



## The energy efficiency of cars

Posted by [Euan Mearns](#) on February 16, 2009 - 10:43am in [The Oil Drum: Europe](#)  
Topic: [Economics/Finance](#)

Tags: [automobile](#), [bbc](#), [energy efficiency](#), [eroei](#), [ethanol](#), [fuel cell](#), [honda](#), [hydrogen](#), [jeremy clarkson](#), [original](#), [saab](#), [tesla](#), [top gear](#), [volvo](#) [list all tags]

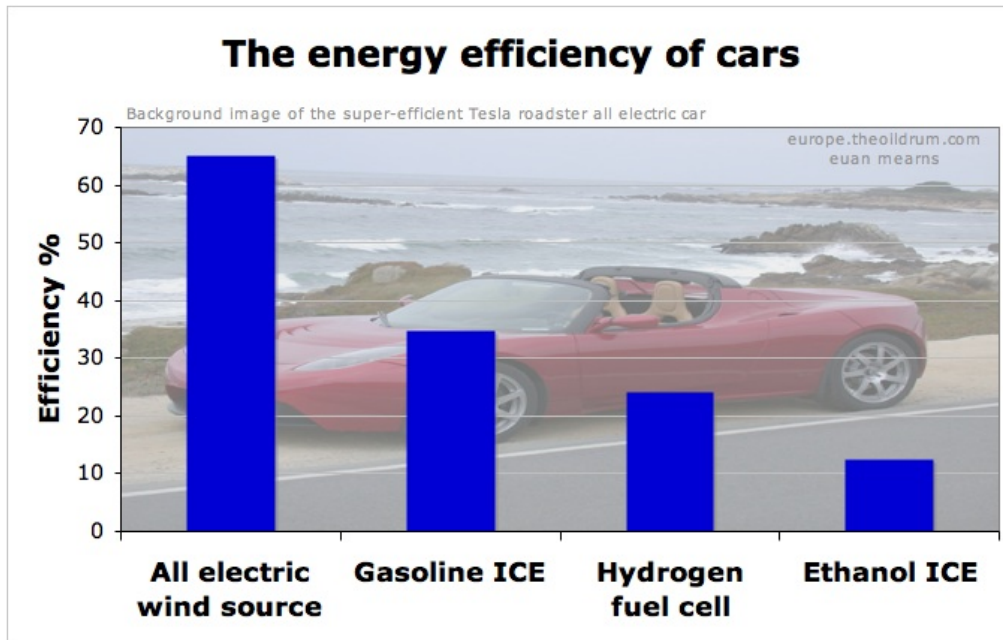


Chart updated 28 February to take account of [this comment](#) from [Profbaldwin](#).

The future of motor vehicles lies in improved efficiency and that is to the left of the gasoline ICE in the chart. That future is electric vehicles powered by high EROEI renewable electricity.

This post is not intended to provide a rigorous analysis of automobile efficiency but aims to provide an overview of the efficiencies of different drive system - fuel combinations.

The procedure followed is to identify the main energy efficiency factors and to multiply these to provide the overall efficiency in %. The efficiency of fuel source is based on EROEI where:

$ERoEI = \text{energy procured} / \text{energy used to procure energy}$

$\text{Efficiency} = (ERoEI - 1) / ERoEI$

I have not considered the energy embedded in the vehicles and energy losses downstream from the motor in the drive systems. The objective is to highlight the major differences between the 4 fuel / drive system combinations.

## The all electric car powered by renewable wind electricity

ERoEI for wind ~ 20, efficiency factor = 0.95  
Grid transmission losses = 0.9  
Battery efficiency = 0.97  
Motor efficiency = 0.92

Combined efficiency = 76.3%

## Gasoline internal combustion engine (ICE)

Procuring oil, ERoEI = 30 (assumed), efficiency = 0.967  
Refining and transport losses = 0.9  
ICE efficiency = 0.4

Combined efficiency = 34.8%

## Hydrogen fuel cell

The calculation is based on producing hydrogen from electrolysis of water using wind power electricity and is based heavily on an analysis by Ulf Bossel (reference at end).

Wind power, as for all electric car = 0.95  
Losses due to electrolysis of water = 0.7  
Compression of hydrogen = 0.9  
Losses during distribution = 0.9  
Losses during hydrogen transfer = 0.97  
Fuel cell efficiency = 0.5  
Motor efficiency = 0.92

Combined efficiency = 24%

## Bio-ethanol internal combustion engine

ERoEI for temperate latitude ethanol ~ 1.5, efficiency = 0.33  
Processing and delivery (estimate) = 0.95  
ICE efficiency = 0.4

Combined efficiency = 12.5%

## Hybrids and plug-in hybrids

I've not covered these but assume that their efficiency will lie between gasoline ICE and all electric.

The world, and in particular the UK, is currently in the eye of the storm of a full blown energy crisis. I think virtually everyone is agreed that improving energy efficiency is essential to the short-term survival of our industrial economies. It is therefore extremely pertinent to ask why EU and US governments have and are still supporting ethanol production for vehicular transportation? And in my own country (Scotland) why it is that our parliament continues to support [hydrogen fuel cell research](#) and to offer the false hope of a hydrogen economy?

At the same time it is pertinent to ask what on earth has driven [Saab](#) and [Volvo](#) to produce ethanol powered vehicles that are arguably the least energy efficient cars built in recent decades. What are their engineers thinking about, and why?

The future of motor vehicles lies in improved efficiency and that is to the left of the gasoline ICE in the chart up top. That future is electric vehicles powered by high EROEI renewable electricity.

On a final more light hearted note, many UK readers will be familiar with the BBC motoring program [Top Gear](#), hosted by Jeremy Clarkson the self styled opponent of all things politically correct who recently added to his notoriety by describing Prime Minister Gordon Brown as a [one eyed Scottish Idiot](#). A number of weeks ago Top Gear road tested the [Tesla](#) all electric car to destruction and a [Honda hydrogen fuel cell vehicle](#) - which the Top Gear team loved. They explained that hydrogen was abundant, but stuck on to other stuff. And all that had to be done was to scrape it off. Guys, I'm a great fan of your show, but please take some time to ponder the chart up top and to maybe bring some energy reality to the motoring debate.

*Top Gear: Perhaps Clarkson would like to test drive this model? Shown is the [all electric Fiat 500](#).*

## Some data sources:

[Hydrogen fuel cells](#)

[Internal combustion engine](#)

[Electric motors](#)

[Batteries](#)

[Wind power](#)



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