Modelling & control of PHEV powertrain systems

Team – 1

Abhishek Rajput-ME14BTECH11002

Arvind Gulia-ME14BTECH11003

Chaitanya Dhakne-ME14BTECH11011

Jyonit Gupta-ME14BTECH11018

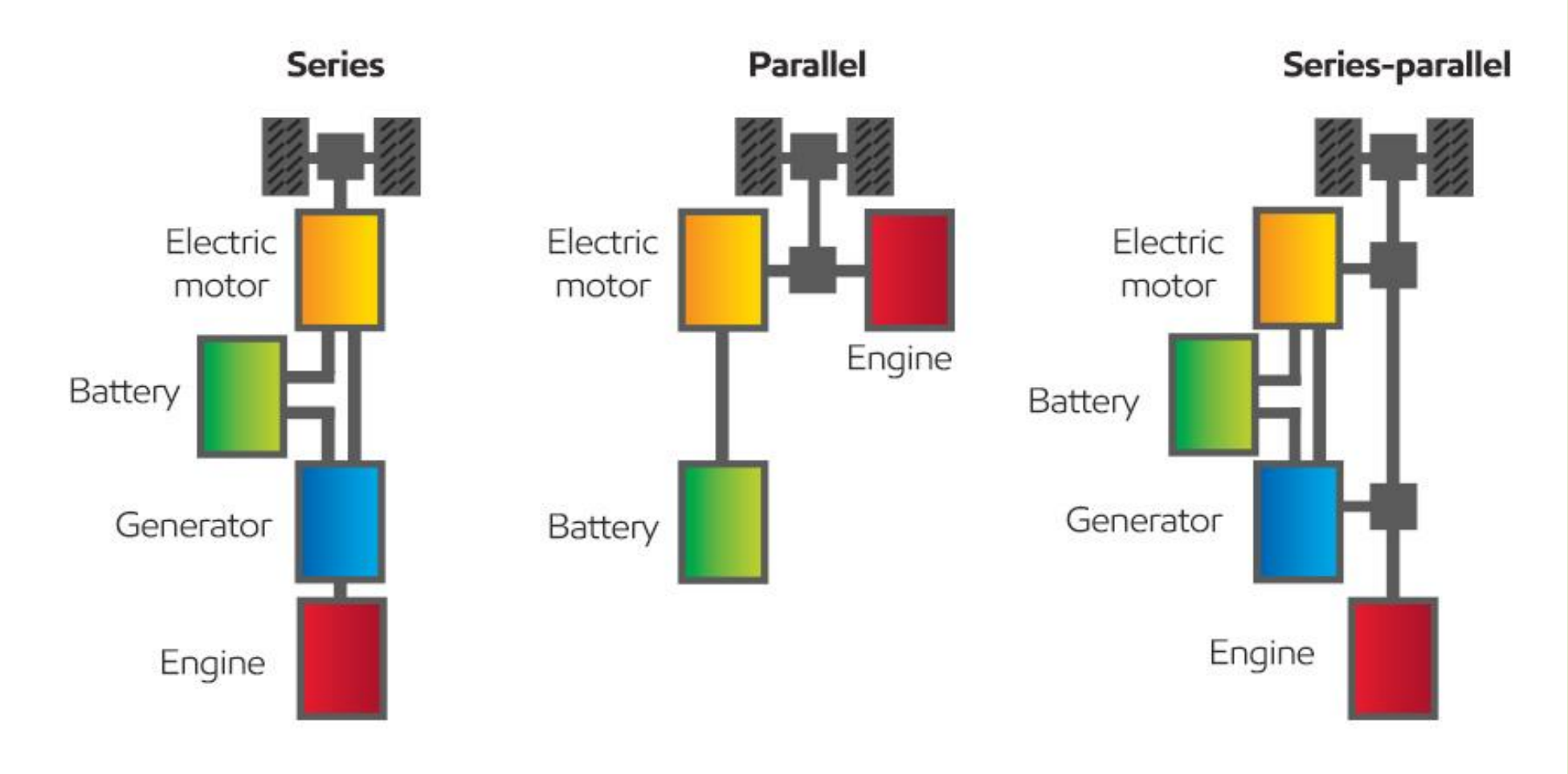
Content

- Introduction
- Series vs. Parallel vs. Plug in Hybrid
- Plug in Hybrid HEV
- CAD models & components
- Subsystems of model
  - Energy Management
  - Electrical
  - Planetary Gear
  - IC engine
  - Vehicle Dynamics
- Results
- Conclusion
- References

Introduction to Hybrid Electrical Vehicle (HEV)

- Hybrid vehicle which combines conventional IC engine system with an electric propulsion system
- Results into better fuel economy and better performance
- This is also eco-friendly concept with low emissions
- Regenerative braking – Energy wasted during braking is stored in battery
- Less maintenance cost and more mileage due to motor and IC engine
- Toyota company came up with this concept at first, implemented in Prius Model in Japan, followed by Honda, Ford and Hyundai
- Initial investing for buying is much more but later cost is less

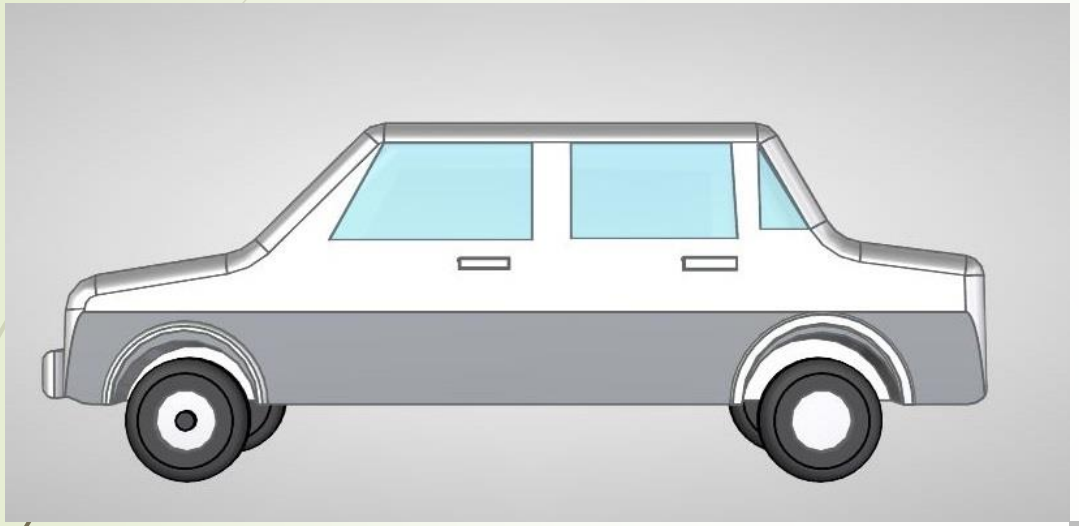
Series vs. Parallel vs. Plug in Hybrid



Plug-in Hybrid System

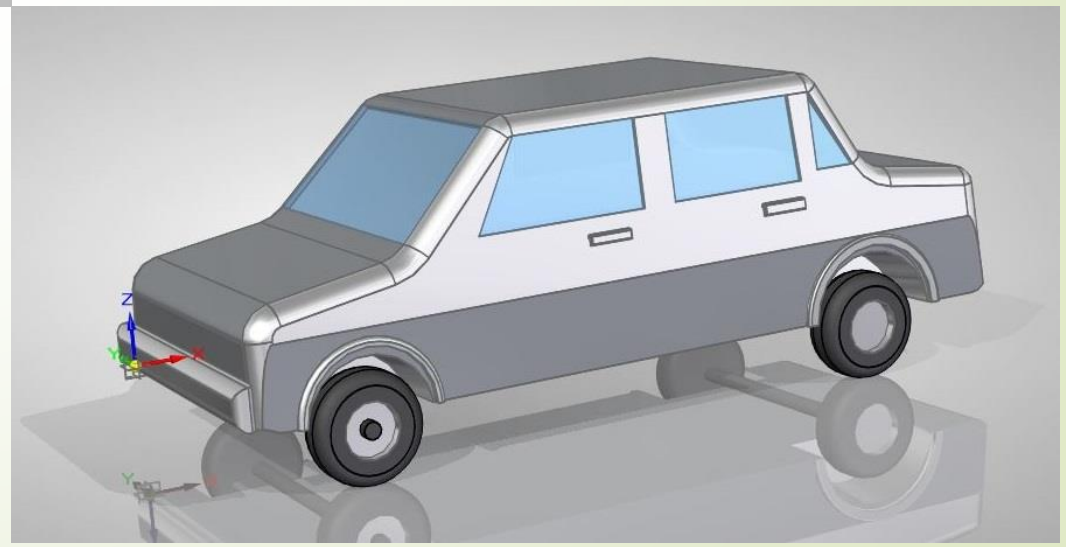
- Here we are analyzing plug-in Hybrid powertrain system
- In this, IC Engine and Electric Motor are to be interconnected to each other for working
- So different conditions plug in according to the power & torque required at the output
- At low power requirement, only electric motor will run
- At high power requirement, IC engine will pitch in with Electric motor
- In addition, for charging of battery, IC engine also can be used according to requirement, which makes it **Plug-In Hybrid System**
- This also improves efficiency of system compared to other ones

CAD Model of full car

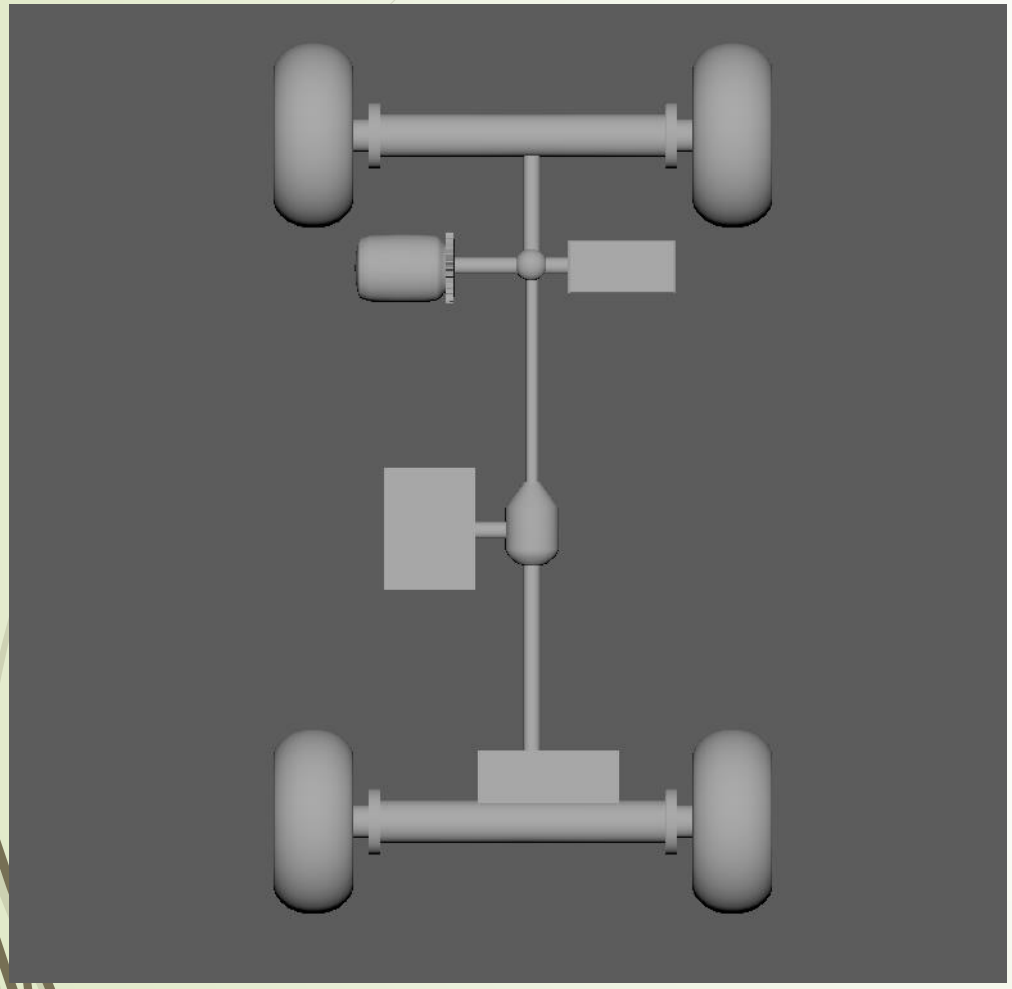


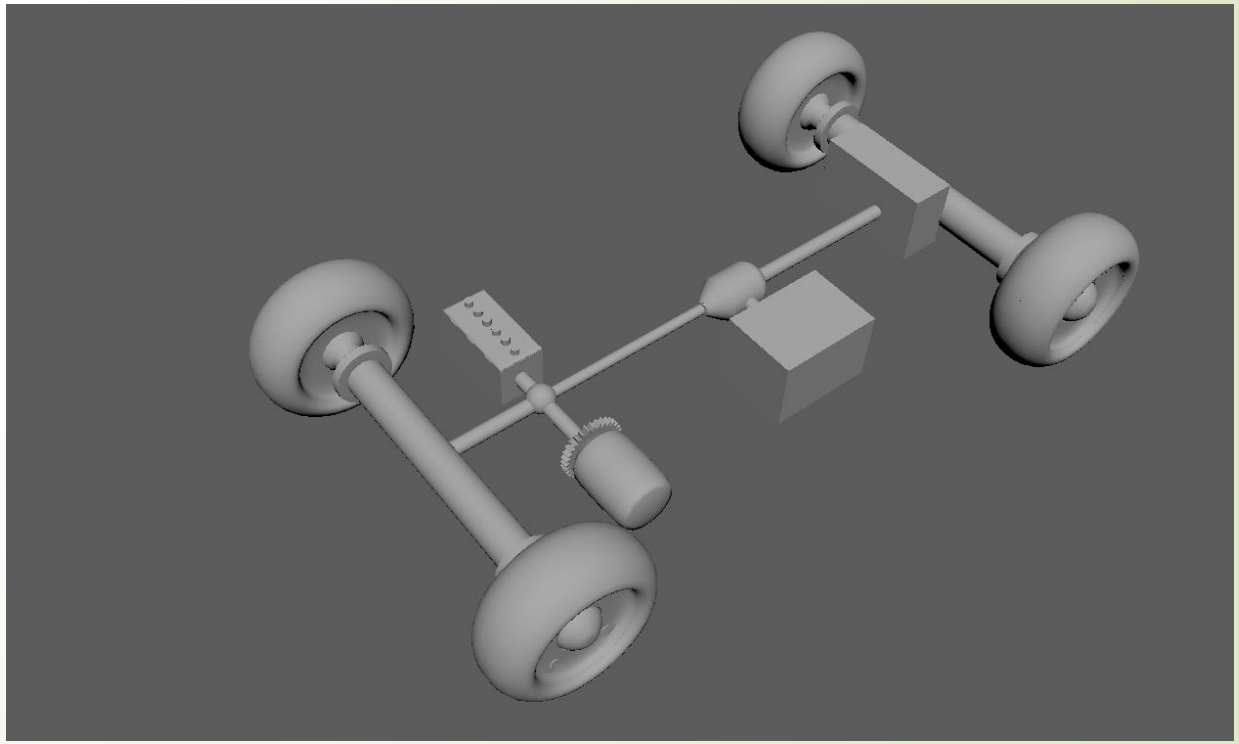
Side View

Isometric View

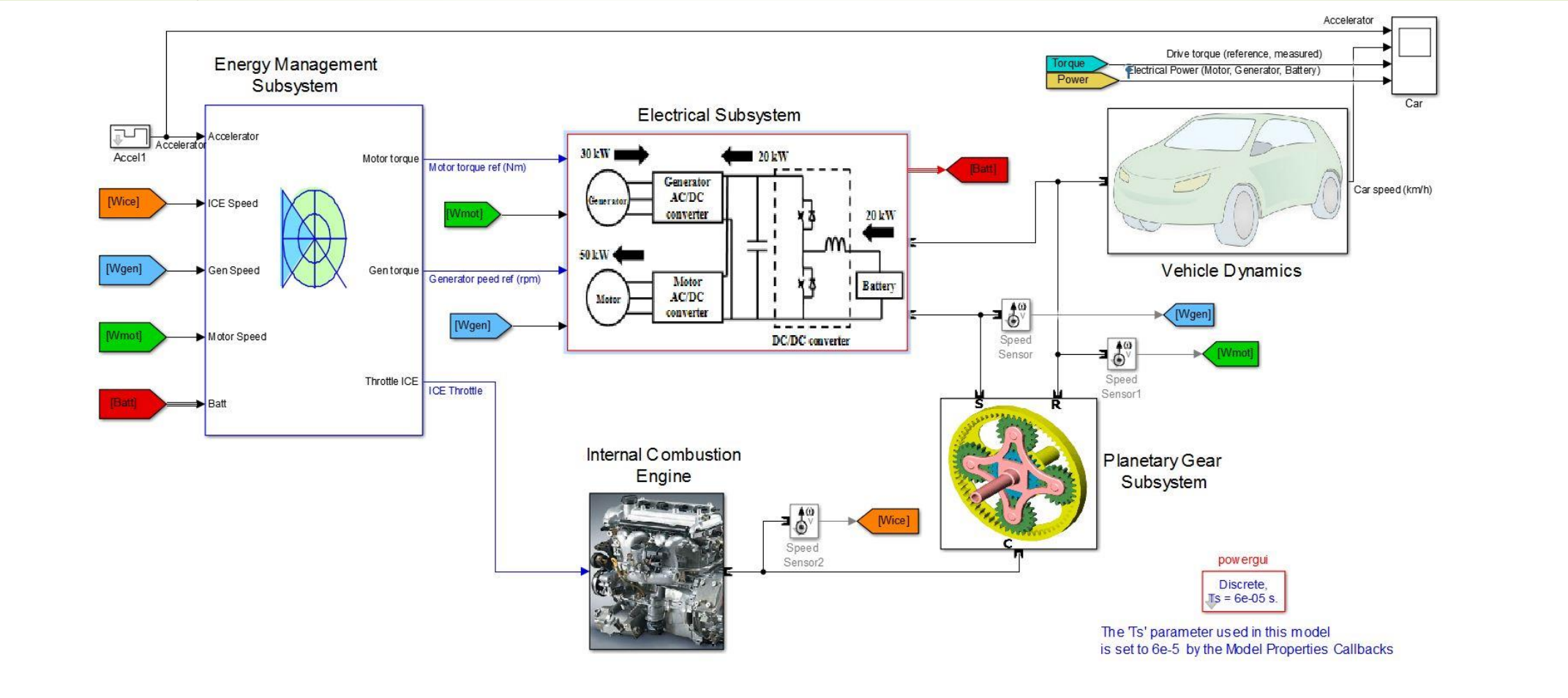


CAD Model of the Drivetrain :



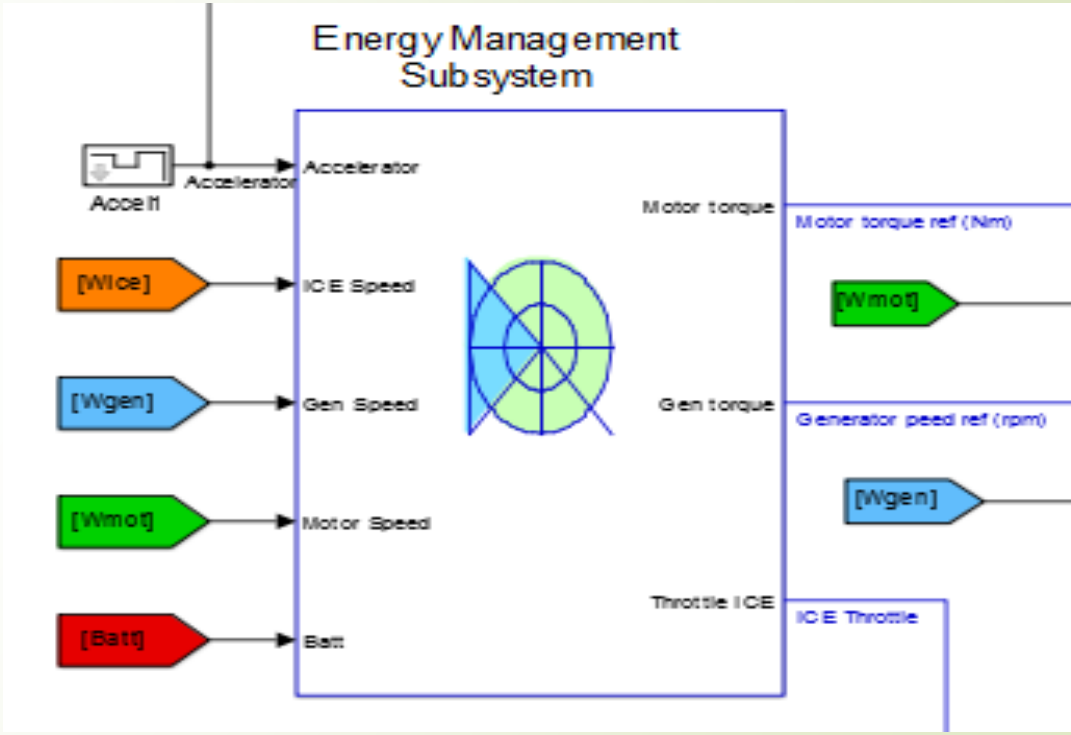


Simulink Block Diagram



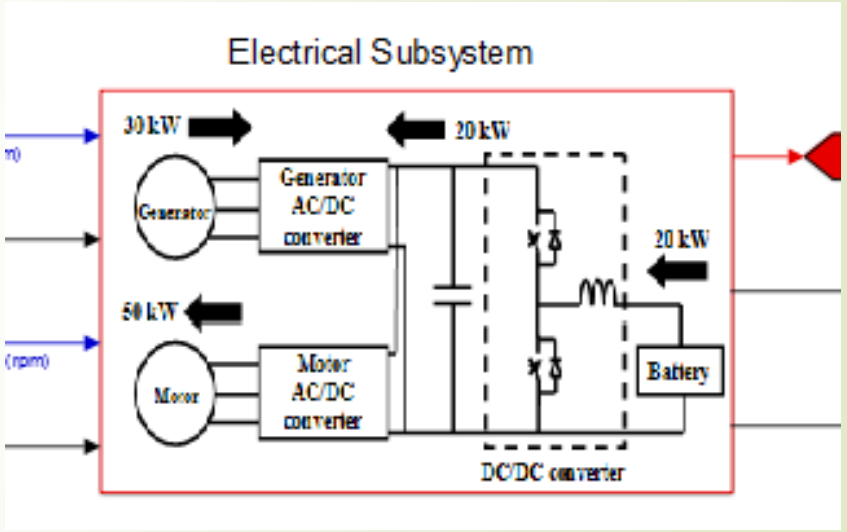
Energy Management Subsystem

- Controls and divides energy requirement between IC engine & Electric Motor
- Input given to the system is speed and acceleration given by driver
- Output is given to Motor, Generator and IC Engine
- Also controls charging of battery by IC engine
- Uses SOC (State-Of-Charge) concept for working of battery



Electrical Subsystem

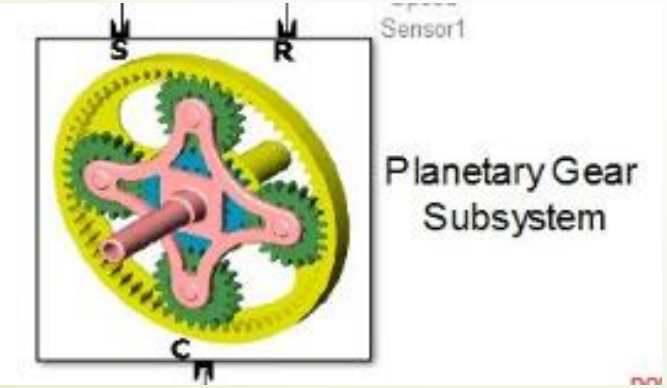
- Includes all components related to Electric motor, generator and converter
- Input is given from Energy management, IC engine and indirectly from driver
- Controls switching between battery, generator or IC engine
- Also includes sensors to implement SOC concept of charging
- Output is given to planetary gear system and vehicle dynamics model



Gear and Engine Subsystems

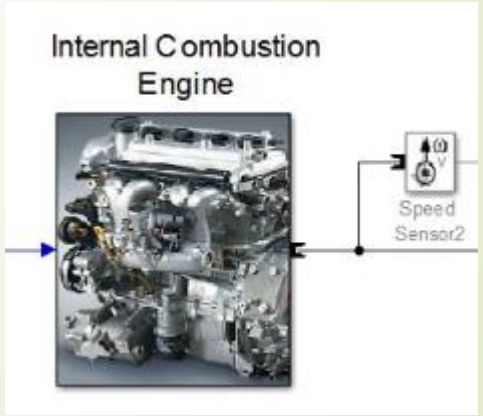
Planetary Gear system

- It takes much less space compared to other ones
- Efficiency is also high enough for working
- Finally reduces input to needed output



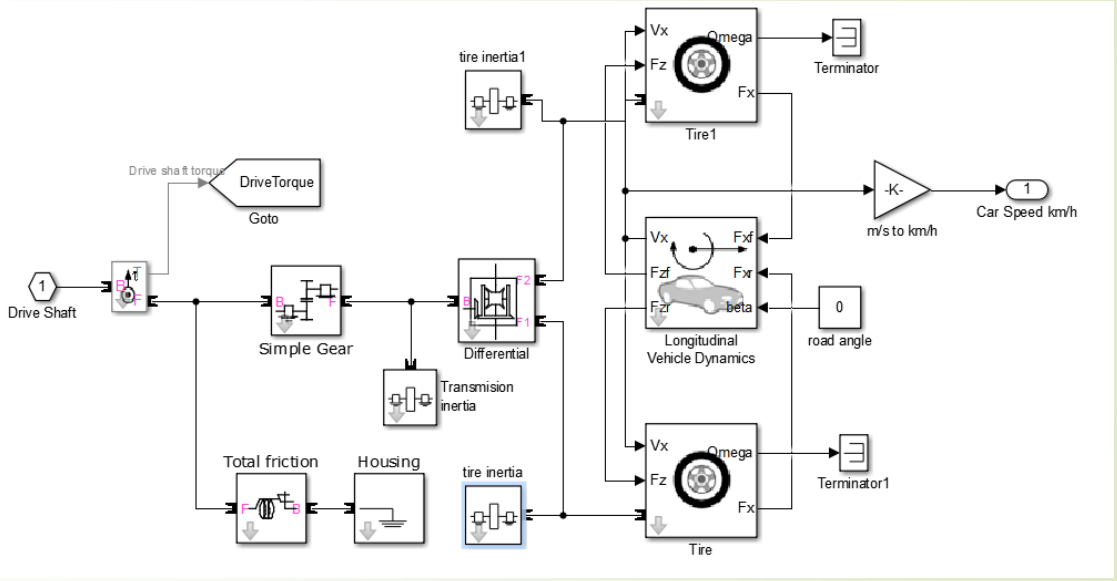
IC Engine

- Simple conventional engine, based on Petrol, Diesel
- Produces polluting emissions
- Output given to gear box and Electrical system for charging purpose



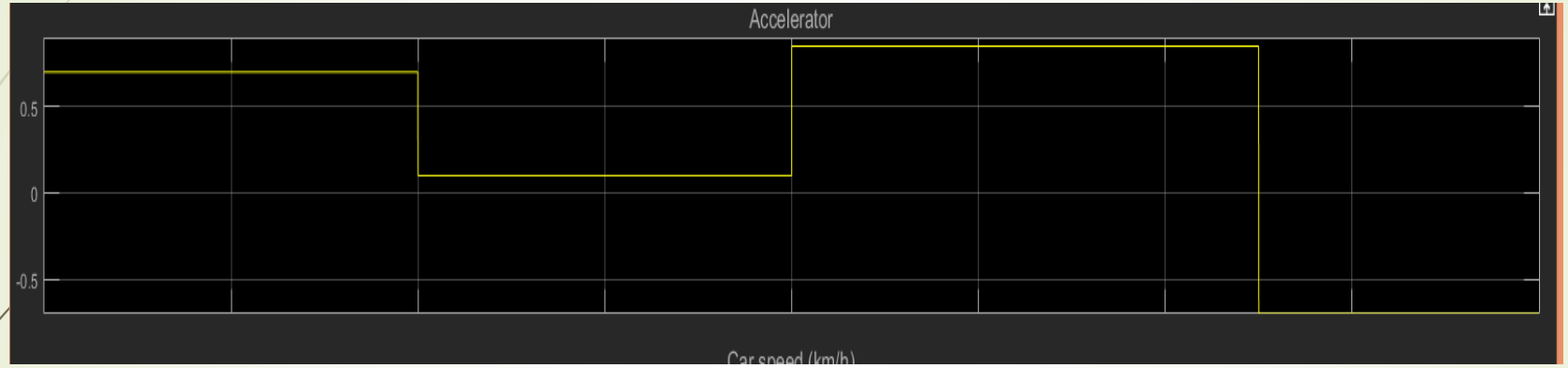
Vehicle Dynamics Subsystem

- Contains all equations required on load, traction and which forces will come to exist
- Takes input from planetary gearbox and gives to the wheels according to equations.
- Involves the equations for inertia, friction, torque etc.
- This is like equations about how vehicle reacts with road condition with its available torque and power

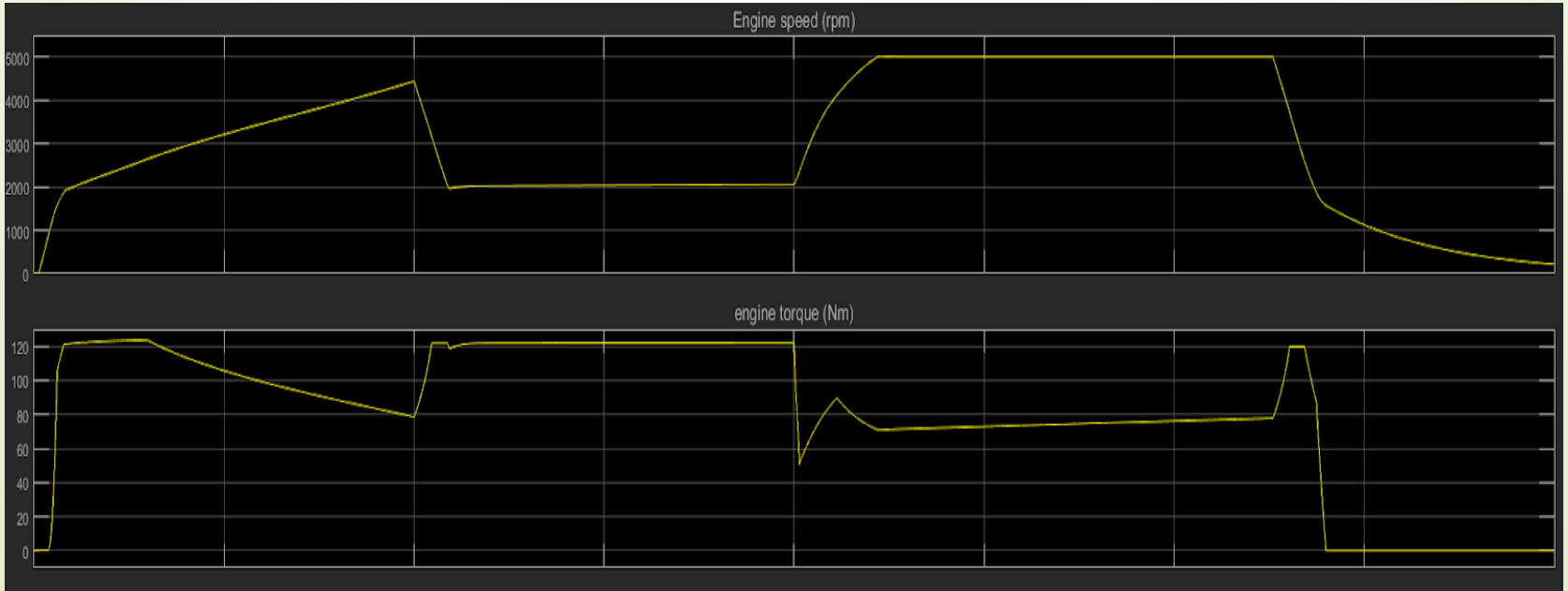


Vehicle dynamics block

Results

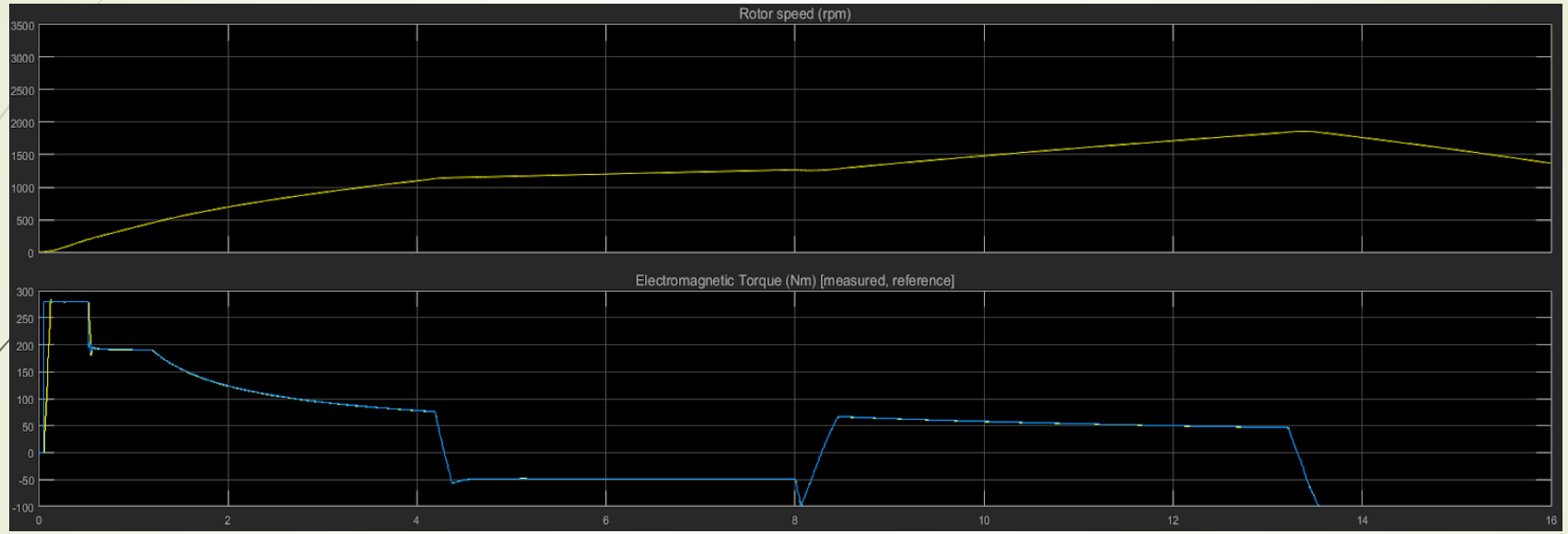


Input as acceleration

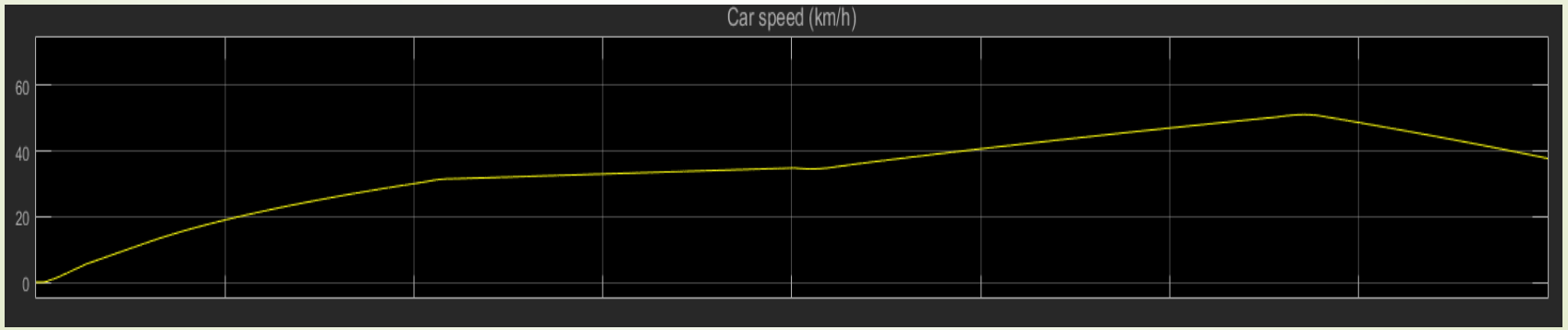


Output as Engine speed & torque

Results (..contd)



Output as Motor torque & rpm



Output as Vehicle speed

Conclusion

- Here we modelled the plug-in hybrid system, by giving throttle input as step input
- This system is more efficient, specially for heavy load vehicles
- Also fuel efficient along with less emissions
- New technologies like regenerative braking, SOC making it more efficient
- For light operations, series HEV is enough, but as load becomes heavy, parallel followed by plug-in HEV gains importance
- All these are expensive, but future maintenance cost is much less
- Market is growing for these with leading company models like Toyota Camry and Honda Accord.

References

- https://www.youtube.com/watch?v=iOmqgewj5XI
- https://www.youtube.com/watch?v=J-JOn5xaZbQ
- https://www.industry.usa.siemens.com/drives/us/en/electric-drives/hybrid-drives/automotive/hyb-sys-tabs/pages/parallel-hybrid.aspx
- https://in.mathworks.com/help/physmod/sdl/examples/parallel-hybrid-transmission.html
- https://pdfs.semanticscholar.org/1091/d5d5a0e9176e491971b9525f4c9594313c8e.pdf
- https://in.mathworks.com/help/physmod/sps/examples/ipmsm-torque-control-in-a-series-parallel-hev.html
- http://www.hybridcars.com/the-three-main-types-of-hybrids-explained/
- https://auto.howstuffworks.com/car-models/plug-in-hybrids/plug-in-hybrid-car2.htm