Driving Economy

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Outline

Energy sources and costs

Energy needs

Engine efficiency

Some of the science

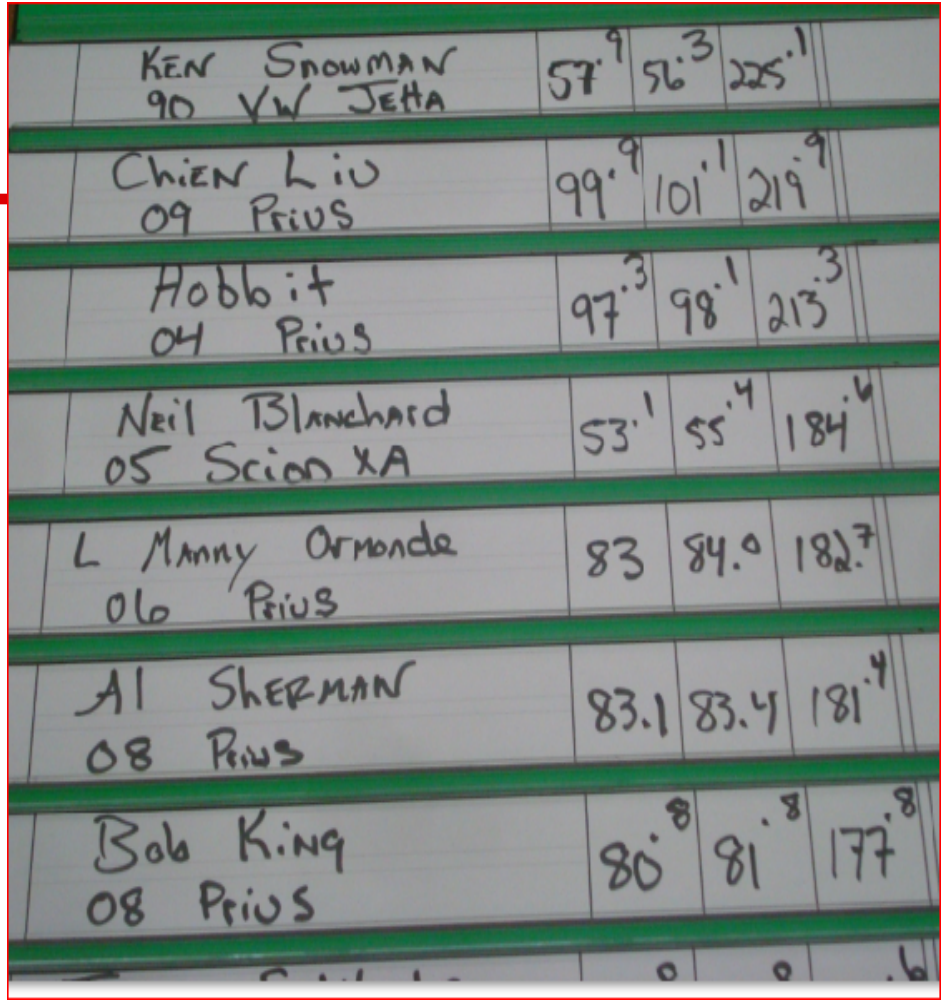
How you can $ave energy

My Credentials

I follow online discussion groups (Prius) and practice frugal driving.

Acton Toyota economy run competition (2011):

81.3 MPG / 25 mile loop



Energy Sources

Power sources are equivalent. Could be gasoline, diesel, CNG, electric, H_2, etc.

Some energy units: kWh, Joule, hp-hr, BTU, calories, tons of TNT, Therms, ft-lbs, etc..

Conversion example: 1 gallon [U.S.] of automotive gasoline = 36.6 kilowatt hours

http://www.onlineconversion.com/energy.htm

Energy Costs

Must include efficiency considerations, for example comparing electric to gasoline power.

Cost in $ vs cost to the planet?

Measure consumption at source?

Why does a vehicle need energy?

Example: Climb hills

Other?

Why does a vehicle need energy?

Climb hills

Accelerate (increase speed)

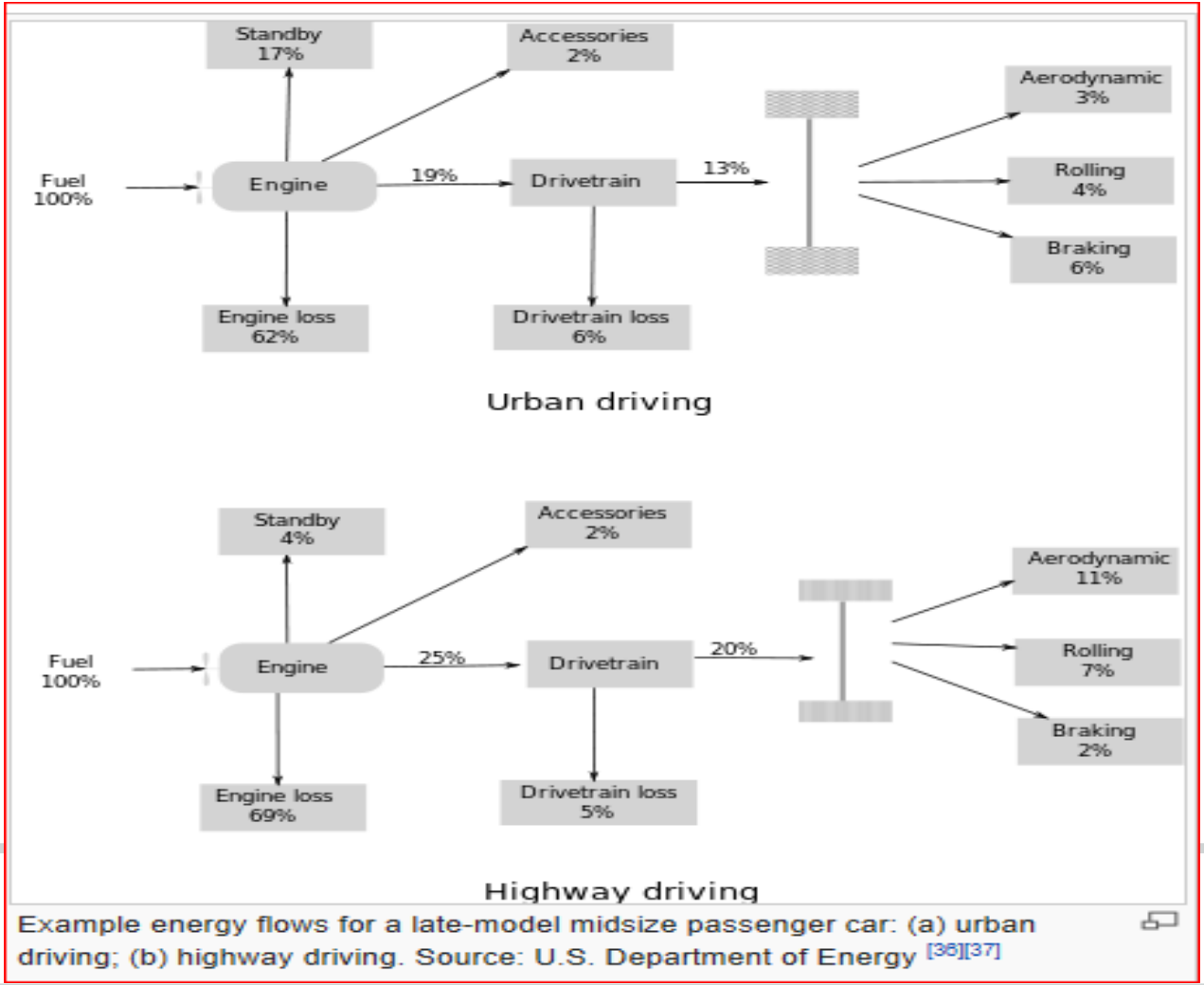
Move through the air

Heat, Light, A/C

Charge Battery

Tire rolling resistance

Keep engine running



Example energy flows for a late-model midsize passenger car: (a) urban driving; (b) highway driving. Source: U.S. Department of Energy [36][37]

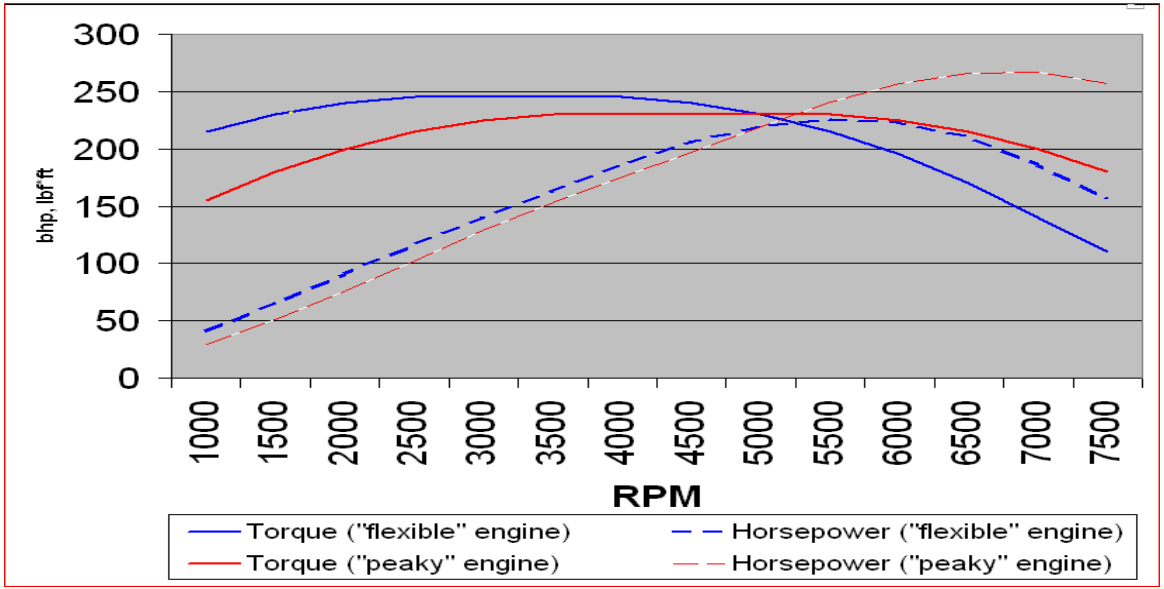
How do you obtain the energy?

We will discuss the gas engine (ICE), but much of what we cover will apply to other sources.

Some conditions cannot be controlled. Engines are inefficient during warm up. Cold weather and short trips make for low efficiency.

Power and Torque Curves

Does not consider efficiency.



http://en.wikipedia.org/wiki/Power_band

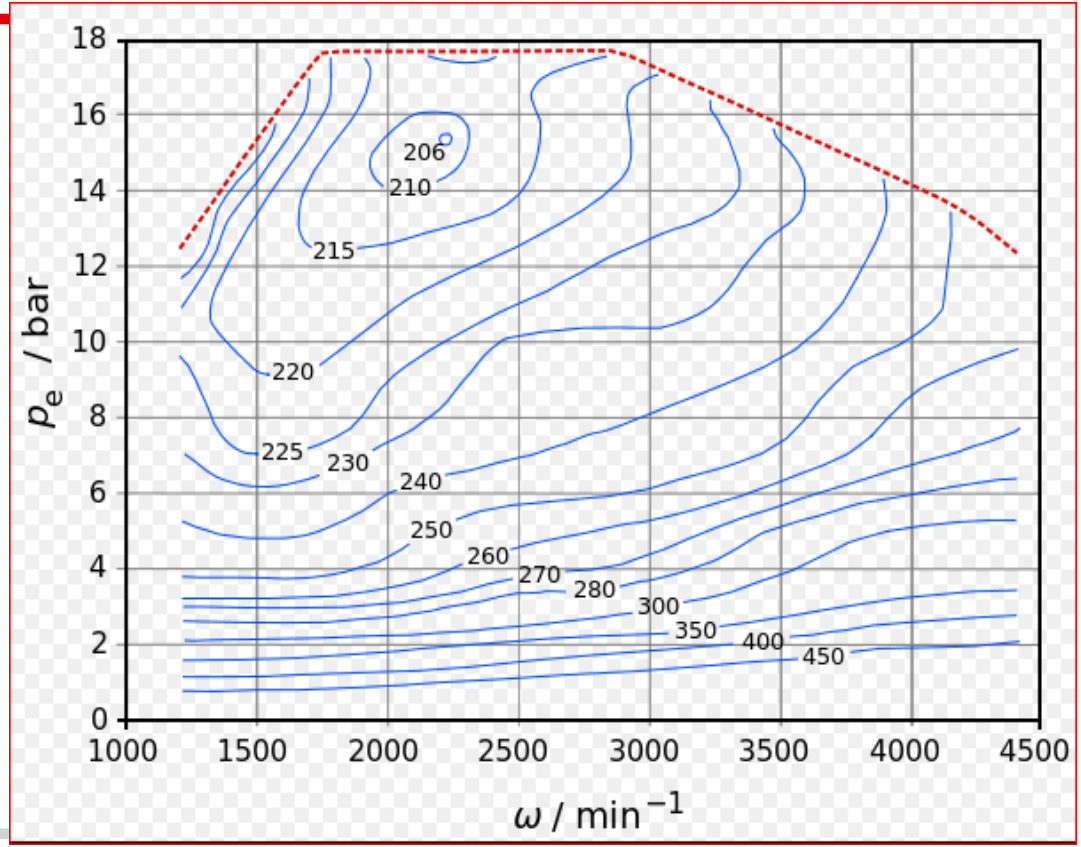
BSFC (Optimal efficiency operation)

Brake specific fuel consumption is different for every vehicle.

Example: An iso-BSFC map (AKA fuel island plot) of a diesel engine (g/kWh) from

http://en.wikipedia.org/wiki/Brake_specific_fuel_consumption

More at: http://ecomodder.com/wiki/index.php/Brake_Specific_Fuel_Consumption_(BSFC)_Maps



How to analyze BSFC

Need instrumentation for precision.

Example: Prius has no tachometer. Useful approximation: ratio of indicated MPG to MPH.

Get familiar from your driving experience.

Overview reference

Energy-efficient driving article from wikipedia

http://en.wikipedia.org/wiki/Energy-efficient_driving

Now let’s consider the science

Details (Physics lesson)

Some technical references

How you can benefit

Hill Climbing = Potential Energy

Gravitational potential energy is the energy stored in an object as the result of its vertical position or height. More massive objects have greater gravitational potential energy. The higher that an object is elevated, the greater the gravitational potential energy.
These relationships are expressed by the following equation:

PEgrav = mass • g • height

PEgrav = m *• g • h

In the above equation, **m** represents the mass of the object, **h** represents the height of the object and **g** represents the gravitational field strength (9.8 N/kg on Earth) - sometimes referred to as the acceleration of gravity.

http://www.physicsclassroom.com/class/energy/Lesson-1/Potential-Energy

Acceleration = Kinetic Energy

$$E_k = \frac{1}{2}mv^2$$

Since the kinetic energy increases with the square of the speed, an object doubling its speed has four times as much kinetic energy. For example, a car traveling twice as fast as another requires four times as much distance to stop, assuming a constant braking force. As a consequence of this quadrupling, it takes four times the work to double the speed.

http://en.wikipedia.org/wiki/Kinetic_energy

Air Resistance = Drag

$$F_D = \frac{1}{2}\rho v^2 C_D A$$

F_D is the drag force, which is by definition the force component in the direction of the flow velocity,[1]

ρ is the mass density of the fluid, [2]

v is the velocity of the object relative to the fluid,

A is the reference area, and

C_D is the drag coefficient – a dimensionless coefficient related to the object's geometry and taking into account both skin friction and form drag.

http://en.wikipedia.org/wiki/Drag_equation

Automobile drag coefficient

Let's compare some vehicles on this web page: http://en.wikipedia.org/wiki/Automobile_drag_coefficient

This article includes discussion of:

Tire Rolling Resistance

http://en.wikipedia.org/wiki/Rolling_resistance

Tire inflation is a compromise between comfort, handling, and economy.

Low rolling resistance tires are available.

Discussion

What about cruise control?

Good for Kansas, but not if there are hills.

Optimum - Choose most economical energy point and let vehicle decide how to use it.

Drive smoothly. Avoid unnecessary acceleration and braking.

References:

Energy-efficient driving and Hypermiling

http://en.wikipedia.org/wiki/Energy-efficient_driving

http://techno-fandom.org/~hobbit/cars/prius-rally-hints.txt

http://cars.chicagotribune.com/fuel-efficient/news/chi-gerdes-hypermiling-20130903

http://www.cleanmpg.com/