

# Life Cycle Assessment of Driving Electric Cars and Scope Dependent LCA models

Dr. Rolf Frischknecht  
ESU-services GmbH



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## Outline

- Goal and scope
- Main characteristics of the cars analysed
- Results and sensitivity analysis
- Conclusions and recommendations

## Life cycle assessment of electric cars

- comparison of driving passenger cars
  - conventional Diesel
  - conventional gasoline
  - conventional natural gas
  - best in class Diesel
  - electric
  - city car (lightweight), Diesel or electric based on a life cycle assessment

## What do we need to drive a car?

- a car
  - manufacture
  - use
  - recycling and disposal
- roads
  - construction
  - operation, maintenance and renewal
  - dismantling
- and ...

## ... Fuel

- Gasoline or Diesel
  - average supply situation in Switzerland
- electricity
 

	CH Mix	certified Mix
- coal/oil:	0%	0%
- natural gas:	1%	0%
- nuclear:	27%	0%
- hydro:	31%	97%
- new renewables:	0%	3%
- imports:	39%	
- Scenarios: different electricity sources

## Environmental impacts

- Primary energy, total
- Climate change (global warming potential 2007)
- Environmental impacts  
ecological scarcity method 2006
- high level radioactive waste

## characteristics of cars analysed

- “lower compact” class (“Golf” class)
- best available technology
- Lifetime performance car: 150'000 km
- lifetime performance battery: 75'000 km  
2 batteries per car life (on average)
- average occupation: 1.6 Persons per car

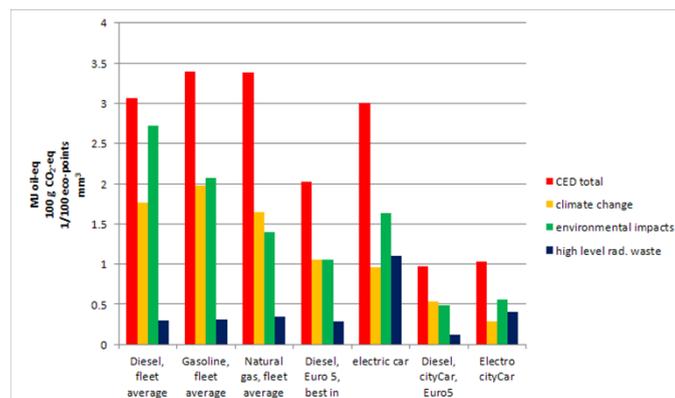
## characteristics lightweight car

- loremo concept car
- seats: 2 + 2
- suited for all kinds of propulsion technologies  
diesel and gasoline (2 cyl. turbo), Electro (synchron)
- lifetime performance car: 150'000 km
- lifetime performance battery: 150'000 km
- average occupation: 1.6 persons per car

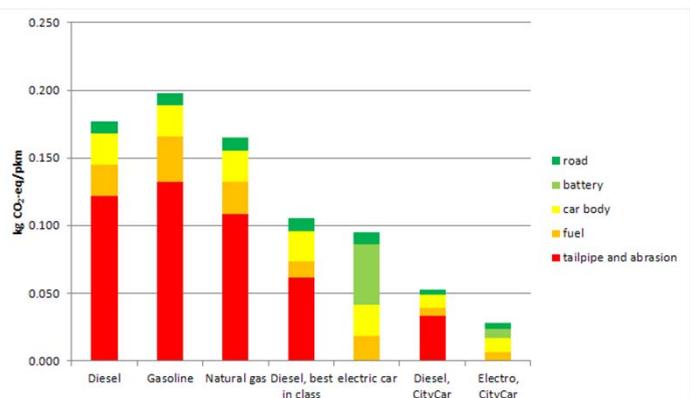
## Further characteristics

property	Unit	Electric car	Hybrid car	Diesel car	City car electro	City car Diesel
Weight of car	kg	1320	1320	1320	550	550
Weight of battery	kg	312	38	-	100	-
Power	kW	60	73/60	77	40	20
Weight of electro motor	kg	104	104	-	70	-
Energy density bat cells	Wh/kg	130	100	-	150	-
Cruising range	km	133	-	-	143	-
electricity / 100 km	kWh	20	-	-	7	-
fuel / 100 km	Litre	-	4.3	3.8	-	2.0

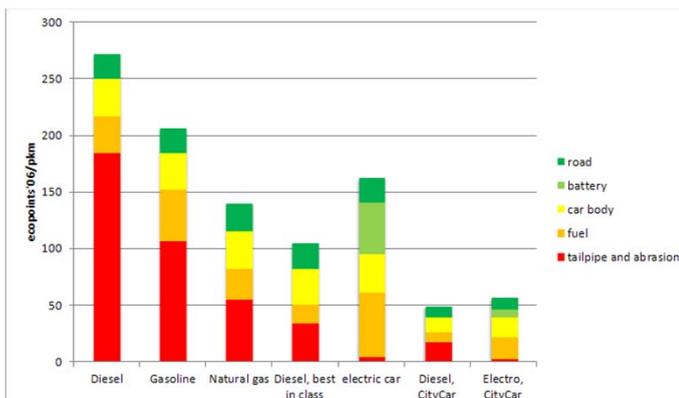
## Environmental impacts of car driving



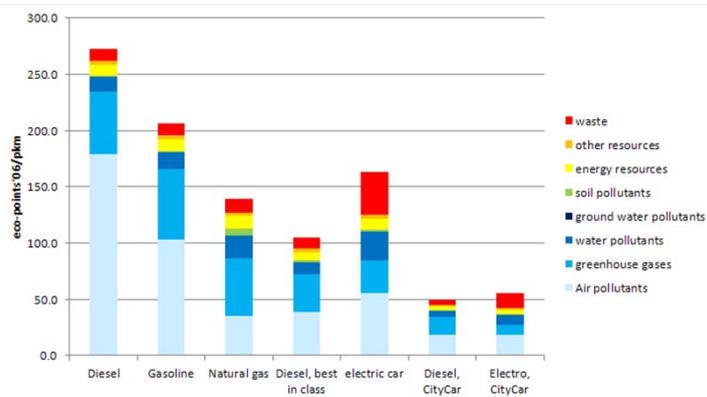
## Climate change impact of car driving



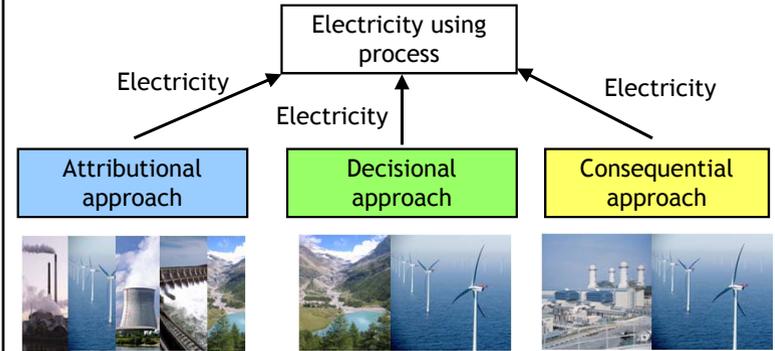
## Environmental impacts (eco-points 2006)



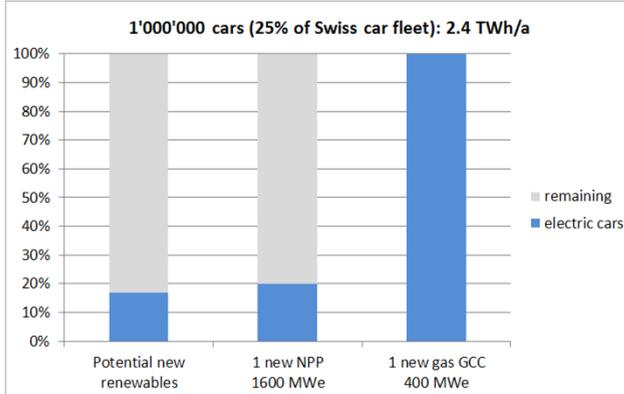
## Environmental impacts (eco-points 2006)



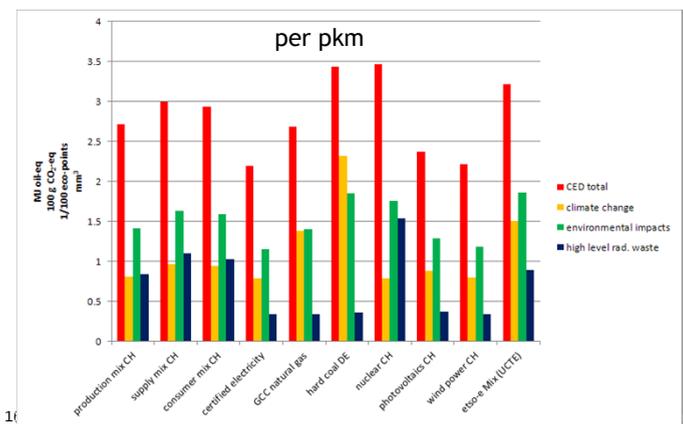
## 3 approaches for modelling electricity in LCA



## How to cover additional electricity demand?



## Sensitivity: electricity mix



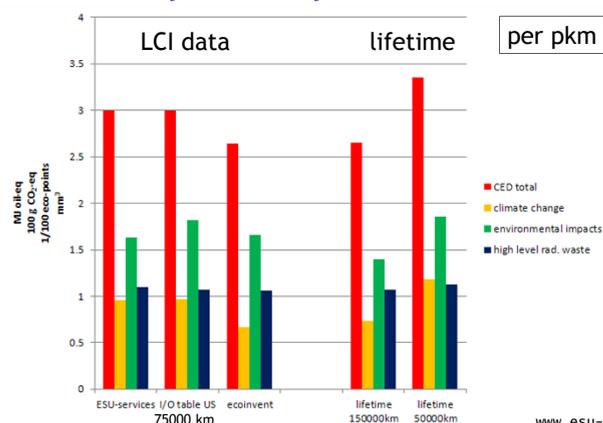
## battery manufacture

- information based on environmental report of Maxell Corp. Japan
- energy demand calculated by allocation of total demand via share of sales and unit price of battery
- electricity demand (CN, JP): 10.2 kWh/kg
- heat demand (oil, natural gas): 1 Litre oil-eq/kg
- lithium content in battery: 11 g/kg battery

## 1 kg battery: impact indicator results

	Unit	Primary energy	climate change	environmental impact	high level rad waste
ecoinvent data v2.2	kg	109	5.8	15.6	17800
<b>ESU-services</b>	kg	<b>265</b>	<b>17.1</b>	<b>23.3</b>	<b>17500</b>
Input-Output	kg	267	17.8	0	32300
Zackrisson et al. 2010	kg	n.a.	15.5-25	n.a.	n.a.
Ishihara et al. 2002	kg	200	10	n.a.	n.a.

## Sensitivity: battery data and lifetime



## Synthesis

- Energy efficiency of electric car - Diesel car comparable
- CO<sub>2</sub> footprint electric car and best in class Diesel comparable
- Reduction potential dependent on
  - size of car
  - fuel- and electricity demand, respectively
  - battery manufacture and -lifetime and
  - electricity mix

## Synthesis (cont.)

- Environmental impacts comparable
- Environmental impacts electric car: from tailpipe to power plant (and battery manufacture)
- Depending on electricity mix, impacts may be higher (high radioactive waste)
- Light weight cars with significantly lower impacts compared to current best in class cars

## Conclusions

- Electric cars are no silver bullets for the challenges of individual mobility

More important than propulsion technology is:

- Reduction of the fleet consumption
- Reduction of the fleet consumption
- Reduction of the fleet consumption

## Recommendations

- Accentuation of the requirements of the energy label of passenger cars
- Incentives for lower specific consumption  
Minergy / Minergy-eco / Minergy-P Label for cars!
- Improve general conditions favouring intelligent combined mobility concepts



Thank you very much for your attention!

contact:

[frischknecht@esu-services.ch](mailto:frischknecht@esu-services.ch)

Website:

[www.esu-services.ch](http://www.esu-services.ch)