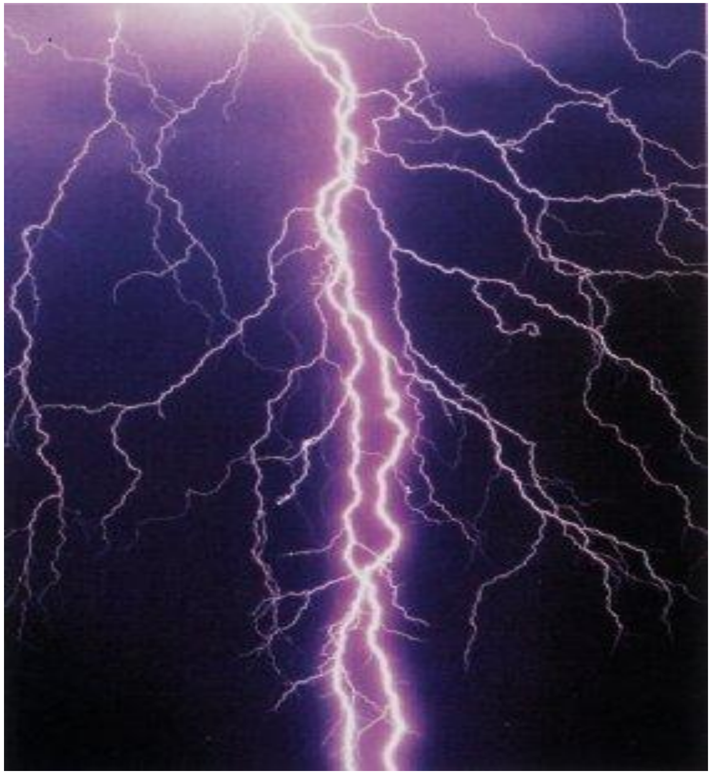
Villardora 13/11/2015

Il problema dell'energia



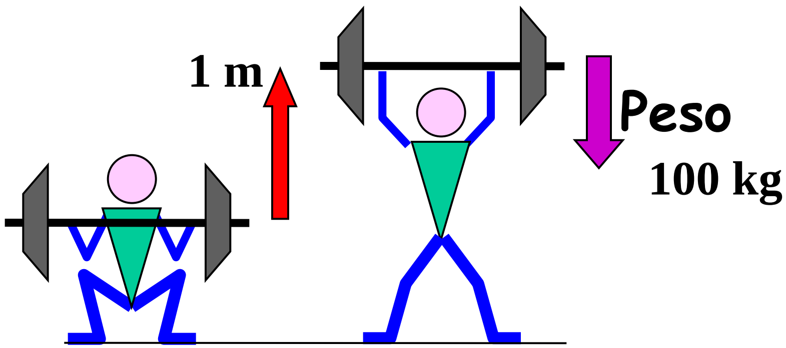
Una panoramica sulle fonti e le tecnologie

Claudio Papuzza cpapuzza@yahoo.it

Indice

Che cosa è l'Energia

Energia = Capacità di compiere Lavoro = Forza x Spostamento



Potenza: chiloWatt [kW]

Alzate al secondo

Lavoro fatto = 1chilo Joul [kJ] = 0,26 chilo calorie [kcal]

l' ENERGIA è la "MONETA" necessaria per "FARE"

cambiare

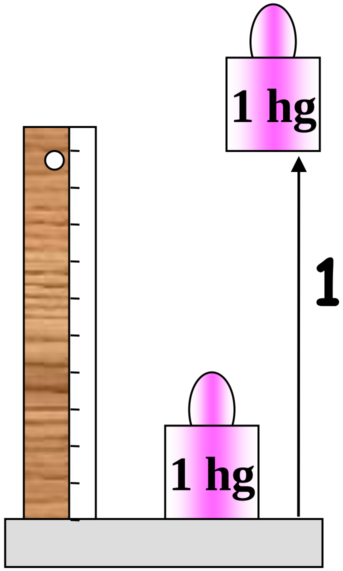
costruire vivere

scaldarsi estrarre montare

trasmettere elaborare gestire

illuminare

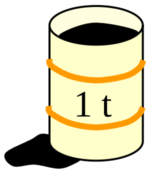
Unità di misura dell'energia



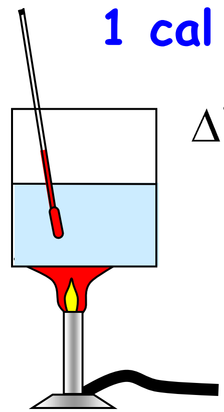
sulla Terra

1 Joule

1 TEP = 10 000 000 kcal



1 cal = 4,18 J

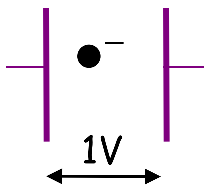


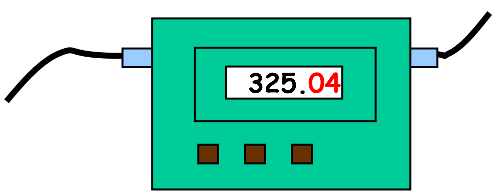
$\Delta T = 1\ C$

$1\ cm^3$

1 Kcal = 1000 cal

$1\ eV = 1{,}6\ 10^{-19}\ J$

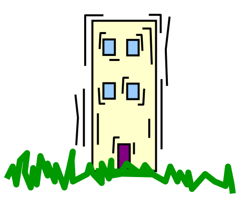




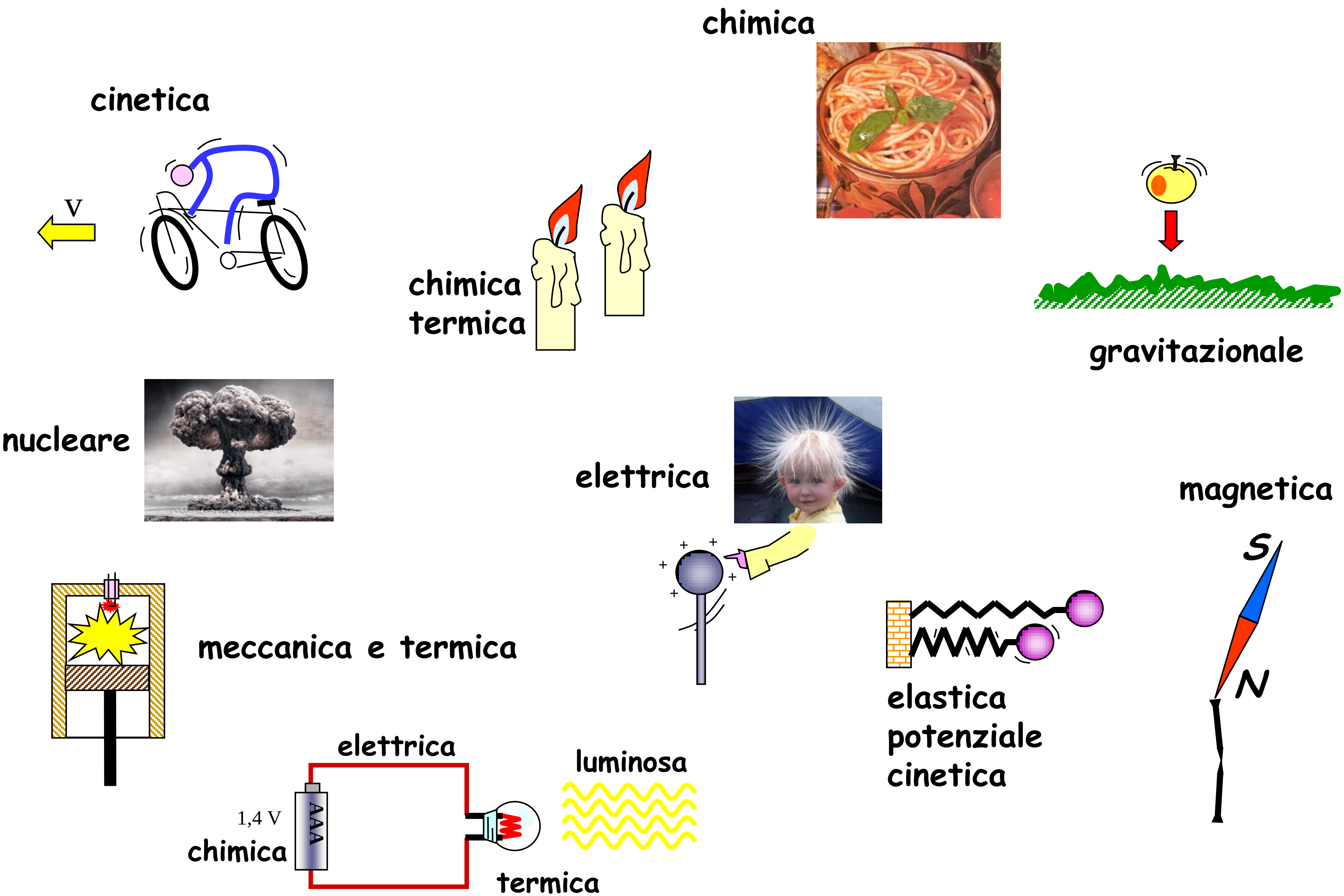
1 Kwh = 3,6 MJ

gradi Richter = 2/3 Log (kg TNT)

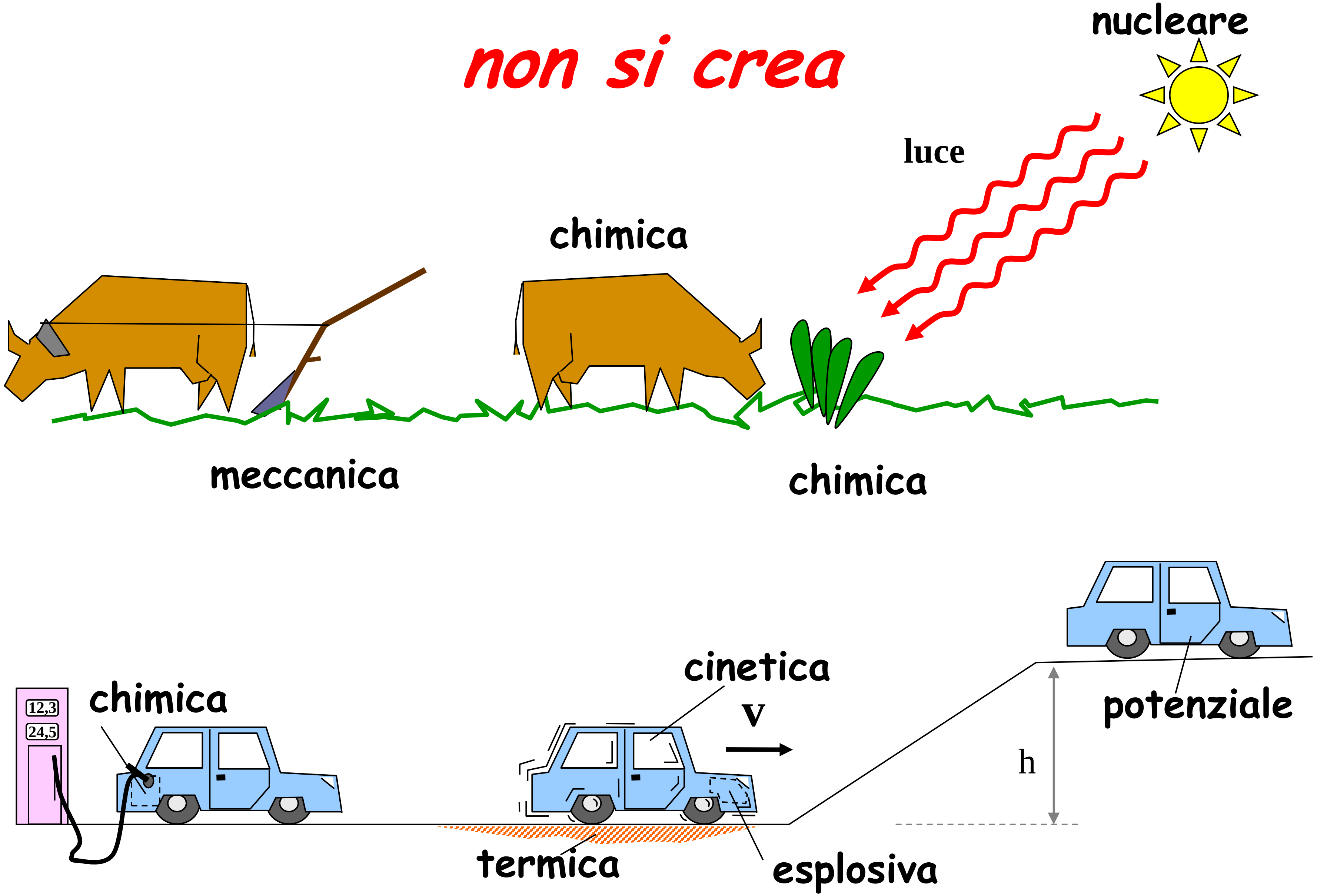
(1000 kcal)



Tante forme di Energia



L'Energia si trasforma
non si crea



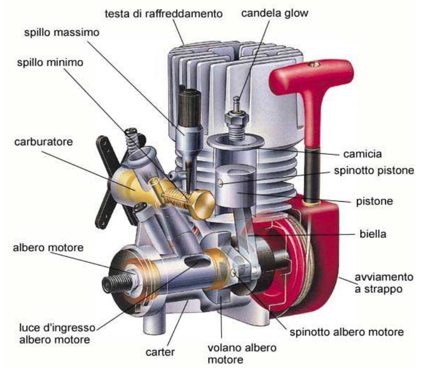
L'Energia si degrada

macchina meccanica

E. Potenziale ⇨ Lavoro ⇨ Calore

tutta l'E potenziale si può trasformare in calore

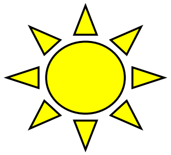
macchina termica



Calore ⇨ Lavoro + Calore

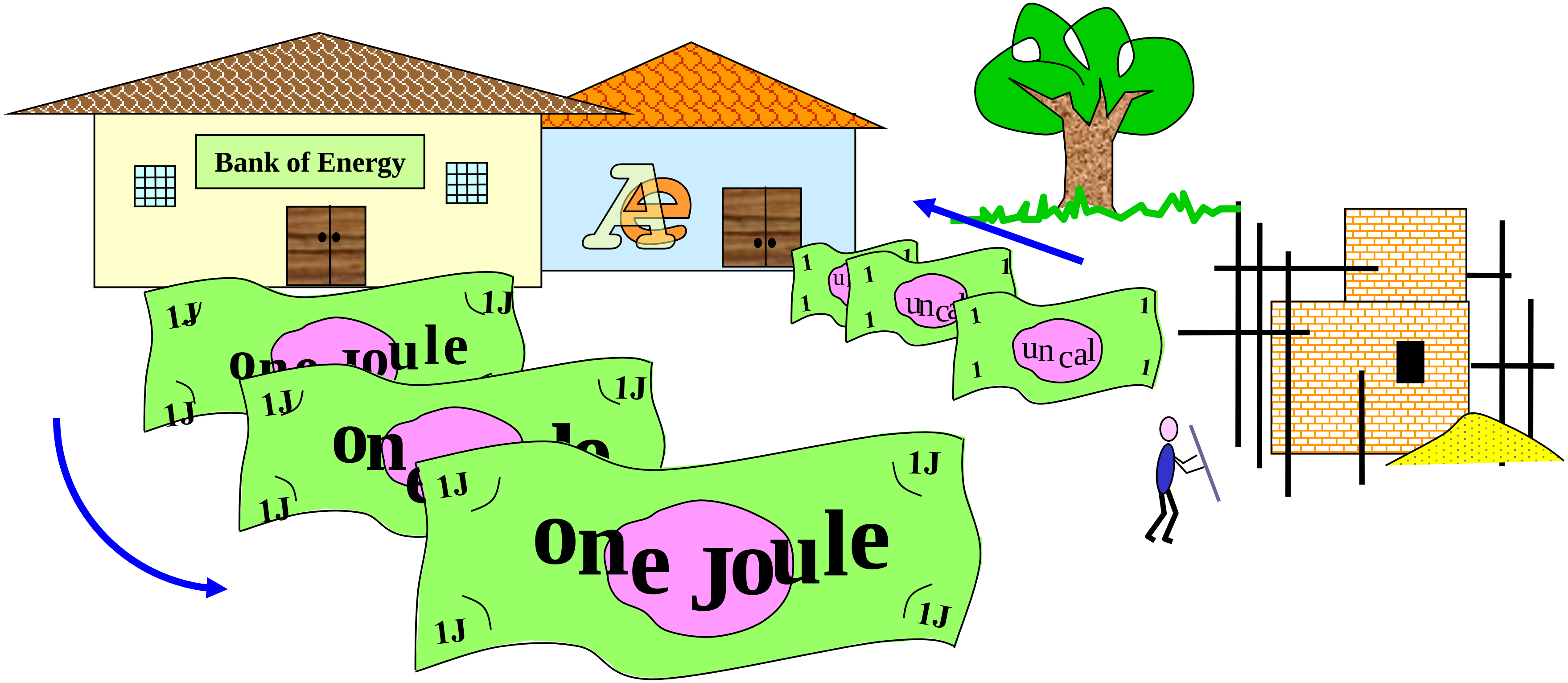
NON tutta l'E termica si può trasformare in lavoro

… in fondo tutto finisce in calore…



Energia

Interpretazione intuitiva



L'Energia è ciò che ci permette di FARE…

ciò che cambia lo stato "inerziale di moto" e "l'uniformità dei materiali"

(ma le regole della banca dell'Energia sono rigorosissime…)

Energia

riassunto

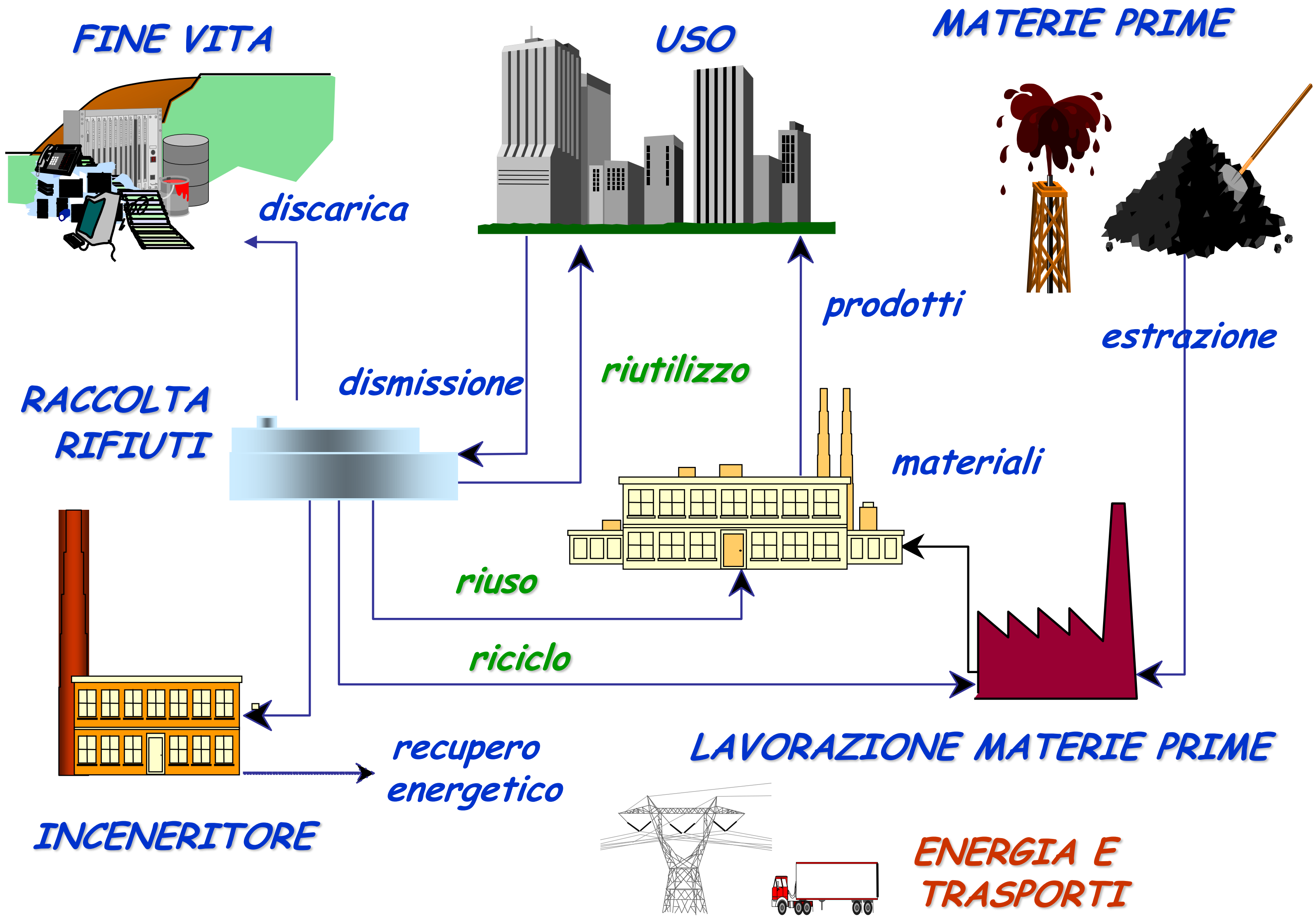
- L'Energia è la capacità di "fare" (compiere lavoro)
- Ci sono molte forme di Energia (cinetica, potenziale, termica…)
- L'Energia si trasforma (da una forma all'altra)
- L'Energia si conserva ($dE = dQ - p\,dV$ I principio)

  (non si può creare energia!)
- L'Energia si degrada (finendo in calore)

  (II principio: aumento di entropia $dS = dQ/T$)

  (non è possibile il moto perpetuo!)

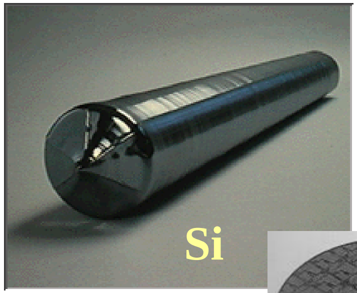
Oggetti e Servizi richiedono Energia

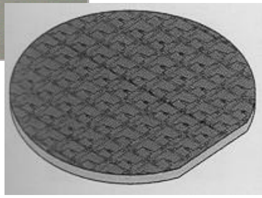


Densita' di Energia

Megajoule per chilogrammi di materiale

materialee	MJ/kg
Si (metallurgico)	33
Si (monocristallo)	560
Si (CI)	35000
Cu(metallurgico)	20
Polietiilene (HDPE)	7
Al (metallurgico)	122
Vetro (bottiglie)	1
Carta (fine)	48
Uomo	60 MJ/kg anno

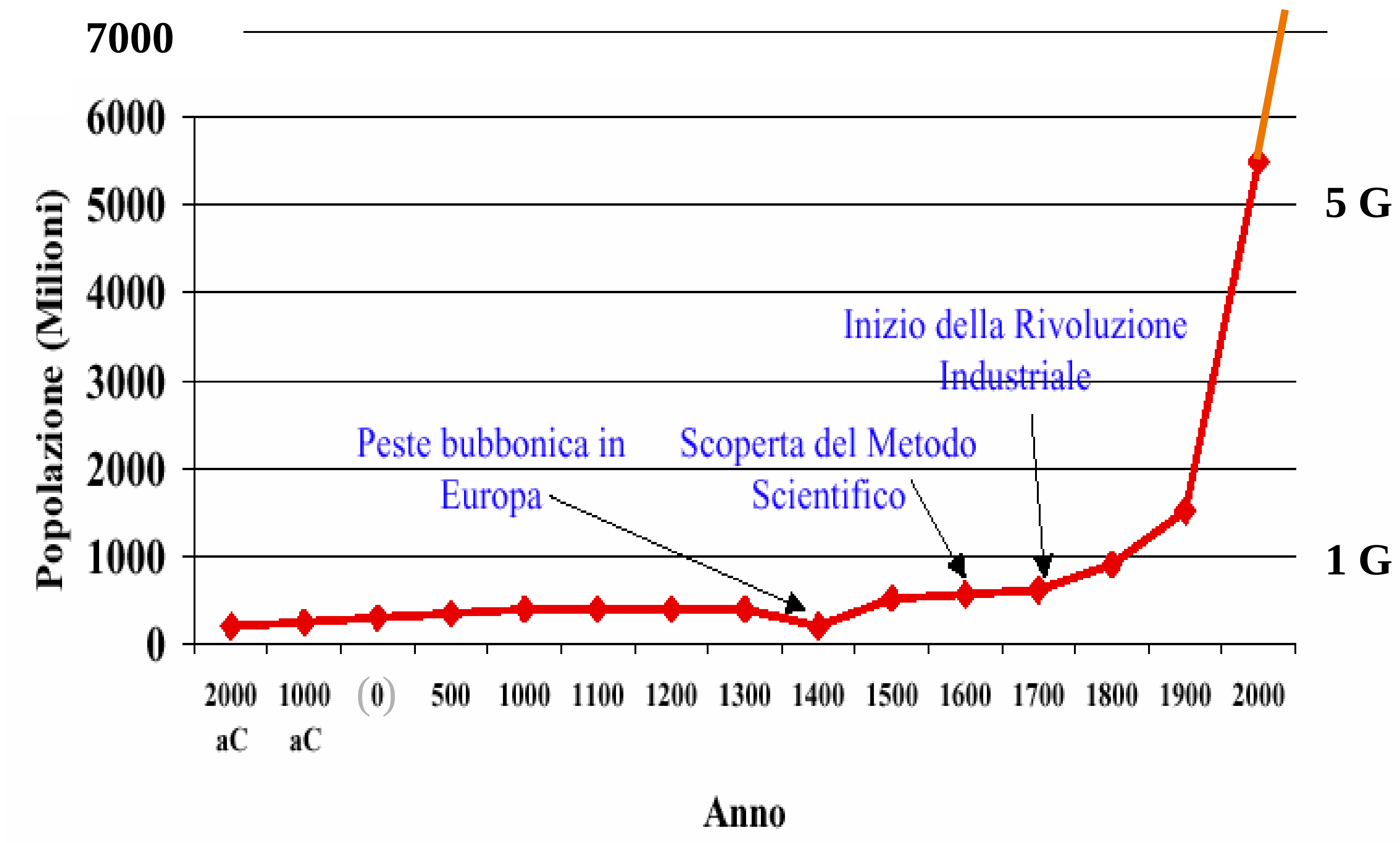




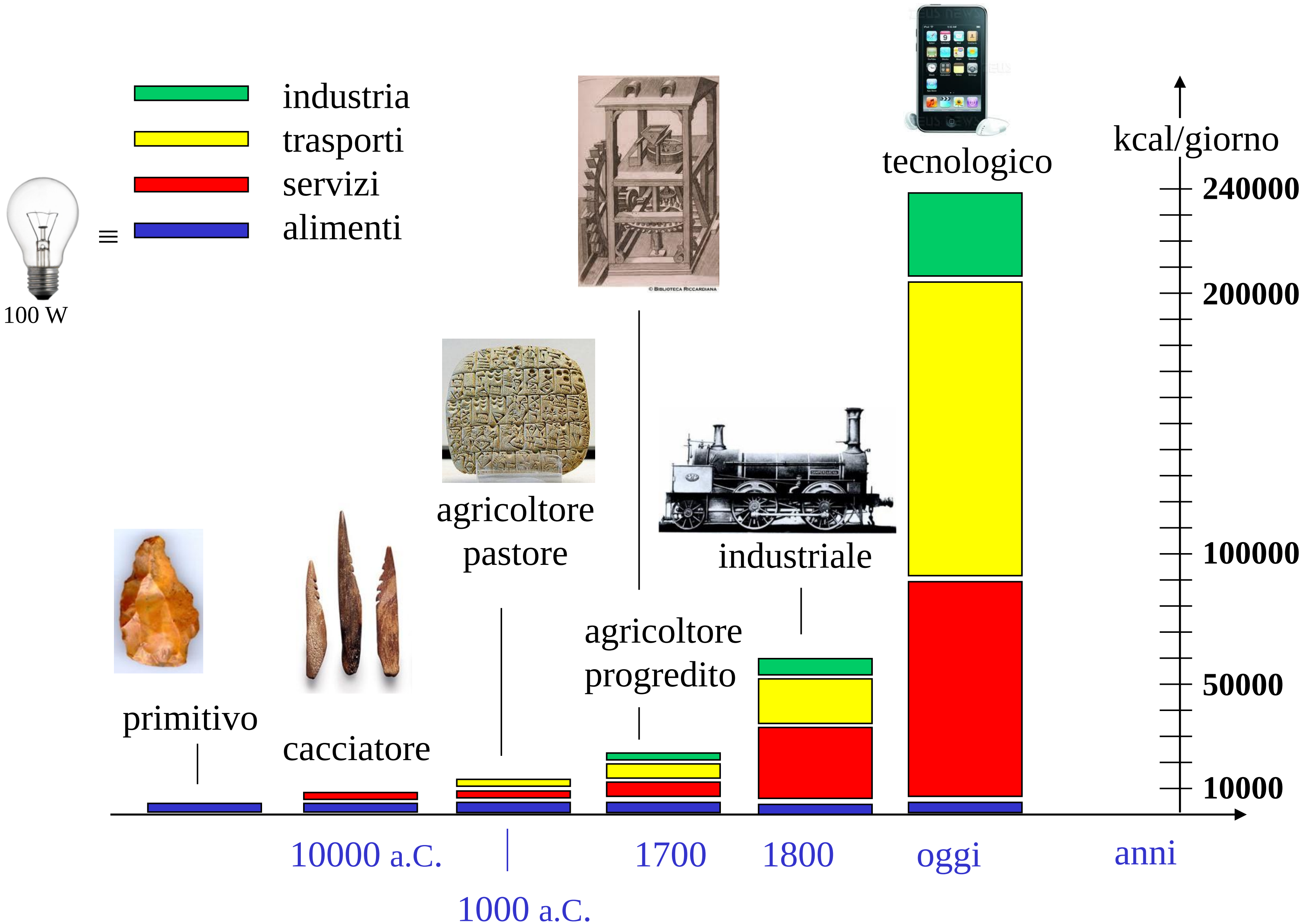
Al

carta

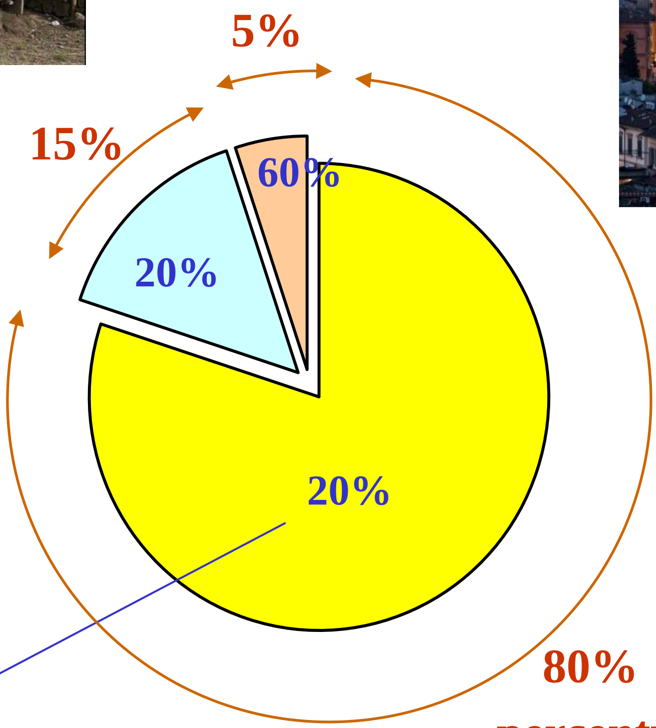
Crescita della popolazione mondiale



Consumi medi individuali di energia



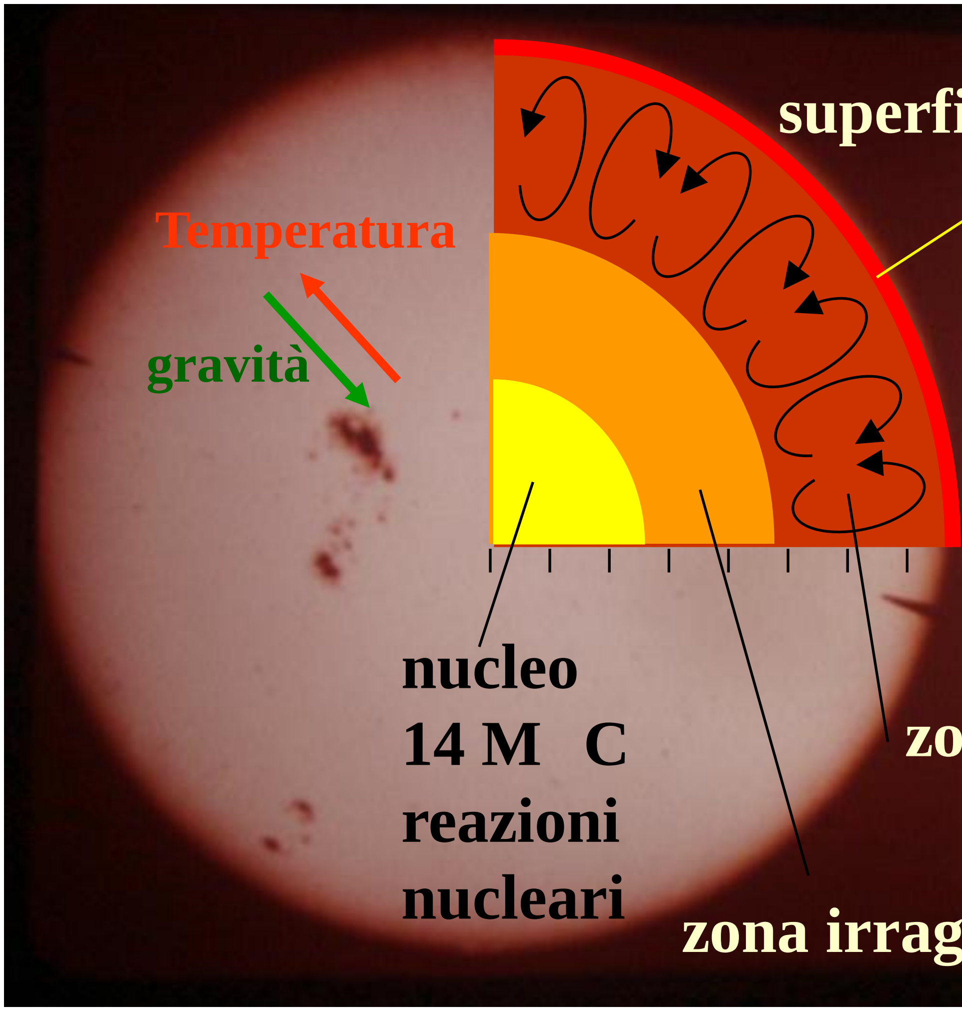
Distribuzione del consumo di energia



percentuale popolazione che dispone dell'energia

percentuale di energia consumata

Sole

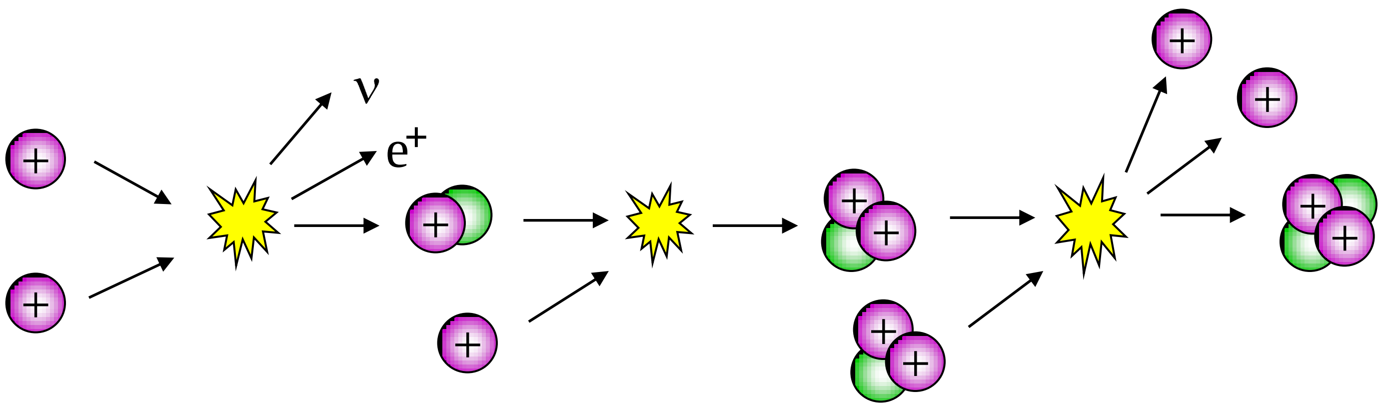


massa 10^{30} kg
diametro 1392000 km
rotazione 25 giorni
atmosfera H He
tracce del resto
densità   1,4 g/cm^3
P emessa ~ 10^{23} kW
(centomila miliardi di miliardi)

perdita di massa

1Mt/s ($E = mc^2$)

Fusione Nucleare



$$2\ {}^{1}_{1}H^{+} \longrightarrow {}^{2}_{1}D^{+} + e^{+} + \nu$$

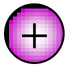
$$ {}^{2}_{1}D^{+} + {}^{1}_{1}H^{+} \longrightarrow {}^{3}_{2}He^{++}$$

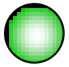
$$2\ {}^{3}_{2}He^{++} \longrightarrow {}^{4}_{2}He^{++} + 2\ {}^{1}_{1}H^{+}$$

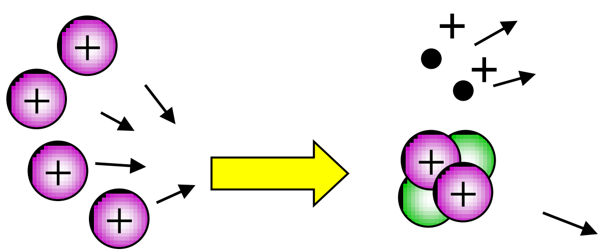
i nuclei di idrogeno"fondono" generando elio ed energia

ν neutrino

e^{+} positrone

 protone

 neutrone



$6{,}688\ 10^{-27}$ kg **$6{,}648\ 10^{-27}$ kg**

(più energia) **(3,5 MeV)**

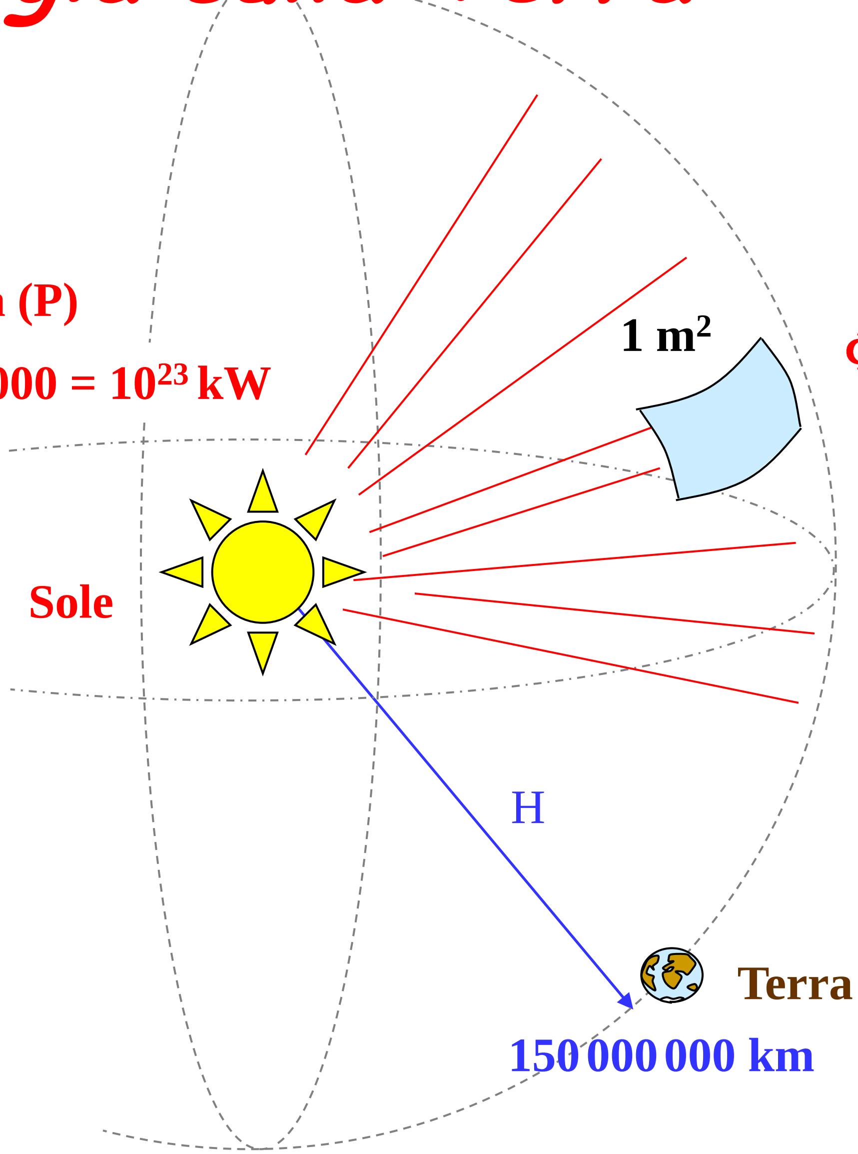
Energia sulla Terra

potenza generata (P)

100 000 000 000 000 000 000 000 = 10^{23} kW

Luce visibile
Raggi UV
Raggi IR
Onde radio
Raggi X
Protoni
Neutroni
Elettroni

fermati ad alta quota

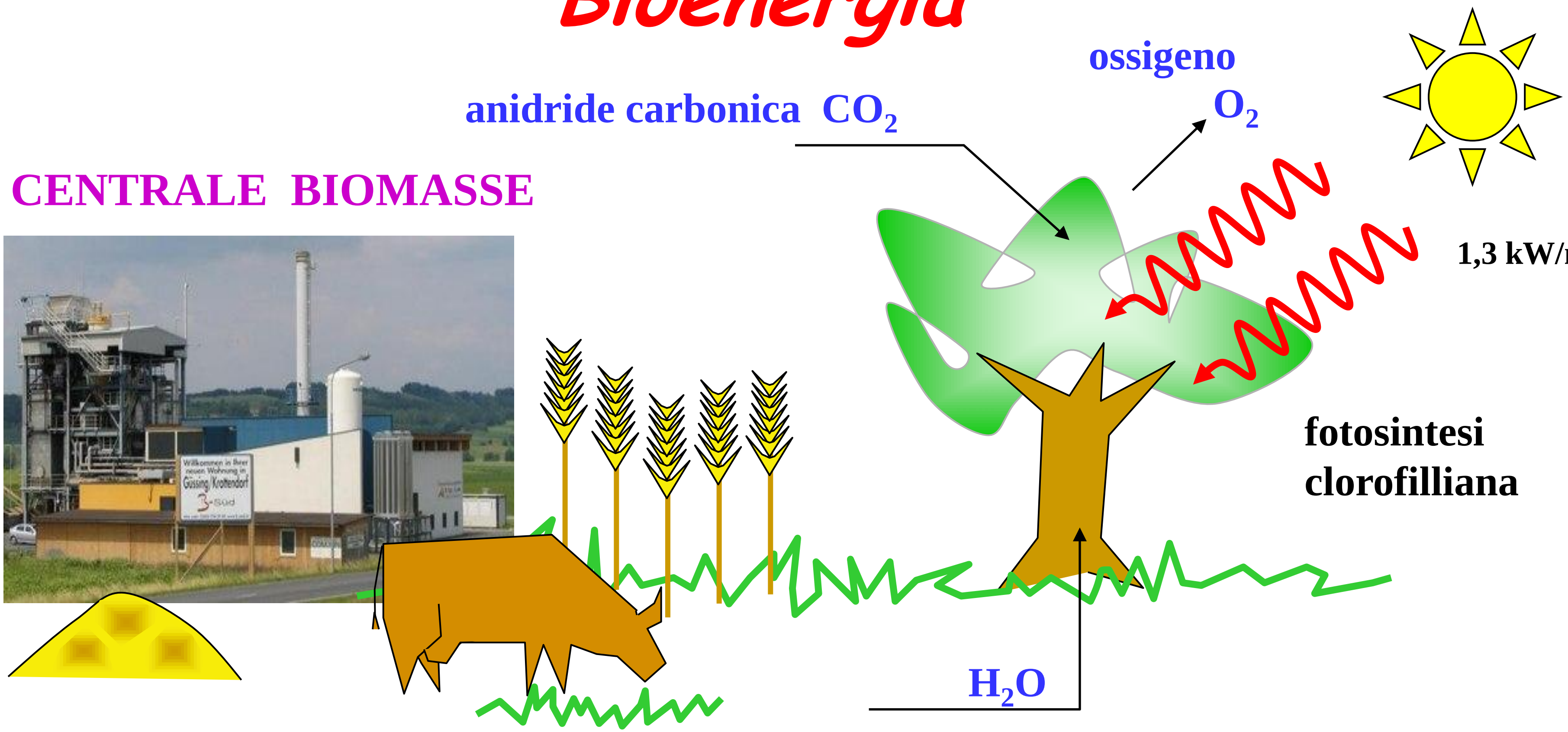


Φ = 1,3 kW/m²

potenza arrivata disponibile

($\Phi = P/4 \pi H^2$)

Bioenergia



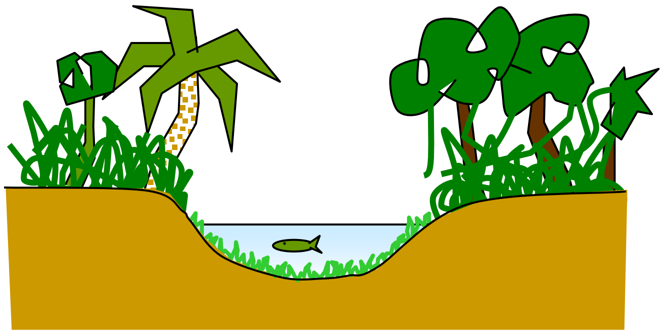
stufa e pellet

$$2\,H_2O + CO_2 \underset{\text{calore}}{\overset{\text{+ luce}}{\rightleftarrows}} (CH_2O) + H_2O + O_2$$

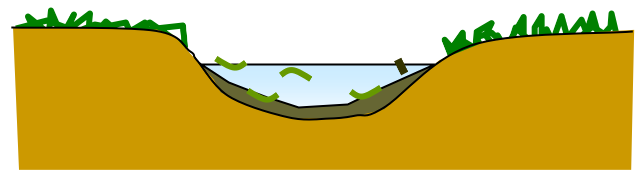
energia

zucchero
amido
cellulosa

Origine Combustibili Fossili

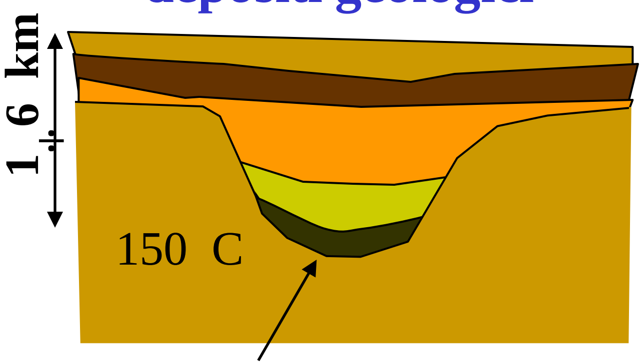


Carbonifero 300 M anni fa



deposito anaerobico

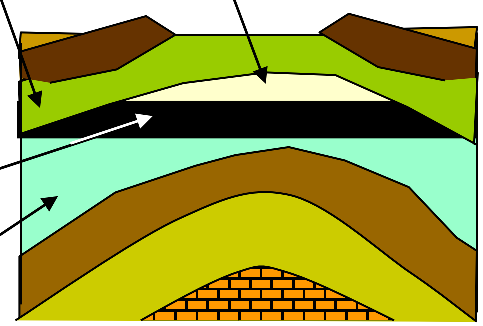
depositi geologici



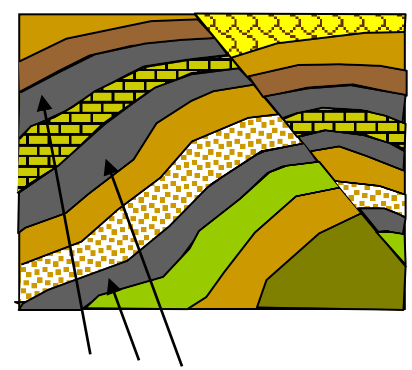
decomposizione anaerobica

torba, antracite,
bitume, petrolio, metano

deformazione strati

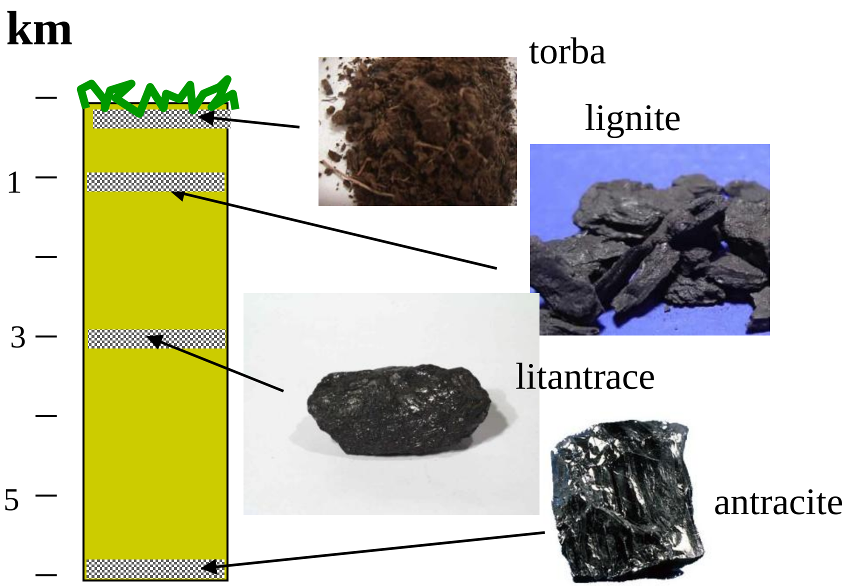


migrazione componenti



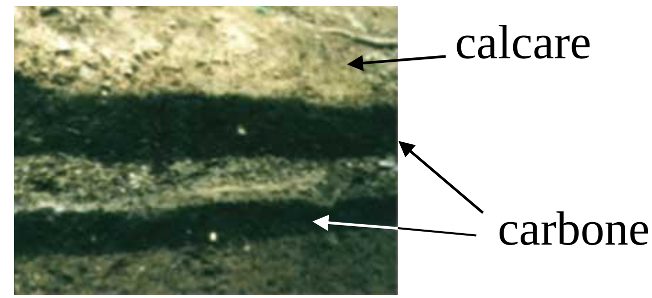
strati carbone

Combustibili Fossili

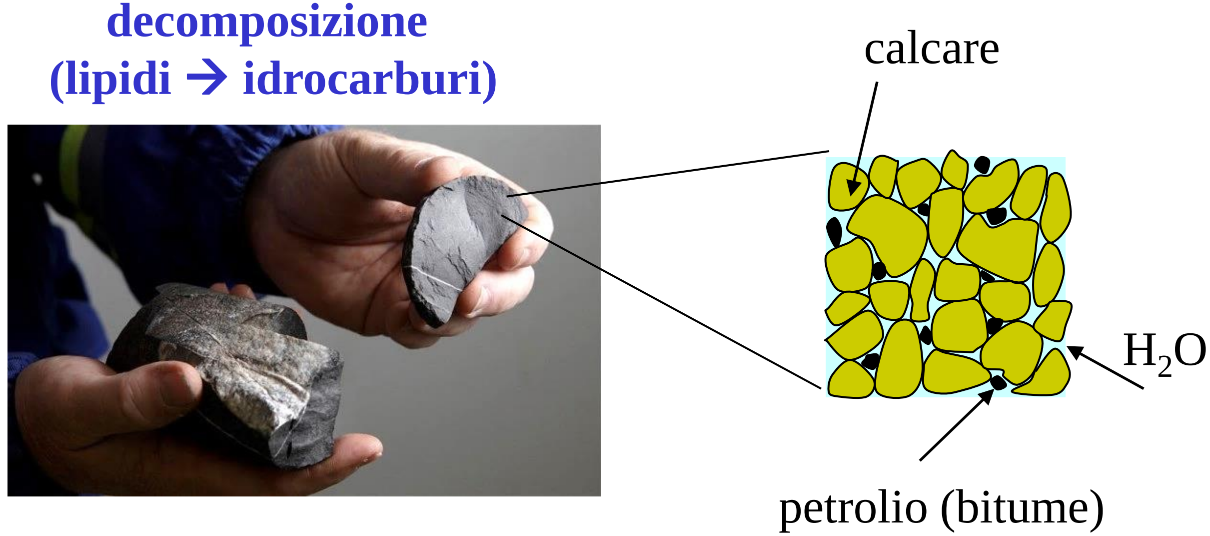


Carbone - Carbonifero (300 M anni)

decomposizione di pinte
(carboidrati → carbonio)

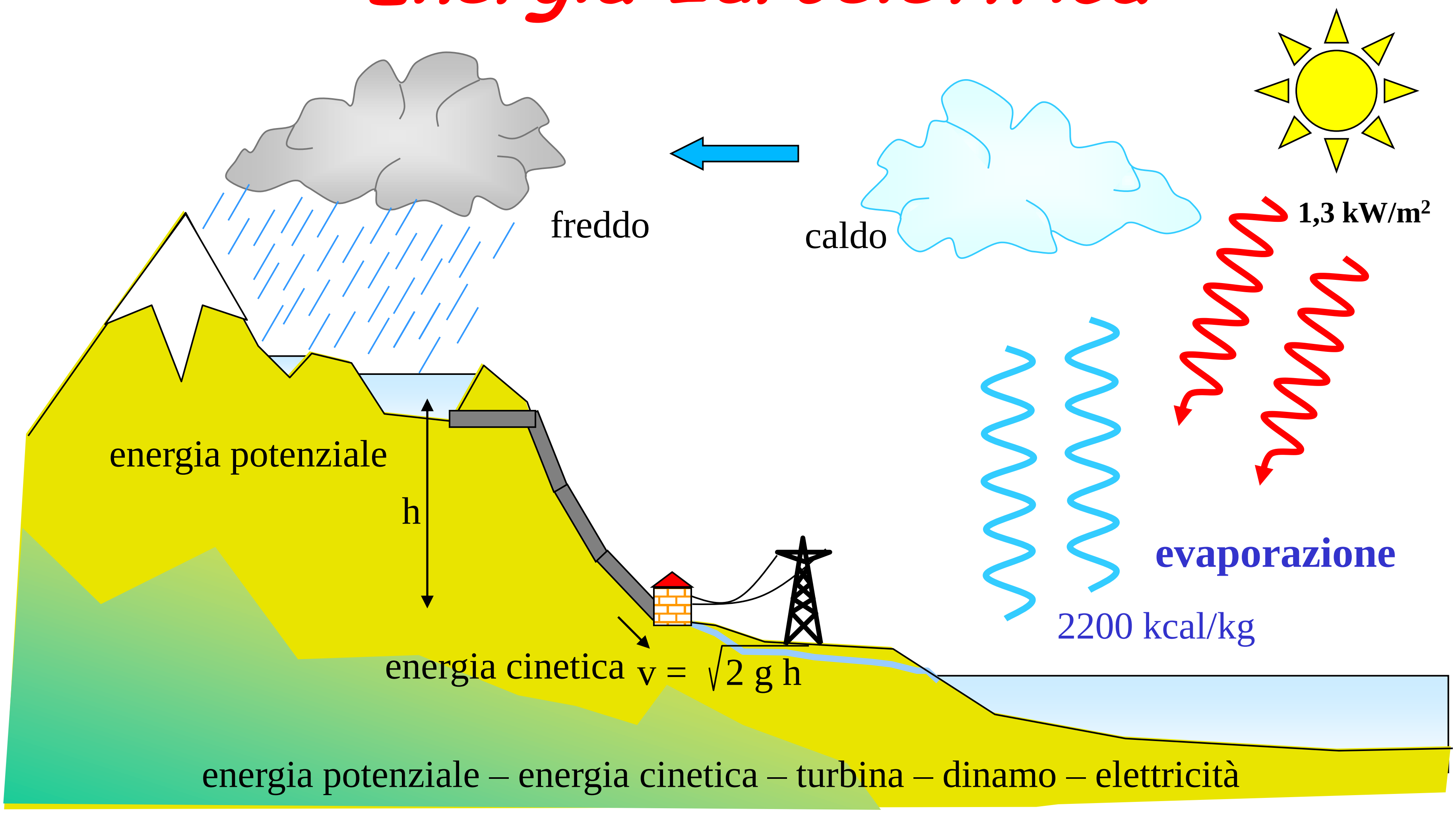


decomposizione
(lipidi → idrocarburi)



Petrolio
Devoniano (400 M anni)
da plancton e pesci

Energia Idroelettrica

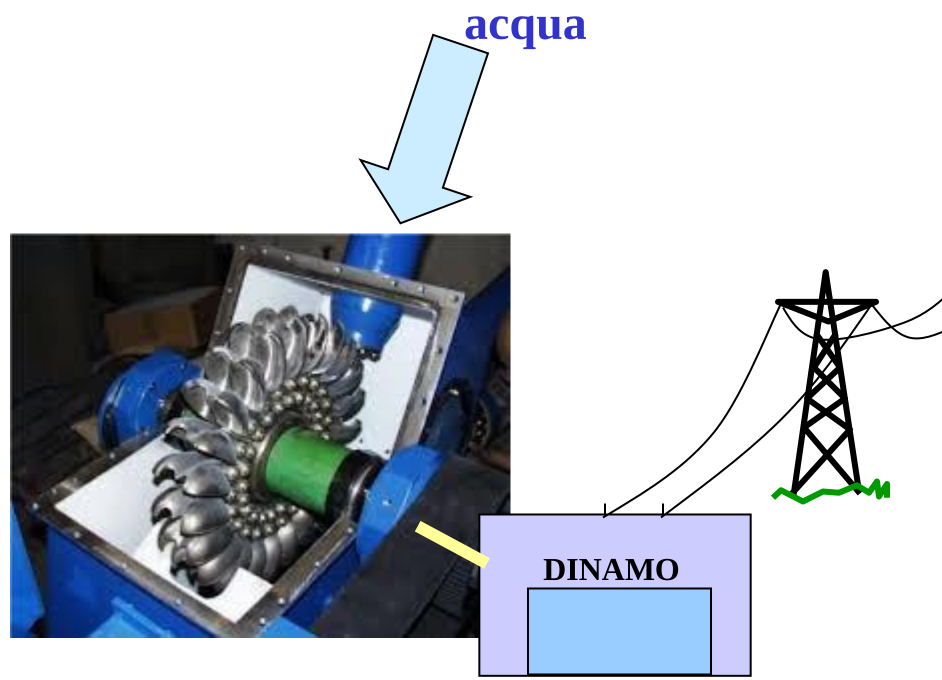


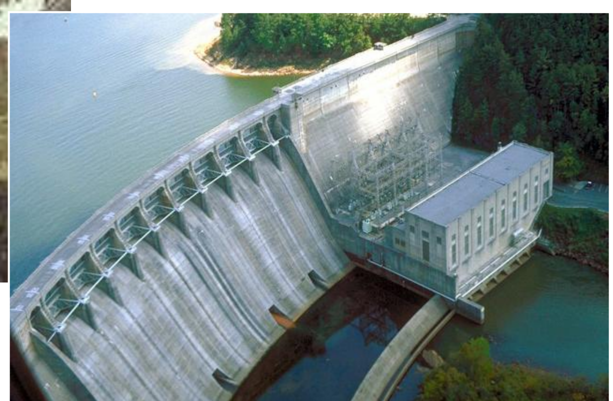
energia potenziale = m g h

energia cinetica = ½ m v^2

g (gravità) = 9,8 m/s^2

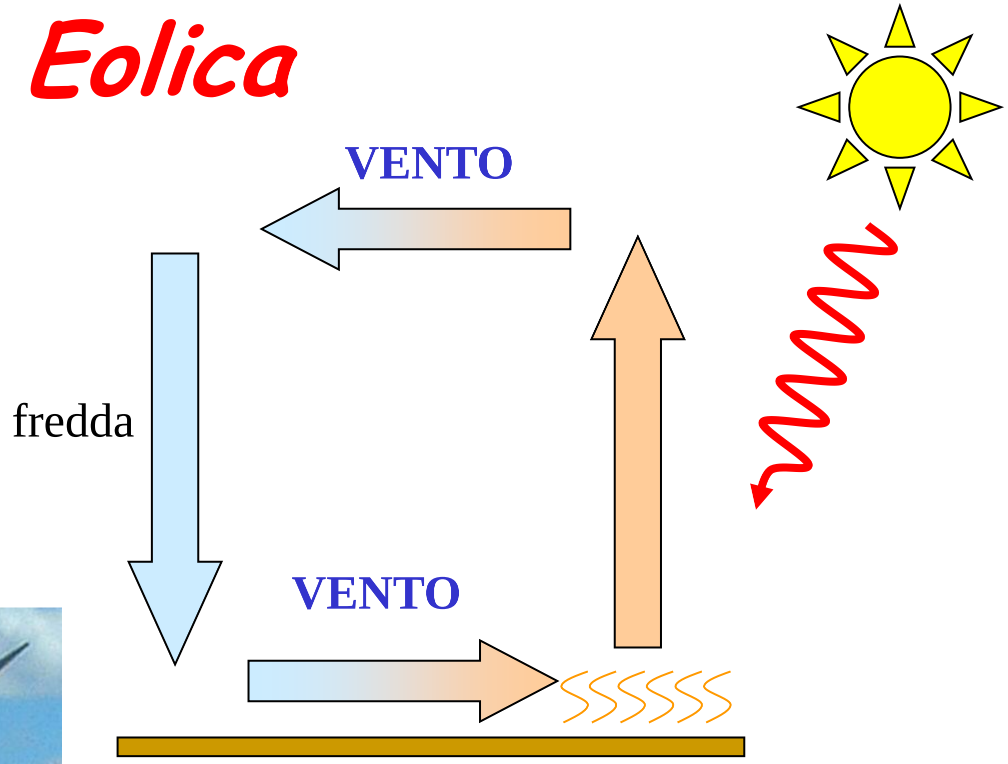
Energia Idroelettrica





Produzione mondiale
1 TW: 6 ÷7 % del totale

Energia Eolica



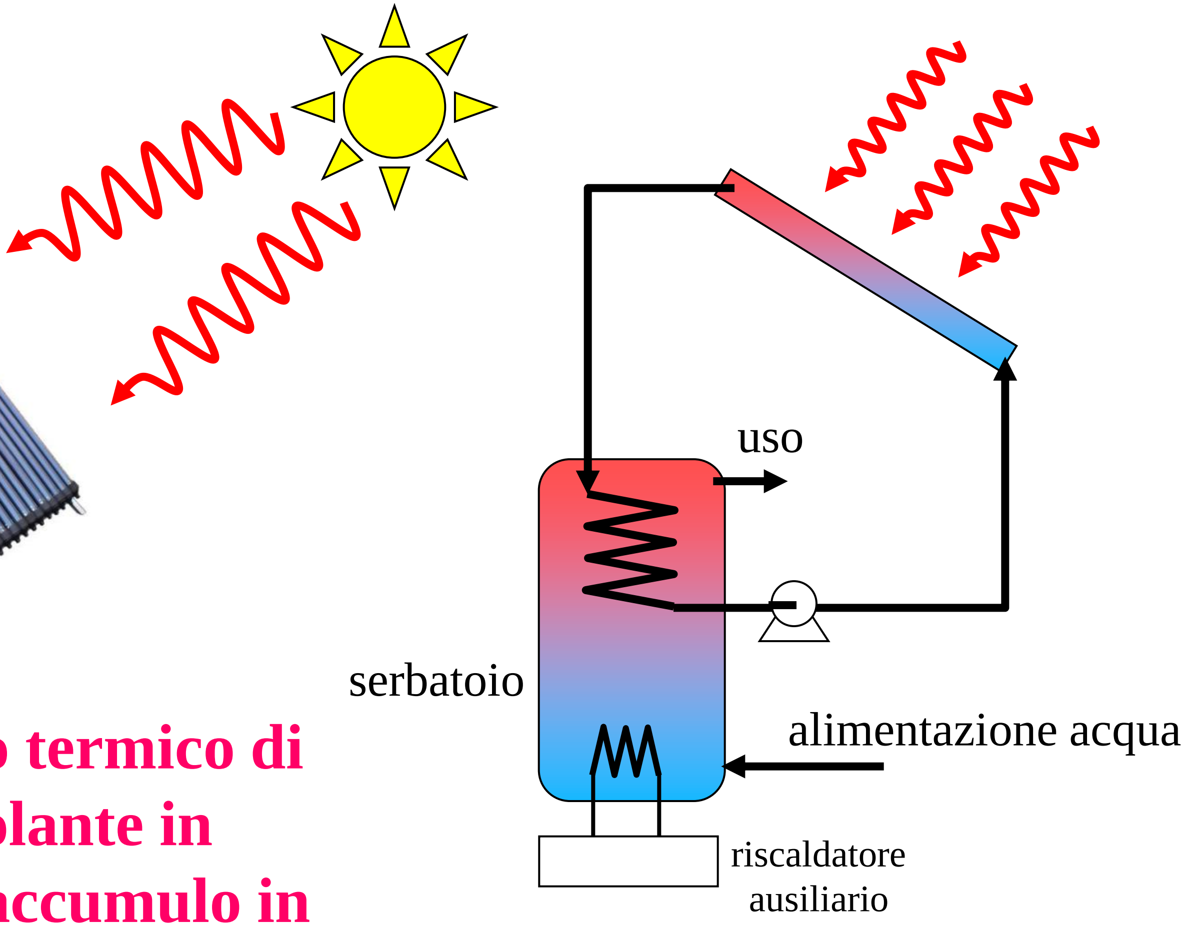
Nel 2010 ha prodotto il 2,5 % dell'energia mondiale

aria calda sale
bassa pressione
richiama altra aria

Pale Eoliche (20 – 60 m)

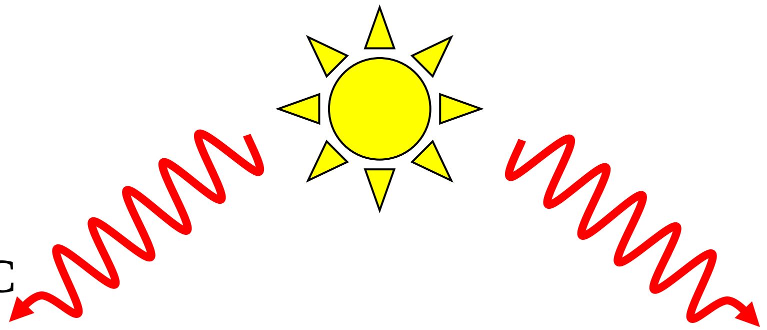
Pannelli Termici

collettori solari



Riscaldamento termico di acqua circolante in serpentine ed accumulo in cisterne isolate

Fornaci Solari



T = 3500 C

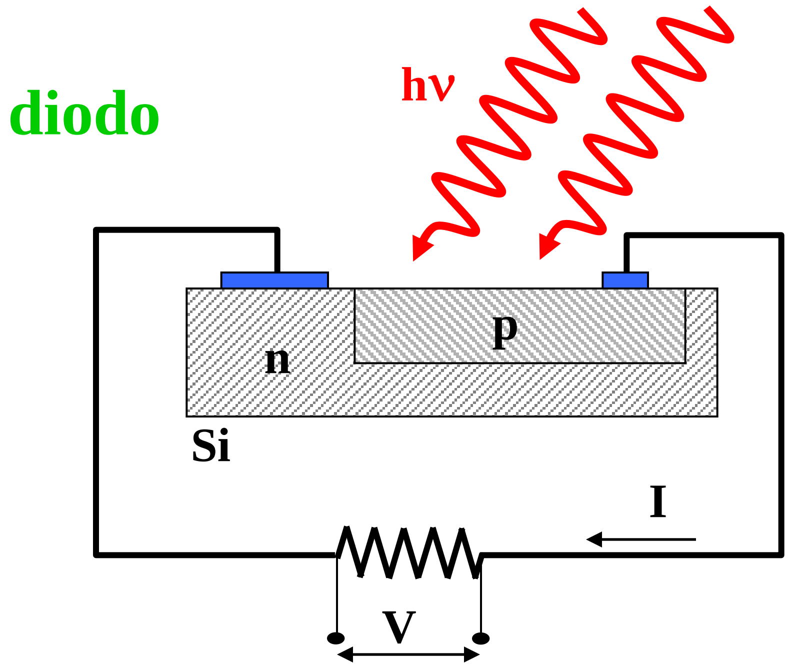
20 MW

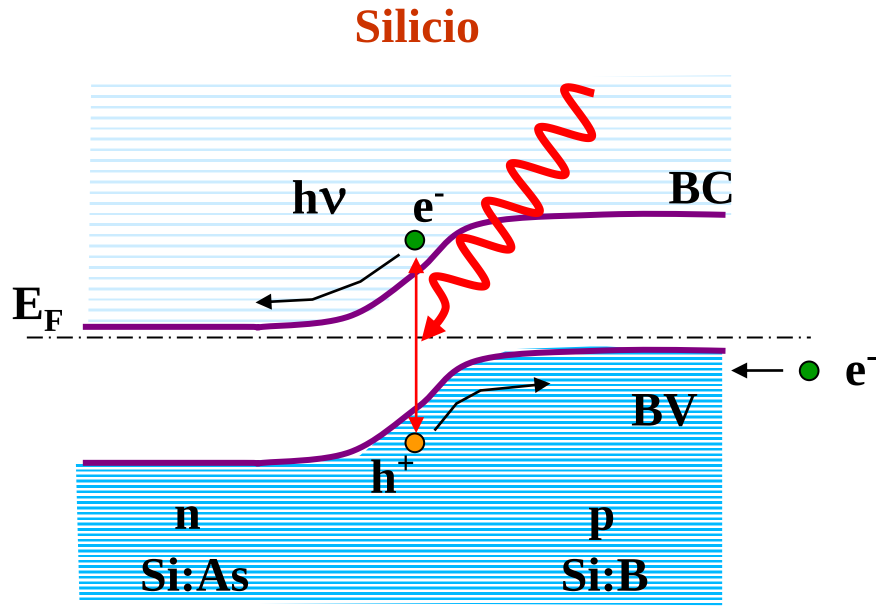
È necessario inseguire il moto apparente del sole

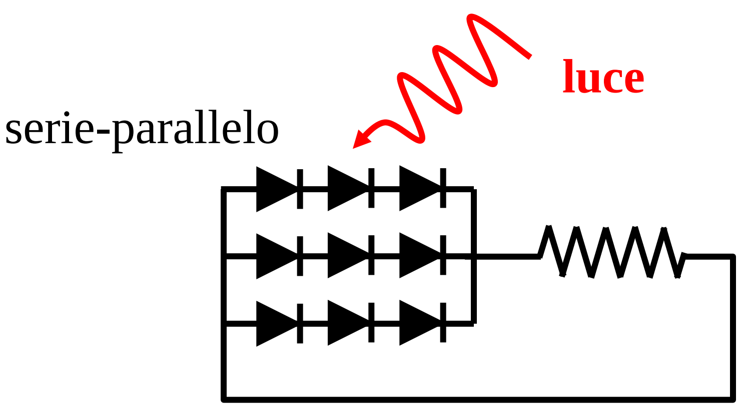
(forno per fusione)

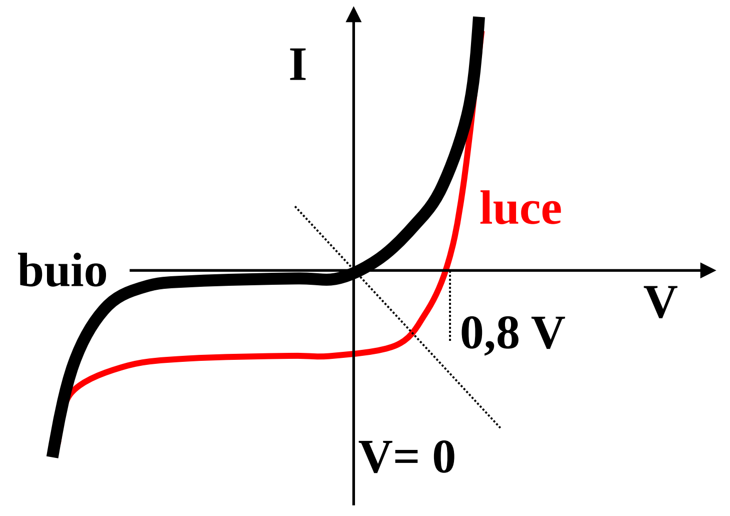
(generazione vapore - dinamo -elettricità)

Fotovoltaico

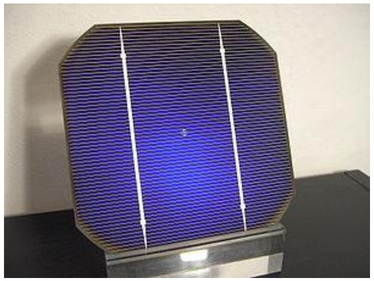








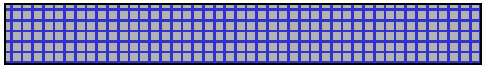
Celle al Silicio



$\eta \sim 20\%$

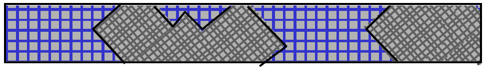
monocristallo

1 mm



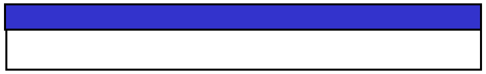
policristallo

1 mm



$\eta \sim 12\%$

10 µm



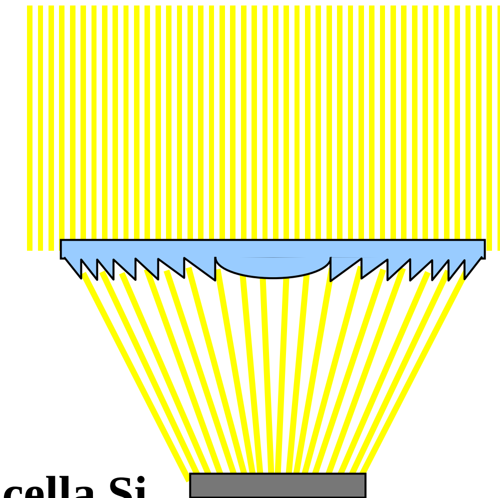
vetro o acciaio

amorfo

$\eta \sim 6\%$

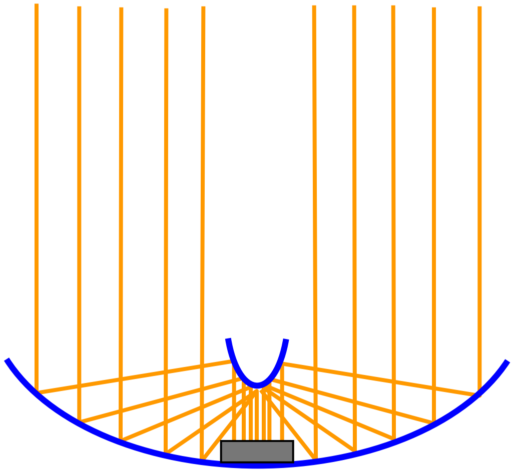
Celle a concentrazione

1,3 kW/m^2



Lente Fresnel

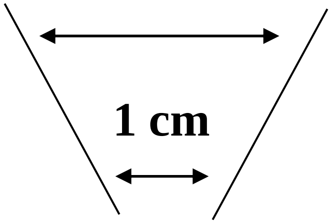
Specchi



cella Si

cella Si

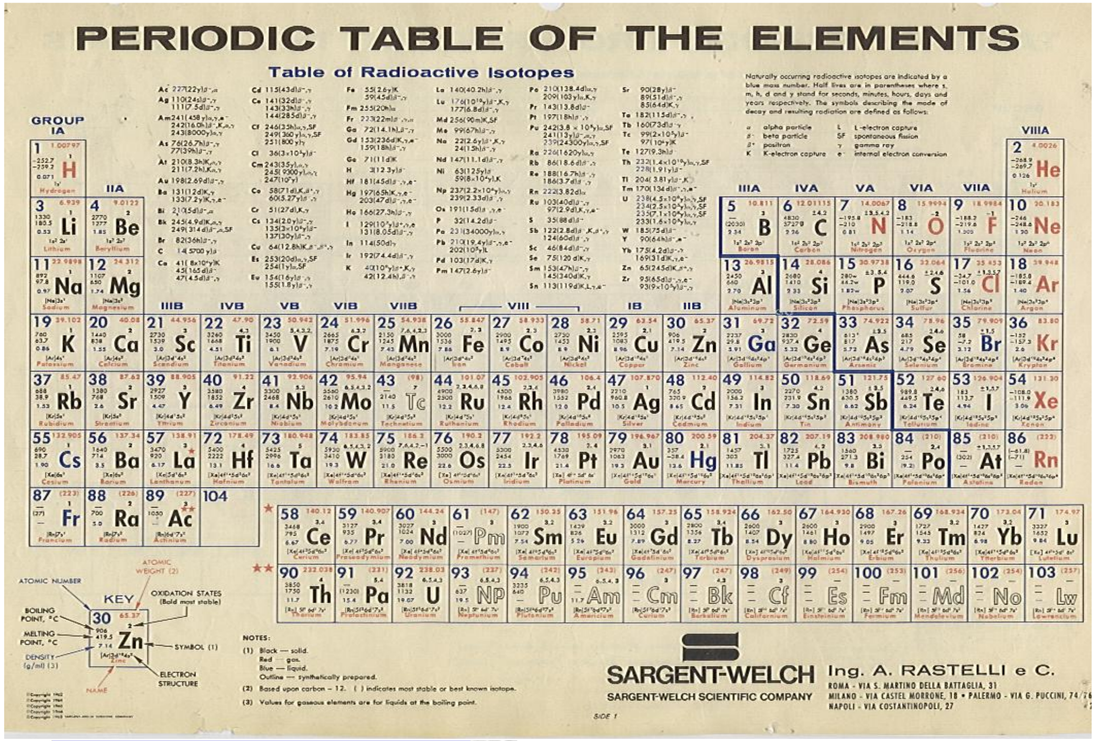
(300 – 1500 soli)

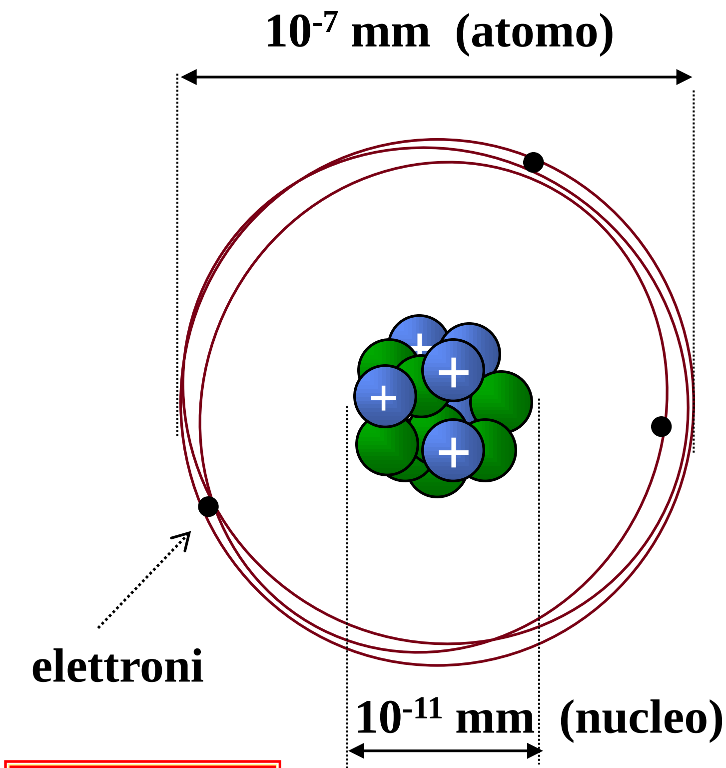


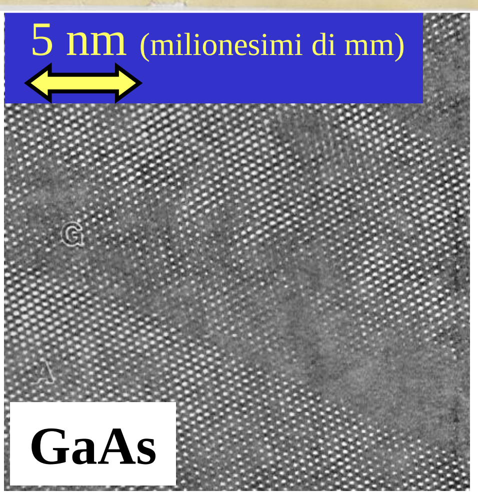
Riduzione di superficie di semiconduttore a parità di energia

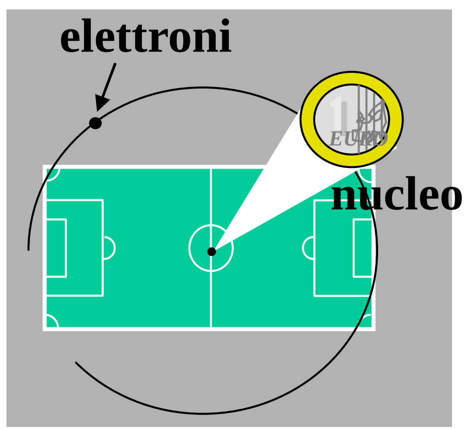
Riduzione di costi

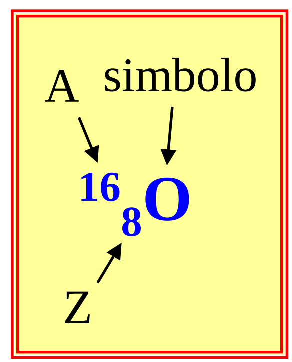
Atomi









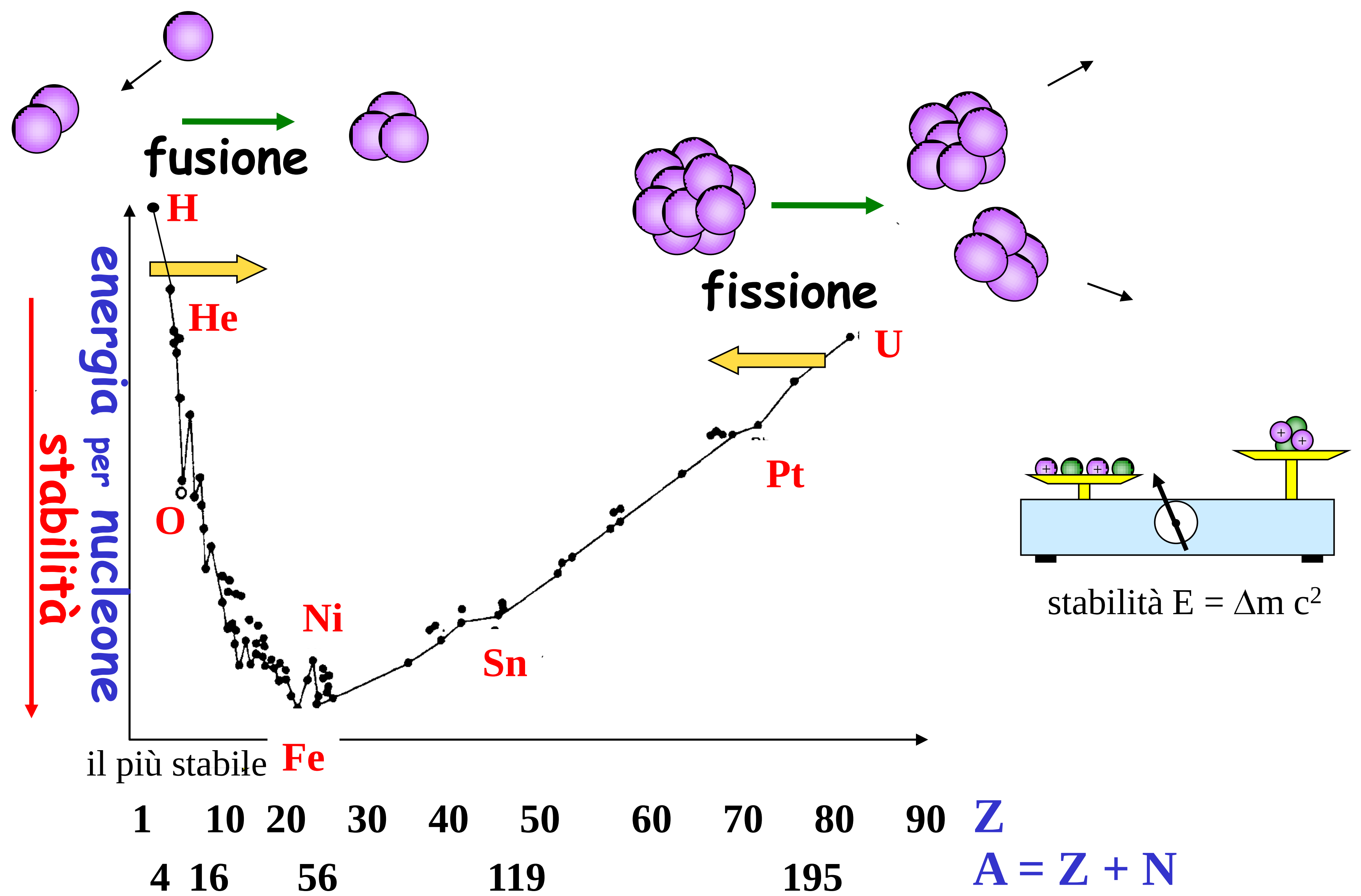


Protoni (+) Z
elementi

Neutroni ( ) N
isotopi

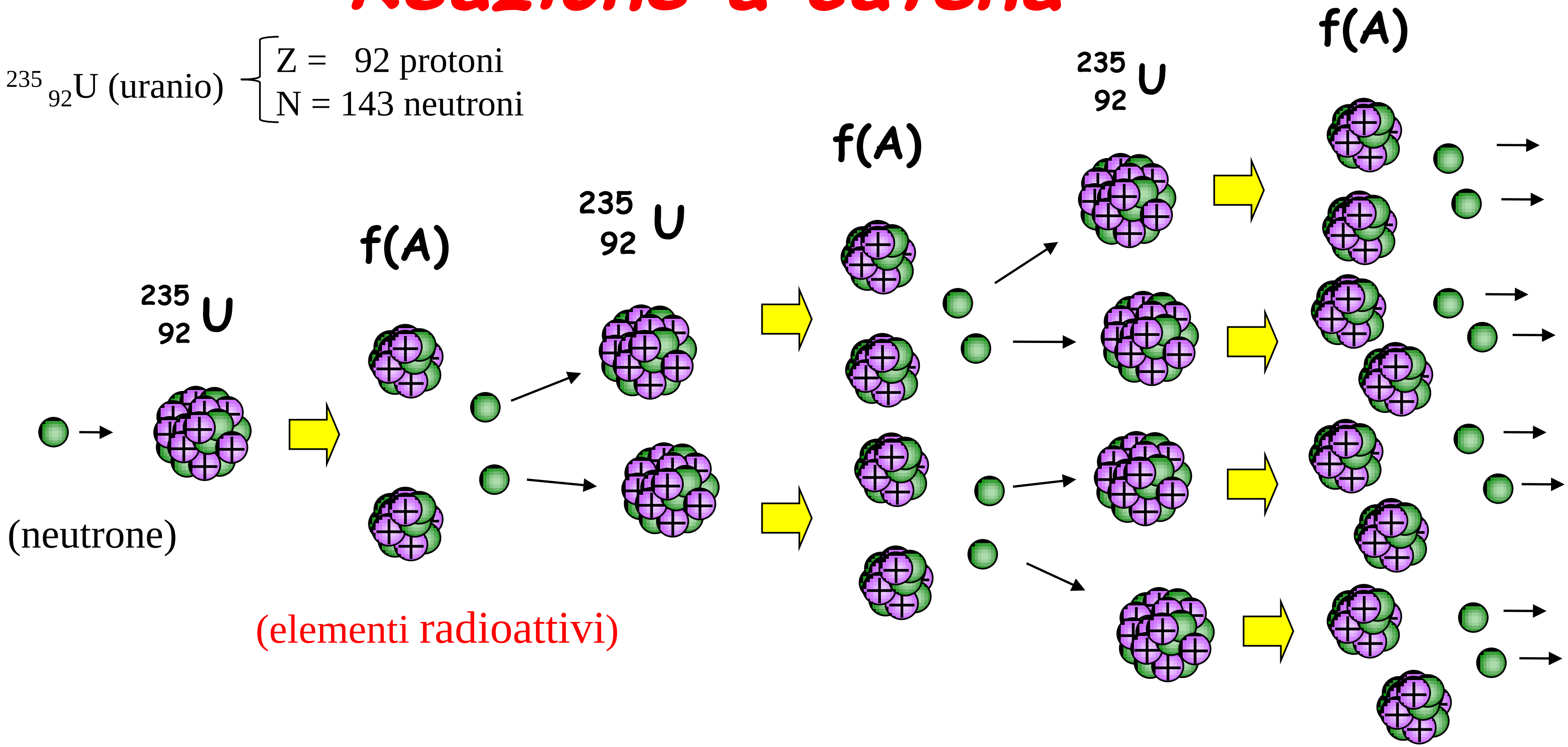
Peso Atomico A = Z + N

Stabilità Elementi



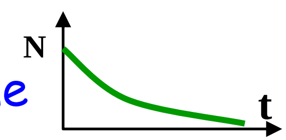
Reazione a catena

$^{235}_{92}U$ (uranio) { Z = 92 protoni, N = 143 neutroni }

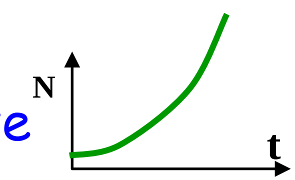


I neutroni si perdono: la reazione si spegne

(poco materiale)



I neutroni si accumulano: la reazione cresce esponenzialmente



(sopra una massa critica > 50 kg)

Reazione a catena

1) Arricchimento Uranio: $^{238}_{92}U$

Si rompe difficilmente

U naturale contiene solo 0,7% $^{235}_{92}U$

Per reattori nucleari occorre $^{235}_{92}U$ $3 \div 10$ %

(per bomba circa 90 %)

2) Rallentare i neutroni

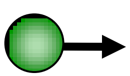
v grande

poco interagente

D_2O

acqua pesante

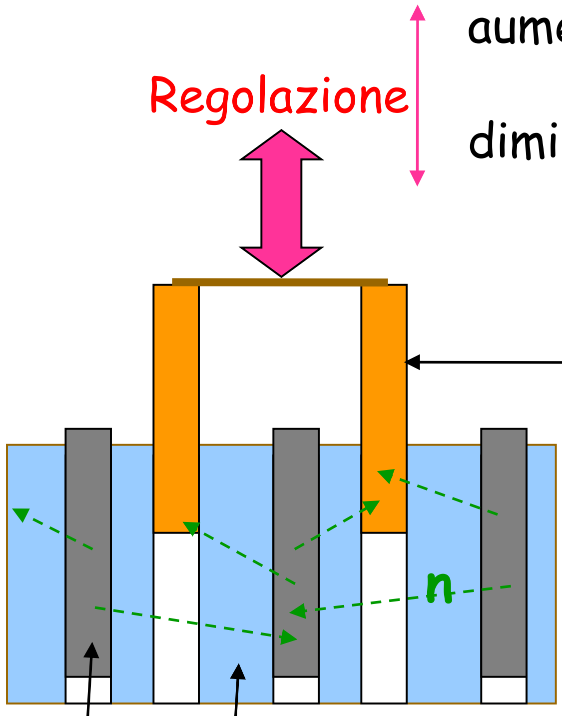
v piccolo

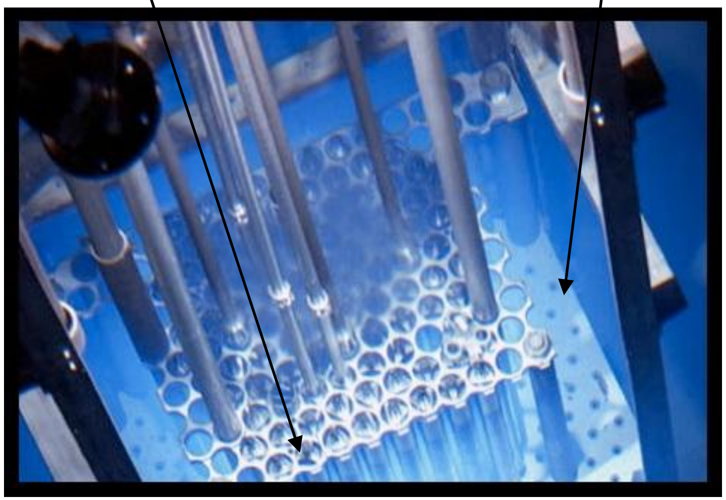


molto interagente

(E ~ eV)

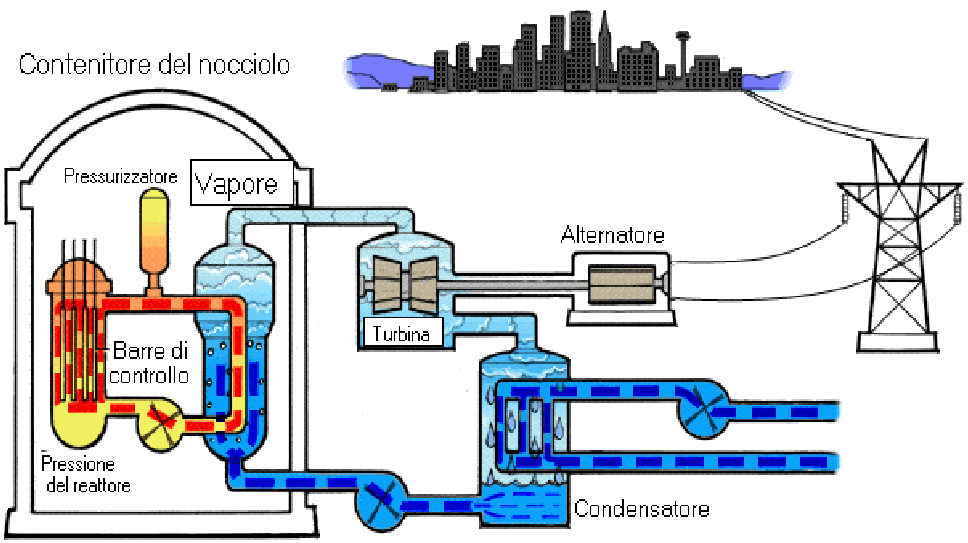
Nocciolo del Reattore





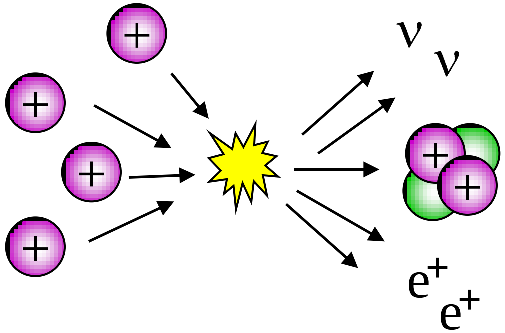
Reattore Nucleare a Fissione

Schema



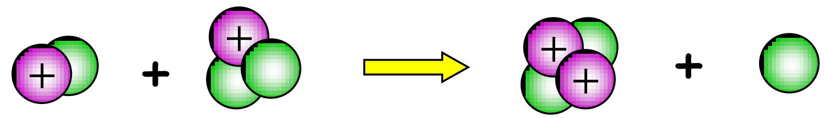
Il reattore produce calore che viene trasformato in energia elettrica da una turbina ed un alternatore

Fusione Nucleare

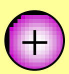


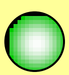
$4\ {}^{1}_{1}H^{+} \longrightarrow {}^{4}_{2}He^{++} + e^{+} + \nu$ (sole)

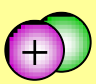
${}^{2}_{1}D^{+} + {}^{3}_{1}Tr^{+} \longrightarrow {}^{4}_{2}He^{++} + {}^{1}_{0}n$

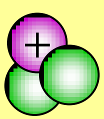


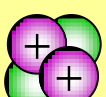
(possibile alternativa)

 idrogeno H

 neutrone

 deuterio D (abbondanza in acqua 30 g/m^3)

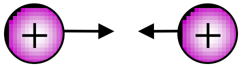
 trizio Tr (radioattivo $\tau_{1/2}$ = 12,3 anni)

 Elio He

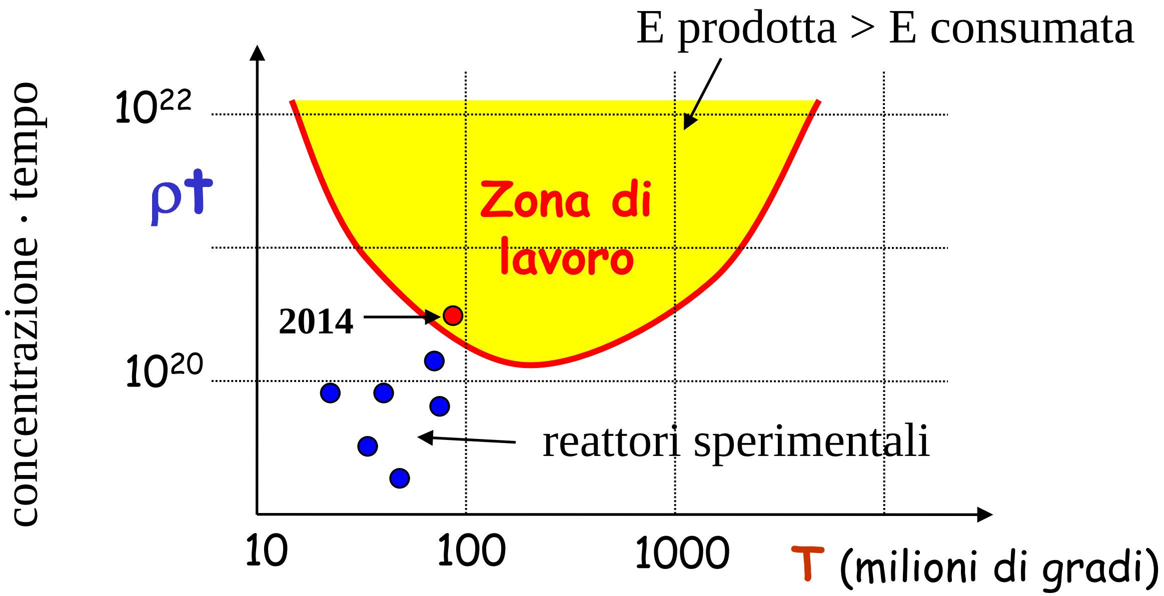
Non ci sono scorie radioattive

Condizioni di Fusione

- **Alta temperatura (T)** per vincere la repulsione tra cariche positive



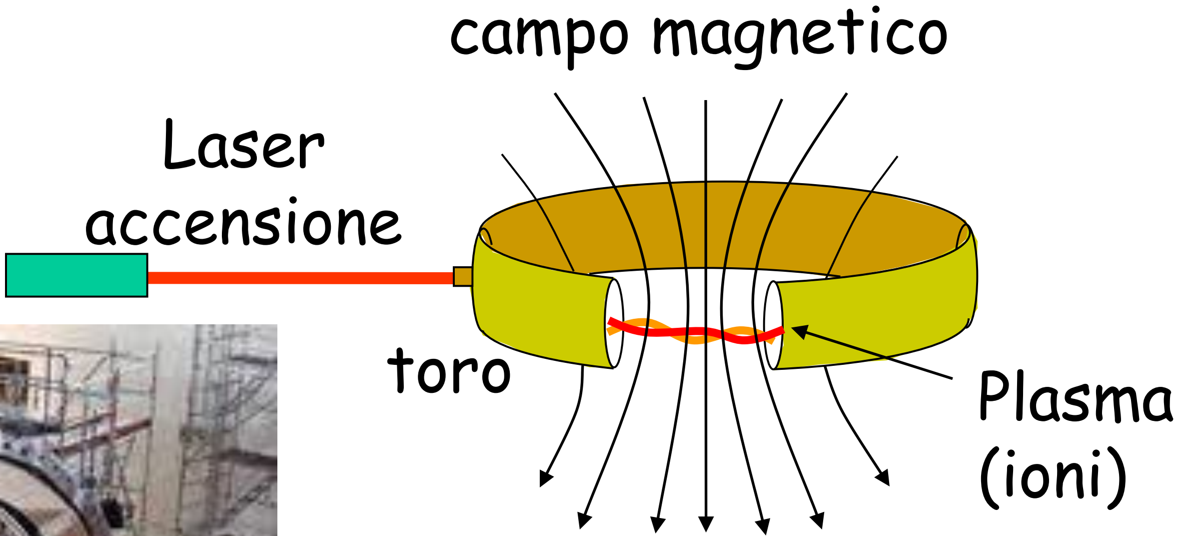
- **Alta concentrazione (ρ)** alta probabilità di scontro
- **Lungo tempo di attivazione (t)** tempo sufficiente per reagire



Confinamento

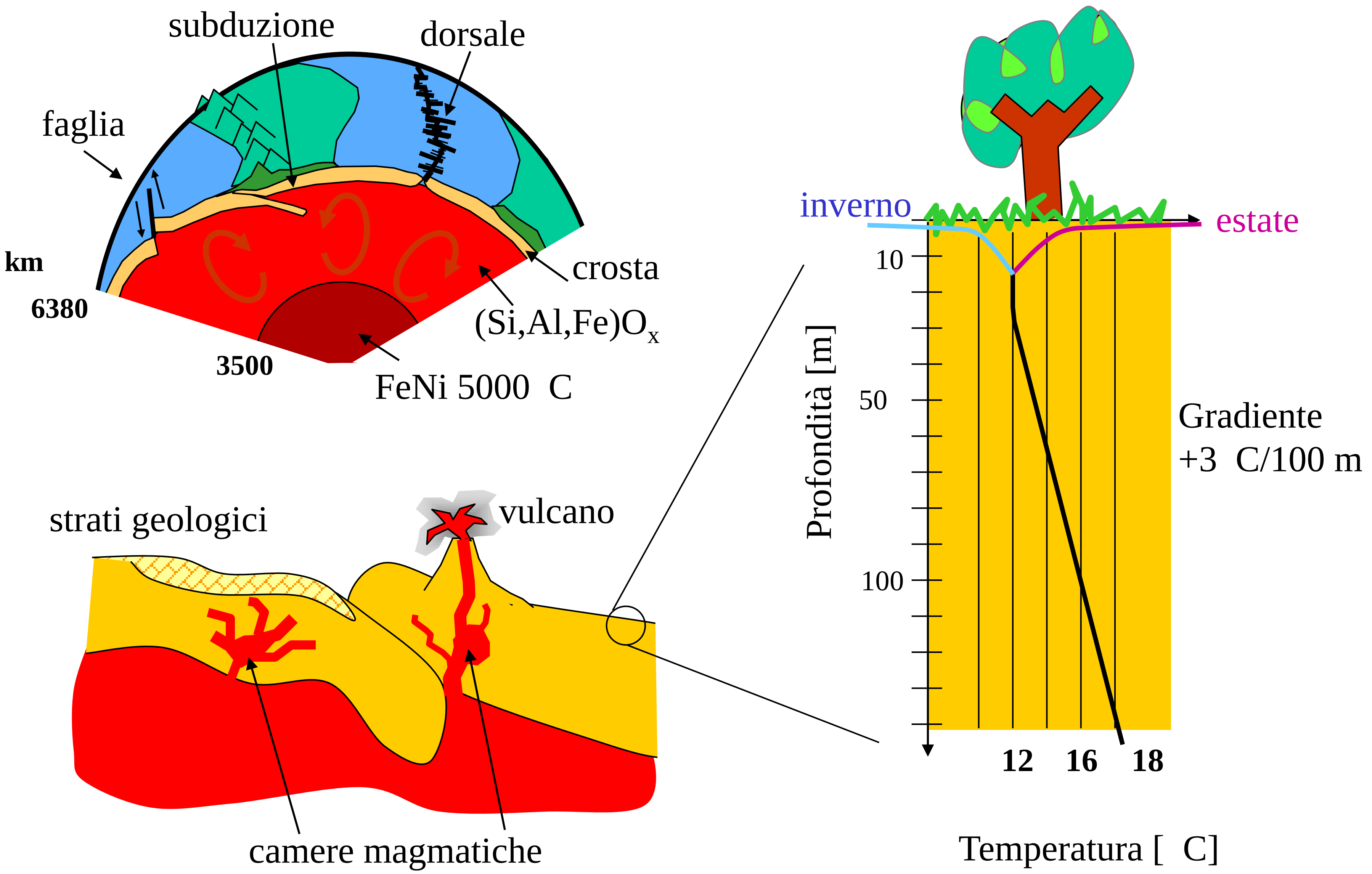
Come tenere un plasma di 100 milioni digradi?

Tokamak



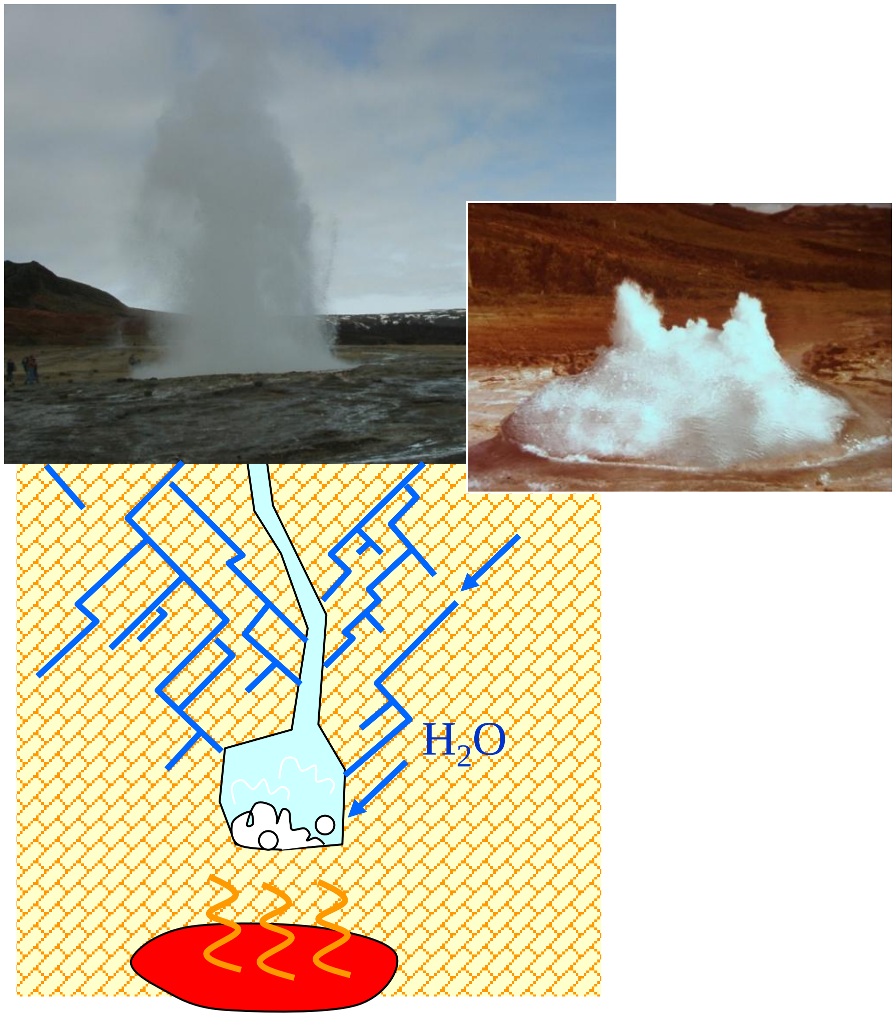
ci vorranno alcune decine di anni per avere le prime centrali industriali

Calore Terra

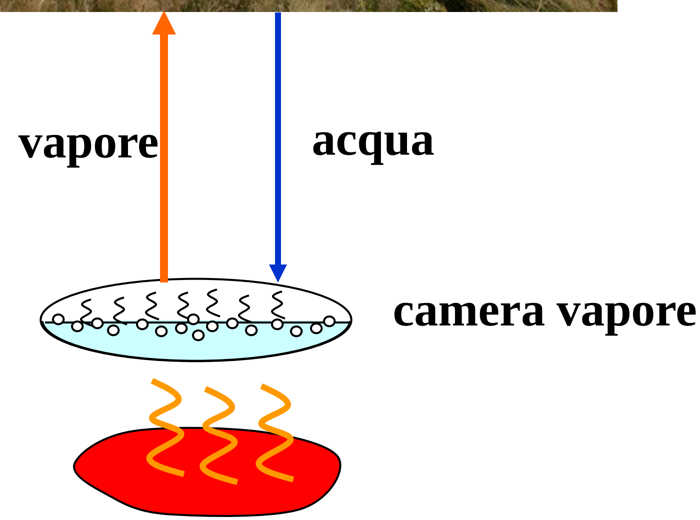


Energia geotermica

Geyser Islanda



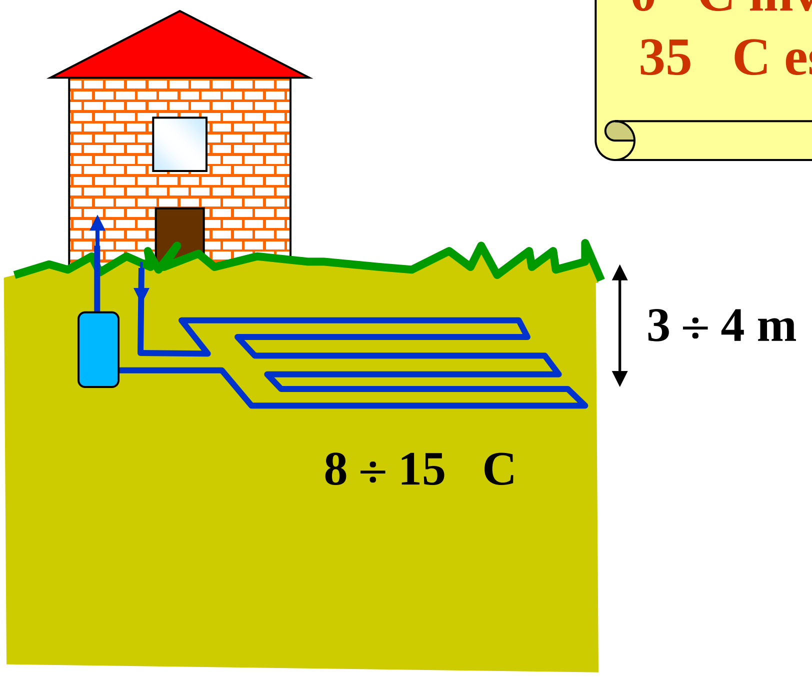
Larderello Italia

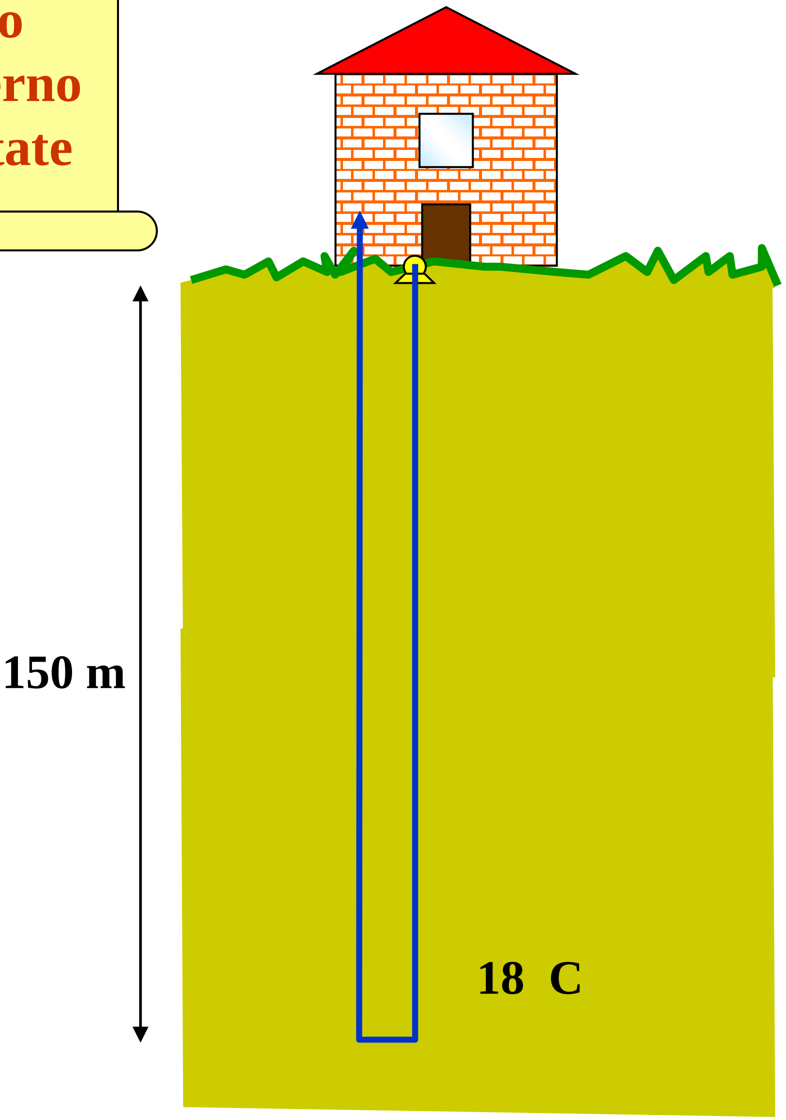


vapore – turbina –dinamo - elettricità

Geotermia

Esterno
0 C inverno
35 C estate

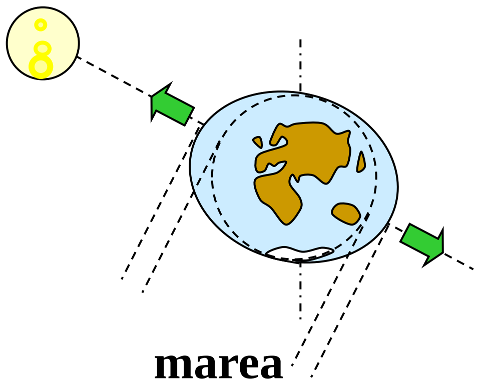




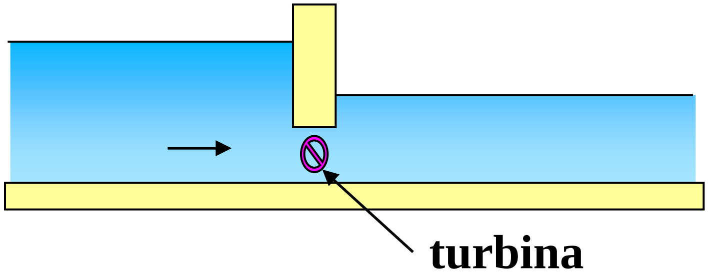
Condizionamento domestico
Riscalda d'inverno
Raffredda d'estate

La centrale mareomotrice

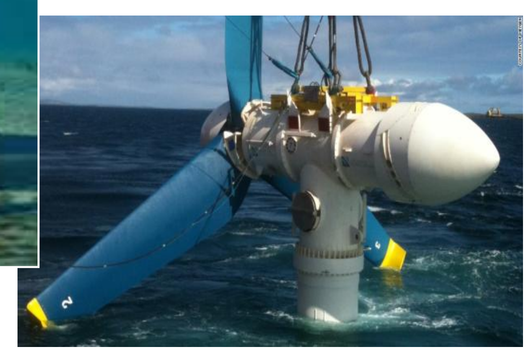
Forza gravitazionale



Cambio di marea ogni 6 ore



13 m marea 240 MW

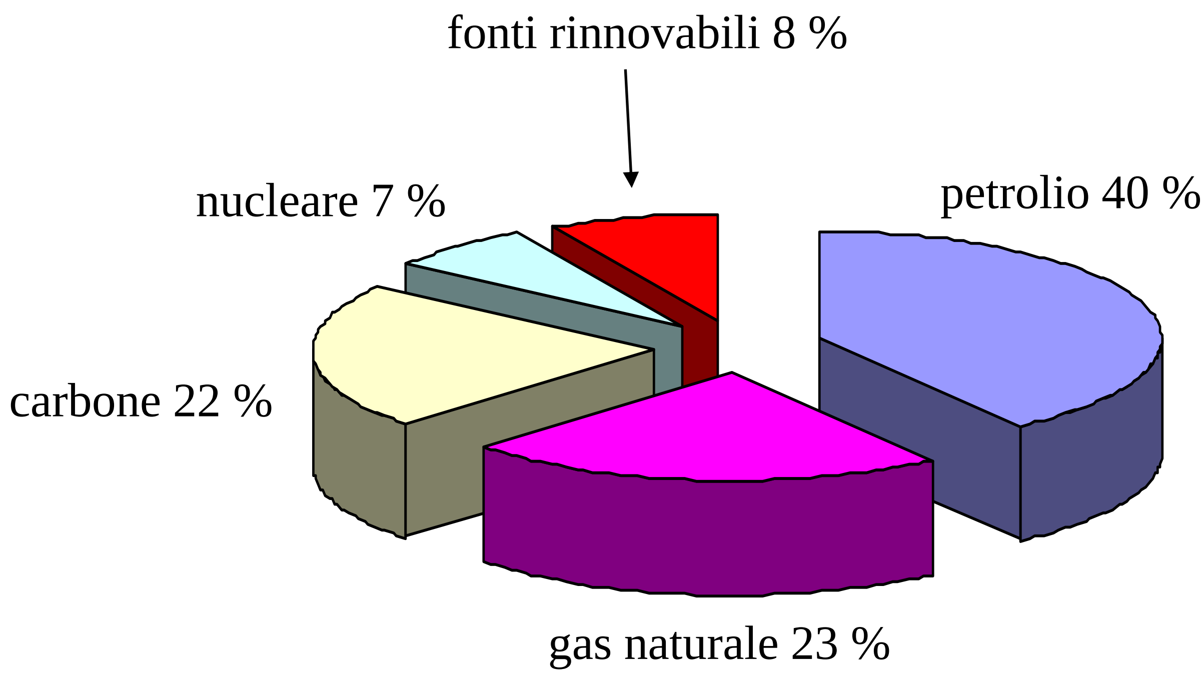


Riassunto

Consumo mondiale = 15 TW (15 mila miliardi di W)

(2010)

fonti energetiche



Conclusione

Bisognerà sviluppare per il futuro un consumo sostenibile

Razionalizzare il consumo
Metodi di risparmio energetico
Sviluppare tecnologie: **Nuove**
Efficienti
Meno costose

FINE