energy efficiency and saving in households

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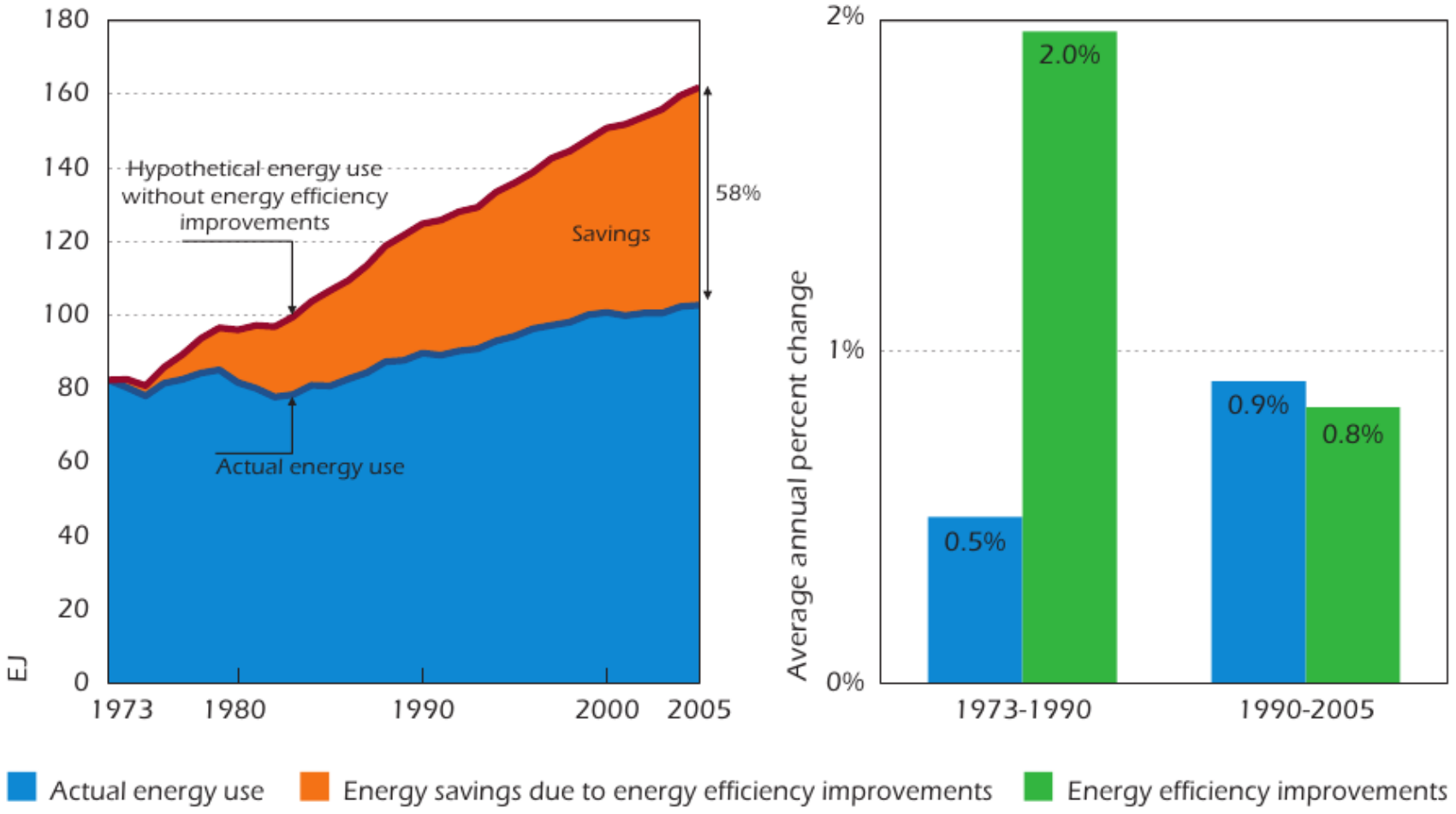
Outline

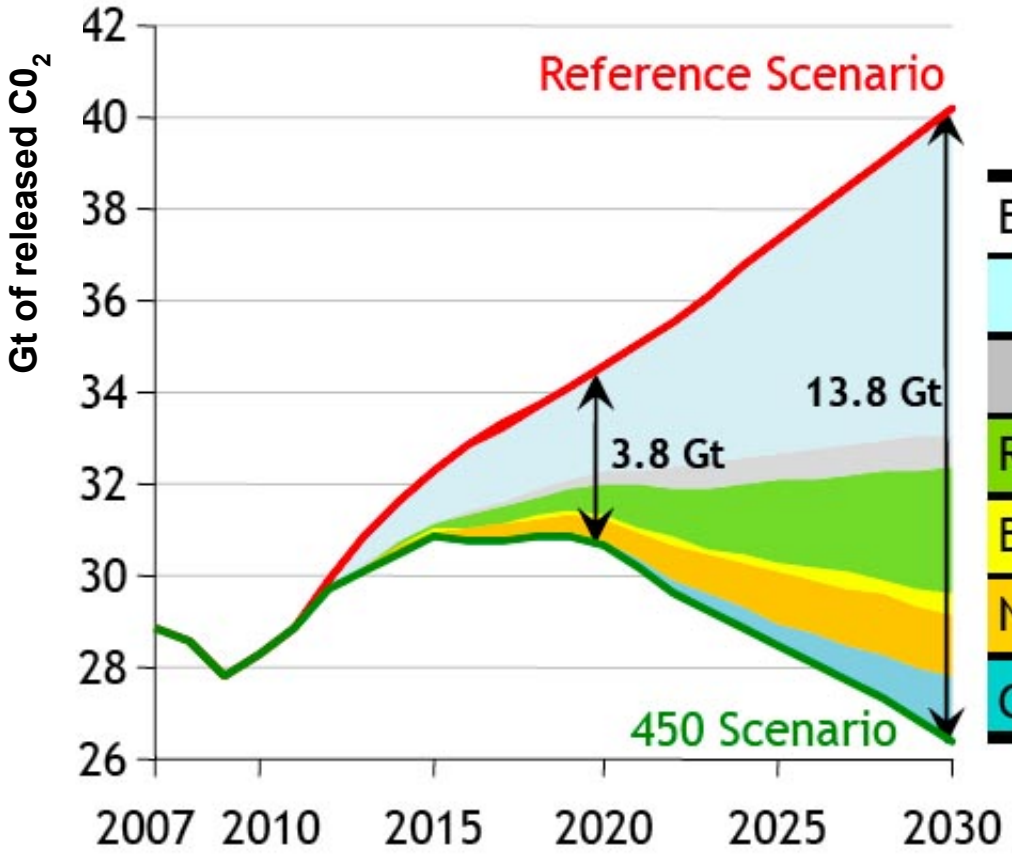
- Introduction
- Energy labeling
- Heating & insulation
- Electric appliances

Improvements in Energy Efficiency



IEA 2008: Worldwide Trends in Energy Use and Efficiency

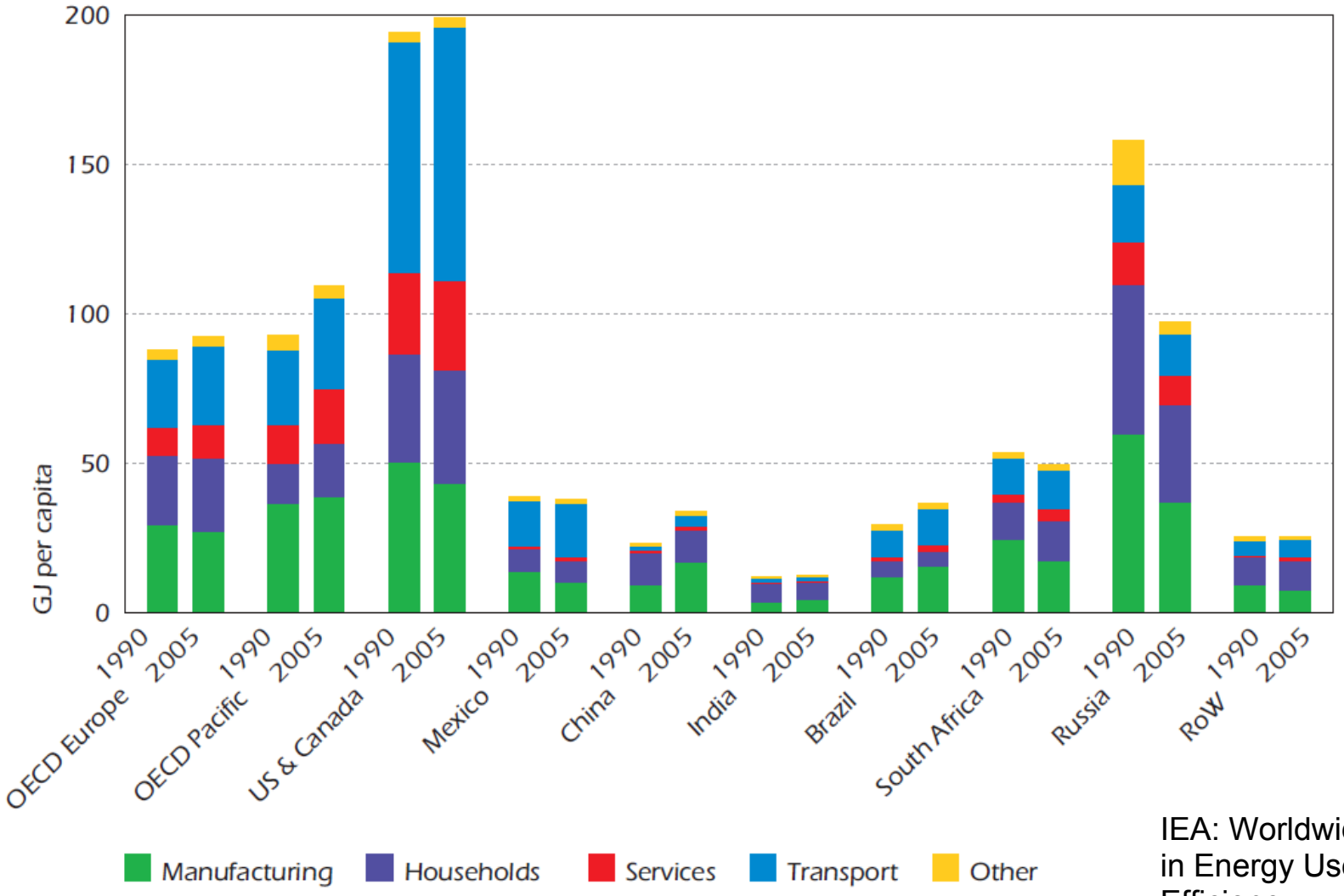
future potential of energy efficiency



Share of abatement %	2020	2030
Efficiency	65	57
End-use	*59*	*52*
Power plants	*6*	*5*
Renewables	18	20
Biofuels	1	3
Nuclear	13	10
CCS	3	10

IEA World Energy Outlook 2009

Total energy consumption



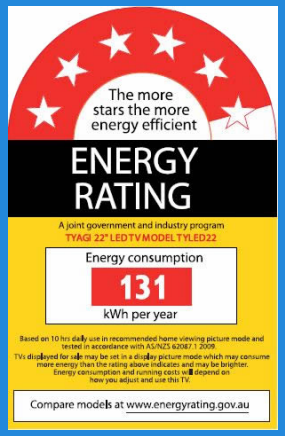
IEA: Worldwide Trends in Energy Use and Efficiency

Motivation for saving energy

- Saving of ...
  - money
  - CO_2 emissions
  - fossil fuels

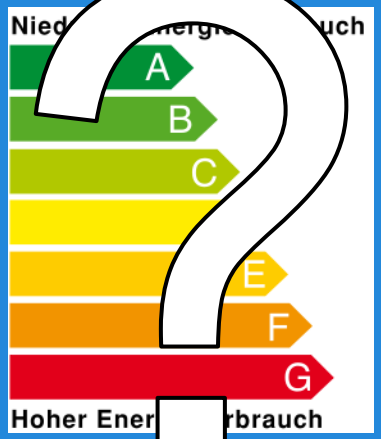
- Methods to save energy:


TCO
CERTIFIED


The more stars the more energy efficient
ENERGY RATING
A joint government and industry program
TYAGI 22" LED TV MODEL TYLED22
Energy consumption
131
kWh per year
Compare models at www.energyrating.gov.au


DER BLAUE ENGEL
JURY UMWELTZEICHEN
schützt
MENSCH UND UMWELT


BCA GREEN MARK


A
B
C
E
F
G


EU
Ecolabel
www.ecolabel.eu

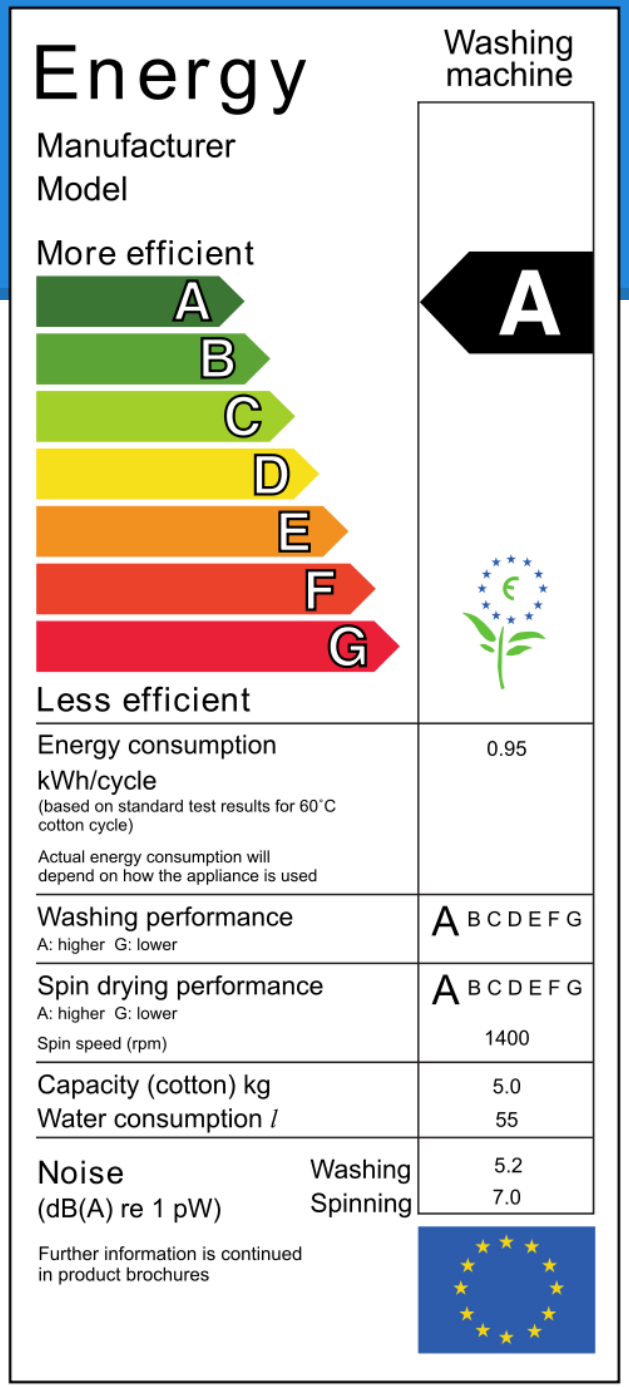

energy
ENERGY STAR


80
PLUS
GOLD


energy saving trust
recommended
energysavingtrust.org.uk
Certification Mark

EU energy labels

- mandatory to be displayed when selling:
  - refridgerators/freezers
  - washing mashines/dryers
  - dishwashers
  - ovens
  - light sources
  - air conditioners
  - televisions
- containes
  - energy class (A - G)
  - consumption, efficiency, capacity, noise, etc.



Scale

- appliances are sorted by energy consumed per typical task
  (e.g. washing 6 kg of cotton at 60 °C)
- A to G scale
  - scale set in 1994
  - today: nearly no products availible in classes E-G

Scale

- A^{+} to A^{+++}
  - A^{+} and A^{++} introduced in 2003
  - A^{+++} in force for refridgerators since 30th Nov. 2011
  - August 2011: 24.9% of all products A^{++}, 1.4% A^{+++}
- easy to read
- not suitible for long terms as scale is limited

Other labels: Energy Star

- standard set by the Environmental Protection Agency (EPA)
- awarded to products with certain amount of higher efficiency than the minimum standard, e.g. 20% for refridgerators
- program launched in 1992
- EPA: saved 18 billion $ of energy cost in 2010 in the USA

Alternatives: Top Runner Program

- certain date: comparison of all products on the market
- a law could state that in a given time (e.g. 6 years) the most efficient product must be the sectors standard
- also applicable to motorized appliances

Alternatives: Top Runner Program

- stimulates competition
- leads to a higher rate of (ecologic) innovations
- beneficial for:
  - environment
  - consumer
  - economy
- short term competitive disadvanteges to other nations without top-runner programs

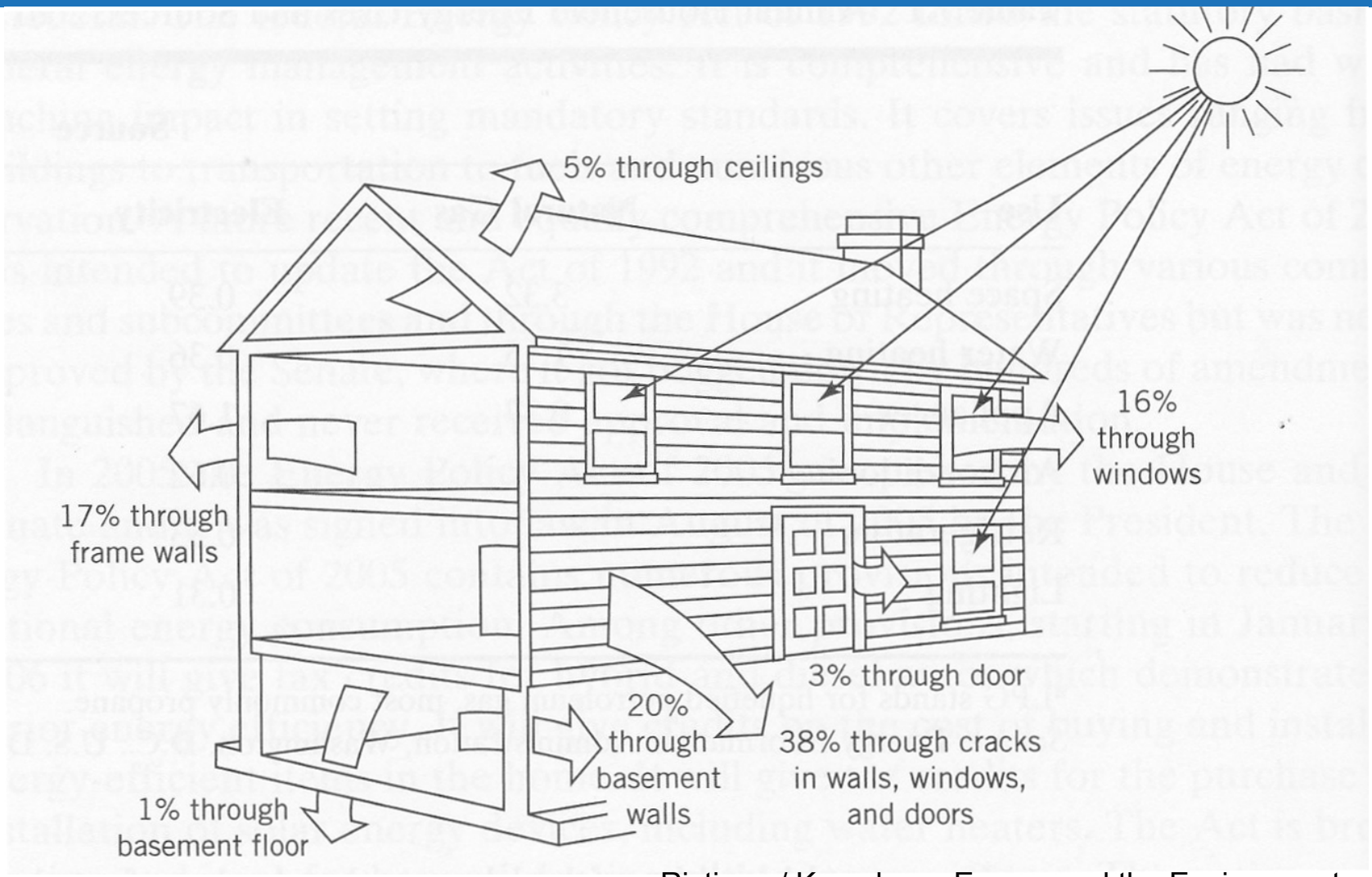
Top Runner model in Japan

- developed in 1999 in the context of the Kyoto Protocol
- Top Runner Standard set by committees of industry, university, trade unions and consumer organisations
- Greenpeace: energy savings in 6-8 years:
  - 63% for air-conditioning
  - 83% for computers
- nearly all products reach the goals, which have been set realistically


A
A
B
C
D
E
F
G

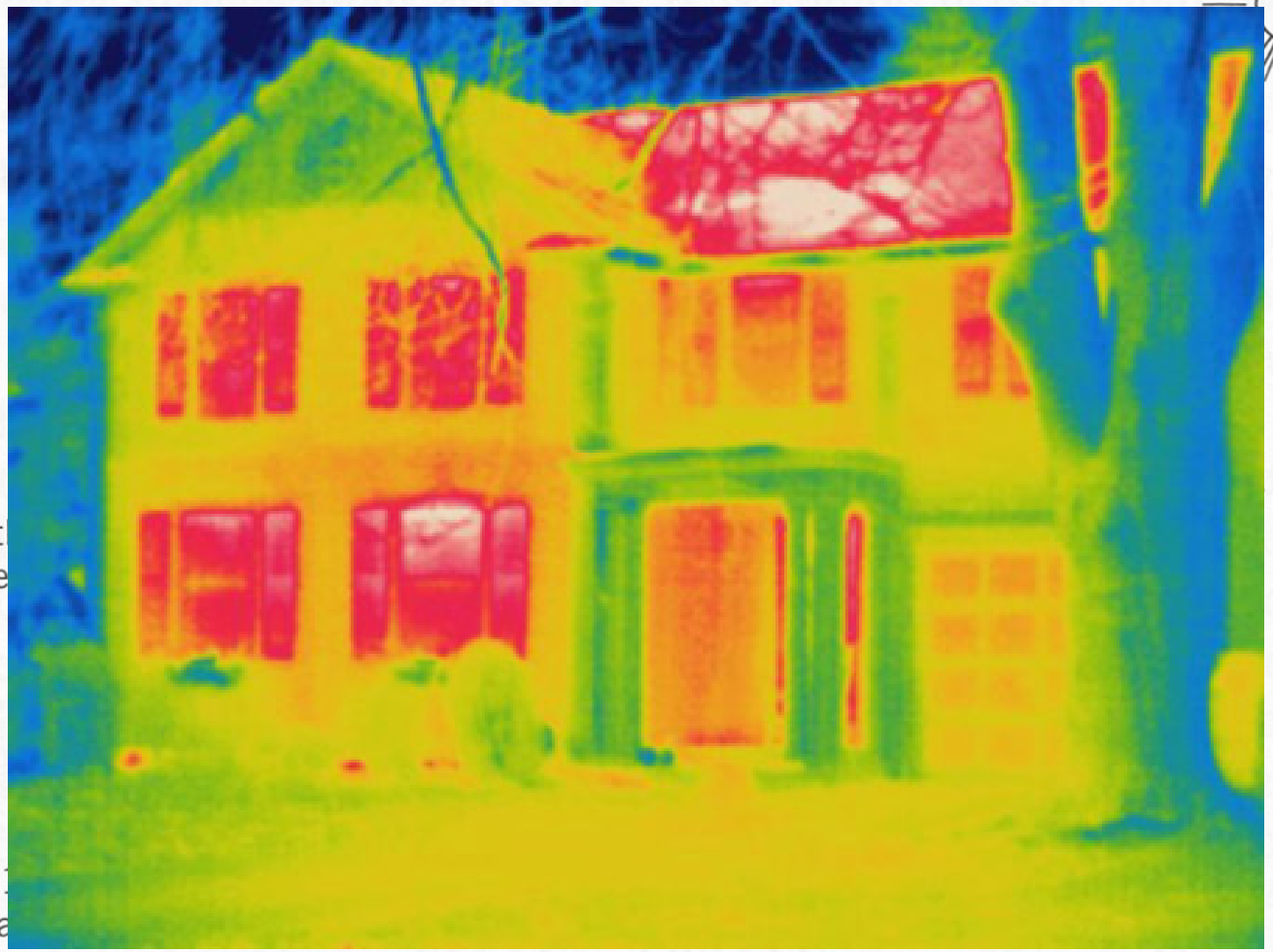
1. Insulation (Philipp)
2. Heating (Alex)
3. Electricity (Johannes)

heat losses of private houses



Ristinen / Kraushaar: Energy and the Environment

heat losses of private houses



Characterising Parameters

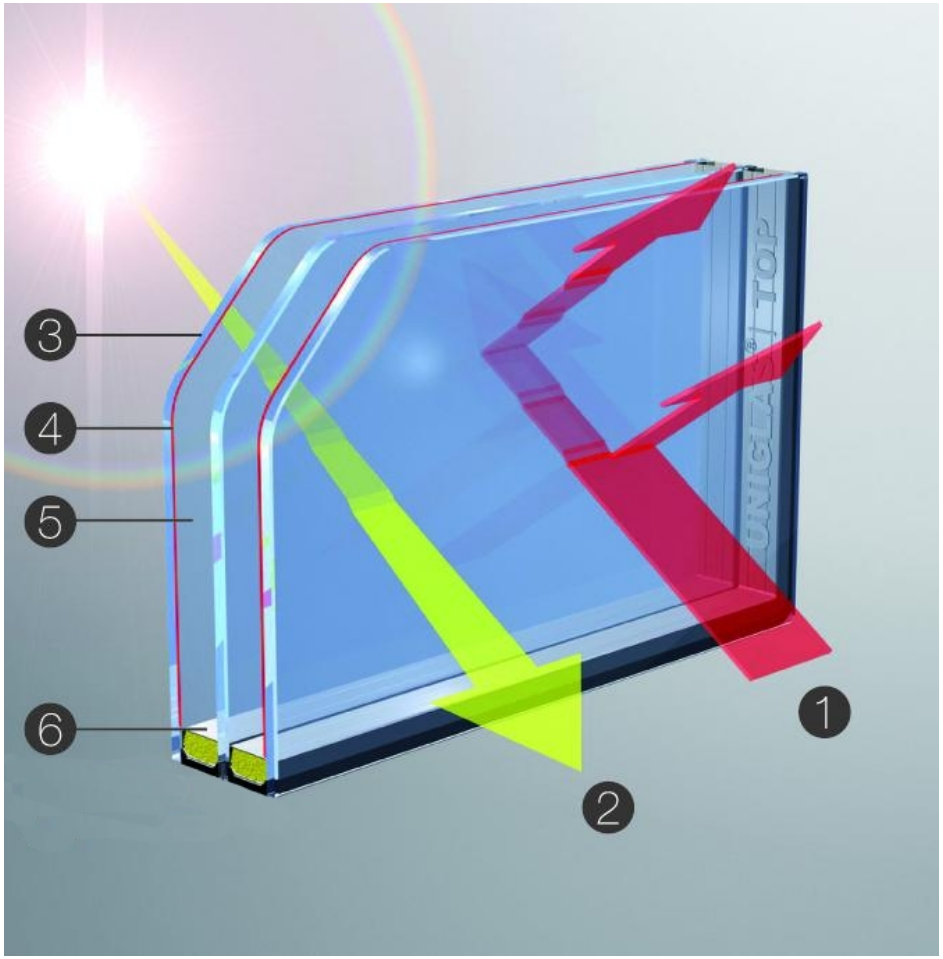
- U - Value:
  The rate of conducting non-solar heat flow:

$$\frac{\Delta Q}{t} = U \cdot A \cdot \Delta T$$

- G - Value
  Fraction of overall transmitted solar radiation
  → heats up inside

$$G = \frac{P_{\text{eff. trans}}}{P_{\odot}}$$

Principle of insulated glazing



1. reflection of thermal radiation
2. total enegy transmisson

3. glass pane
4. metal coating
5. gap, filled with inert gas
6. spacer

http://www.glas-schneider.de/

Comparison of energy losses

Type	U - Value [W / m^2 K]	annual energy loss per m^2	annual coasts per m^2
single glazing	5.8	670 kWh	57 €
uncoated insultated glazing	2.8	330 kWh	28 €
coated insultated glazing (double paned)	1.2 -1.5	140 kWh	12 €
coated insultated glazing (triple paned)	0.7 - 0.8	8 kWh	7 €

purchase advice and payback periods

- purchase new windows:
  U-Value: < 0.9 W / m^2K
  G-Value: > 0.55

- replace single paned glazing:
  6 year payback period
- replace uncoated
  double pane glazing:
  15 year payback period

Bayerisches Landesamt für Umwelt, Energiesparfenster mit 3 Scheiben

heating your home

- by far the largest amount of household energy is put into space heating
- about 47% of residential energy is used for space heating
- In 1994 Germans consumed about 3100PJ (860 billion kWh) of energy for space heating (2/3 for homes, 1/3 for workspace)
- this is an average of 180 kWh/(m^2 a) per apartment

heating your home

- many different energy sources
  - heating oils
  - natural gases
  - coal, wood
  - electricity
- many different systems:
  - central heating
  - district heating
  - geothermal heating
  - (night) storage heating

heating your home

- most efficient heating method depends strongly on individual house configurations, like outside temperature, size of the house, distance to the boiler, etc.
- quantitatively: energy factor is a better measure than the pure energy conversion efficiency of the boiler
- The energy factor is a measure of how much of the energy can be used in a complete heating cycle!

heating your home

Example:

An oil boiler has a energy conversion efficiency of 85% at full performance.

In real use it has an effective efficiency (energy factor) of only 60% due to losses in insulation and cooling at low power use

Approximate energy factor for different systems

- wood boiler: ca. 0.51
- oil boiler: 0.77
- gas boiler: 0.77
- condensing boiler with gas: 0.89-0.96
- (night) electric storage: 0.89 *
- electric direct heating: 1.0 *

* remember: electric power is created out of primary sources with an efficiency of ~30%

These numers vary a lot from source to source

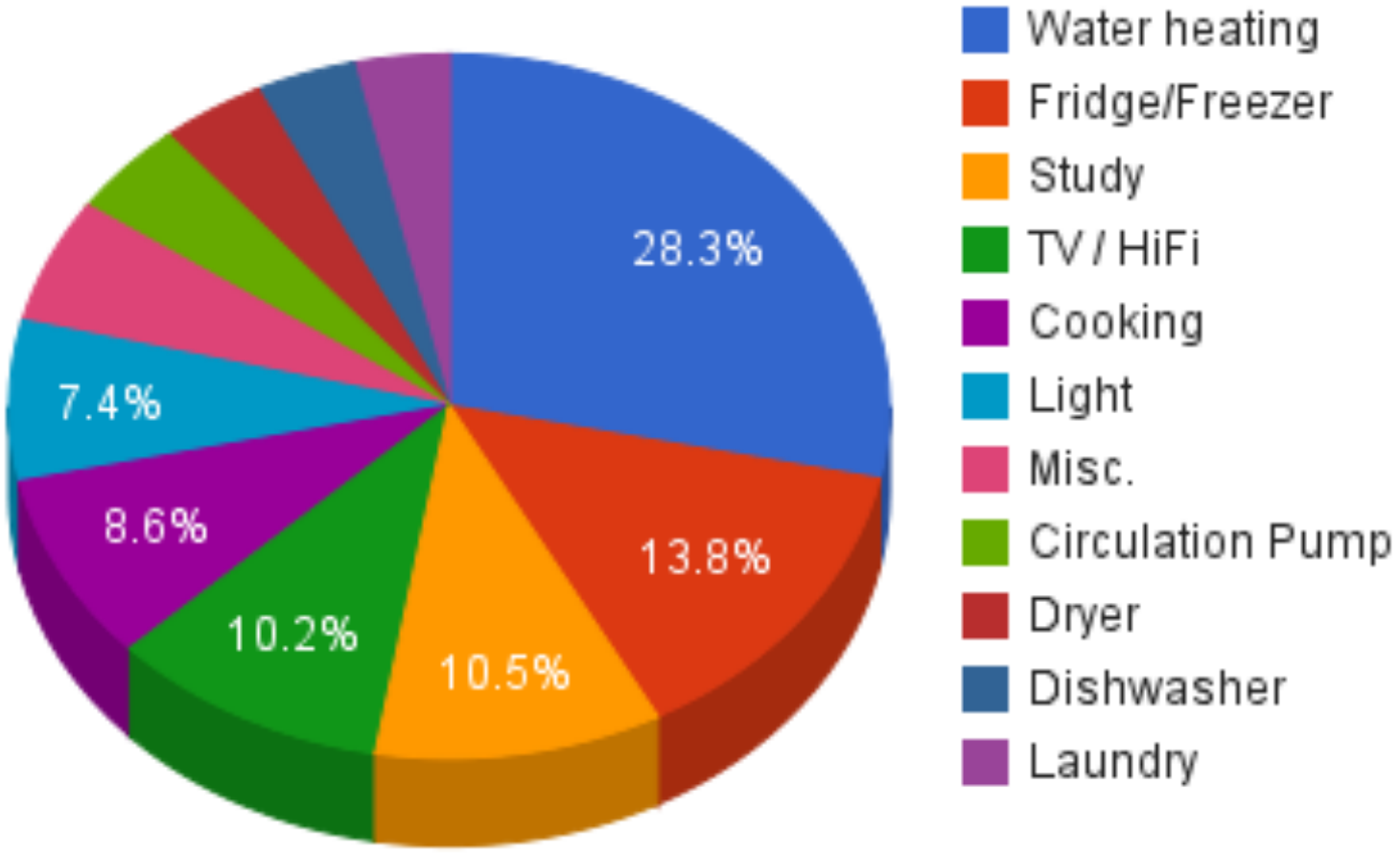
http://www.energiesparhaus.at/fachbegriffe/nutzungsgrad.htm

What is most efficient for me?

I don't know!

free calculation tool:
http://www.heizanlagenvergleich.ch/

Average energy usage in form of electricity in a 2 person household



Total: 3760 kWh, 830€ (0.22€/kWh)

http://www.energieagentur.nrw.de/

Fridge and Freezer

(14% of energy usage)

Calculation of energy efficiency

(Commission Delegated Regulation (EU) No 1060/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of household refrigerating appliances Text with EEA relevance)

(1) The Energy Efficiency Index (EEI) is calculated and rounded to the first decimal place, as:

$$EEI = AEC/SAEC \times 100$$

where:

AEC = annual energy consumption of the household refrigerating appliance

SAEC = standard annual energy consumption of the household refrigerating appliance.

(...)

(3) The standard annual energy consumption (SAEC) is calculated in kWh/year and rounded two decimal places, as:

$$SAEC = V\_eq \times M + N + CH$$

where:

V_eq is the equivalent volume of the household refrigerating appliance

CH is equal to 50 kWh/year for household refrigerating appliances with a chill compartment wi a storage volume of at least 15 litres

the M and N values are given in Table 7 for each household refrigerating appliance category.

$A+++ < 22$

$22 \leq A++ < 33$

$33 \leq A+ < 44$

$44 \leq A < 55$

$55 \leq B < 75$

$75 \leq C < 95$

$95 \leq D < 110$

Fridge and Freezer

(14% of energy usage)

Example 1: new fridge-freezer (300 l)

- cost for A+++: 700€ (150 kWh/a)
- cost for A+: 500€ (320 kWh/a)

⇨ additional costs of 200€ amortise after 5 years (lifetime 15 years)

Example 2: replacement of old fridge-freezer with efficiency C

- equiv. energy usage: ~600 kWh/a

⇨ additional costs of 700€ amortise after 7 years

Fridge and Freezer - Embodied energy
(14% of energy usage)

- energy used for production, transport, storage, sale, disposal
- From a survey: **Embodied energy** of one specific **A+ fridge-freezer (310 l)** was equal to **2100 kWh**
- **Cumulated energy cost** in assumed lifetime of **15 years** of this A+ fridge-freezer:
  200 kWh x 15 = **3000 kWh**
- Same holds for e.g. washing machines

http://www.thema-energie.de/strom/haushaltsgeraete/kuehl-gefriergeraete/ein-neuer-kuehlschrank-kann-sich-lohnen.html)
http://www.haushaltstechnik.uni-bonn.de/energylabel/PP_Kuehlschraenke.pdf
http://www.esu-services.ch/download/steiner-2005-Kuehlschrank_Graue_Energie_1.0.pdf

Study (computer, printer, etc.)

(11% of energy usage)

- Consumption:
  - p. computer: 40-150 Watts
  - screen: 20-100 Watts
  - laptop: 10-50 Watts
  - laptop instead of computer (4h/day, 330day): saves 10-30 € a year
- Amortisement of new hardware is very low compared to "white goods"
- Embodied energy in a computer: ~ 4000 kWh much larger than cumulated energy costs!
- Consciously using standby modes for computer and screen has the most energy saving potential

TV & HiFi

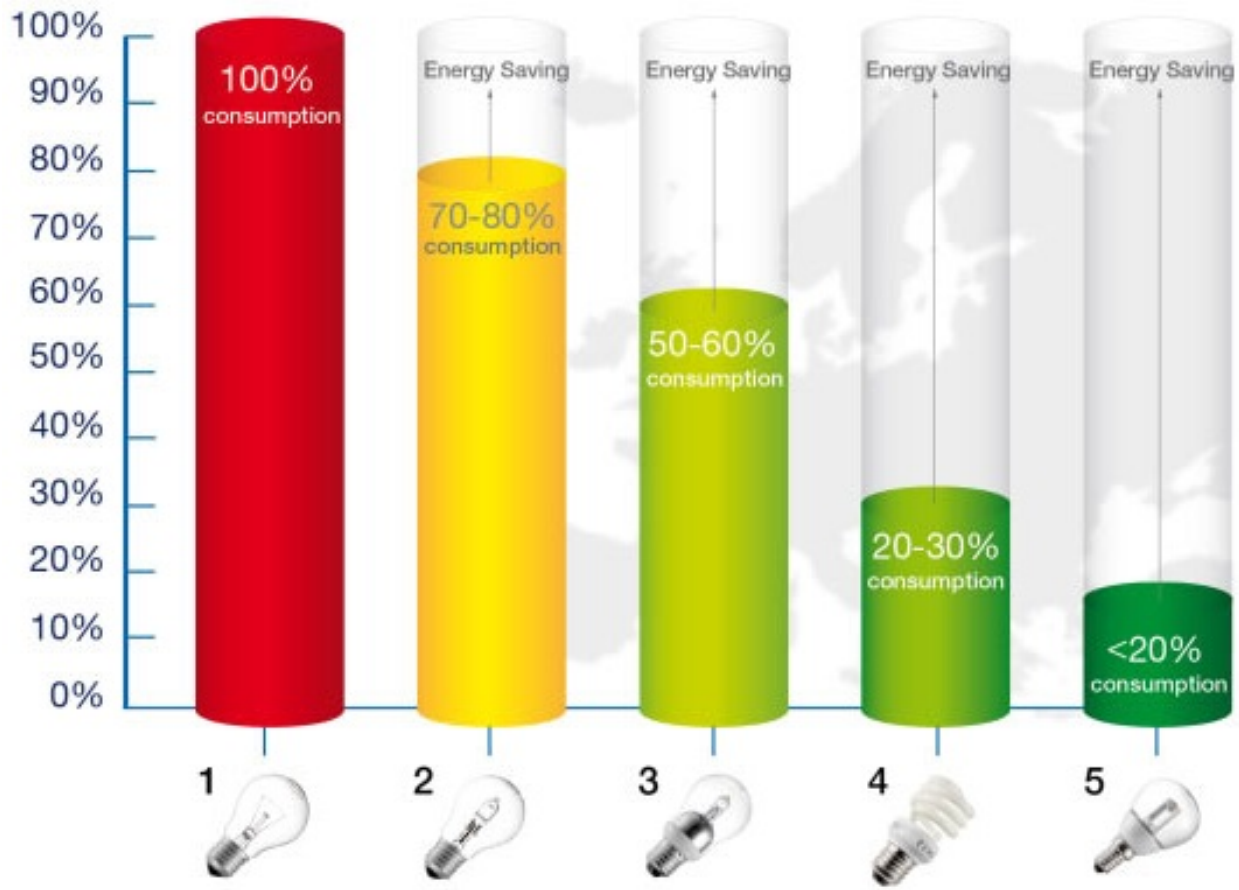
(10% of energy usage)

- 4 types of TV:
  - LCD (LED/CCFL)
  - Plasma
  - CRT
- energy label for TVs since 30.11. 2011, **but** manufacterers can cheat easy on that! better: IEC 62087 http://www.lnvtesting.com/manages/pic/200841434682269.pdf
- Power scales with screen size

- Similar to study appliances: resonable usage can save you a lot!

Light - comparison of light sources

(7% of energy usage)



http://ec.europa.eu/energy/lumen/overview/whatchanges/index_en.htm

Light

(7% of energy usage)

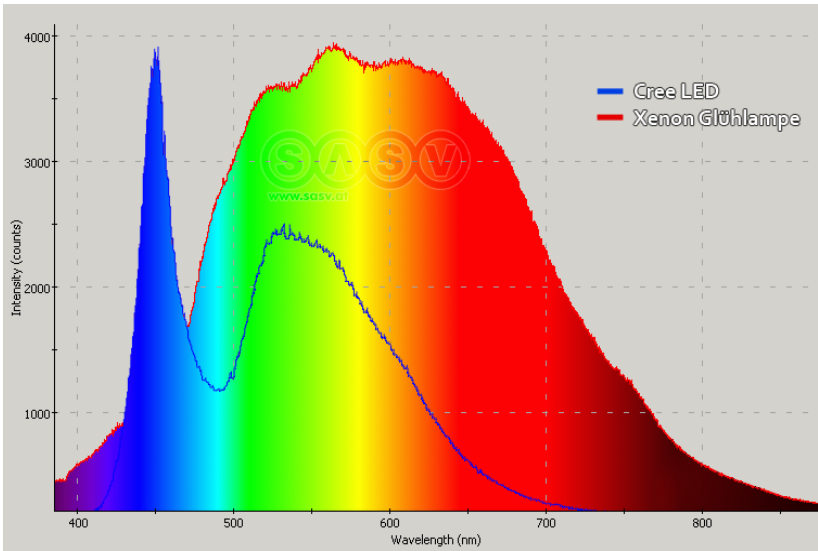
- Light output efficiency
  - lumen/watt

	lumen	watt	**lumen/watt**	c.f. Lightbulb watts	€	€/1000 lumen
CFL	1500	23	**65**	115	8	5
LED	650	10	**65**	50	35	54
LED	360	6	**60**	28	27	75
LED	500	9	**56**	38	65	130
LED	136	3	**50**	10	15	110
CFL	300	7	**43**	23	3	10
LED	90	2	**38**	7	20	222
LED	120	5	**23**	9	20	167
Halogen	850	53	**16**	65	3	4
LED	26	2	**14**	2	5	192
Lightbulb	1300	100	**13**	100	1	1

Light

(7% of energy usage)

- Temperature
- Color rendering index (CRI)
- Lifetime
  - light bulb ~ 1 kh
  - CFL (compact fluorescence light) ~ 10 kh
  - LED (light emitting diode) ~ 30 kh
- Disposal
- Embodied energy: < 2%



Standby

Max Schreck in **Nosferatu**, presumably climbing the stairs to plug in some unused appliances.

Standby

- Approx. cost for 1 Watt 24/7 per year:
  1 W x 24 h x 365 x 0.22 €/kWh = 2€
- crude example: Two chargers, one halogen trafo, TV and PC plugged in 20/7
  ~ 13 € / year
- Modern appliances have less than 1 Watt standby power

And now for something completly different

Total amount of energy spent to prepare this presentation

Total amount of electric energy spent to prepare this presentation

3 notebooks:		120 W x 60 h
halogen table lamp:	+	40 W x 60 h
overhead light bulbs:	+	20 W x 60 h
coffee on the stove:	+	1300 W x 2 h
1000 google searches :	+	300 Wh
		= 13700 Wh

Cost: 3.0 €

Emission: ~ 7 kg CO_2

Thank you for your attention

Are

there

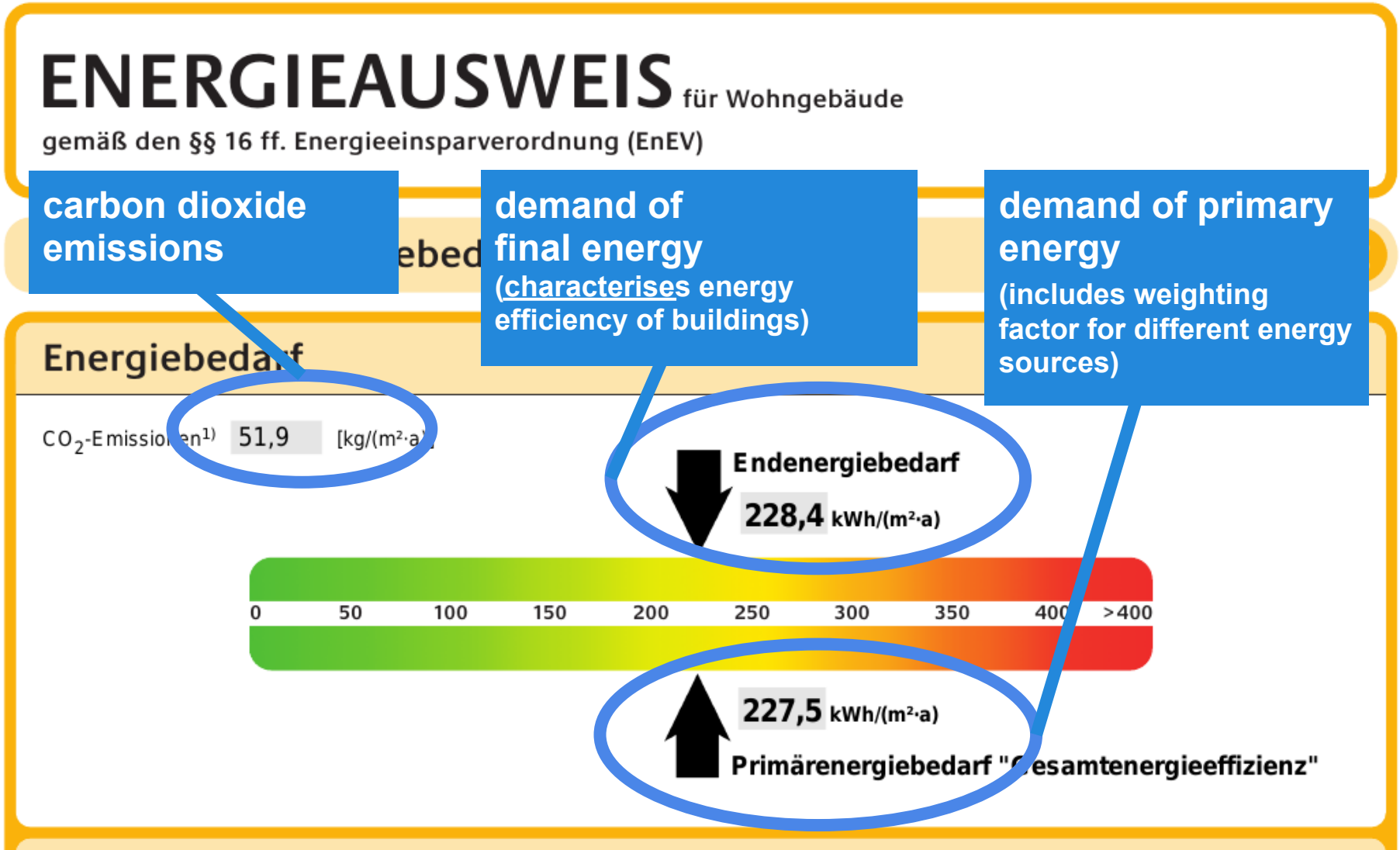
questions?

Energieausweis

- January 2003:
  Directive on the energy performance of buildings:
  EU member states have to introduce "Energy Performance Certificates"
- July 2007:
  "Energiepass- / ausweis" for residental and office buildings in Germany

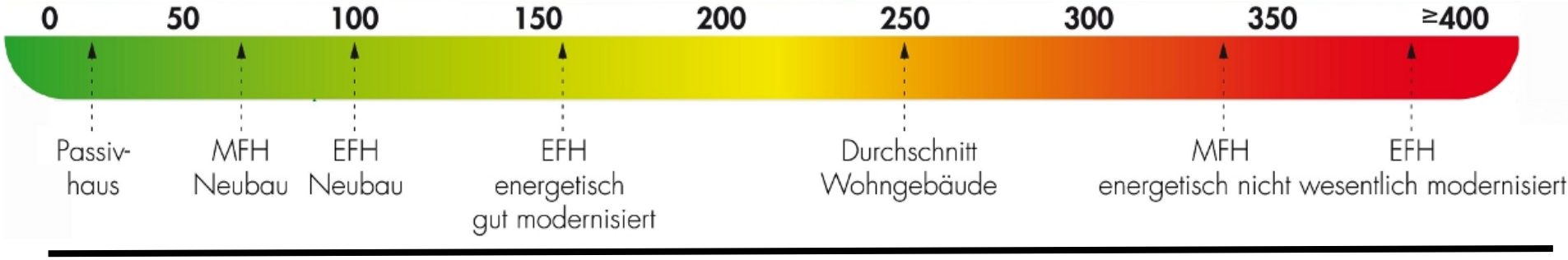
- Has to be made accessible to new potential tenants

Energieausweis



Energieausweis

scale: characterize energy demand (in kWh / m^2 a)



<u>criticism:</u>

- quantities cause confusion to non-experts
- two different bases of calculation (energy - consumption vs. demand)
- **lack of simplicity**

Water heating

- electric energy can be converted to heat very efficiently (about 100%), but electricity is produced from primary sources with an efficiency of about 30%!
- there are many different systems:
  - traditional storage heater
  - tankless heater
  - solar water heater
  - and many more...
- combination boilers are used for space heating and water heating together

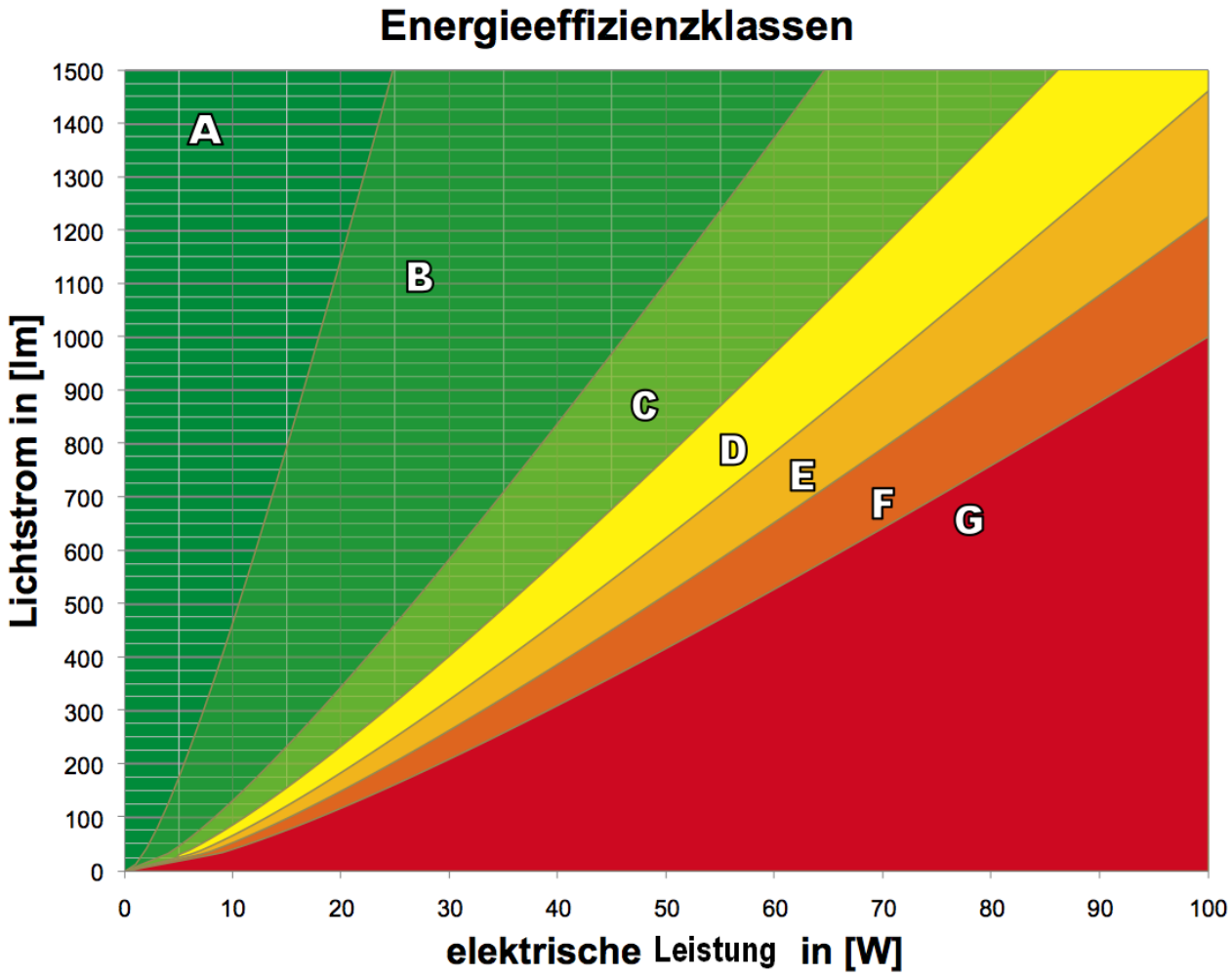
Water heating

tankless heater

- water is heated just when needed
- warm water is always availible
- can be installed at different points-of-use
- needs a largeer amount of power for a much shorter time
- in general more efficient

Light

(7% of energy usage)



Wikipedia