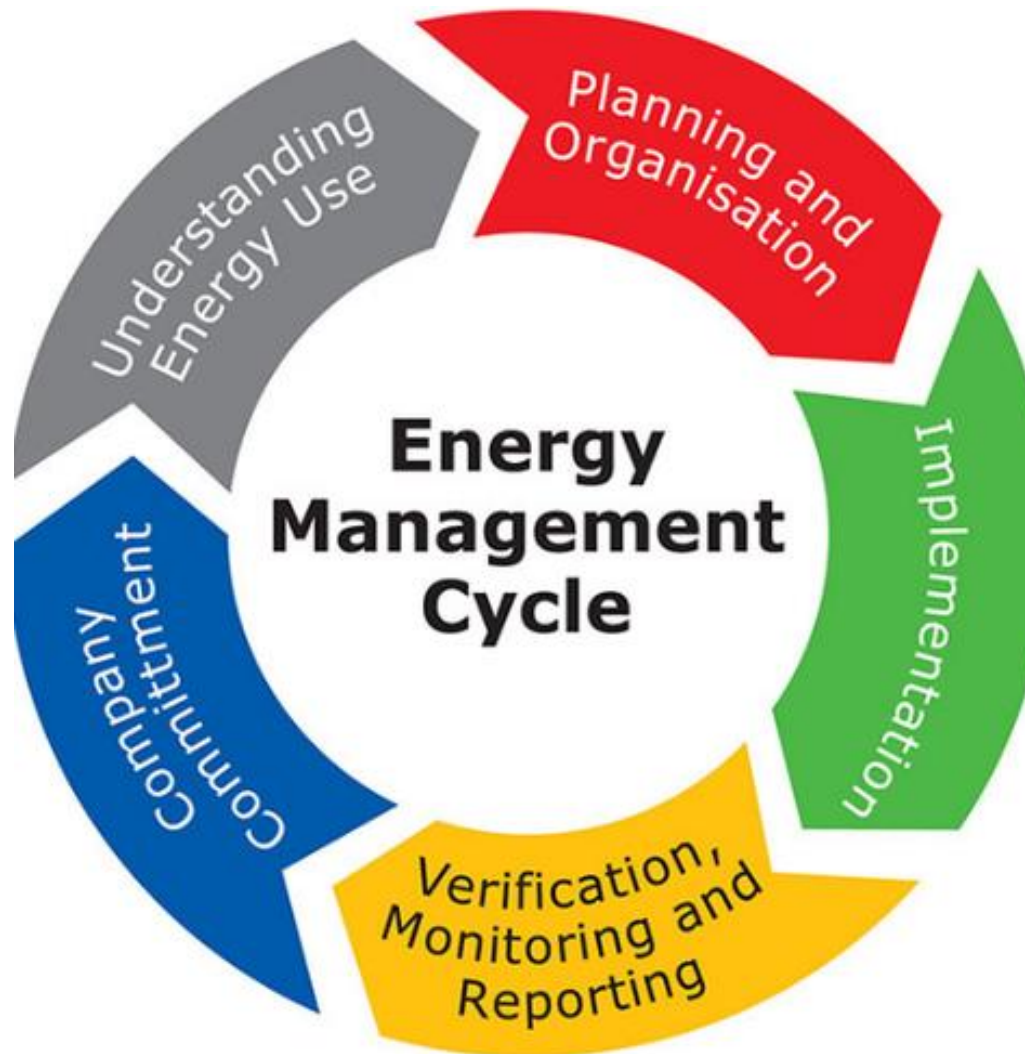


Energy Management

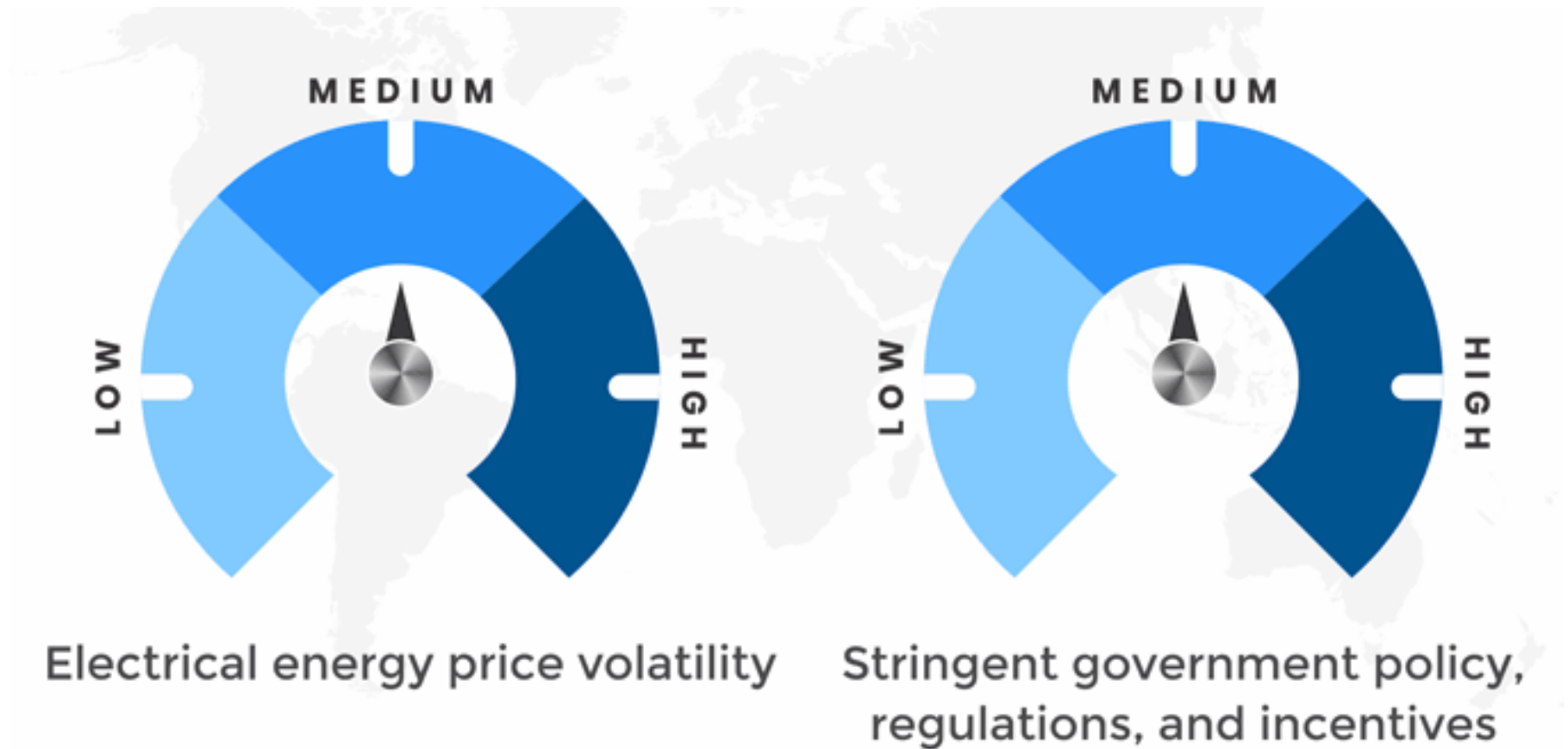
Energy management is defined as:

The strategy of adjusting and optimising energy, by modifying the systems and procedures in order to reduce the overall energy requirement per unit output, whilst maintaining or reducing total costs of producing the output from these systems and procedures.

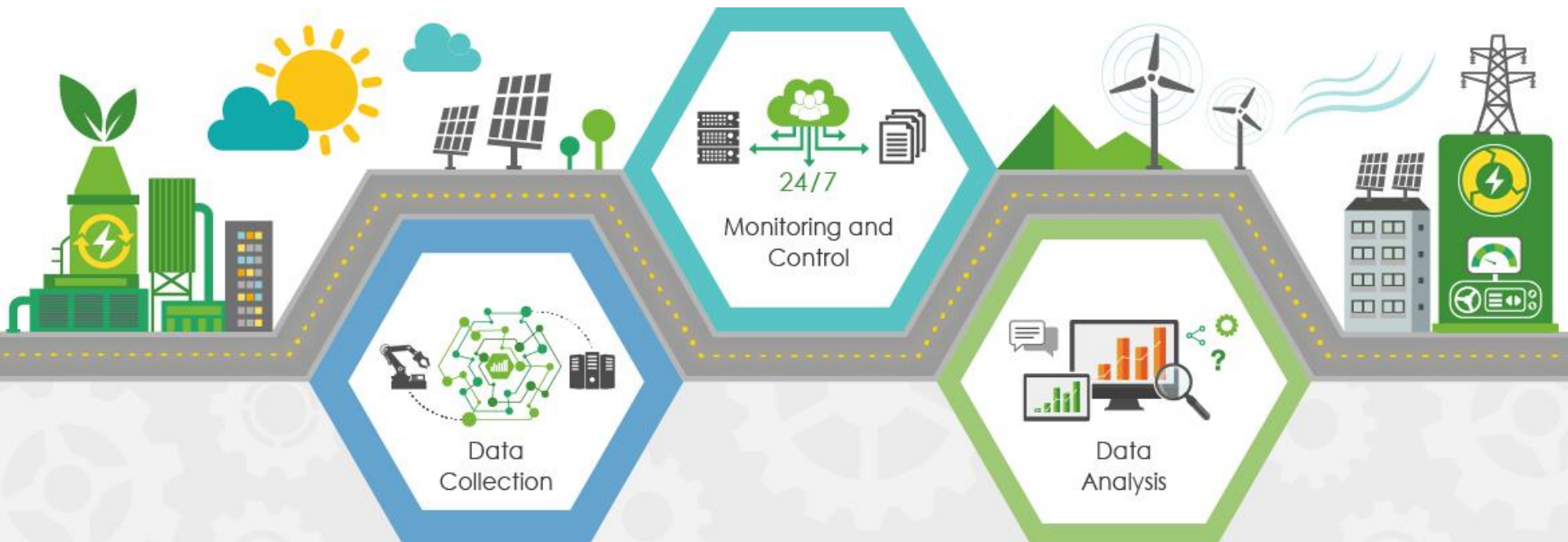
The Energy Management Cycle



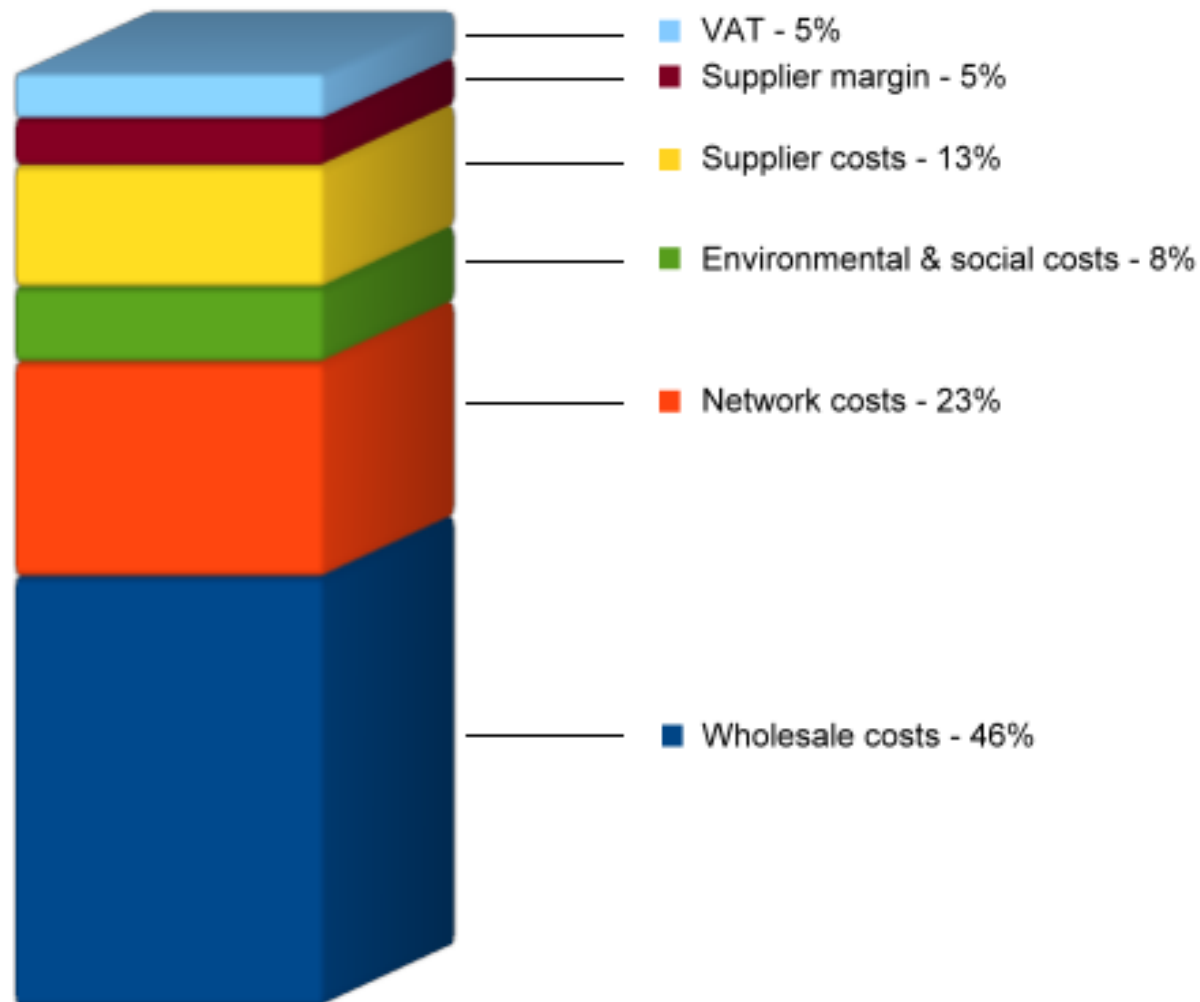
Energy Management System Drivers



Energy Management Solutions



Fuel Bill Component Costs



Electrical Load Factor Definition

The **Load factor** is defined as the ratio of the **average load** over a given period to the **maximum demand (peak load)** occurring in that period.

In other words, the load factor is the ratio of energy consumed in a given period of the times of hours to the peak load which has occurred during that particular period.

Load Factor Calculation

For Example:

Let total kWh = 36,0000 kWh

Demand = 100kW

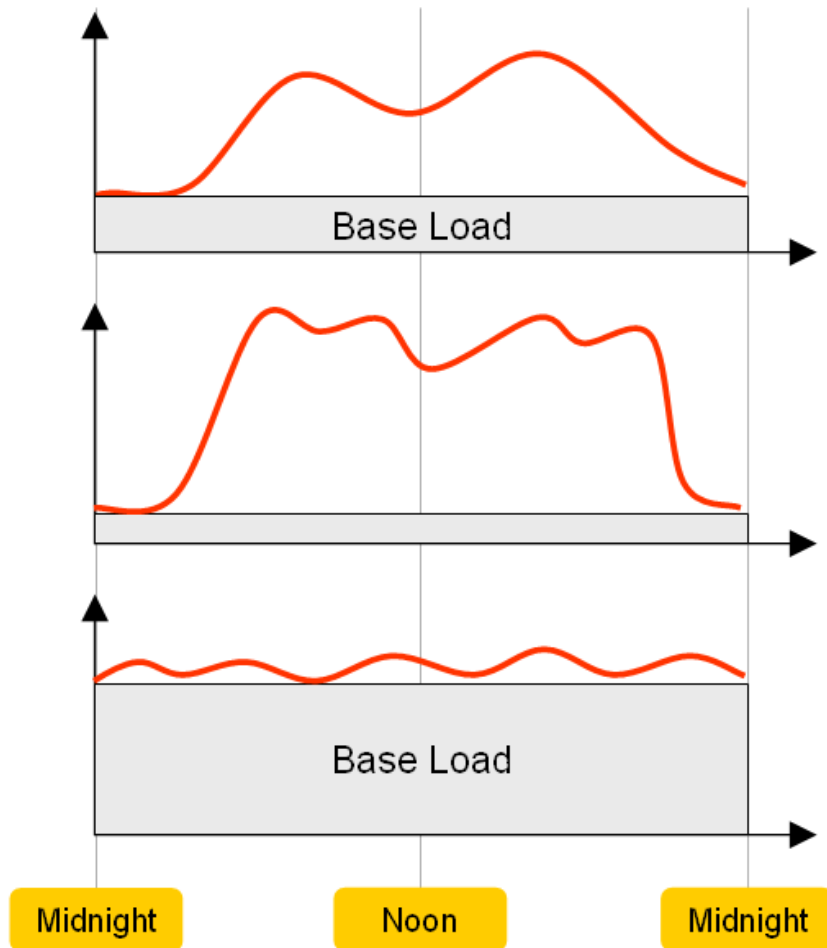
The number of days = 30 days

Hours per day = 24 hours

$$\begin{aligned}\text{Monthly load factor} &= 36,000 / (100 \times 30 \times 24) \\ &= 50\%\end{aligned}$$

Load Factors

Example Daily Electrical Load Profiles

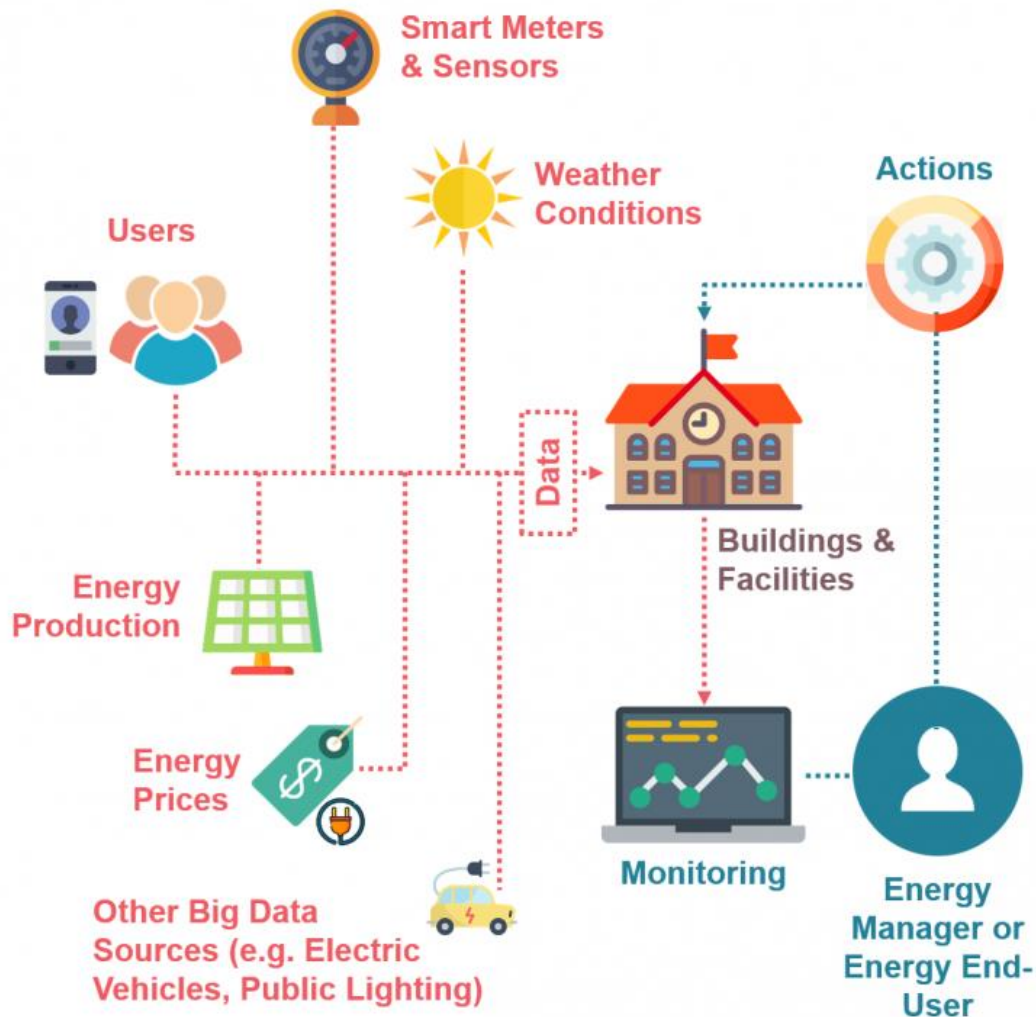


Typical home. Load factor varies –
~ 30% - 60%

Typical commercial building: Load factor
varies - ~ 20% - 80%

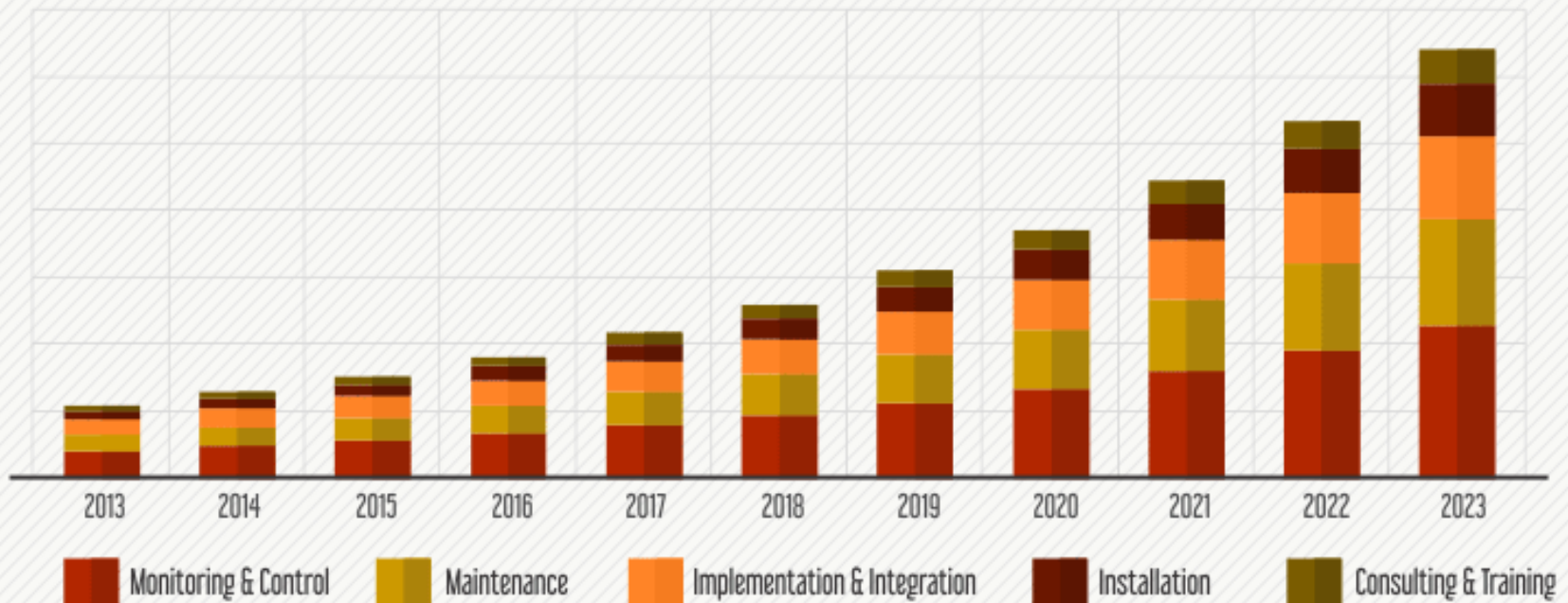
Example industrial load. Load factors are
sometimes 90%+.

Energy Management Systems

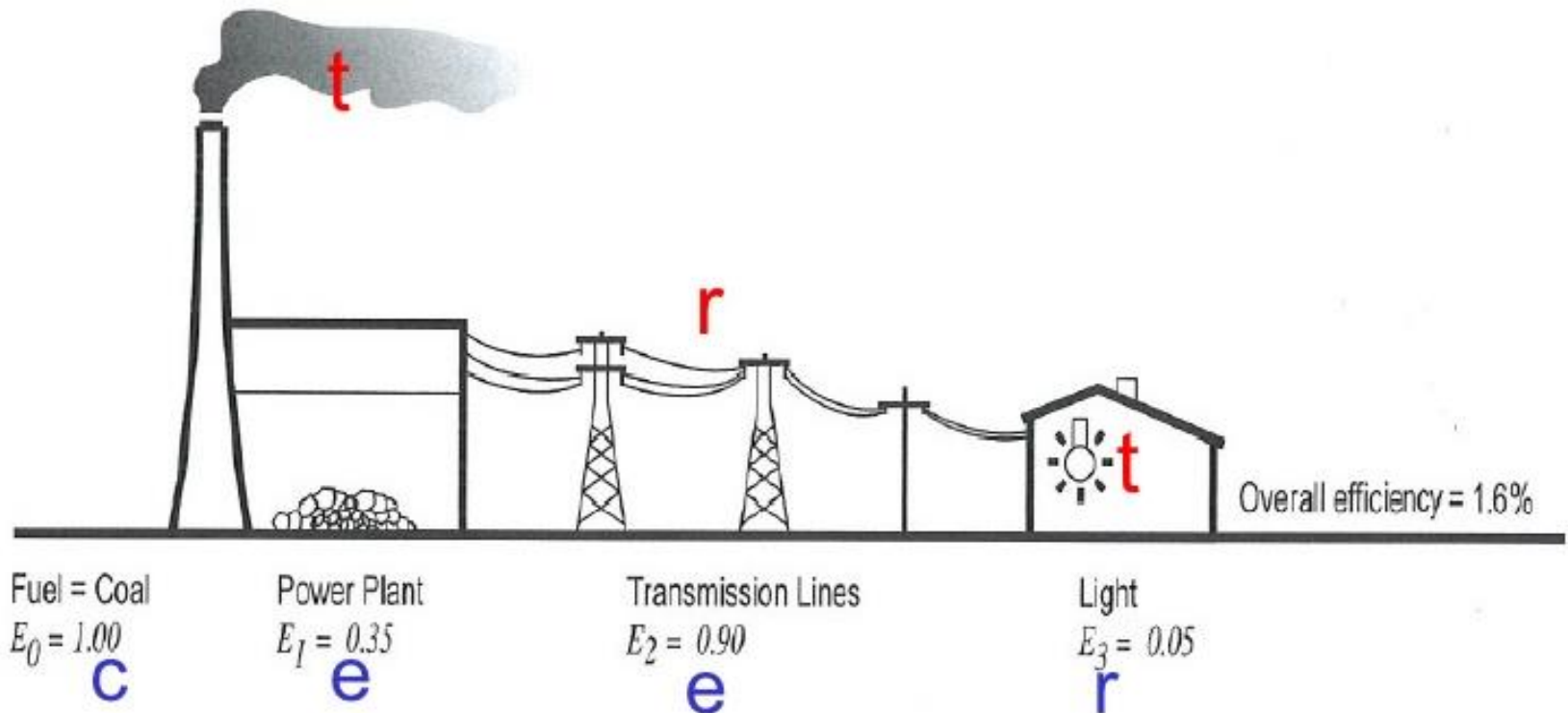


Global EMS Market Growth

Global Energy Management Service Market, By Type, \$m (2013 – 2023)



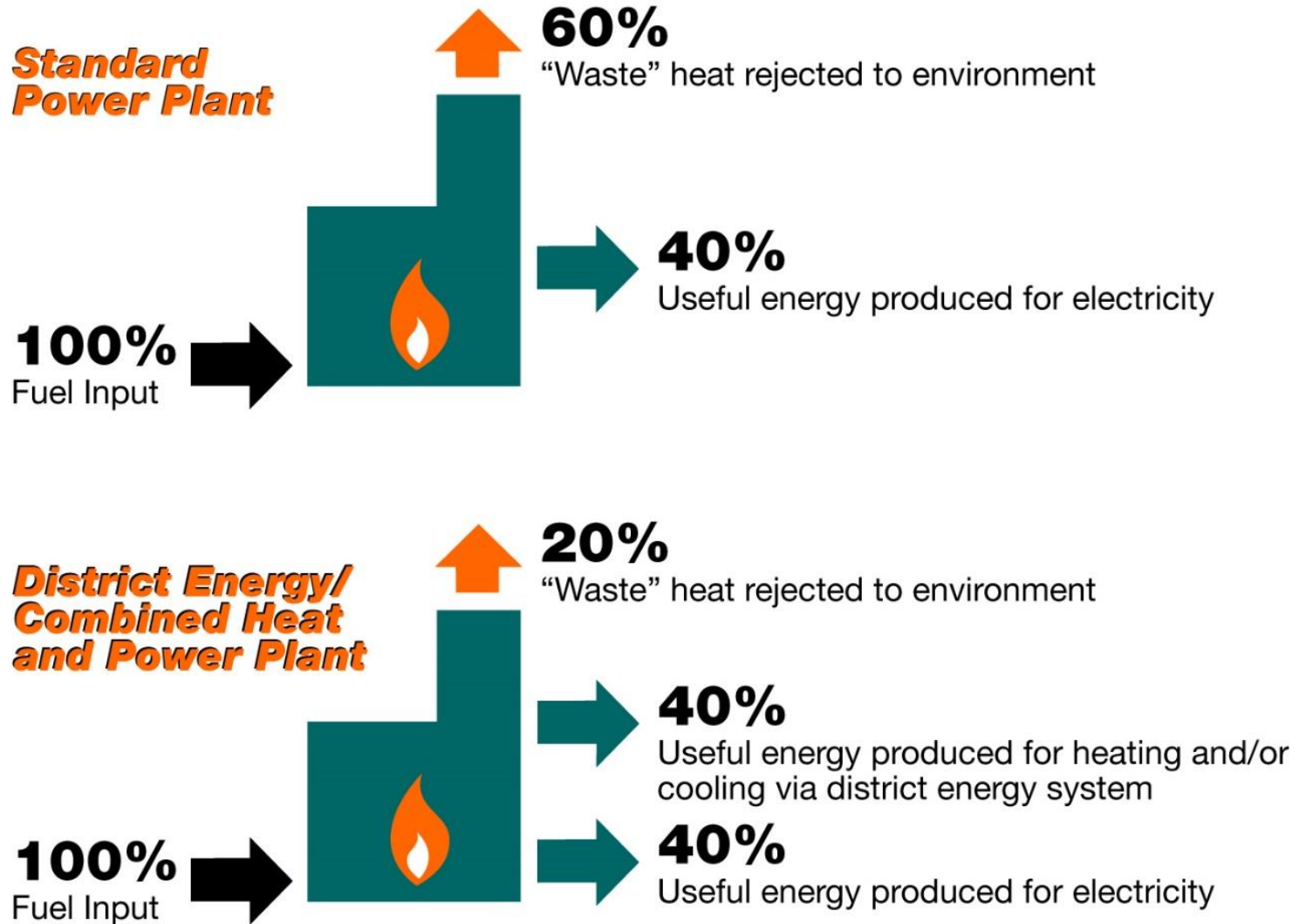
Light Bulb Conversion Efficiencies



$$E_{\text{total}} = E_1 \times E_2 \times E_3 = 35\% \times 90\% \times 5\% = 1.6\%$$

Source: Tester et al 2005

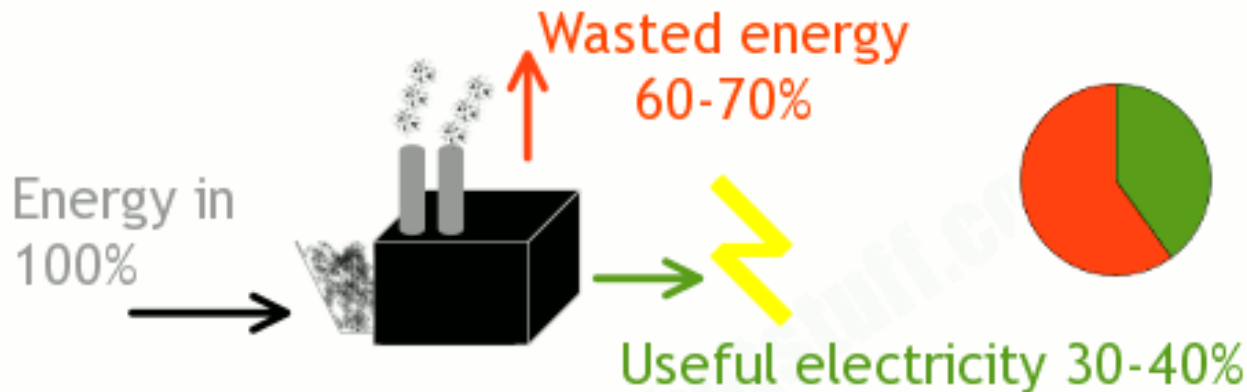
Energy Efficiency Comparisons



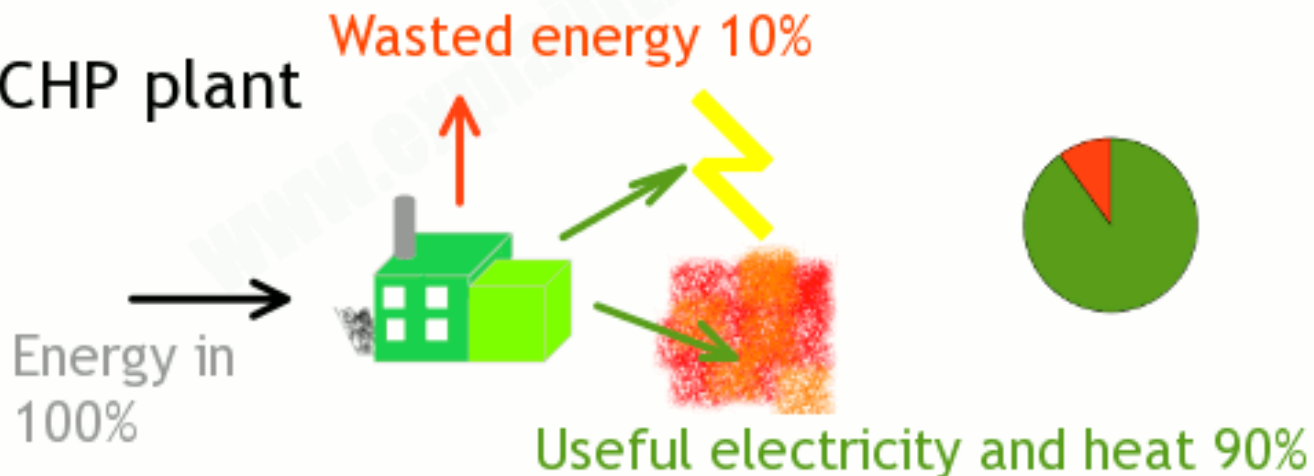
Combined Heat and Power

Conventional power plant

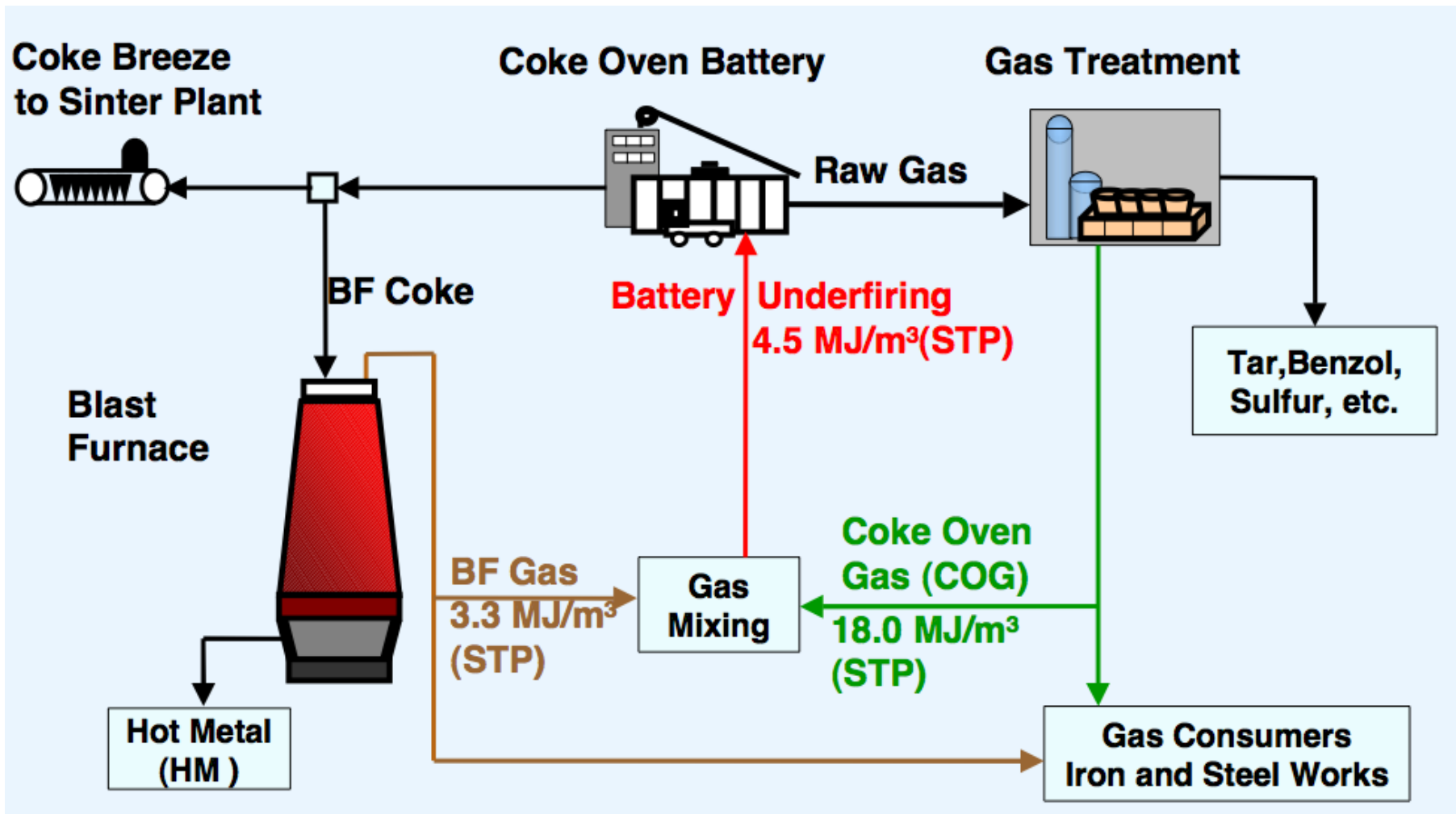
www.explainthatstuff.com



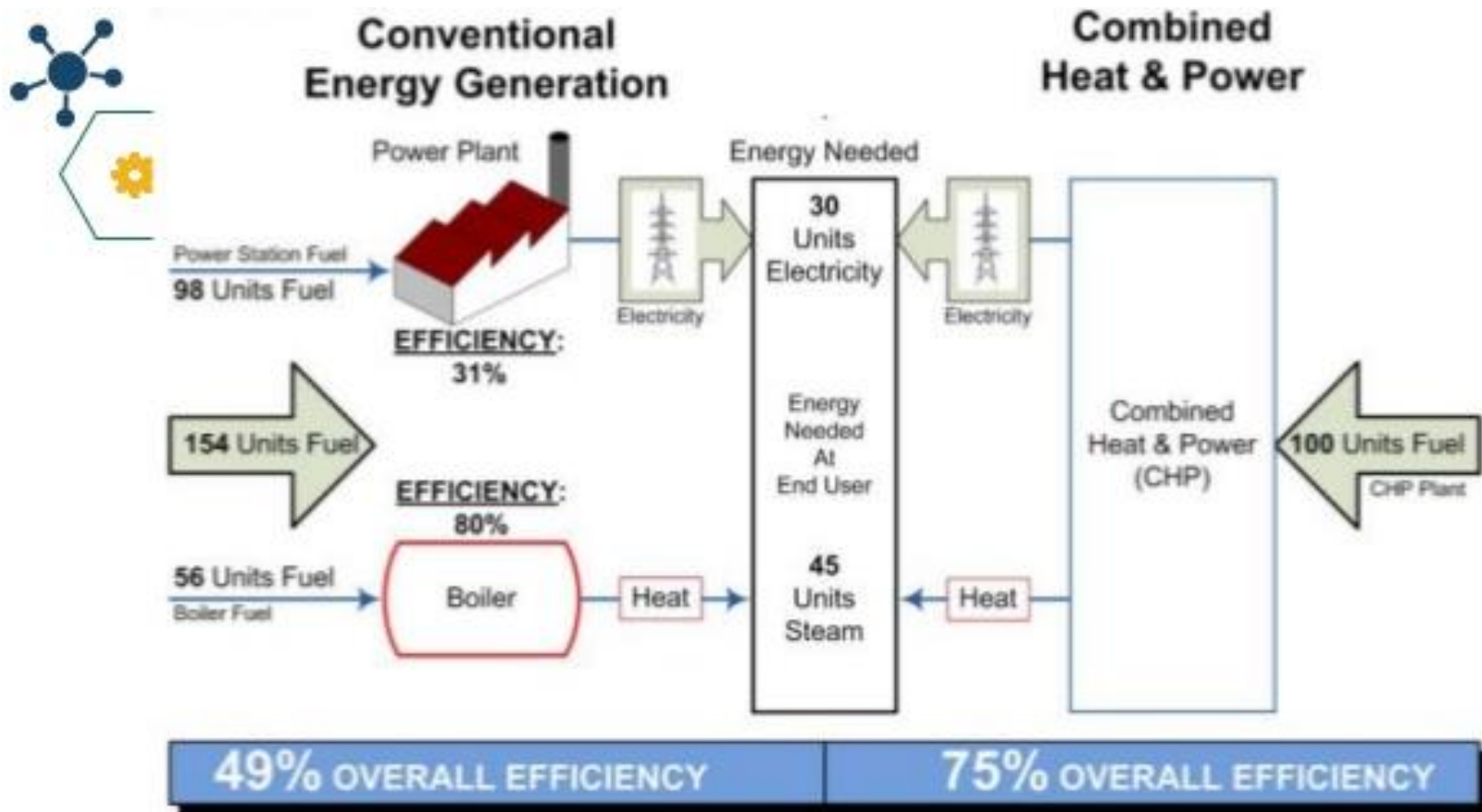
CHP plant



Typical utilisation of coke oven gas



Benefits of CHP



Disadvantages of CHP

- Not Suitable for All Sites
- CHP systems are only suitable for sites where there is a need for heating and hot water systems. For larger scale systems heat and power demand need to remain fairly consistent for maximum efficiency. This particularly applies to heating which is powered continuously on larger systems.
- Financially Intensive
- The initial costs for a CHP system can be high without funding. Which can make it prohibitive for smaller scale (non-domestic) installations.
- Not Necessarily Environmentally Friendly
- Not all CHP systems run on environmentally friendly fuels.

Smart Meters and In-home displays



Smart meter

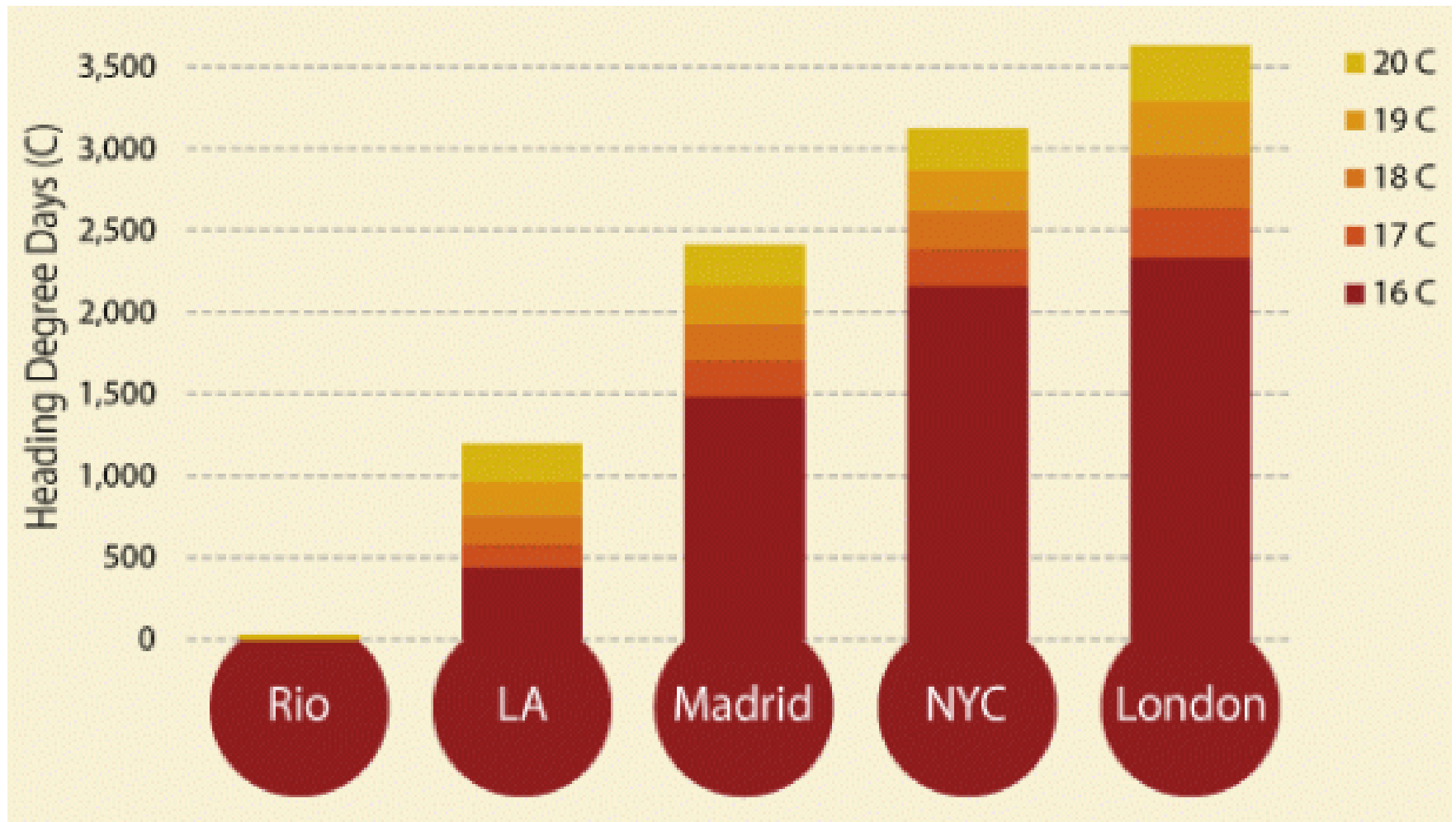


In-home display

Heating Degree Days

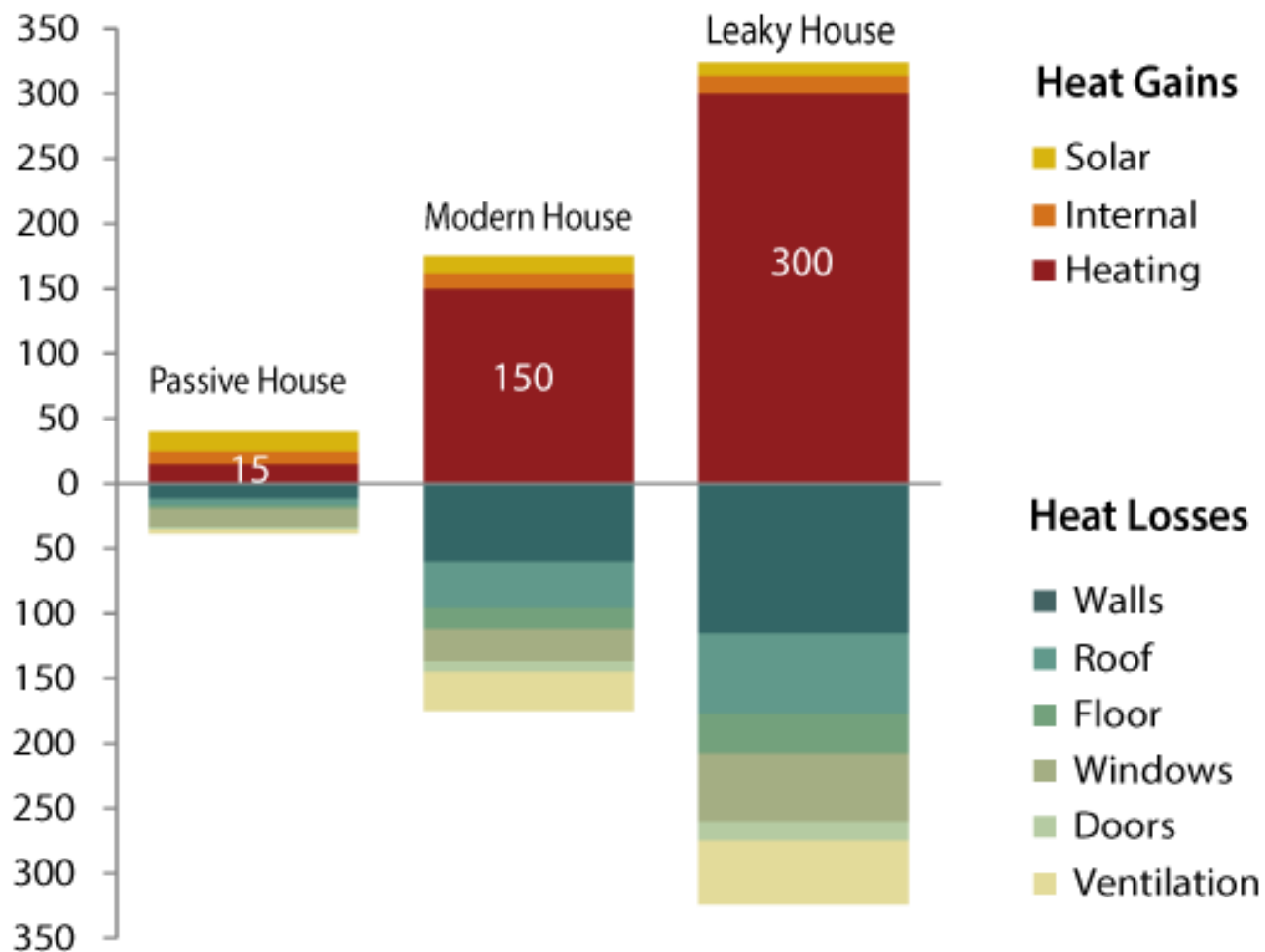
- The difference between internal and external temperature over a period of time can be measured in heating degree days (HDD).
- For example if the outside temperature was **10°C** all week and you kept your home at a constant **20°C** inside, that would be **7 days x 10 degrees** difference adding up to **70 heating degree days (HDD)**.
- The image at the top of this post shows the heating degree days over a year in five of the world's major cities. It also shows how these figures change between 5 different base temperatures, from 20°C down to 16°C.
- The first thing to notice is that Rio has virtually no heating degree days at any base temperature, because it has a warm climate. LA is still pretty good, Madrid is getting chilly in winter and New York and London are pretty cold.

Heating Degree Days Compared By Base Temperature in °C



The Value of a well Insulated Home

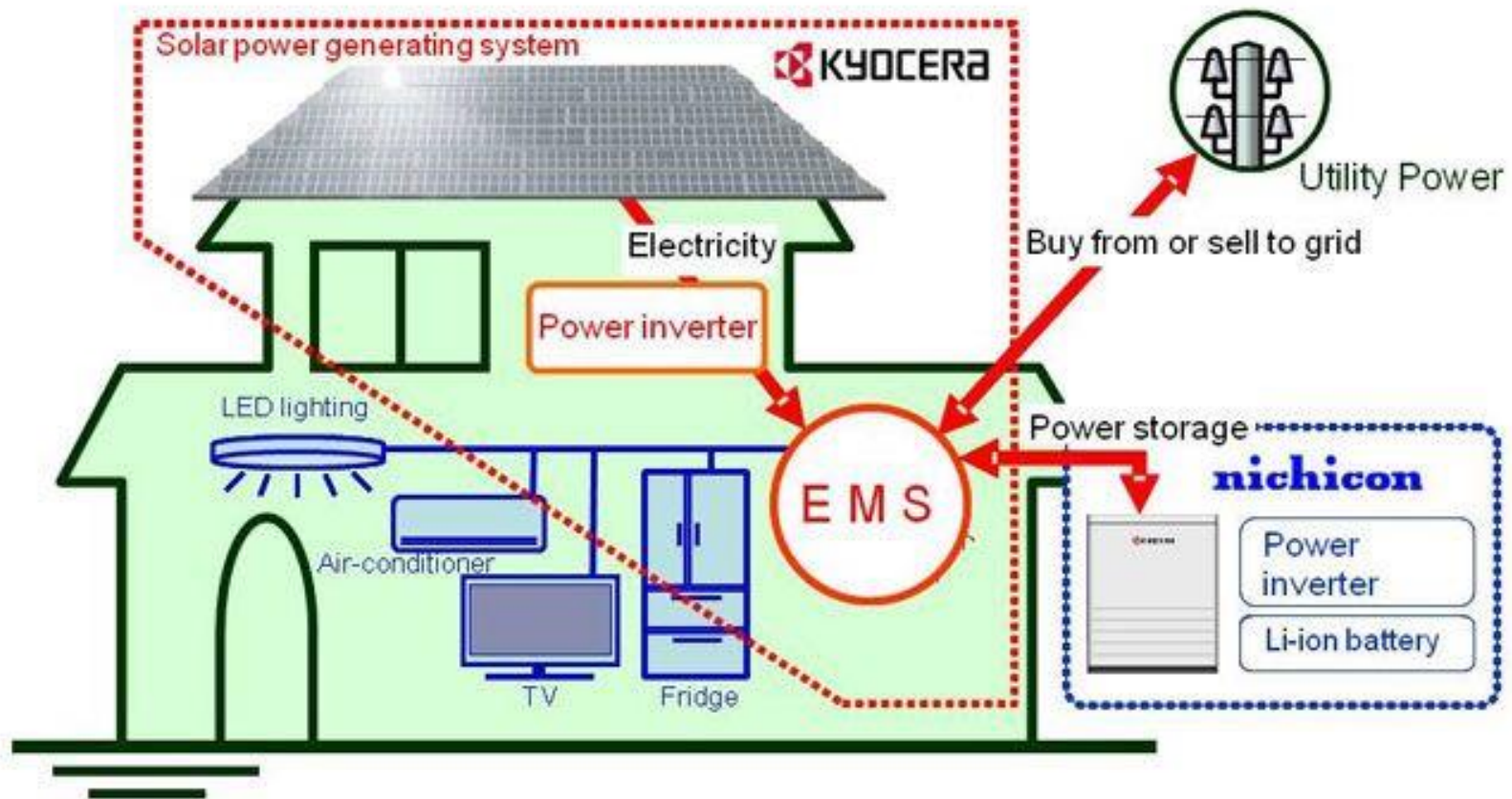
Average heating gains and losses by house type in kWh/m²a



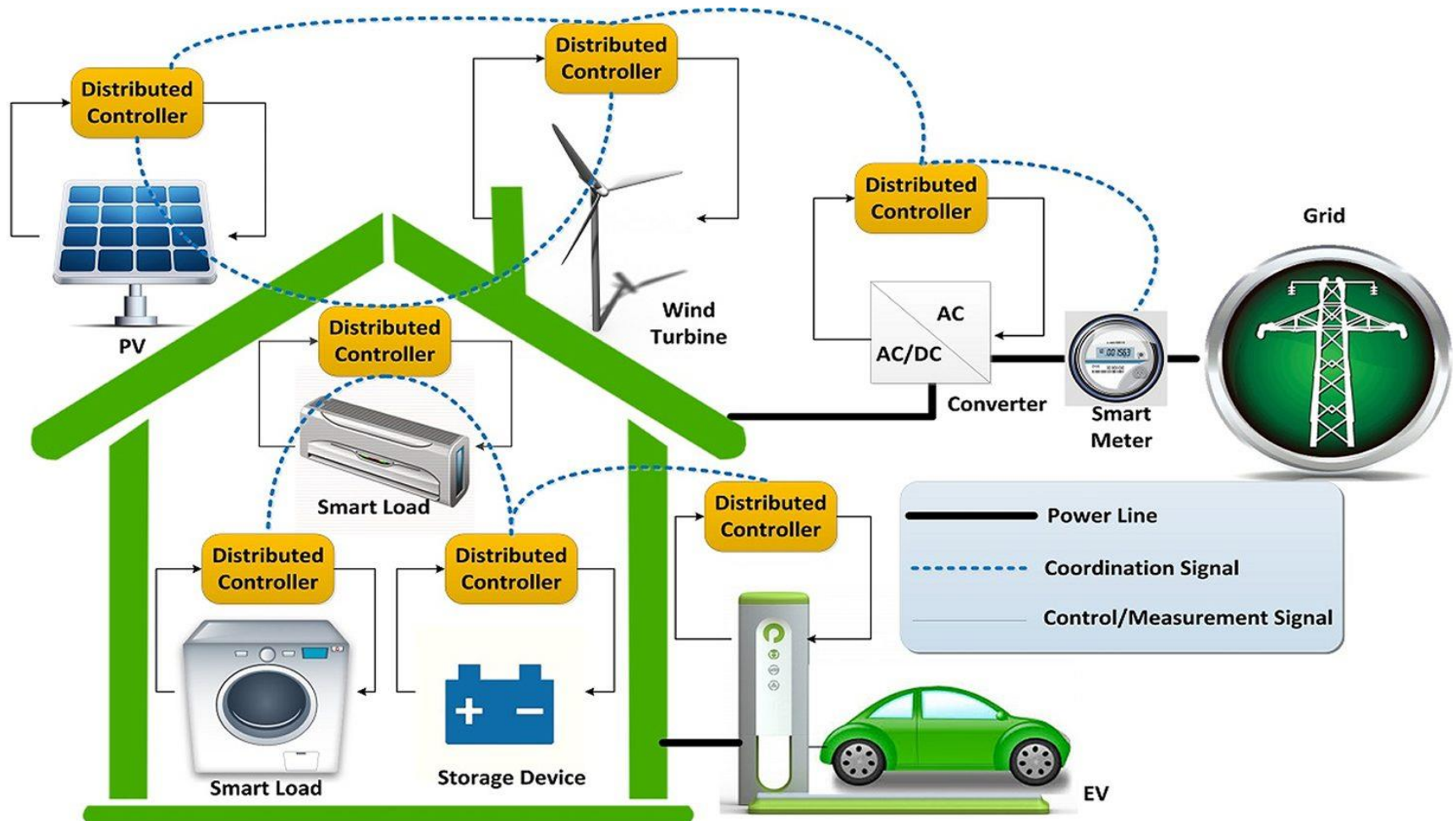
Data: typical values for Northern European climates

shrinkthatfootprint.com

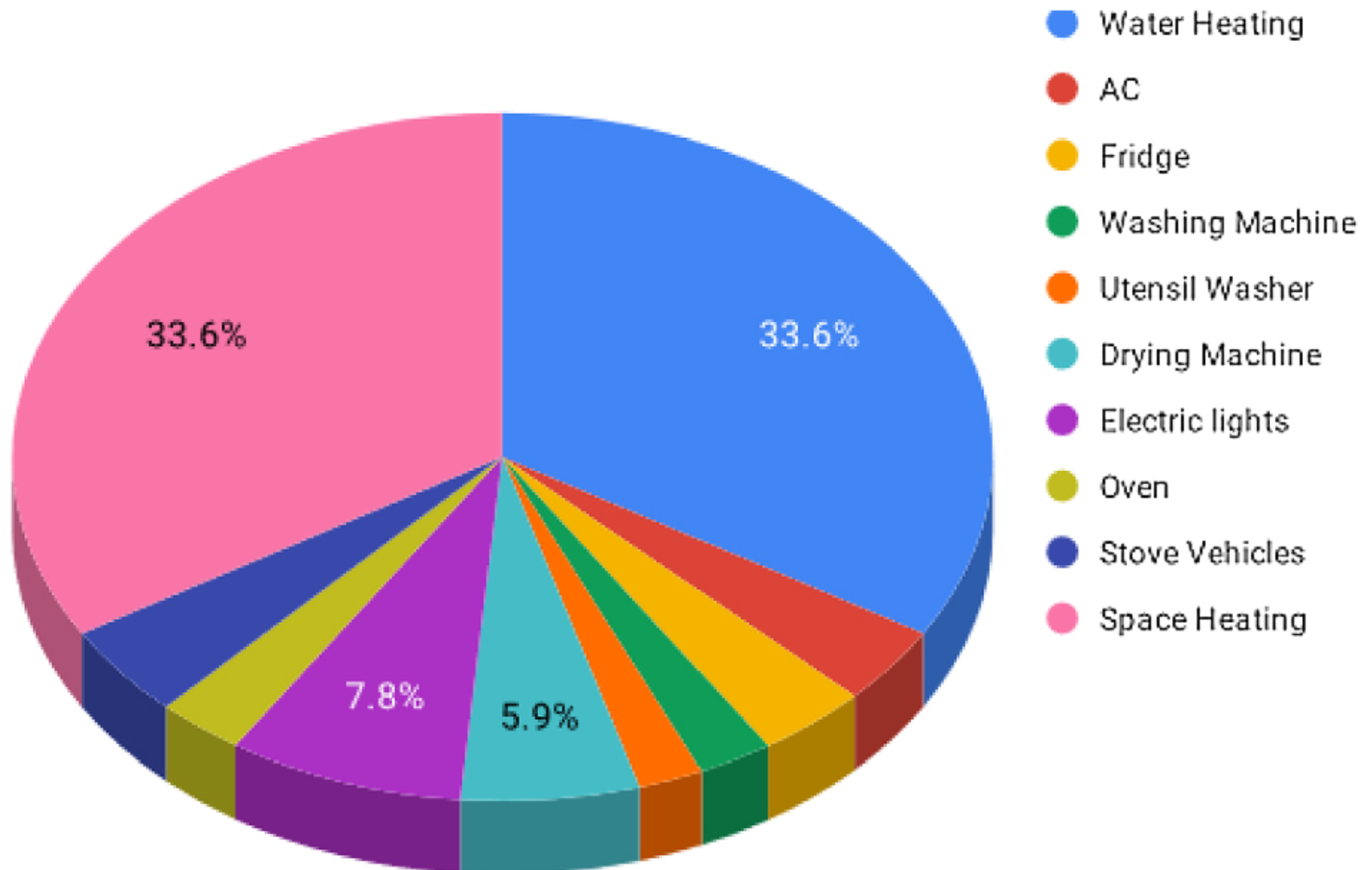
Domestic Energy Management Systems



Home Energy Management Systems (HEMS)

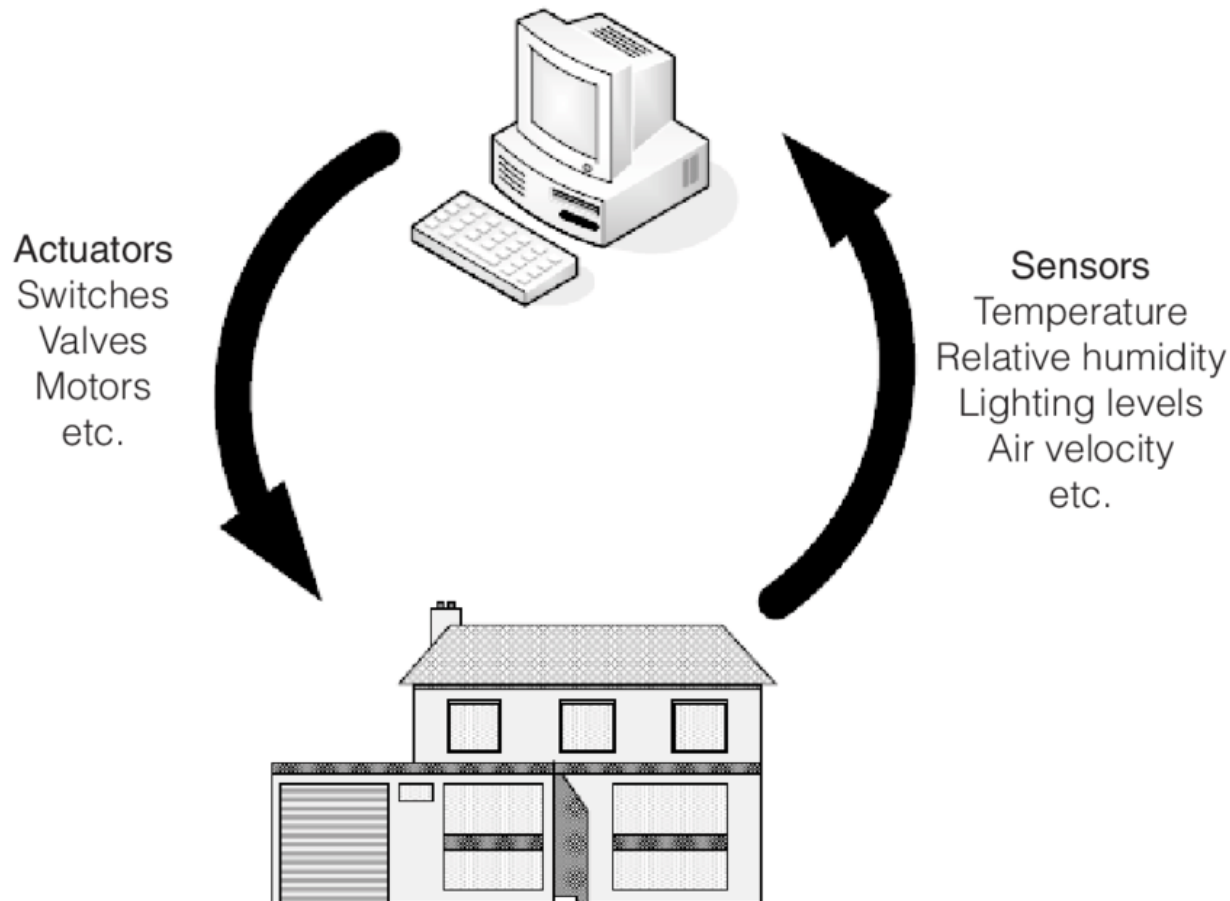


Pie Chart for HEMS

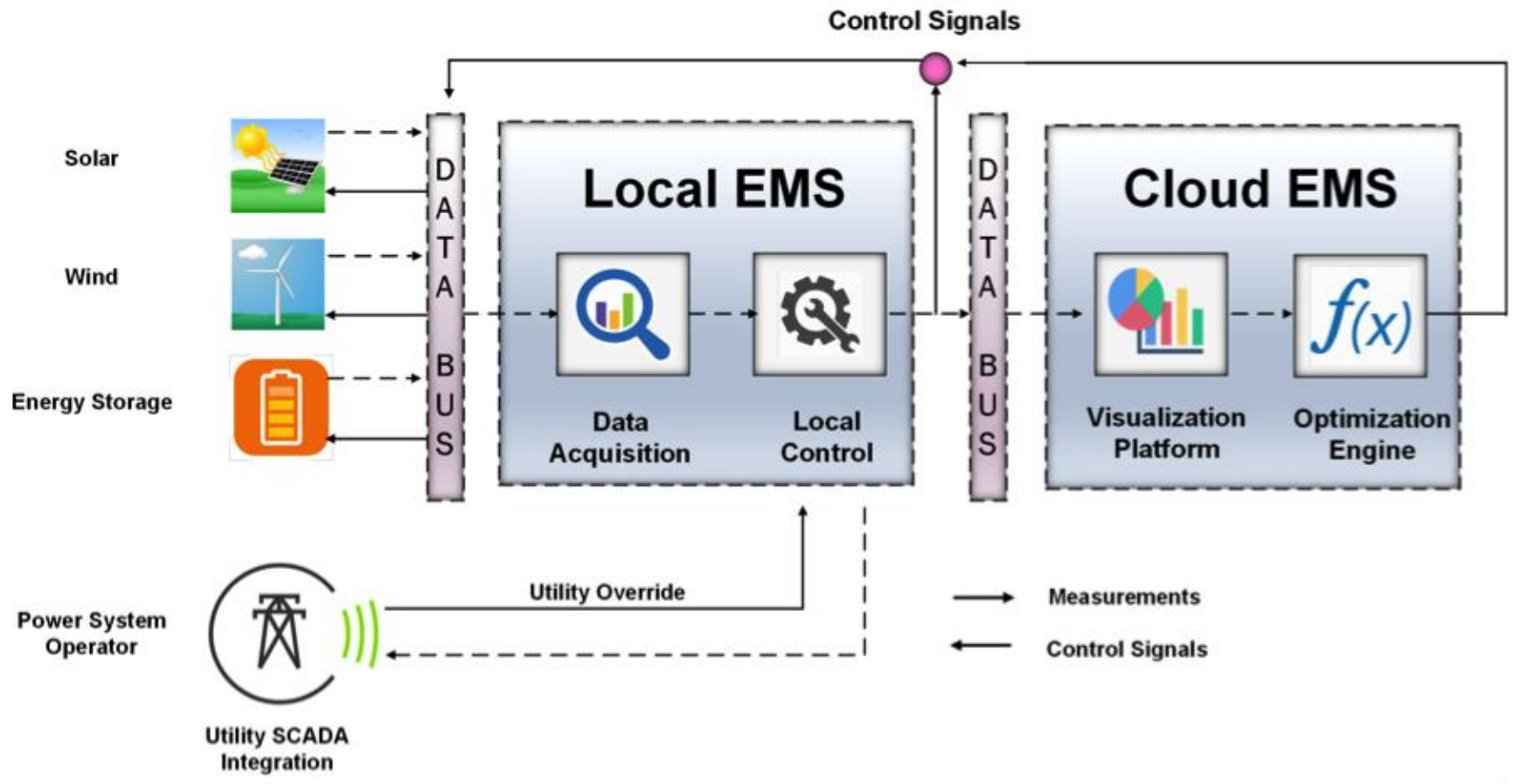


Building Energy Management Systems

Database and monitoring
Decision support
Advanced building automation and control



EMS Block Diagram



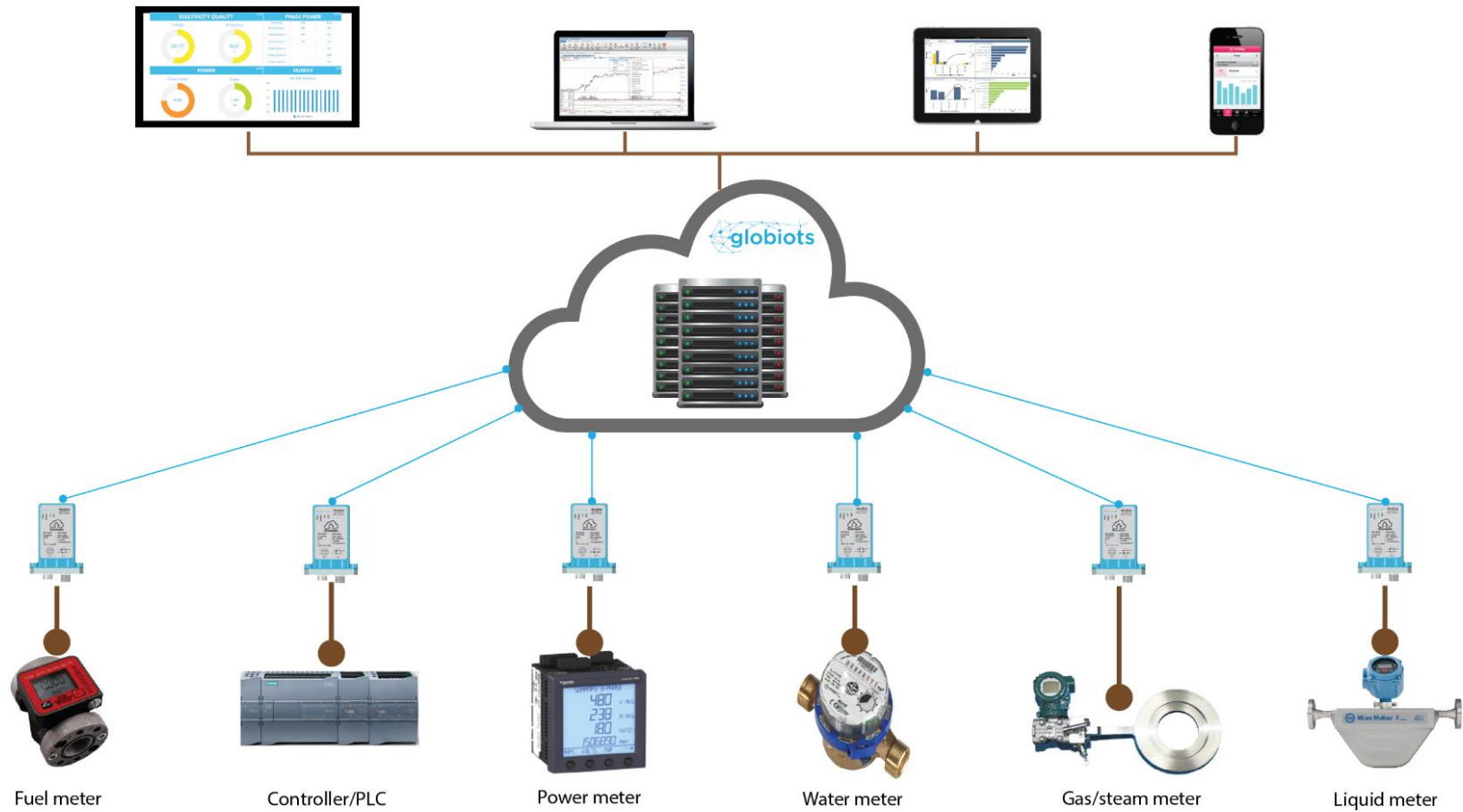
The Local Energy Management System

The **Local EMS** acquires data from all **assigned assets** and executes multi-objective real-time control strategies, which can include: the optimal dispatch of renewable energy, peak shaving/shifting, emergency power, and power quality management.

The Cloud Energy Management System

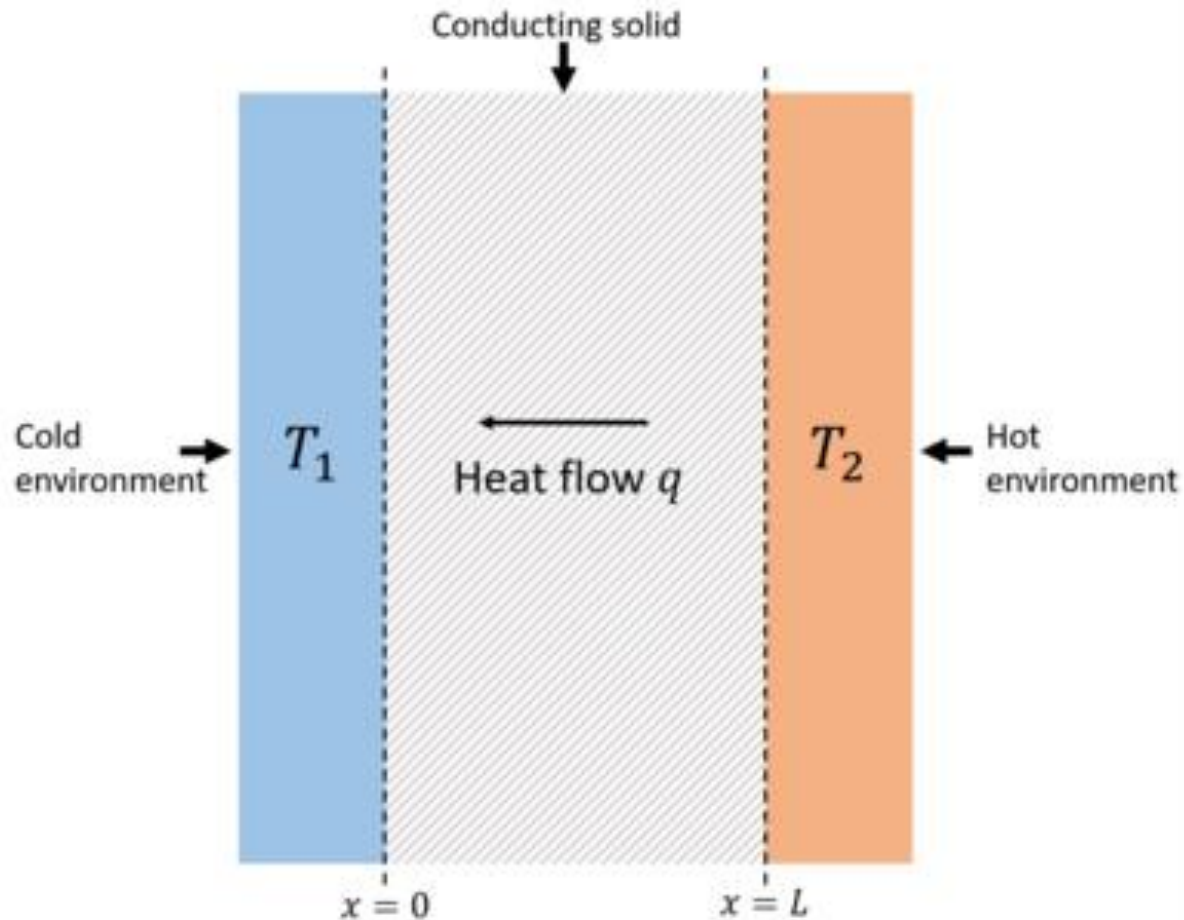
The **Cloud EMS** relies on **machine learning algorithms and forecasting** to optimize the setpoints generated by the Local EMS. The Cloud EMS is especially useful in applications such as peak shaving, where the demand trend can be predicted and combined with weather trends to generate the optimal dispatch of renewables/energy storage to minimize peak usage. The Cloud EMS also provides a visualization platform where system users can review, analyze, and plot system data to determine the impact of the EMS over time.

Typical Industrial EMS



Advantages	Disadvantages
No need to manually submit readings	If you have SMETS 1, it may lose smart functionality after you switch
Easy to monitor your energy usage and spending using in-home display	In-Home Display may be inaccurate
Accurate bills- no more estimates!	They won't reduce your bills alone
Can highlight faulty appliances or potential safety issues	Smart meters may not work if you have a poor signal in your area
Positive impact on the environment	Some suppliers can't support smart meters
Greater selection of tariffs on	

Thermal Conductivity



Thermal Conductivity

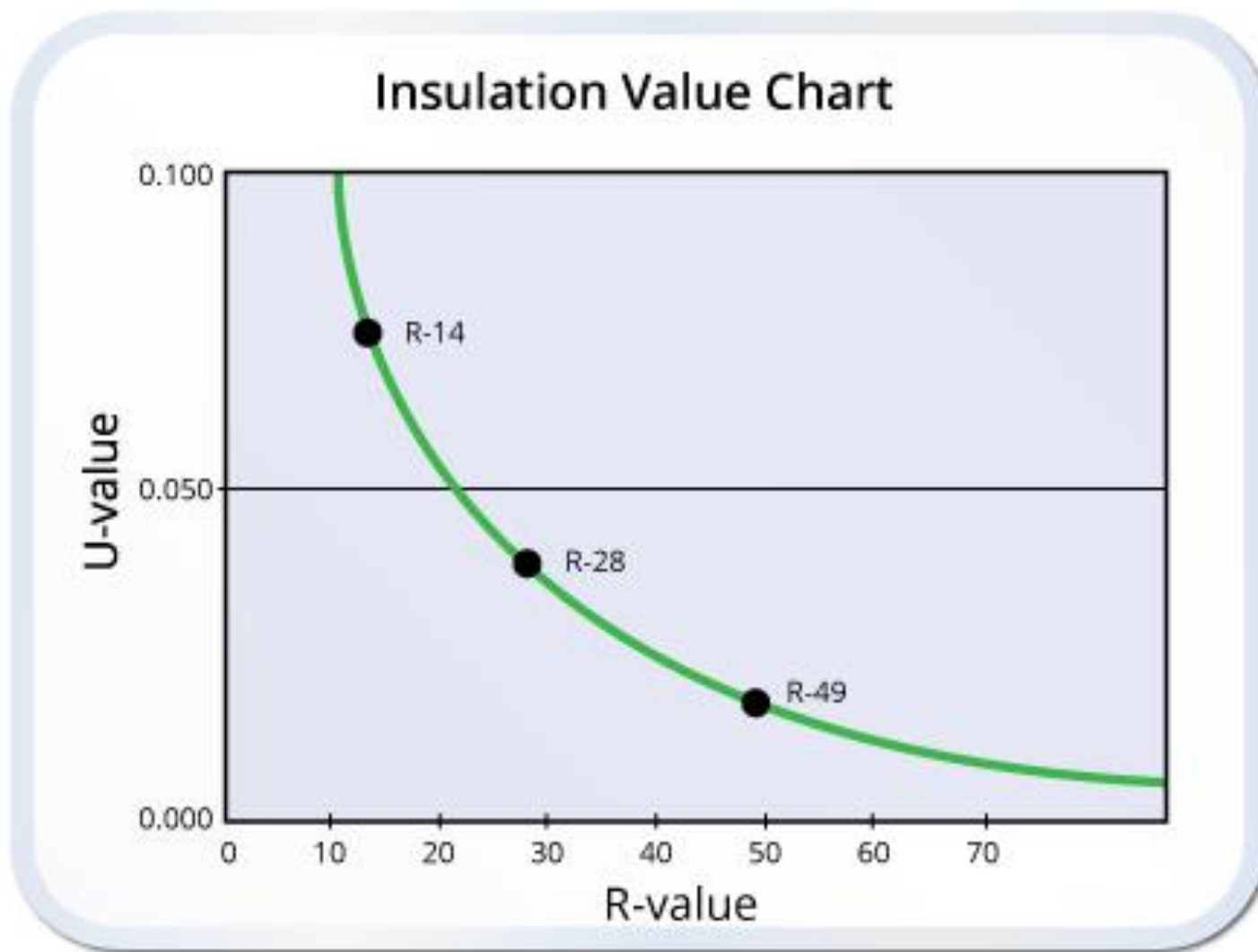
Thermal Conductivity of Common Materials (at 25° C)

Material	Conductivity (Watts/meter-°C)
Acrylic	0.200
Air	0.024
Aluminum	250.000
Copper	401.000
Carbon Steel	54.000
Concrete	1.050
Glass	1.050
Gold	310.000
Nickel	91.000
Paper	0.050
PTFE (Teflon®)	0.250
PVC	0.190
Silver	429.000
Steel	46.000
Water	0.580
Wood	0.130

R and U Values

- **R-value** measures resistance to heat transfer
- **U-value** measures the rate of heat transfer. The lower its **U-value**, the better the product's ability to resist heat conduction. In simple terms, **U-value** is the mathematical reciprocal of **R-value**; that is, $U = 1/R$ and $R = 1/U$.

R values versus U values



Calculation of R-Value

$$**R-Value** = \frac{\text{Temp Difference} \times \text{Area} \times \text{Time}}{\text{Heat Loss}}$$