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Environmental and Cost Assessment of Motorcycles

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Capacity Area B2 SCCER Mobility

Paul Scherrer Institut

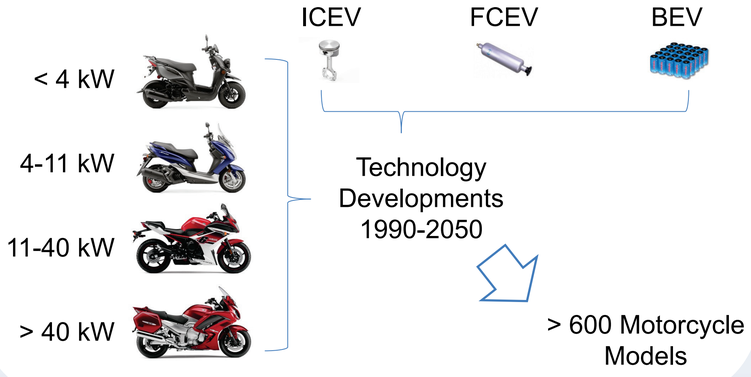
Introduction

- Motorcycles make up only 3% of total passenger kilometers in Switzerland. However, due to their lower operating costs and environmental impacts compared to passenger cars they are seen to have a great potential for the future transportation system.
- Advanced powertrain motorcycles may be able to further reduce the environmental impacts of motorcycle travel compared to conventional motorcycles.

Aim

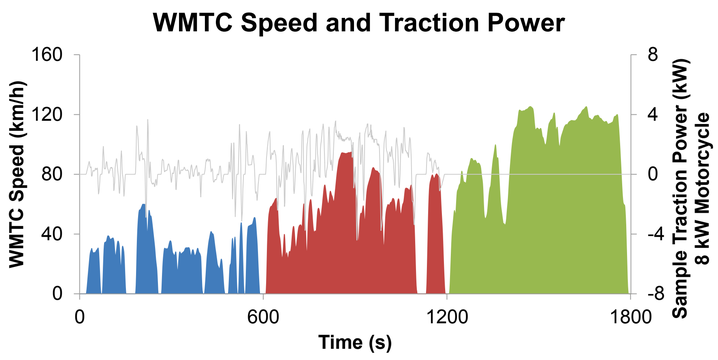
- Examine the life cycle costs and environmental impacts of different motorcycle size classes with conventional (ICEV), battery electric (BEV) and fuel cell electric (FCEV) powertrains. Compare current (2015) technology to estimated future (2050) technology.
- Develop models that allow consistent and fair comparison across different powertrains and size classes.

Motorcycles Assessed

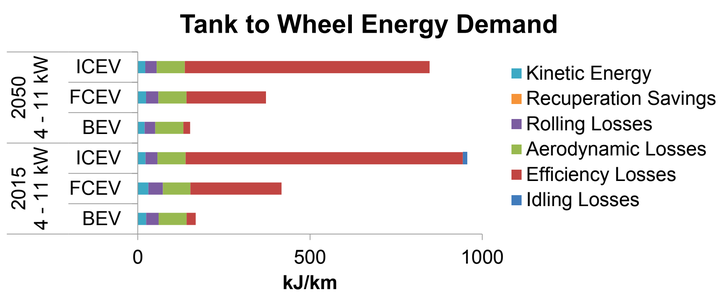


Motorcycle Modelling

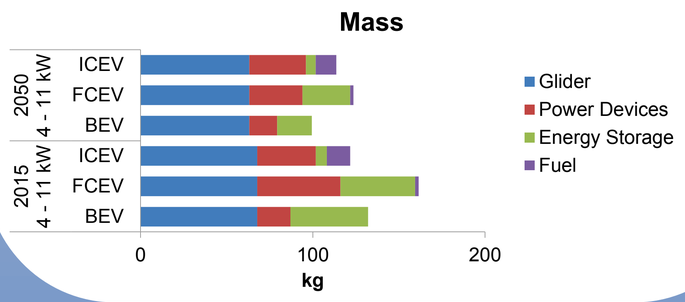
- Driving profile based on WMTC* velocity profiles.
- Traction power is calculated using assumptions for aerodynamic and rolling loss parameters for each motorcycle. *World harmonised Motorcycle emissions Test Cycle (WMTC)



- Traction power is integrated to calculate energy demand per kilometer.

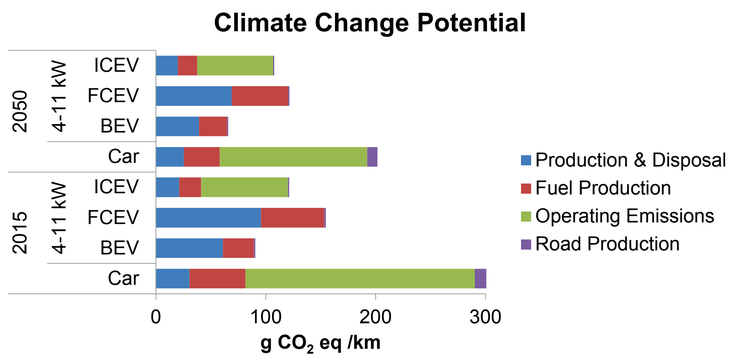


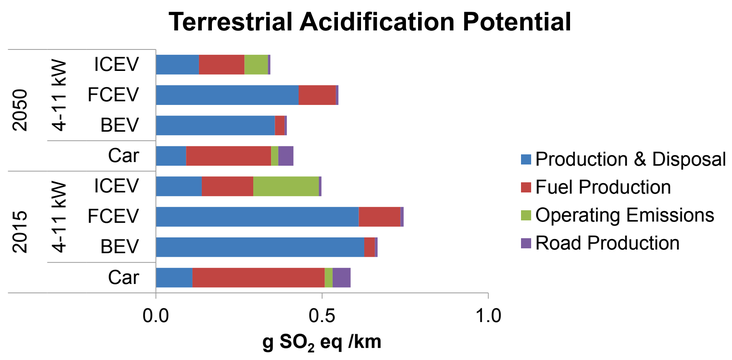
- The calculation is iterated with energy storage and range requirements to find final motorcycle mass and energy consumption.

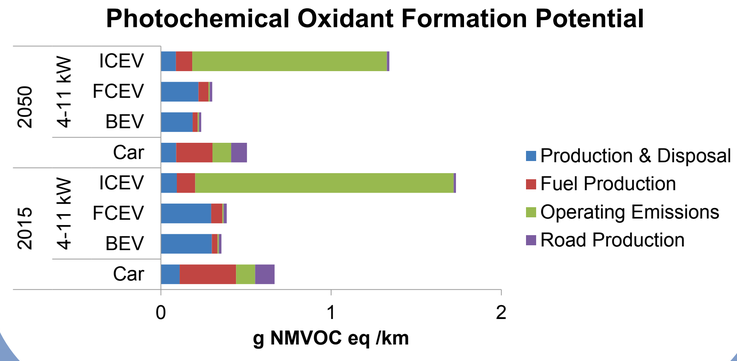


Environmental Results

- Life Cycle Assessment (LCA) methodology used.
- Functional unit is “1 vehicle km”.
- Cradle-to-grave system boundary.
- Comparison is with mid-sized car (VW Jetta).

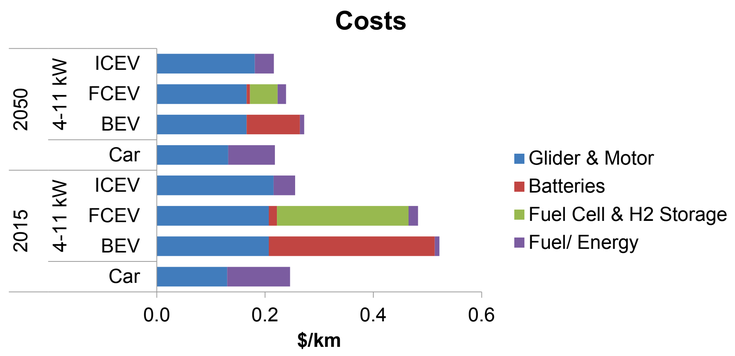






Cost Results

- Total ownership costs refer to costs seen by owner (do not include public infrastructure or external costs).



Conclusions

- Motorcycles perform better in most environmental categories than conventional cars.
- BEV have the lowest climate change impacts, even when charged with natural gas electricity.
- FCEV can have excellent environmental performance only if the hydrogen production pathway is renewable.
- Investment costs for motorcycles are more important than for cars because lifetime distance travelled is much lower.
- Advanced powertrain motorcycles have higher investment costs but lower operating costs than conventional motorcycles.
- Significant cost reductions are expected for advanced powertrains until 2050.

Outlook

PSI is developing consistent, high quality data for the environmental burdens and costs of transportation for current and 2050 technology levels.

Future work will include:

- extending existing data coverage to all transportation modes including road, rail, water and air for both personal and freight transportation for current and future technology levels.
- implementing more advanced models using state of the art LCA techniques such as consequential, dynamic and regionalized LCA.
- extending analysis to include other sustainability indicators such as noise, accident risk, etc..

Acknowledgements

- This research is conducted within the SCCER-Mobility.

Assumptions and Remarks

- Results presented only for 4-11 kW motorcycle size class
- Electricity from natural gas combined cycle plant
- Hydrogen from steam methane reforming
- All fuels cost $ 0.15 /kWh
- Motorcycle lifetime 32 000 km, 16 years
- Car lifetime 240 000 km
- Future discount rate 5%

References

- Bundesamt für Statistik (2013). Mobilität und Verkehr 2013.
- THELMA Project - Technology-centered Electric Mobility Assessment (2014). www.thelma-emobility.net.
- Bauer et. al. 2015 DOI:10.1016/j.apenergy.2015.01.019

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