A Journey Towards a Greener Tomorrow

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How many of you, use mobile phone?

What is the **source of energy** to use the mobile phone?

Battery!

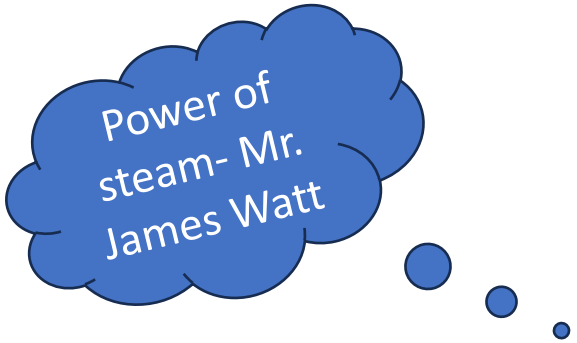
How is the battery charged?

Using electricity from wall socket!

From where we get the electricity in wall socket?

From electrical grid!

How is the electricity generated?



By running turbine!

How to run turbine?

By steam!

What is the **source of energy** to generate steam from water?

Mainly by burning coal!

What is the **primary** **source** of energy to utilize your mobile phone?

Coal

What is the **secondary** **source** of energy to use your mobile phone?

Electricity

What is the unit of energy?

Joule

Generally, how we measure electrical energy?

kWh

1 kWh (1 unit of electricity): 1000 W bulb glows for 1 h

3 kW instant geyser in kitchen run for how long for a consumption of 1 kWh electricity

How much CO_2 is generated (in coal power plant) for 1 Unit of electricity?

~ 1 kg CO_2

What is the average electricity consumption in your home?

I used petrol car to come at this venue, which is ~ 15 km away from my residence.

My car's fuel economy (average) is ~ 10 km/L

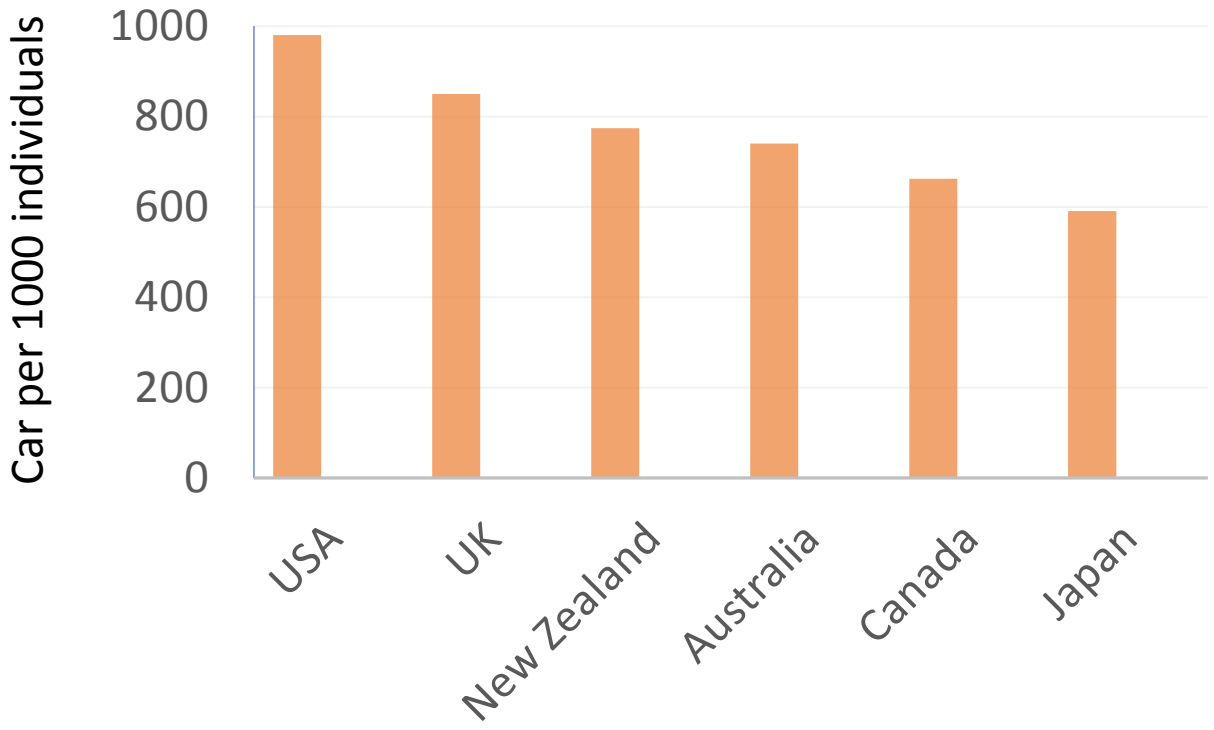
How much petrol I burnt?

1.5 litre

How much CO_2, the car has emitted?

~ 1.5 x 2.3 kg ~ 3.5 kg

Emissions Produced by Cars



China: 164

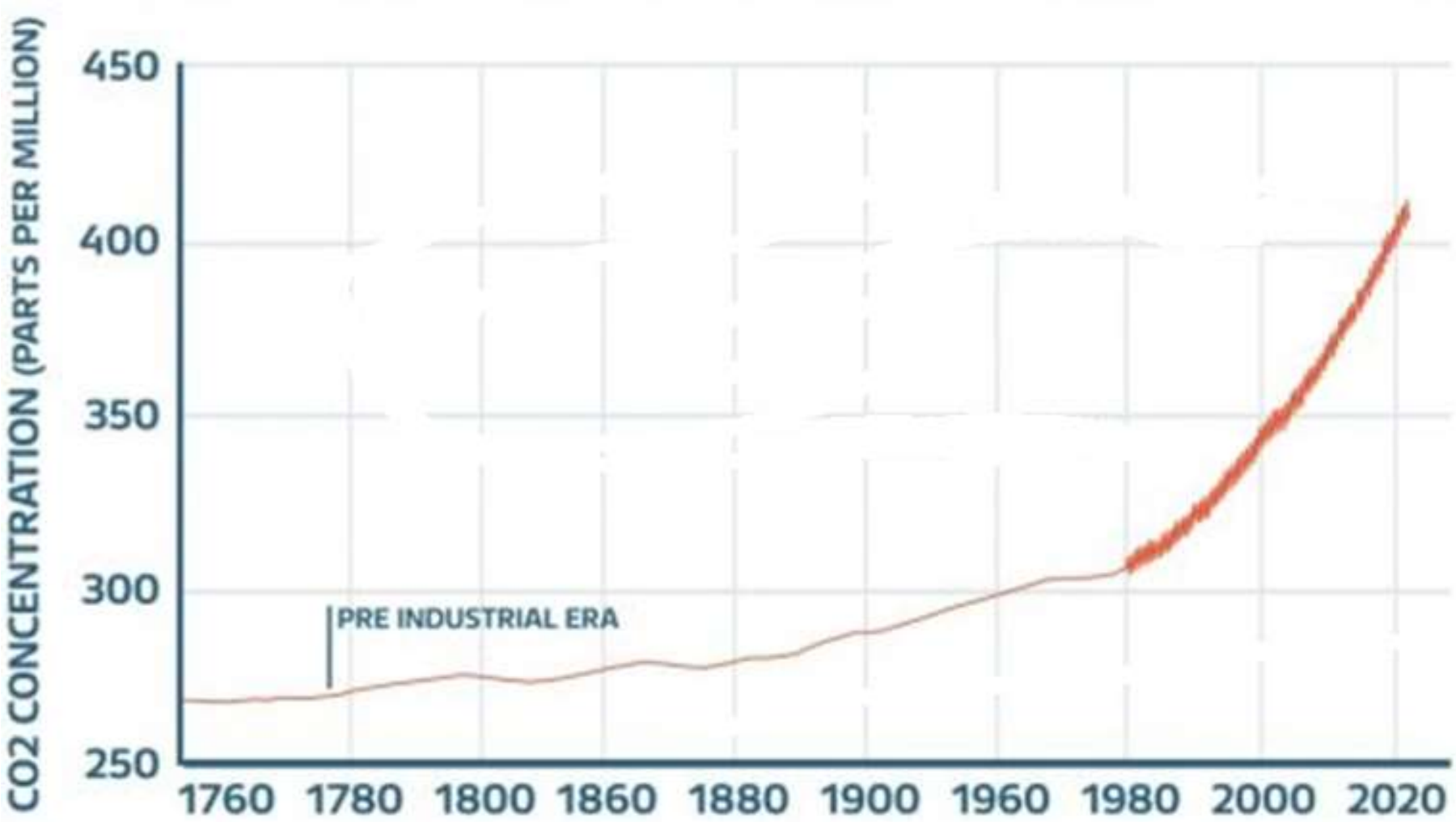
India:22

India: 3rd in crude oil consumption

20th in production

Sources: ET-Auto Dec 2018; BEE India

CO_2 Level in the Environment



https://www.itv.com/news/2021-03-17/global-carbon-dioxide-levels-set-to-reach-all-time-high-latest-met-office-research-finds

Climate change and its meaning…

Climate change refers to **long-term shifts in temperatures and weather patterns**.

- Natural: due to changes in the sun's activity or large volcanic eruptions
- Human activity: main driver of climate change

* primarily due to the burning of fossil fuels like coal, oil, and gas.

Mean rise of earth's surface temp. by 1.5 °C (max.)

Industrial pollution

Traffic pollution

Power plants

Residential

Increasing frequency of extreme weather events

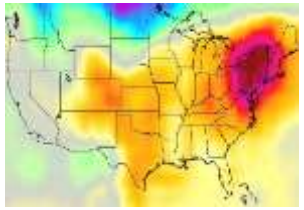
Hurricanes

Forest fires

Floods

Tsunami

Heatwave



Landslide

Image Source: Microsoft Bing

Climate change and sustainability

Sustainability: "Meeting the needs of the present without compromising the ability of future generations to meet their own needs."

Environmental Sustainability

Humanity's rate of consumption (or pollution) < nature's rate of replenishment (or restoration) ***TIME!***

Mahatma Gandhi's statement: "The Earth has enough resources to meet the needs of all but not enough to satisfy the greed of even one person".

The ways, one can be sustainable **in everyday life** by

cycling to school/office, if possible

not wasting electricity/food/water …

reduce, reuse, and recycle

…

https://www.mcgill.ca/sustainability/files/sustainability/what-is-sustainability.pdf

A story

One day, as the Buddha sat in deep thought about the world and ways of instilling goodness in human beings, he was approached by one of his disciples.

"Oh teacher! You are so concerned about the rest of the world!
Why don't you also look into the welfare and needs of your own disciples?"

"Tell me, how can I help you?"

"Master! My attire is worn out beyond the limits of decency. Could I get a new one, please?"

https://www.youtube.com/watch?v=ryvUrWgEdOM&ab_channel=FroehlichLearner

The Buddha looked at him closely and found that the robe did appear to be in bad condition and needing of replacement.
He asked the store-keeper to give the disciple a new robe.

A little while later, the Buddha visited his disciple.

Buddha: I hope, then, that you have disposed of your old bedspread?

Disciple: No, no, Master. I am now using my old bedspread as a pillow.

Buddha: What did you do to your old pillow?

Disciple: I am now using my old pillow as a doormat.

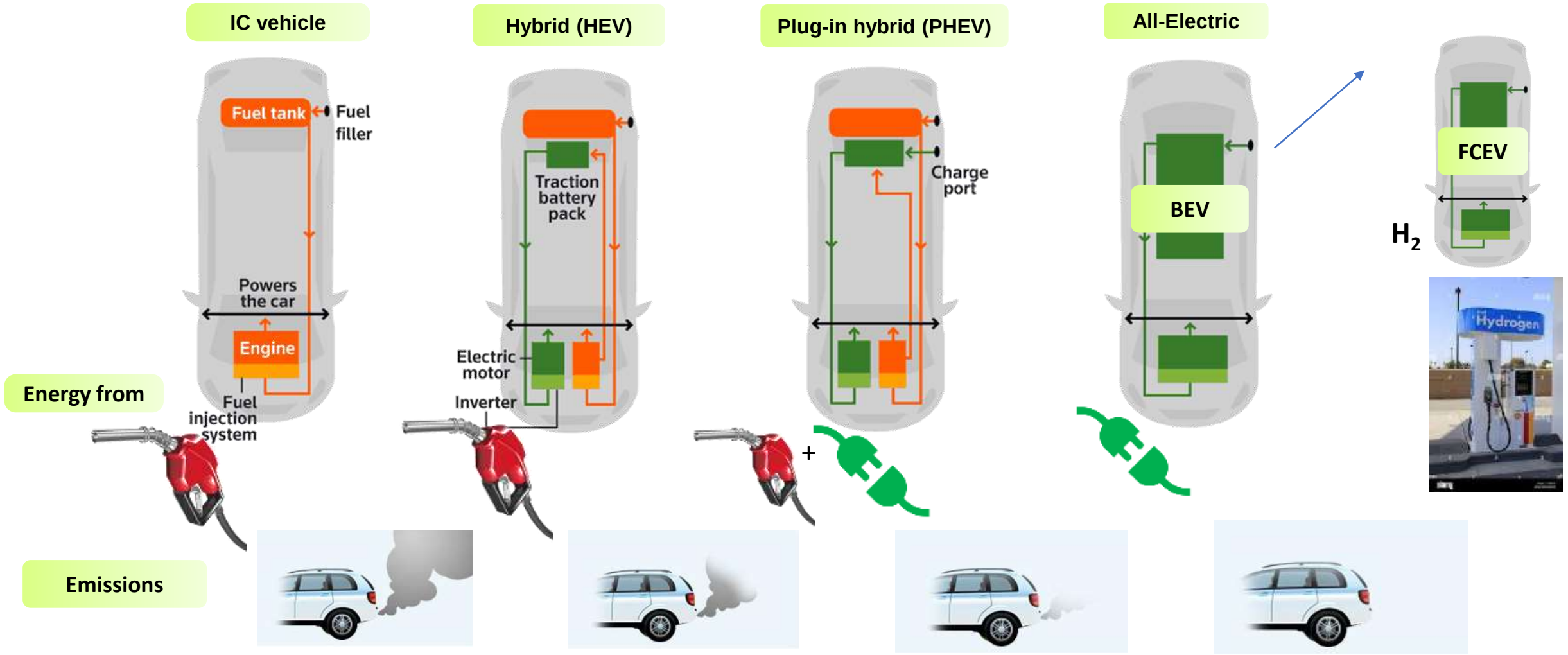
Buddha: What did you do to your doormat?

Disciple: Master, since the doormat was already tattered, could not find any better use for it thus I took its cotton fibres to make wicks for the oil lamps, and lighting up study

The Buddha smiled in contentment and walked out of the disciple's room.

https://www.youtube.com/watch?v=ryvUrWgEdOM&ab_channel=FroehlichLearner

Type of Electric Vehicles



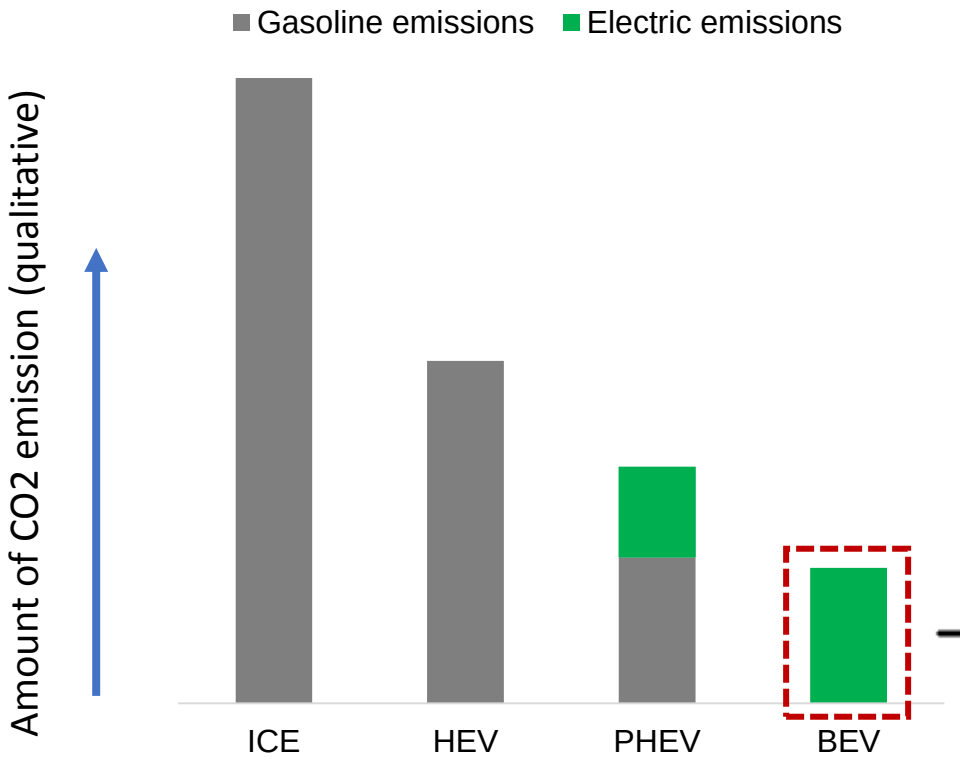
How many km a typical small BEV can run using 1 unit (1 kWh) of electricity?

10 km

Images: Courtesy Team BHP and Thomas Reuters

How *Green* are Electric Vehicles?

The source of electricity influences the emissions of an EV!



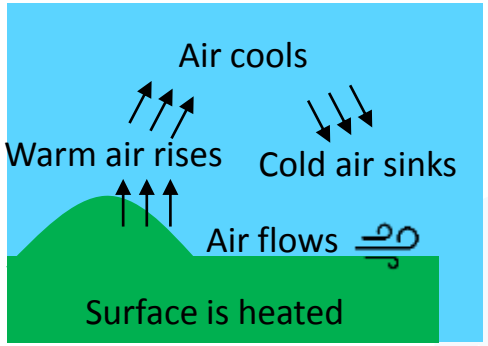
Emissions due to electricity utilized from fossils-driven power plants

Ref.: International Council on Clean Transportation

Sun: Source of energy on the Earth

Wind energy

Wind flows from unequal heating of the Earth

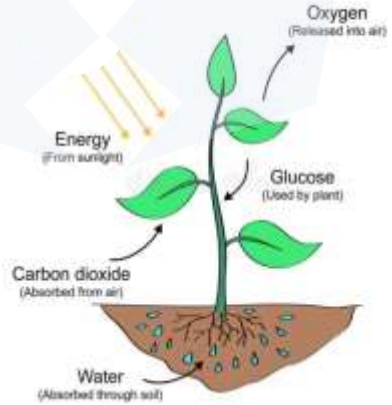


Solar energy

Wood from trees

Biomass-processing

Biomass

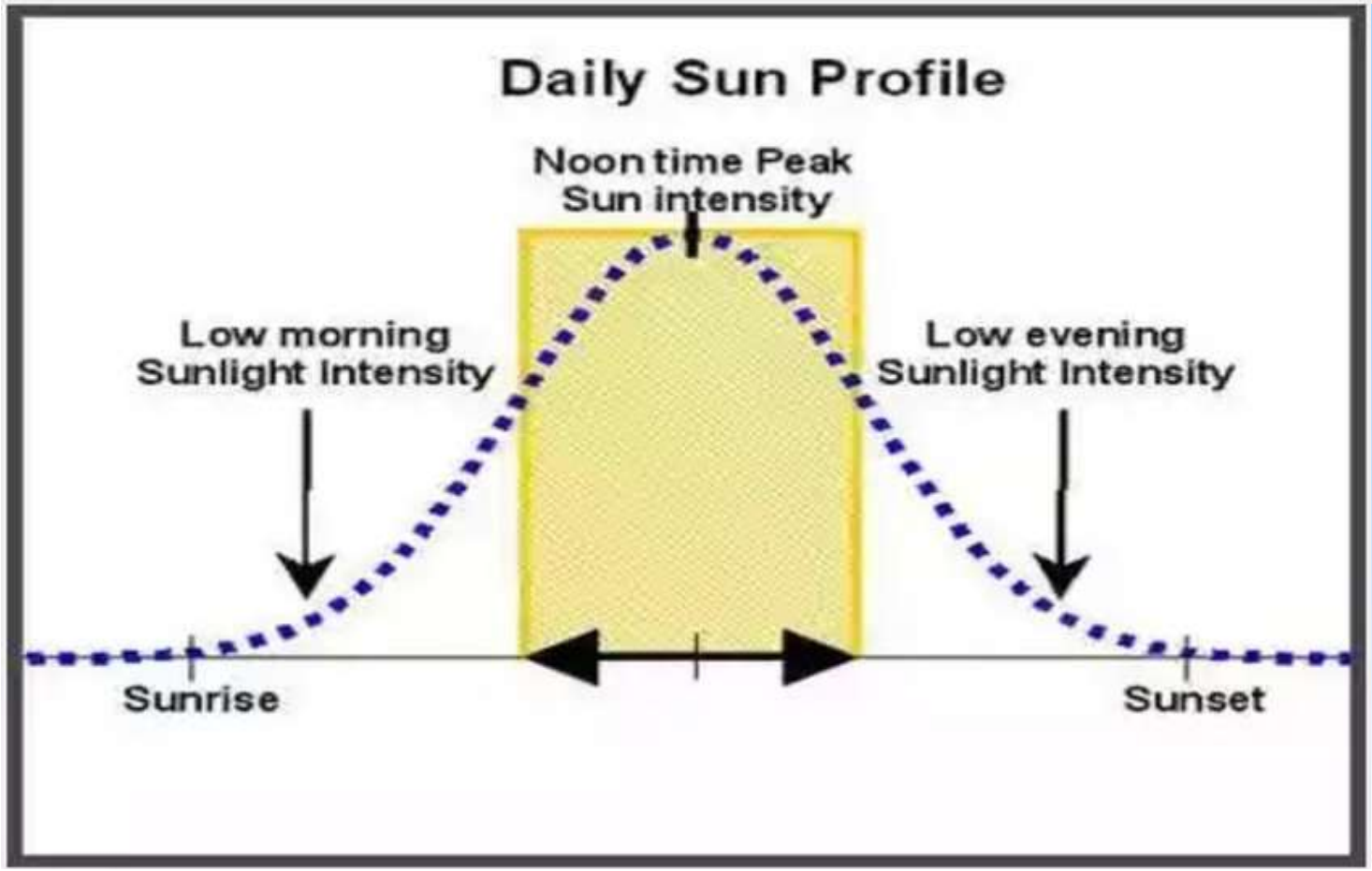


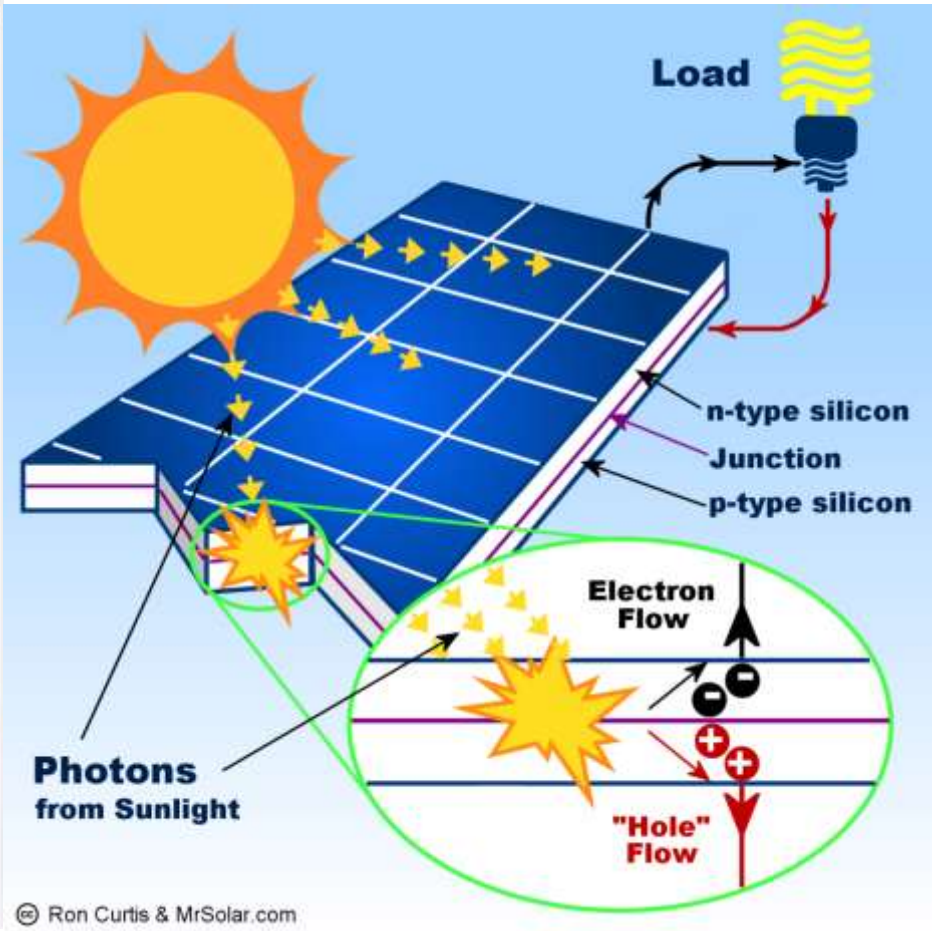
Food from photosynthesis

Fossil fuels from wood

Pharmaceuticals | **Chemicals** | **Plastics**

Solar energy profile in a typical day





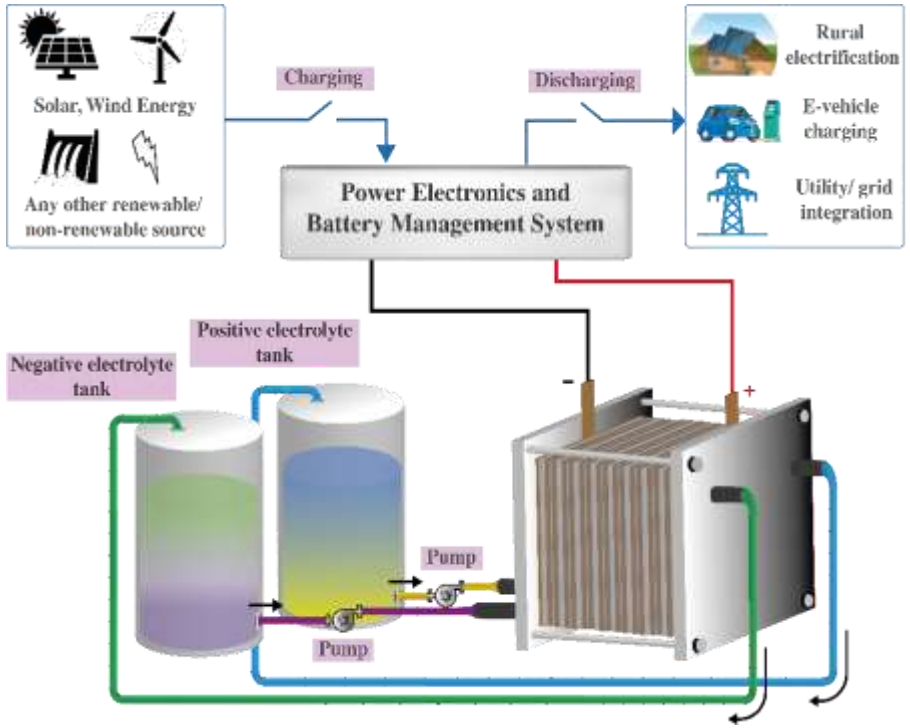
https://www.researchgate.net/figure/Figure-2-Variations-of-solar-radiation-intensity-with-time_fig2_338327730

Batteries: A glance

Li-ion battery

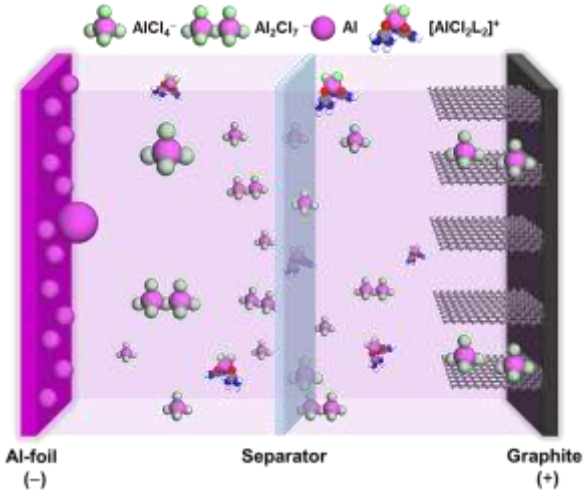
- Portable/stationary applications
- Short life
- Inflammability
- Large environmental footprint

Vanadium redox flow battery



- Stationary applications
- Long life
- Economic scale-up
- Environmentally safe

Aluminum-ion battery



- Portable/stationary applications
- Long life
- Ultrafast charging
- Environmentally safe

Fuel Cell and Electrolyzer: A glance

Anode

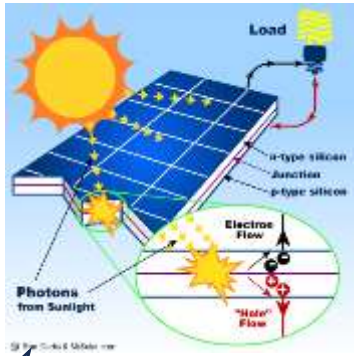
$$2H_2 \rightleftarrows 4H^+ + 4e^-$$

Cathode

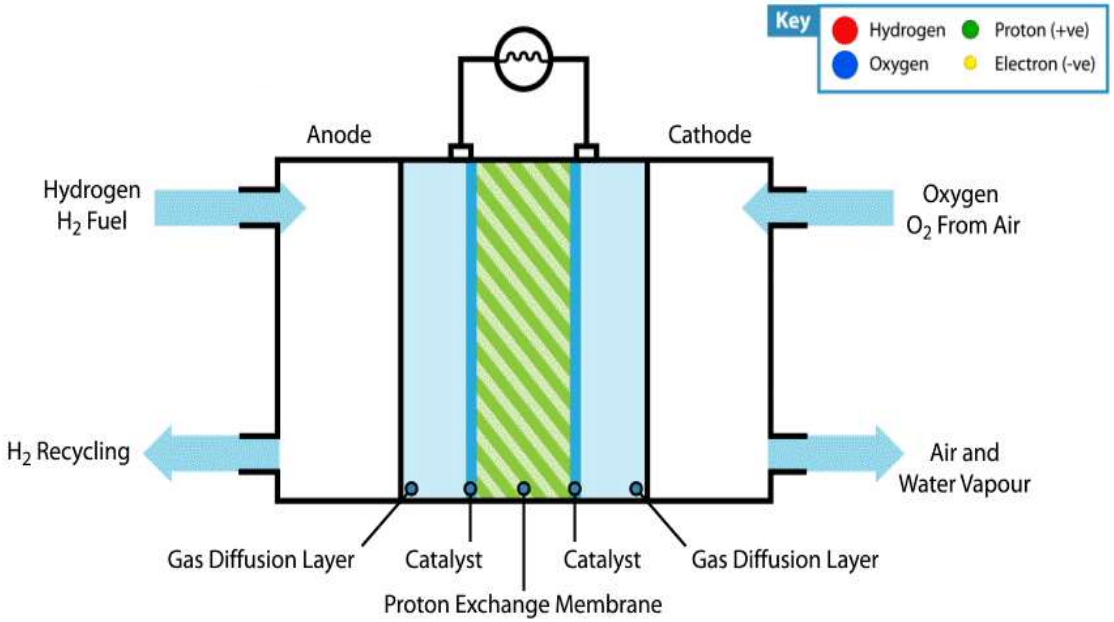
$$O_2 + 4H^+ + 4e^- \rightleftarrows 2H_2O$$

Overall Reaction

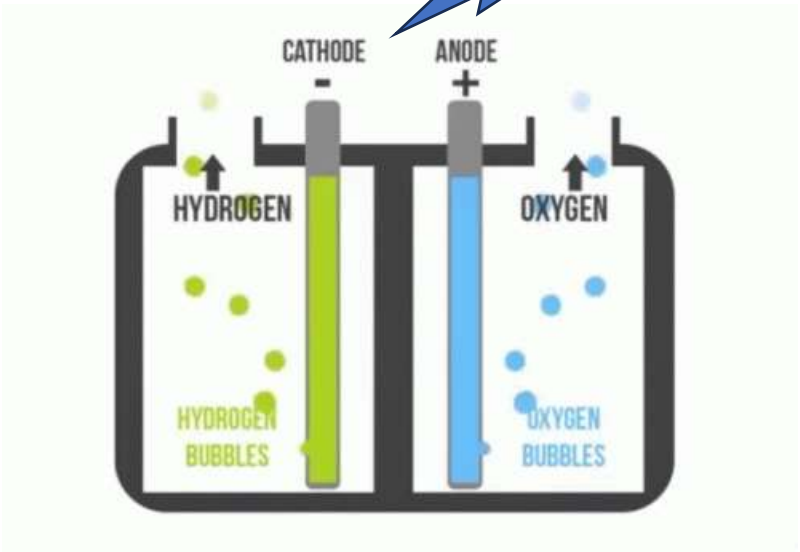
$$2H_2 + O_2 \rightleftarrows 2H_2O$$



Fuel Cell



Water Electrolyzer



Let's Summarize!

Are present electric vehicles really carbon neutral?

a. Yes

b. No

Images: Courtesy Microsoft Bing

If not, why?

Because they are still charged from fossil fuel derived electricity

Images: Courtesy Microsoft Bing

How can we eliminate the **tail-pipe emission** completely from transport sector?

a. CNG based vehicles

b. Electric vehicles

c. Hydrogen-powered vehicles

d. Carpool

Images: Courtesy Microsoft Bing

What is the main problem with renewable energy sources?

These are intermittent (not always available)

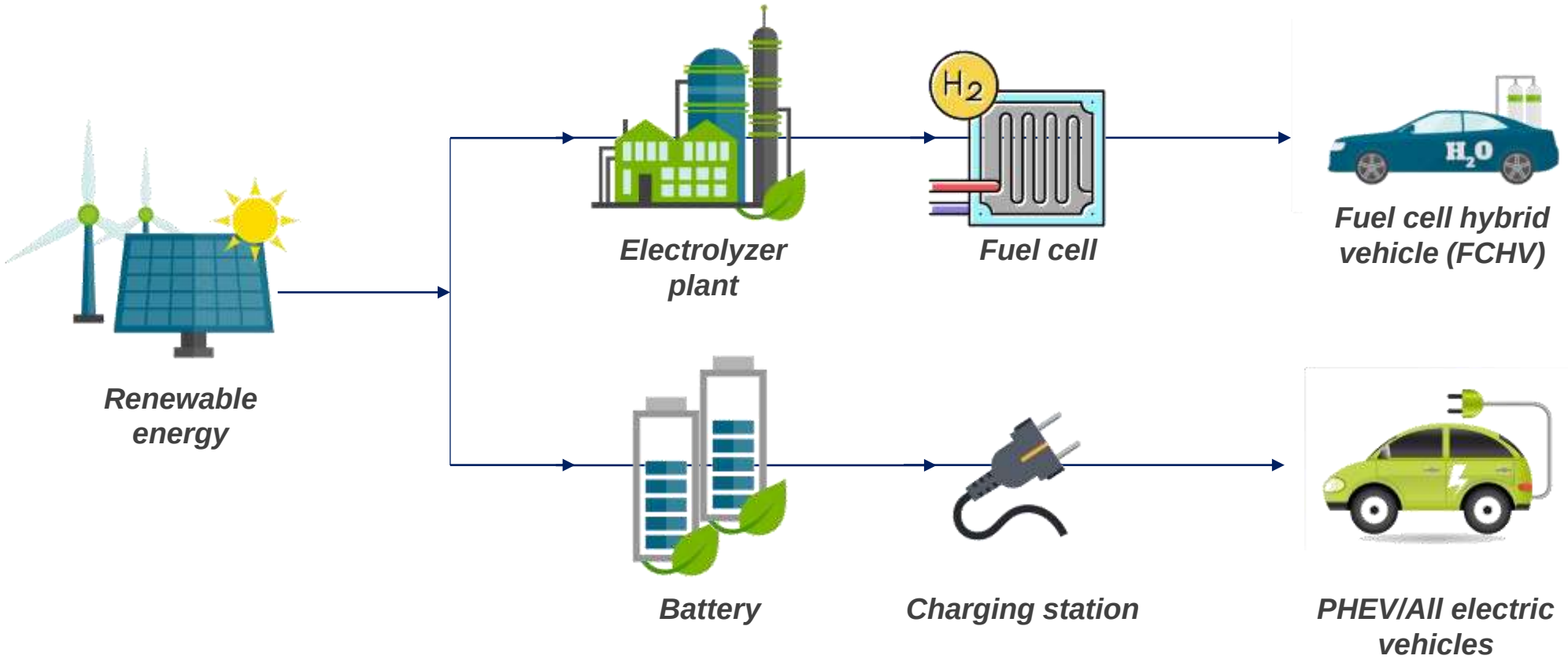
How can we tackle intermittency associated with renewable energy sources such as solar/wind etc.?

a. By integrating with an energy storage system

b. By using grid power during intermittency

c. By using diesel generator during intermittency

d. By enjoying nature during downtime


Renewable energy
Electrolyzer plant
Fuel cell
Fuel cell hybrid vehicle (FCHV)
Battery
Charging station
PHEV/All electric vehicles

Thank You