DDL753 Design of sustainable habitats

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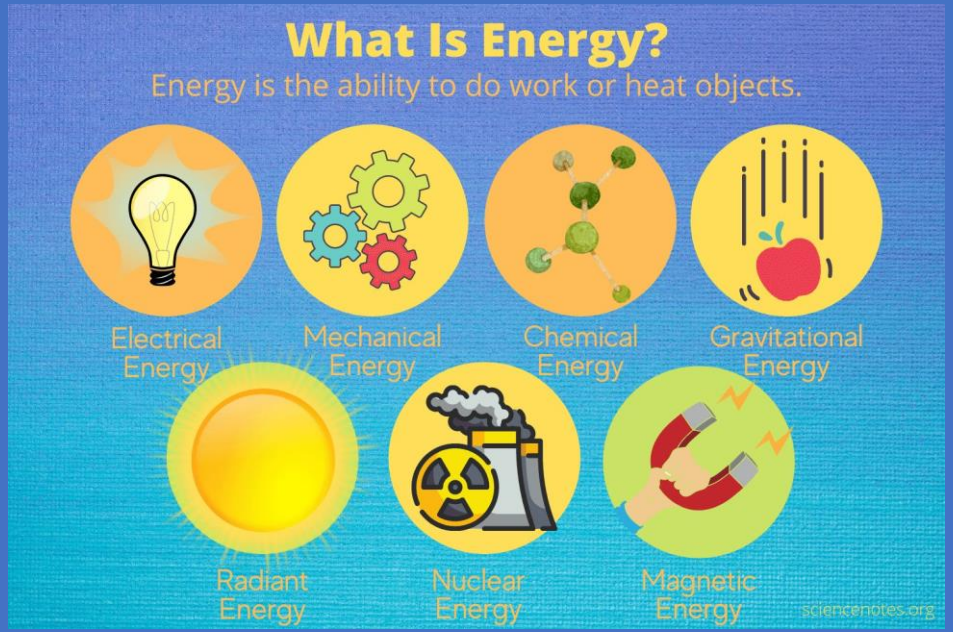
Department of Design, IIT Delhi



Topic 2: Energy

06th September, 2023

Dictionary

Definitions from Oxford Languages · Learn more

English

energy

/ˈɛnədʒi/

noun

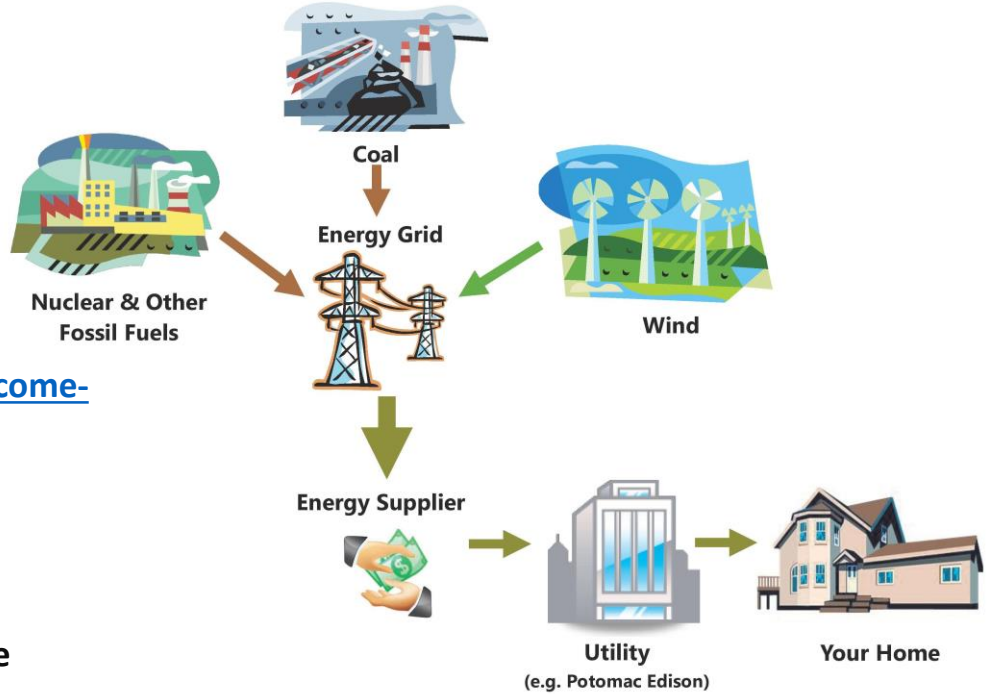
1. the strength and vitality required for sustained physical or mental activity.
   "changes in the levels of vitamins can affect energy and well-being"

   Similar: vitality, vigour, life, liveliness, animation, vivacity, spirit

2. power derived from the utilization of physical or chemical resources, especially to provide light and heat or to work machines.
   "nuclear energy"

   Similar: power

What powers the world?



Where Does Energy Come From?
https://dcmp.org/media/7454-where-does-energy-come-from

Energy 101: Where Electricity Comes From
https://www.youtube.com/watch?v=AKuoIeupGHc

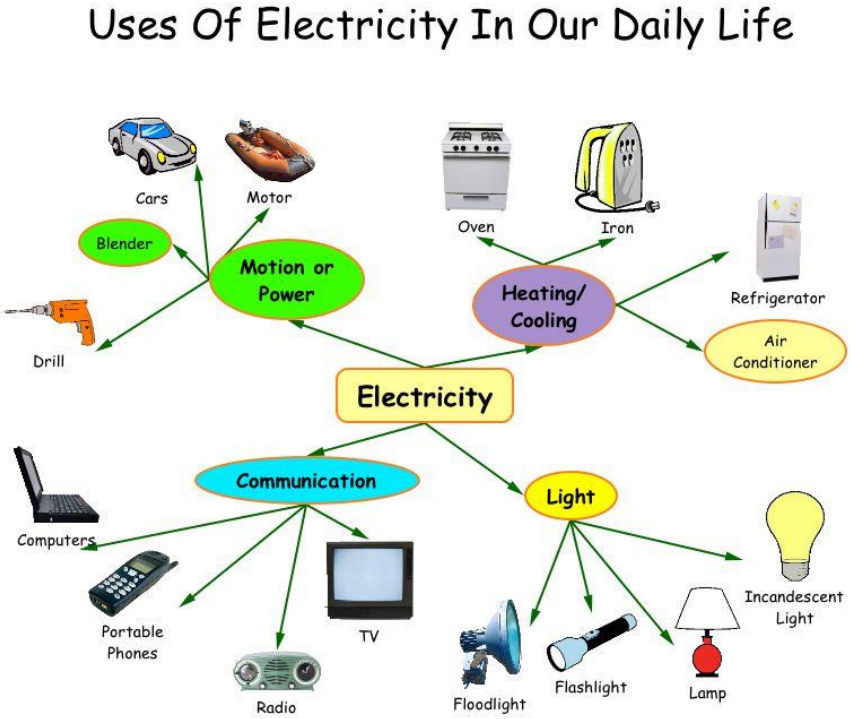
Thermal Power Plant | Boiler | Economizer | Turbine
https://www.youtube.com/watch?v=m4CwaKTQikw

How to make 220V Steam Dynamo - DIY Energy Genarator
https://www.youtube.com/watch?v=vfth8RT1j98

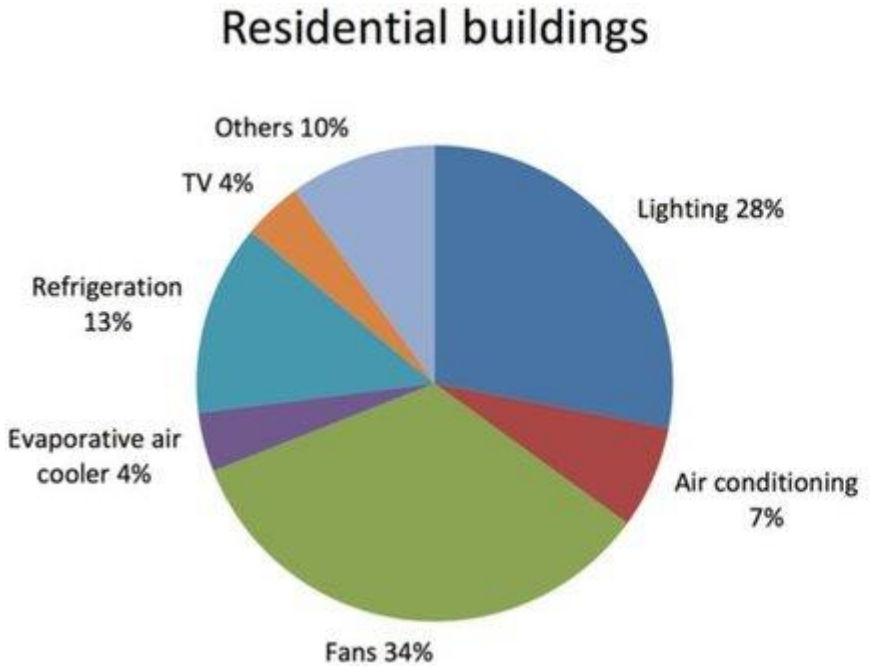
Power Generation
https://www.youtube.com/watch?v=F6YW8h8cML4

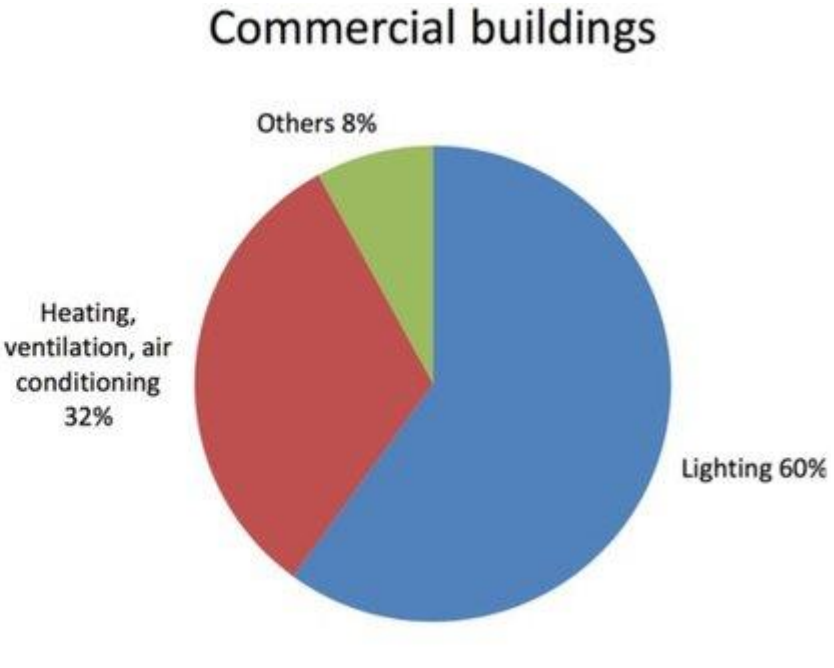
Source:
https://frederickgreenchallenge.org/pages/handbooks/rs-handbook/chapter1

Energy use in Iron & Steel Industry

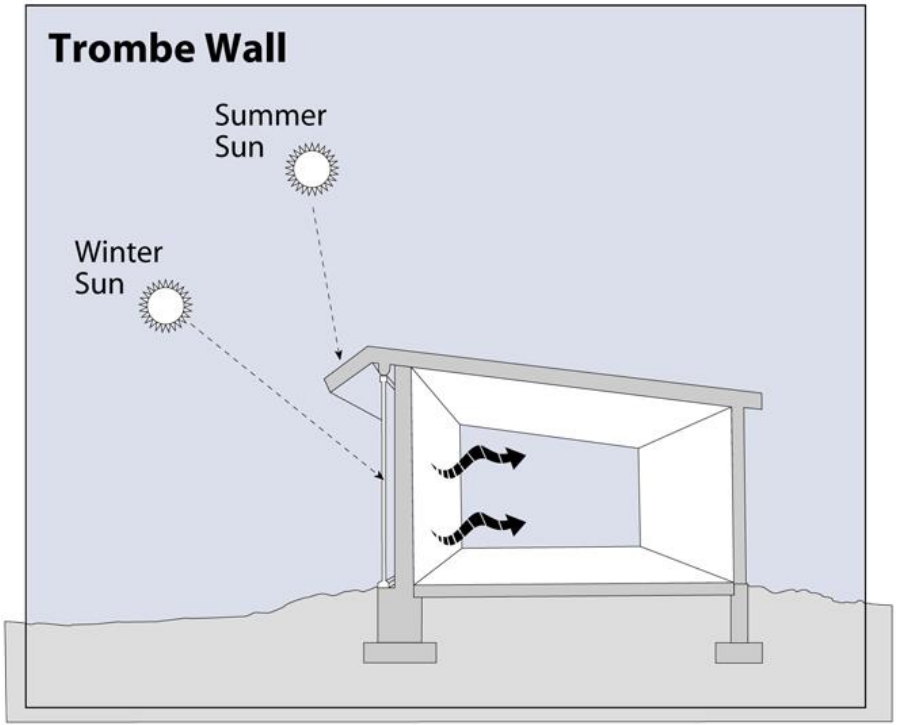


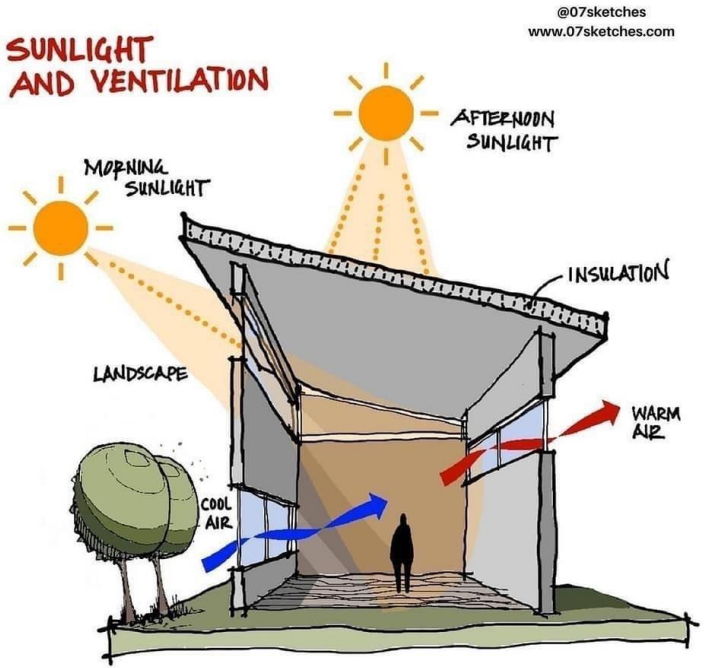
Energy use in buildings in India





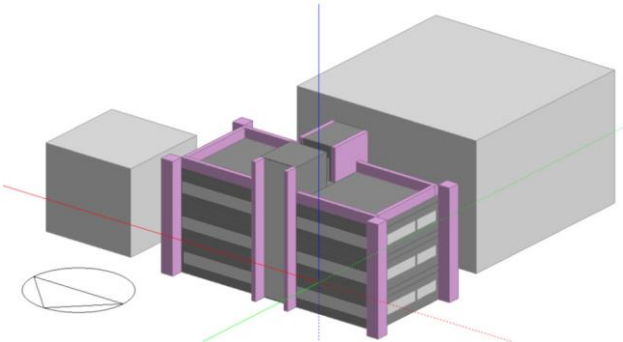
Minaal Sahlot , Saffa B. Riffat, Desiccant cooling systems: a review, *International Journal of Low-Carbon Technologies*, Volume 11, Issue 4, 15 December 2016, Pages 489–505, https://doi.org/10.1093/ijlct/ctv032



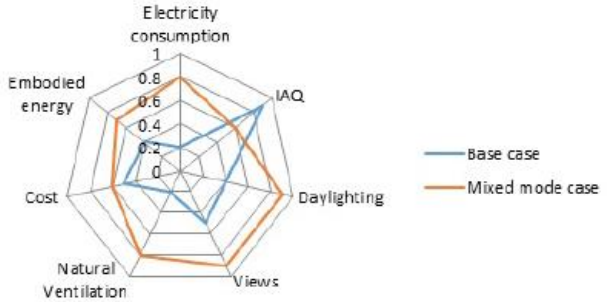


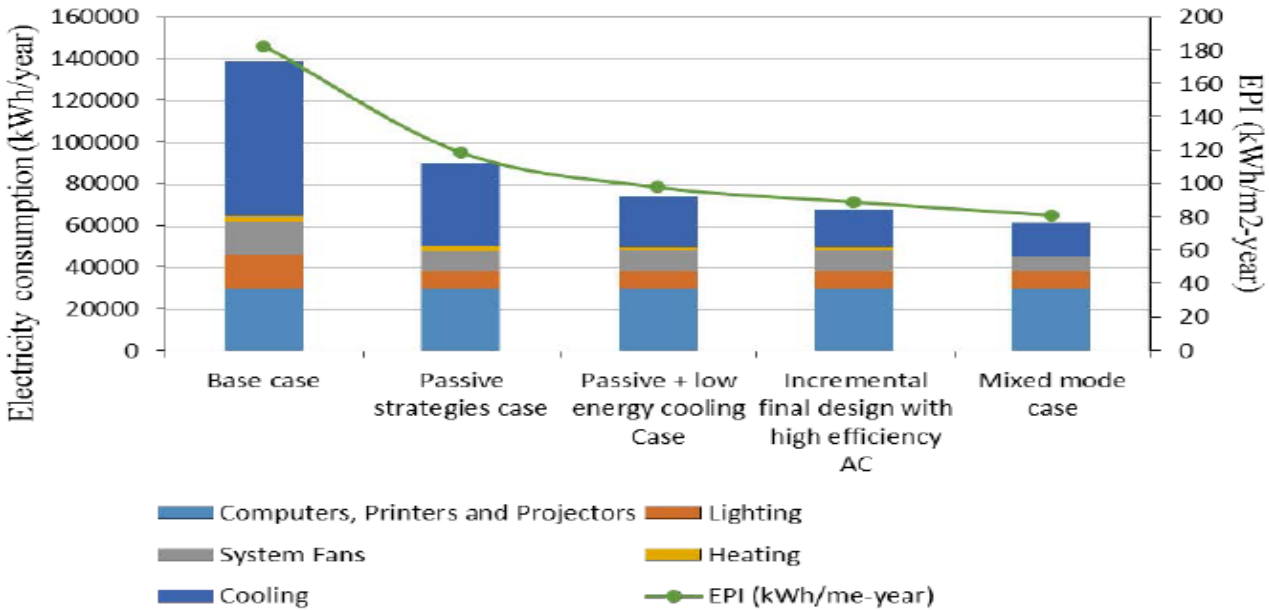
Eco-friendly ways of energy use

Source: https://www.energy.gov/energysaver/passive-solar-homes



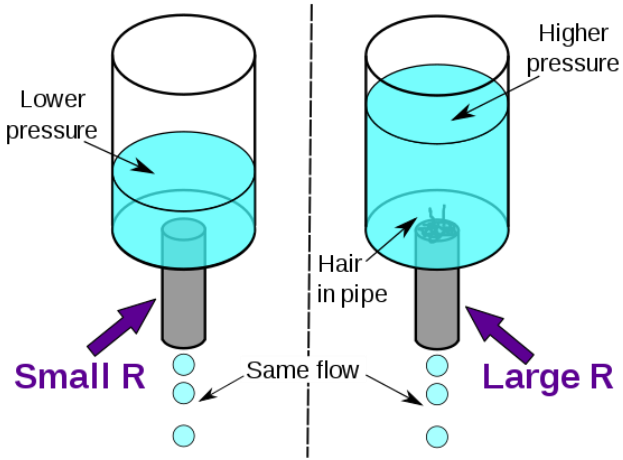
New Delhi climate

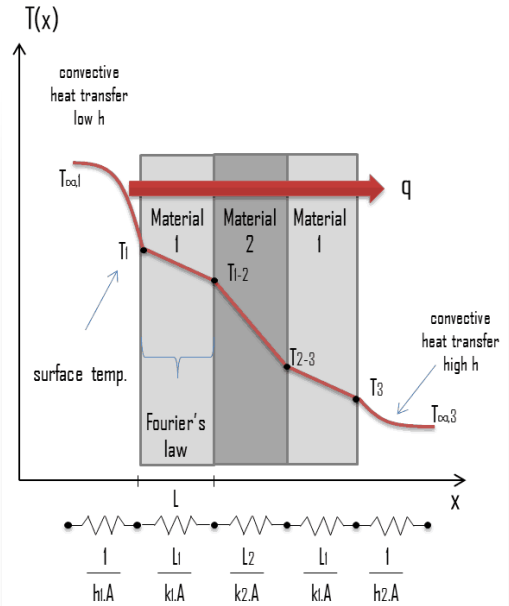


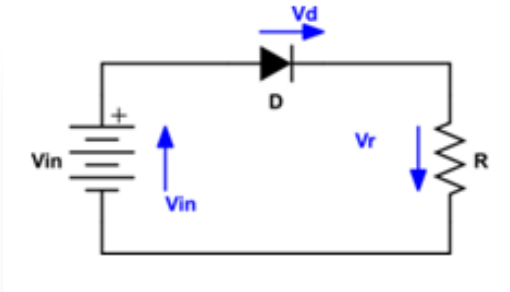


Source: J. Dhariwal, R. Banerjee, Simulation based mixed mode building design, Materials Today: Proceedings, Volume 5, Issue 11, Part 2, 2018, https://doi.org/10.1016/j.matpr.2018.11.079.

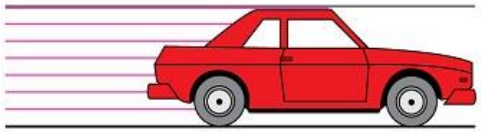
Thermal, Hydraulic and Electrical analogies





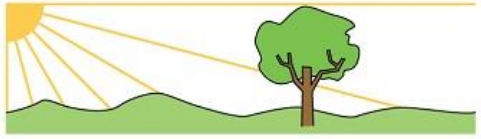


Energy transformation

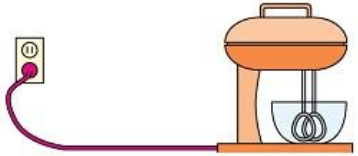


An automobile engine changes chemical energy to mechanical and heat energy.

A thermonuclear reaction changes nuclear energy to radiant and heat energy.

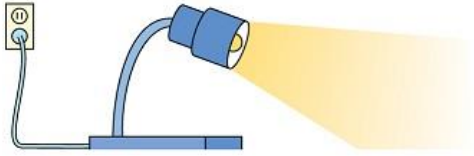


A tree changes radiant energy to chemical energy.



An electric mixer changes electrical energy to mechanical and heat energy.

Hammering a nail changes mechanical energy to deformation and heat energy.

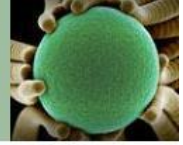


A lamp changes electrical energy to radiant and heat energy.

Law of conservation of energy states that energy can change forms, but is neither created nor destroyed.

Source: https://mechanicalengineering.blog/law-of-conservation-of-energy/

Units of Energy



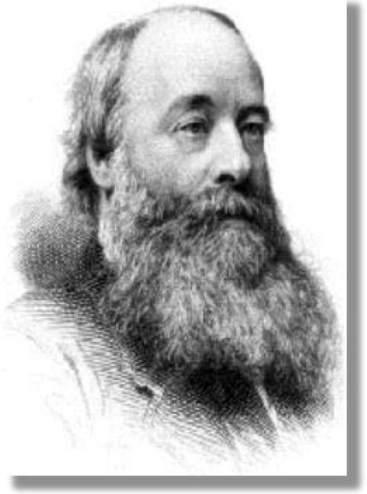
1 calorie = heat required to raise temp. of 1.00 g of H_2O by 1.0 ° C.

1000 cal = 1 kilocalorie = 1 kcal

1 kcal = 1 Calorie (a food "calorie")

SI units for energy: joule (J)

1 cal = exactly 4.184 J

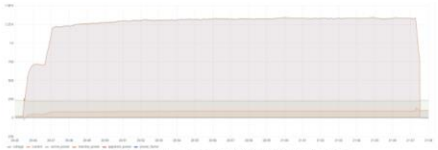


James Joule
1818-1889

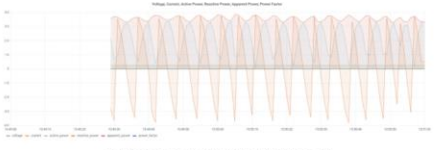
Units of Power

- Power is Energy used per unit Time
- SI unit of Power is Watt = Joule per second
- 1 kW = 1000 W
- Electrical Power (P) = Voltage (V) X Current (I)
- 1 unit of electrical energy consumed = 1 kWh = Power (kW) X Time (hour)

Energy measurements using Energy Monitors



data from a new AC : 1.25 kW max

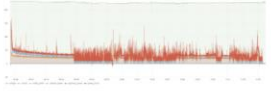


data from a old AC : 3 kW max

Fan : 80 W

9 Fin oil Heater : 2 KW max

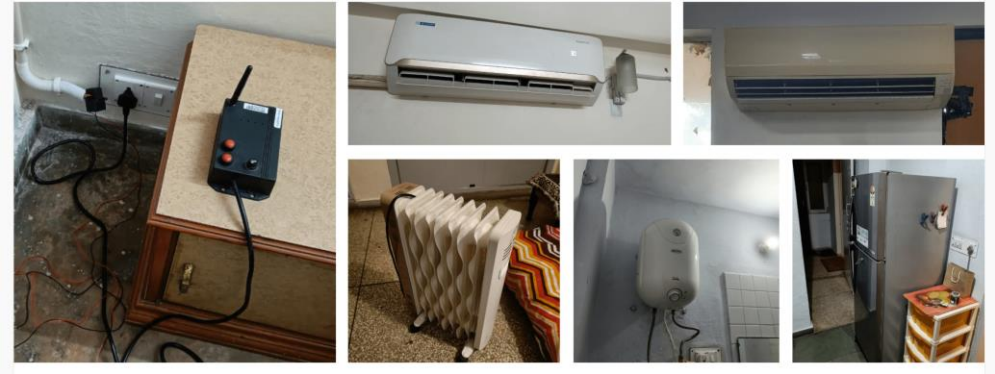
Geyser : 2 KW max

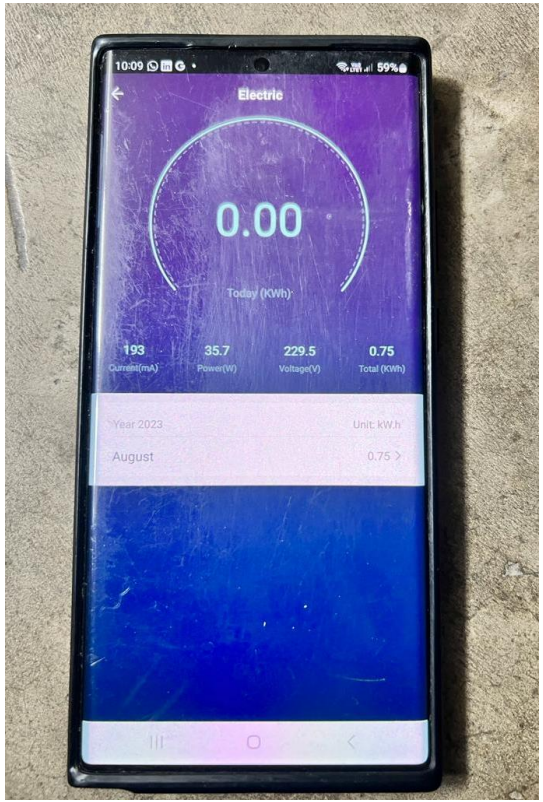


Laptop : Fluctuating (100 W max)

Light : 10 W max

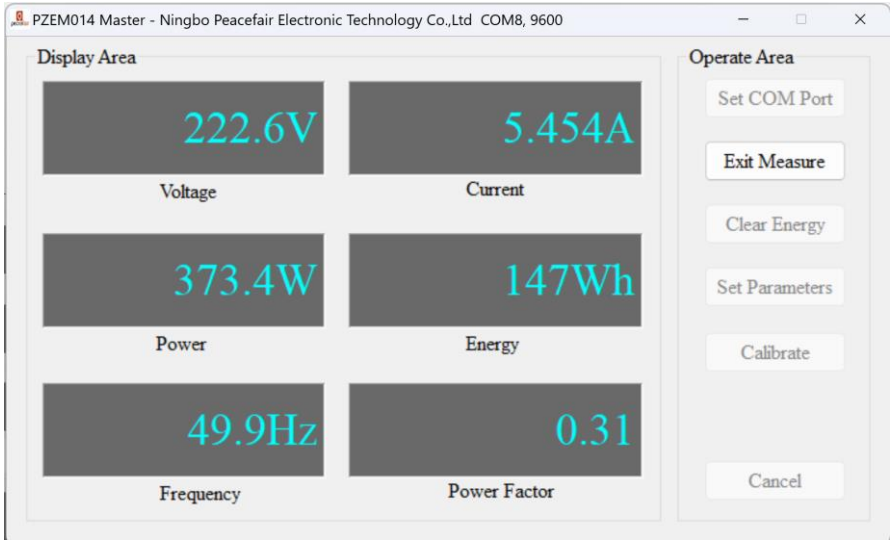
Fridge : 80 W max





Measuring Power consumption using a Smart Plug

[Power consumption by Household Appliances]

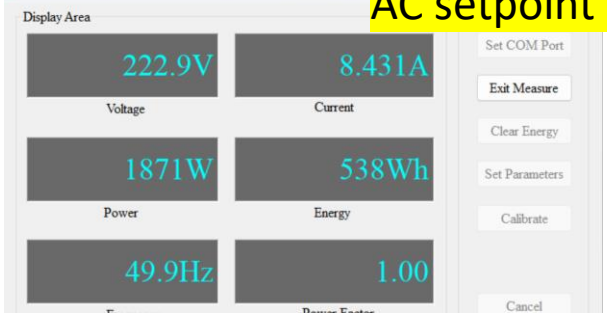


Energy Meter (with CT)

Power Factor = True Power/Apparent Power
Apparent Power = 373.4/0.31 = 1205 VA

Measurements for an inverter AC

AC setpoint = 23.5 C



AC off, ODU running

AC setpoint = 30 C

AC off, ODU also off

Computing energy consumption per person

Equipment type	Number of equipment	Operating hours per day	Number of days used per year	Power consumption (W) of one equipment	Shared with how many people	Energy consumption (kWhr)	Carbon Footprint (kg CO2 equivalent)
Laptop	1	10	350	40	1	140	119
Washing Machine							
Geyser and so on …							

Energy consumption (kWhr) = (Number of equipment X Operating hours per year X Power consumption (W) of one equipment) / (Shared with how many people X 1000)

Carbon Footprint (kg CO2 eq) = Energy consumption X Emission Factor

https://greencleanguide.com/calculate-your-carbon-footprint/

Can you work on your carbon footprint for transport? What else – products, food, building?

How do these numbers relate to each one of us?

Basis 1 for calculation: from fuel consumption per flight

One way to calculate CO_2 emissions is from fuel consumption per flight.

A **Boeing 737-400** jet is typically used for short international flights.

For a distance of 926 km, the amount of fuel used is estimated to be 3.61 tonnes [1], including taxiing, take-off, cruising and landing.

Using a seating capacity of 164 [Wikipedia, viewed 28.2.08] and an average seat occupancy (or 'load factor') of 65% [2], this gives a fuel use of 36.6 g per passenger per km.

CO_2 emissions from aviation fuel are 3.15 grams per gram of fuel [1], which gives CO_2 emissions from a Boeing 737-400 of 115 g per passenger per km.

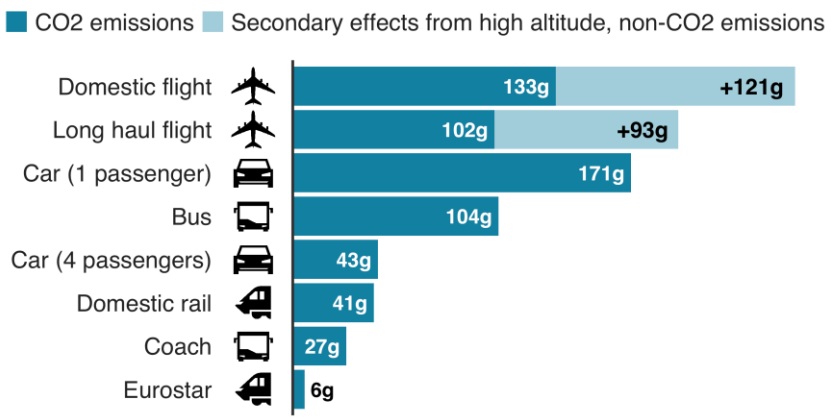
At a cruising speed of 780 km per hour [Wikipedia, 28.2.08], this is equivalent to 90 kg CO_2 per passenger per hour.

You can relate 90 kg CO_2 eq per person per hour to 50 billion tons CO_2 eq per year for planet!
What would be the CO_2 emissions if you use a car/public transport/bike ride?

Source: https://www.carbonindependent.org/22.html#:~:text=CO2%20emissions%20from%20aviation%20fuel,CO2%20per%20passenger%20per%20hour.

Emissions from different modes of transport

Emissions per passenger per km travelled



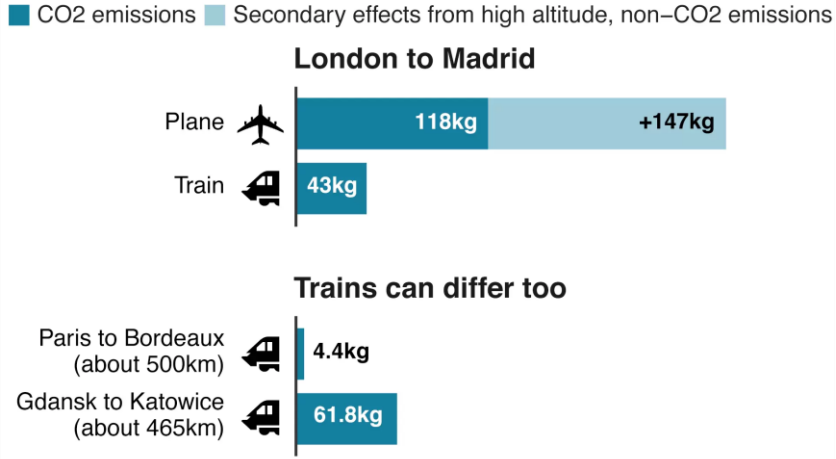
Note: Car refers to average diesel car

Source: BEIS/Defra Greenhouse Gas Conversion Factors 2019

BBC

Emissions from different journeys

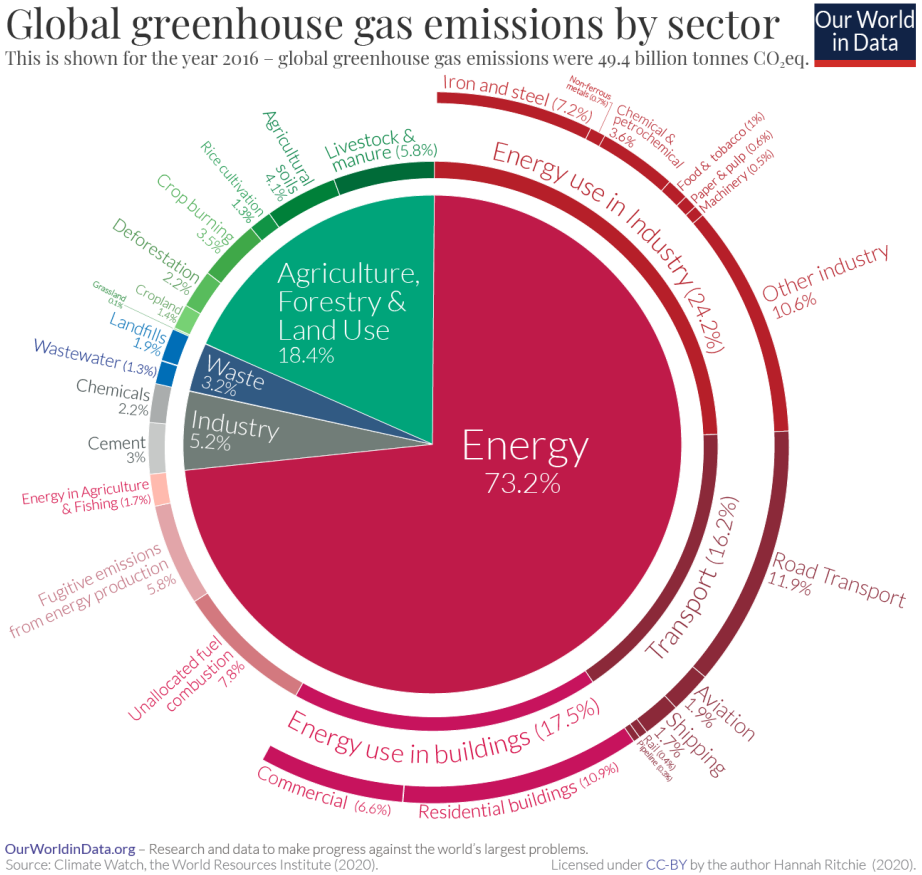
Emissions per passenger for journey

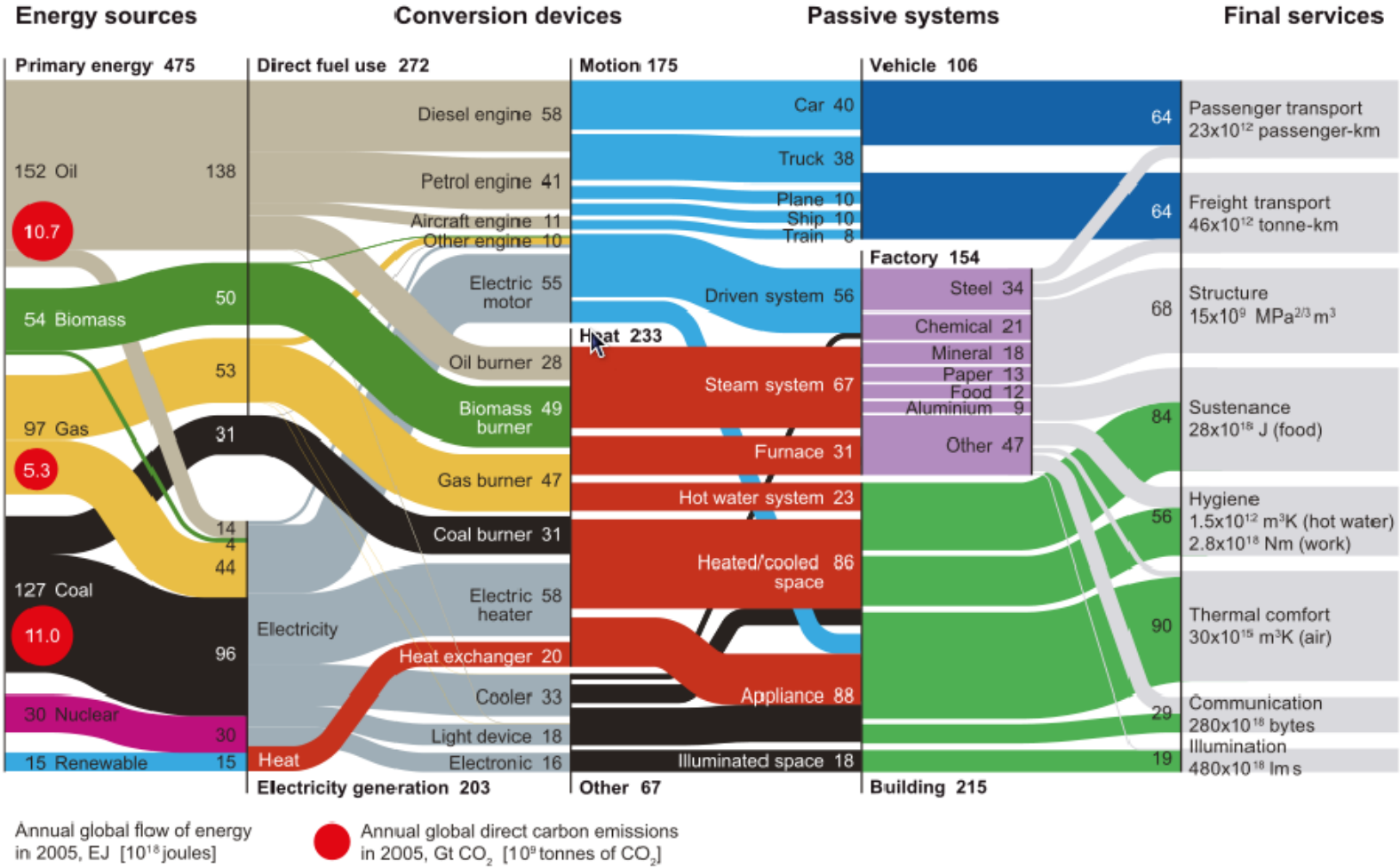


Source: EcoPassenger

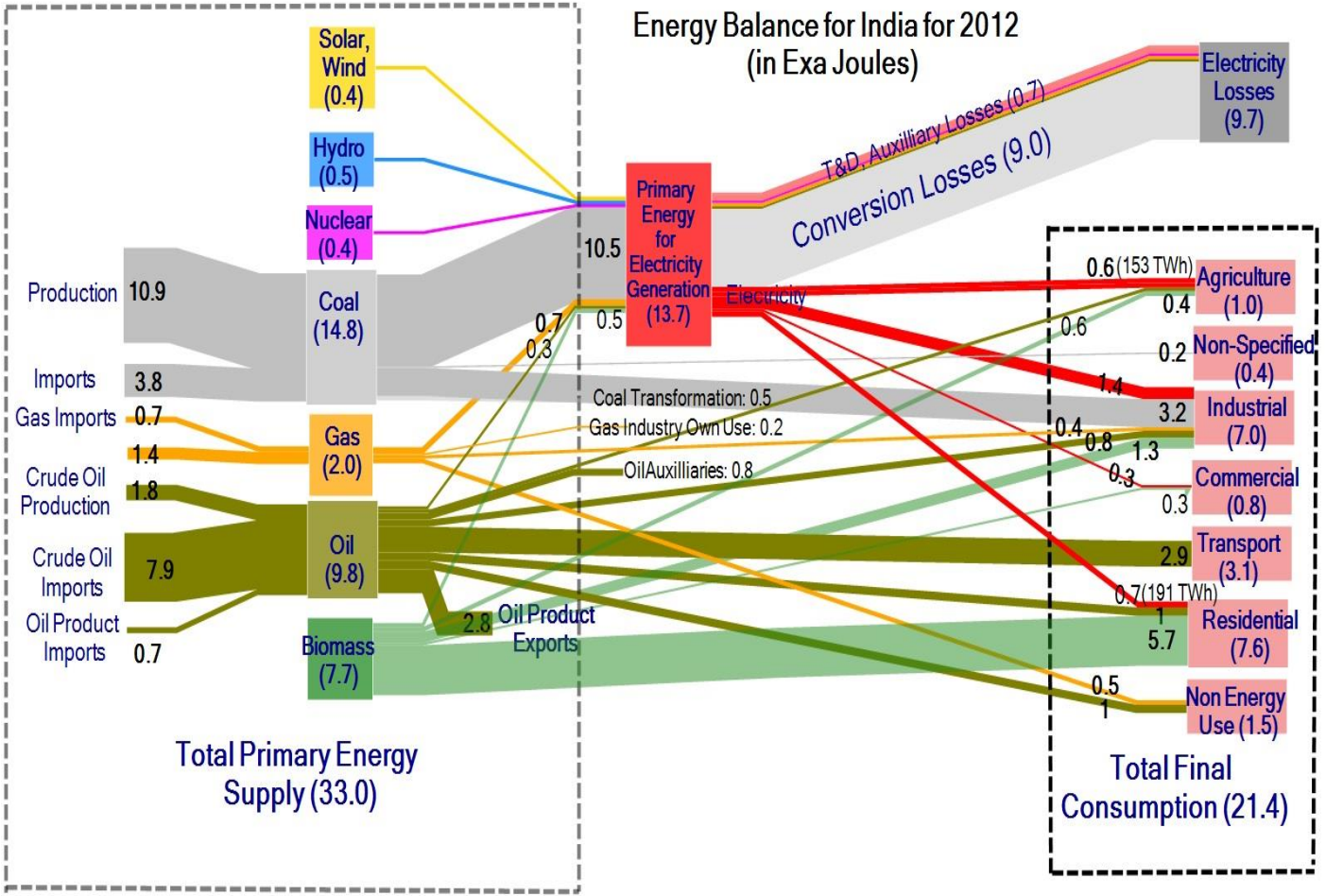
BBC

Manmade emission sources



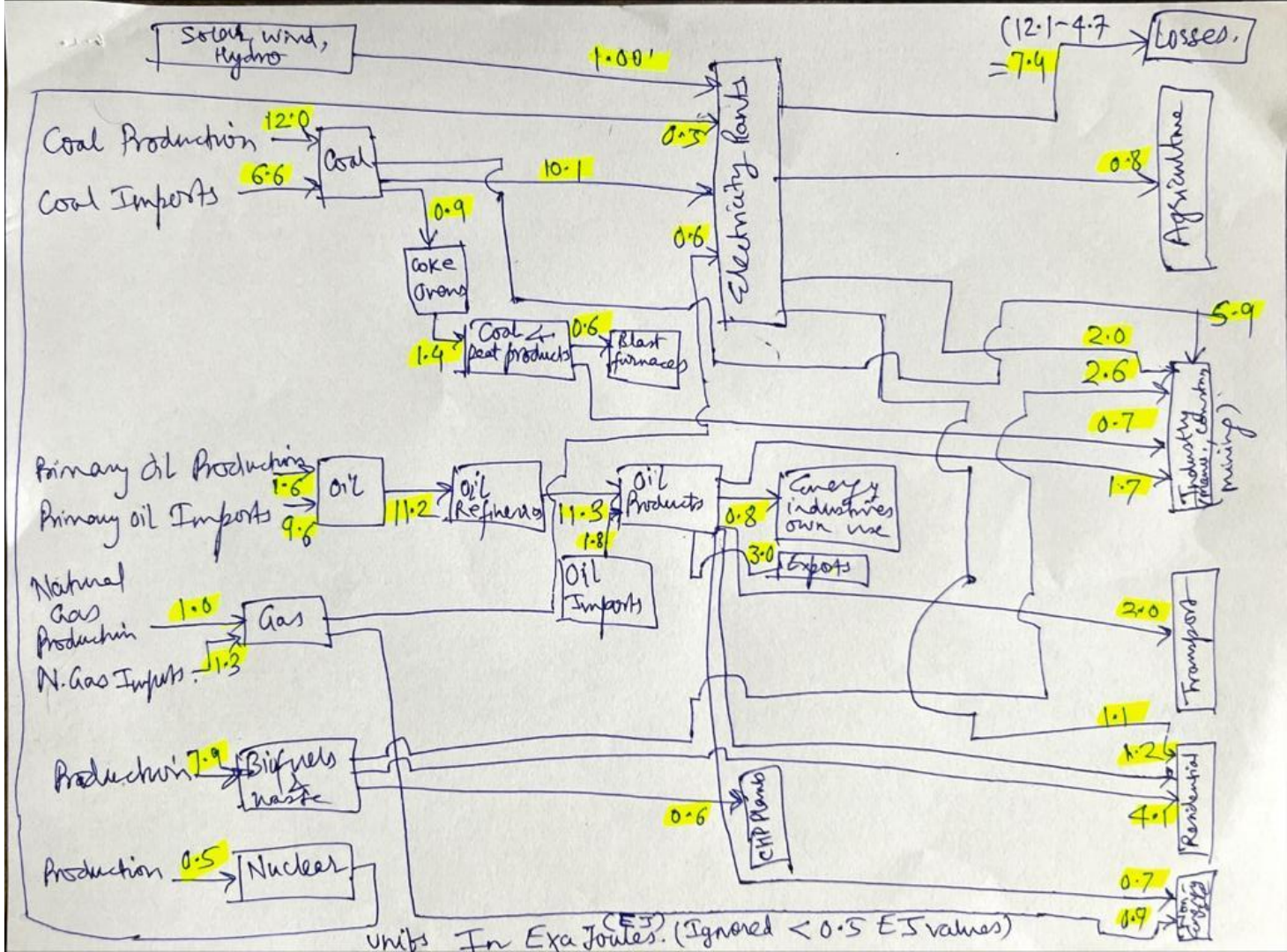


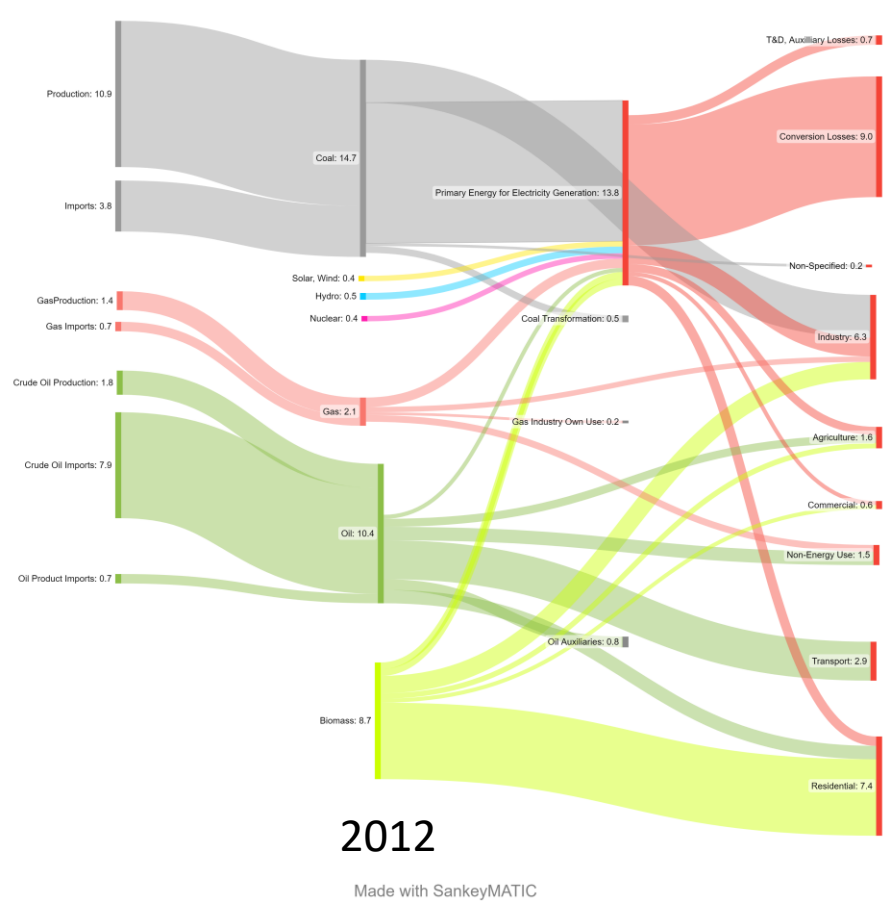
Source: World Energy Flows Sankey Diagram, as shown on http://aspoireland.org/2011/05/08/a-review-of-green-energy-growth-prospects-at-the-oil-economy-maxima/ Diagram originally by Cullen, J.M. & Allwood, J.M. (2010)


Energy Balance for India for 2012
(in Exa Joules)
Solar, Wind (0.4)
Hydro (0.5)
Nuclear (0.4)
Production 10.9
Coal (14.8)
Imports 3.8
Gas Imports 0.7
1.4
Gas (2.0)
Crude Oil Production 1.8
Crude Oil Imports 7.9
Oil (9.8)
Oil Product Imports 0.7
Biomass (7.7)
Total Primary Energy Supply (33.0)
10.5
0.7
0.3
0.5
Primary Energy for Electricity Generation (13.7)
Electricity
T&D, Auxilliary Losses (0.7)
Conversion Losses (9.0)
Electricity Losses (9.7)
Coal Transformation: 0.5
Gas Industry Own Use: 0.2
OilAuxilliaries: 0.8
2.8 Oil Product Exports
0.6 (153 TWh)
Agriculture (1.0)
0.4
0.6
0.2
Non-Specified (0.4)
1.4
3.2
Industrial (7.0)
0.4
0.8
1.3
0.3
Commercial (0.8)
0.3
2.9
Transport (3.1)
0.7(191 TWh)
1
5.7
Residential (7.6)
0.5
1
Non Energy Use (1.5)
Total Final Consumption (21.4)

Energy Balance for India (2019)

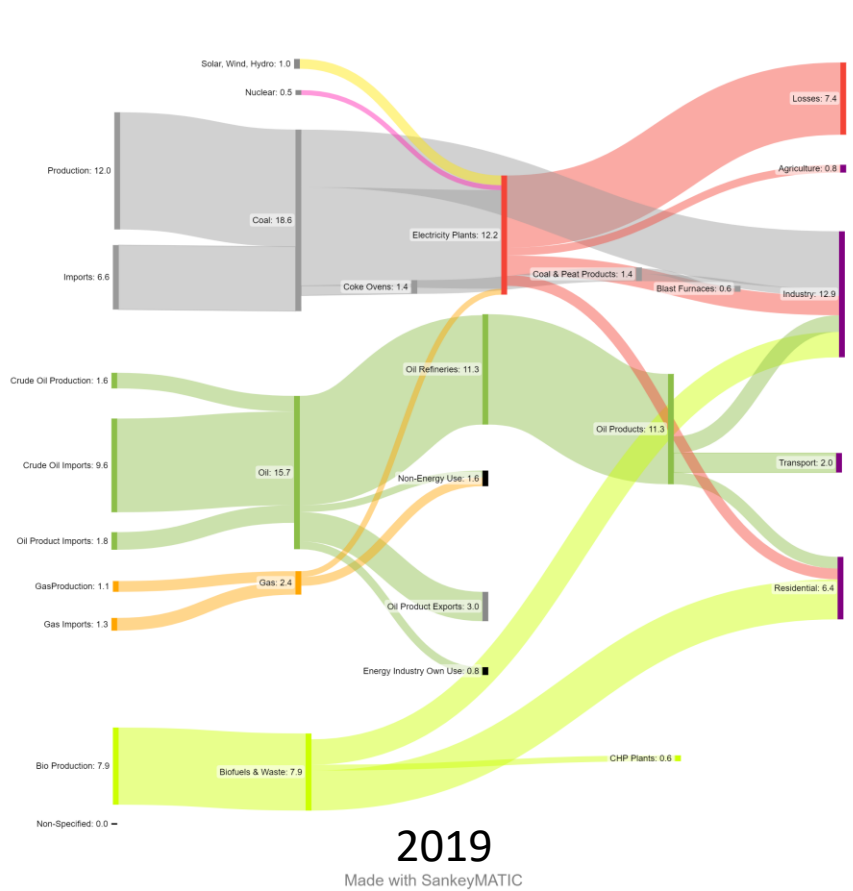
Source: https://unstats.un.org/unsd/energystats/pubs/balance/





2012

Made with SankeyMATIC



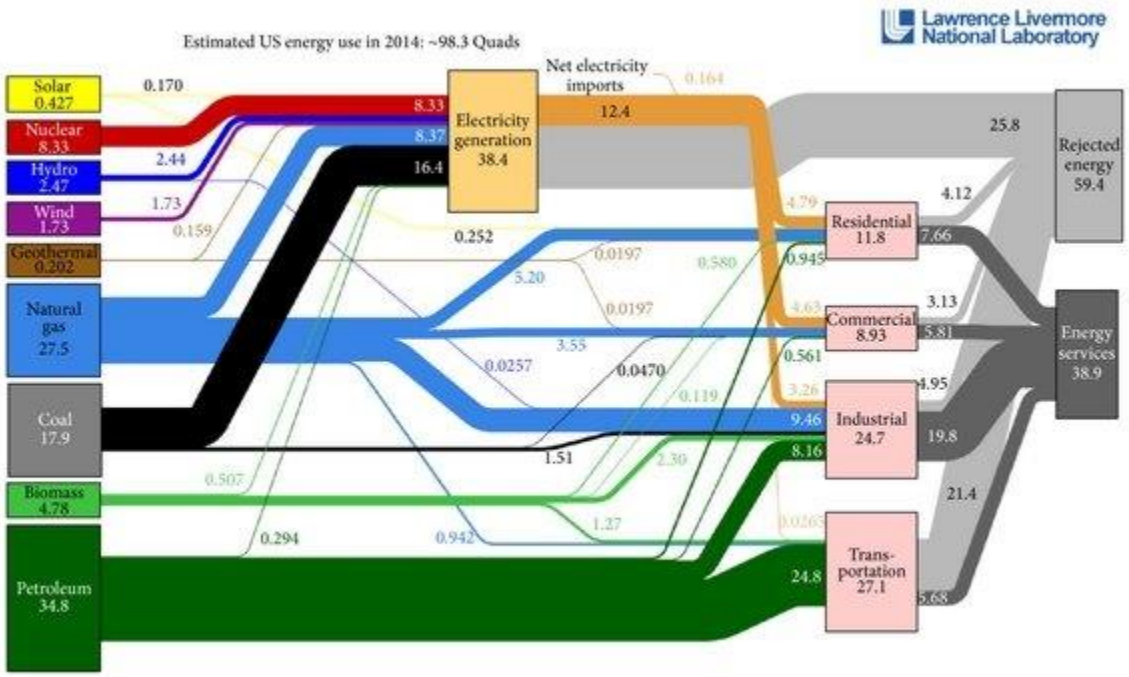
2019

Made with SankeyMATIC

Energy Balance for India (in Exa Joules)

IEA Webinar : Energy Balances

Energy balance data for countries



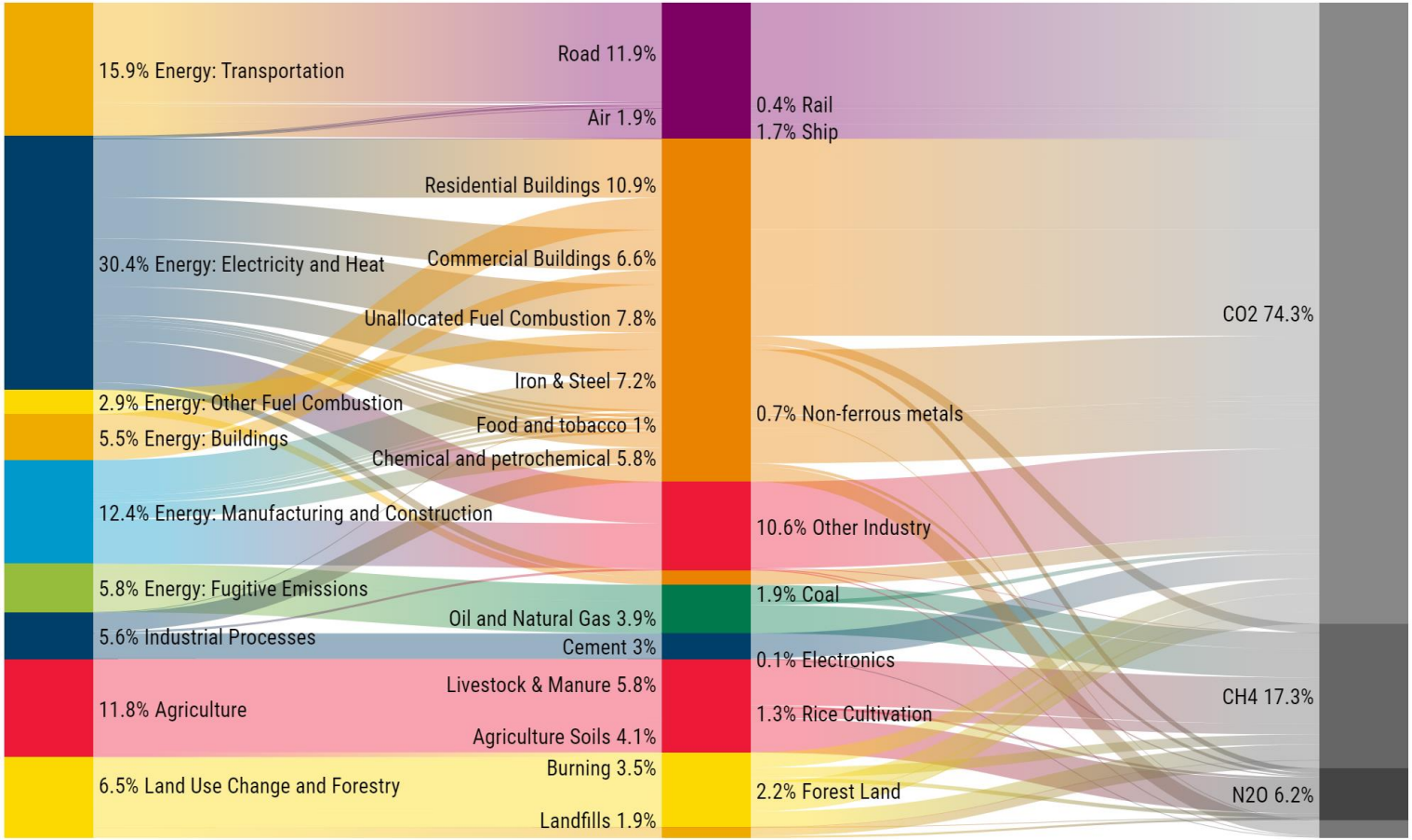
[Pick a country and make a Sankey Diagram for the Energy Flows Sankey Diagram for Japan]

Source: https://www.researchgate.net/figure/Sankey-diagram-of-USA-Source-5-Data-is-based-on-DOE-EIA-00352015-03-March-2014_fig1_306245519

Energy to Emission Factors

World Greenhouse Gas Emissions in 2016 (Sector | End Use | Gas)

Total: 49.4 GtCO2e



Source: Climate Watch, based on raw data from IEA (2018), CO2 Emissions from Fuel Combustion, www.iea.org/statistics; modified by WRI.

WORLD RESOURCES INSTITUTE

Energy issues in news

G-20 Summit 2023 | New Delhi Declaration underlines need for more finance to arrest global warming

The Leader's Declaration lays down that USD 5.8-5.9 trillion will be required in the pre-2030 period for developing countries to reach net zero by 2050

September 09, 2023 10:50 pm | Updated 10:50 pm IST - NEW DELHI

How the Russia-Ukraine war accelerated a global energy crisis

By **David Gaffen**

December 15, 2022 3:44 PM GMT+5:30 · Updated 9 months ago

UK PM Rishi Sunak defends shift in climate policy as 'realistic' approach

Thank you!