# A new energy indicator for life cycle analysis of buildings

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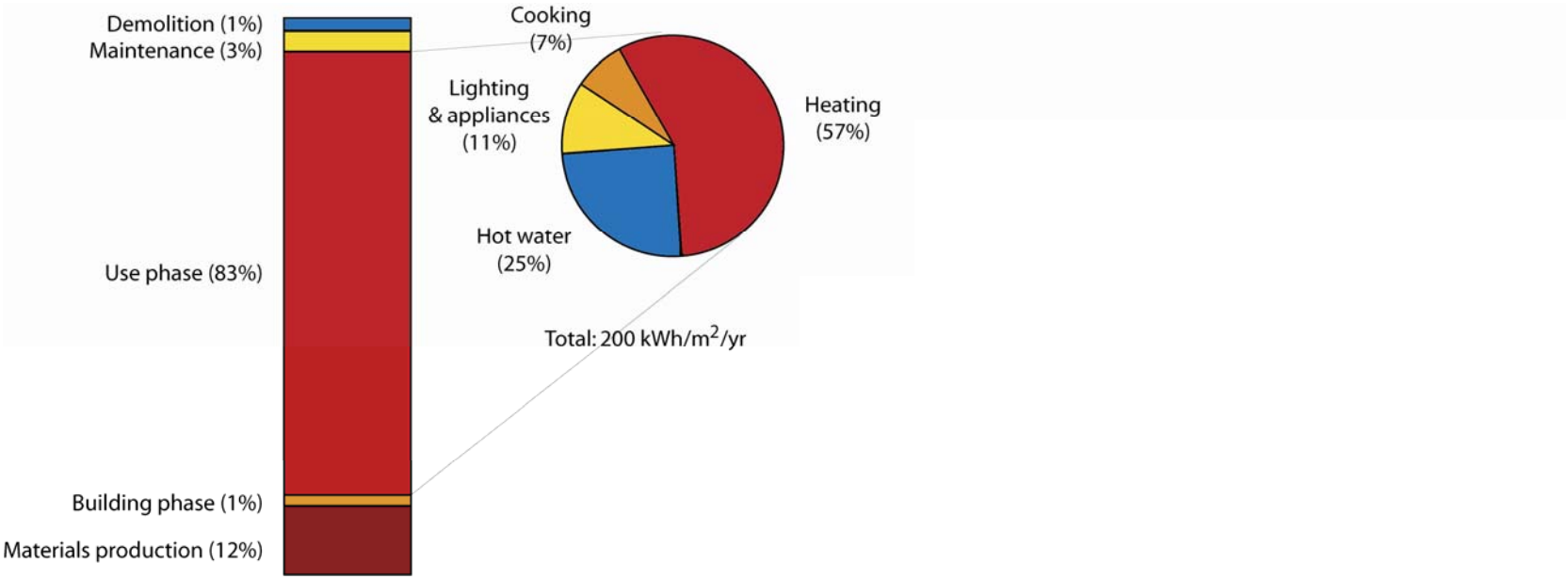
# Power and the new paradigm for sustainable energy use

# Why looking at energy in construction sector ?



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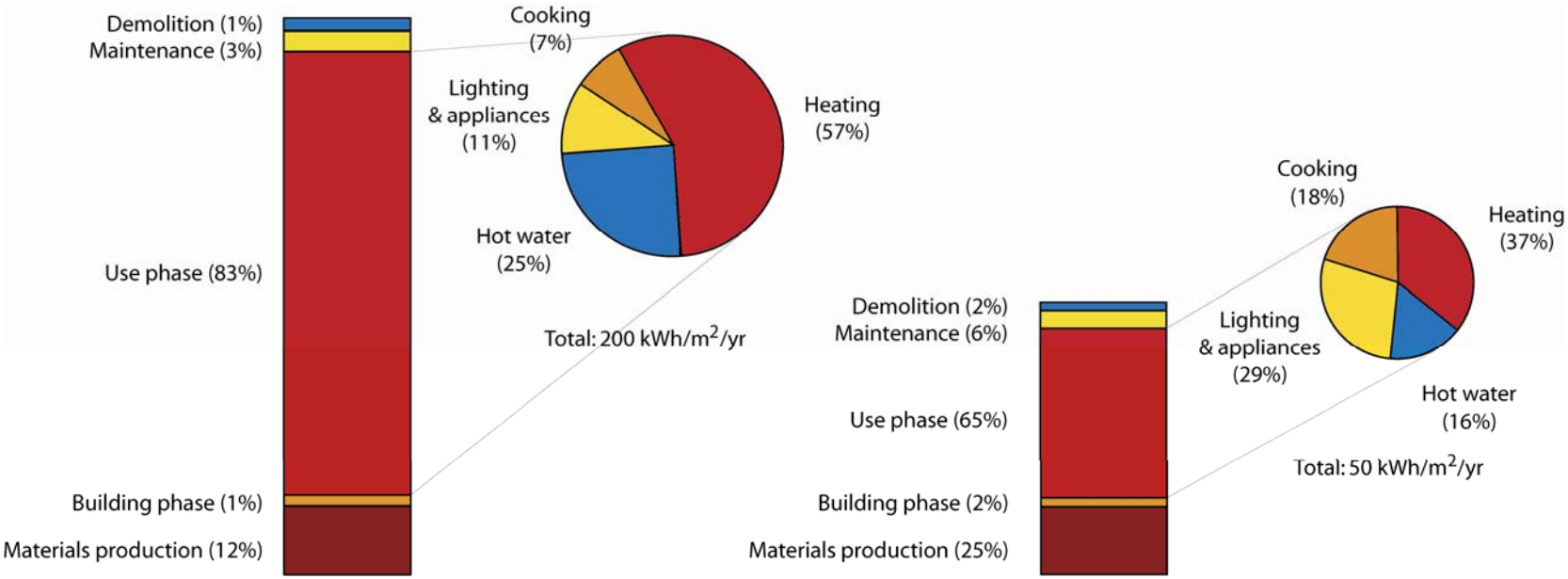


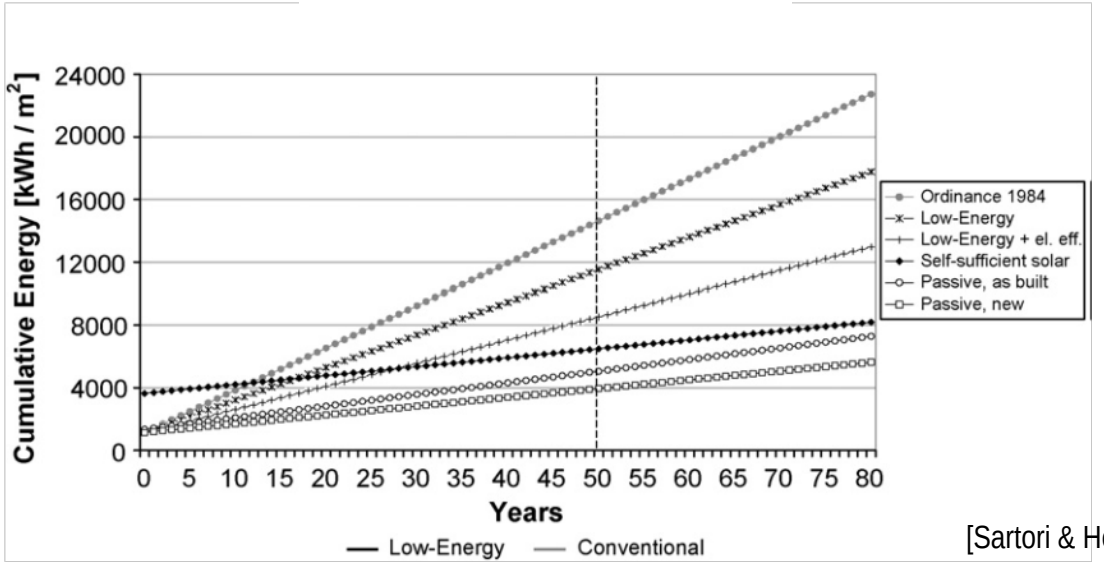


Building phase is negligible compared to operating phase

[Sartori & Hestnes, *Energy & Buildings*, 2007]

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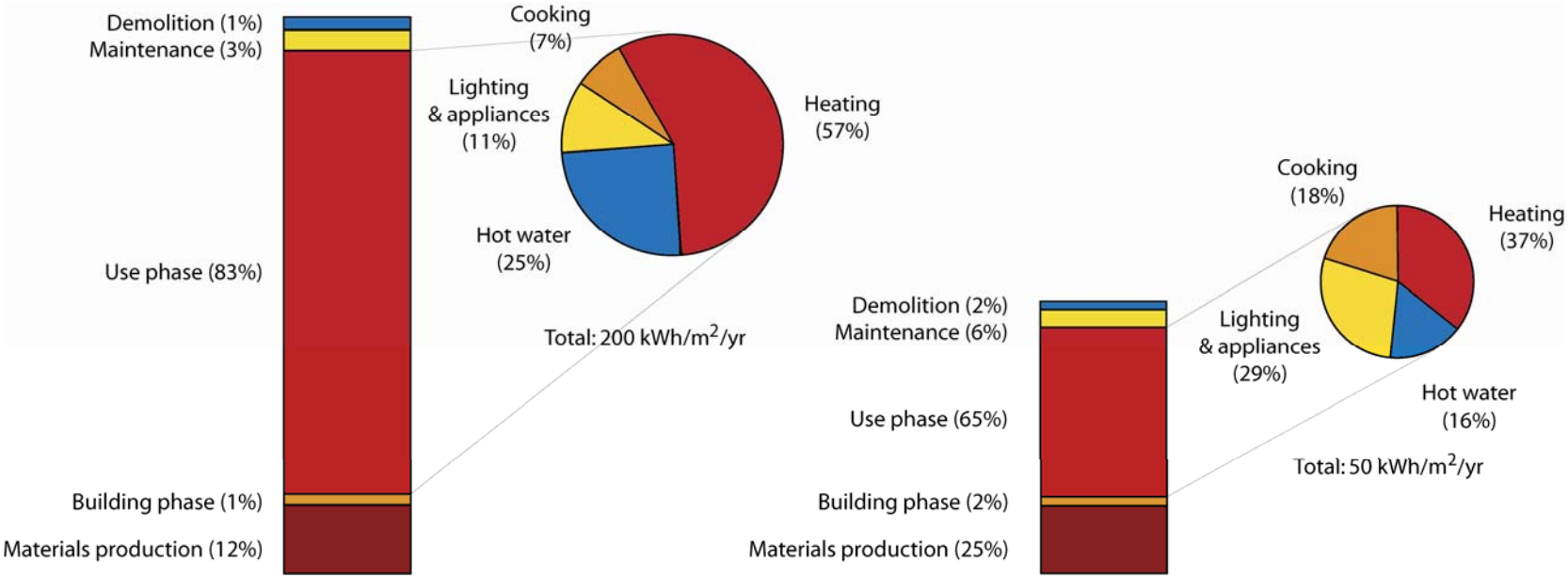


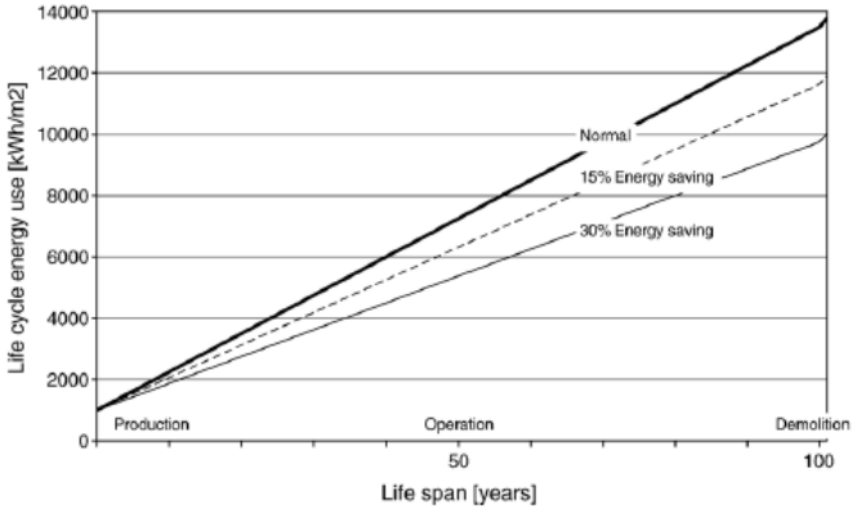


Using concrete during the building phase saves energy during the operating phase because of its thermal properties

[Damtoft et al., *Cement and Concrete Research*, 2008]

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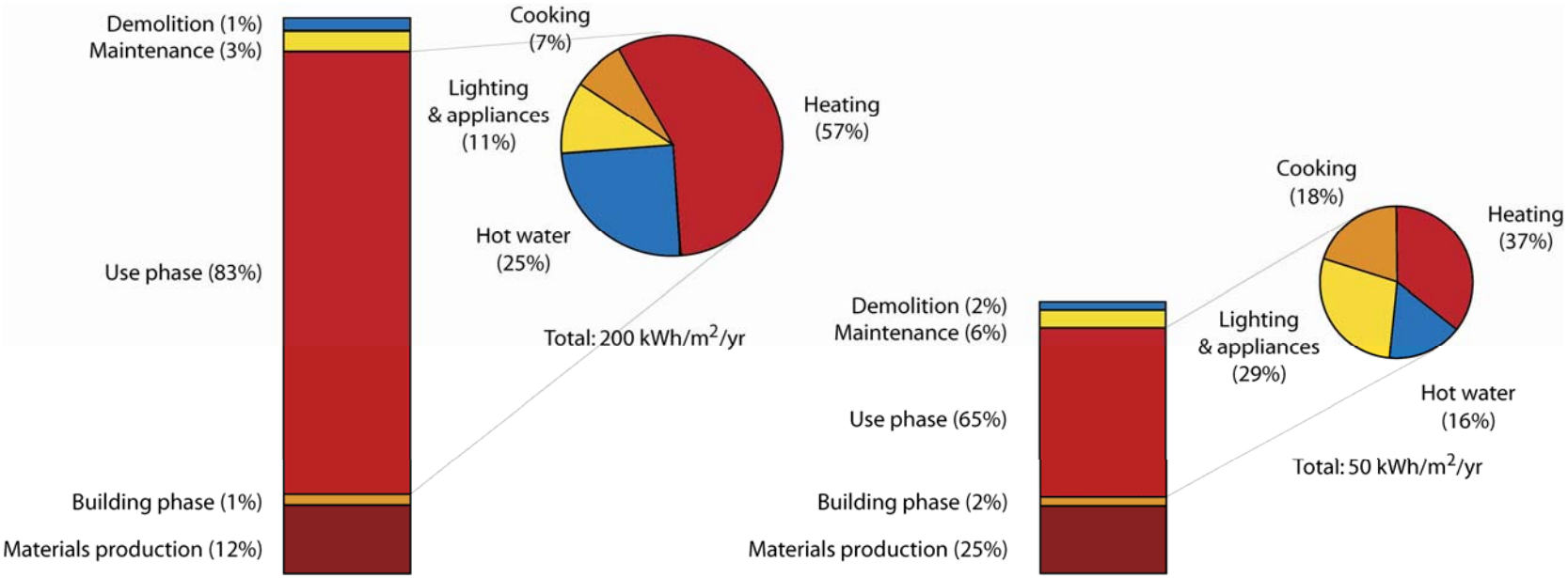


Is it the same energy that is used
for materials production
and during the use phase ?

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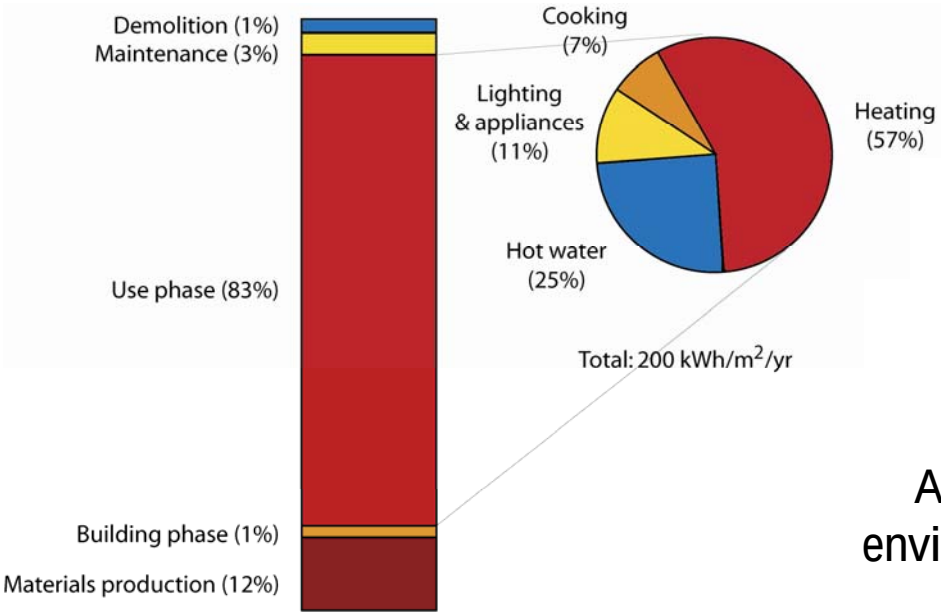
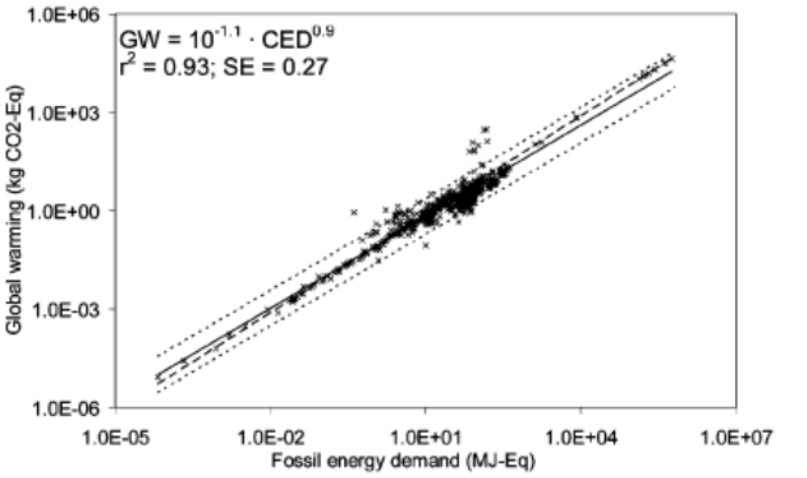
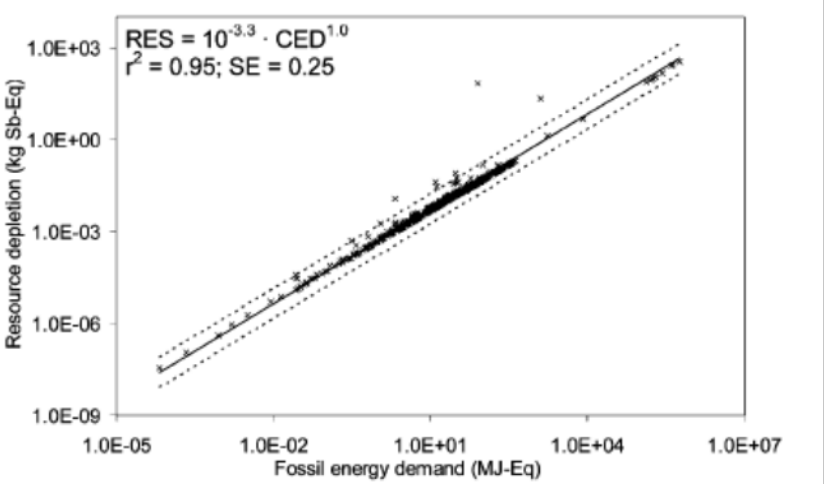



A distinction can be made between renewable and non renewable (fossil)

A strong correlation exist between major environmental impact categories (GWP, Ab) and fossil energy demand




[Huijbregts et al., *Environment & Science Technology*, 2006]

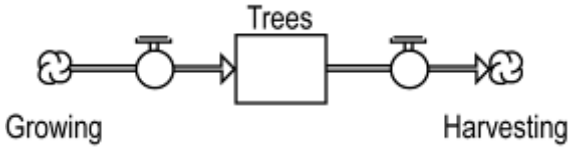
Herman Daly, 1990

# A sustainable use of resources

## Renewable resources

Soil, water, wood or industrial by-products

Consumption is as fast as production



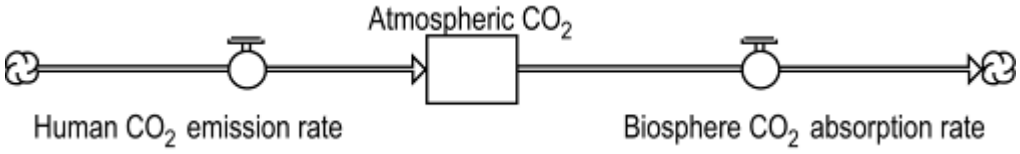

## Non renewable resources

Oil, minerals, water from fossil aquifers

Rate of use is not higher than the rate at which a new resource can be developed and used


## Pollutant

Emission rate is not higher than the ecosystem's potential rate of absorption




[Daly, 1990, Toward some operational principles of sustainable development, *ecological economics*, 2, 1-6]

# A sustainable use of resources

## Stock energies:

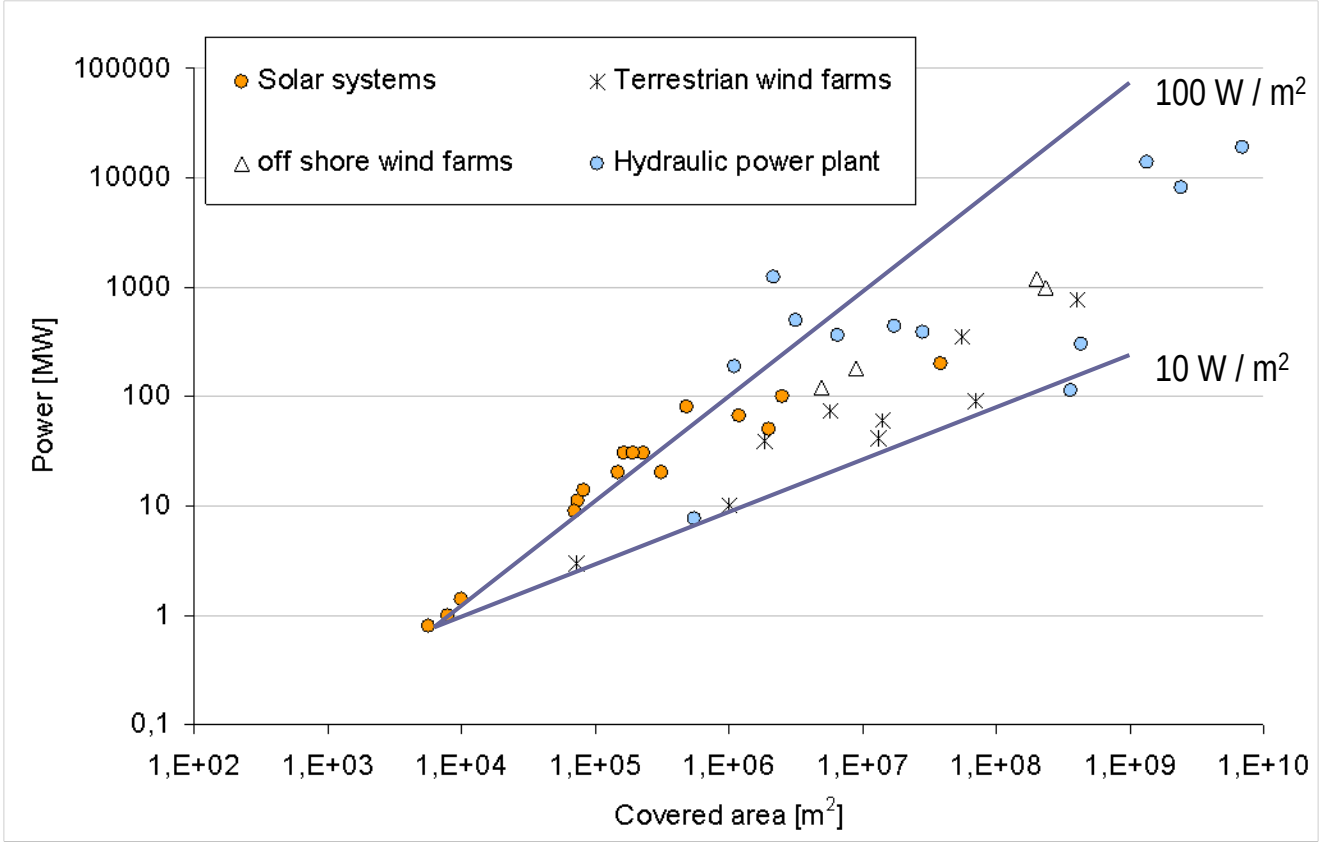
Energy= Limited by the availability of material

Power = Quantity of material

## Flow energies:

Energy = limited by the time of use and the surface

Power = Surface used to produce energy



# Power and the new paradigm for sustainable energy use

[Morel et al., *Building and Environment*, 2001]

| | Stone masonry with soil mortar | concrete |
|---|---|---|
| cement (t) | 7 | 20 |
| Aggregates (t) | 0 | 20 |
| Stone (t) | 120 | 0 |
| Timber (t) | 5.25 | |
| Steel (t) | 0.21 | 2 |
| Baked brick (t) | 0 | 10 |

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| a) | Energy (MJ/t) | Daily production (t) | Mean power (MW) |
|---|---|---|---|
| European Cement kiln | 3 600 | 4 000 | 167 |
| Blast furnace | 12 726 | 4 107 | 605 |

| b) | Unit (*) | Energy (MJ/*) | Mean Power (MW) |
|---|---|---|---|
| Loader (Caterpilar 950 F) | h | 657.4 | $18.3\ 10^{-2}$ |
| Dragueline | h | 484.4 | $13.5\ 10^{-2}$ |
| Jaw crusher (38-156 $m^3$/h capacity) | h | 475.5 | $13.2\ 10^{-2}$ |
| Spring cone crusher (PYD1750) | h | 576.5 | $16.0\ 10^{-2}$ |
| Crawler excavator (0.6 $m^3$) | h | 260 | $7.2\ 10^{-2}$ |

# Power and the new paradigm for sustainable energy use

1) Calculate the power needed for the different processes during the life cycle

# Power and the new paradigm for sustainable energy use

[Morel et al., *Building and Environment*, 2001]

[Habert et al., *Ecological indicators*, 2012]

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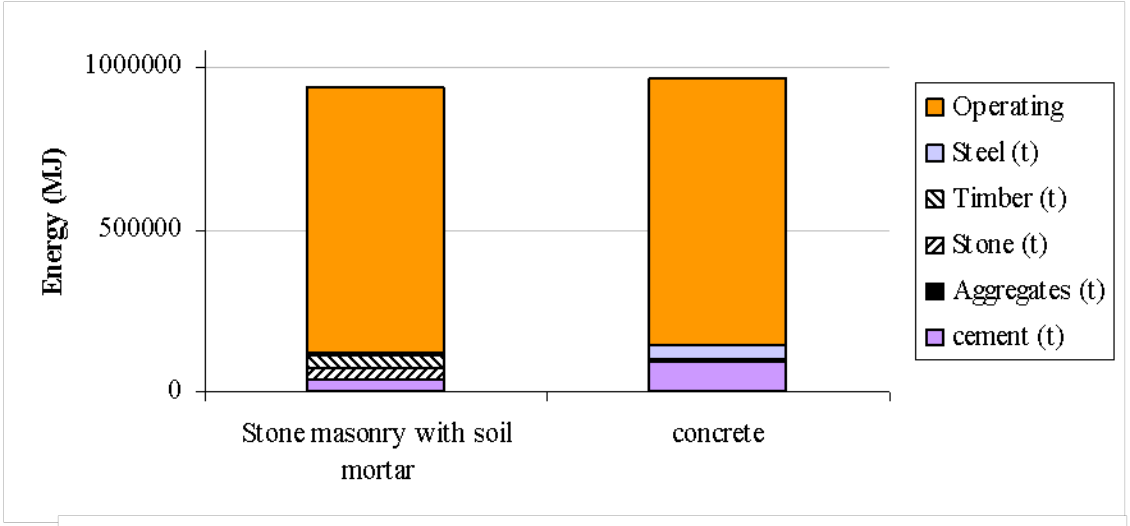
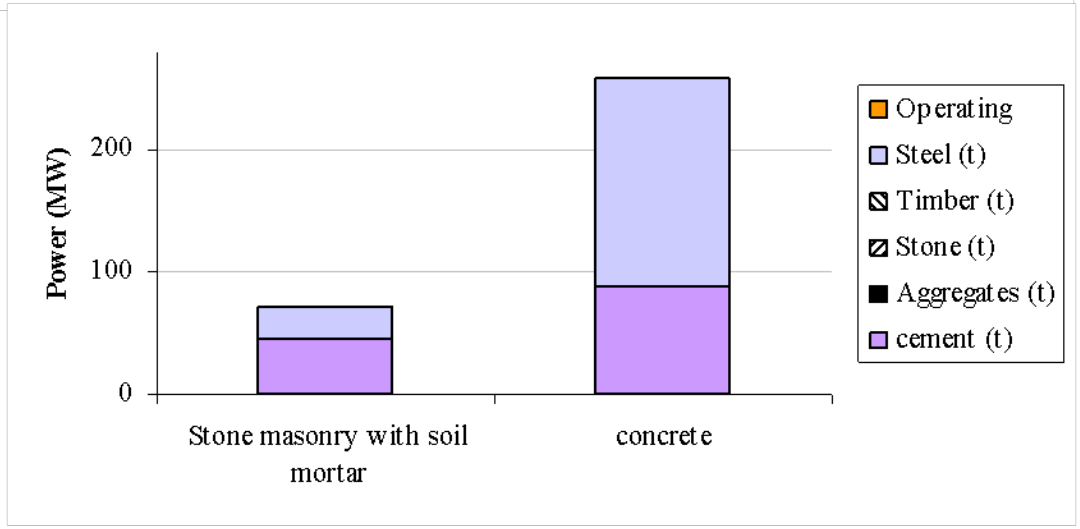
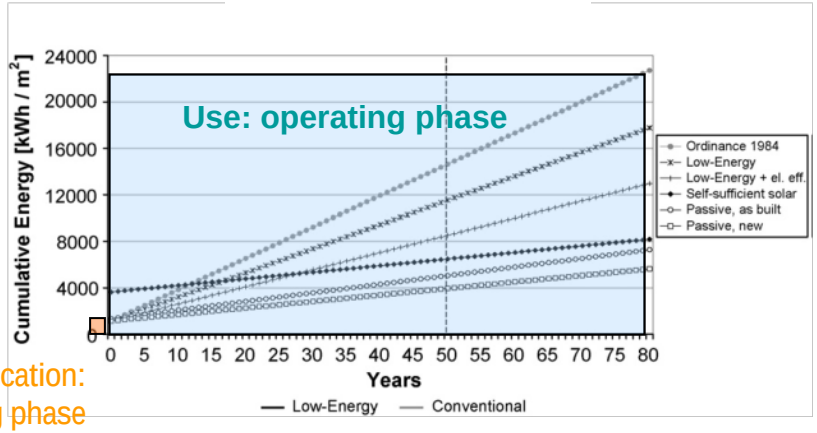


# Power and the new paradigm for sustainable energy use

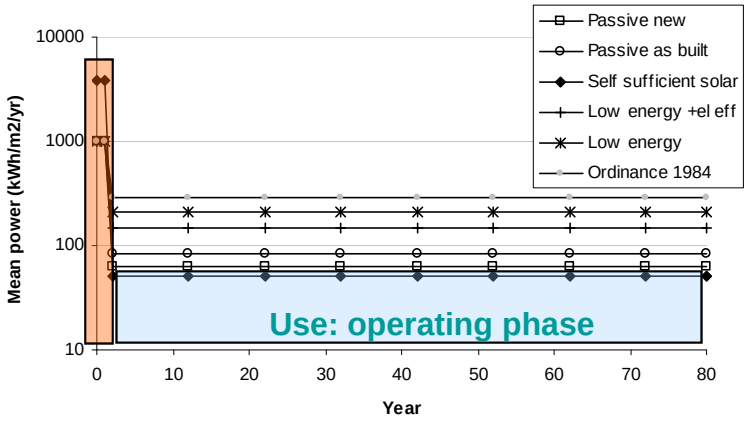
## Energy representation




fabrication: building phase

$$\frac{Building_{phase}}{Operating_{phase}} \approx 0.6$$

## Power representation

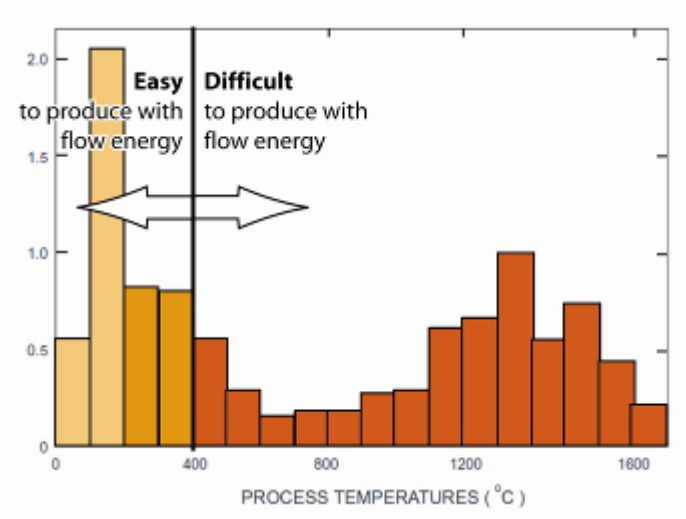



$$\frac{Building_{phase}}{Operating_{phase}} \approx 56$$

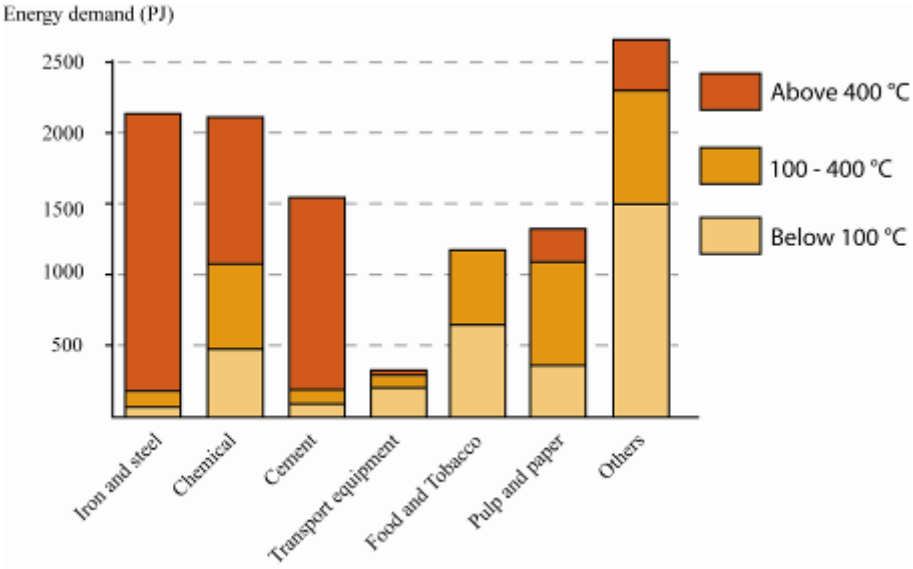
Power calculation shows that building phase more dependent to high power energy sources than operating phase

# Power constraints in construction sector

- Heat distribution among European industries




[Hammond, *Applied energy*, 2007]




[Werner et al., Ecoheatcool, 2006]

**Cement and iron industries are among the few industries that are difficult to supply with flow energies**

# Power constraints in construction sector

- Use of buildings:

  Energy consumption: 56 Mtep / yr

  Number of housings: 32 $10^6$

  Continuous power demand of 2300 W / housing


Thank you for your attention