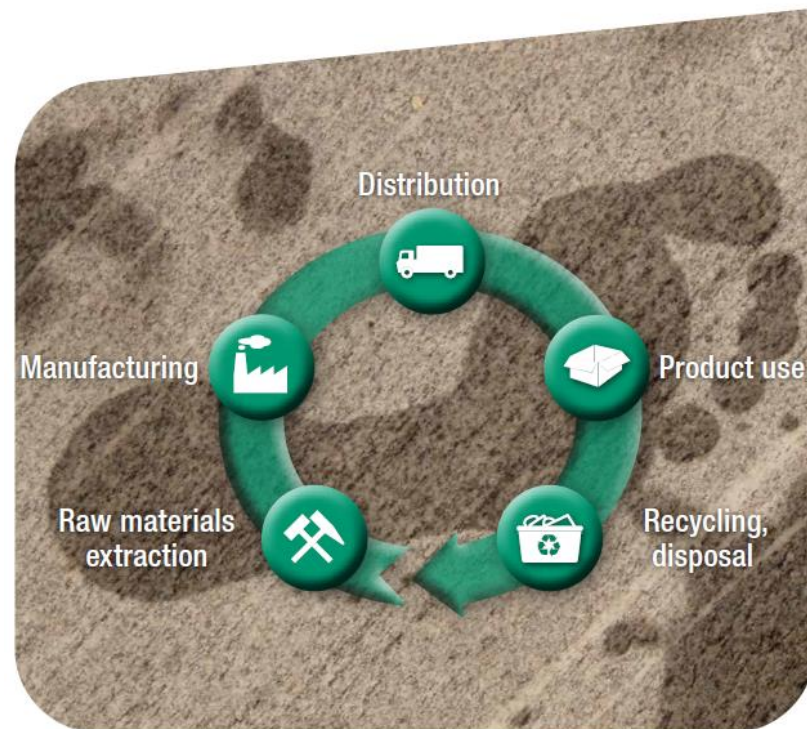


# Life-cycle Based Environmental Effects of 1.3 Mio. Electric Vehicles in 35 Countries

Facts & Figures from the  
IEA Technology  
Collaboration Program on  
Hybrid & Electric Vehicles

Gerfried Jungmeier, Amgad A.  
Elgowainy, Lorenza Canella, Simone  
Ehrenberger, Gabriela Benveniste  
Pérez, Pierre-Olivier Roy

EVS30 Symposium  
Stuttgart, Germany, October 9 - 11, 2017

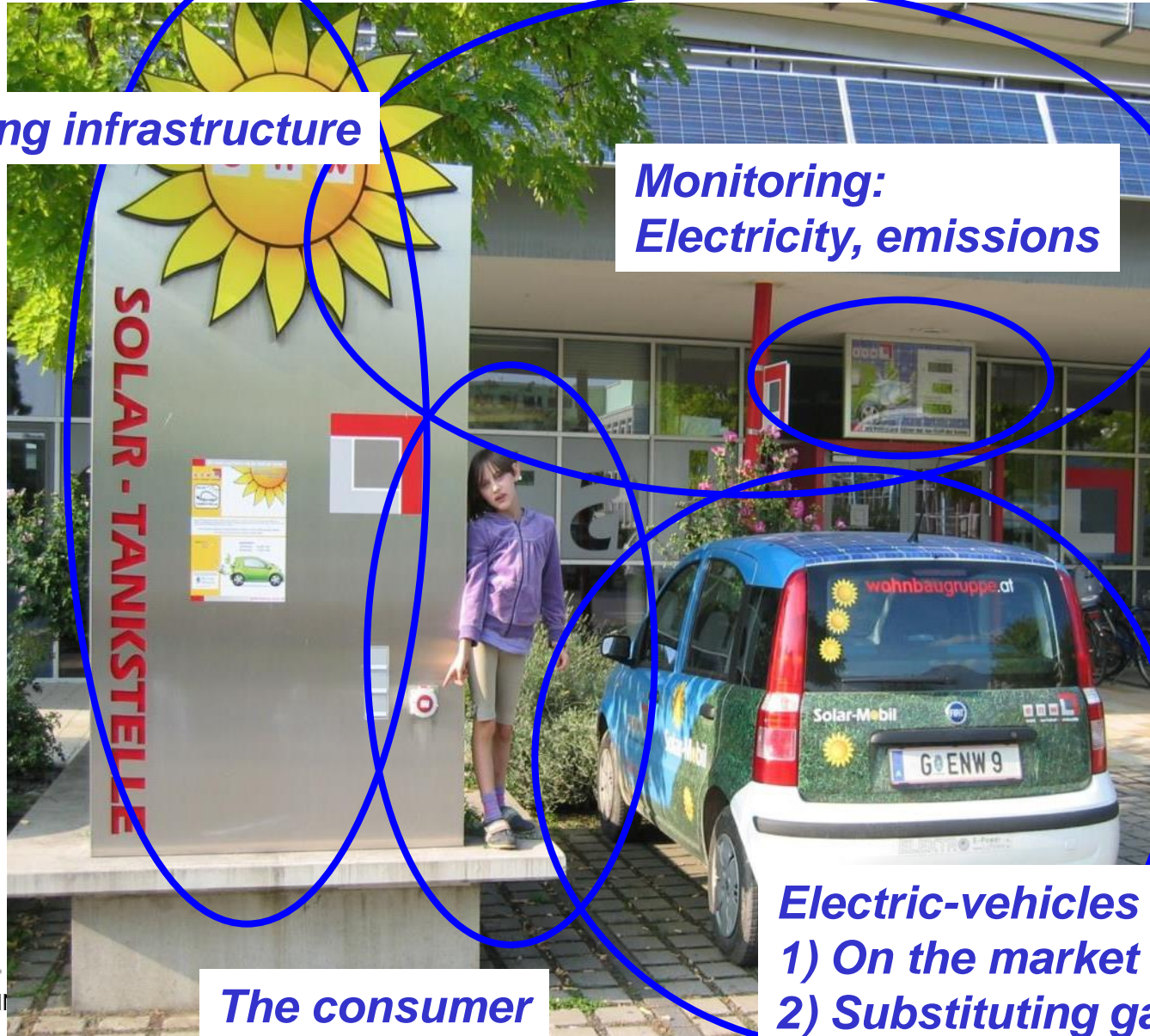


# Challenges for the Successful Market Introduction of Electric-Vehicles

**Charging infrastructure**

**Monitoring:  
Electricity, emissions**

**Additional  
renewable  
electricity**



**The consumer**

**Electric-vehicles**  
1) On the market available  
2) Substituting gasoline&diesel

# Statement on Environmental Assessment of Electric Vehicles

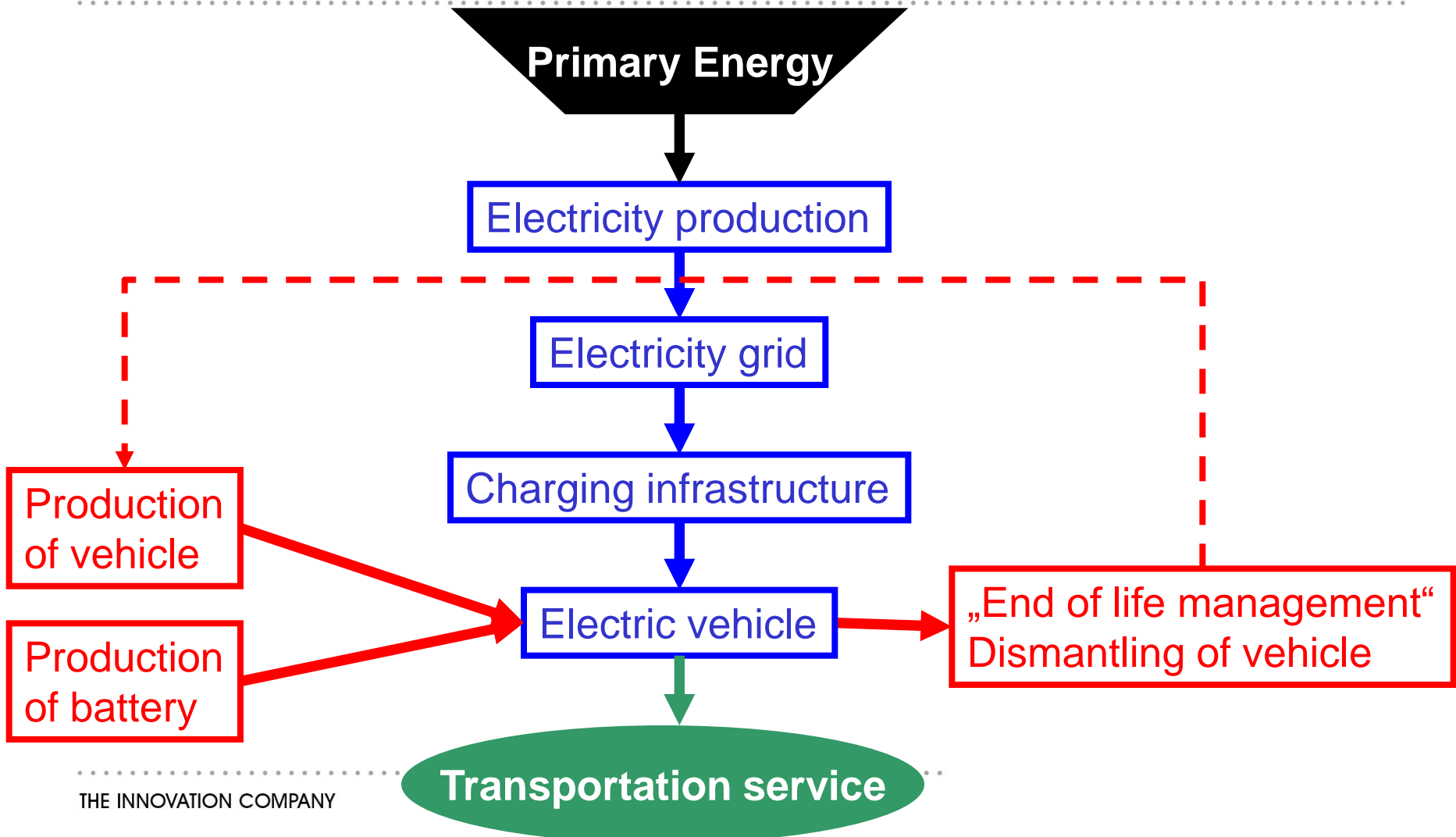
“There is international consensus that the environmental effects of electric vehicles can only be analyzed on the basis of

**Life Cycle Assessment (LCA)**

including the production, operation and the end of life treatment of the vehicles”

“....and in comparison to conventional vehicles”

# Assessment of LCA-Aspects over Full Value Chain



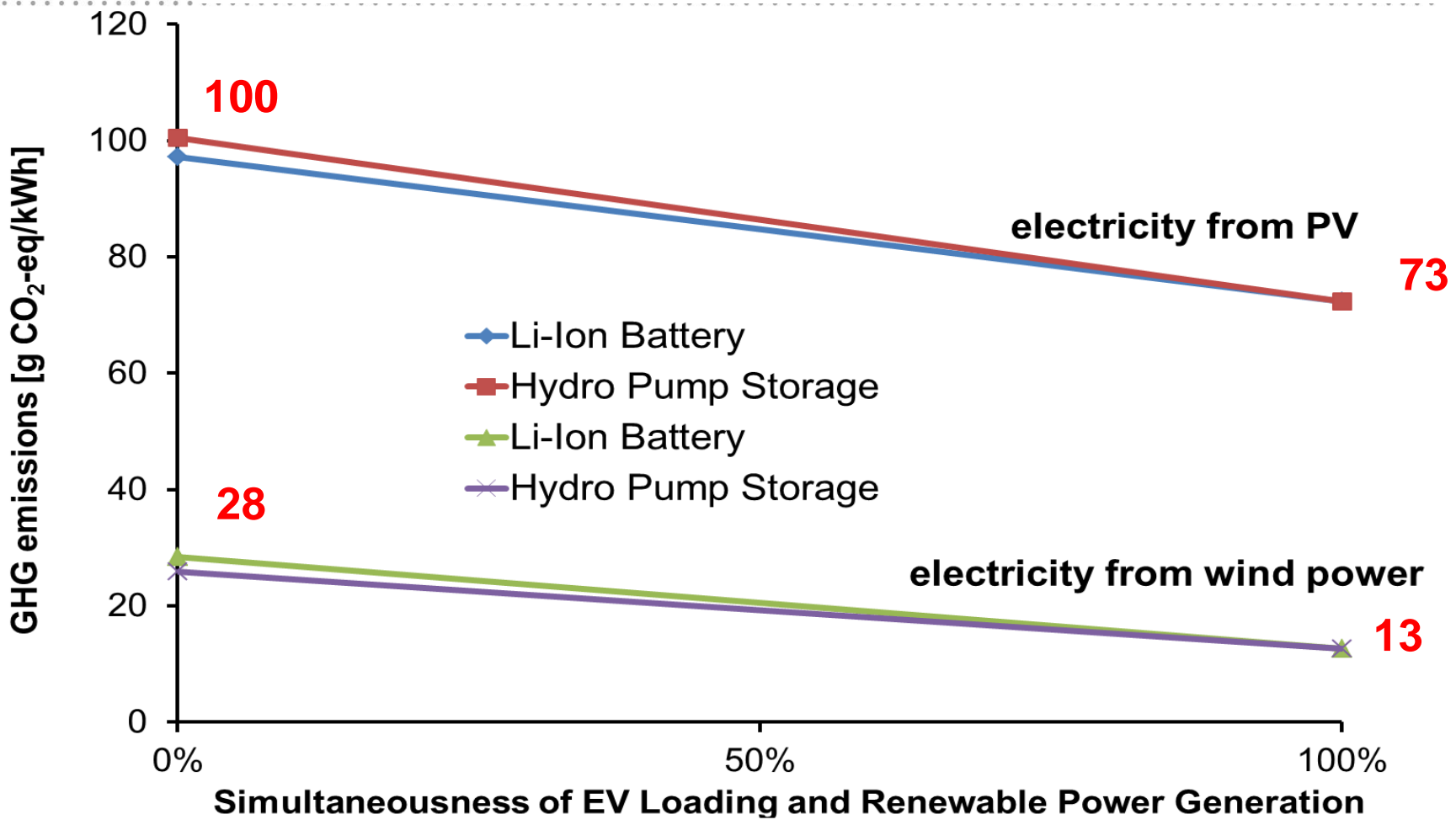
**Example: 66,000 BEV in Norway** (Norsk elbil forening 2015)

- 85% substitute „fossil driven“ ICE kilometres
- 15% substitute walking, bicycling, public transport and additional mobility

→ 9,000 additional vehicles?

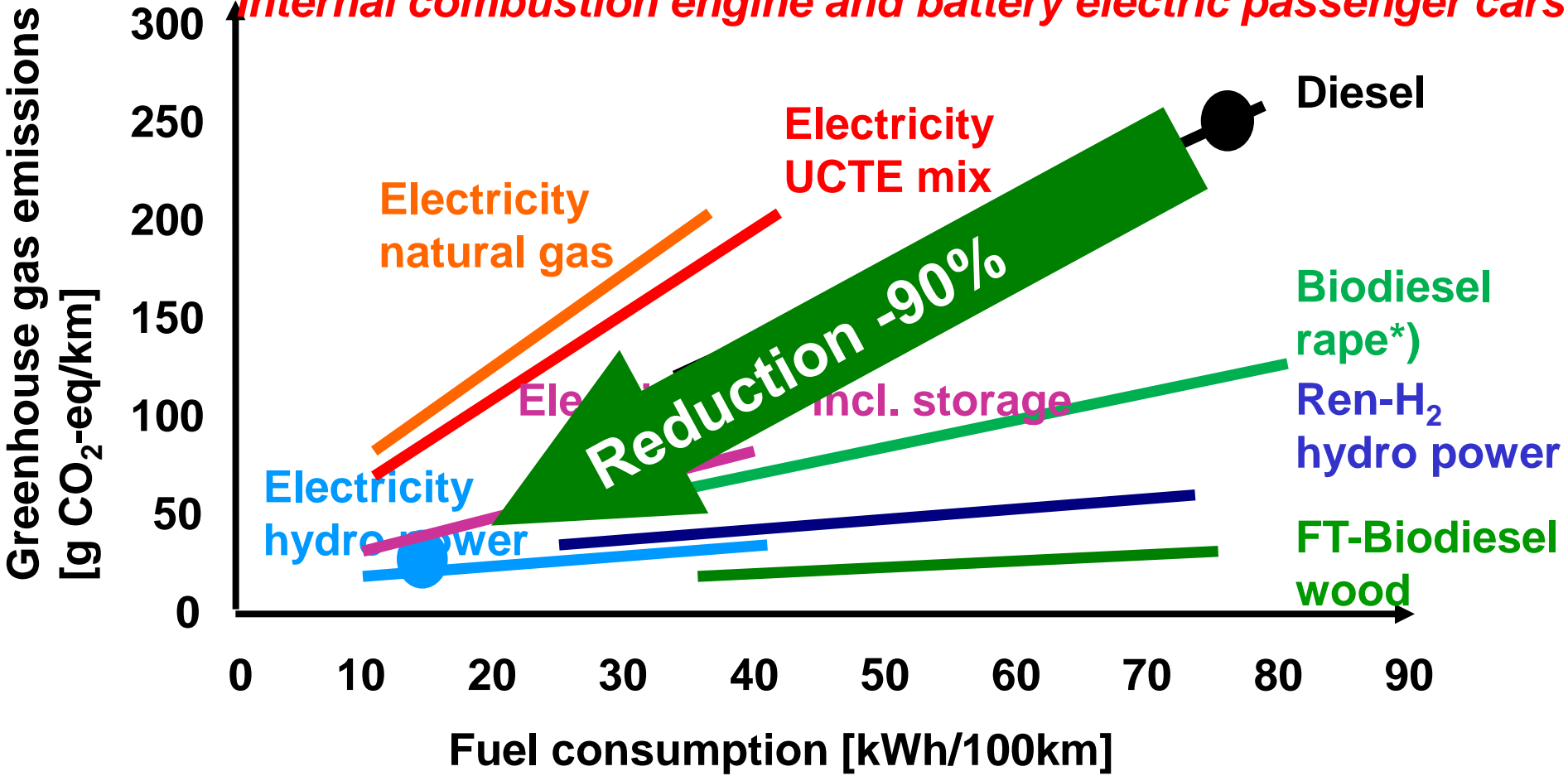
- 3) Vehicle demand → demand of vehicle
- 4) Fuel Cycle (electricity production with storage)
- 5) Inventory analysis: CO<sub>2</sub>, MJ, kg <-> waste water, heavy metals
- 6) Impact assessment: GHG, primary energy → biodiversity, toxicity
- 7) Reference system: vehicle size, driving range, ≤ 100% substitution?

# Emissions of Loading Strategies with Additional Renewable Electricity



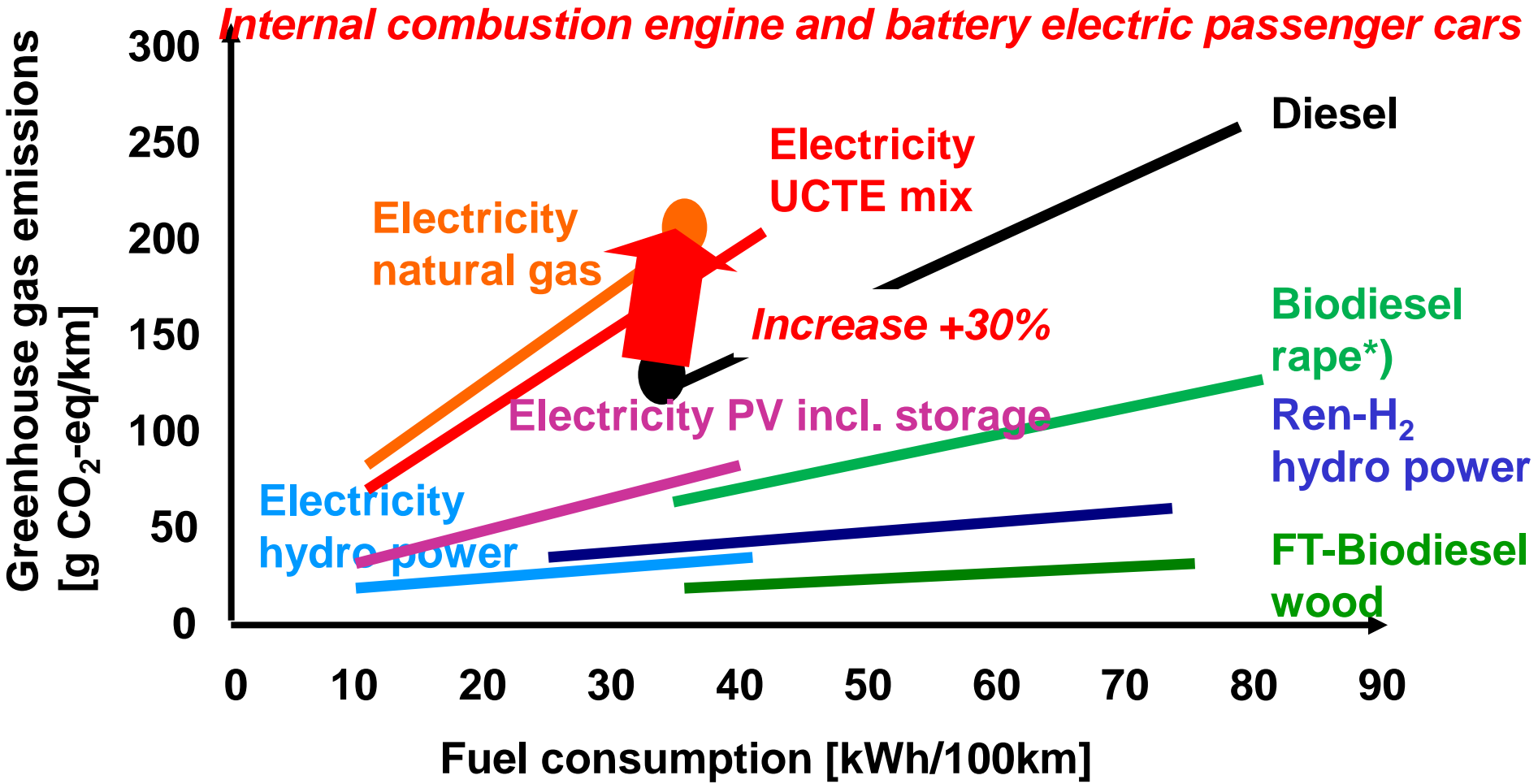
# The 2 Keys: Renewable & Energy Efficiency

*Internal combustion engine and battery electric passenger cars*



Source: LCA of passenger vehicles, Joanneum Research, \*) without iLUC

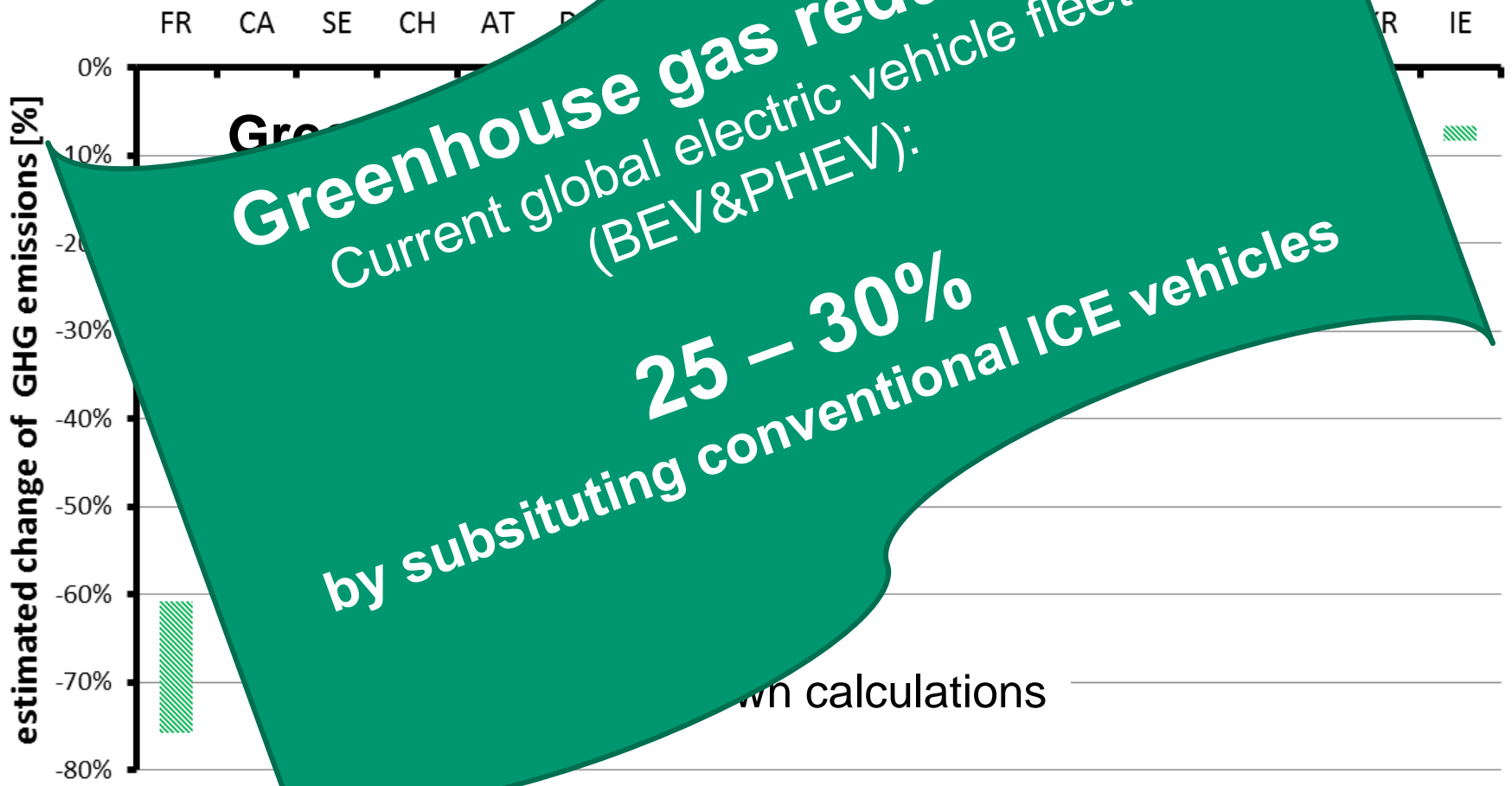
# The 2 Keys: Renewable & Energy Efficiency



Source: LCA of passenger vehicles, Joanneum Research, \*) without iLUC

# ENVIRONMENTAL EFFECTS: GHG Emissions (I)

9

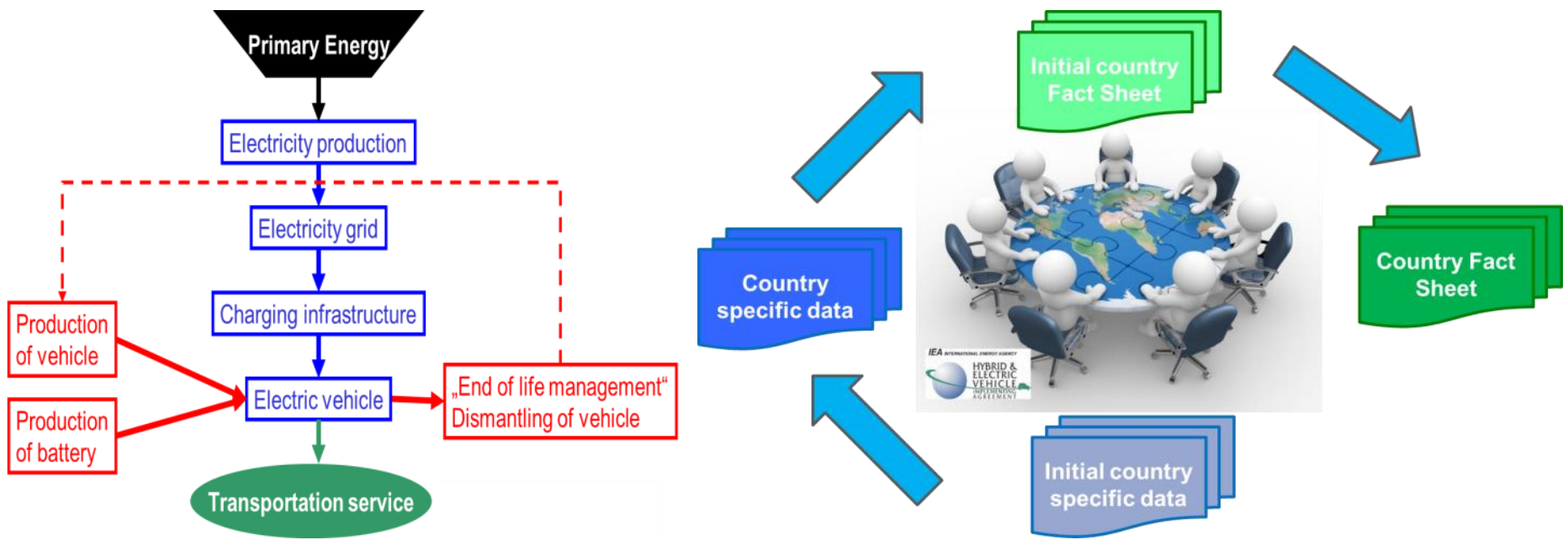


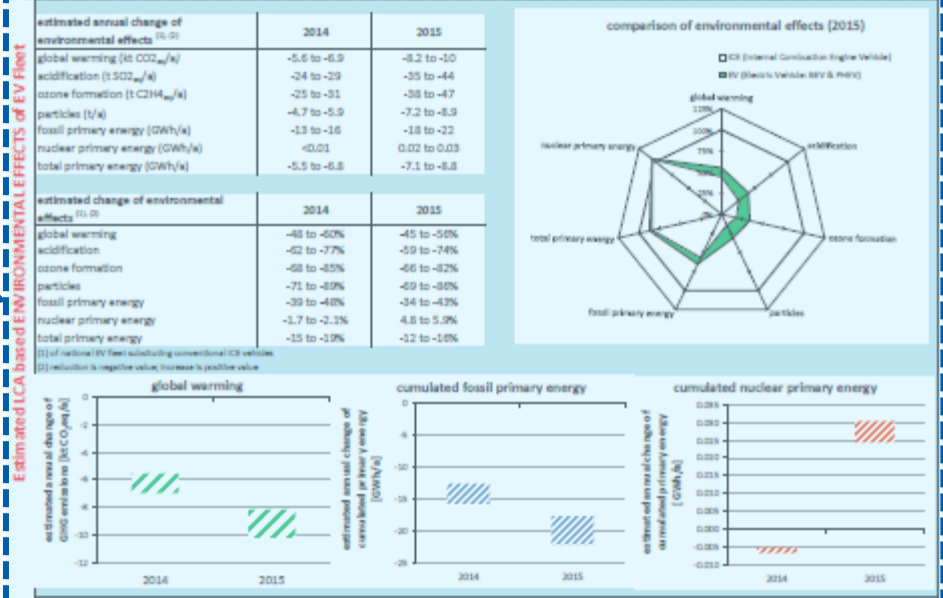
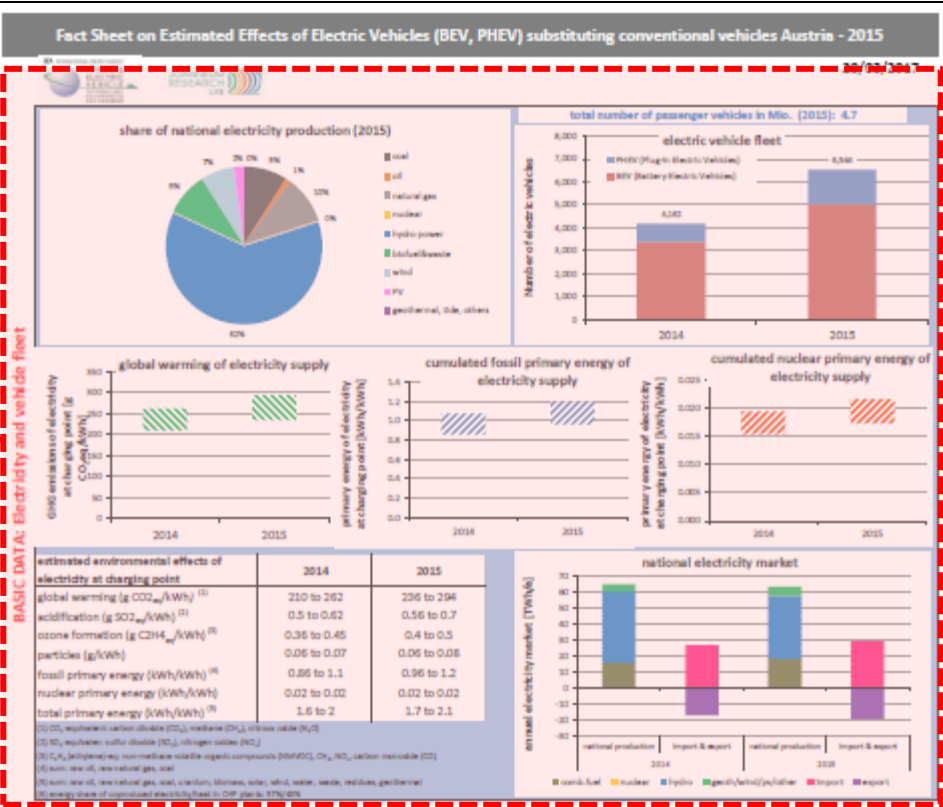
**Greenhouse gas reduction of**  
**Current global electric vehicle fleet**  
**(BEV&PHEV):**  
**25 – 30%**  
**by substituting conventional ICE vehicles**

# Aim of Project “FACTS&FIGURES”

Provide annually **FACTS&FIGURES** on life cycle based environmental benefits of EVs worldwide and country specific in comparison to conventional vehicles

Based on LCA achievements in IEA HEV since 2011





1) Basic data

2) Estimated Environmental effects



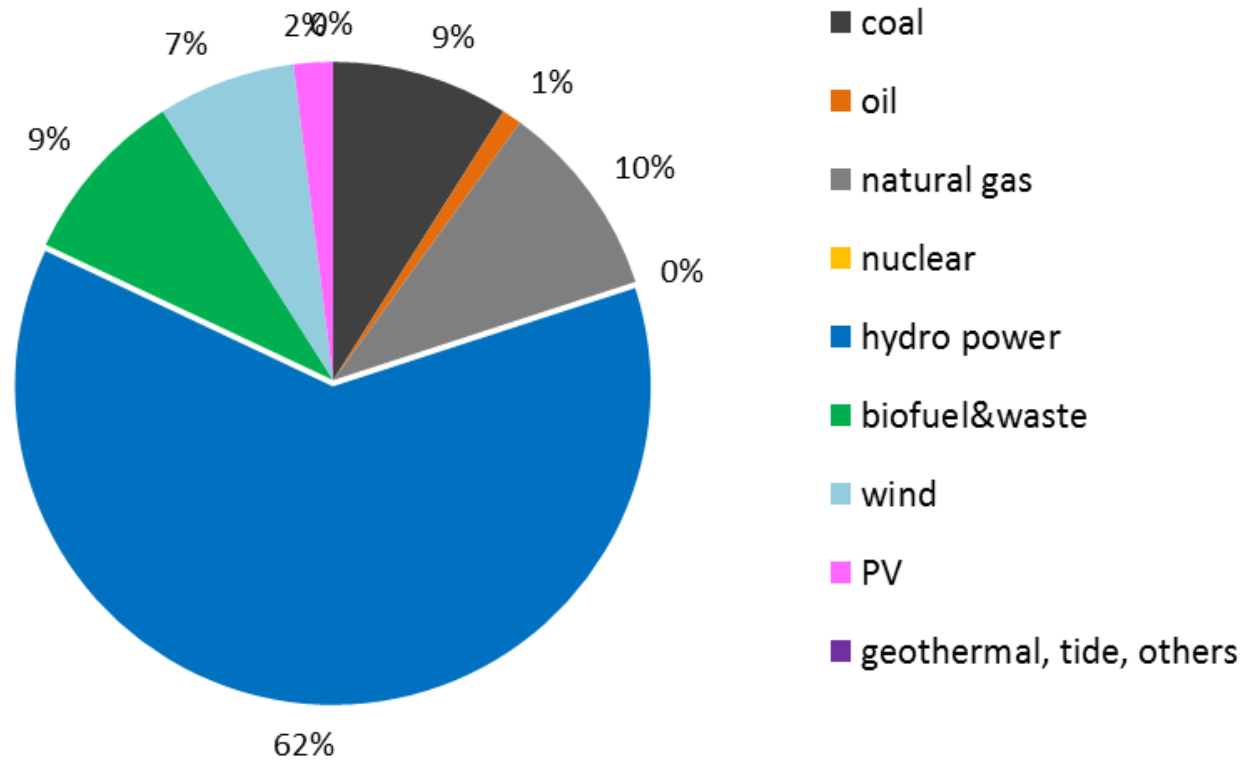
# BASIC DATA:

## Share of National Electricity Production

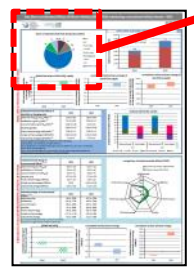
13

### Austria

### 80% Renewable electricity



FACT SHEET



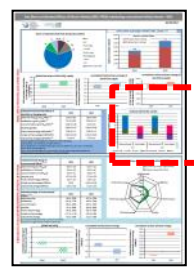
Source: IEA statistics

<http://www.iea.org/statistics/statisticssearch/report/?country=ITALY&product=electricityandheat&year=201x>

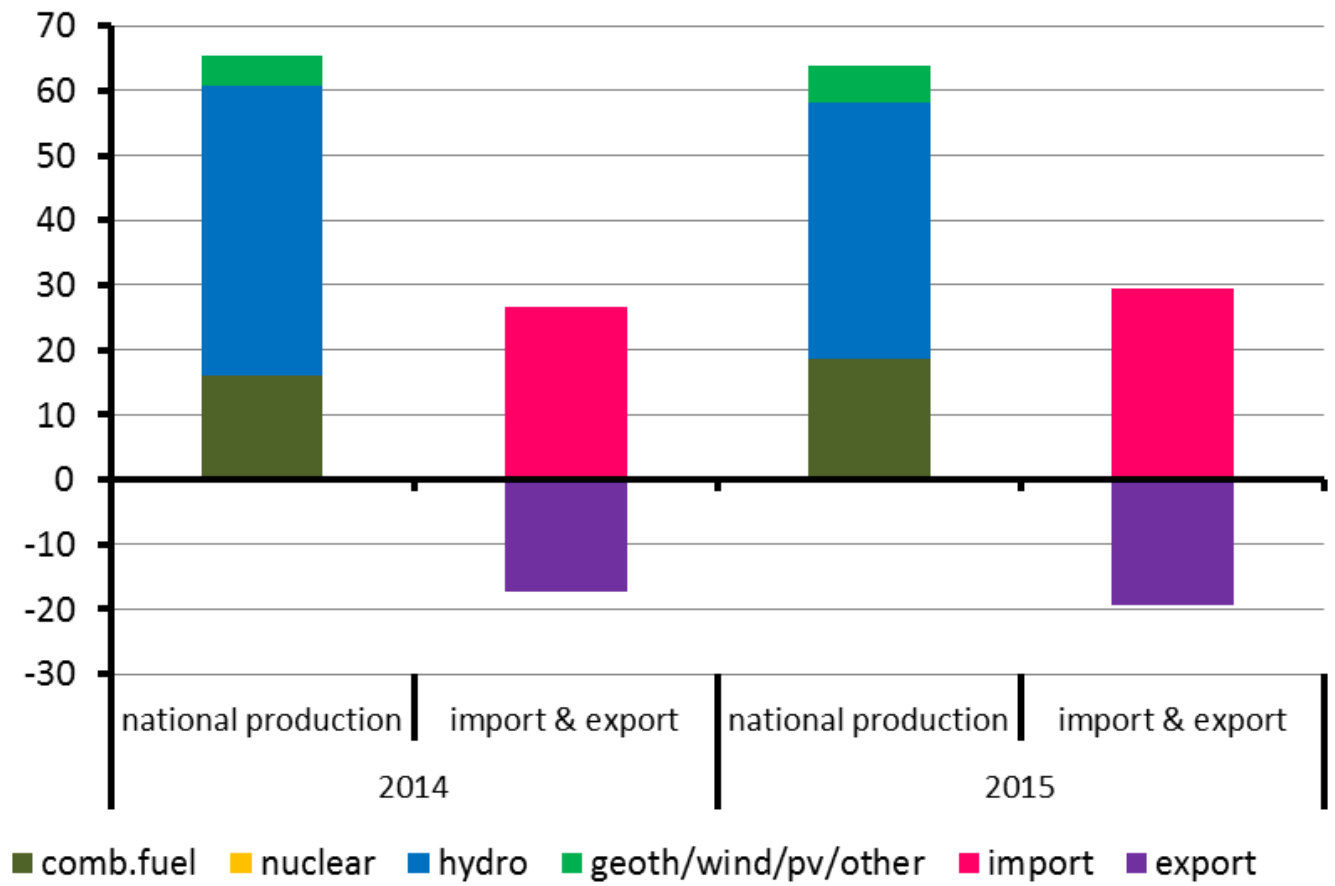
# BASIC DATA: National Electricity Market

## Austria

FACT SHEET



annual electricity market [TWh/a]



Source: IEA statistics

<http://www.iea.org/statistics/statisticssearch/report/?country=ITALY&product=electricityandheat&year=201x>

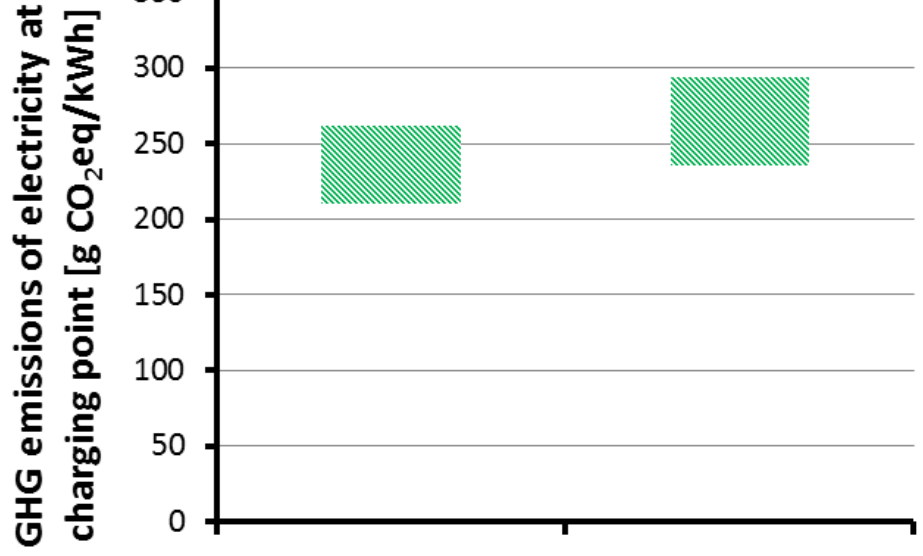
# BASIC DATA:

## Estimated Environ. Effects of Electricity (II)

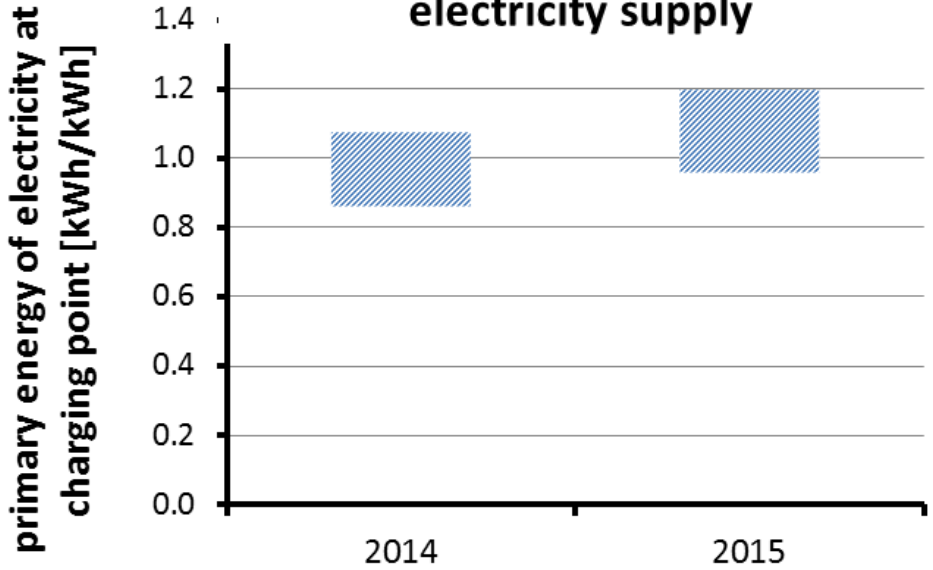
15

### Austria

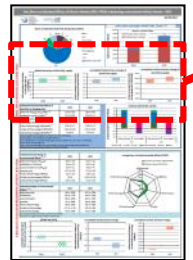
global warming of electricity supply



primary energy of electricity supply



FACT SHEET



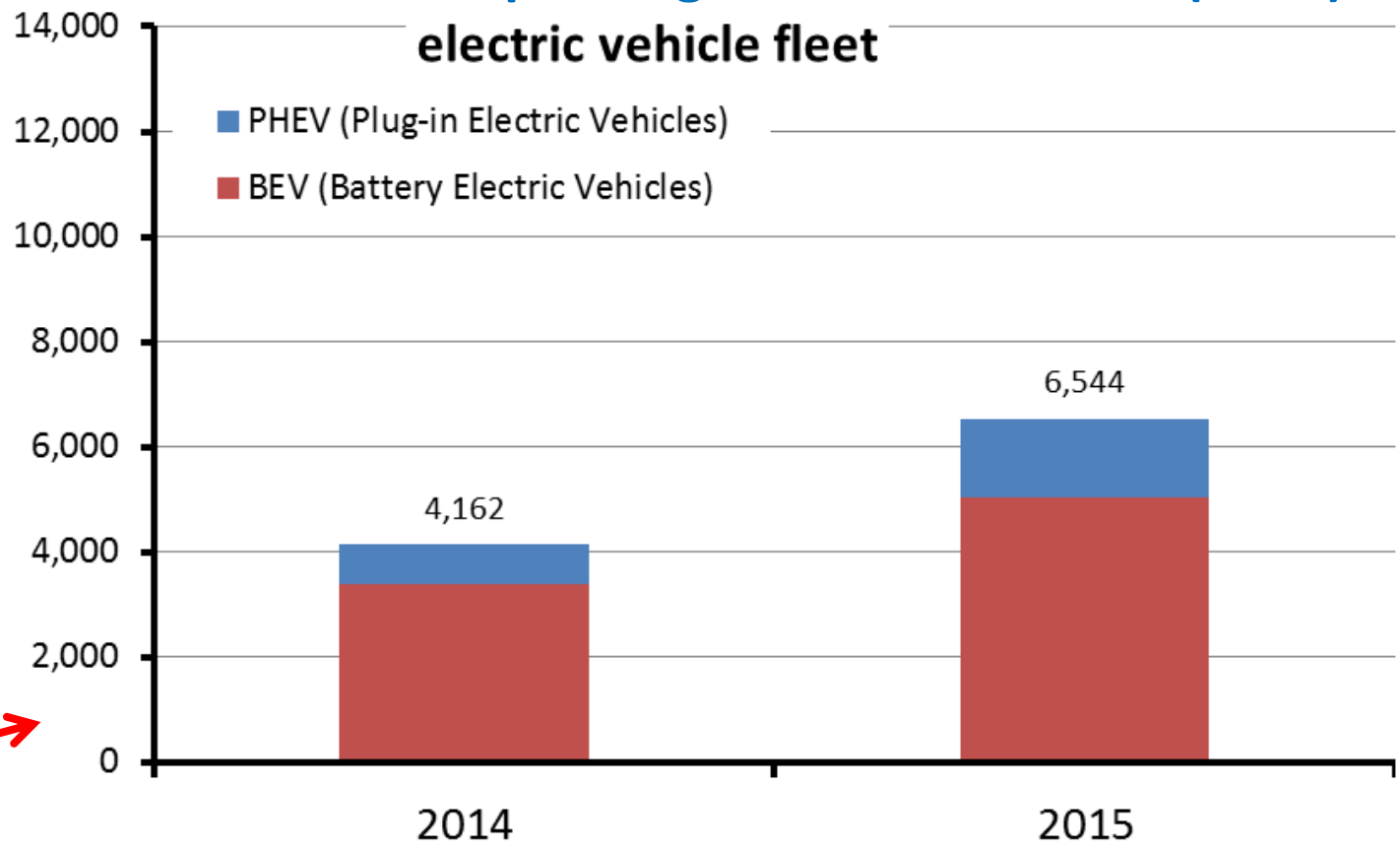
Source: own calculations using data from ecoinvent and GEMIS

# BASIC DATA: Number of Electric Vehicle

total number of passenger vehicles in Mio. (2015): 4.7

**Austria**

Number of electric vehicles



FACT SHEET



# ENVIRONMENTAL EFFECTS:

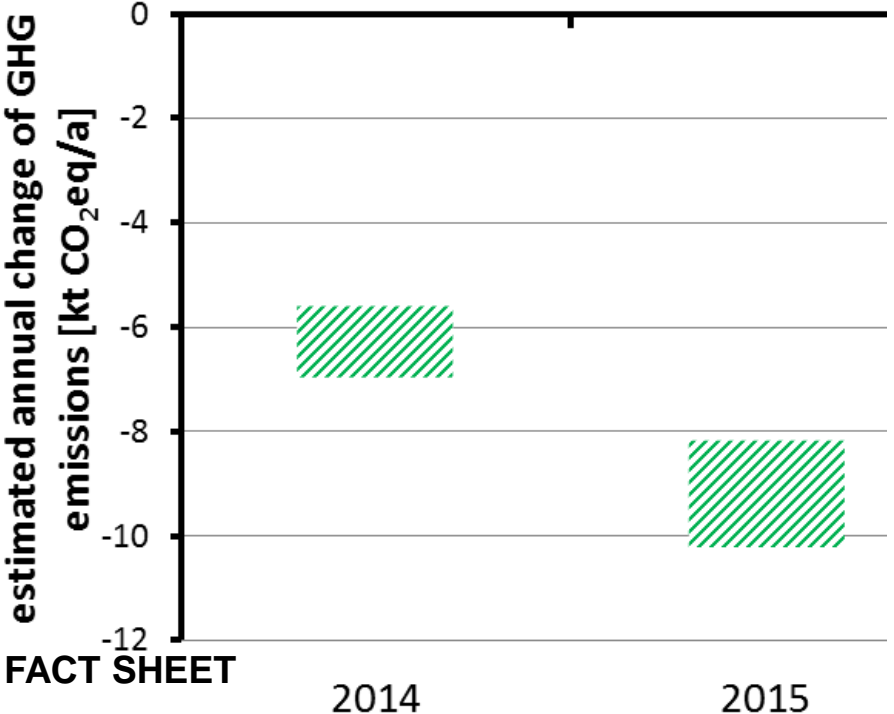
## Estimated Annual Change of national EV Fleet

17

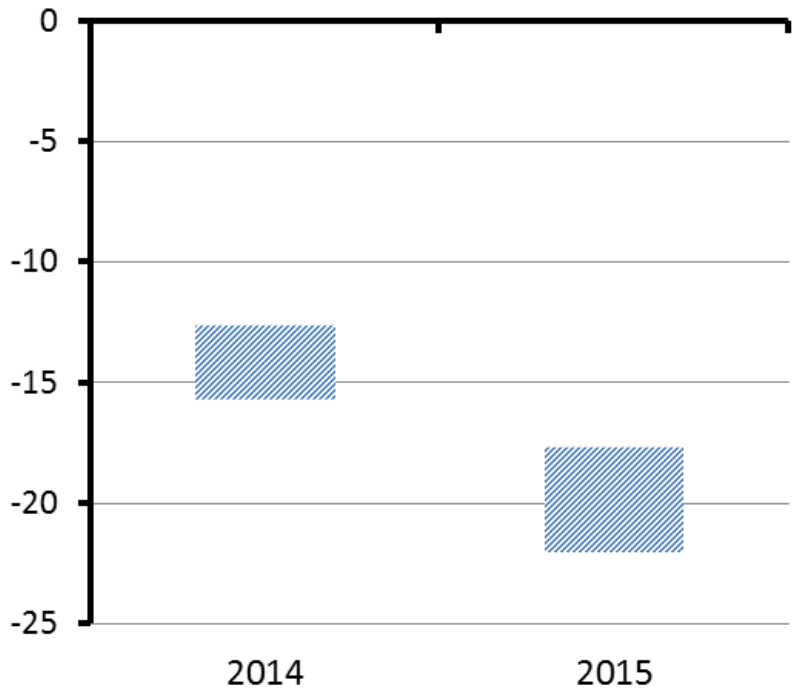
### Austria

global warming

cumulated fossil primary energy



estimated annual change of cumulated primary energy [GWh/a]



FACT SHEET



EVATION COMPANY

Source: own calculations

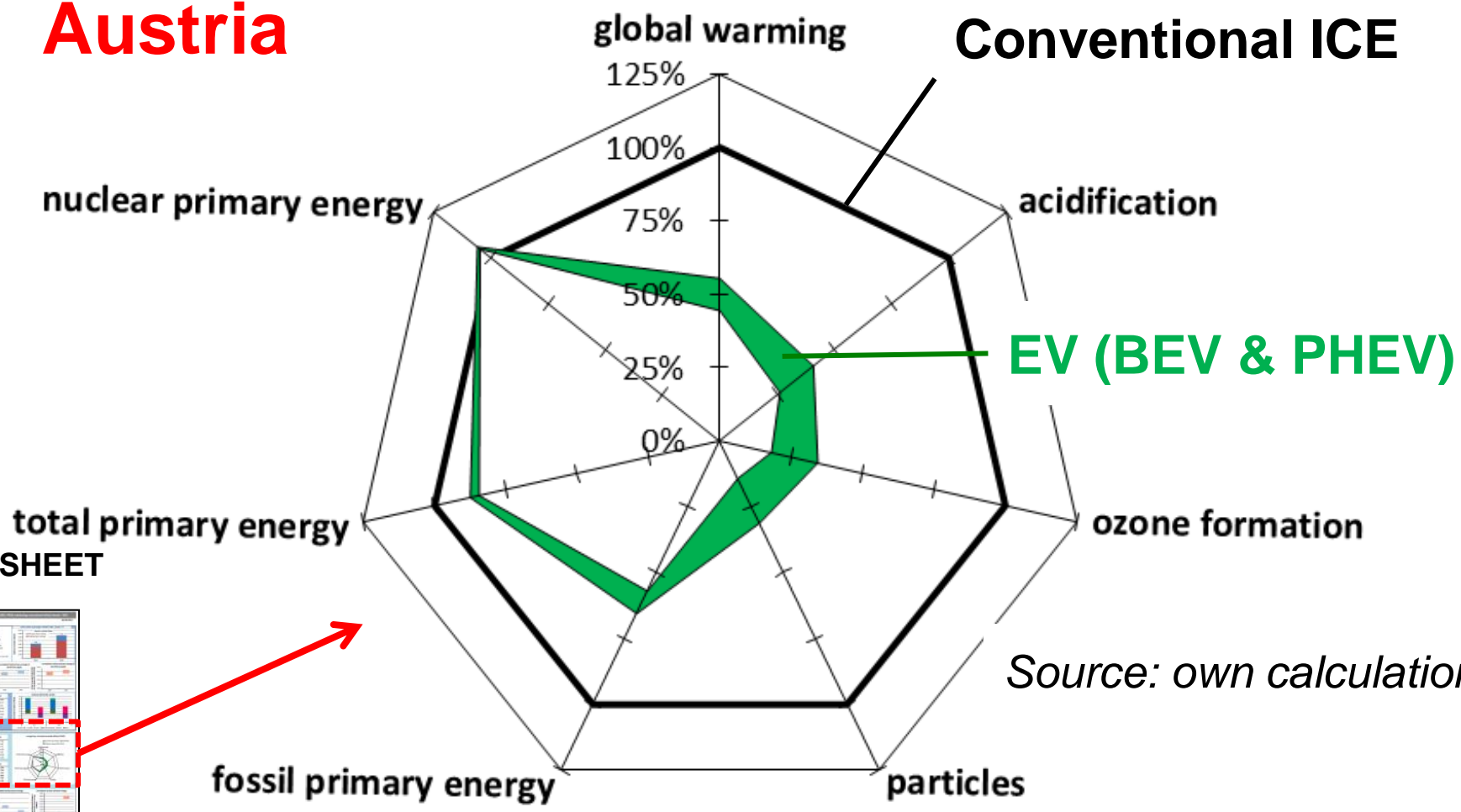
# ENVIRONMENTAL EFFECTS: Comparison ICE and BEV&PHEV

18

## Austria

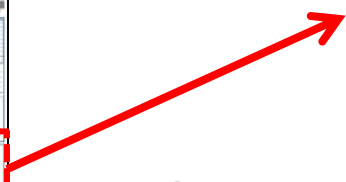
### Conventional ICE

### EV (BEV & PHEV)



Source: own calculations

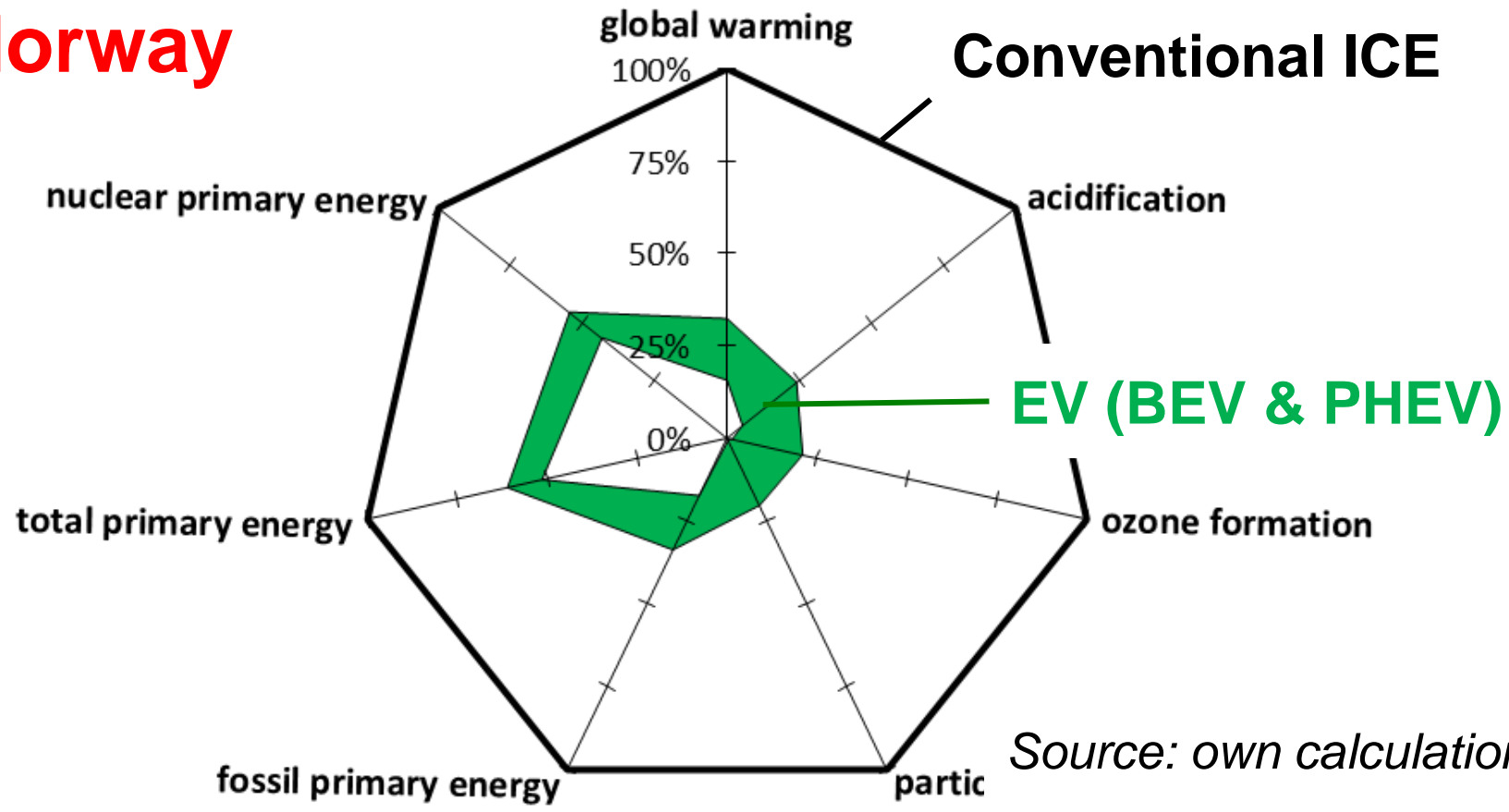
FACT SHEET



# ENVIRONMENTAL EFFECTS: Comparison ICE and BEV&PHEV

19

## Norway

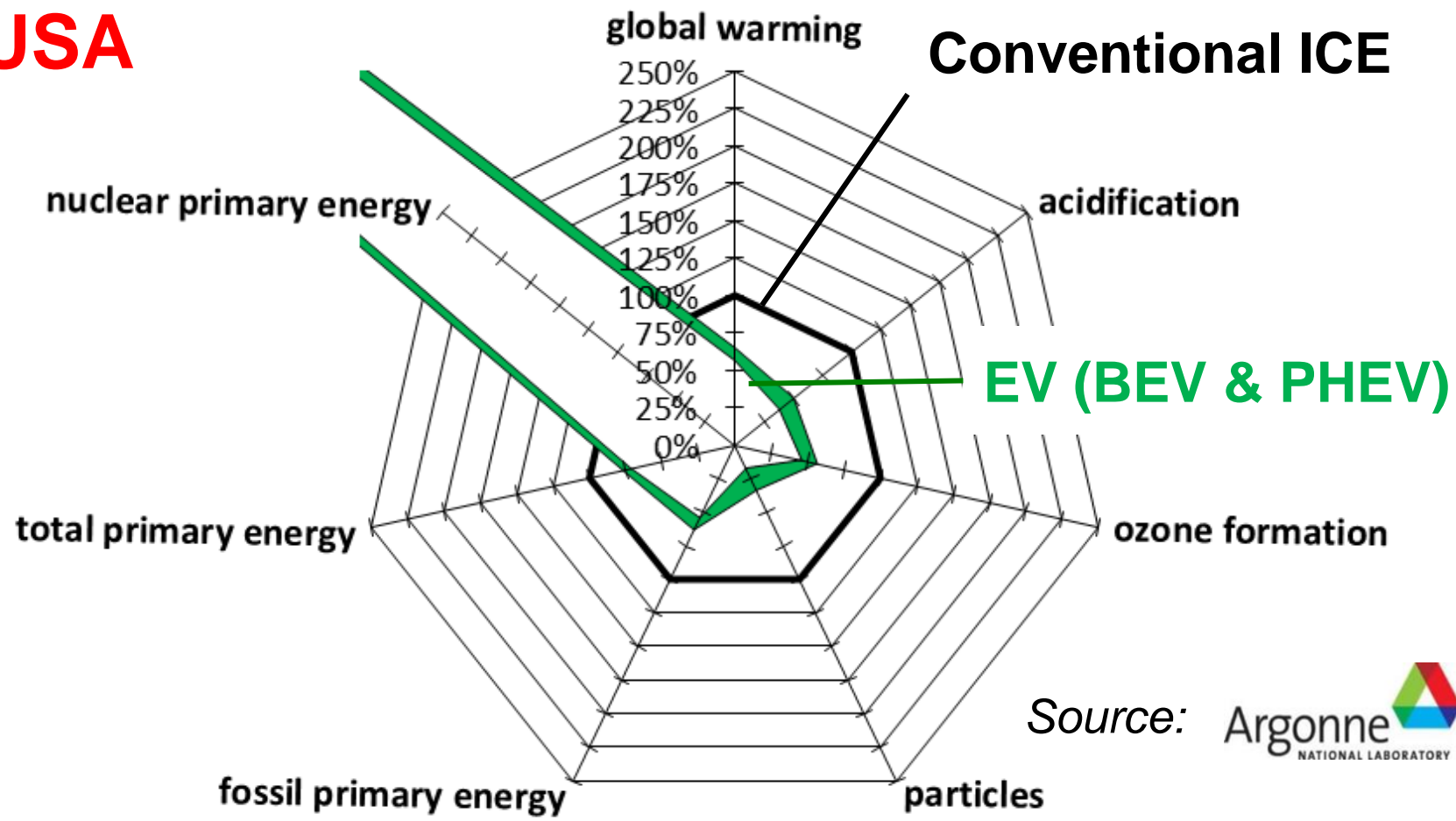


Source: own calculations

# ENVIRONMENTAL EFFECTS: Comparison ICE and BEV&PHEV

20

## USA



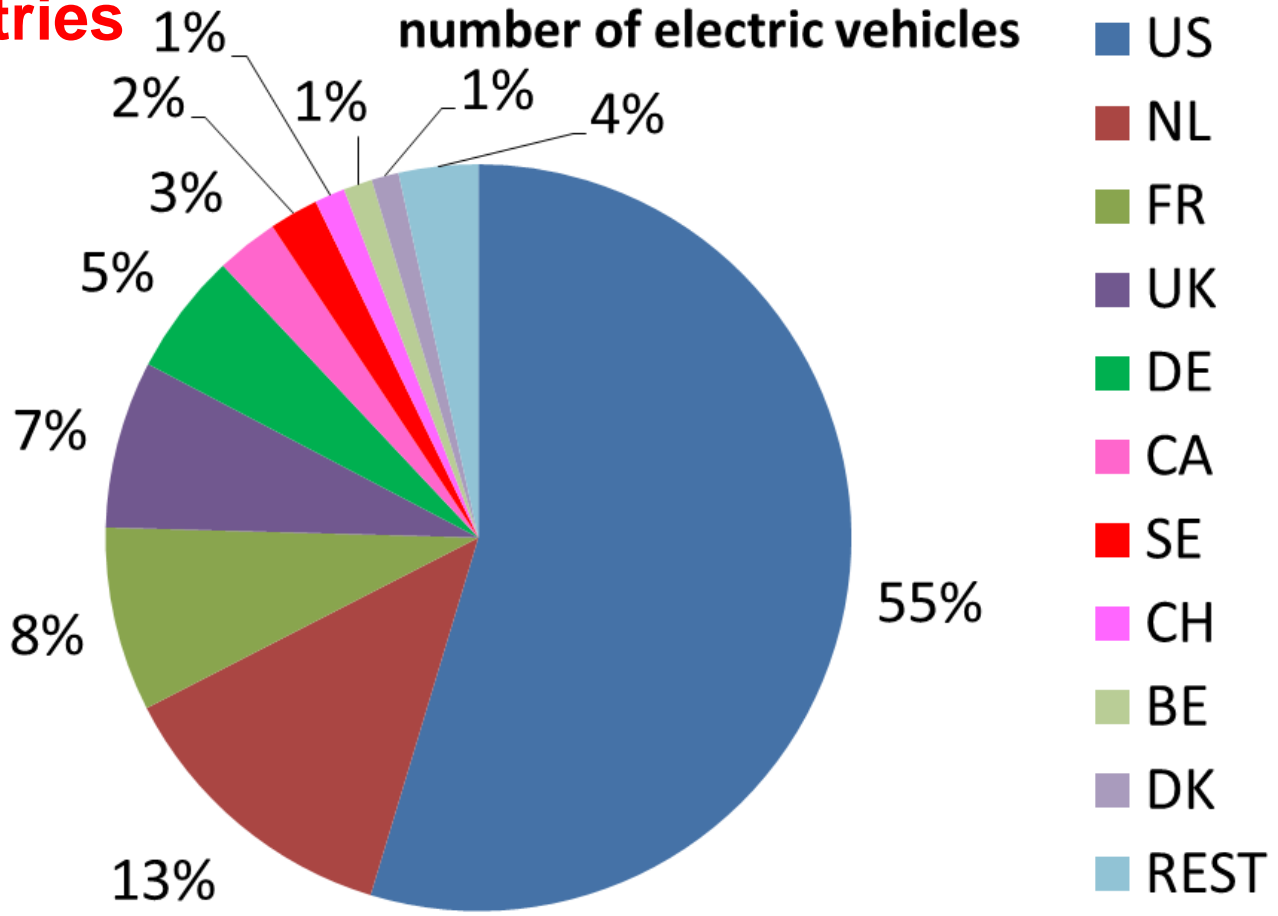
Source: Argonne NATIONAL LABORATORY

# BASIC DATA:

## Number of Electric Vehicle

21

**IEA HEV Countries**  
**Total: 684,700**

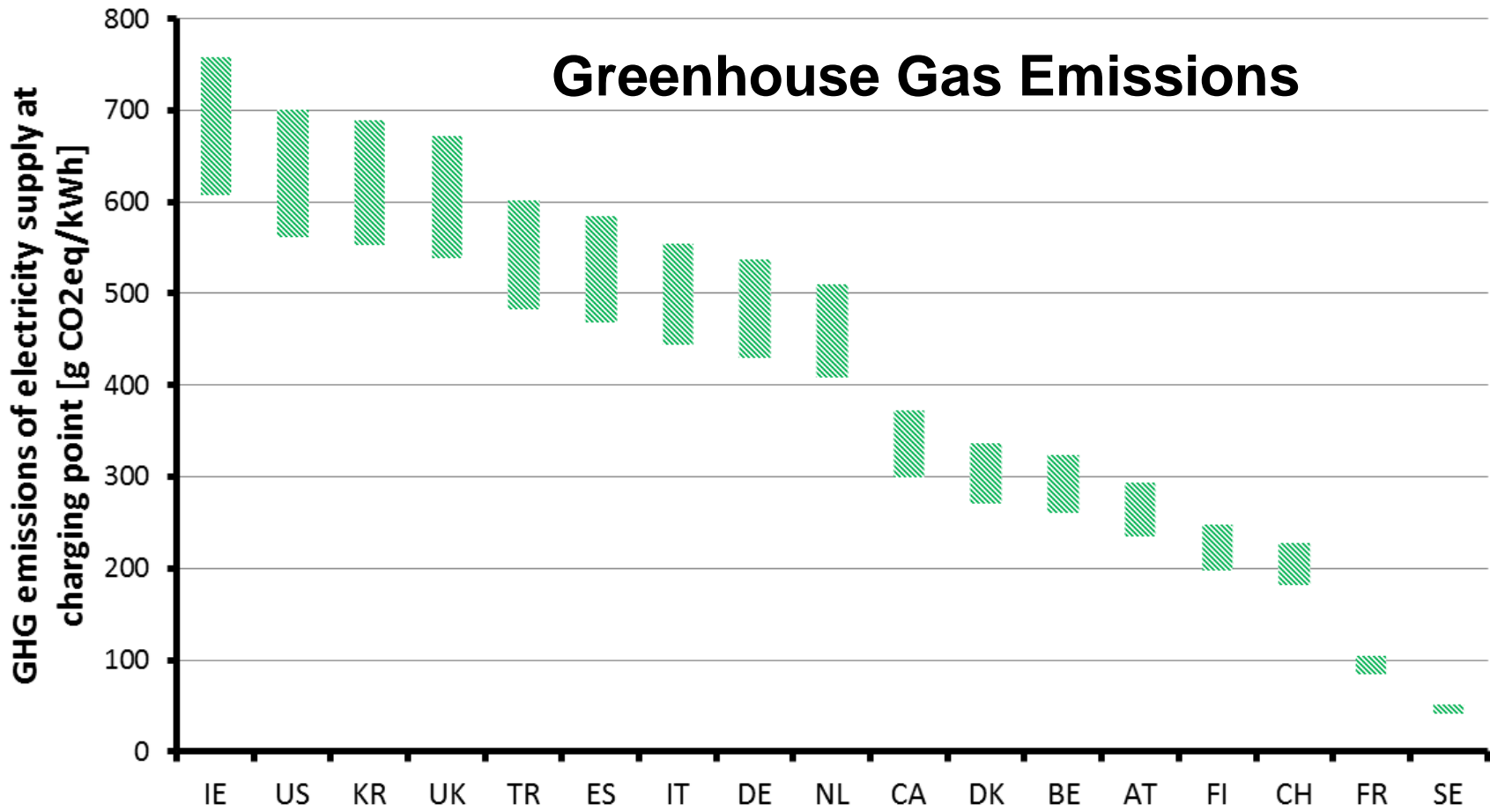


Source: IEA HEV annual report, EVI, ExCo members

# BASIC DATA:

22

## Estimated Environ. Effects of Electricity (I)

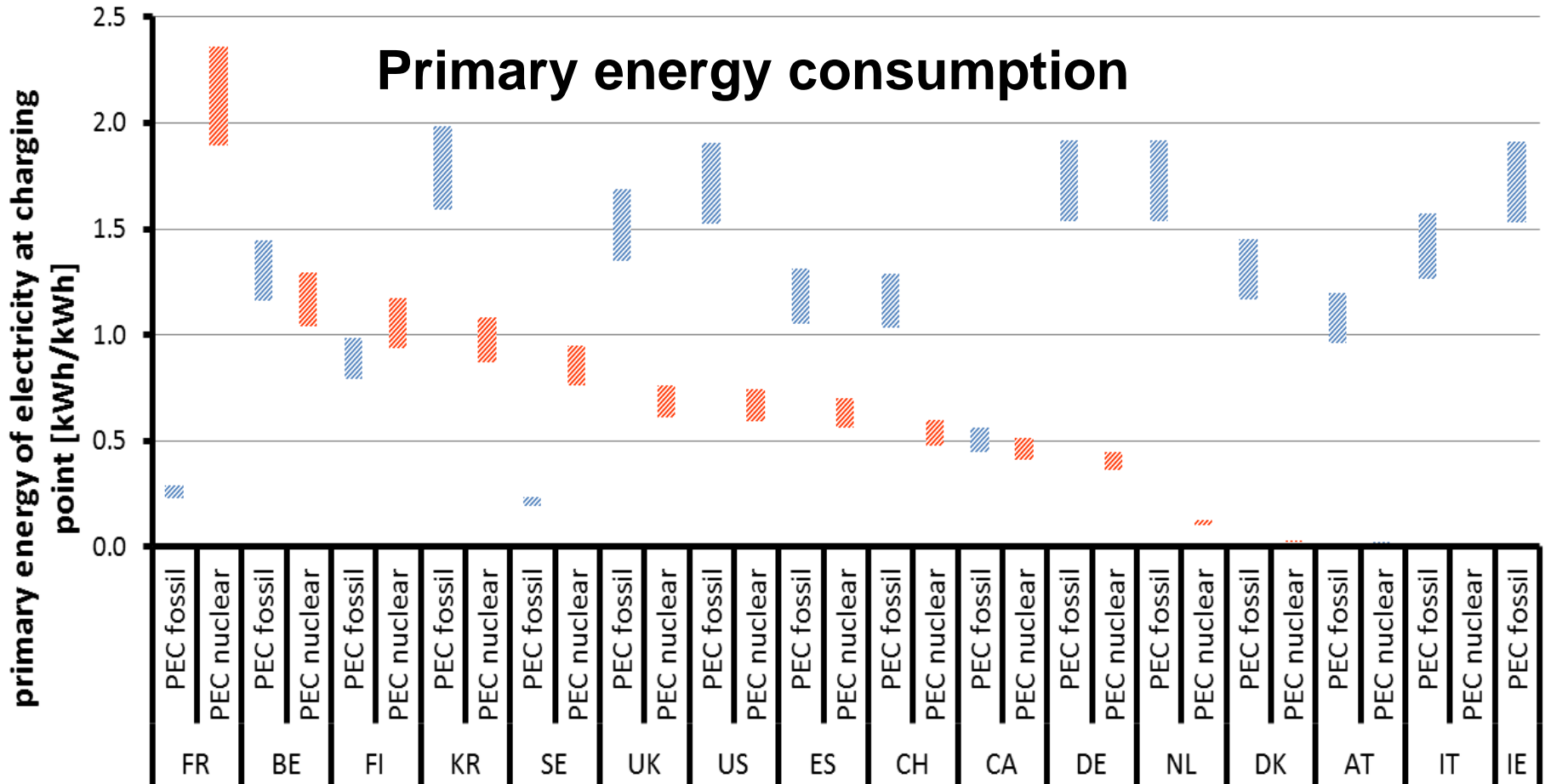


Source: own calculations using data from ecoinvent and GEMIS

# BASIC DATA:

## Estimated Environ.Effects of Electricity (II)

23

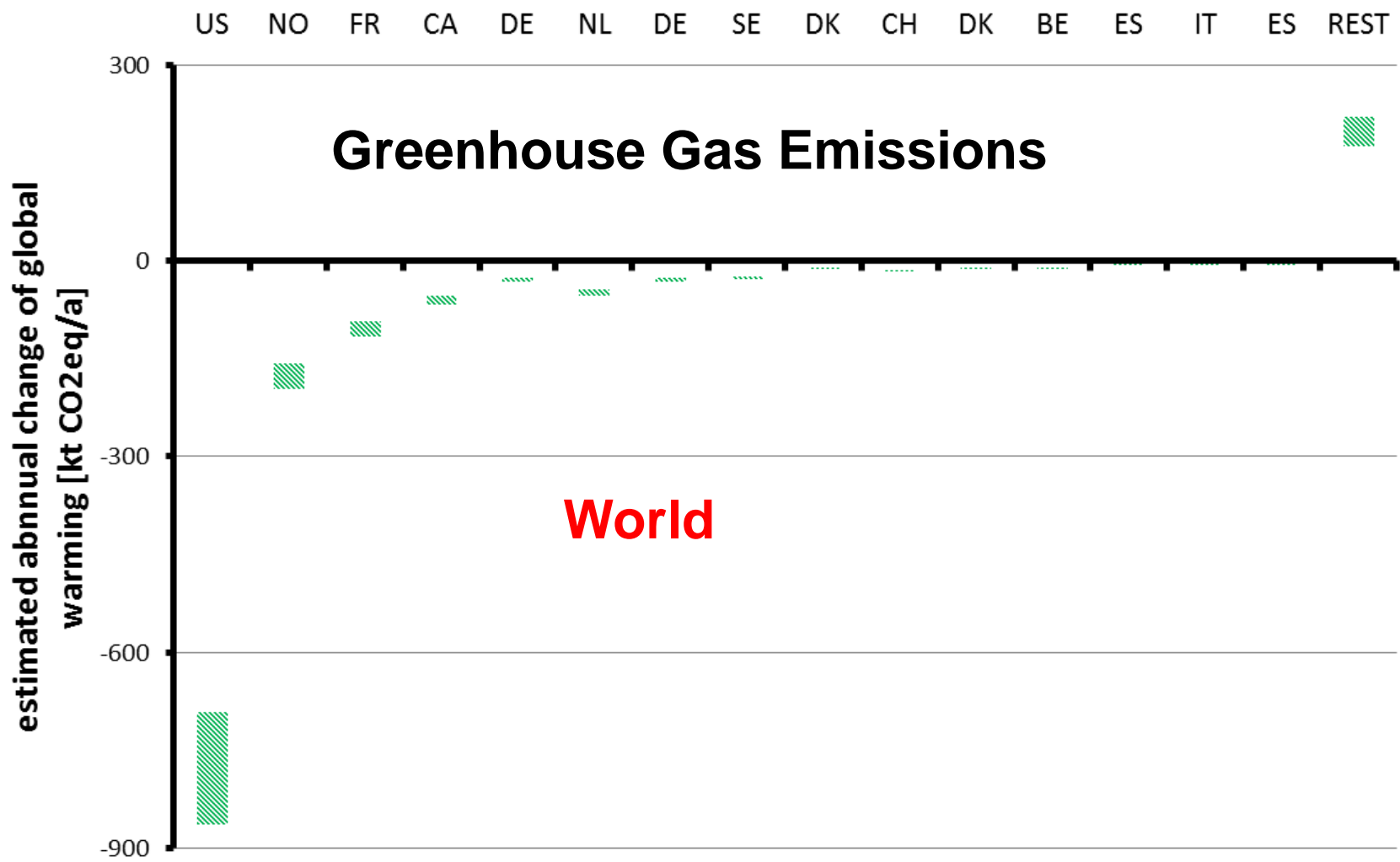


Source: own calculations using data from ecoinvent and GEMIS

# ENVIRONMENTAL EFFECTS:

## Estimated Annual Change of EV Fleet (I)

24



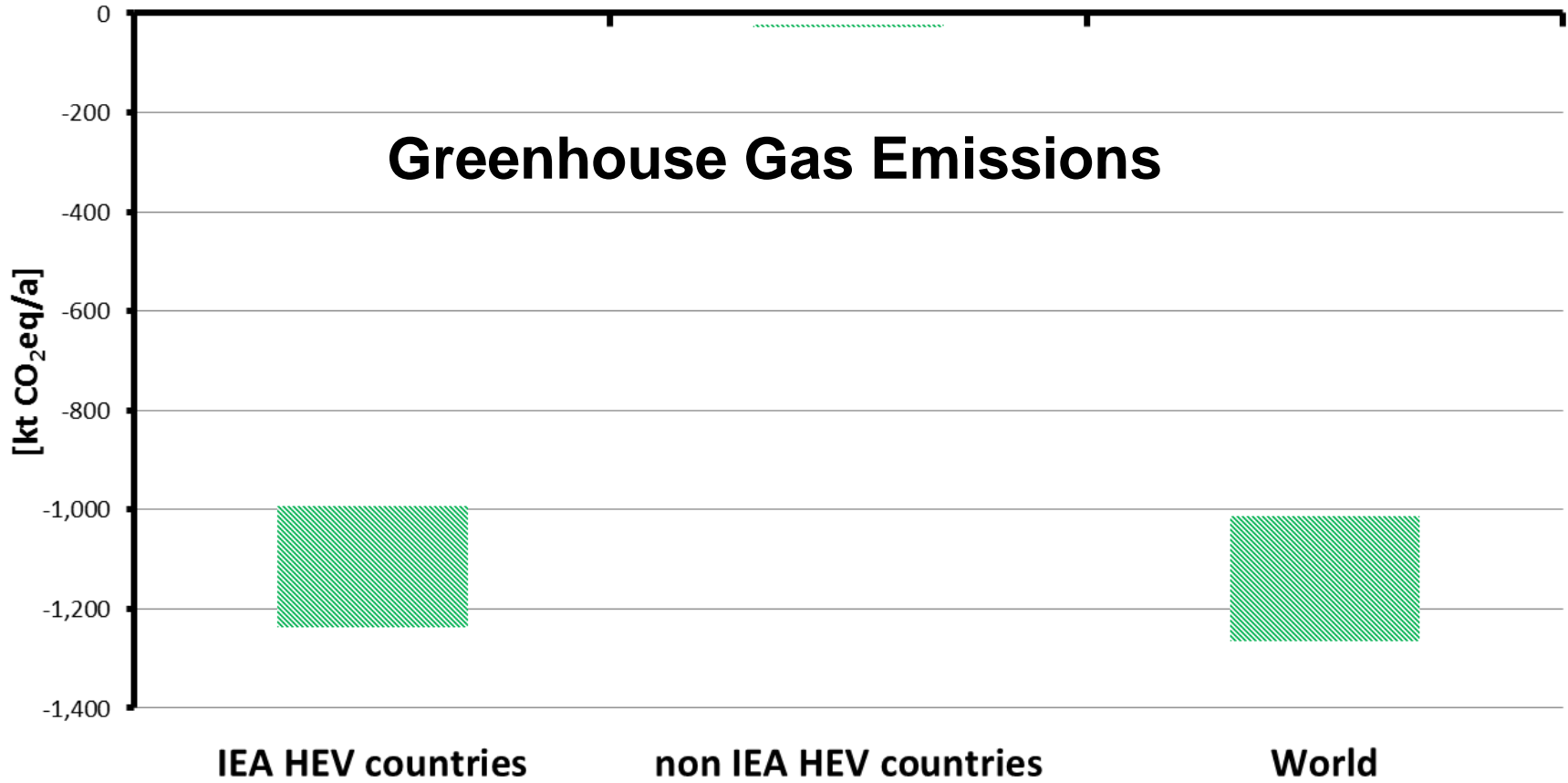


# World EV-Fleet (2015):

**1,234,999** BEV&PHEV of which  
**684,700** in IEA HEV countries

25

estimated annual change in GHG emissions



# Total Results

Estimation of the **average environmental benefits** of BEVs and PHEVs substituting diesel and gasoline globally shows

■ GHG-reduction:	- 25% to - 30%
■ PM < 10 reduction:	- 40% to - 50%
■ Acidification:	0% to - 5%
■ Ozone reduction:	- 50% to - 60%
■ Fossil primary energy reduction	- 25% to - 30%
■ Renewable primary energy increase	+ 10% to + 15%
■ Nuclear primary energy increase	+ 600% to + 800%
■ Total primary energy reduction	- 15% to - 20%

**Communication strategies are essential:** Interaction with stakeholders, show database, explain assumptions

Summary

**Additional renewable electricity** with adequate charging strategies is essential for further significant reductions

**Broad estimated ranges** mainly due to

- Emissions of national electricity production
- Electricity consumption of EVs at charging point
- Fuel consumption of substituted conventional ICEs
- Data availability, uncertainty and consistency, e.g. PM

**Estimation of environmental effects** substituting diesel/gasoline show positive environmental effects by 1.3 Mio. EVs in 2015

Key issues in **LCA methodology** and key data for electric vehicles are continuously **harmonized** in IEA HEV Task 19&30

Environmental Assessment of EVs only possible on

**Life Cycle Assessment** compared to conventional vehicles

# Your Contact

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**Operating Agent**  
**IEA HEV Task 30 & 33**

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