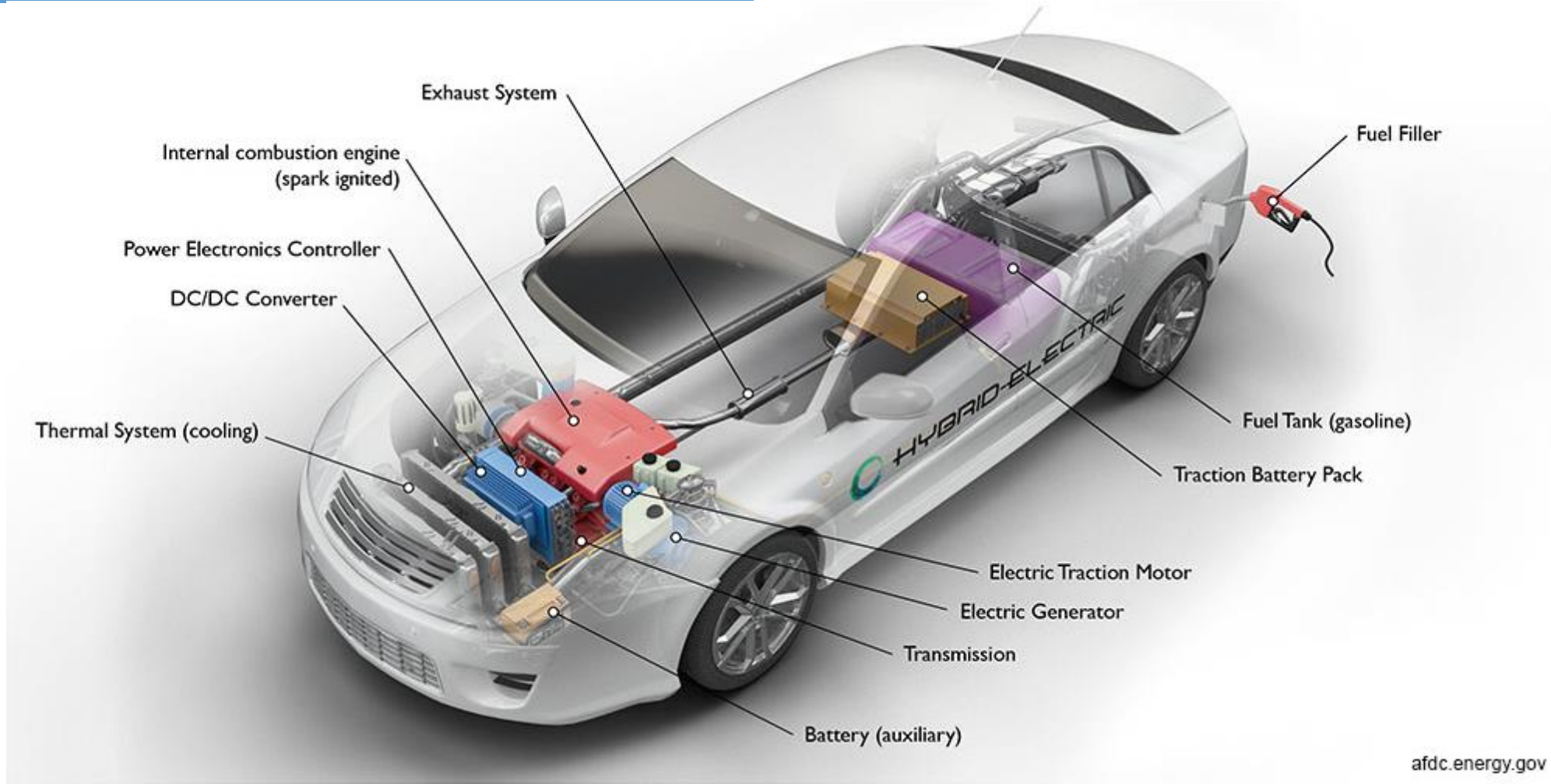
Lecture-3

Series, parallel, Series parallel, PHEV

Hybrid electric vehicle

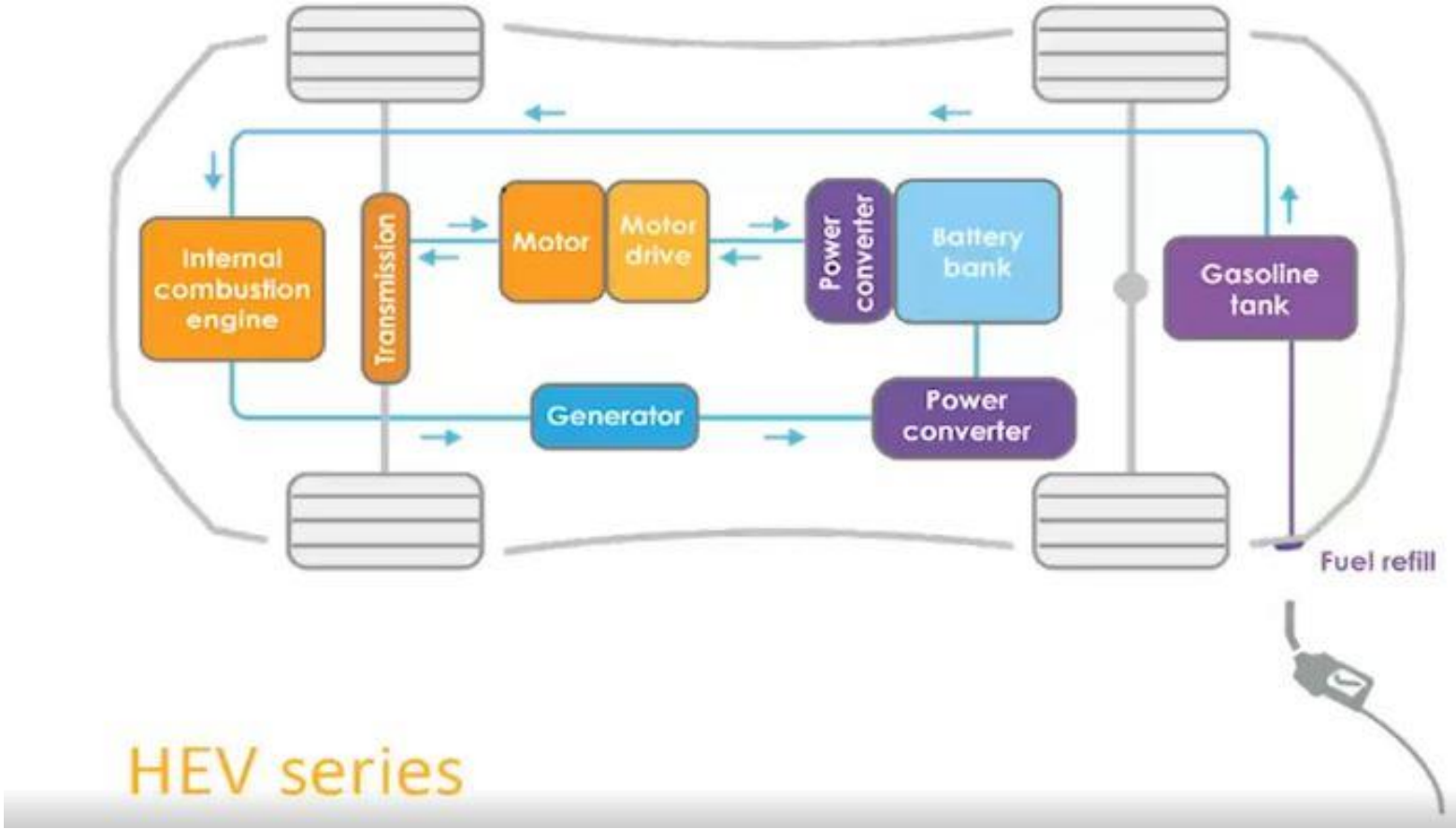
(a) Series Hybrid vehicle



Electric Vehicle

Hybrid electric vehicle

(a) Series Hybrid vehicle



Case 1 : Normal Driving

- IC Engine
- Motor

Case 2: Light Load

- IC Engine
- Motor

Case 3: During Braking

- IC Engine
- Motor

Case 4: Vehicle at stop

- IC Engine
- Motor

Hybrid electric vehicle

Advantages & Disadvantages

- **Advantages of the Series Hybrid Vehicle.**
  - Mechanical decoupling between the ICE and driven wheels allows the IC engine operating at its very narrow optimal region.
  - Nearly ideal torque-speed characteristics of electric motor make Multi-gear transmission unnecessary.
- **Disadvantages of the Series Hybrid Vehicle.**
  - The energy is converted twice (mechanical to electrical and then to mechanical) and this reduces the overall efficiency.
  - Two electric machines are needed and a big traction motor is required because it is the only torque source of the driven wheels.

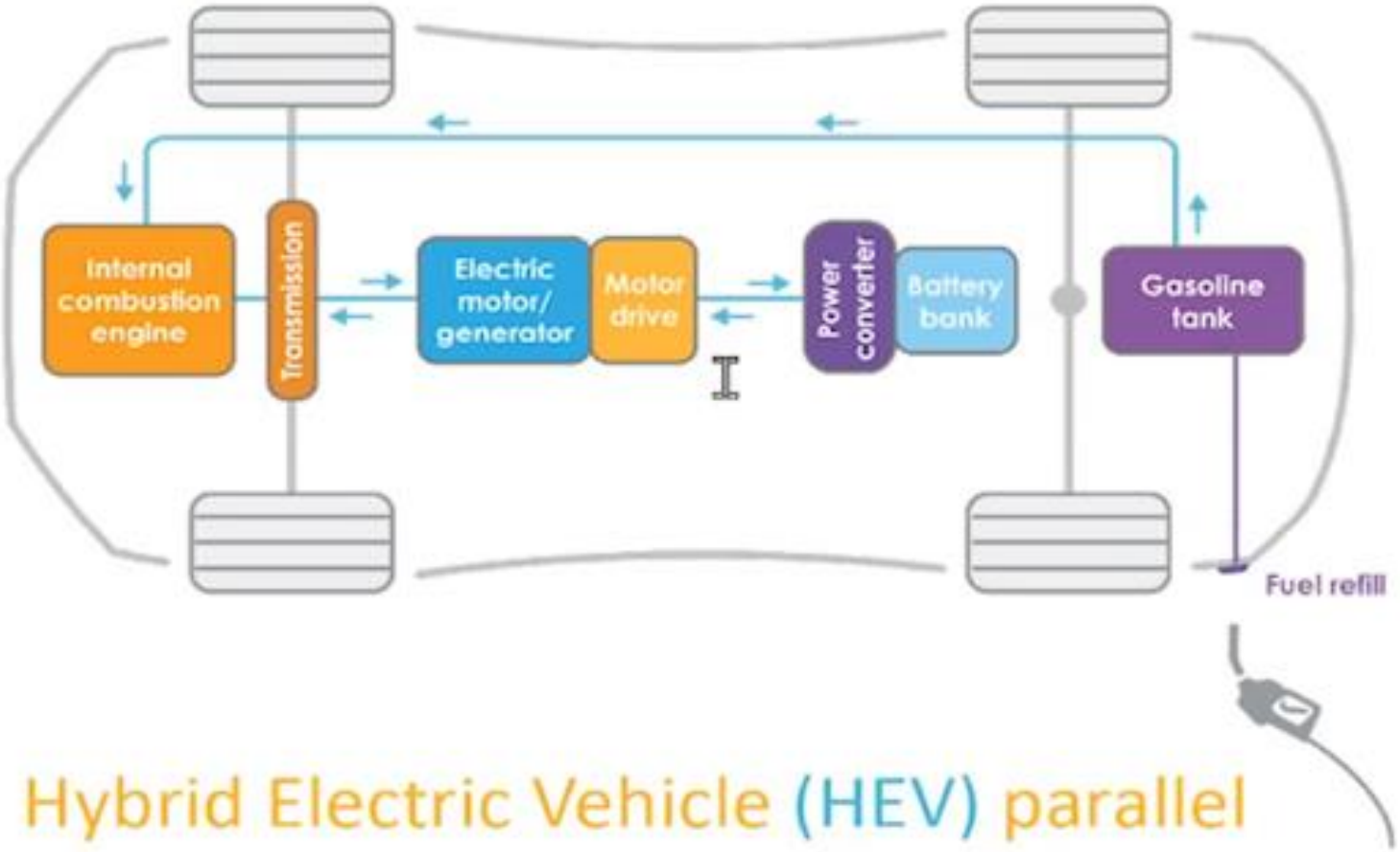
Hybrid electric vehicle

Applications

- Used in heavy commercial vehicles
- Military buses trucks

Hybrid electric vehicle

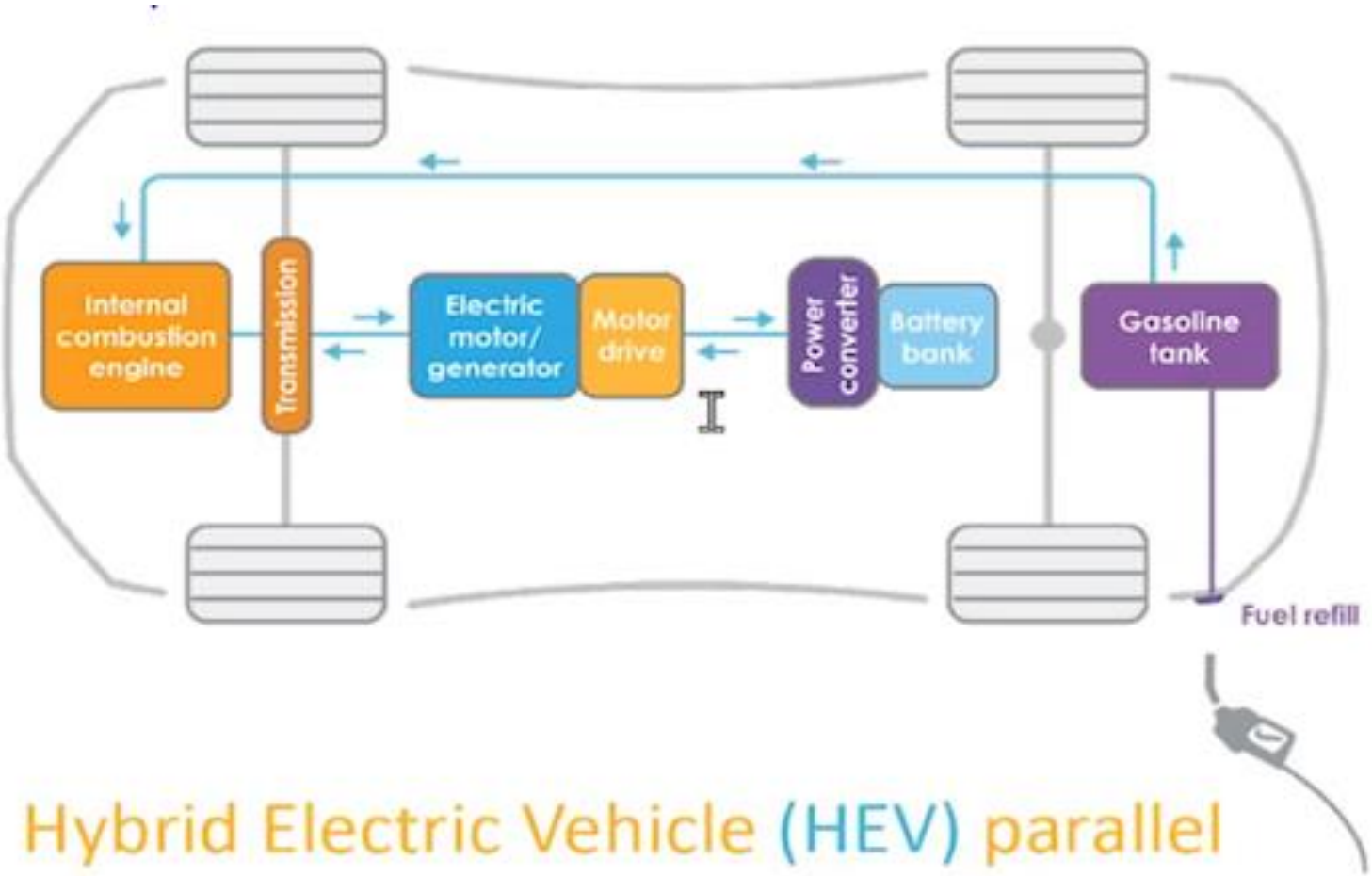
(b) Parallel Hybrid vehicle



Hybrid Electric Vehicle (HEV) parallel

Hybrid electric vehicle

(b) Parallel Hybrid vehicle



Hybrid Electric Vehicle (HEV) parallel

Case 1 IC Engine

- Motor – Charging
- IC Engine – Performing Drive

Case 2: Electric Drive

- Motor - Performing Drive
- IC Engine- Rest Condition

Case 3: Hybrid Mode

- Engine
- IC Engine

Case 3: Low Battery

- Engine – Charging & drive mode

Case 5: Regenerative Braking

- Motor- Generator, Power stored in battery.

Hybrid electric vehicle

Advantages & Disadvantages

➢ **Advantages of the Parallel Hybrid Vehicle.**

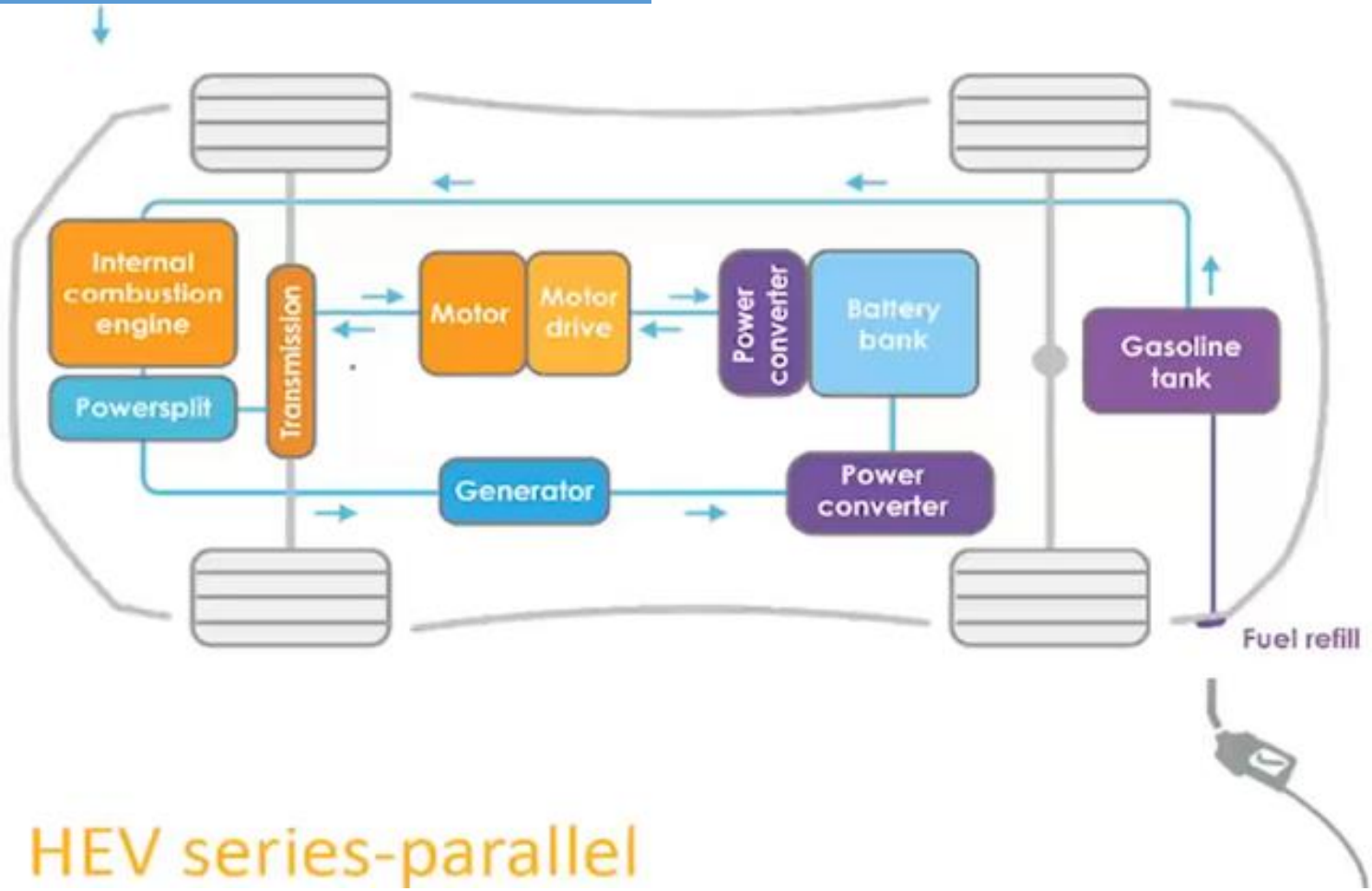
- Both engine and electric motor directly supply torques to the driven wheels and no energy form conversion occurs, hence energy loss is less.
- Compactness due to no need of the generator and smaller traction motor.

➢ **Disadvantages of the Parallel Hybrid Vehicle.**

- Mechanical coupling between the engines and the driven wheels, thus the engine operating points cannot be fixed in a narrow speed region.
- The mechanical configuration and the control strategy are complex compared to series hybrid drivetrain.

Hybrid electric vehicle

(c) Series Parallel Hybrid vehicle

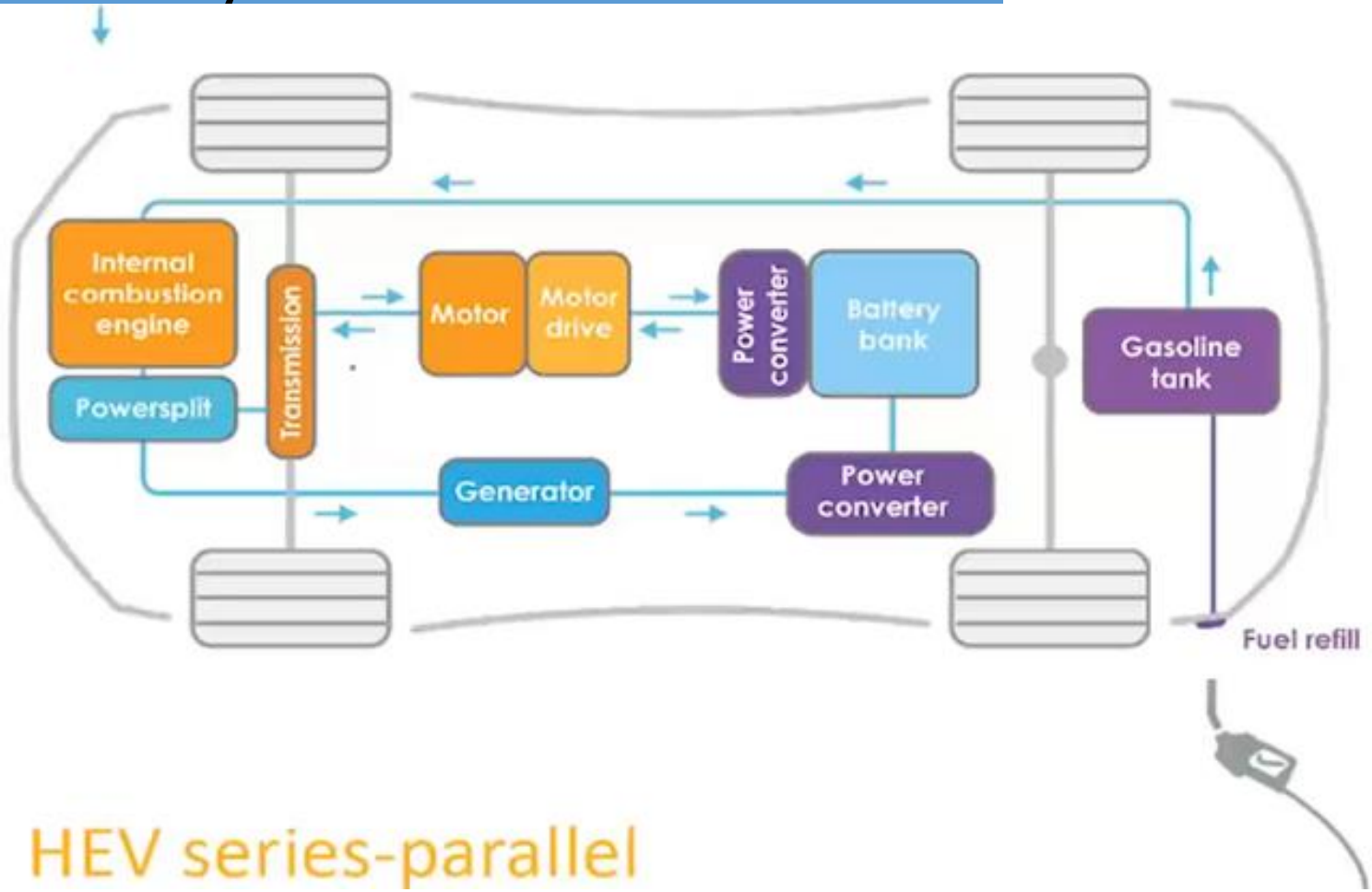


HEV series-parallel

Toyota Prius Engine Cut section

Hybrid electric vehicle

(c) Series Parallel Hybrid vehicle

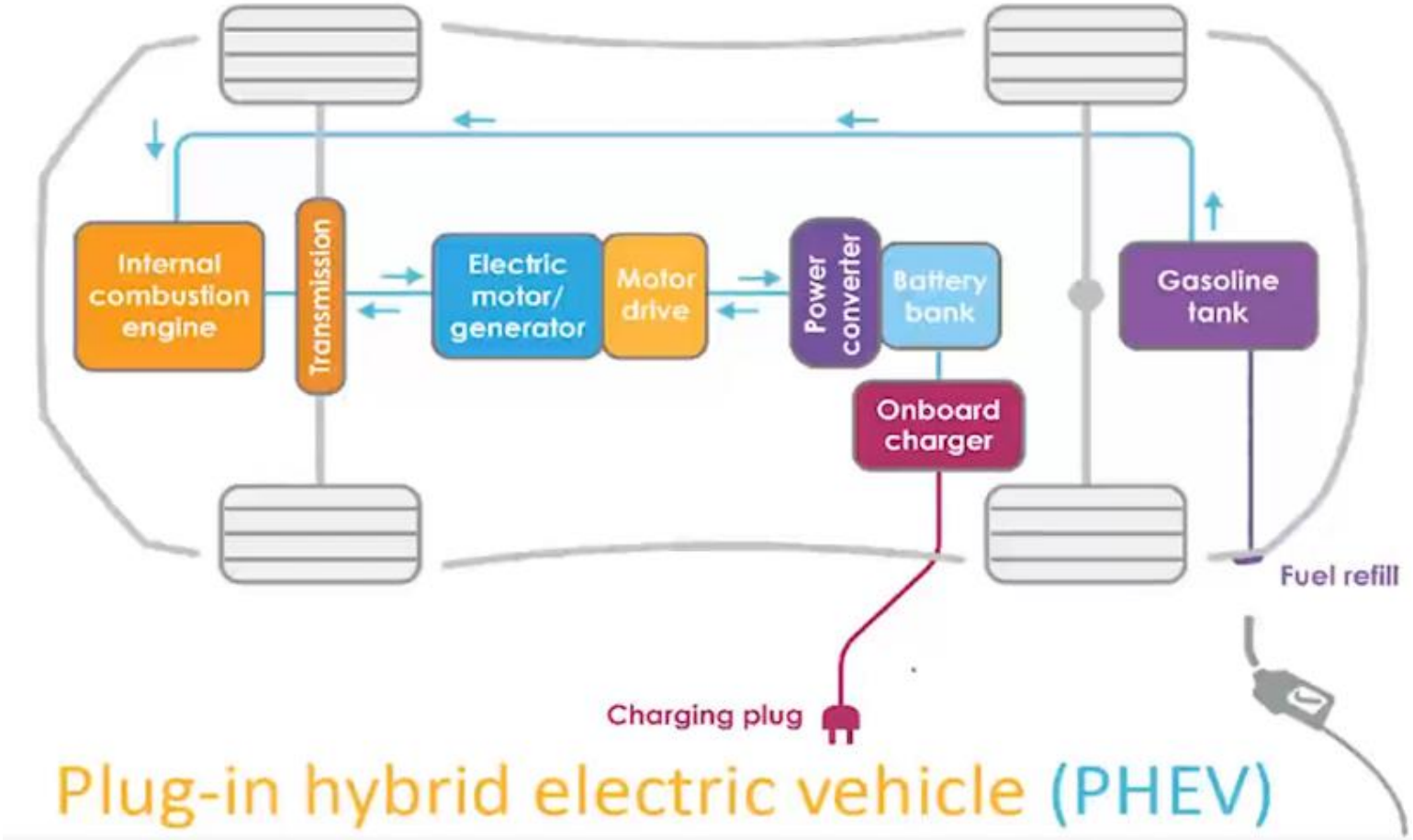


HEV series-parallel

- Have feature of both series and parallel hybrid.
- Many different modes of driving are possible under ICE dominant hybrid vehicle and under Motor dominant drive mode.
- First model- Toyota Prius, 1995.

Hybrid electric vehicle

(d) Plug in Hybrid electric vehicle (PHEV)



Advantages & Disadvantages

- **Advantages of the Plug in Hybrid electric vehicle (PHEV)**
  - zero emission when driving on batteries
  - fuel efficient in traffic
  - easy to drive
  - cheap to run if doing regular 10/15 mile commutes .
- **Disadvantages of the Plug in Hybrid electric vehicle (PHEV)**
  - relatively expensive & complex to maintain
  - fuel economy not very good on motorway journeys
  - battery life concerns

Plug In Hybrid Electric vehicle- BMW i8