Vehicle Propulsion Systems
Lecture 1
Course Introduction & Energy System Overview

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Outline

Vehicle Propulsion Systems

Vehicles as a hot topic is everlasting

- Brings freedom to the user
- Have a direct influence on the environment
- Consume resources that are limited
- Have different appeal to different persons

Vehicle Propulsion Systems

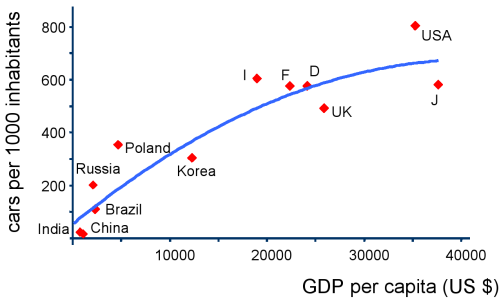
A diversity of powertrain configurations is appearing

- Conventional Internal Combustion Engine (ICE) powertrain. Diesel, Gasoline, New concepts
- Hybrid powertrains – Parallel/Series/Complex configurations
- Fuel cell electric vehicles
- Electric vehicles

Course goal:

- Introduction to powertrain configuration and optimization problems
- Mathematical models and . . .
- . . . methods for
  - Analyzing powertrain performance
  - Optimizing the powertrain energy consumption

The Challenge – Vehicle density (2005)



Source: OECD/IEA (2006)

The demand for vehicles (and thus fuel) is rising!

Top Priorities in Vehicle Development

- Improve the fuel economy of vehicles (Better cars are our best oil-wells)
- Reduce costs
- Drivability
- Safety
- Emissions
  - Exhaust emissions
  - Road dust
  - Noise
  - Legislations

All issues are important but the first item is the main topic here.

Vehicle properties

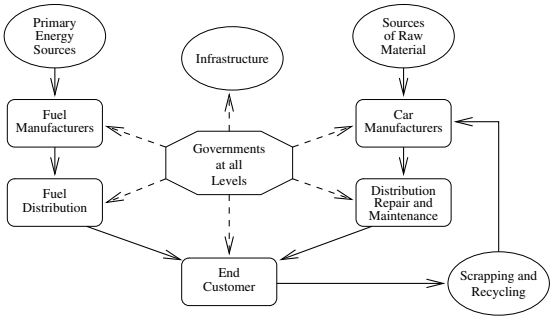
The vehicle in focus is passenger cars. (In the book.)
–What characterizes passenger cars?

- Autonomous and do not depend on fixed power grid.
- Have refueling time negligible compared to the driving time between two refuelings.
- Transport two to six persons and some payload.
- Accelerate from 0 to 100 km/h in 10-15 seconds, or drive uphill a 5% ramp at legal top speed.

Methods and tools are also applicable to trucks and other transportation systems.

- Some numerical values differ
- Demands can be different
- Principles the same but some solutions differ

Life Cycle of a Vehicle



Many things are important!
–Focus is on energy path and in-vehicle energy conversion

Outline

More Course Details

- Third time the course is given.
  – Material and assignments might still have edges...
  – Help us polish the edges with feedback (continuously).
- 5th year course.
- Goal is to give independent engineers.
- Problem solvers that can work with problems spanning over different domains.
  Mechanical, Electrical, Chemical, Signals and Systems, ...
- Examination: Hand-In assignments.
  –Done individually.
  –It is OK to discuss problems and solution.
  –No cooperation in programming or report writing is allowed.

Examination – Grading system

1. Pass (grade 3).
   All mandatory tasks must be completed.
   Handed in, examined, returned (corrected, handed in again, until pass).
2. Higher grades.
   Handed in, graded by us (like an exam), returned.
   Point system connected to extra tasks.
   - 0-6 p – grade 3
   - 7-13 p – grade 4
   - 14-? p – grade 5
3. More details are found in the compendium.
   Deadlines given on the home page.

Examination – 4 Hand-In Assignments

Compendium for Hand-In assignments.

1. Fuel consumption requirement of a driving mission.
   Methods and tools for estimating the fuel consumption.
   –Mandatory and optional tasks.
2. Optimal control of series and hybrid concepts.
   Tools for investigating the best possible driving schedule.
   –Mandatory and optional tasks.
3. Three concepts for short term energy storage.
   Very open ended problems.
   –Mandatory to investigate one concept.
4. Fuel cell vehicle.
   –Optional tasks.

Resources

- Computer tools are necessary, to be able to solve interesting problems.
  –Matlab and Simulink with extra packages.
- If you have your own computer please use it.
- 1 computer room booked on 2 occasions per week
  Mon 17–21, Wed 13-17.
- Independence important.
  – Lab room assistant, answers questions.
  – Collect your questions and come to us.

Course Outline

Lets have a look on the course home page!

Hand-in Dates

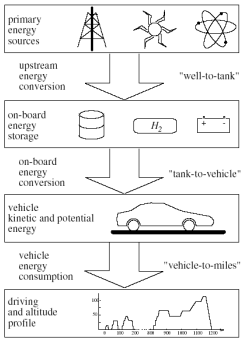
- Dates proposed as deadlines, for being able to complete the Hand-ins in time.

Hand-In 1	November 12.
Hand-In 2	November 19 and 26.
Hand-In 3	December 3.
Hand-In 4	December 10. Last date for handing in extra tasks for higher grades.

  The weekdays are Fridays.
- Contact us (Martin Sivertsson) if you
  1. fail to meet a deadline
  2. want to propose other personal deadline dates

Outline

Energy System Overview



Primary sources

Different options for on-board energy storage

Powertrain energy conversion during driving

Cut at the wheel!

Driving mission has a minimum energy requirement.

Primary Energy Sources

Few sources – But many options

- Oil, Natural Gas, Coal
  - Oil wells as we know them will be depleted
  - Still much usable carbon in the ground
  - Cost will increase
- Nuclear power
  - Fission material available
  - Fusion material available
- Solar power
  - Hydro electric power
  - Solar cell electricity
  - Crop, forest, waste
  - Bacteria

Energy Carriers for On-Board Storage

Energy carriers – Many possibilities

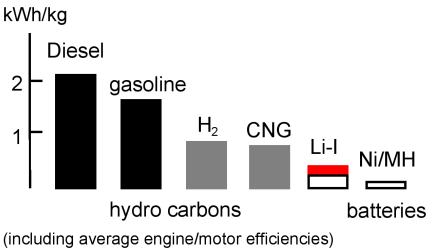
- Diesel, Gasoline, . . .
- CH3OH, C2H5OH, C4H9OH, DME, . . .
- H2, CH4, CNG, . . .
- Batteries

–What are the desirable properties?

- High energy density – Long range
- High refueling power – Fast refueling
- Simple refueling.
- Low environmental impact (health aspects).
- Infrastructure.

Why (Liquid) Hydrocarbons?

- Excellent energy density.
- High refueling power.
- Good Well-to-Tank efficiency.



(including average engine/motor efficiencies)

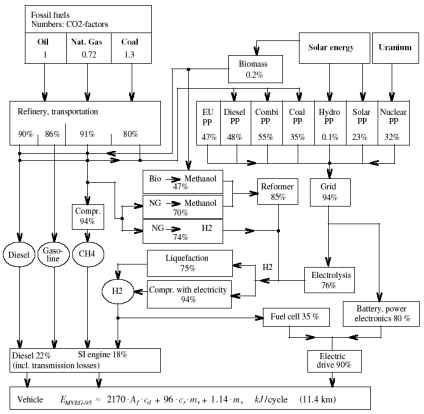
Upstream Energy Conversion

- Manufacturing (pumping, crop, . . .).
- Transport to refinery
- Refining
- Transport to filling station
- Filling of Vehicle

Ongoing intense research

–Investigating energy paths and improving processes.

Example of Some Energy Paths



Energy Conversion in Vehicles

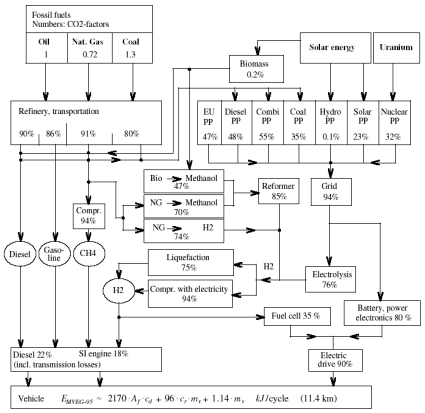
Many paths in the vehicle

- Energy storage(s) (tank, battery, super caps)
- Energy refiner (reformer)
- Energy converter(s)
- Power (force) to/from transportation mission

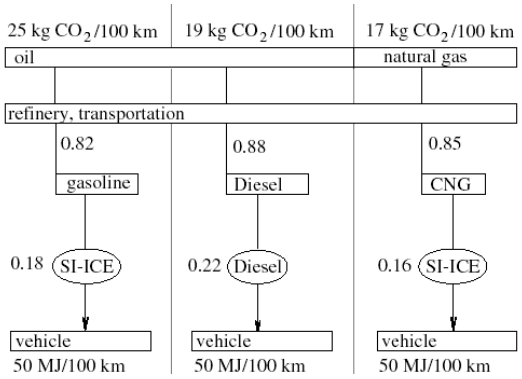
This important topic will be covered later in the course

Outline

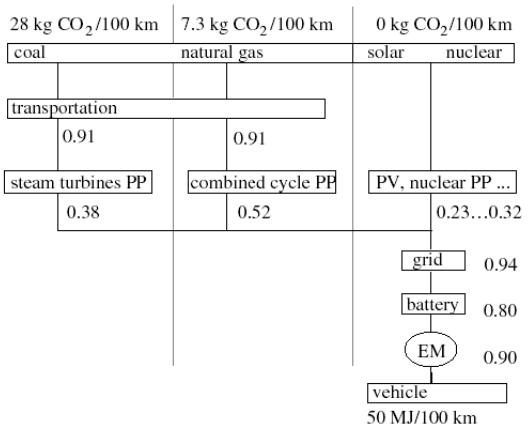
W2M – Energy Paths



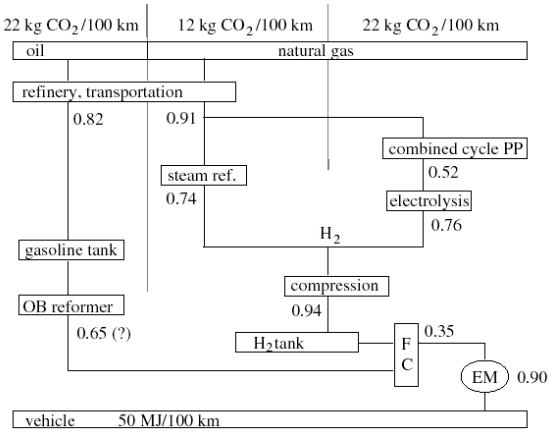
W2M – Conventional Powertrains



W2M – Electric Vehicle



W2M – Fuel Cell Electric Vehicle



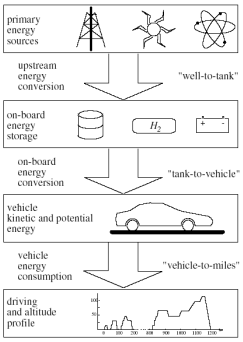
Pathways to Better Fuel Economy

Improvements on the big scale

- Well-to-tank (Upstream)
- Wheel-to-miles (Car parameters: mass, rolling, aerodynamics)
- Tank-to-wheel

- Peak efficiency of the components
- Part load efficiency
- Recuperate energy
- Optimize structure
- Realize supervisory control algorithms that utilize the advantages offered in the complex systems

Energy System Overview



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