



Hybrid Drive Systems for Vehicles

- L3
 - Non ideal vehicle components
 - The conventional vehicle



So far

- No ICE efficiency and limitation model
- No transmission efficiency model
- Modelling needed !
 - Today the ICE and the transmission

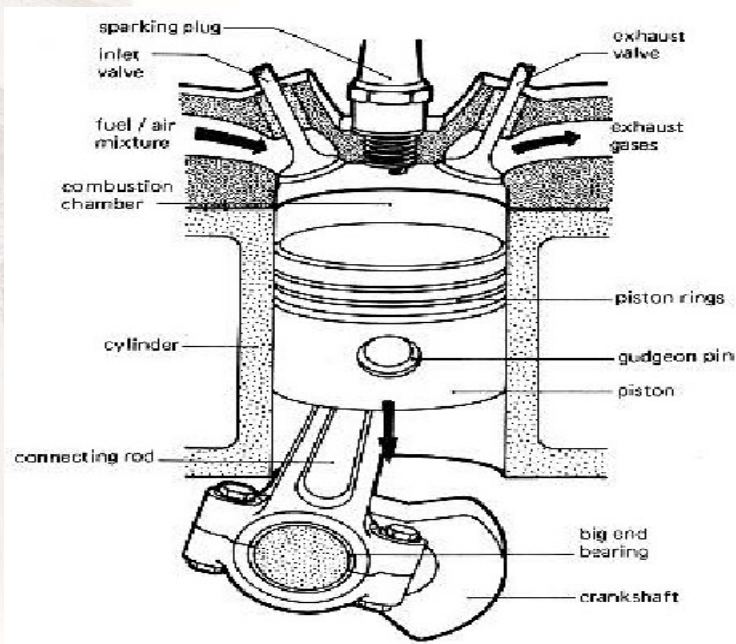


ICE combustion principles

- Otto
 - Balanced fuel/air ratio
 - Injection, ignition and throttle controlled
- Diesel
 - No throttle
 - Direct diesel injection

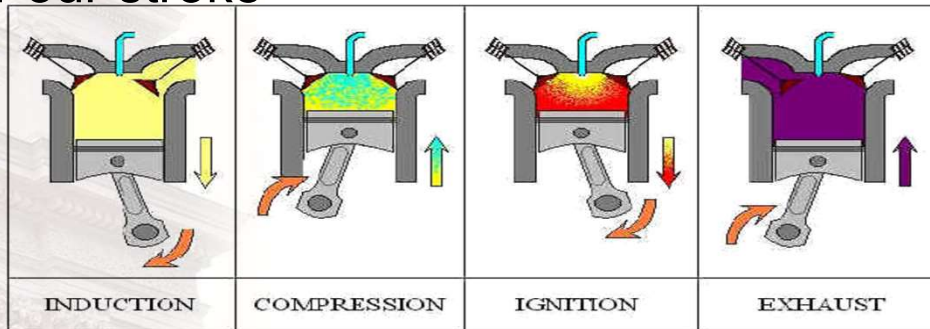
Primary energy converters – The ICE

- Reciprocating or rotating

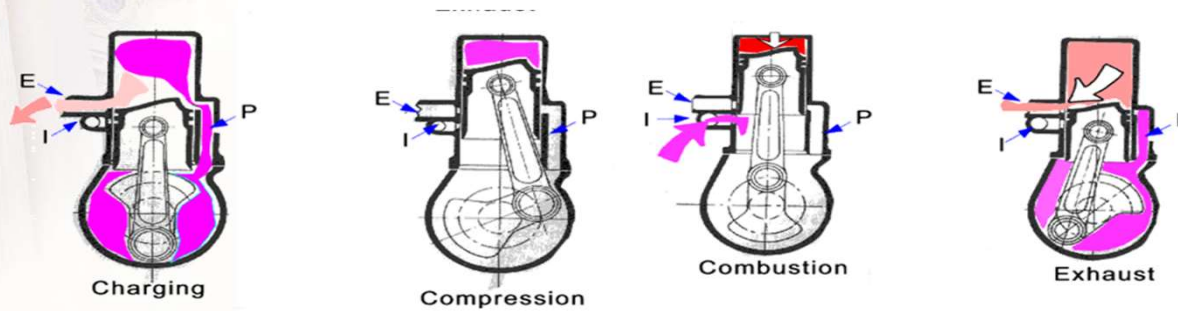


ICE – combustion cycles

- Four stroke

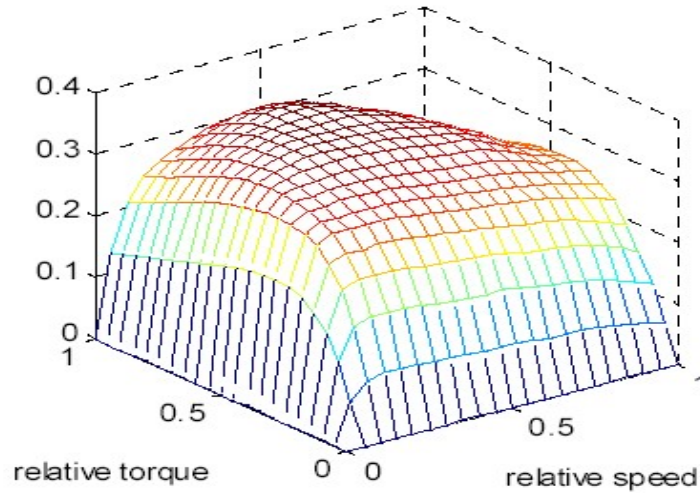


- Two stroke

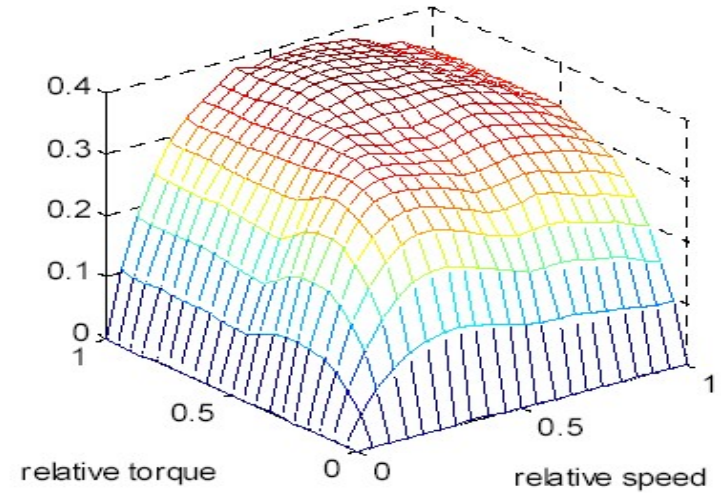


ICE modelling

- Efficiency in stationary operation

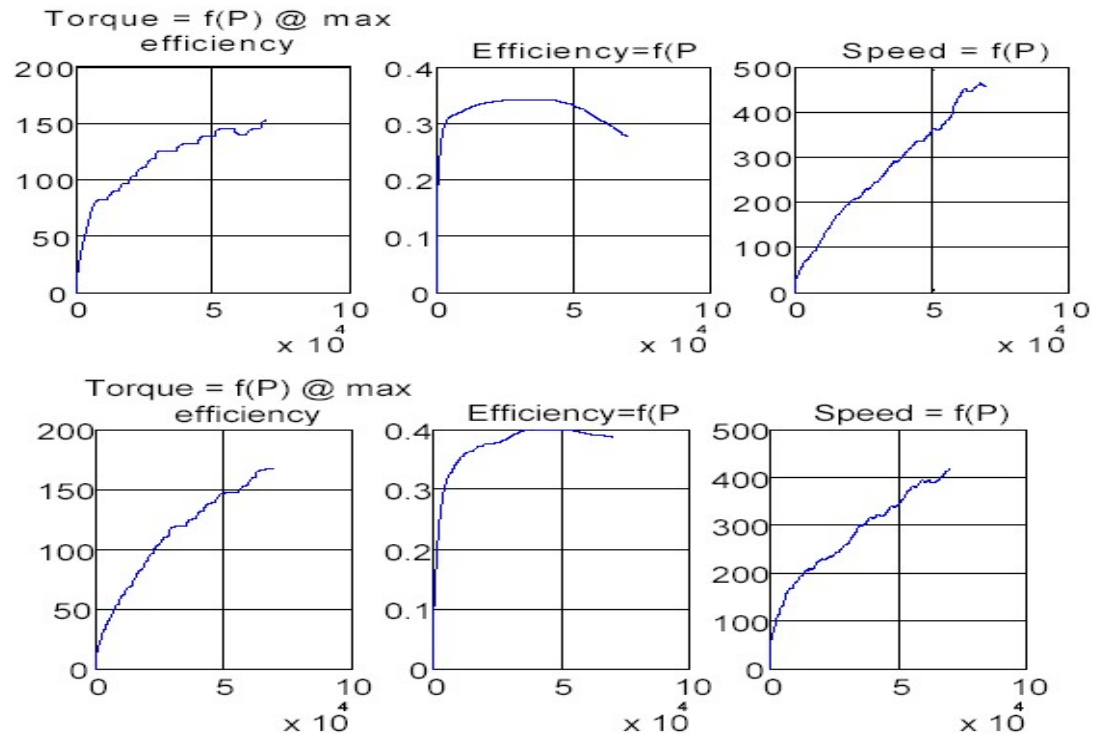
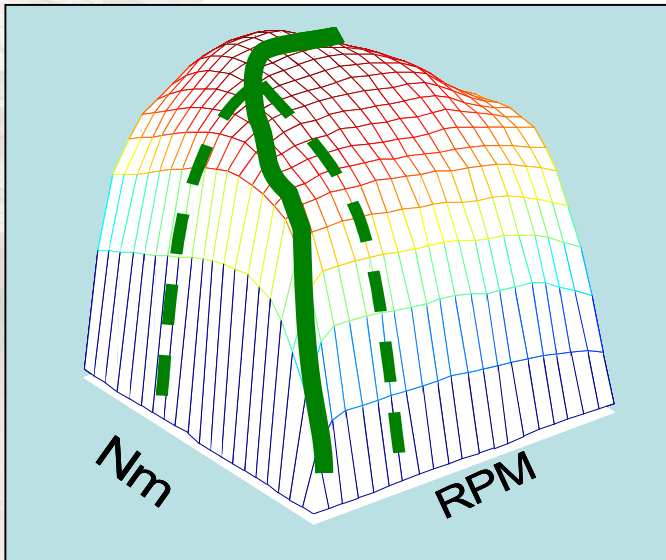


OTTO



DIESEL

ICE Optimal working point



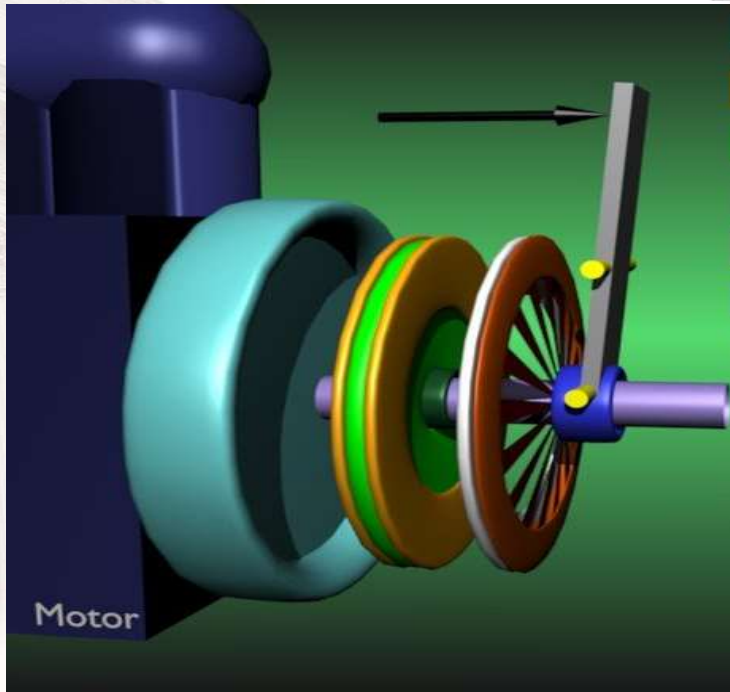
P = mechanical power



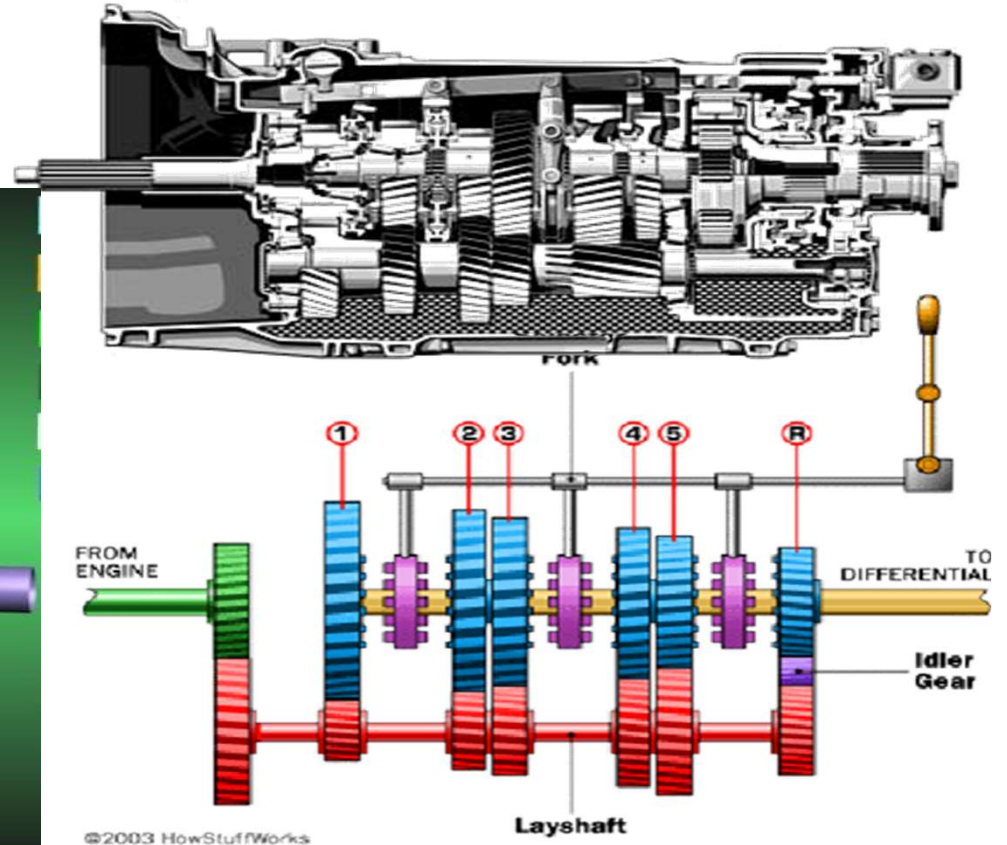
ICE Dynamics

- Look up tables only true in stationary operation
- In a transient, several phenomena cause deviations:
 - *Wall wetting*
 - *Air flow dynamics*
 - ...
- Quasi stationary OK, slower than e.g. 0.5...1 second time constant.
- Possible in Hybrid Vehicles. Not really in conventional vehicles.
- Soot att to high fuel/air mixtures, especially diesel.
 - *"Getting up through the soot-map"*

Transmissions (Manual)

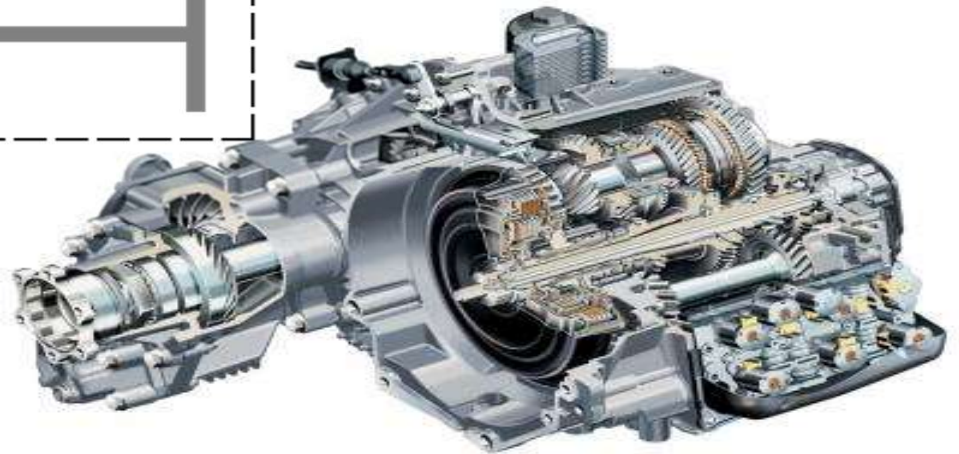
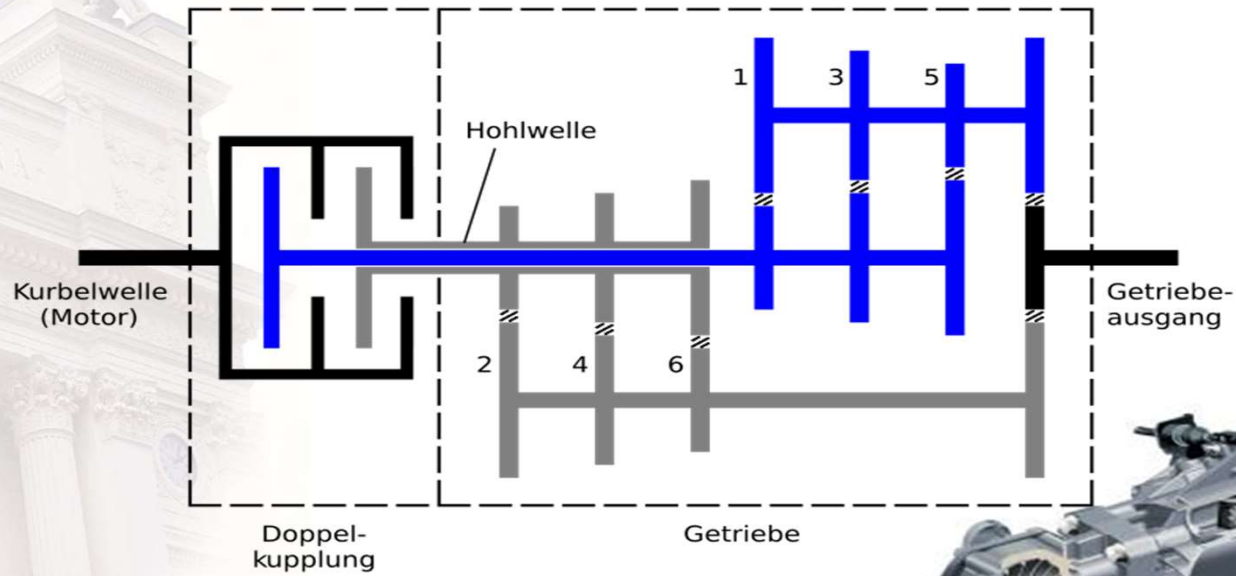


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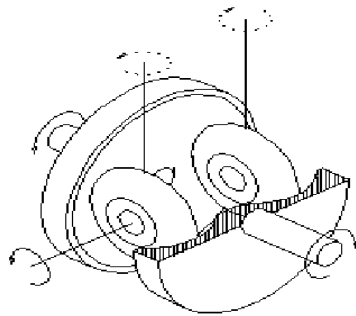
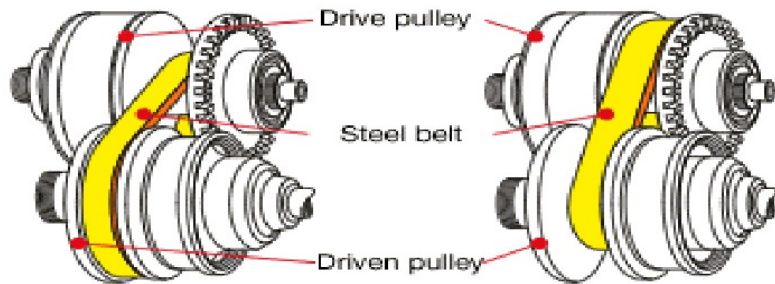
EHS

Transmissions (Dual Clutch)

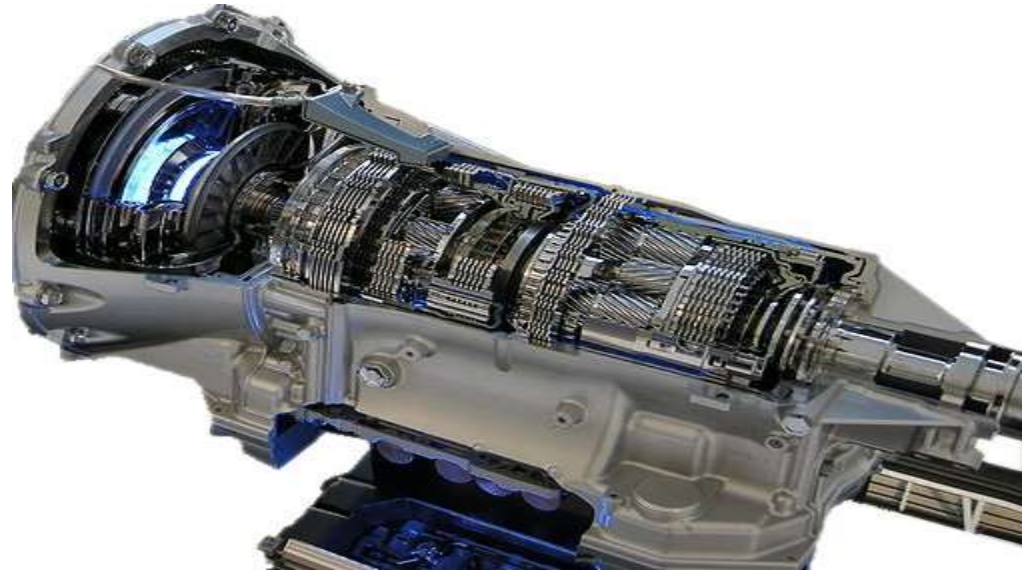


Transmissions (CVT)

- Continuously Variable



Transmissions (Automatic with torque conv)

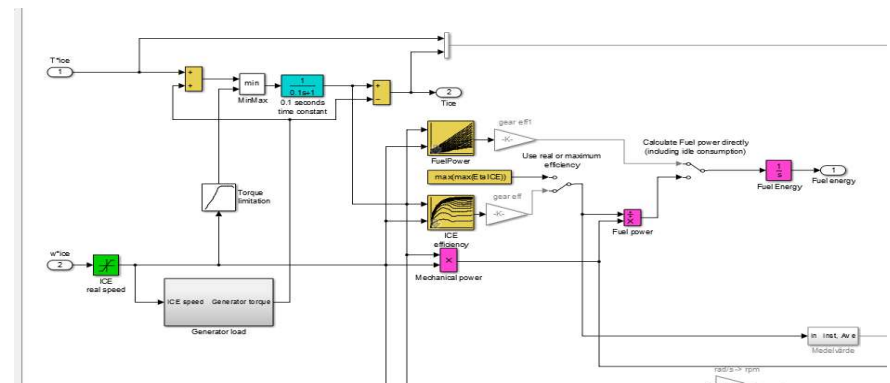


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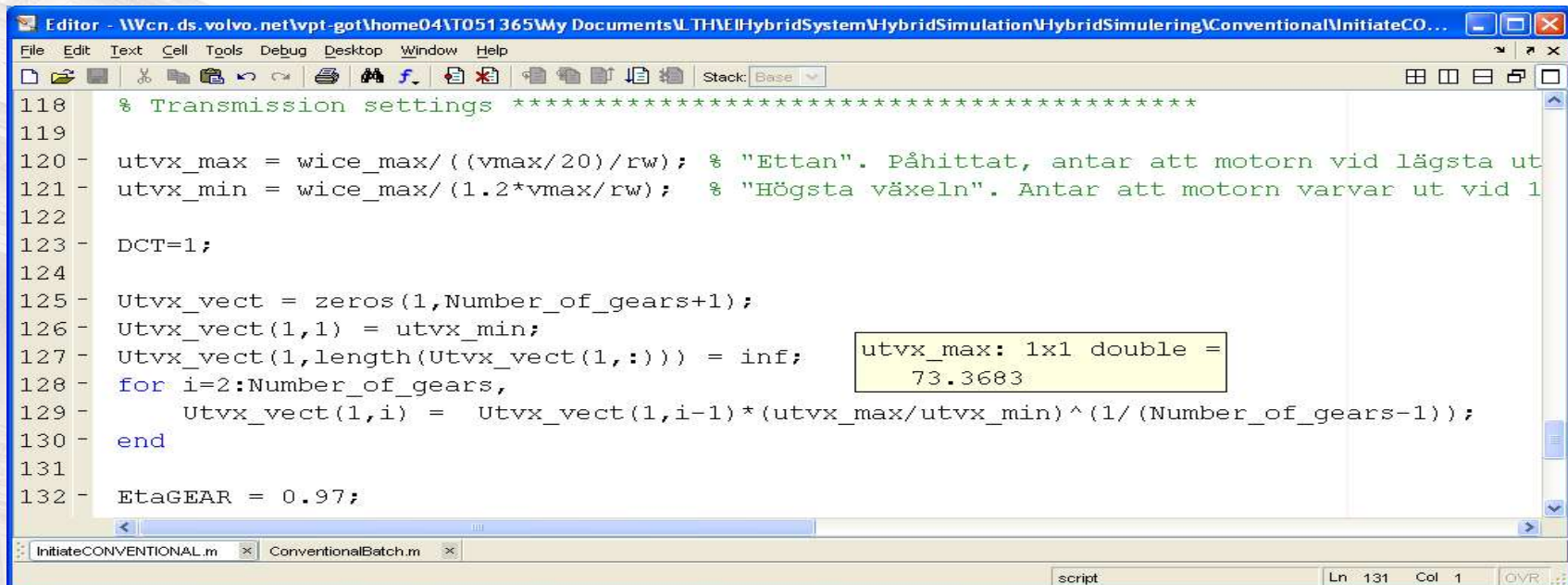
EHS

Generator load

- Apart from the drivers torque requirement:
 - *The Aux Power is recalculated into a torque and added to the torque reference*
 - *The corresponding load torque is subtracted from the ICE output torque*



Modelling of the transmission in the Simulation program

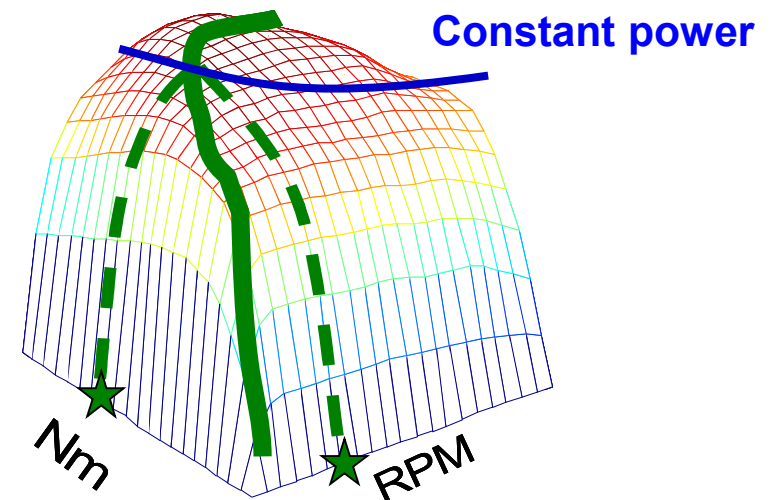


```
118 % Transmission settings *****
119
120 - utvx_max = wice_max/((vmax/20)/rw); % "Ettan". Påhittat, antar att motorn vid lägsta ut
121 - utvx_min = wice_max/(1.2*vmax/rw); % "Högsta växeln". Antar att motorn varvar ut vid 1
122
123 - DCT=1;
124
125 - Utvx_vect = zeros(1,Number_of_gears+1);
126 - Utvx_vect(1,1) = utvx_min;
127 - Utvx_vect(1,length(Utvx_vect(1,:))) = inf;
128 - for i=2:Number_of_gears,
129 -     Utvx_vect(1,i) = Utvx_vect(1,i-1)*(utvx_max/utvx_min)^(1/(Number_of_gears-1));
130 - end
131
132 - EtaGEAR = 0.97;
```

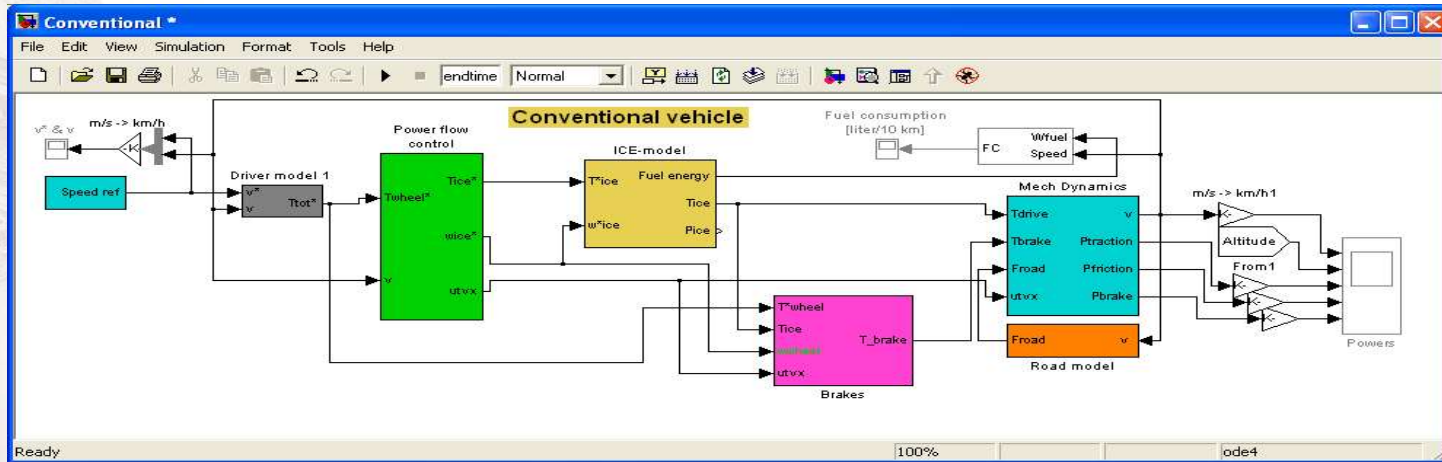
utvx_max: 1x1 double =
73.3683

Manual transmission gear shift strategy

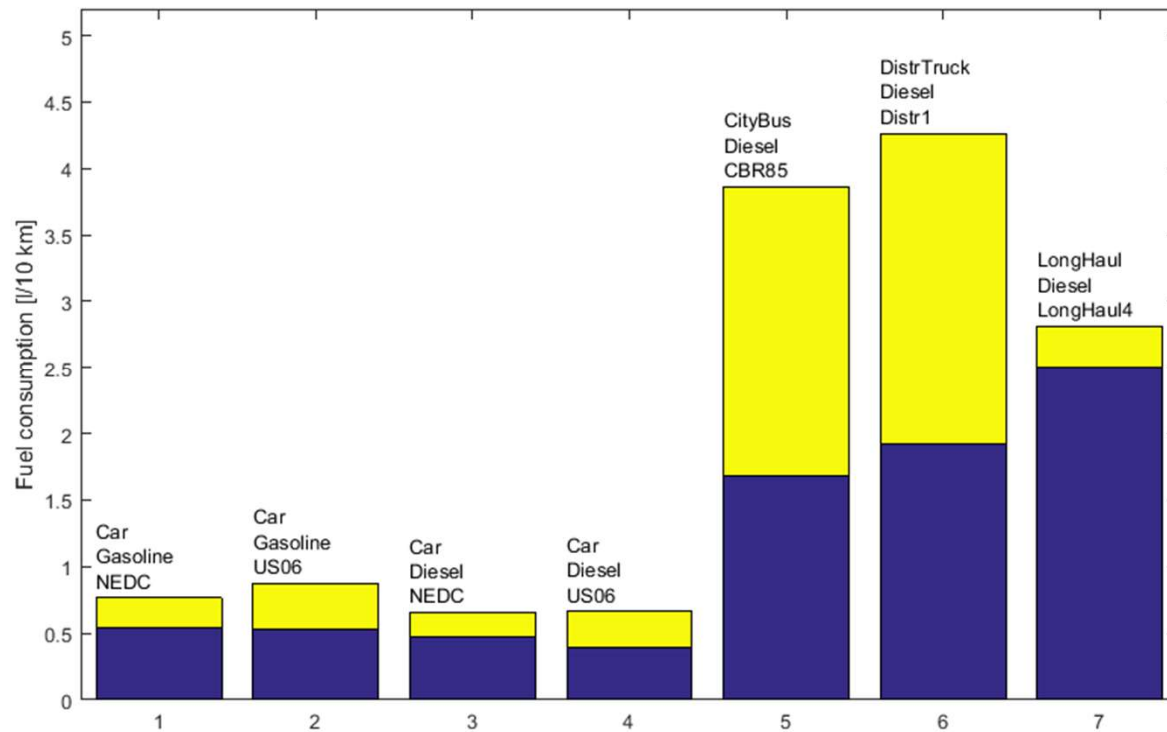
1. The desired **ICE power** is calculated
2. The **ideal ICE Torque and Speed** is picked
3. Based on vehicle speed and desired ICE speed, the best gear ratio is selected in the transmission
4. Transmission efficiency assumed constant = 97%



To Simulink



Some simulation results on Conventional



Ideal:

