# Closer look at life-cycle impacts of lithium-ion batteries and proton exchange membrane fuel cells

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Does it really help to drive an electric car if the electricity you use to charge the batteries come from a coal mine in Germany, or if the batteries were manufactured in China using coal?

Researchers at the Norwegian University of Science and Technology's Industrial Ecology Programme have looked at all of the environmental costs of electric vehicles to determine the cradle-to-grave environmental footprint of building and operating these vehicles.

In the 6 December issue of *Nature Nanotechnology*, the researchers report on a model that can help guide developers as they consider new nanomaterials for batteries or fuel cells. The goal is to create the most environmentally sustainable vehicle fleet possible, which is no small challenge given that there are already an estimated 1 billion cars and light trucks on the world's roads, a number that is expected to double by 2035.

With this in mind, the researchers created an environmental life-cycle screening framework that looked at the environmental and other impacts of extraction, refining, synthesis, performance, durability and recyclablility of materials.

This allowed the researchers to evaluate the most promising nanomaterials for lithium-ion batteries (LIB) and proton exchange

membrane hydrogen fuel cells (PEMFC) as power sources for electric vehicles. "Our analysis of the current situation clearly outlines the challenge," the researchers wrote. "The materials with the best potential environmental profiles during the material extraction and production phase.... often present environmental disadvantages during their use phase... and vice versa."

The hope is that by identifying all the environmental costs of different materials used to build electric cars, designers and engineers can "make the right design trade-offs that optimize LIB and PEMFC nanomaterials for EV usage towards mitigating climate change," the authors wrote.

They encouraged material scientists and those who conduct life-cycle assessments to work together so that electric cars can be a key contributor to mitigating the effects of transportation on climate change.

**More information:** Linda Ager-Wick Ellingsen et al, Nanotechnology for environmentally sustainable electromobility, *Nature Nanotechnology* (2016). DOI: 10.1038/nnano.2016.237

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