Sustainable Mobility
Supplying Clean and Affordable Energy for TUM’s Electric Vehicle MUTE

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TUM’s Electric Vehicle MUTE

Final energy demand (plug2wheel): 7.5 kWh/100km
Efficiency plug2wheel: 80%

Emissions? [gCO₂/km]
Costs? [€/100km]

Source: FTM
2010 Electricity Generation in Germany, Austria and Switzerland by Source

Germany

625 TWh
- Nuclear Energy: 22%
- Natural Gas: 13%
- Lignite: 23%
- Hard Coal: 19%
- Misc.: 11%
- Wind: 6%
- Hydro: 4%

Source: BMWi

Austria

71 TWh
- Hydro: 53%
- Hard Coal: 19%
- Misc.: 12%
- Natural Gas: 20%
- Crude Oil: 2%

Source: e-control

Switzerland

66 TWh
- Nuclear Energy: 38%
- Hydro: 57%
- Misc.: 5%

Source: Schweizerische Elektrizitätsstatistik 2010
V2G Load Management: Valley Filling and Peak Shaving

Installed Power Plant Capacity [GW]

- Peak Shaving
- Valley Filling
- Peak Load Power Plants
- Middle Load Power Plants
- Base Load Power Plants
- Renewable Energy Feed-In
- Load Forecast

Hour of Day [h]
Composition of the MUTE’s Charging Mix in Germany 2015

→ 67 gCO₂/km and 1,30 €/100km
EV Emission Scale: Specific CO$_2$ Emissions Attributable to the MUTE in Various Countries 2015

→ Scenario: controlled charging during off-peak hours

Renewables!
Charging the MUTE with Electricity from Renewable Sources

- Micro - CHP
- Photovoltaics
- Micro – Wind
- Storage
- Grid

2 kWh (Lithium-Ion)

9 kW
2 kW

→ investment costs: 23,000 €
→ state incentives EEG: 22,000 €

0 g CO₂/km
0.40 €/100km

max. 1 %

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Exemplary Coverage of the Charging Demand of the MUTE at a Typical Day in Summer

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Exemplary Coverage of the Charging Demand of the MUTE at a Typical Day in Winter

- PV
- wind
- storage
- electricity purchase
- charging demand

Winter

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### Summary and Conclusion

#### MUTE

<table>
<thead>
<tr>
<th>Car Model</th>
<th>ICE</th>
<th>Off-Peak Charging Grid Power Plants</th>
<th>Renewables Sun, Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daimler Smart</td>
<td>Diesel</td>
<td>88 gCO₂/km</td>
<td>0 gCO₂/km</td>
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<tr>
<td></td>
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<td>4,50 €/100km</td>
<td>0,40 €/100km</td>
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<td>MUTE</td>
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</tbody>
</table>

Source: FTM

Source: Daimler
Recent Publications

• Kandler, C.: *Energiewirtschaftliche Optimierung der hauseigenen erneuerbaren Stromerzeugung zur Versorgung eines Elektrofahrzeugs.* Diplomarbeit am Lehrstuhl für Energiewirtschaft und Anwendungstechnik (IfE), TU München, Oktober 2010


Questions?