UCID - Unione Cristiana Imprenditori Dirigenti

Patto fra Generazioni

Parola ai Giovani

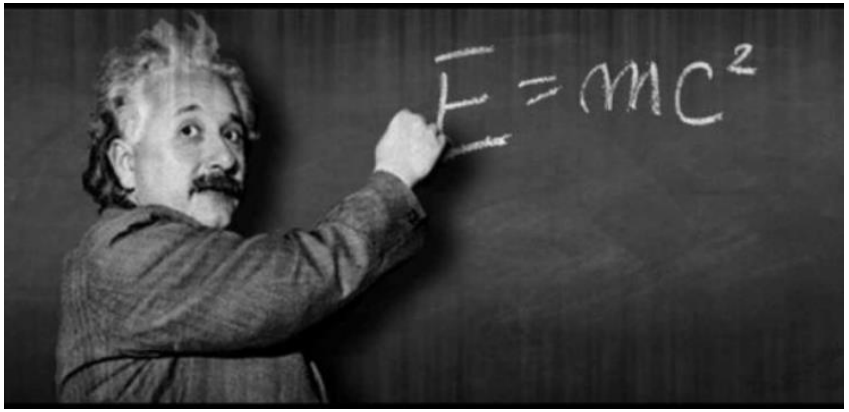
27 Giugno 2020

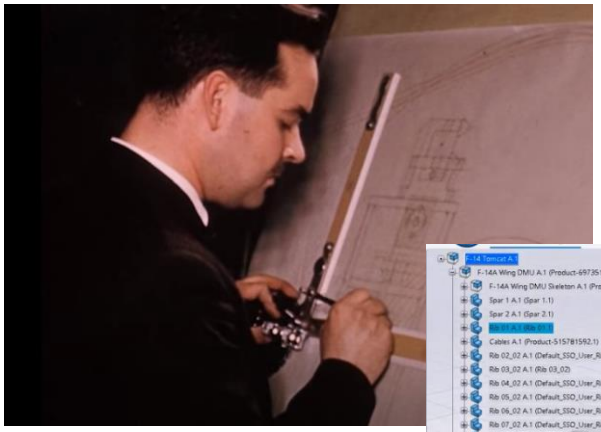
THE GLOBAL GOALS

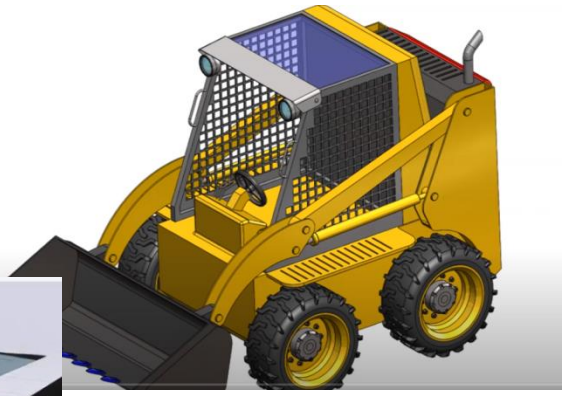
OBIETTIVI GLOBALI PER LO SVILUPPO SOSTENIBILE

#Recovery_Resilient

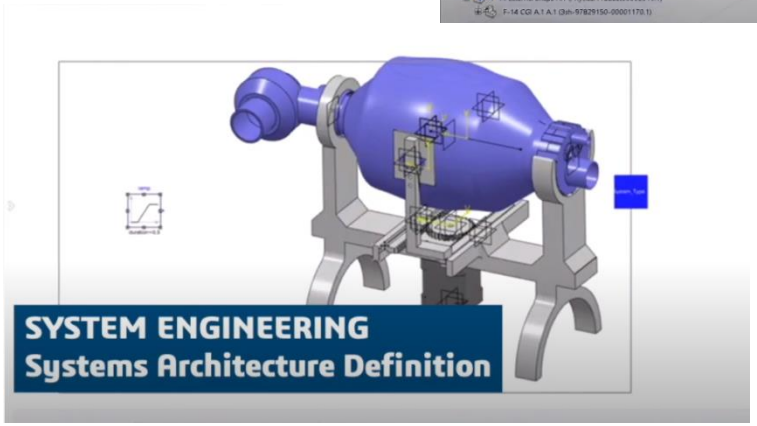
Science
Vs
Engineering
Vs
Technicality


E = mc²

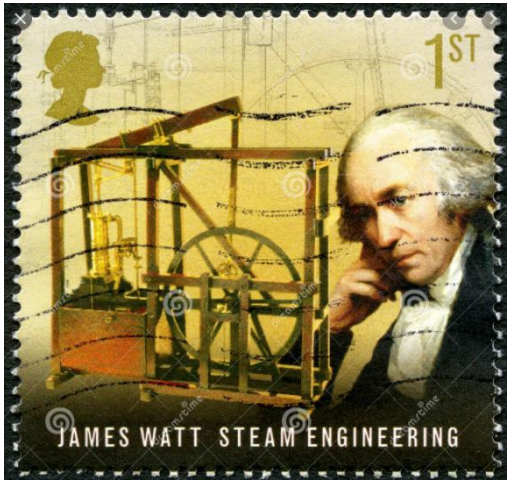




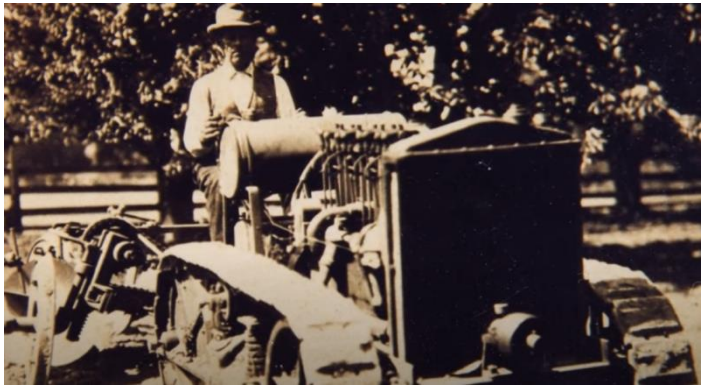
Tools!

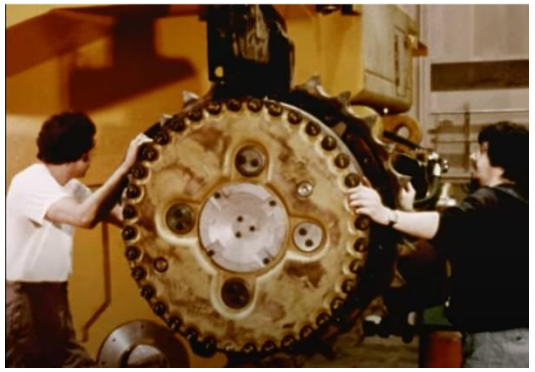


Steam Machine
Vs
Steam Power



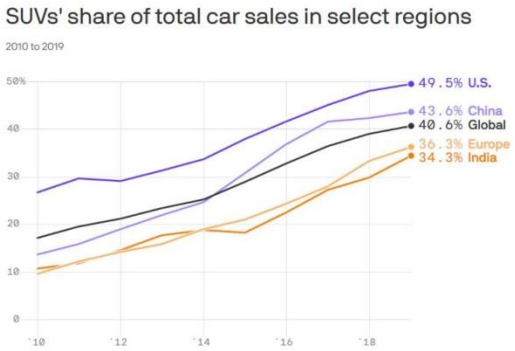
Machines do it better!



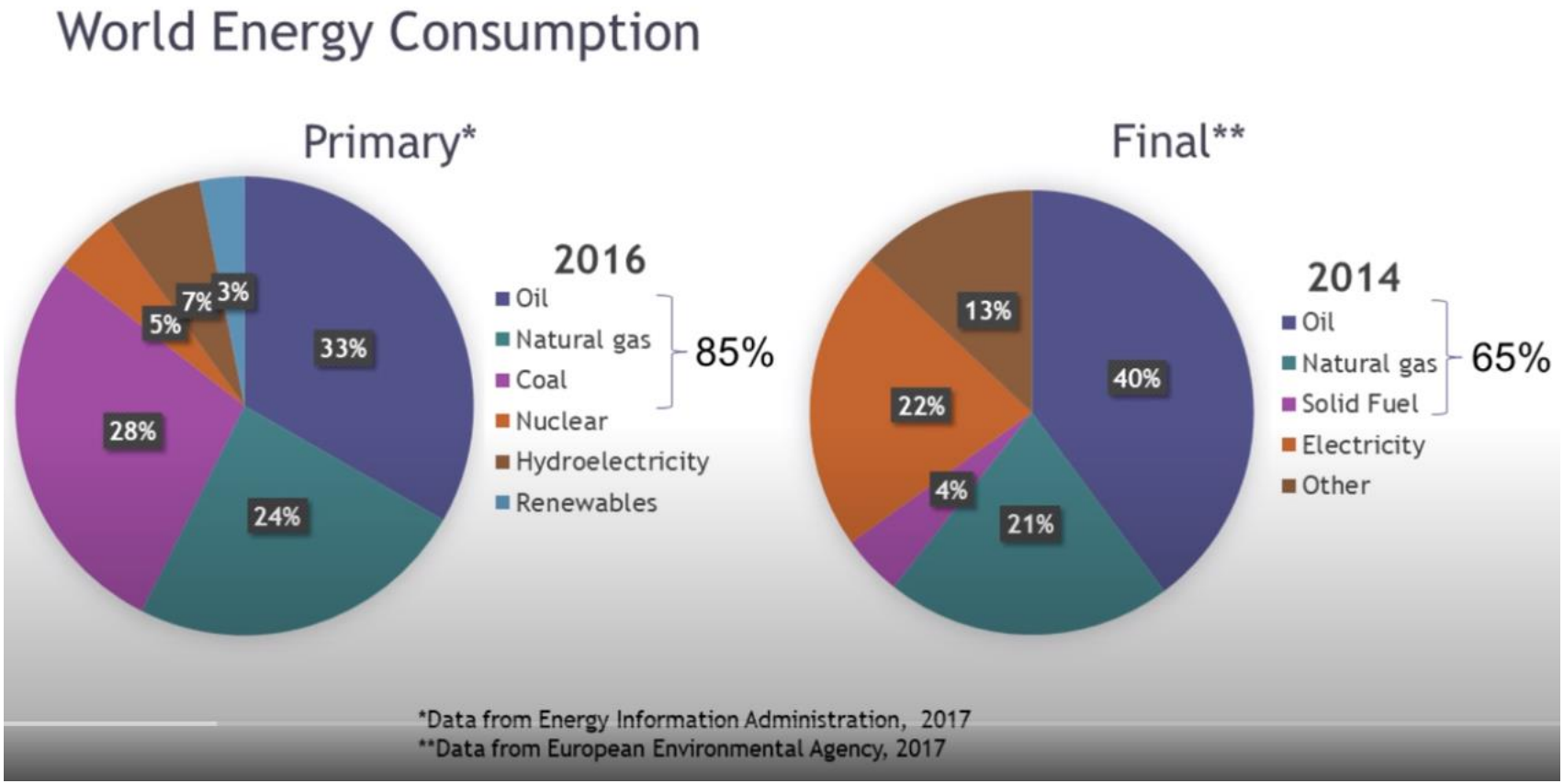


Machines never tired,
but thirsty: capacity factor!

Supply Vs Demand Of Energy:



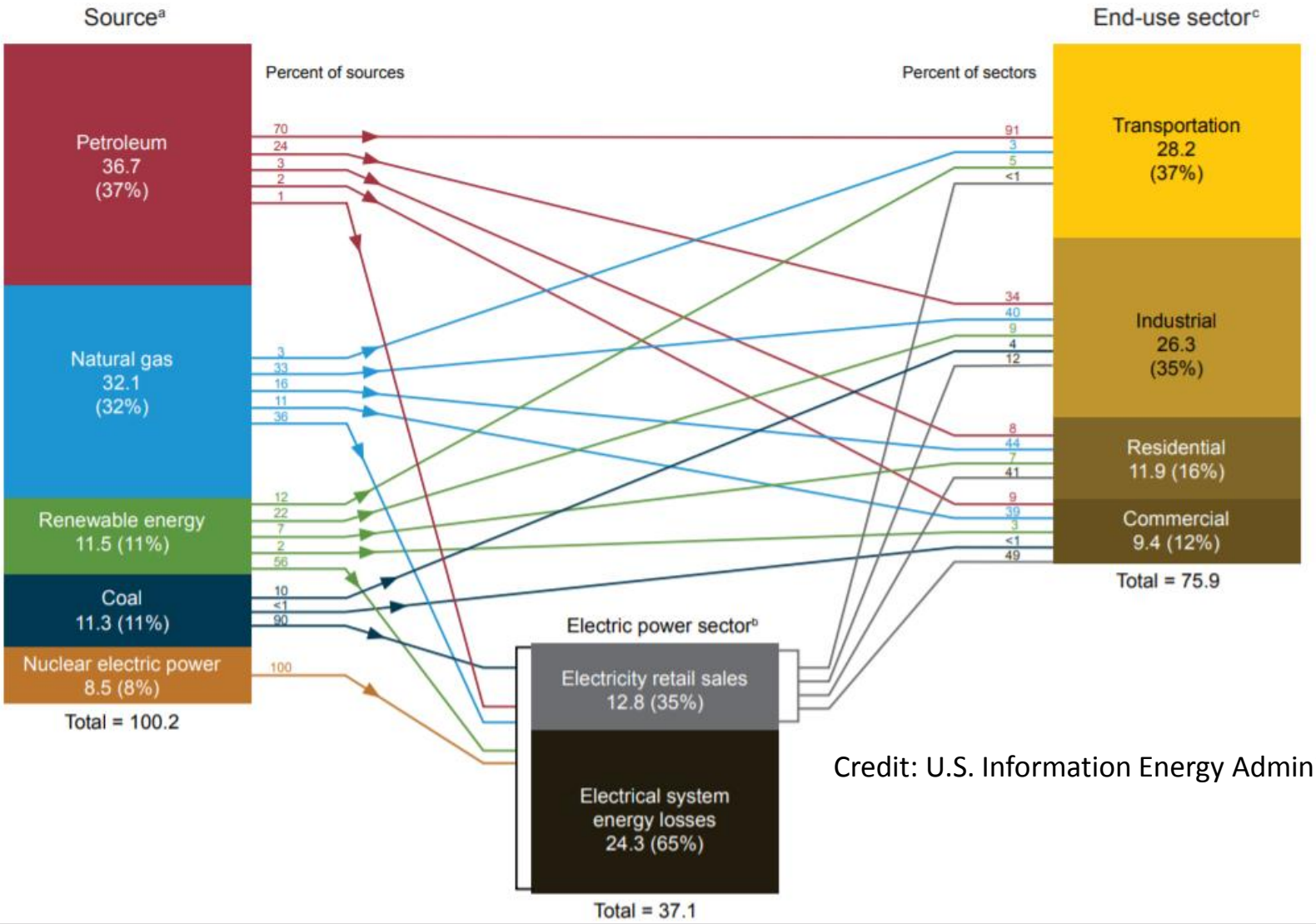
Just in time vs Lost in space?
Wealth of people!



Credit: John Bucknell, Professional Engineer – Nuclear Rocket Engine

U.S. energy consumption by source and sector, 2019

(Quadrillion Btu)



Credit: U.S. Information Energy Administration

Credit: David JC MacKay – Without Hot Air
https://www.withouthotair.com/sewthacontents.shtml

125kWh/p/d UK

250kWh/p/d US

CONSUMPTION PRODUCTION

Nature cannot be fooled

Richard Feynmann

Some key forms of consumption for the left-hand stack will be:

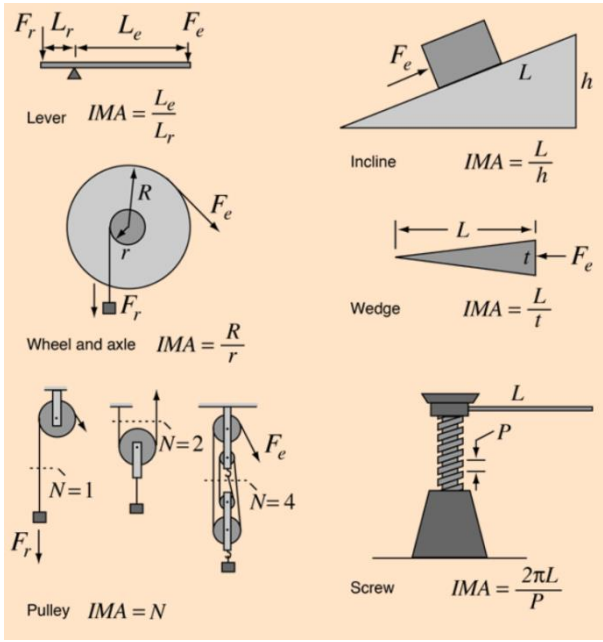
- transport
  - cars, planes, freight
- heating and cooling
- lighting
- information systems and other gadgets
- food
- manufacturing

In the right-hand sustainable-production stack, our main categories will be:

- wind
- solar
  - photovoltaics, thermal, biomass
- hydroelectric
- wave
- tide
- geothermal
- nuclear? (with a question-mark, because it's not clear whether nuclear power counts as "sustainable")

Work [J]

refers to an activity involving a force and movement in the direction of the force. A force of 20 newtons pushing an object 5 meters in the direction of the force does 100 joules of work.



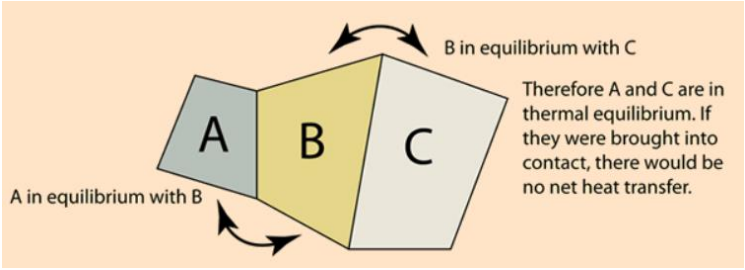
Energy [J or kWh]

is the capacity for doing work. You must have energy to accomplish work - it is like the "currency" for performing work. To do 100 joules of work, you must expend 100 joules of energy.

Power [W or kW, MW, GW]

is the rate of doing work or the rate of using energy, which are numerically the same. If you do 100 joules of work in one second (using 100 joules of energy), the power is 100 watts.

Zeroth Law of Thermodynamics



Exergy better than Energy:

For a fistful of Entropy!

First Law of Thermodynamics

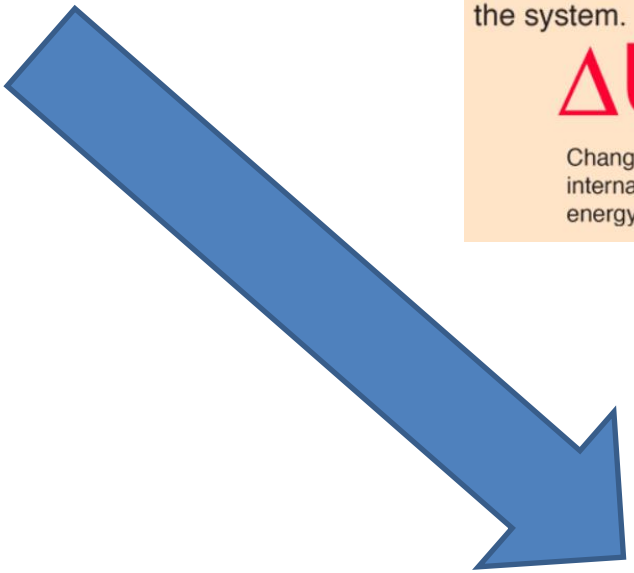
The change in internal energy of a system is equal to the heat added to the system minus the work done by the system.

$$\Delta U = Q - W$$

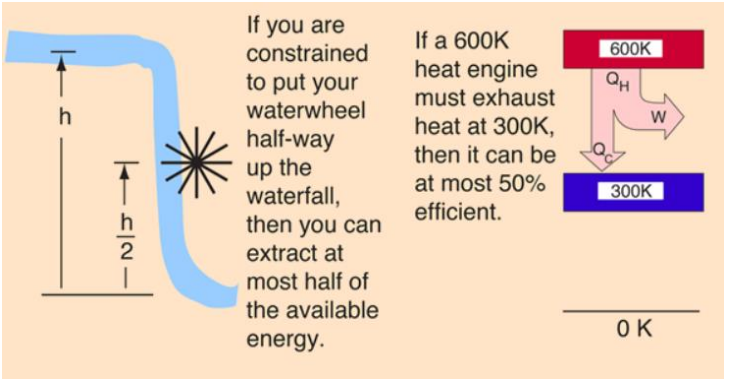
Change in internal energy

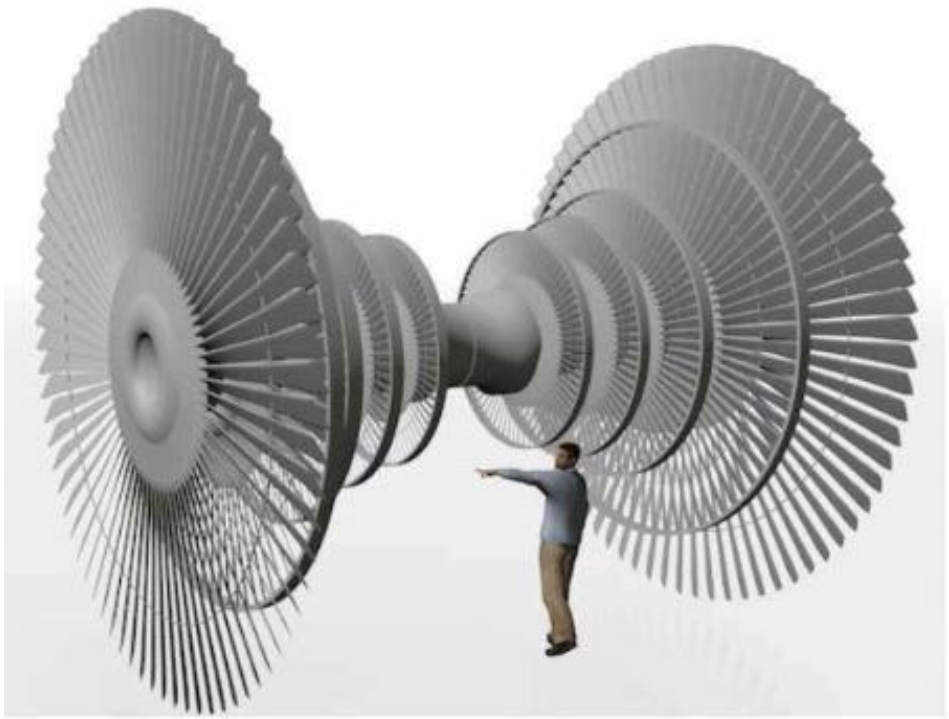
Heat added to the system

Work done by the system



Second Law of Thermodynamics





20 meter Steam Turbine (300 MWe)
(Rankine Cycle)

- **Comparison**
  - Rankine efficiency is 33%
  - Supercritical CO_2 (sCO_2) has potential to surpass 40% efficiency
  - Greatly reduced cost for sCO_2 compared to the cost of conventional steam Rankine cycle are possible
  - sCO_2 compact turbo machinery is easily scalable

1 meter sCO_2 (300 MWe)
(Brayton Cycle)

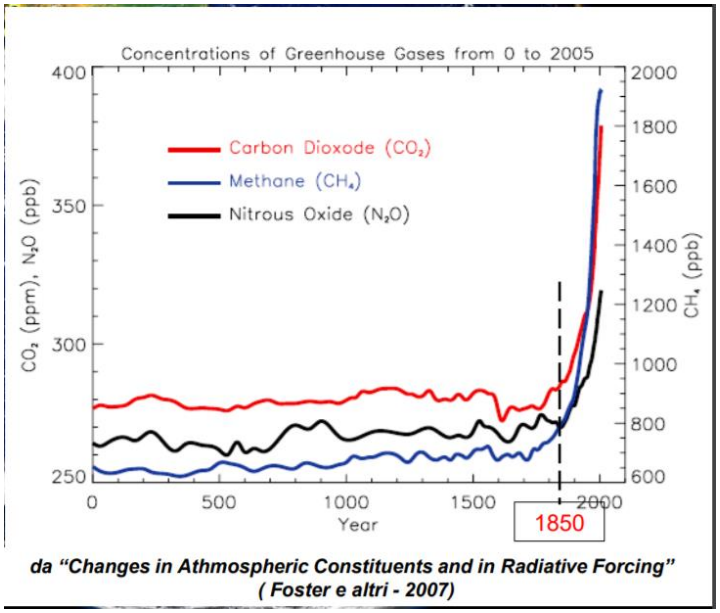
Zeroth Law of Thermodynamics

First Law of Thermodynamics

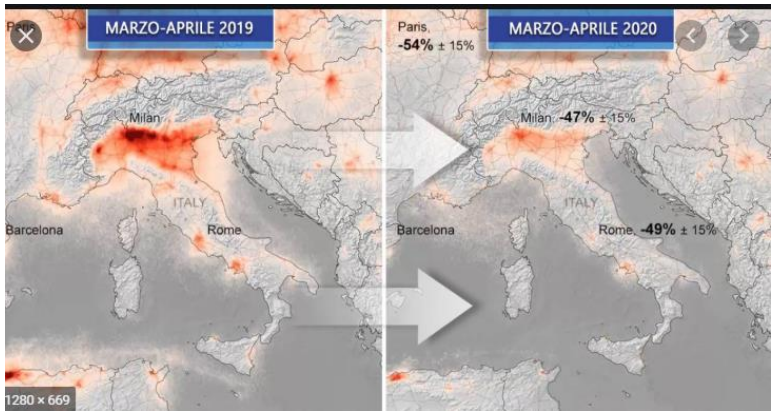
Second Law of Thermodynamics

Jobless vs Poorness
Richness vs Wisdom

€/ MWh **€/ MW** **gCOx, NOx / MW** **gCOx, NOx / MWh**



da "Changes in Athmospheric Constituents and in Radiative Forcing" (Foster e altri - 2007)



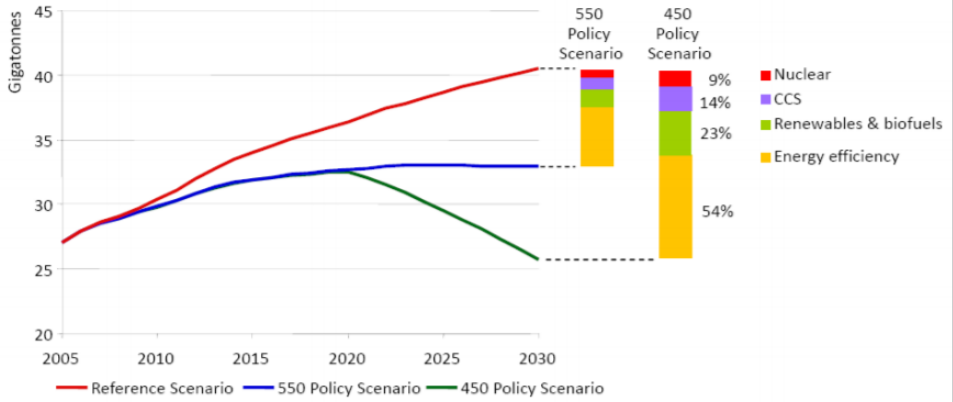
Credit: ESA 2020

E(n)(x)ergy: a matter of Power / Energy / **Safety** / **Cost** / **Environment impact** / Footprint / Demography / Economy … Society&People…etc..

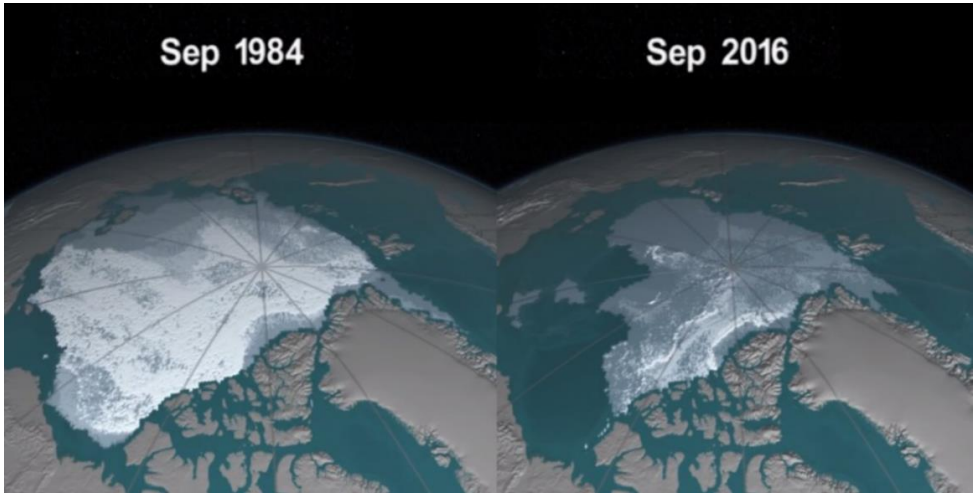
System thinking: actions vs interactions

Exergy is better than Energy!

Reductions in energy-related CO_2 emissions in the climate-policy scenarios



While technological progress is needed to achieve some emissions reductions, efficiency gains and deployment of existing low-carbon energy accounts for most of the savings



From solar radiation to renewable energies

Solar radiation

Figure 6.7. A solar photovoltaic farm: the 6.3 MW (peak) Solarpark in Mühlhausen, Bavaria. Its average power per unit land area is expected to be about 5 W/m². Photo by SunPower.

Wind

Transmitted radiation

Rain

Wind energy

Thermal and thermoelectric energy

Photovoltaic energy

Energy from biomass

Hydro and hydroelectric energy

$$Solar\ energy + nCO_2 + nH_2O = (CH_2O)_n + nO_2$$

- **All renewable sources derives from solar radiation (nuclear fusion)**
- **Renewable sources are unlimited over time**
- **Renewable sources are very abundant**

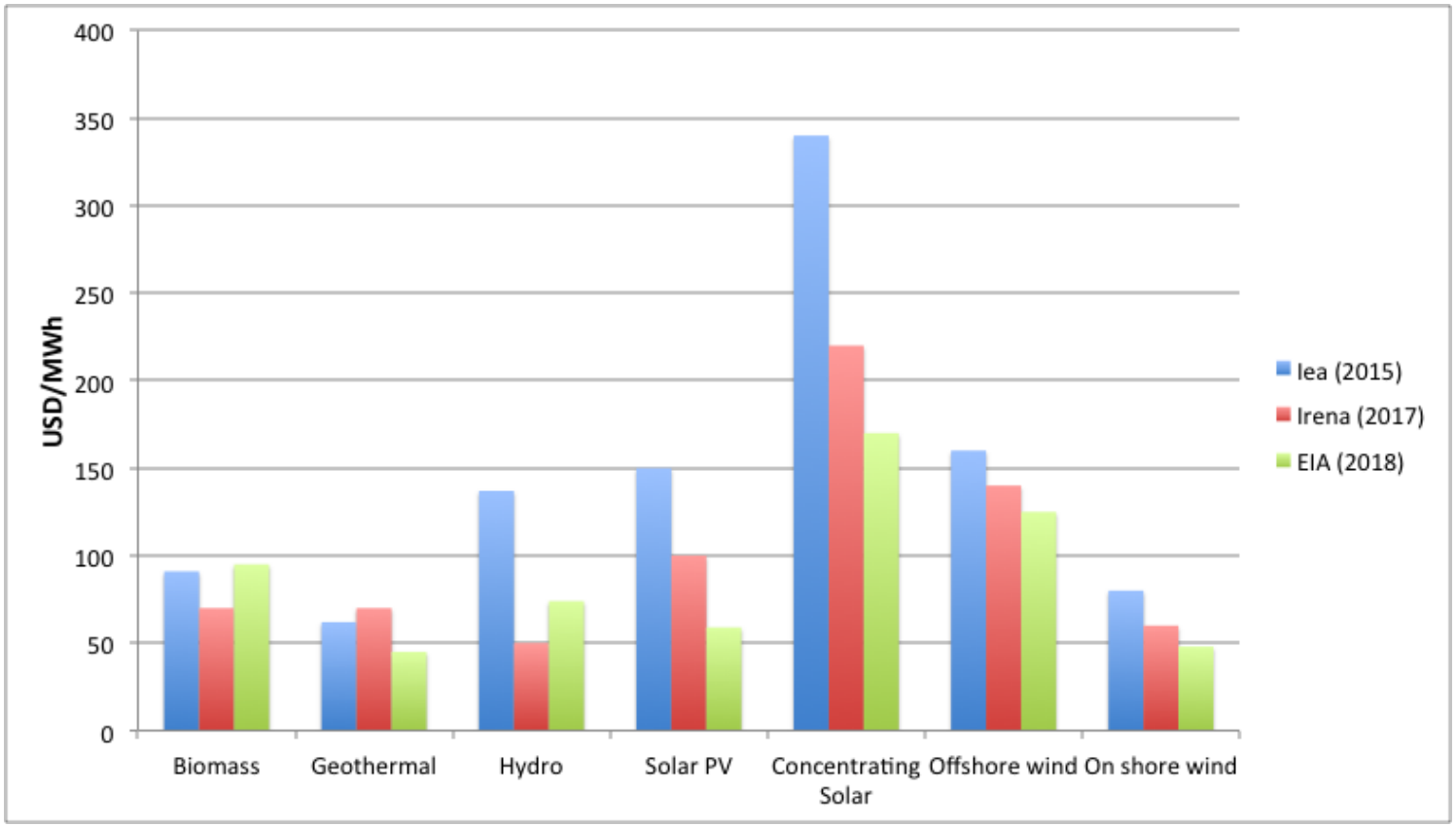
Comparing fossil fuels vs. renewables: under which terms?

- **Abundance**: the amount of resources available in nature; their duration
- **Density**: availability (for example) over space, per unit of land (energy footprint)
- **Predictability (Intermittency)**: certainty of energy availability when needed (rough indicator: Capacity Factor (CF)=Energy production//Maximum possible production)
- **Environmental impact**: mainly related to global warming (GHG emissions)

Renewables

- **Abundance**: unlimited over time (all renewables derives from sun whose assumed lifetime is 5 billions of years); huge per year (annual solar energy intercepted by earth surface is around 1400 times the annual world energy consumption)
- **Density**: 40 kWh per m2 of land with wind power and 150 kWh per m2 with PV power (vs. 80,000 kWh with FF)
- **Predictability (Intermittency)**: we can not decide when (and/or where) producing (important for wind and PV power whose production depends on exogenous factors: wind and solar radiation availability).
- **Environmental impact**: depends on technology. However, no emission of CO2

Generating costs (median or average): comparison of most recent publications



Iea: International Energy Agency (OECD)

Irena: International Renewable Energy Agency (International independent Institution)

EIA: U.S. Energy Information Administration (U.S. DOE)

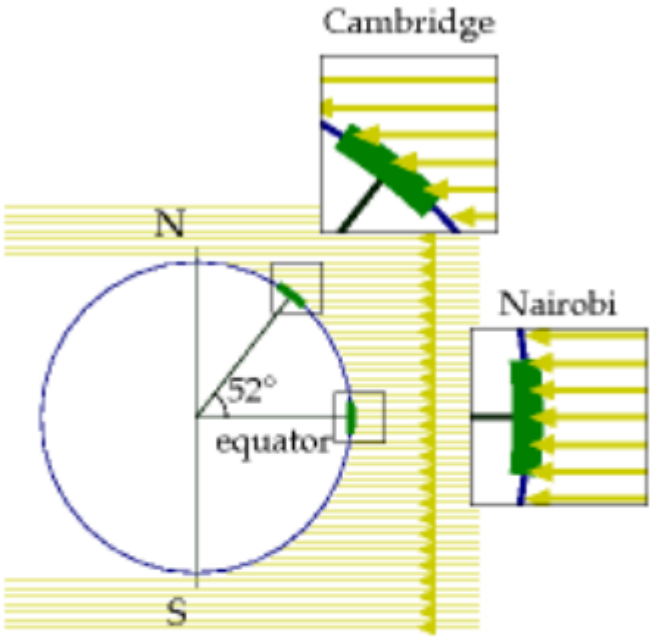


Figure 6.1. Sunlight hitting the earth at midday on a spring or autumn day. The density of sunlight per unit land area in Cambridge (latitude 52.) is about 60% of that at the equator.

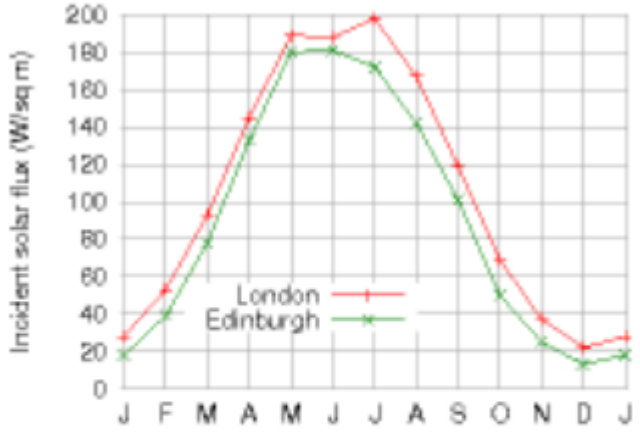


Figure 6.2. Average solar intensity in London and Edinburgh as a function of time of year. The average intensity, per unit land area, is 100 W/m².

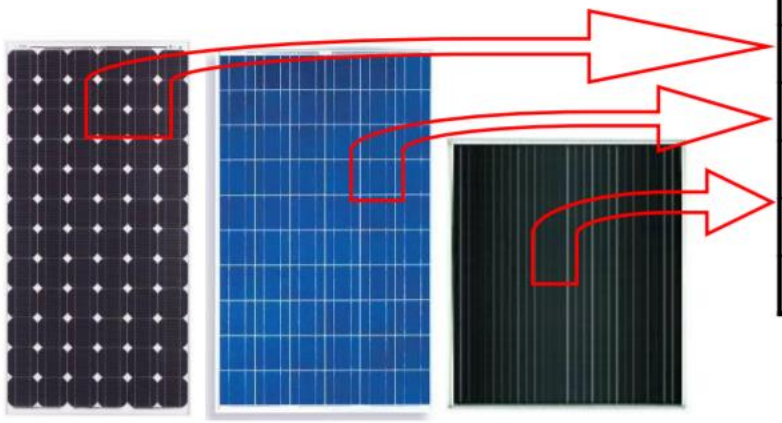
Figure 6.7. A solar photovoltaic farm: the 6.3 MW (peak) Solarpark in Mühlhausen, Bavaria. Its average power per unit land area is expected to be about 5 W/m². Photo by SunPower.

Credit: David JC MacKay – Without Hot Air
https://www.withouthotair.com/sewthacontents.shtml

Photovoltaic (PV) systems convert sunlight, visible or not, directly (no moving parts) into electricity with 6-22% efficiencies.

They do not transform heat in electrical energy (operate at T=40- 70°C) like the concentrated solar-thermal plants.

They also do not require water for cooling as the conventional nuclear and fossil fuel power plants (oil, coal or gas).



Technology	Efficiency
m-Si ; m-Si/a-Si	15-22 %
p-Si	14-16 %
a-Si ; a-Si/μc	6-10 %
CIS/CIGS	11-13 %
CdTe/CdS	13-15 %

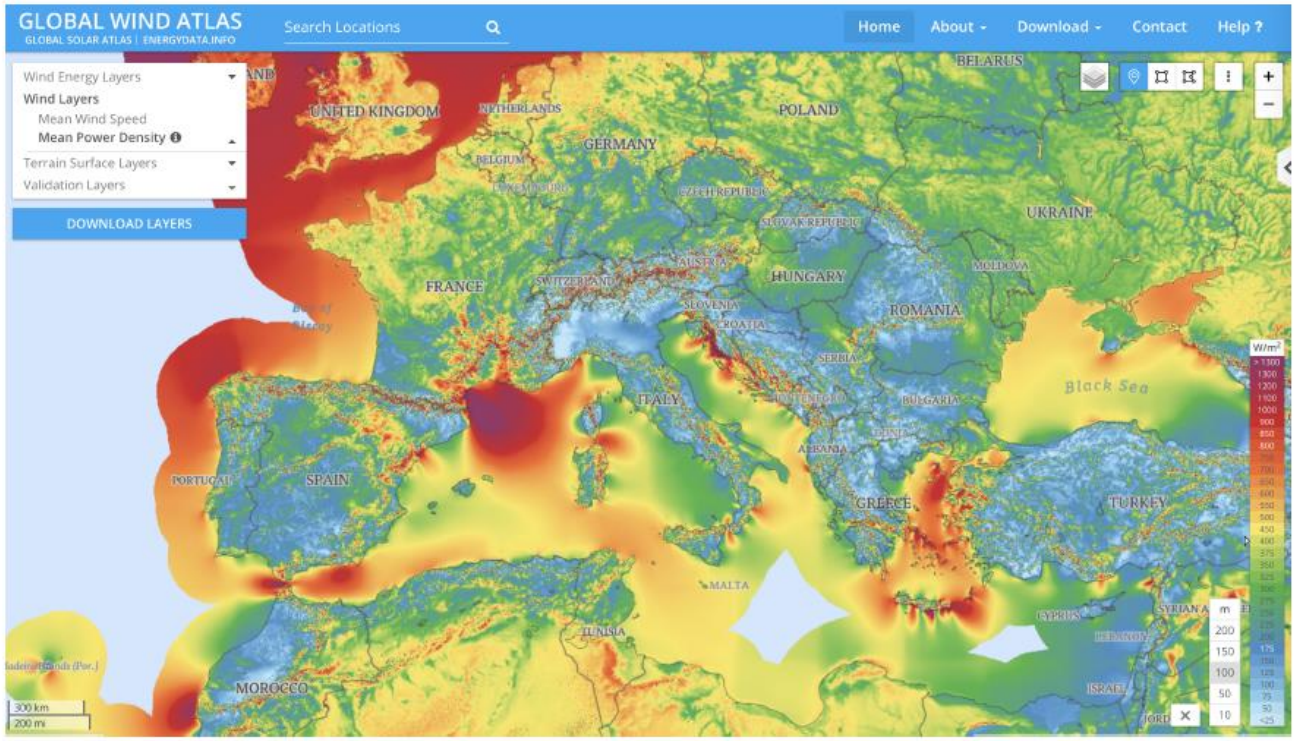
Advantages of PV modules (or panels) are:

- High reliability and long life (> 25 years with EPBT ≈ 2 years);
- Low maintenance cost (glass cleaning); Absence of noise and air pollution during operation;
- The electricity production takes place near consumers (PV roof);
- The possibility of recycling without wastes at the end of life.

Disadvantages include:

- Fluctuations of electrical energy production;
- Necessity of additional components (storage and power conversion);
- Installation costs (1000-2000 €/kWp).

atlante eolico: potenza specifica media per unitá di superficie del rotore della turbina @100 m



wind speed > 11m/s

wind speed > 4m/s ???

The wind, as a direct motive power, is wholly inapplicable to a system of machine labour, for during a calm season the whole business of the country would be thrown out of gear. Before the era of steamengines, windmills were tried for draining mines; but though they were powerful machines, they were very irregular, so that in a long tract of calm weather the mines were drowned, and all the workmen thrown idle.
William Stanley Jevons, 1865

il carbone bianco...

- la generazione idroelettrica é la piú consistente fonte di energia elettrica rinnovabile
- la tecnologia é consolidata e matura
- le basi della produzione idroelettrica sono giá presenti nei curricula ingegneristici

Lago della Rovina – Entracque (provincia di Cuneo)

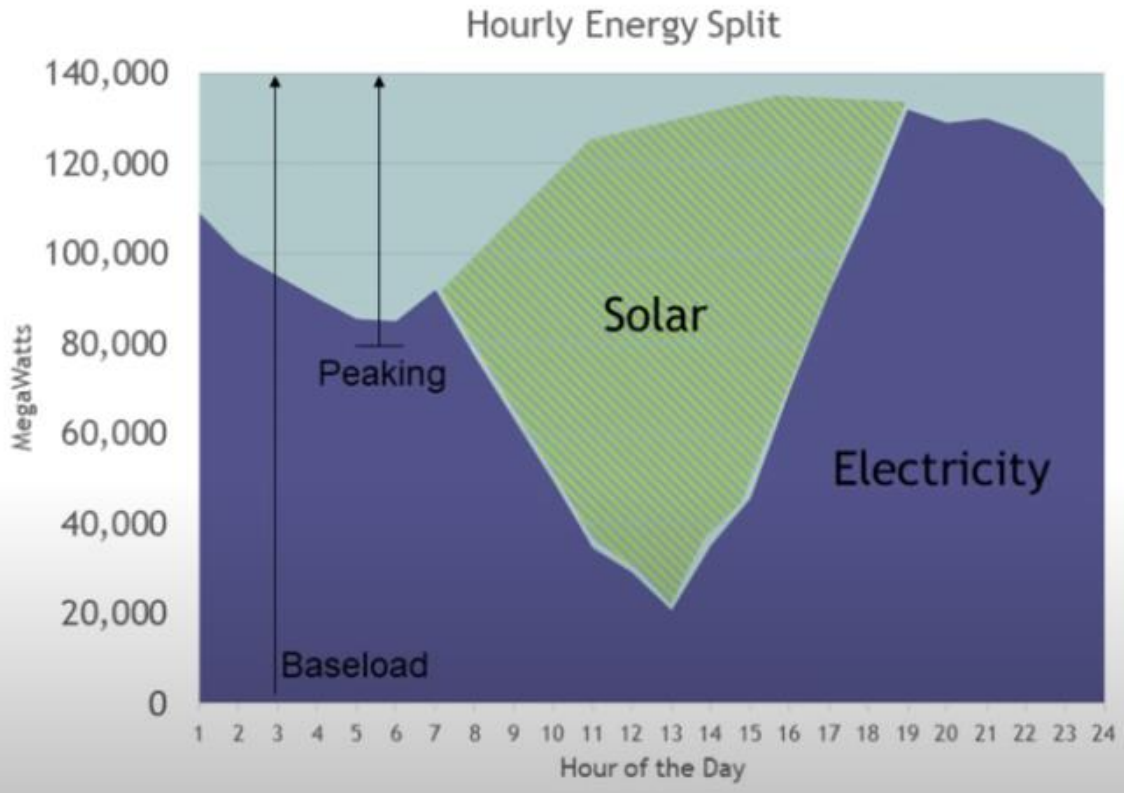
« Per tutti gli impianti idroelettrici cominciati a costruire dopo il 1º gennaio 1919 il Governo accorderà alla ditta concessionaria una sovvenzione annua di lire quaranta (lire 40) per ogni cavallo nominale medio risultante dal decreto di concessione.

« Tale sovvenzione sarà corrisposta per la durata di anni quindici decorrenti dalla data di effettiva entrata in funzione dell'impianto dopo il collaudo ».

Regio Decreto 242, 12 febbraio 1919

Credit: Future Power - MDAAE – Murimoos Community Plant – ing.M.Baudino

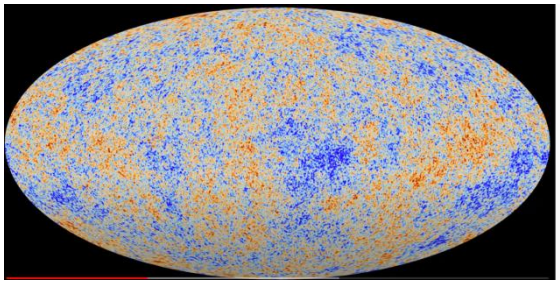
Generating Operation (Summer) - With 10% Solar Energy



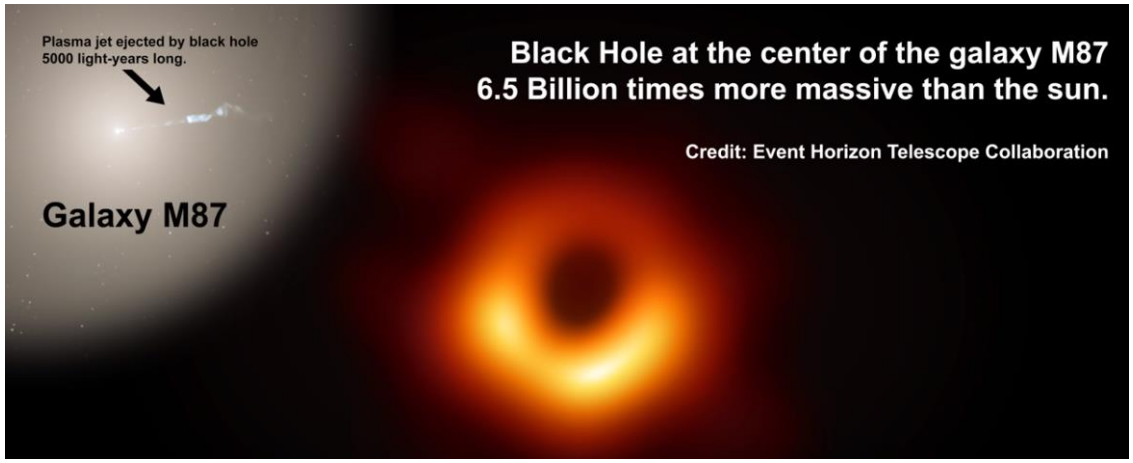
Peaking:
28% Capacity Factor

Baseload:
60% Capacity Factor

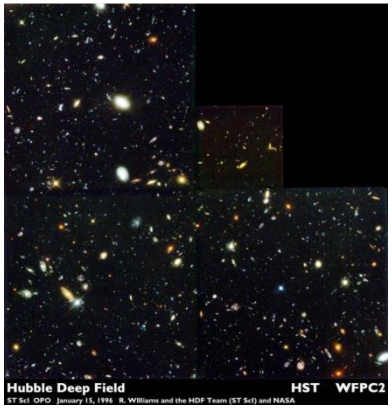
Credit: John Bucknell, Professionale Engineer
https://www.withouthotair.com/sewthacontents.shtml

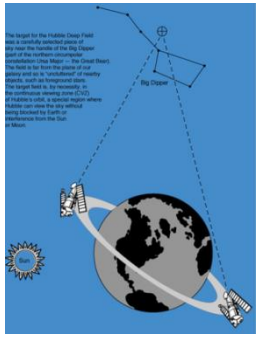


Credit: 2009 Planck Satellite image of Cosmic Microwave Radiation – relic radiation -14bn years ago

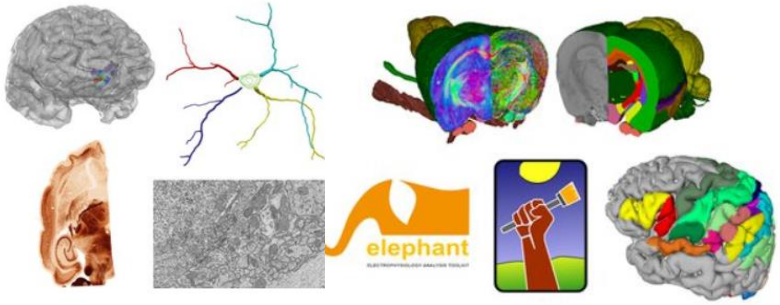


Credit: 2019 Event Horizon Telescope Collaboration





Credit: 1995 Hubble Space Telescope



Human Brain: sinapsi 2M km , m=1kg, P=2kW.
10^720 semantic configurations
(10^87 nr of protons in the universe)
self-consciousness vs Turing test

Venga, o Padre, il tuo Spirito e ci trasformi interiormente con i suoi doni;
crei in noi un cuore nuovo, perché possiamo piacere a te e cooperare al tuo disegno di salvezza.

Colletta, giovedì 7 settimana Tempo di Pasqua

Per questo mettete ogni impegno per aggiungere alla vostra fede la virtù, alla virtù la conoscenza, alla conoscenza la temperanza, alla temperanza la pazienza, alla pazienza la pietà, alla pietà l'amore fraterno, all'amore fraterno la carità.

2Pt 1,5-7