

How green are e-cars in Sweden?

This exercise in the form of a research paper is suggested as an option to replace the virtual labs 1 and 2 in the KTH course SK183N, and, if passed, completes the lab part of the course (2 hp).

1 Motivation

The human society is expanding, consuming more and more of the planetary resources. In order to avoid or at least mitigate the related negative effects on our biosphere a development is on-going worldwide to replace some of the traditional oil-based transportation with more environment-friendly technologies, such as the private electrical or hybrid car. Armed with data from the open literature, show if and how well this transition is justified, technically, economically, environmentally.

2 Topics and tasks

Your task in this project is to compare, as detailed and illustratively as possible, the modern gasoline and diesel cars with the electrical and gas-el-hybrid counterparts. Think about the following aspects:

- e-cars can reduce carbon emission into atmosphere, reliance on oil.
- The “green effect” of e-plug-ins depends on the source of electricity used.
- Local electricity grids may have several sources: hydro, nuclear, bio, thermal, etc.
- Nuclear power is low-carbon, but how would you estimate its sustainability? Is it green?
- e-cars may be green to run, but what about extra emissions in manufacturing? Quantify.
- What is the breakdown of the electricity by sources for different regions of Sweden?
- What is the equivalent carbon emission by source (e.g. kg-CO₂/kWh) – hydro, nuclear, ...?
- Carbon emission of gasoline combustion is >2 kg CO₂/liter (plus actually about 0.5 kg CO₂/liter to produce gasoline). Similar numbers for diesel fuel.
- What is the average CO₂/kWh for electricity produced in Sweden? Any regional variation?
- For hybrid e-cars (non-plug-ins) the gasoline efficiency is higher but how does it compare with the resources spent to produce the electrical sub-system (extra engine and heavy battery)? Choose a popular hybrid model for Sweden (e.g. Toyota Prius or Auris) for numerical estimates. When (in units of distance traveled or years of use) does one recover the costs?
- Grid electricity can have direct effective emission (say, a bio-thermal power plant), indirect emission (from producing fuel for that power plant), and grid transmission losses.
- What is your conclusion on how green is a plugin e-car (running on grid electricity only) versus a regular gasoline or diesel car? Try to quantify in equivalent CO₂ emission.
- What is your conclusion on how green is a hybrid e-car (runs on gasoline, assisted by an electrical engine/battery system) versus a regular gasoline or diesel car?
- What is the spare capacity of the Swedish electrical grid for converting, say, one half of our private car fleet to e-plugin-cars? What are the practical limits today?
- It is informative to compare your conclusions for Sweden with another country, preferably having a carbon-heavy electricity generation grid (as opposed to Sweden’s low-carbon grid).

The above list is in no particular order and is not a dogma, but a good report should address many of the listed aspects. Creativity and improvisation is encouraged, those of the educated kind – based on

hard data and analysis rather than pure speculations. **Attempt to quantify all aspects discussed and make as few general-speculative statements as possible.**

3 Report

Produce a report in the form of a typical research paper:

- Title and author.
- Abstract – essence of the report in a few sentences.
- Introduction – context of the study, assumptions, aims.
- Analysis – technical, economic, environmental, data tables, graphs, modeling, simulations.
- Discussion of the results obtained.
- Conclusions.
- List of references.

The report does not have to be long in order to be informative. It is difficult, though, to expect the topic of this breadth and depth elaborated with a reasonable level of detail in less than several pages. All data sets must be properly referenced – attempt to use only respected sources, such as peer-reviewed academic journals, rather than hear-say blogs. The report can be written in English eller på svenska. A suitable total work effort is 1 to 2 weeks of full time study (motsvarande 2 hp).

4 Submission

Upload your report as a PDF file to Bilda in place of report for LAB 1 in SK183N. At the same time (to speed up the grading) send a short text note to vk@kth.se that you have – “subject: uploaded e-cars lab”. **The deadline is 2016-12-31** – the course is retired at the end of 2016.