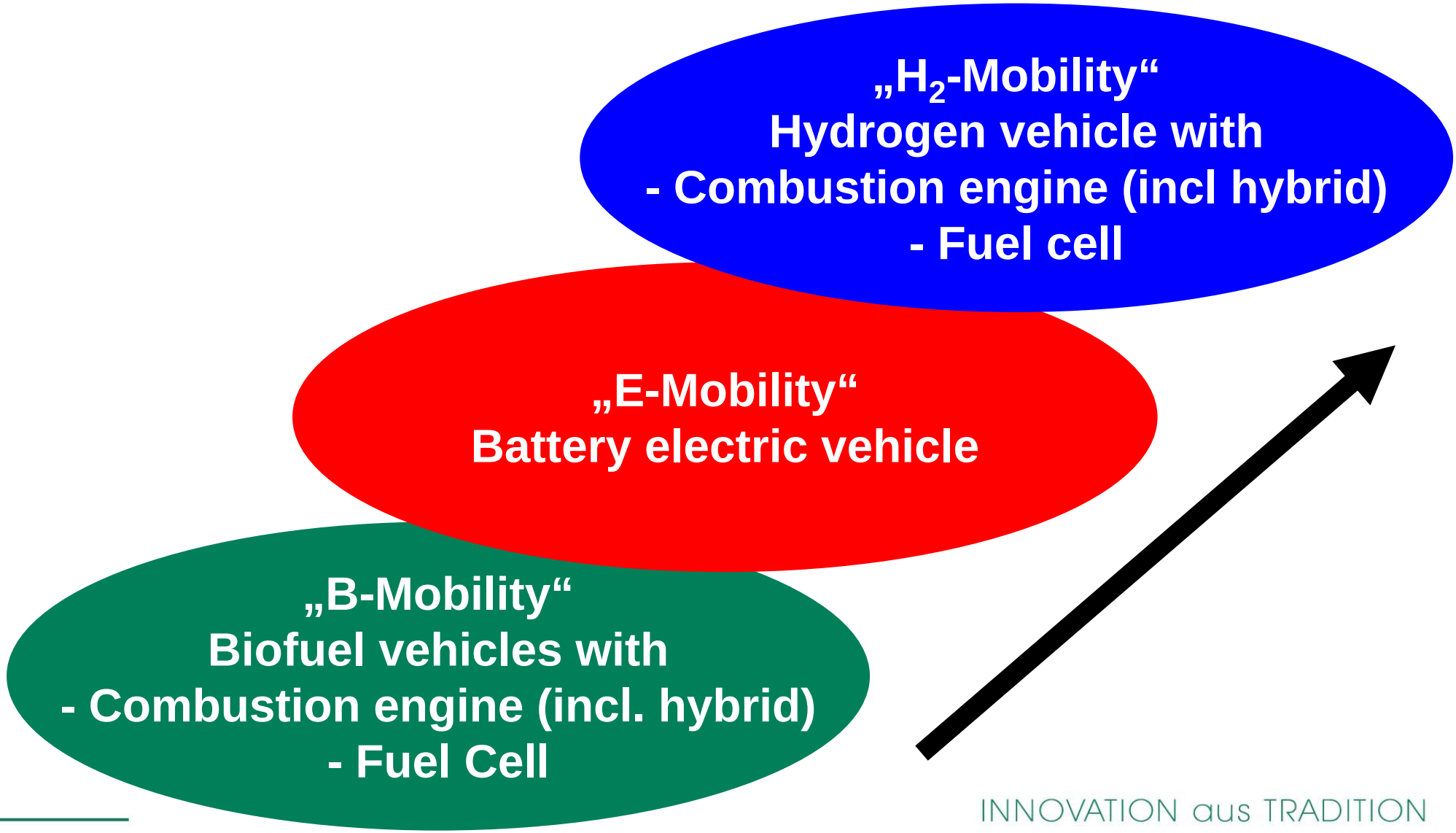


The Future Options for Renewable Transportation Fuels



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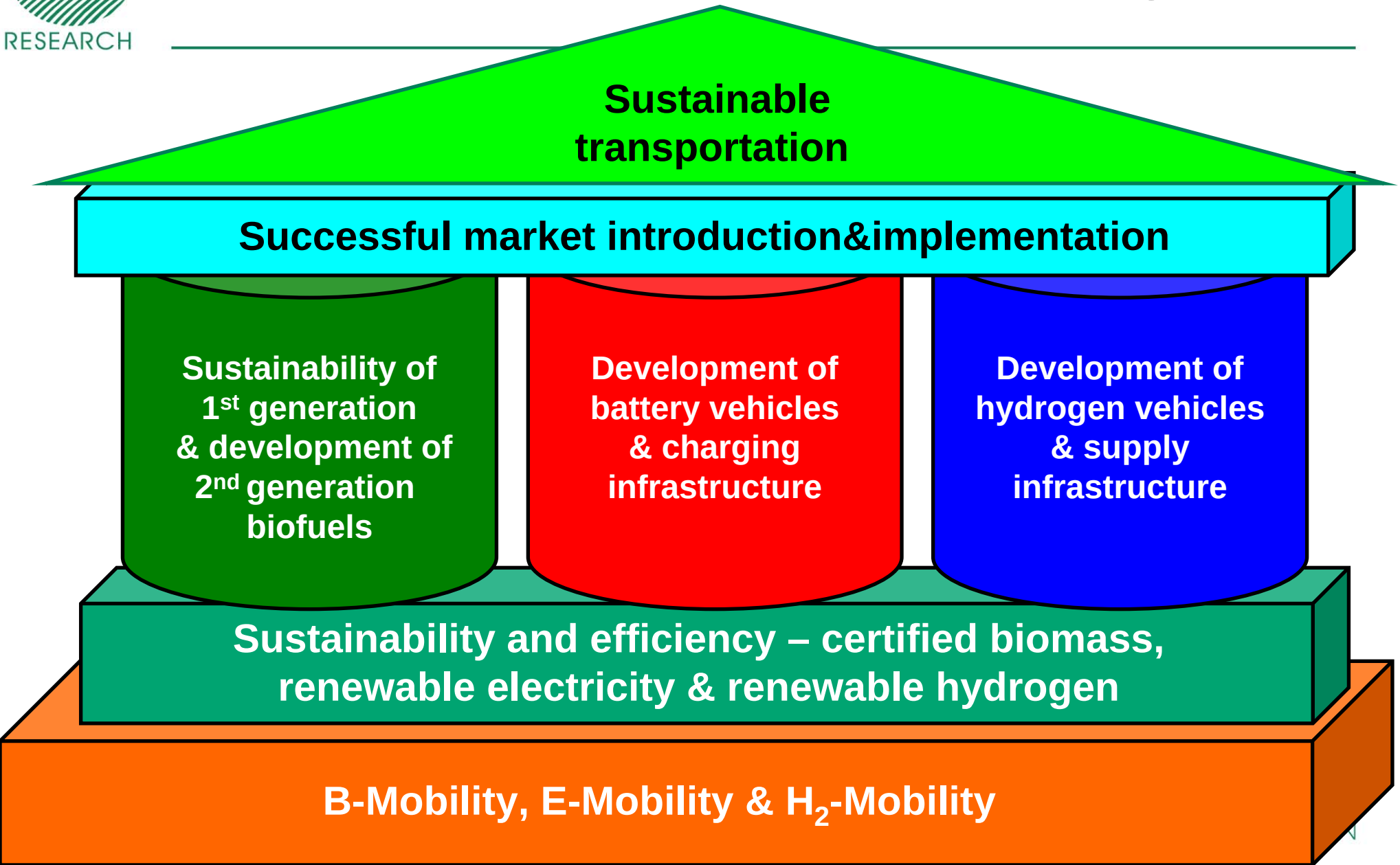
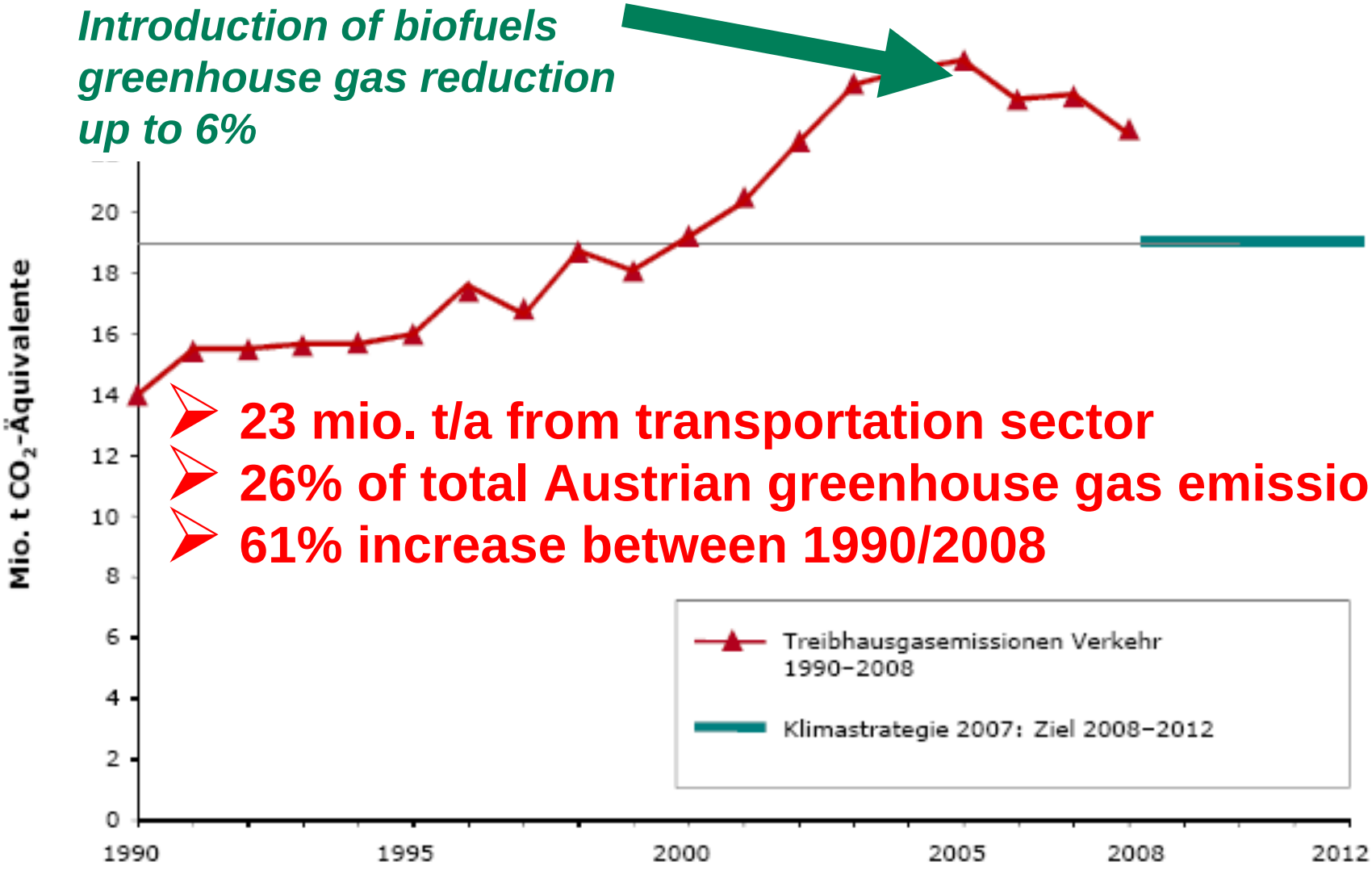
The Challenges



Key Figures I of Austria Transportation Sector

Introduction of biofuels greenhouse gas reduction up to 6%

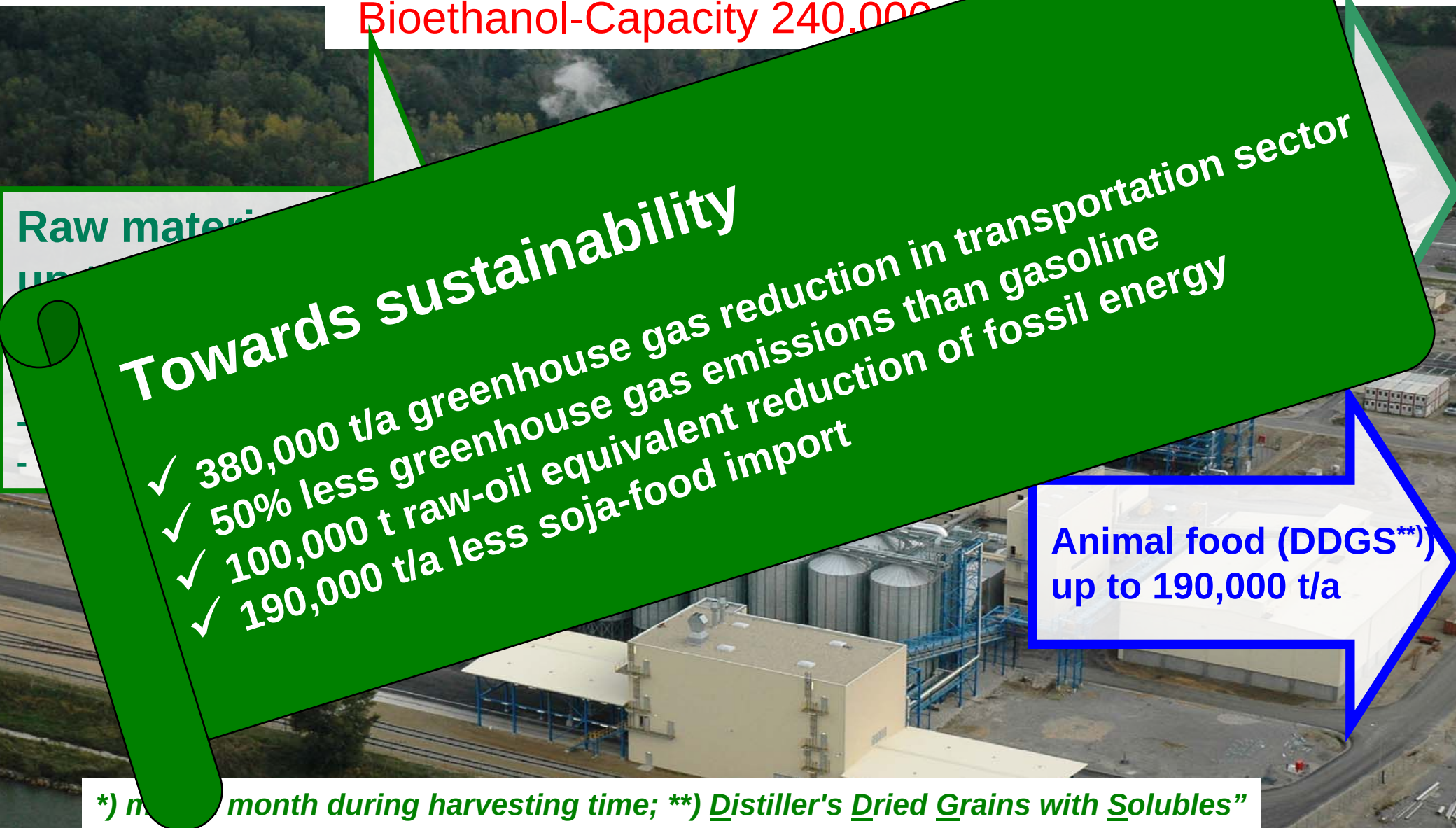


- **23 mio. t/a from transportation sector**
- **26% of total Austrian greenhouse gas emissions**
- **61% increase between 1990/2008**

Quellen: Umweltbundesamt (2010), Lebensministerium (2007)

The AGRANA Bioethanol-Plant Pischelsdorf / Austria

Bioethanol-Capacity 240,000



Raw materi
up
-
-

Towards sustainability

- ✓ 380,000 t/a greenhouse gas reduction in transportation sector
- ✓ 50% less greenhouse gas emissions than gasoline
- ✓ 100,000 t raw-oil equivalent reduction of fossil energy
- ✓ 190,000 t/a less soja-food import

Animal food (DDGS)**
up to 190,000 t/a

**) m month during harvesting time; **) Distiller's Dried Grains with Solubles"*

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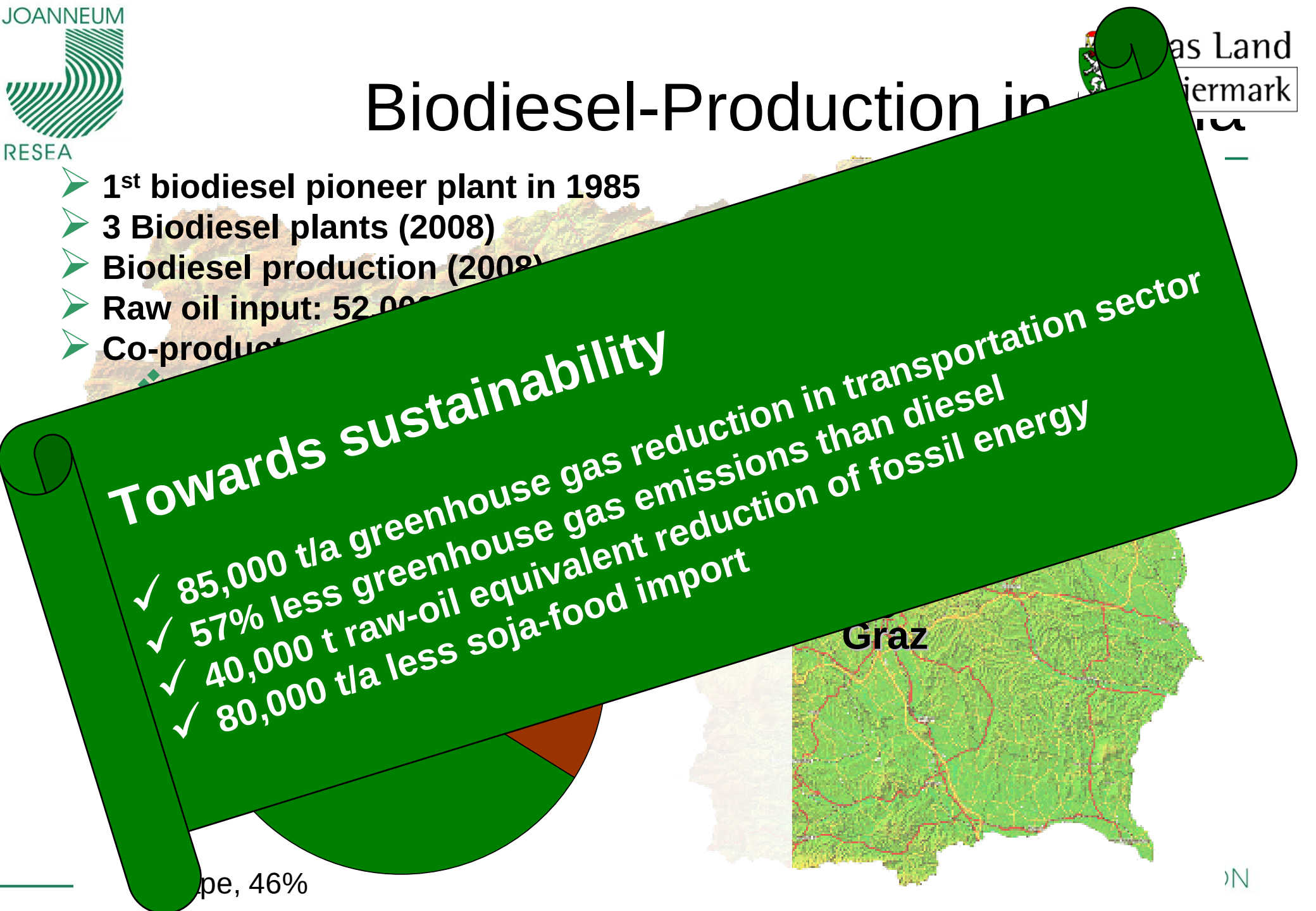
Biodiesel-Production in

- 1st biodiesel pioneer plant in 1985
- 3 Biodiesel plants (2008)
- Biodiesel production (2008)
- Raw oil input: 52.00
- Co-product

Towards sustainability

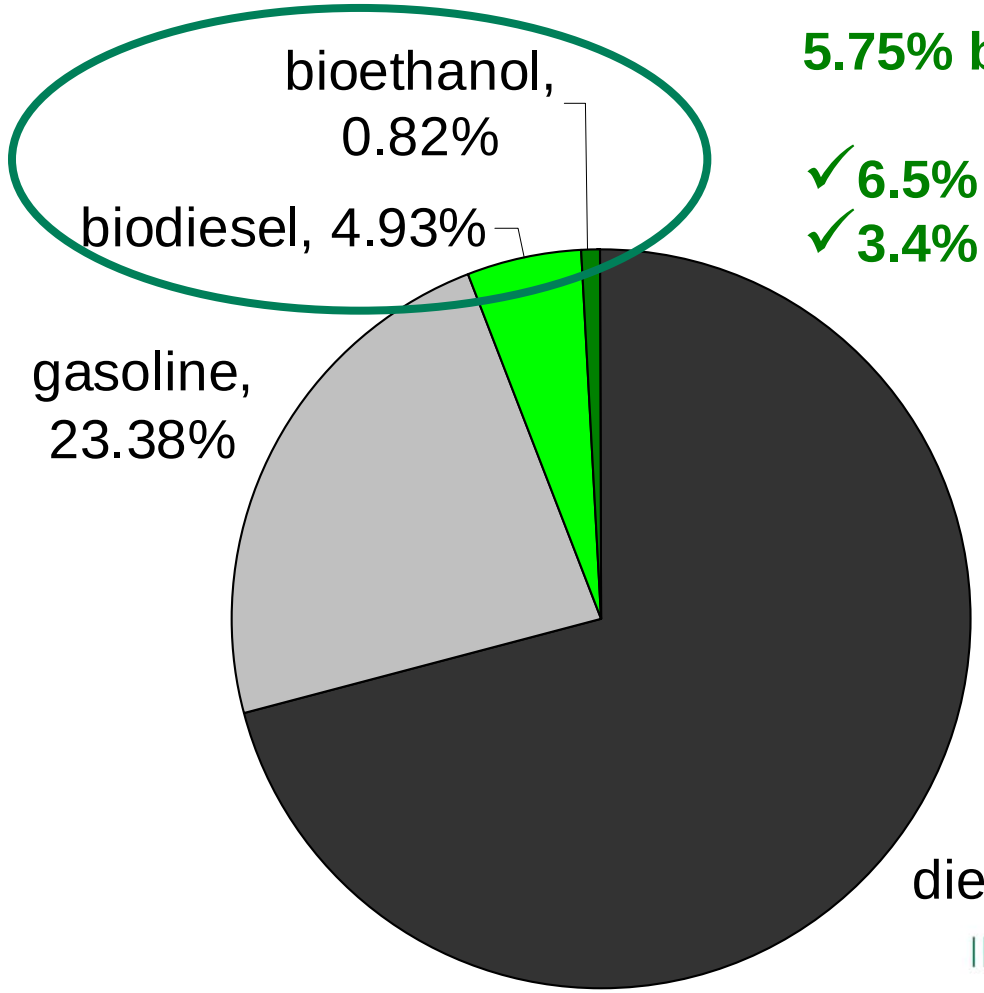
- ✓ 85,000 t/a greenhouse gas reduction in transportation sector
- ✓ 57% less greenhouse gas emissions than diesel
- ✓ 40,000 t raw-oil equivalent reduction of fossil energy
- ✓ 80,000 t/a less soja-food import



pe, 46%

Key Figures II of Austria Transportation Sector

Transportation fuel consumption 2008: 350 PJ/a
(domestic passenger cars: 135 PJ/a)



5.75% biofuels via blending of

- ✓**6.5% biodiesel to diesel**
- ✓**3.4% bioethanol to gasoline**

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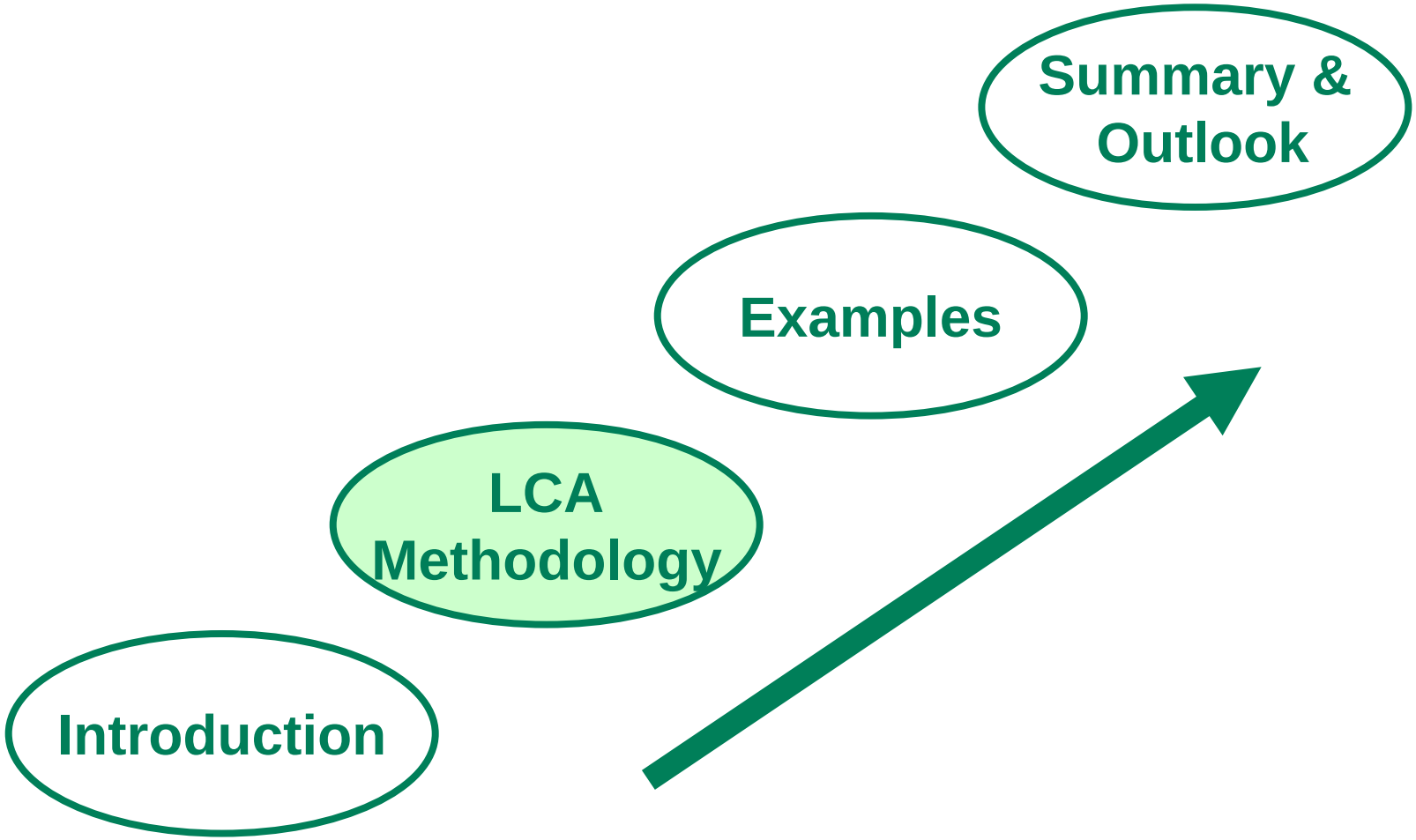

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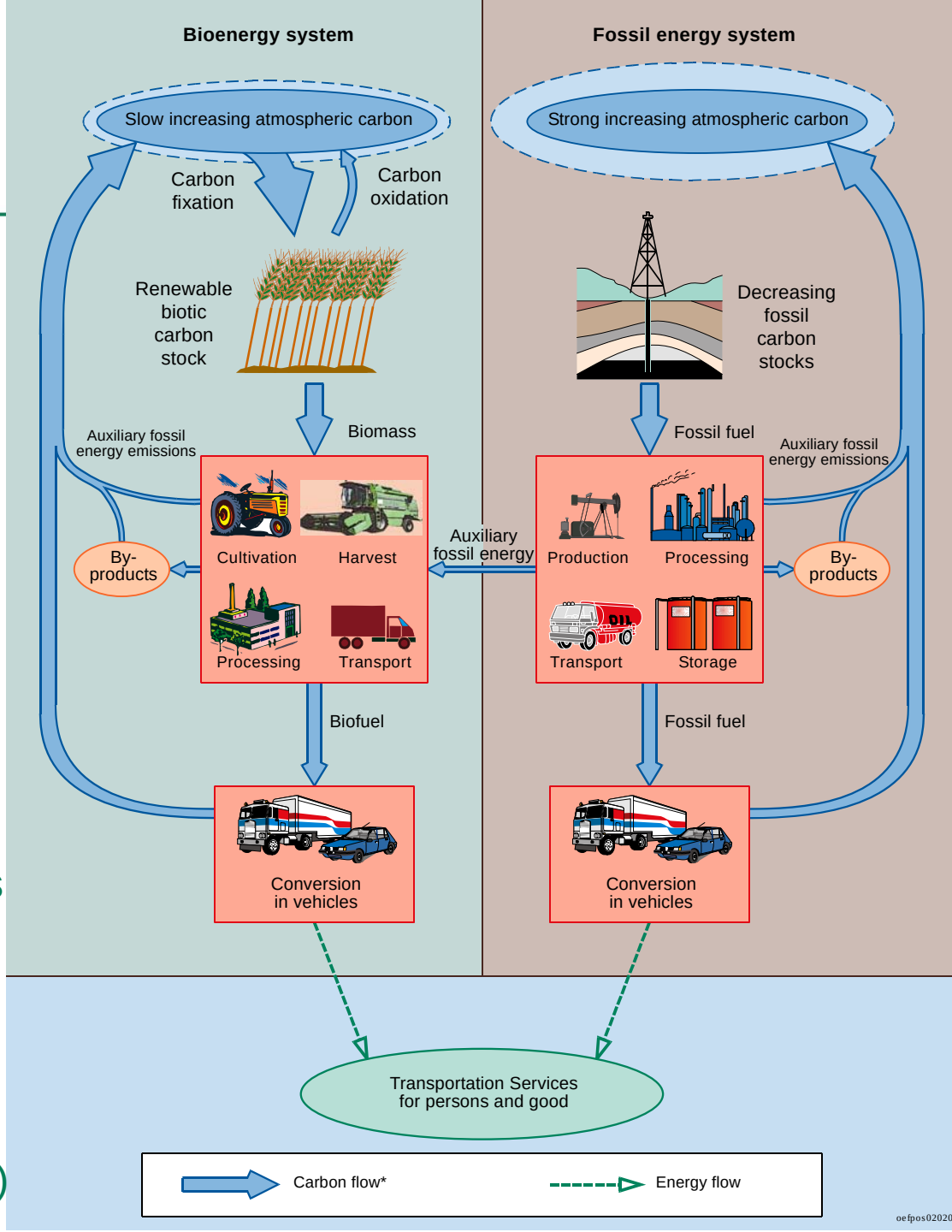
Life Cycle Assessment

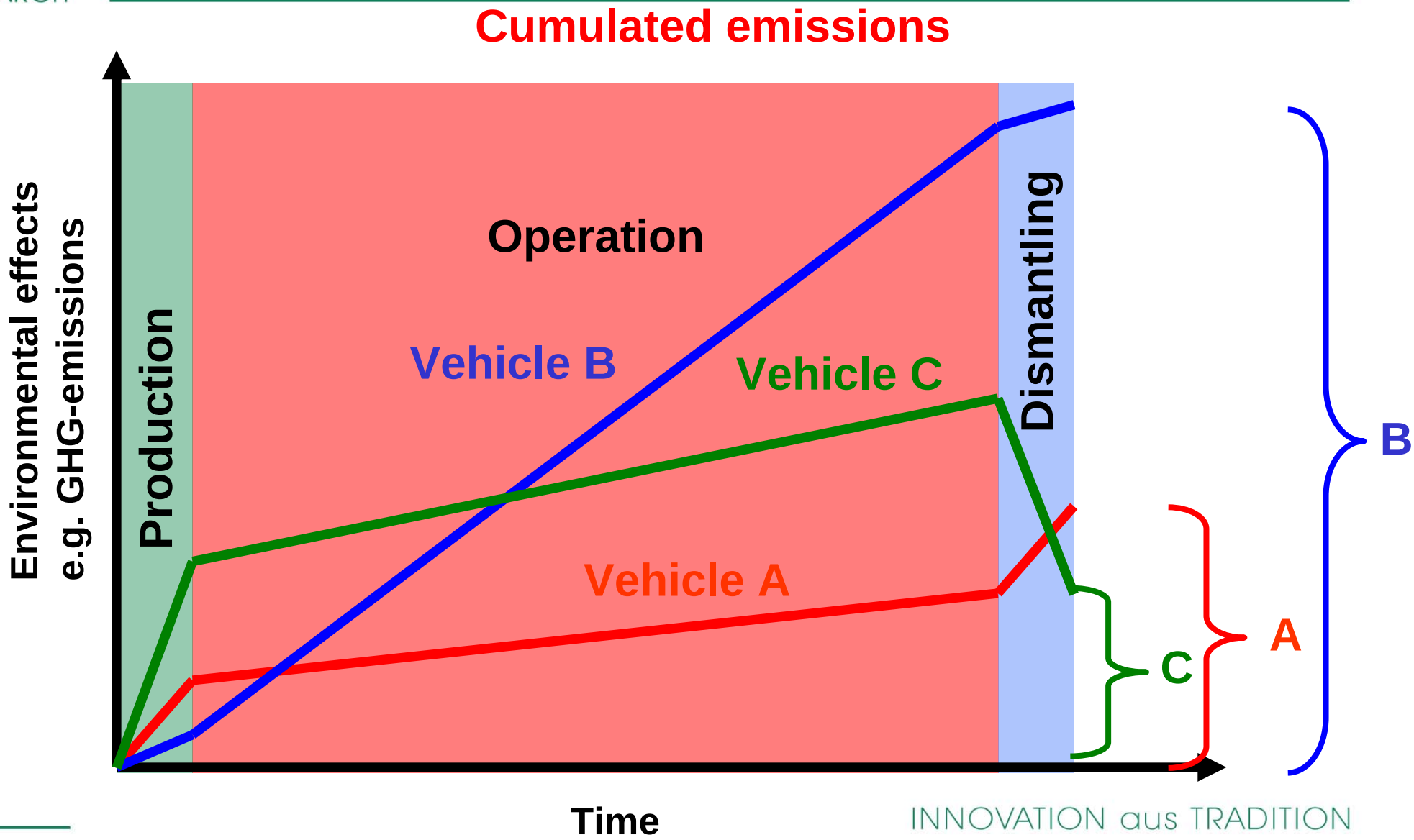
Life Cycle Assessment *(LCA) is a method to estimate the material and energy flows of a product (e.g. transportation) to calculate the environmental effects in the total lifetime of the product „from cradle to grave“*

Methodology according to

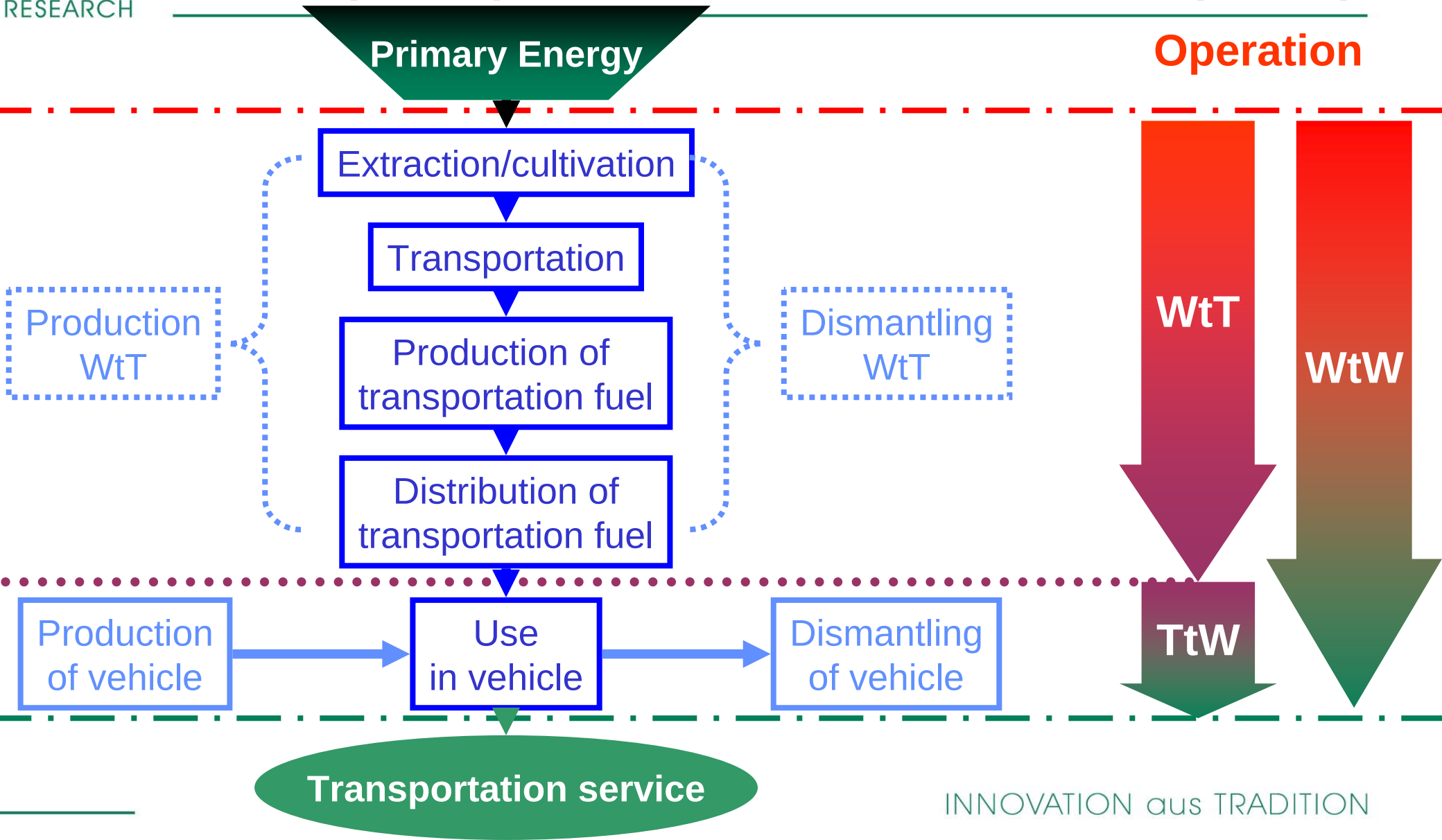
- ✓ ISO 14,040 „Life Cycle Assessment“
- ✓ Standard Methodology of IEA Bioenergy Task 38 „Greenhouse Gas Balances of Bioenergy Systems“
- ✓ JRC/CONCAWE/EUCAR: Well-to-Wheels analysis of future automotive fuels and powertrains in the European context
- ✓ EU-Directive on Renewable Energy (RED)



The three Phases in the Life Cycle of A Vehicle



Well to Wheel (WtW) = Well to Tank (WtT) and Tank to Wheel (TtW)



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Main Environmental Contributions

	3 phase in LCA	„F-Mobility“ Gasoline, diesel, CNG, ice/hybrid)	„B-Mobility“ Biofuels, ice/hybrid	„E-Mobility“ Battery vehicles	„H_2-Mobility“ Hydrogen fuel cell
Well to Tank (WtT)	Operation	++	+++	+++	+++
	Production	+	+	++	++
	Dismantling	+	+	+	+
Tank to Wheel (TtW)	Operation	+++	++	+	+
	Production	+	+	++	+++
	Dismantling	+	+	++	++
Well to Wheel (WtW)	Operation	+++	+++	+++	+++
	Production	+	+	++	+++
	Dismantling	+	+	++	++

environmental relevance: +…..low, ++…..medium, +++…..high

Based on more than 15 years of LCA experience at Joanneum Research

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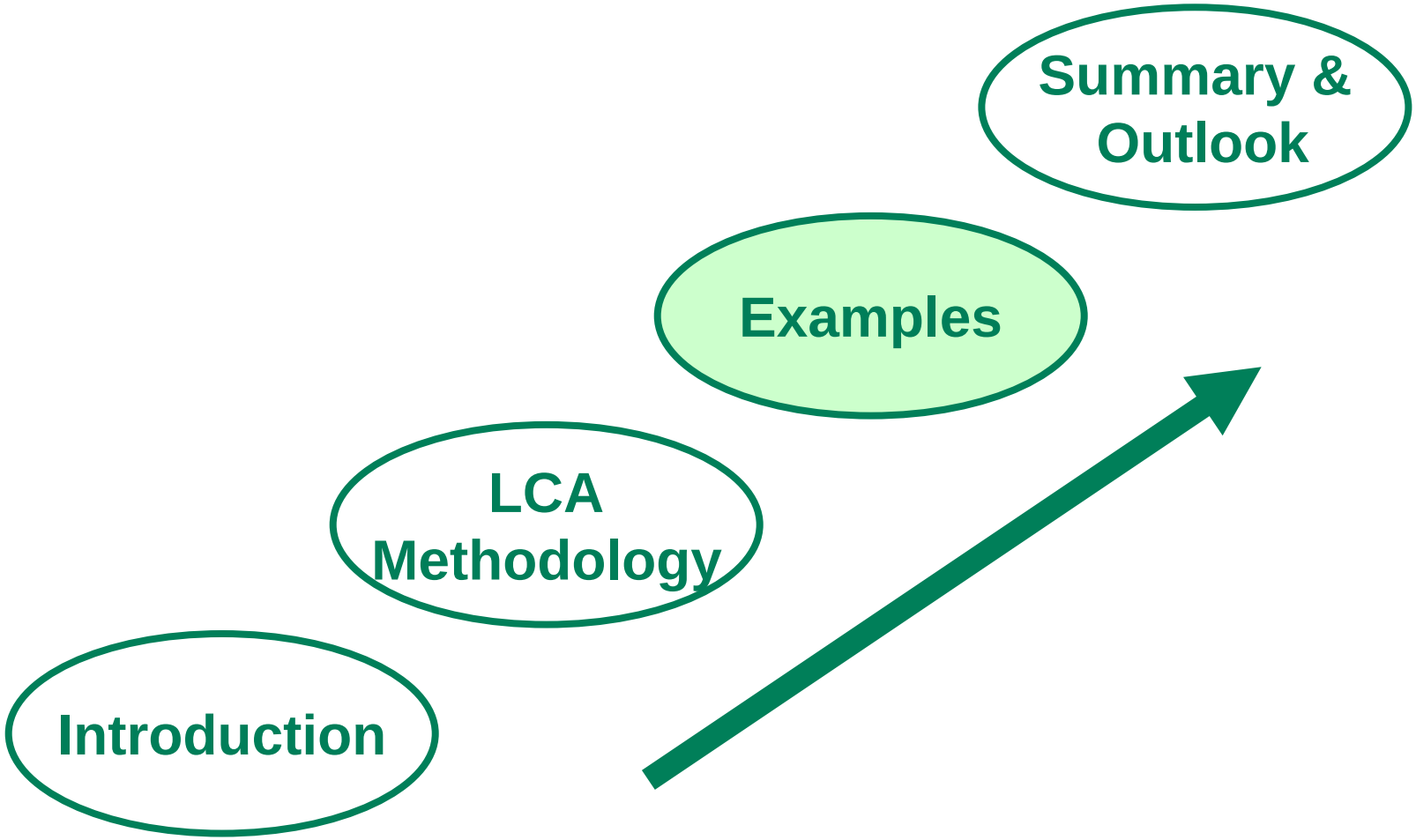


394 Combinations of Vehicle, Fuel and Propulsion System (I)

6 Propulsion systems:

1. Internal combustion engine (ICE)
2. Micro hybrid
3. Mild hybrid
4. Full hybrid
5. Electric engine with battery
6. Fuel cell

3 Vehicle sizes:

1. Small passenger car
2. Medium sized passenger car
3. Big/high class passenger car

2 States of technology:

1. 2010
2. 2050

Based on

***ELEKTRA** - Entwicklung von Szenarien der Verbreitung von PKW mit teil- und voll-elektrifiziertem Antriebsstrang unter verschiedenen politischen Rahmenbedingungen, TU-Wien, Joanneum, AVL, 2009*

Project partners:

Financed by

394 Combinations of Vehicle, Fuel and Propulsion System (II)

7 Electricity:
1. Hydro power
2. Wind
3. PV
4. Wood chips
5. Short rotation forestry
6. Natural gas
7. Austrian grid mix (2008)

7 Hydrogen:
1. Hydro power
2. Wind
3. PV
4. Biogas
5. Wood chips
6. Short rotation forestry
7. Natural gas

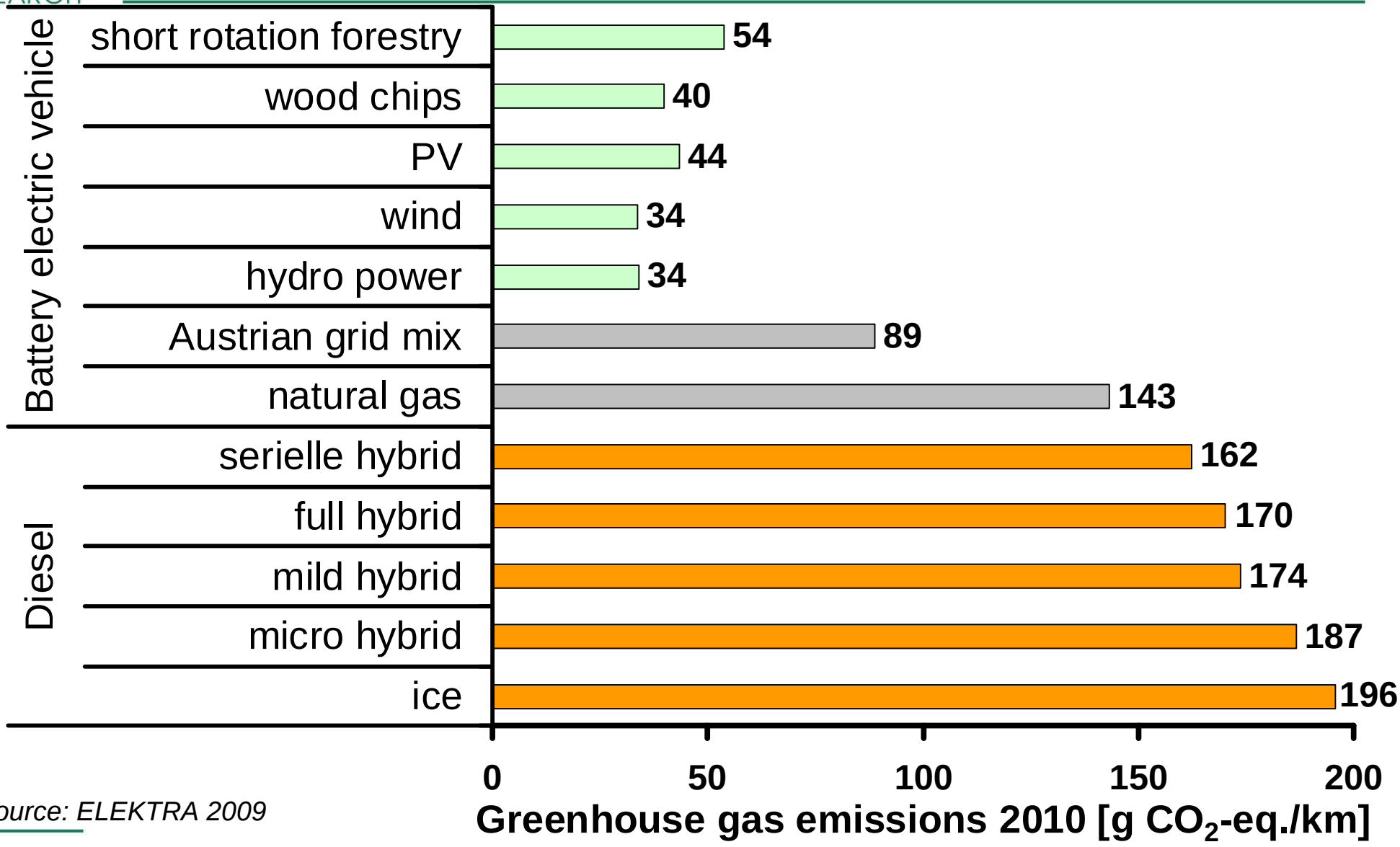
3 Fossil fuels:
1. Gasoline
2. Diesel
3. Natural gas

5 Transportation biofuels:
1. Bioethanol
2. Biodiesel
3. Synthetic natural gas (SNG)
4. Biomethan (made of biogas)
5. Fischer-Tropsch-(FT)biofuels

11 Feedstocks for transportation biofuels:
1. Maize
2. Wheat
3. Sugar beet
4. Wood
5. Straw
6. Rape
7. Sunflower
8. Used cooking oil
9. Manure
10. Maize sillage
11. Mix of energy crops

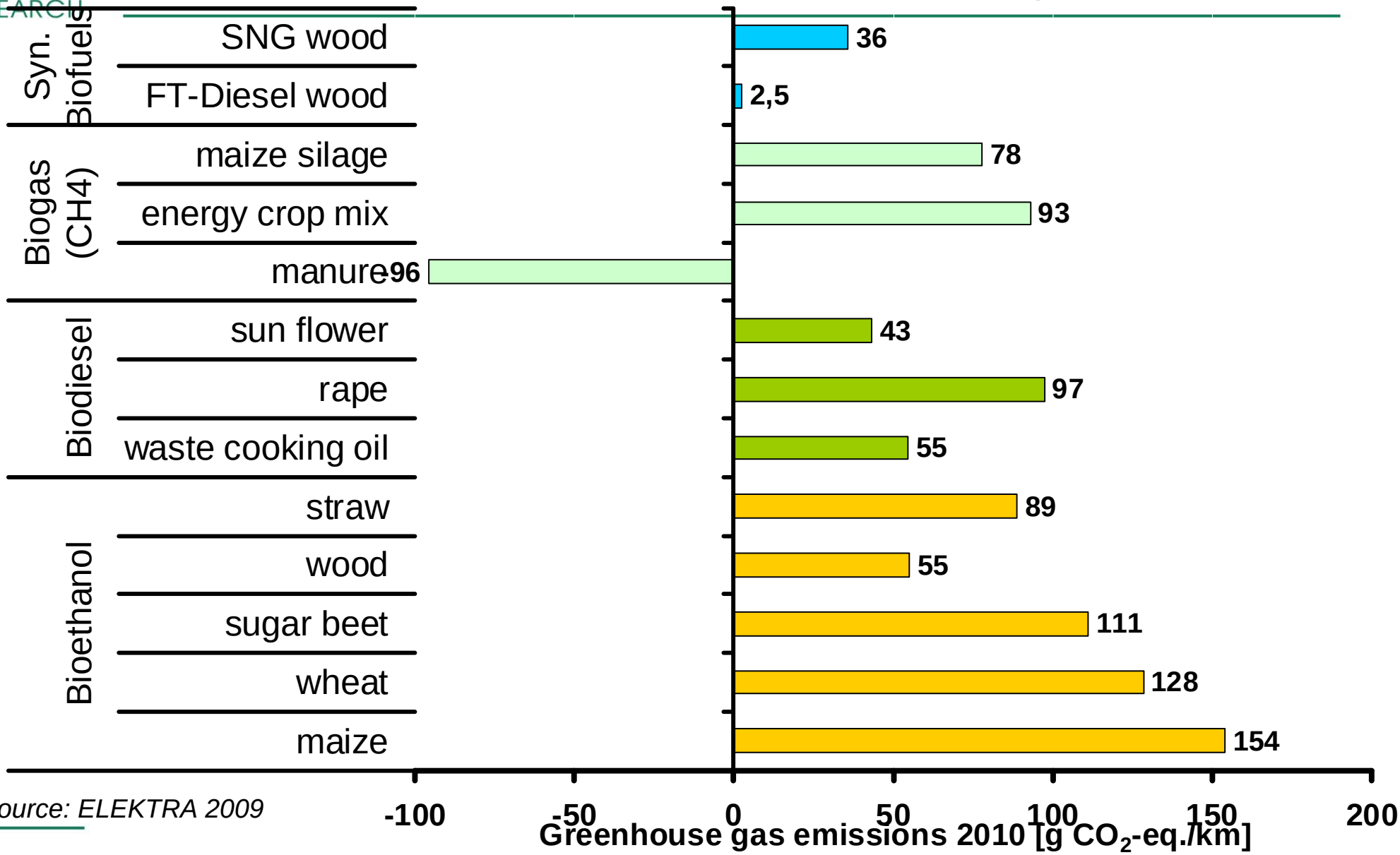
Source: ELEKTRA 2009

Greenhouse Gas Emissions of A Medium Class Car (2010)



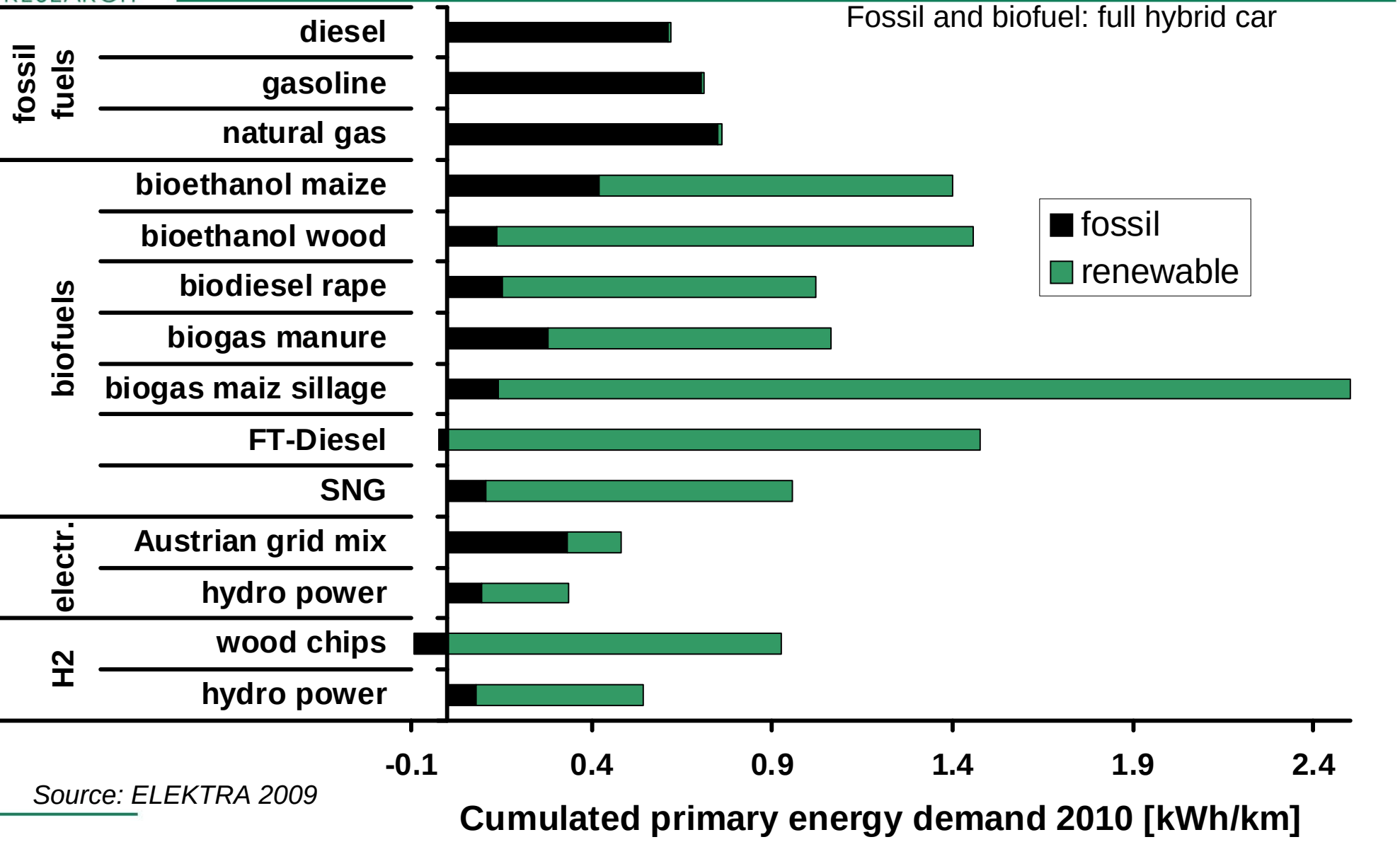
Source: ELEKTRA 2009

Greenhouse Gas Emissions of A Medium Class Car/Full Hybrid Car



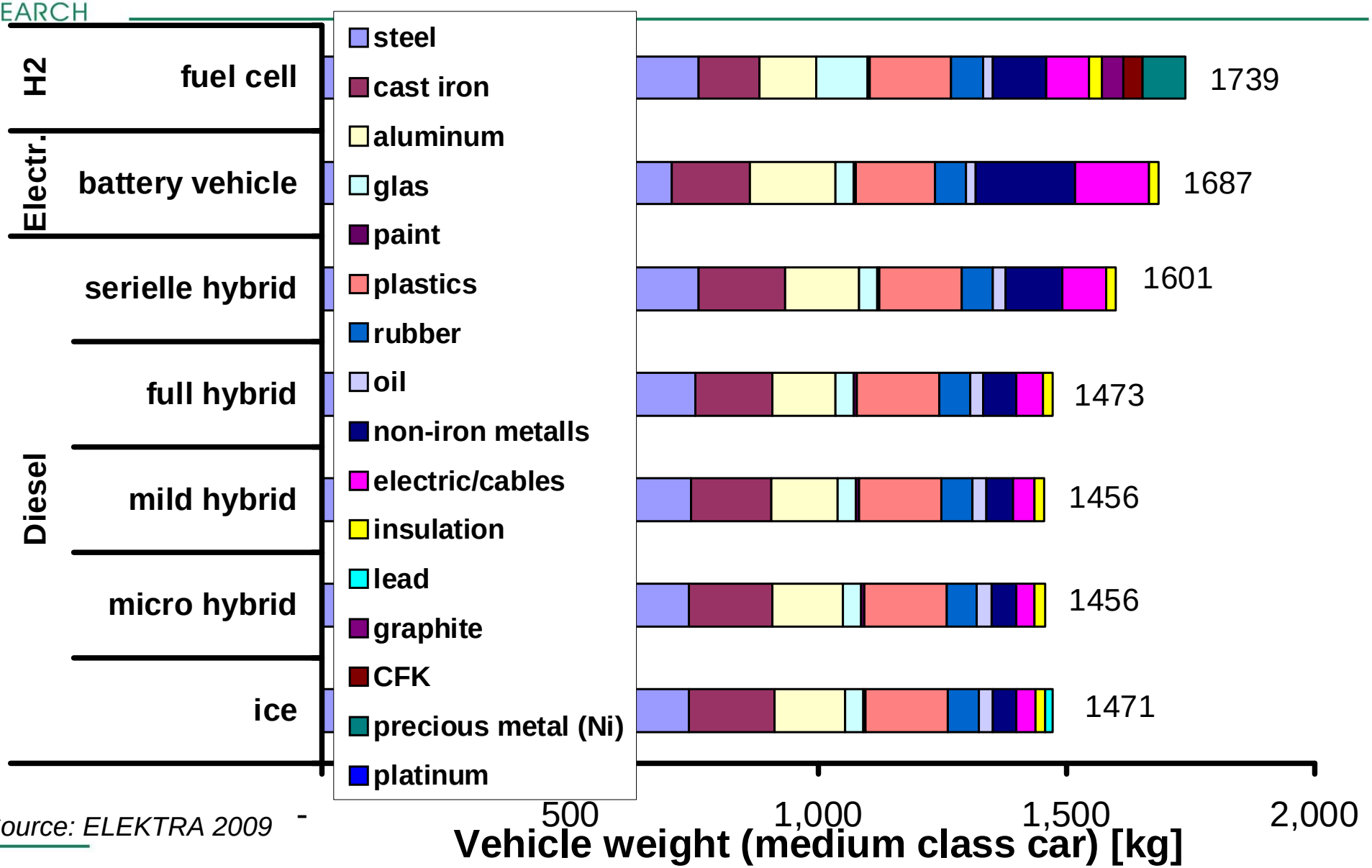
Source: ELEKTRA 2009

Primary Energy Demand of A Medium Class Car (2010)



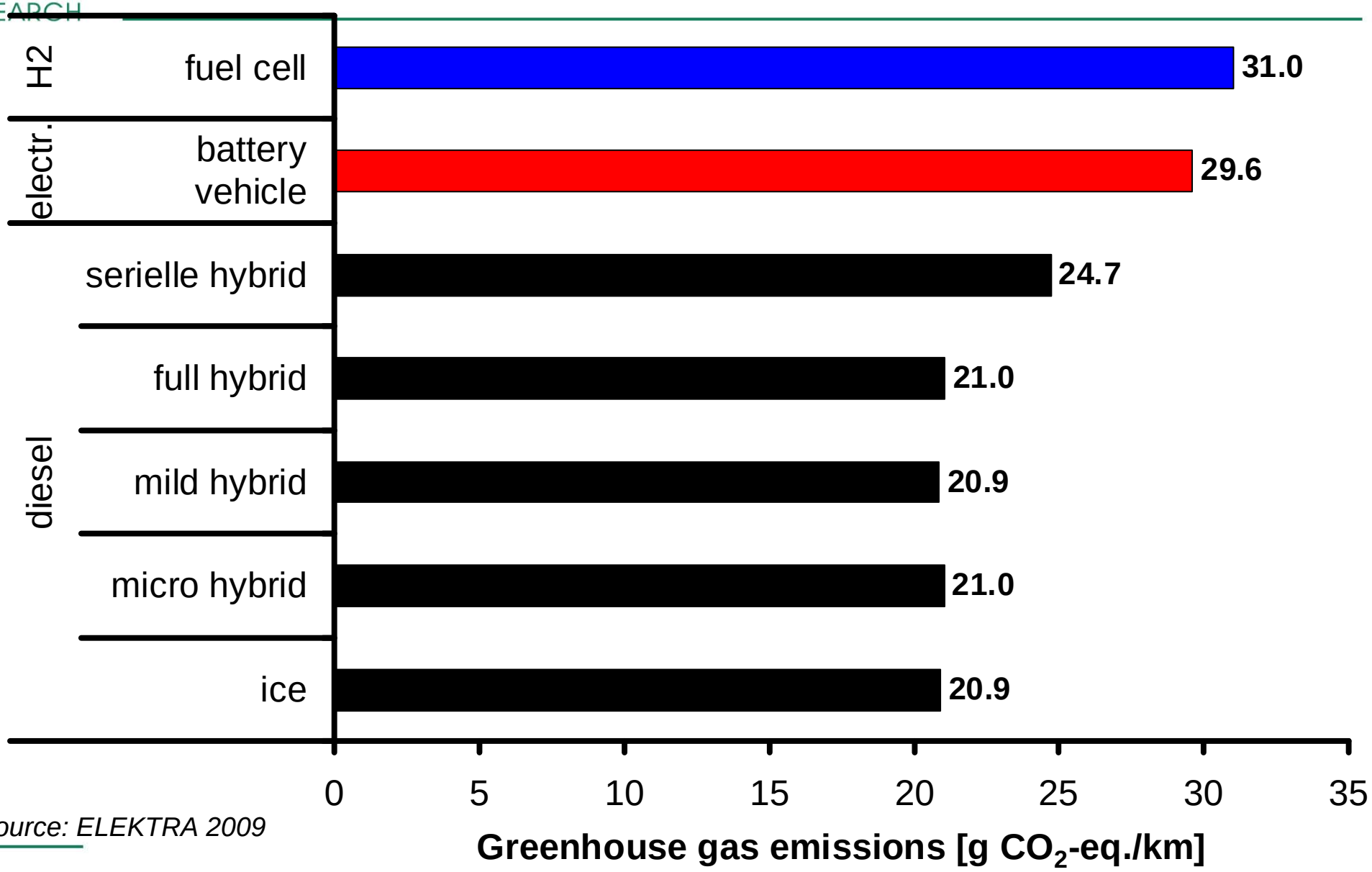
Source: ELEKTRA 2009

Weights of Different Vehicle Concepts



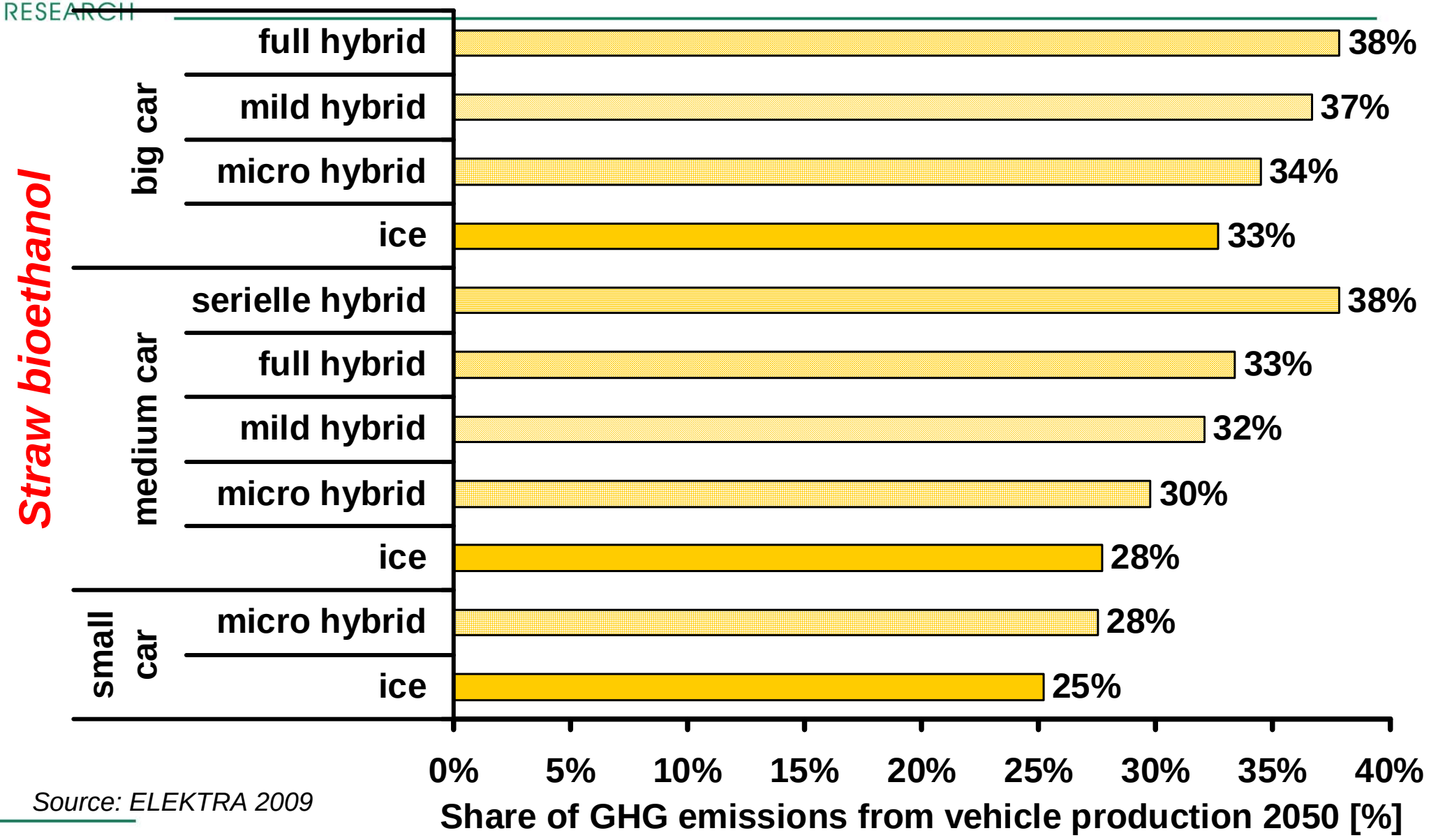
Source: ELEKTRA 2009

Greenhouse Gas Emissions of Vehicle Production



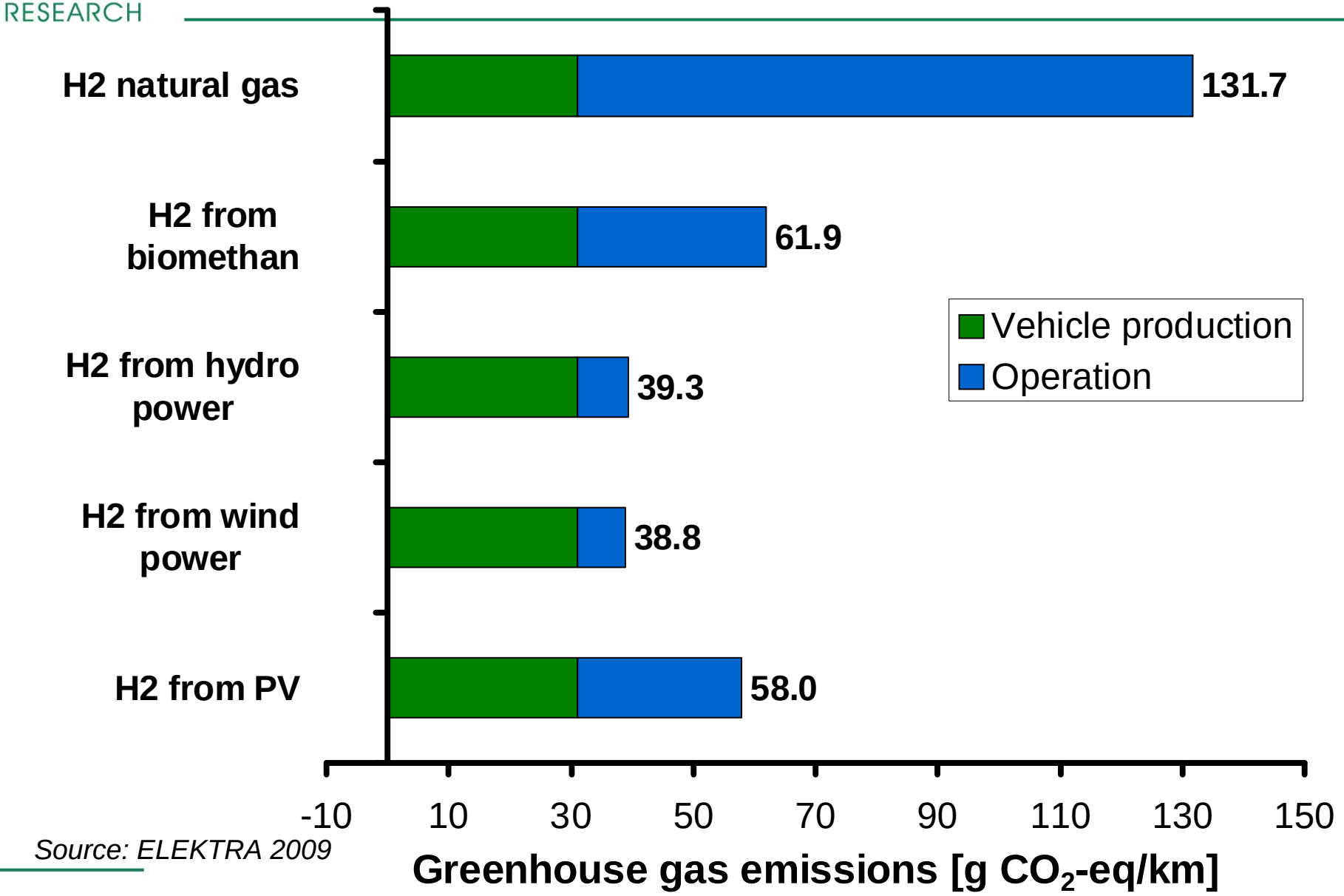
Source: ELEKTRA 2009

Share of GHG Emission from Vehicle Production



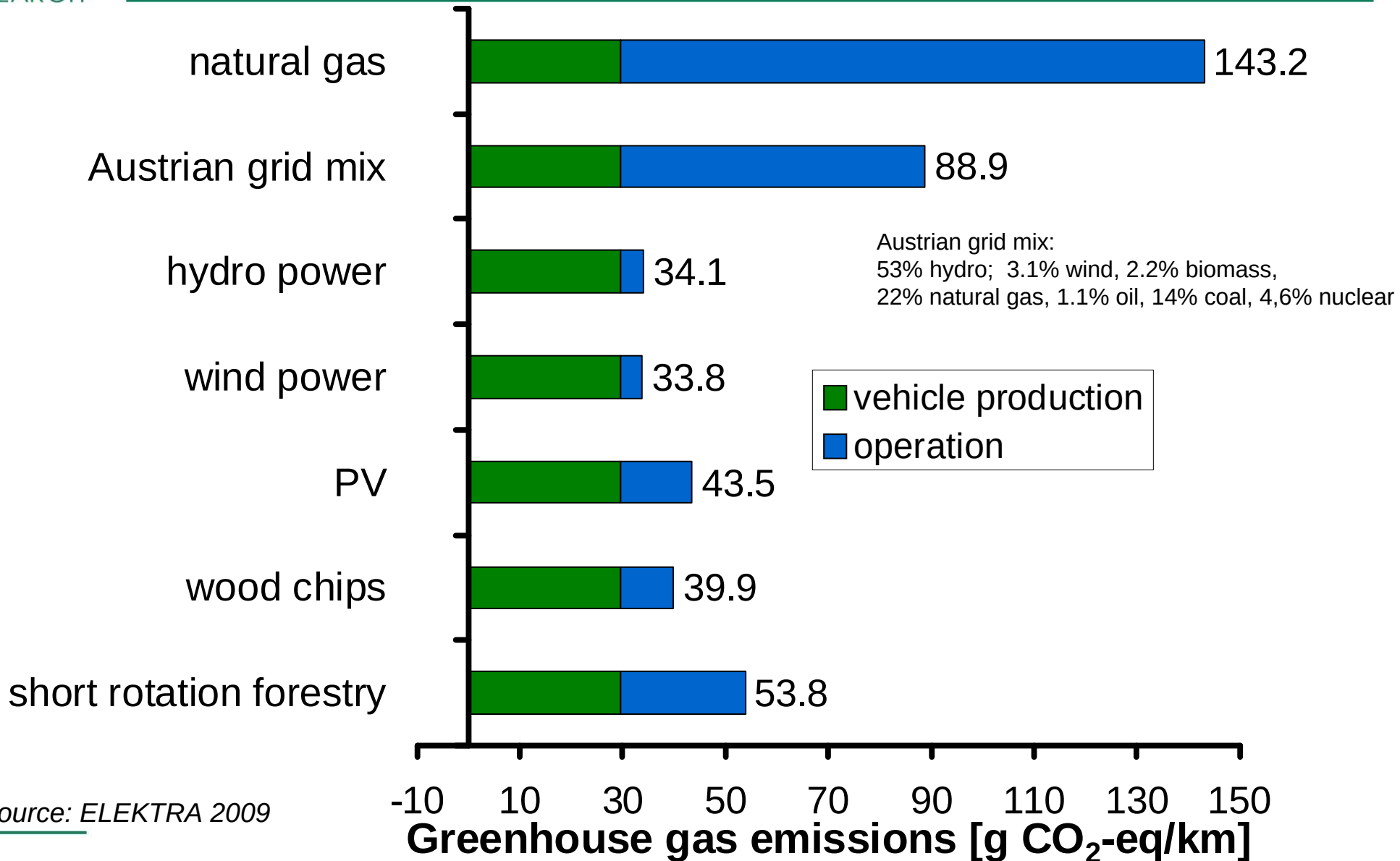
Source: ELEKTRA 2009

Greenhouse Gas Emissions of Fuel Cell Vehicle



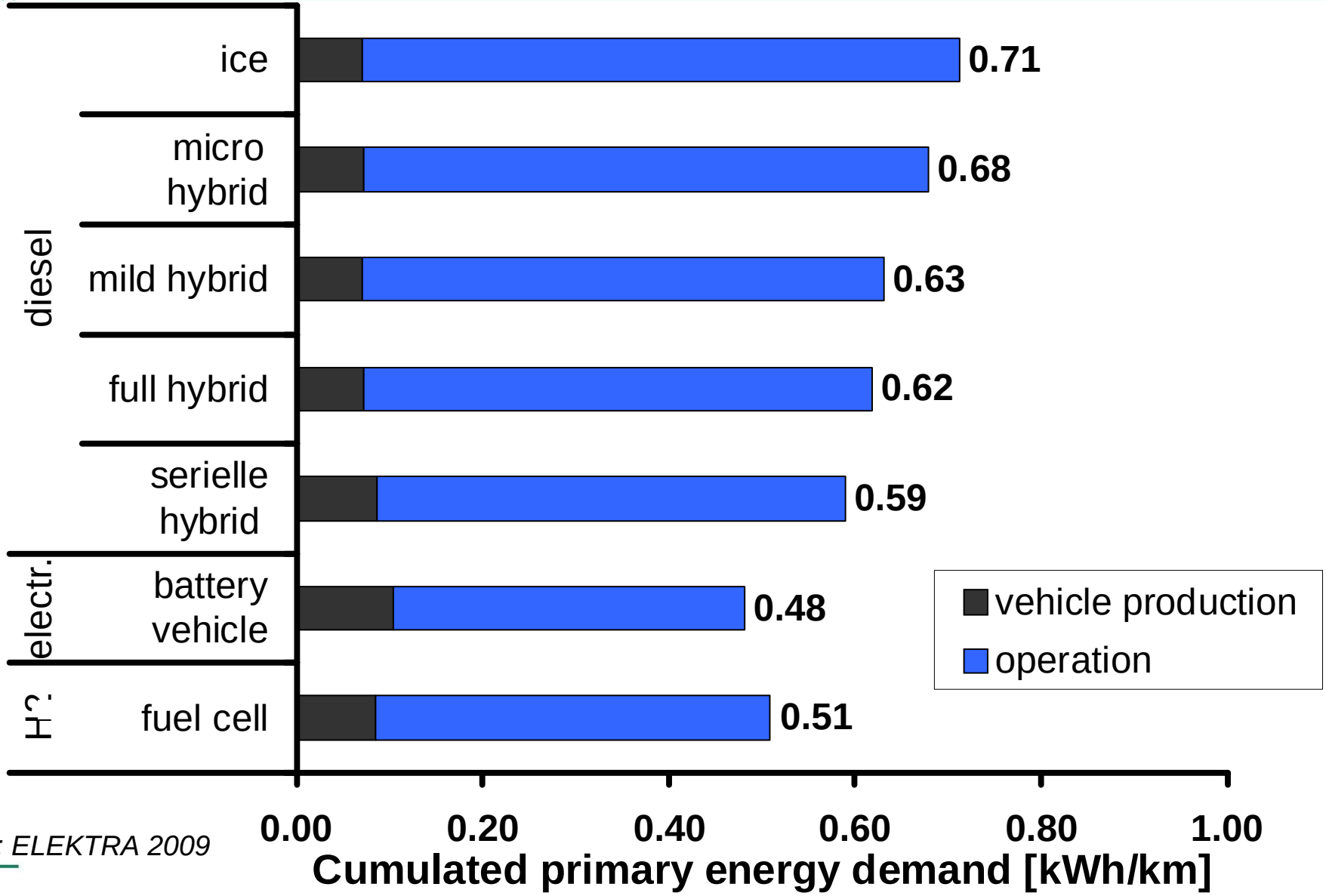
Source: ELEKTRA 2009

Greenhouse Gas Emissions of Electric Battery Vehicle



Source: ELEKTRA 2009

Cumulated Energy Demand of Vehicle Production



Source: ELEKTRA 2009

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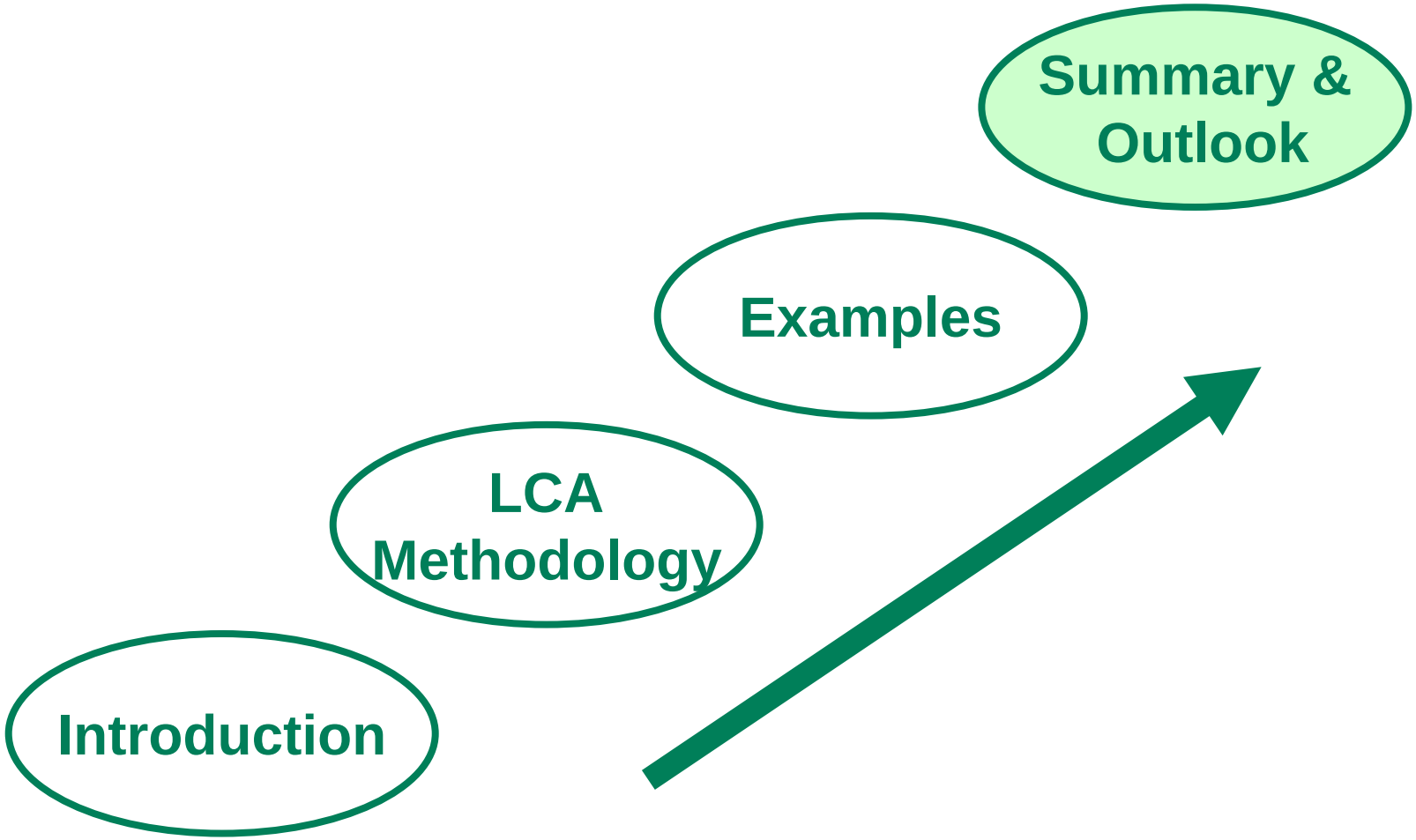

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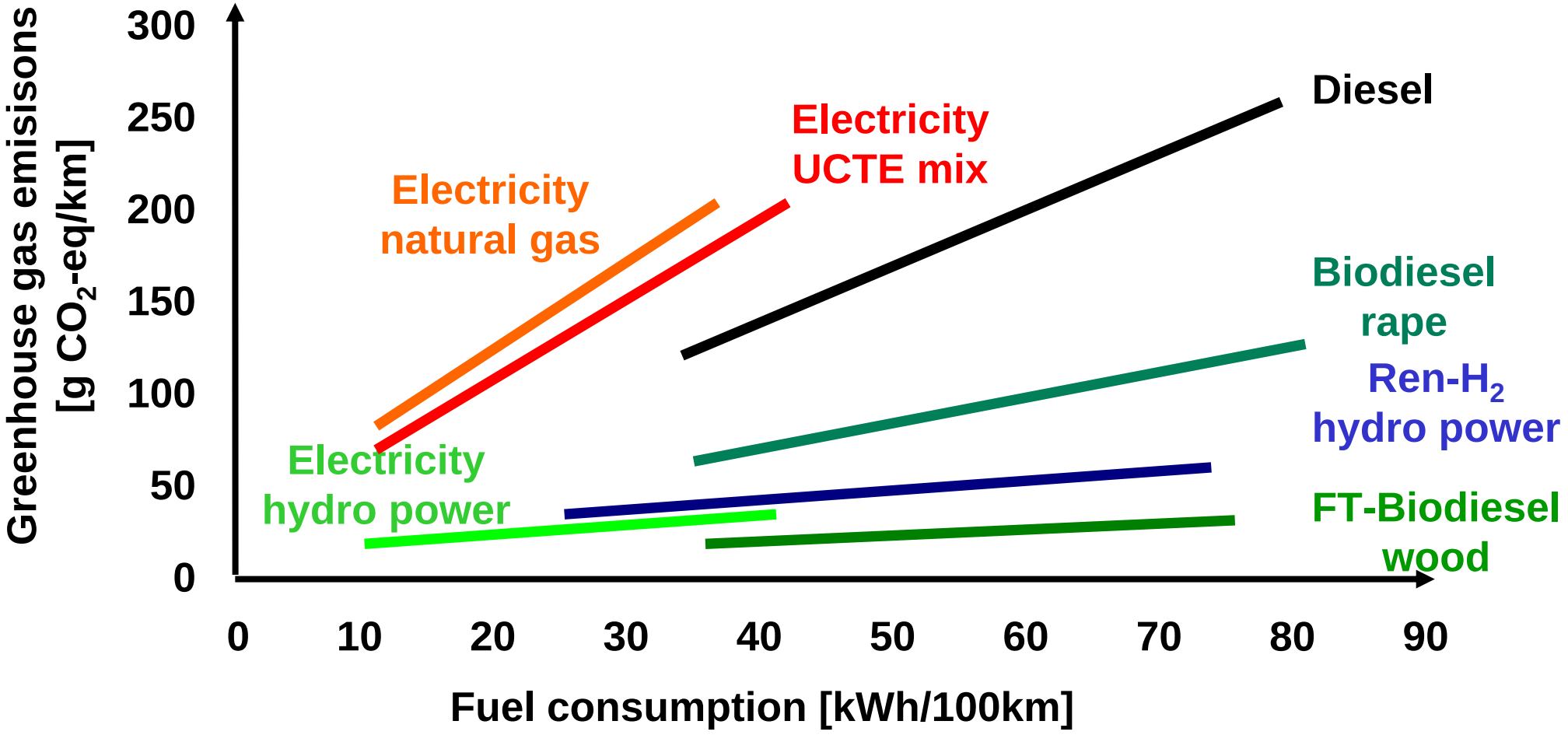
The Energy Efficiency Issue



Source: passenger cars based on LCA, Joanneum Research

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Comparative Assessment for the Different Renewable Transportation Fuels

	"B-Mobility"	"E-Mobility"	"H_2-Mobility"
Primary energy	many options	many options	many options
Fuel production technology	1st generation existing 2nd generation under development	existing	fossil existing renewable under development
Sustainability	food/feed/fibre/fuel	renewable	renewable
Local emission	yes	no	very low
Infrastructure	existing	partly existing	not existing
Vehicle technology	existing	under development	under development
Customer needs (Range/Refuel time)	common	uncommon	less common

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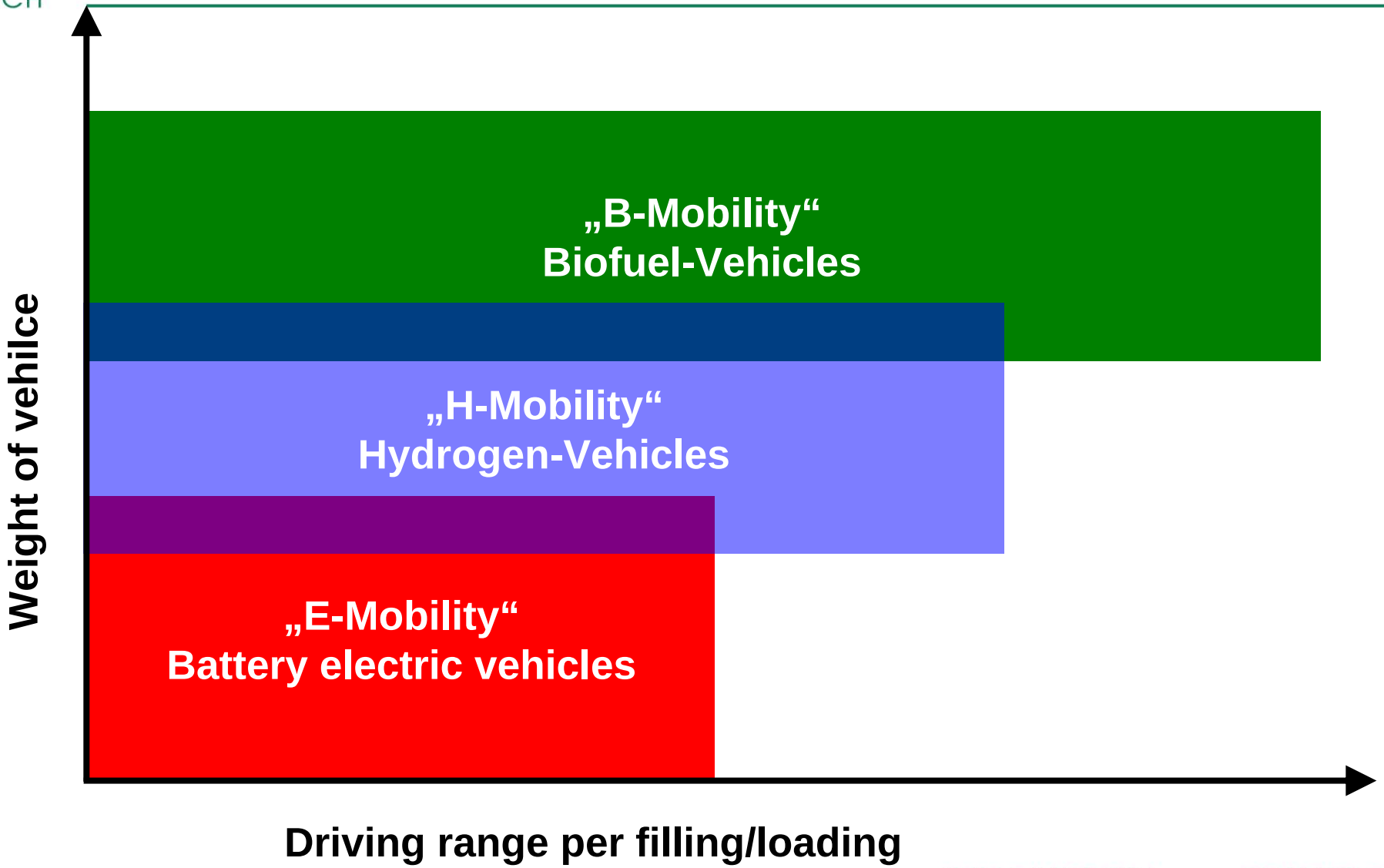
Optimum Application of Vehicles with Renewable Energy



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Conclusions

9) Renewable transportation fuels save greenhouse gas emissions and fossil energy

8) Reycling of fuel cells and batteries is a key aspects

7) Biofuels: type of feedstock and use of co-products relevant

6) B-Mobility based on (certified) sustainable biomass feedstock

5) H_2 & E-Mobility must be based on renewable energy

4) Fossil fuels and biofuel mainly environmental effects from operation

3) Production and dismantling phase relevant for H_2- & E-Mobility

2) Cover all three phase in life cycle: production, operation & dismantling

1) Life cycle assessment basis for environmental evaluation

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