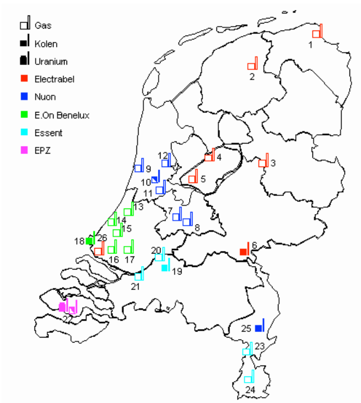
Sun

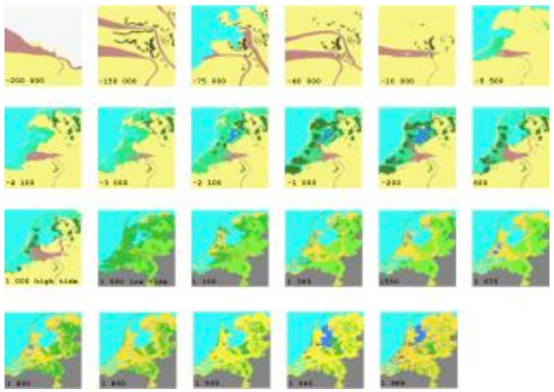
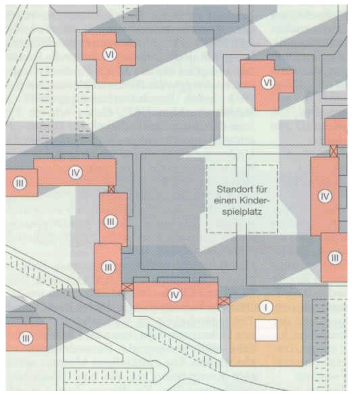
Energy, Light, Temperature, Vegetation

Prof.dr.ir. Taeke M. de Jong
Chair Technical Ecology and Methods (TEAM)

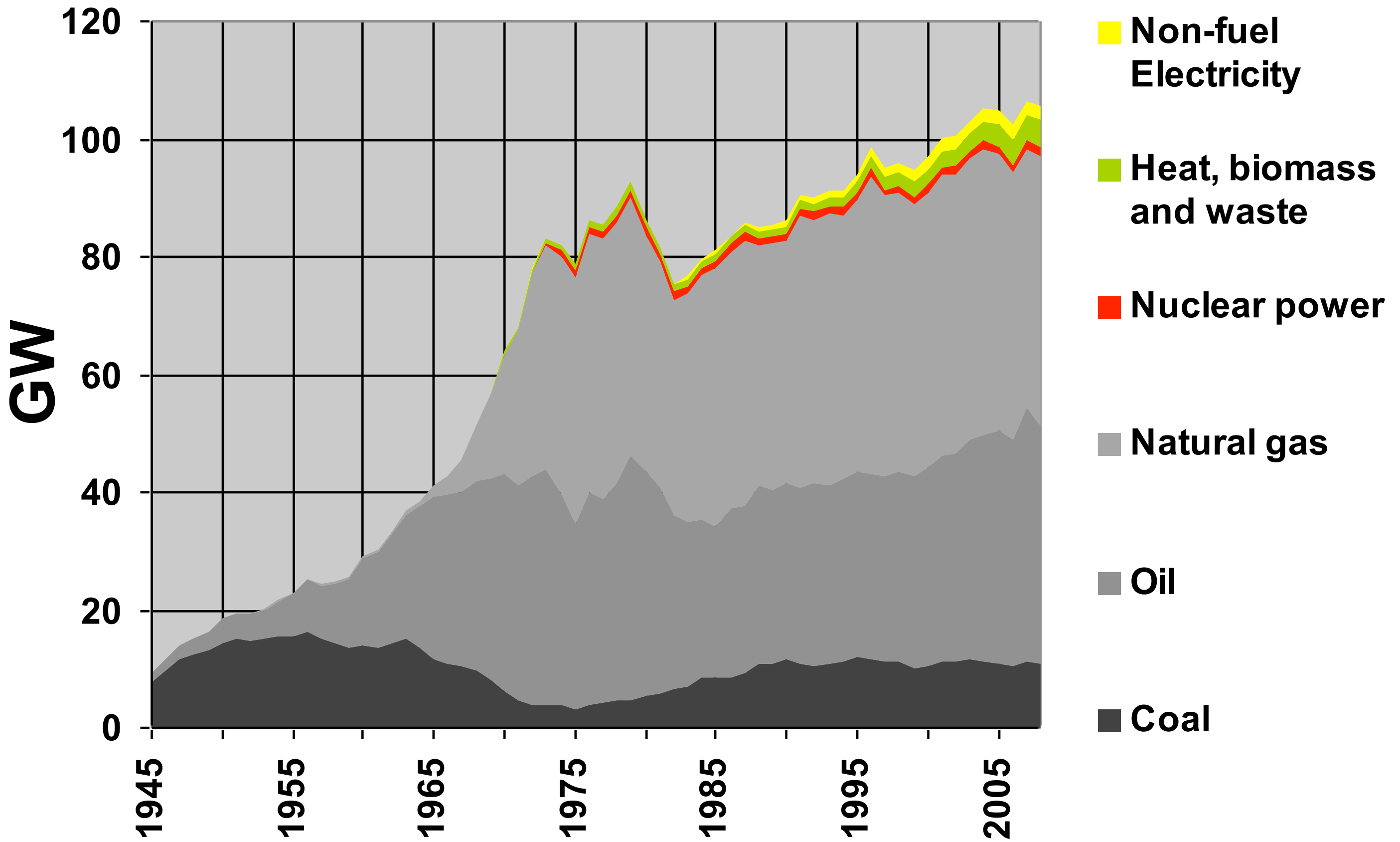
energy, temperature, light, vegetation

- energy use and supply
- temperature, historical geography
- light, shadow
- planting

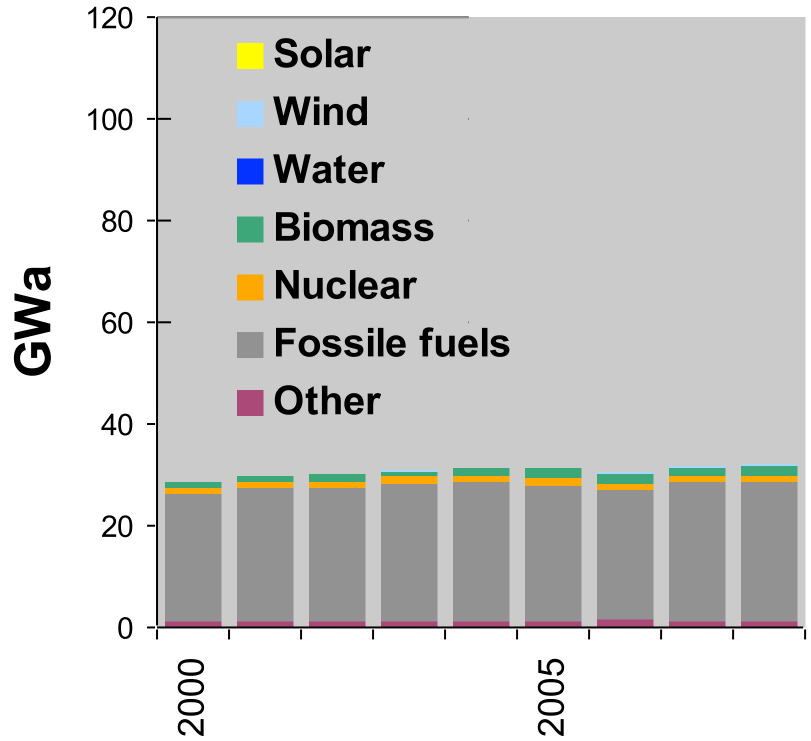


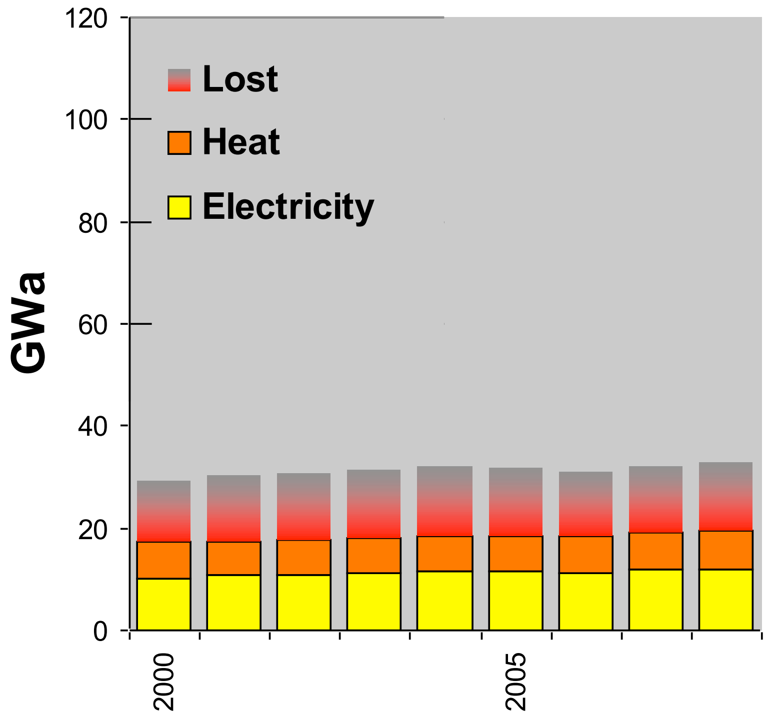
Dutch power use



30% Electricity and heat



Input still mainly fossile

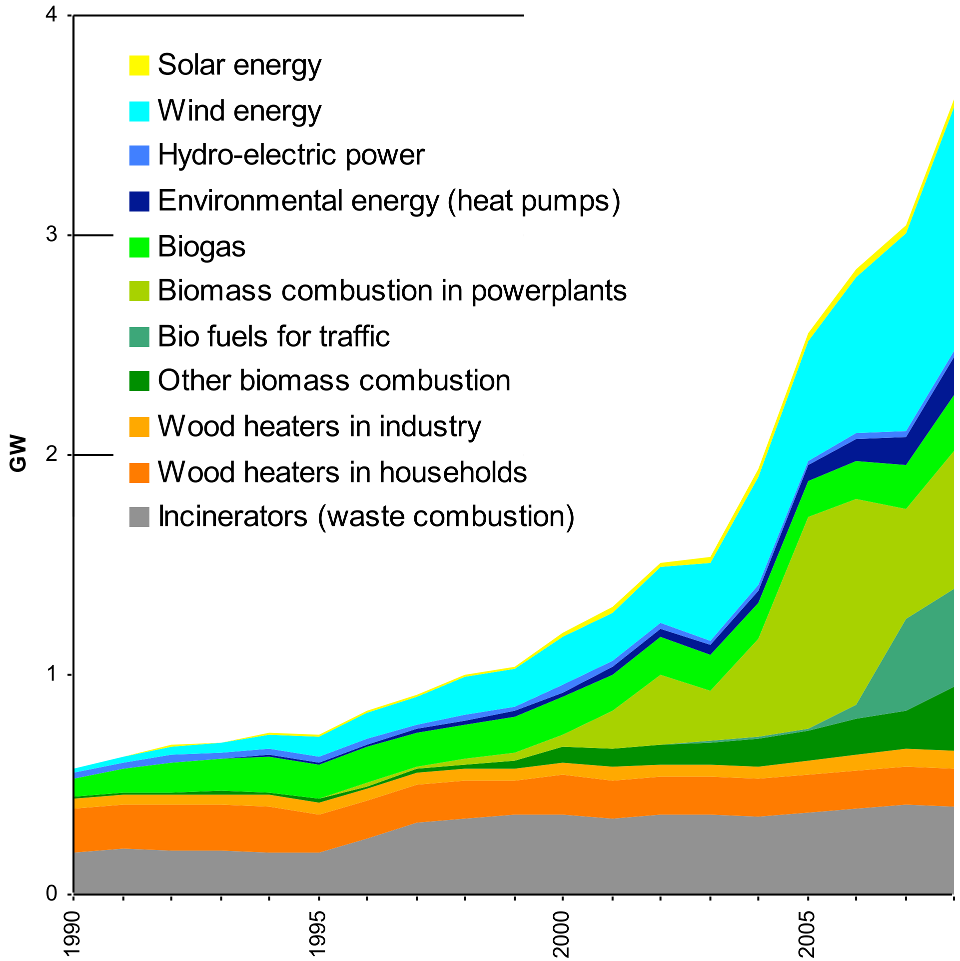


Output still 10% heat loss

Efficiencies

Device or process	chemical->thermic	thermic->mechanical	mechanical>electric	electric->mechanical	electric->radiation	electric->chemical	chemical->electric	radiation->electric	thermic->electric	efficiency
										100%
electric dynamo										
electric motor										
										90%
steam boiler										
HR-boiler										80%
central heating boiler										
electrisc battery										70%
fuel cell										60%
										50%
steam turbine										
										40%
electric power station										
gas turbine										
										30%
car engine										
neon lamp										20%
solar cell										10%
thermocouple										
										0%

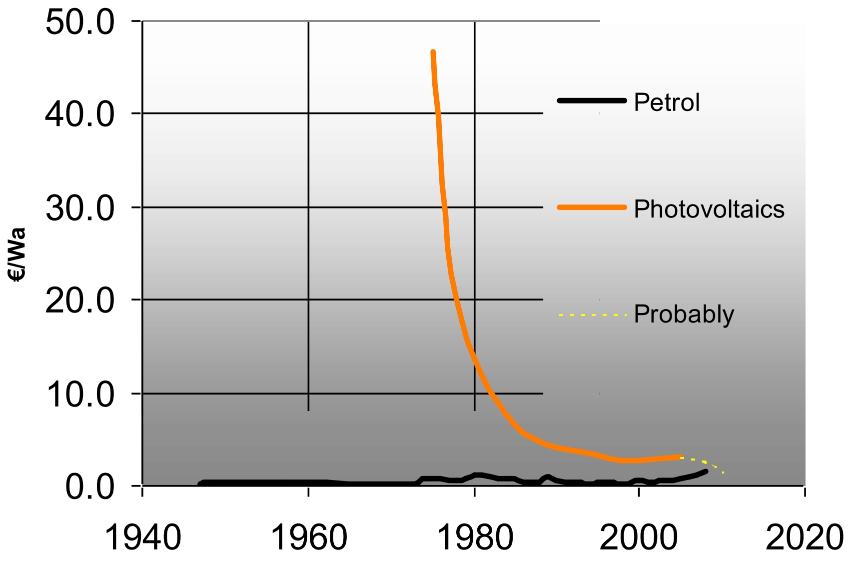
4% ‘Sustainable’

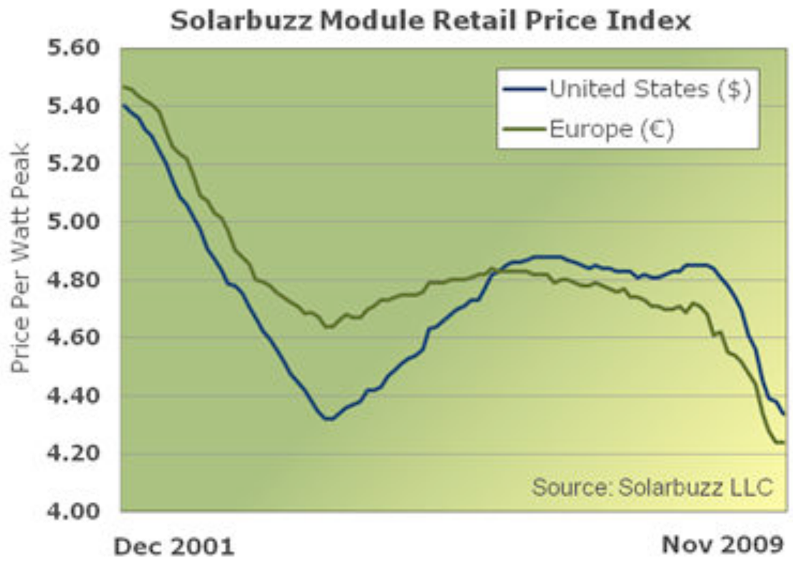


Sun

- There is ample 5000 x as much solar power available as world economy and biosphere use together
  - Wind can yield at most 0.1% of that source
  - Biomass 1%
  - Solar 10%
- Covering total energy use of the Netherlands requires:
  - 5 times its surface by wind
  - its total surface by biomass
  - 1/5th of its surface by solar energy

Energy an enduring environmental problem?





Since 1975, the price of a solar watt installed decreased a factor 10

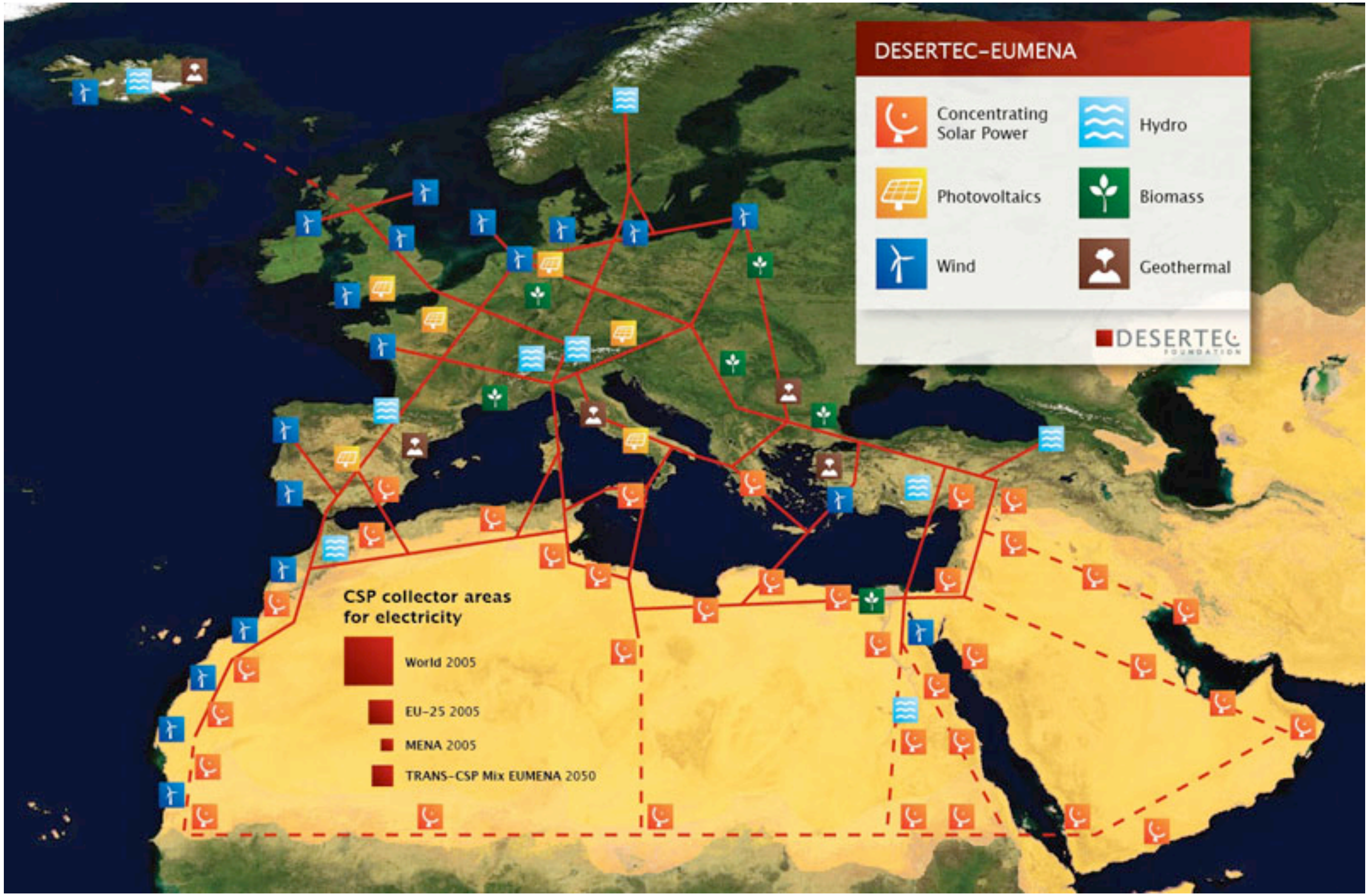
The temporary impact of silicon shortage

A competition of two technologies

- What will win in the coming decade?
  - technology of extracting dispersed fossile fuels
  - solar technology
- Energy saving
  - offered time to exploit oil sands and dispersed gas
  - reduced solar market
- If solar wins
  - oil industry declines
  - global economic and geopolitical shifts
  - many new engineering tasks

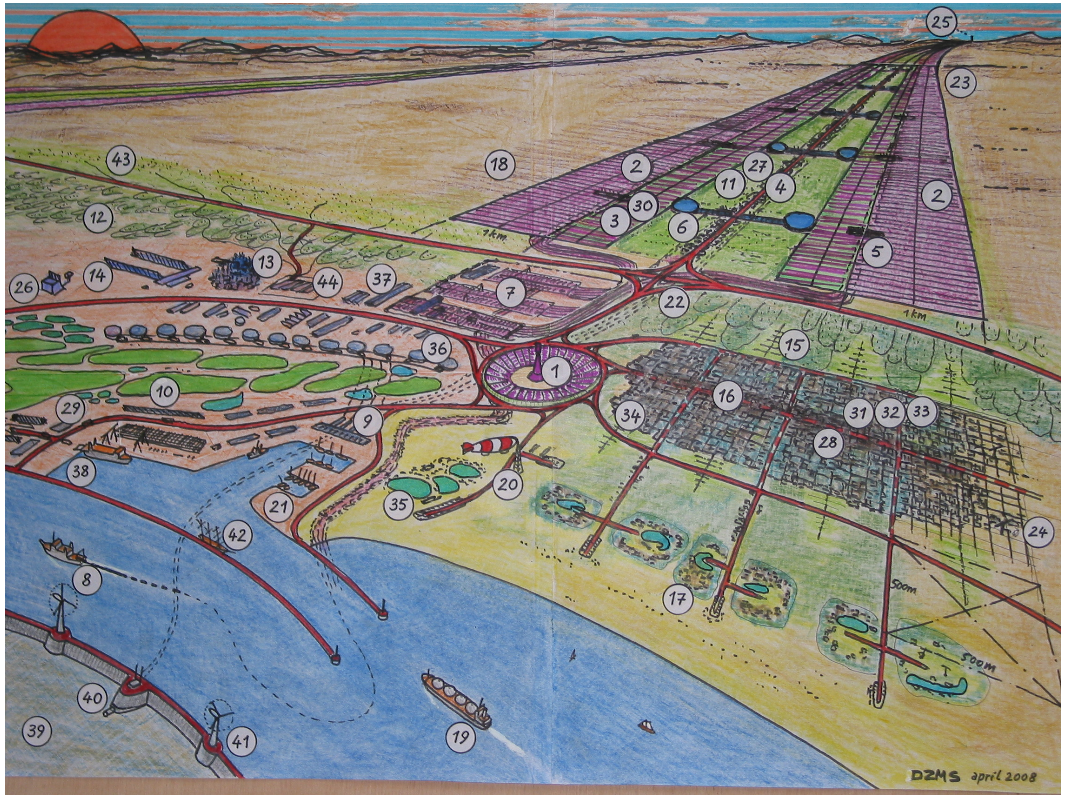
Oil sands, two tons of soil a barrel

Sahara Sun: a German initiative 2009



Desert development

44 engineering tasks



Smets (2008)

The legend: an engineering agenda

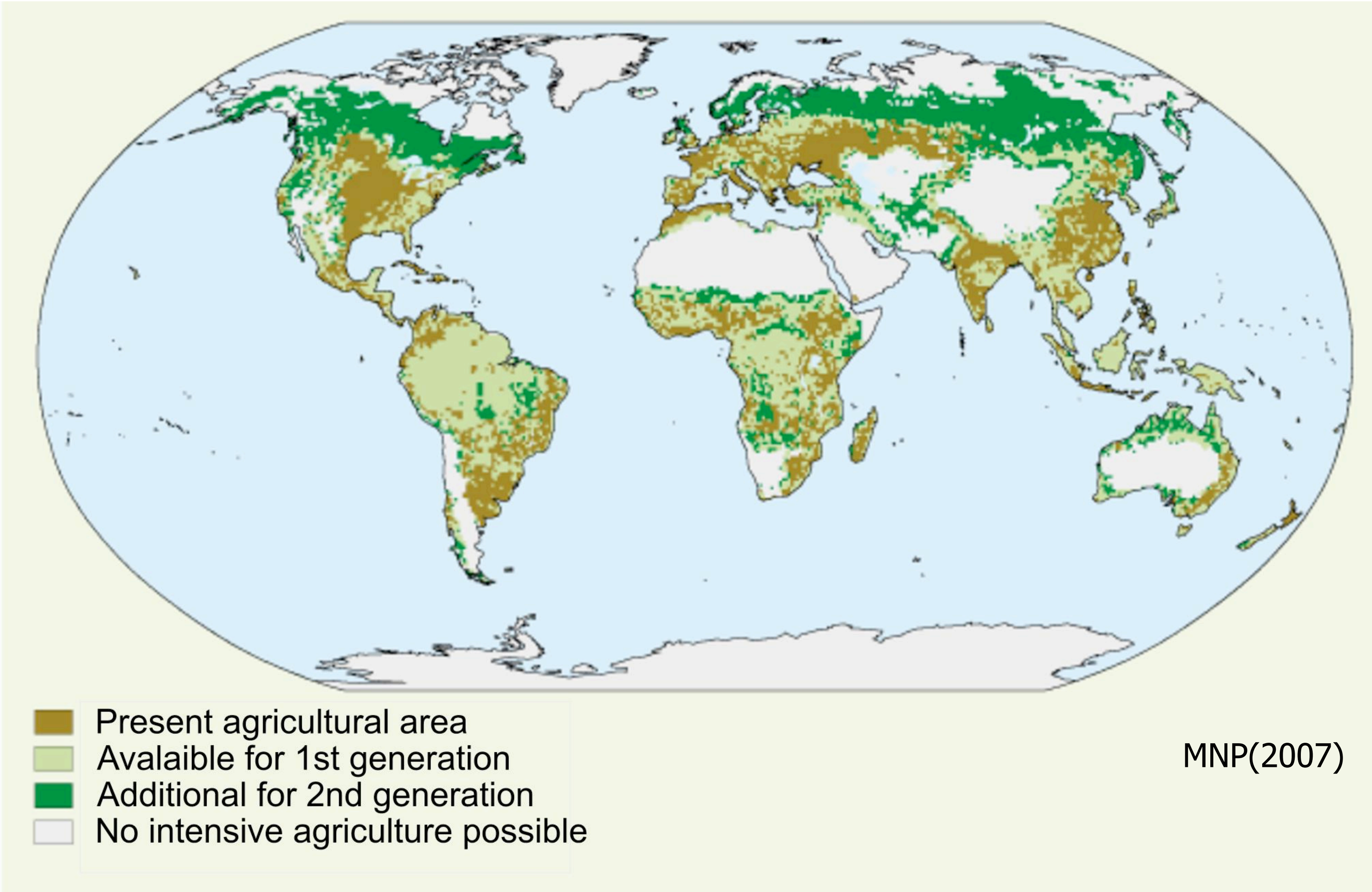
1 sun tower; **2** trough mirrors; **3** fresnel mirrors with funds at the bottom; **4** desert road with water supply piping; **5** night flow power station and generators; **6** water desalinisation devices and water basin; **7** transformer station; **8** ultra high voltage direct current cable to Europe; **9** hydraulic pump station; **10** algae cultivation; **11** agriculture and horticulture; **12** sylviculture; **13** chemical industry: salt, chlorine, cement, glass.; **14** aluminium production (factory walls are rigid giant trough mirrors); **15** blotter fields with effluent recovery; **16** new founded band shaped city; on central ash keeps on driving electrische shuttle; **17** recreation and tourisme with resorts; **18** olivine-sand plains CO_2 –absorption; **19** supply of gas for nocturnal additional heating at pick charges; **20** zeppelin for transport mirrors and CO_2-arme trips; **21** yacht-basin; **22** connections with intercity road and intercity high tension lines; **23** control and maintenance of the mirrors farms; **24** mobile solar power units with dish mirrors; **25** solar chimney (one-off experimenting because of low output); **26** solar furnace for heat technology; **27** irrigation with desalinated marine water; **28** market in the city with locally extracted products; **29** fish cultivation in salt and fresh water; **30** combination of tilapia-kalebas-en tomato cultivation under the fresnel mirrors; **31** upper town with traditional shady lanes; **32** upper town for pedestrians and downtown with electric movement; **33** electric supplies from the downtown; **34** nocturnal current downtown information centre; **35** warm marine water health sources; **36** fresh water reservoirs; **37** building blocks and panel bakery with solar heat technology; **38** arrival of goods from Europe; **39** low lake for nocturnal current generation; **40** water turbines in the low lake dam; **41** wind turbines to drain the low lake for nocturnal current generation; **42** CO_2-free cruises to solar city-resorts; **43** xerofites on aride soils for vegetable oil: yatrofa, ricinus etc.; **44** factory pressing feed cakes, oils, greases and biodiesel xerofites.

The basic environmental problem

- If energy is affluent, then:
  - waste is a resource: cradle to cradle
  - pollution can be avoided and reduced
  - risks can be covered

- What is the long term problem then?
- Decreasing biodiversity and health
  - biodiversity requires a diversity of environments
  - health includes safety and well-being (WHO 1946)
- Even climate change would be no problem
  - if it would not affect biodiversity or health

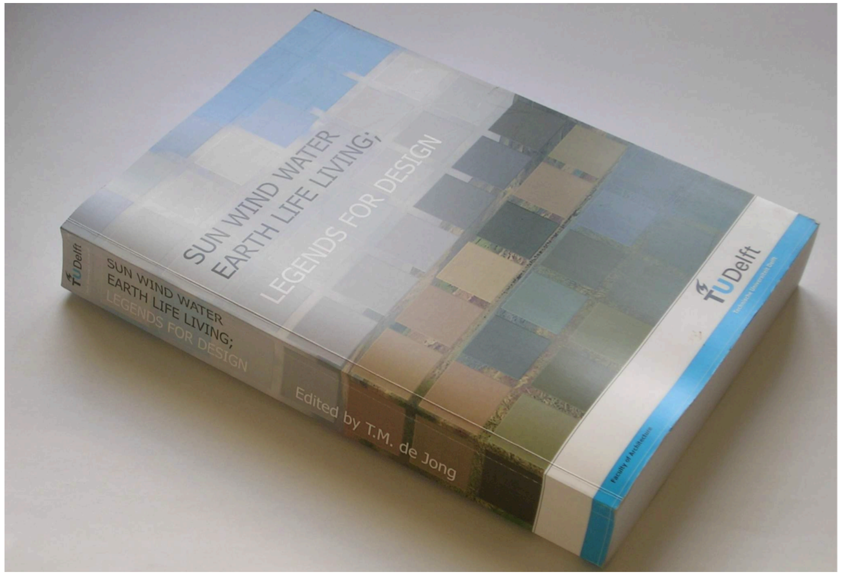
Climate change



Economic and political impacts

- An economic shift into the poles
  - Natural gas of the North Pole becomes accessible
  - Free shipping in the Arctic Ocean: new harbours
  - Tundras become agricultural land
  - Increasing methane discharges
- Russia and Canada are the winners of climate change
- Africa source of hydrogen production?

Energy related questions in spatial design

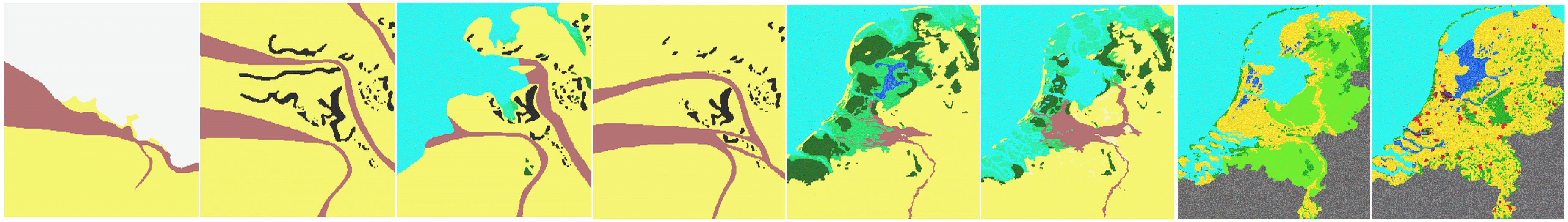


urban, architectural and related technical design

integrating sun, wind, water, earth, life, living

legends for design

Temperature changes of the Netherlands



1600 Dutch Golden Age

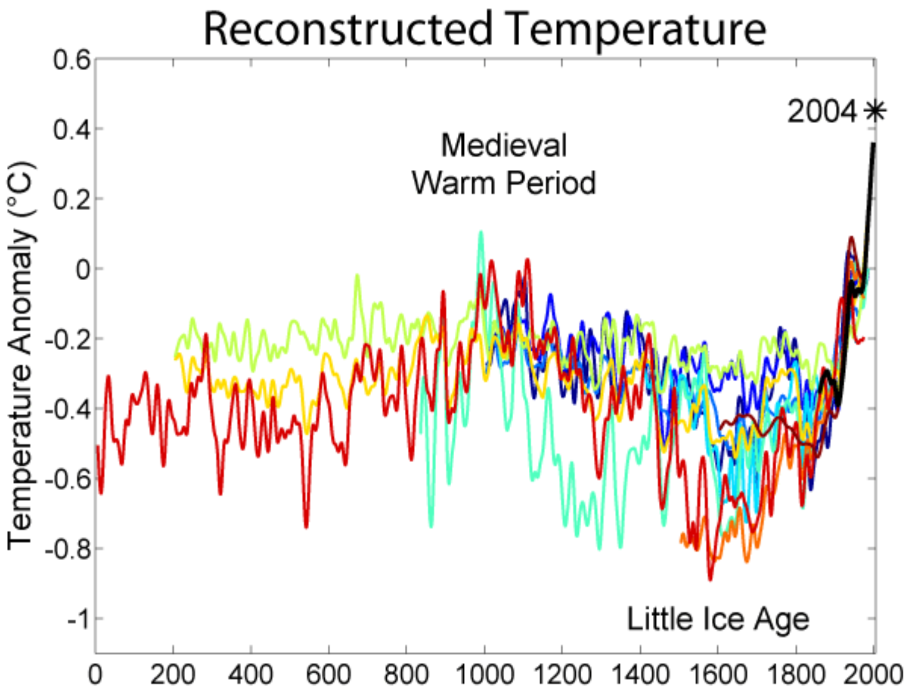
based on wind and peat

1750 English golden age

on coal

1900 US golden age

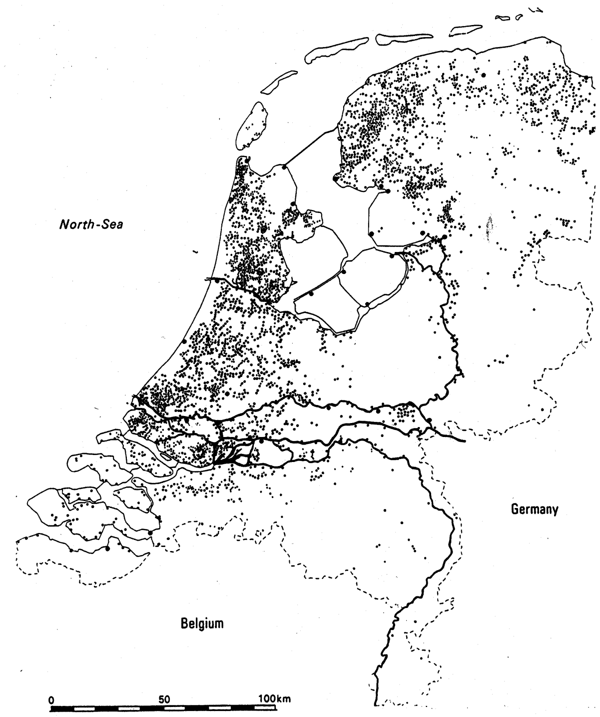
on oil



http://en.wikipedia.org/wiki/Global_warming

Warming up

Risks of flooding



Pumping stations

Kinds of water, source of biodiversity

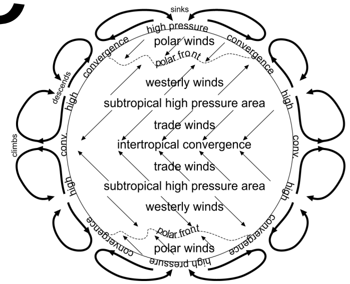
<table>
<tr><td rowspan="3"></td><td colspan="6">SURFACE WATER</td></tr>
<tr><td colspan="2">SALT</td><td colspan="2">BRACKISH</td><td colspan="2">FRESH</td></tr>
<tr><td>current</td><td>still</td><td>current</td><td>still</td><td>current</td><td>still</td></tr>
<tr><td>deep</td><td rowspan="5">Ooster-
schelde

Wadden-
zee</td><td rowspan="5">Greve-
lingen

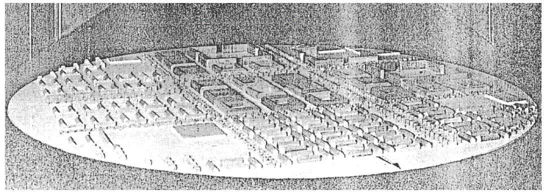
Veerse
Meer</td><td rowspan="5">Haring-
vliet</td><td rowspan="5">Bies-
bosch</td><td rowspan="5">Uiter-
waarden
Rijn
En
Maas</td><td rowspan="5">IJssel-
meer

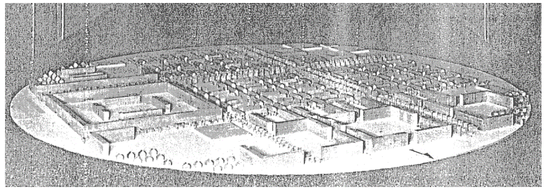
Oost-
vaarders
plassen</td></tr>
<tr><td>shallow</td></tr>
<tr><td>bank</td></tr>
<tr><td>swamp</td></tr>
<tr><td>bottom</td></tr>
<tr><td></td><td colspan="6">GROUNDWATER</td></tr>
</table>

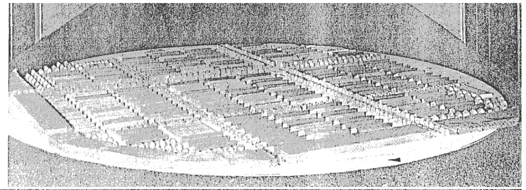
Wind, noise

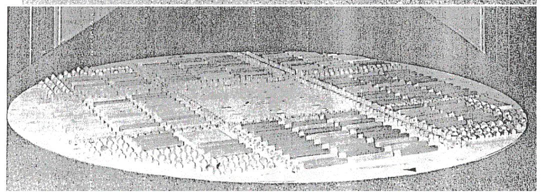


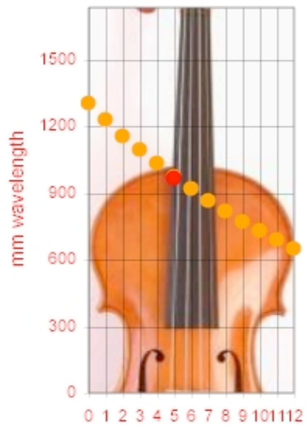
- movements of air
  - from global into local
  - from years into milliseconds
  - wind, sound and noise

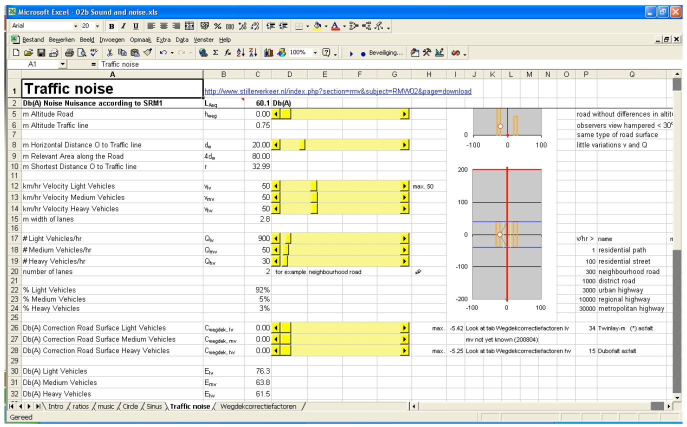






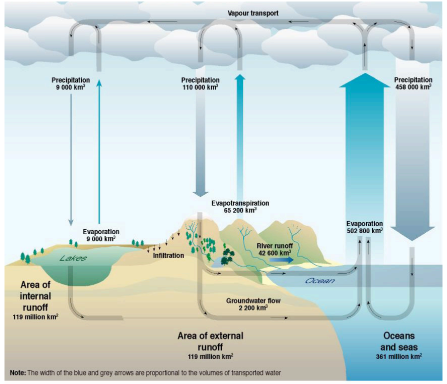


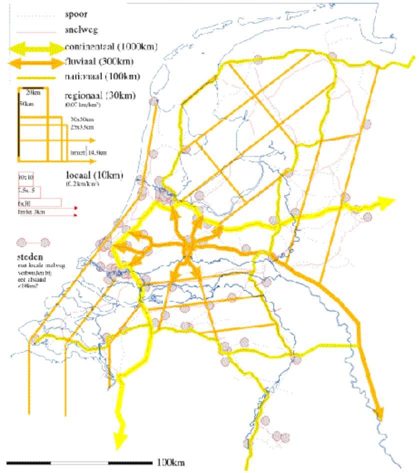


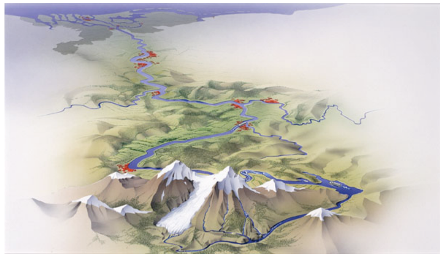


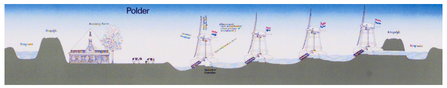
Water, networks

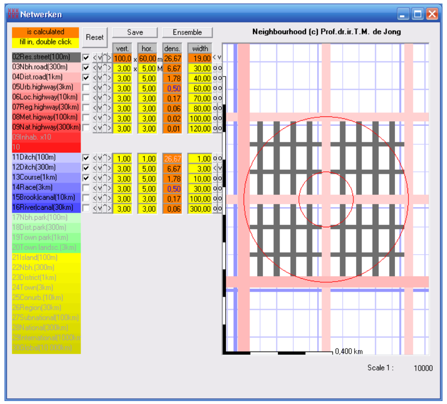
- water balance
- civil engineering
  - wet and dry networks
  - crossings
  - traffic
  - tunnels, cables and pipes

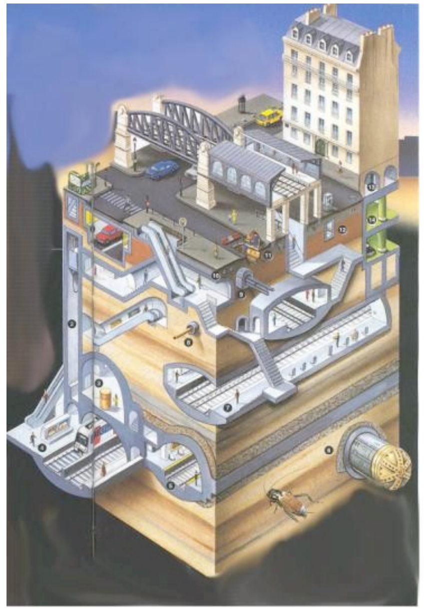


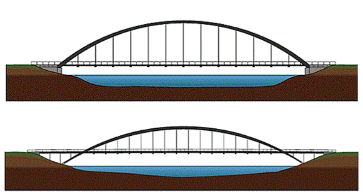


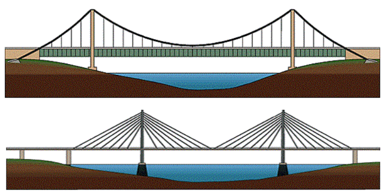






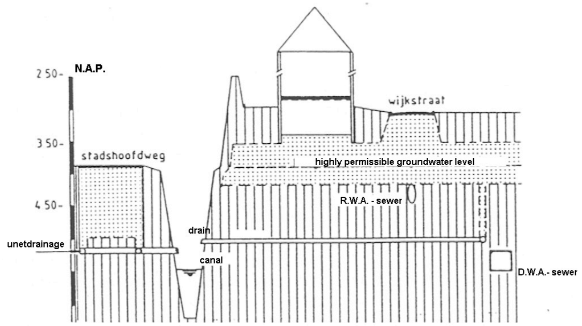


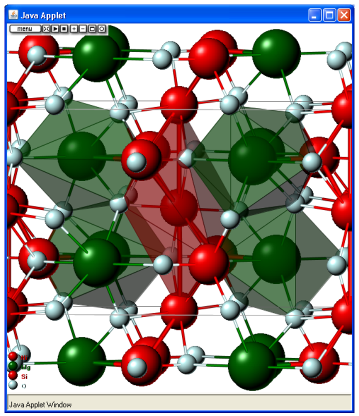


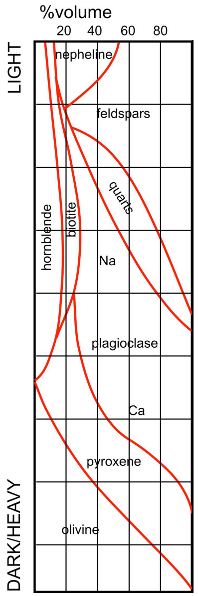


Earth

- soil
- site preparation
- terrestrial heat
- minerals



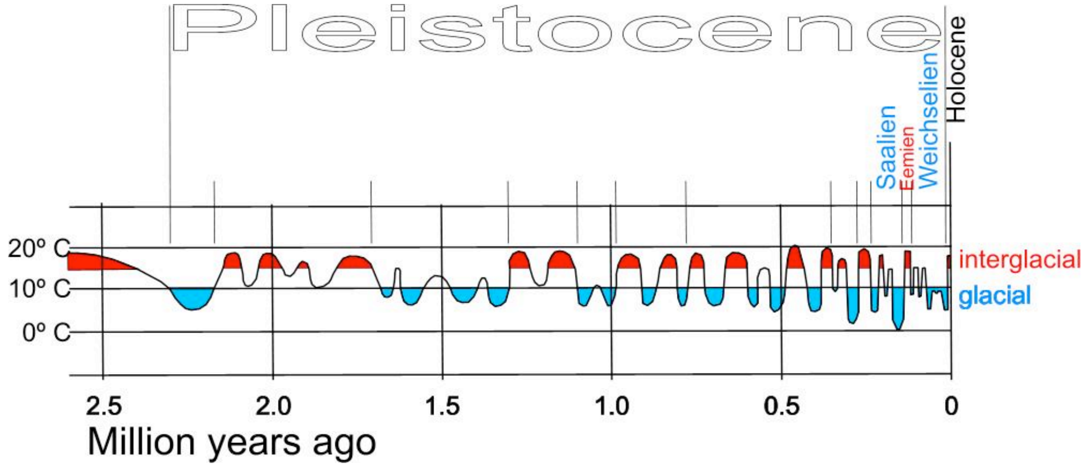


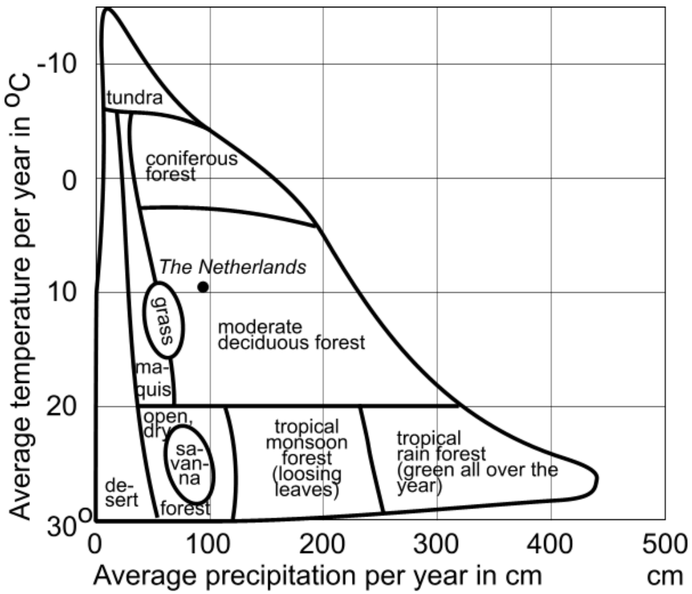


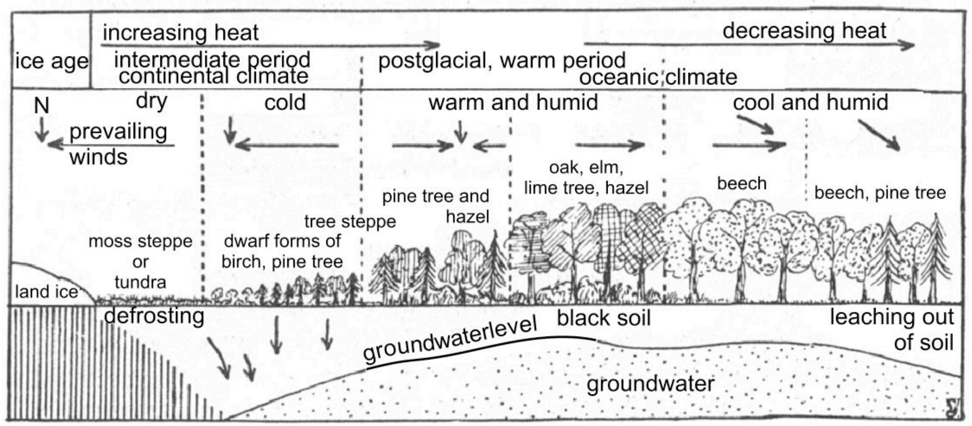
Heaviest mineral olivine, capturing CO_2 if brought to surface

Life, ecology

- natural history, geography
- ecology
- nature preservation

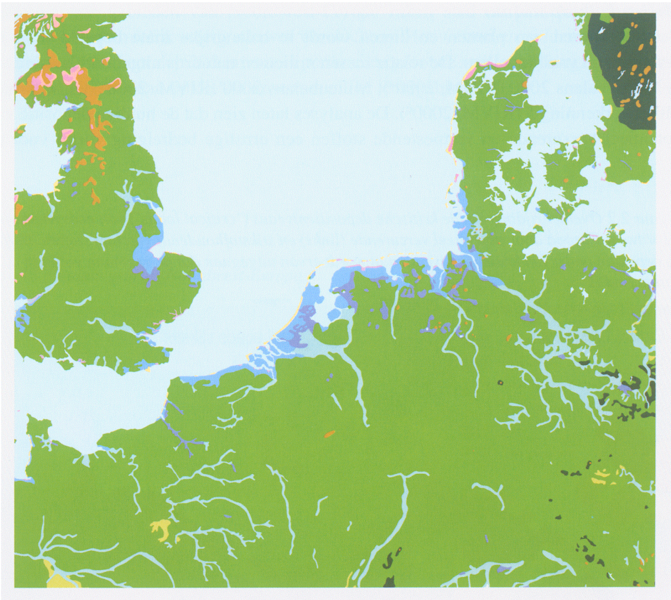




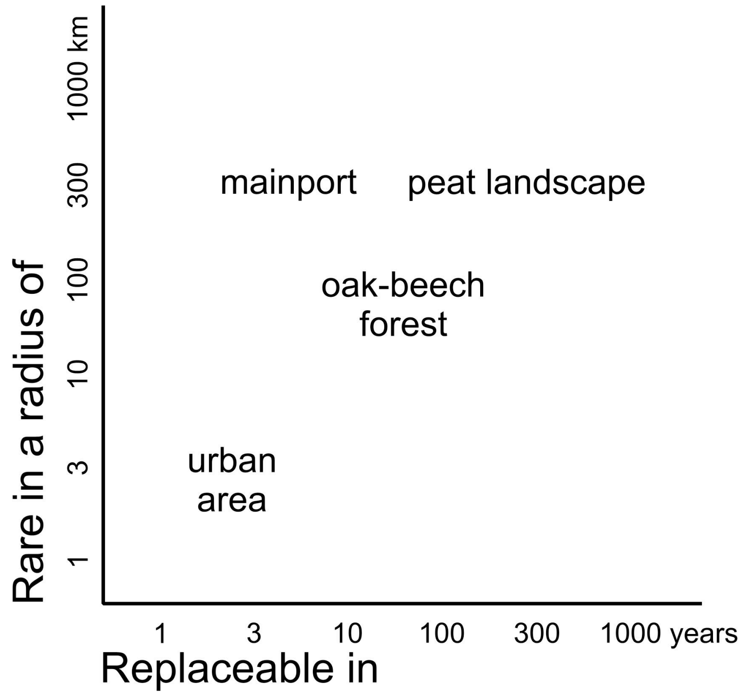


Change of vegetation by change of temperature

Ecological value(rarity, replacebility)

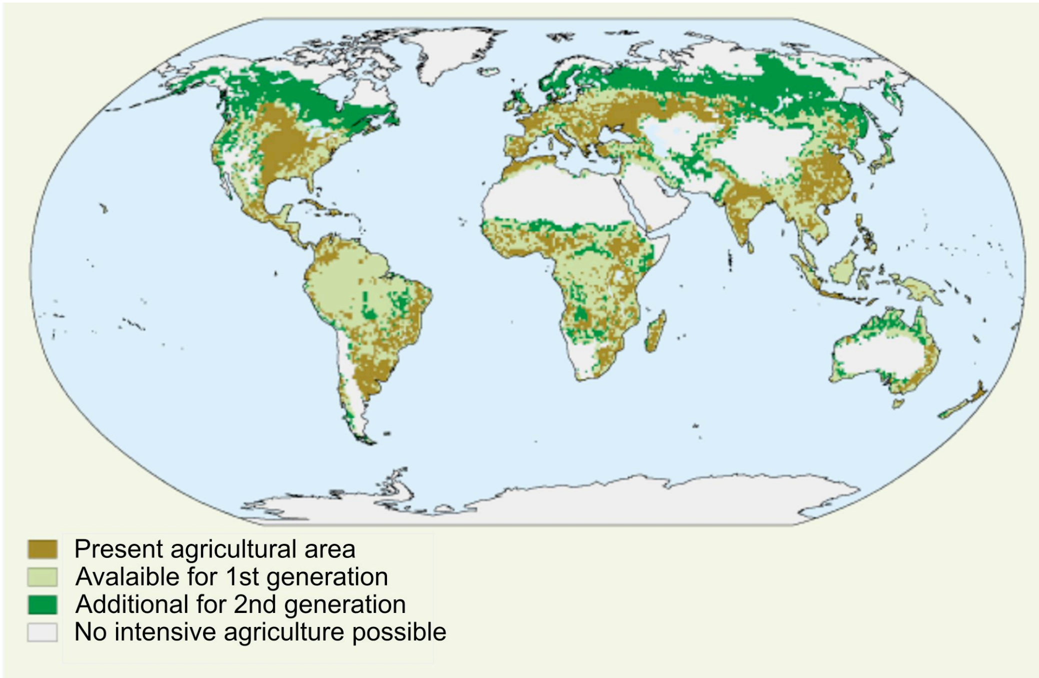


Continental ecological typology



Living

- human adaptation and accomodation
- habitat
- agriculture
- density
- economy
- environment



Less or more shadow of trees

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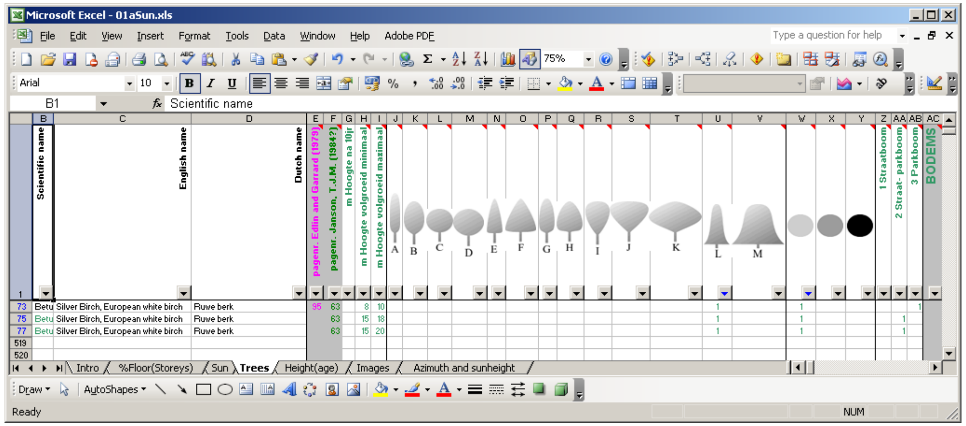
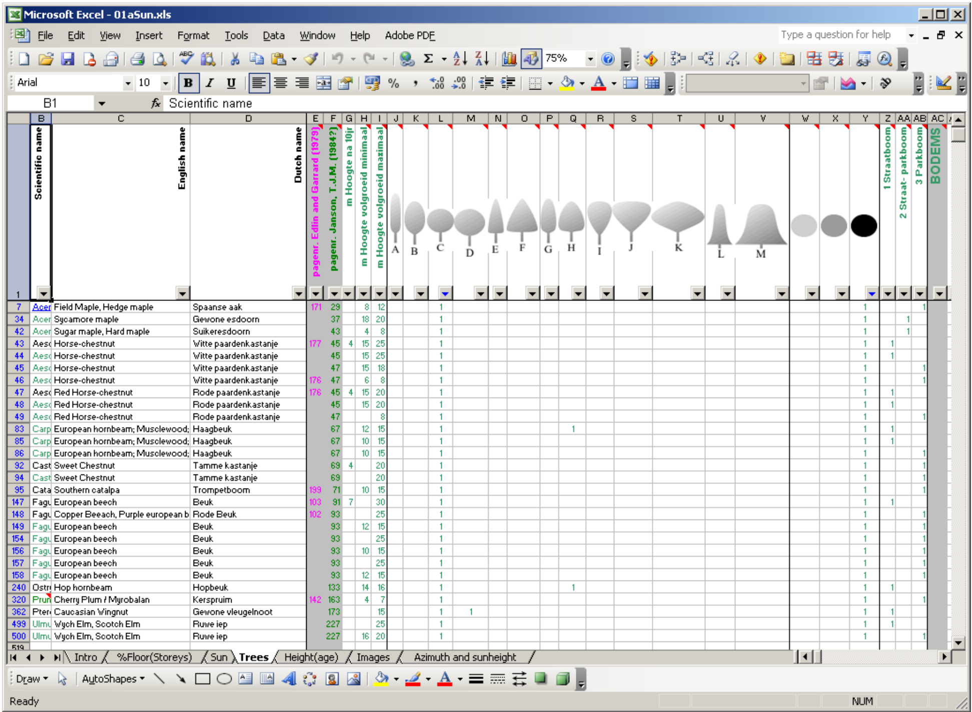
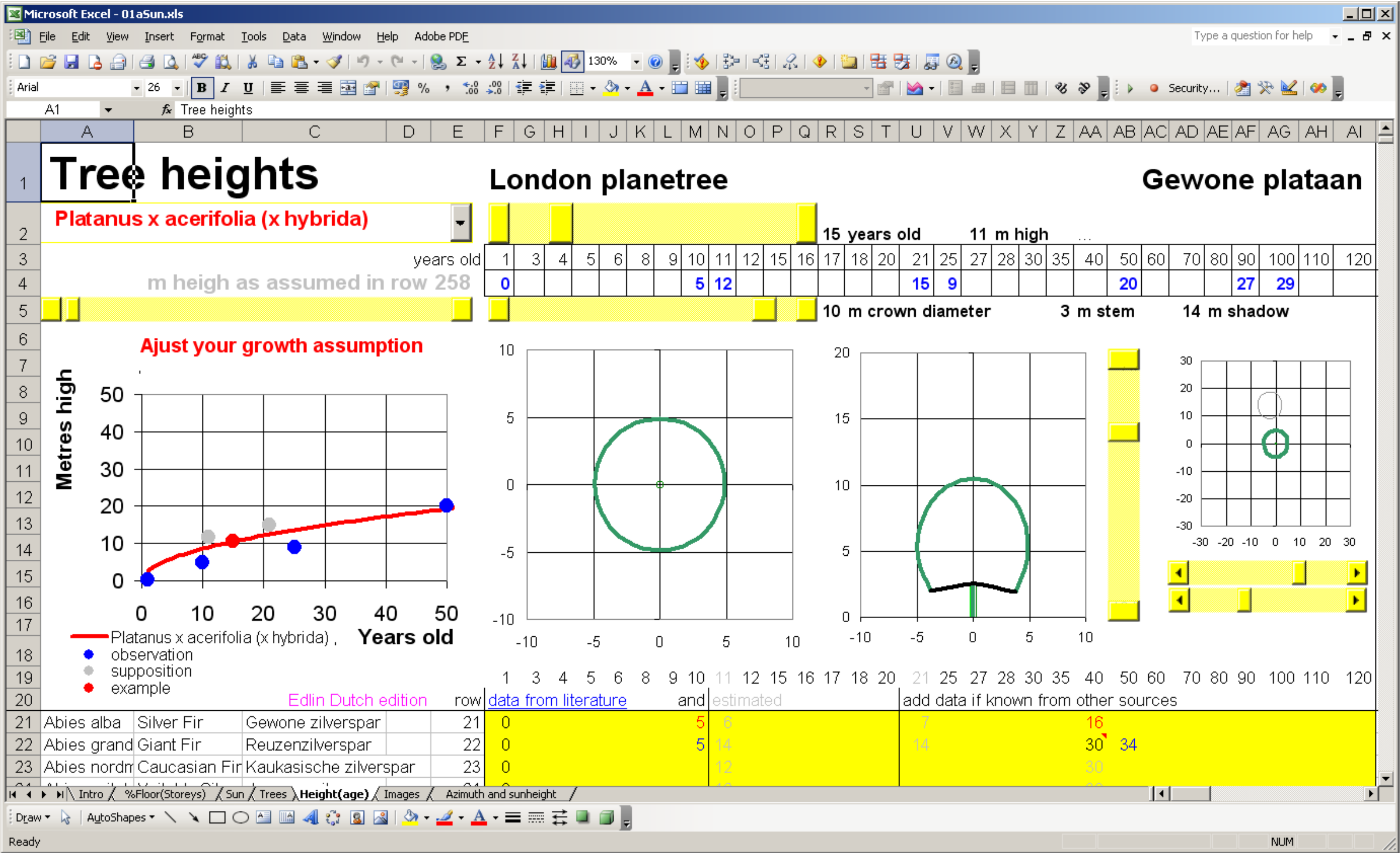




Simulating the growth of trees



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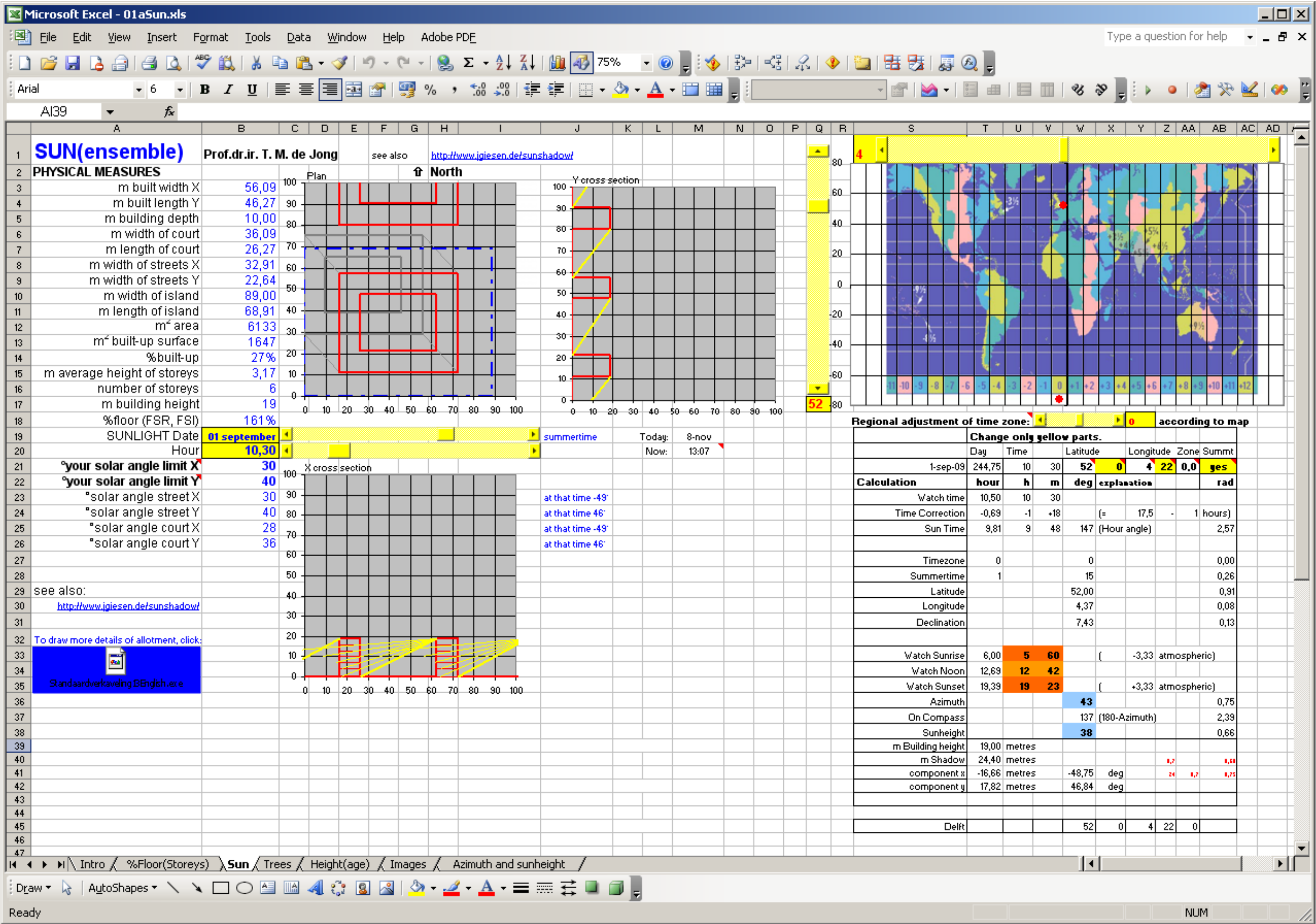
Shadows of buildings



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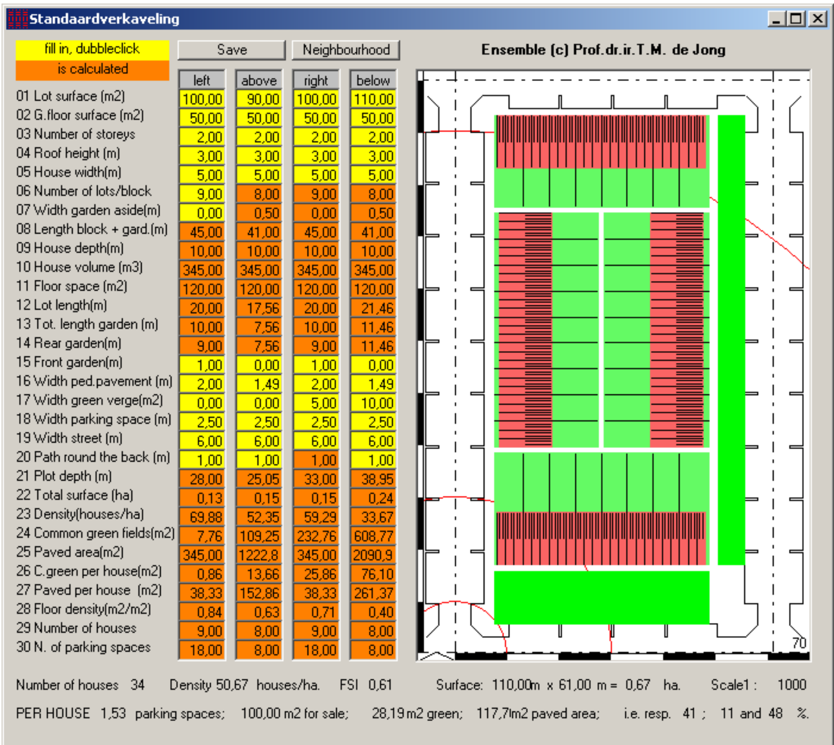
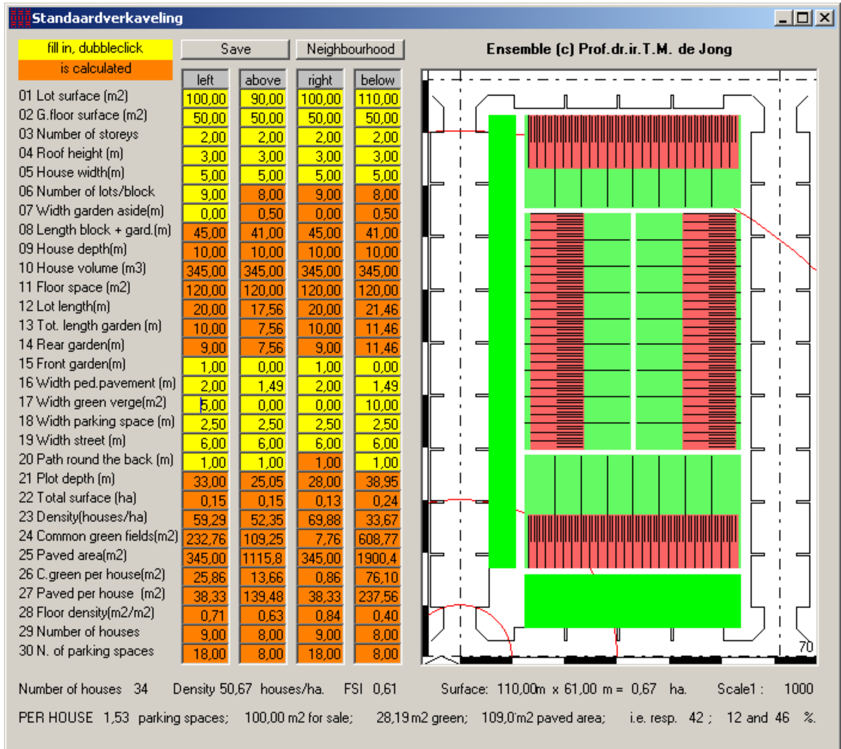
Sun in the morning or in the evening





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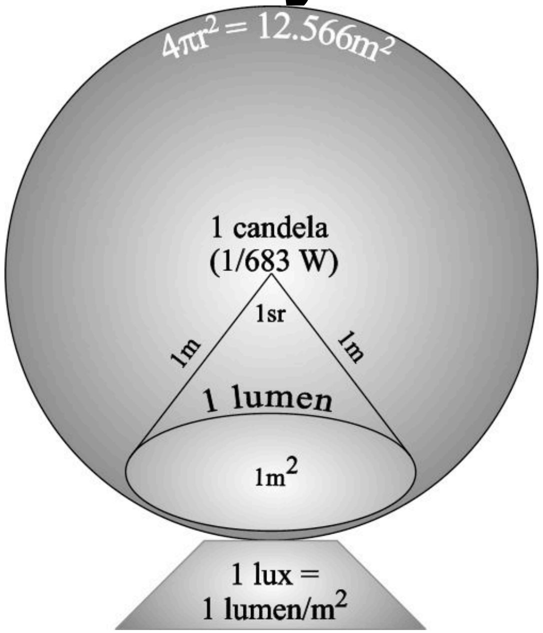
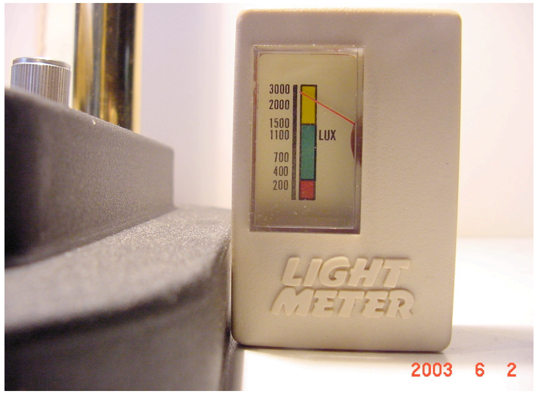
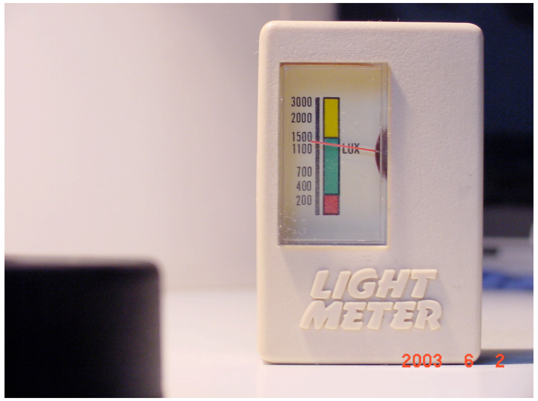
Light on your desk







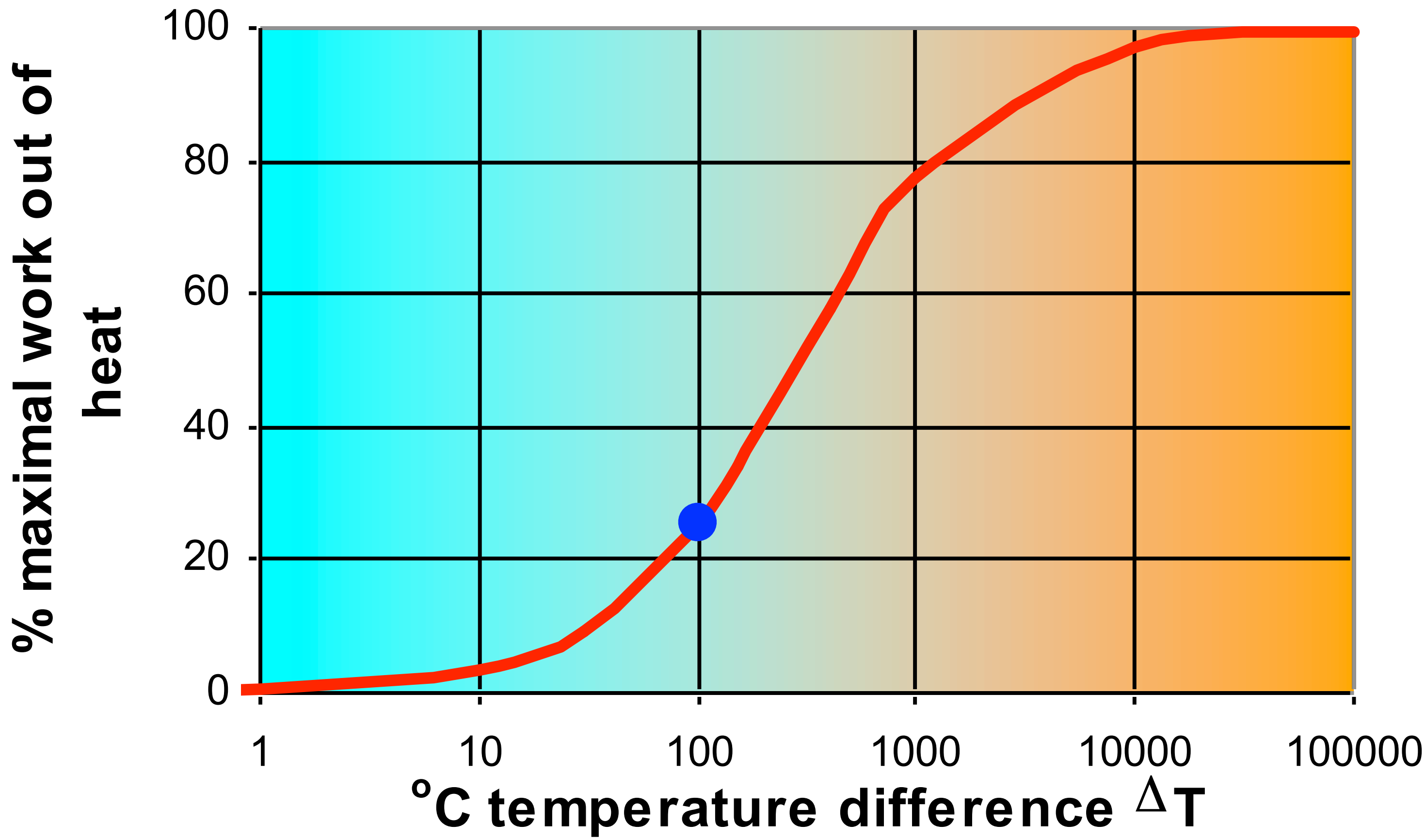
Dimensions useful in spatial design

- In spatial design the use of energy often has to be averaged over a year, counting 31 556 926 seconds.
- J=Ws, so: Wyear = ‘Wa’ = 31 556 926 J
- Wa=31.6MJ ~ 1litre petrol ~ 1m^3 gas ~ 1kg coal
- 31.6*31.6 ≈ 1000, so 31.6 * 31 556 926 J = 1 GJ
- So, the reverse GJ=31.6 Wa

Energy and power

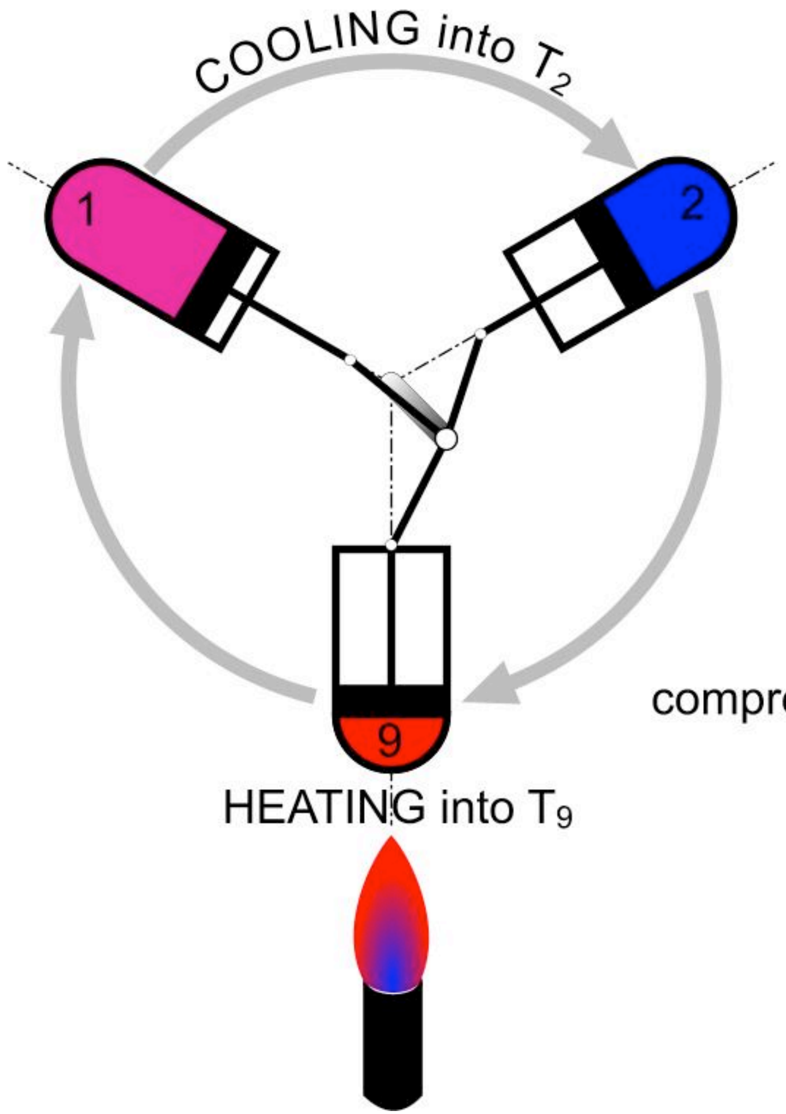
Speed and acceleration suppose distance and time:		
d (distance)	**d**	**d**
	-- = v (velocity)	**-- = a (acceleration)**
t (time)	**t**	**t^2**
Linear momentum and force persuppose mass, velocity and acceleration:		
	d	**d**
m (mass)	**-- m = i (momentum)**	**-- m = ma = f (force)**
	t	**t^2**
	x distance	*/ time*
	d^2	**d^2**
	-- m = e (energy)	**-- m = e/t = p (power)**
	t^2	**t^3**
Energy is expressed in joules (J), power (energy per second) in watts (W)		
	$J=kg*m^2/sec^2$	W = J/sec

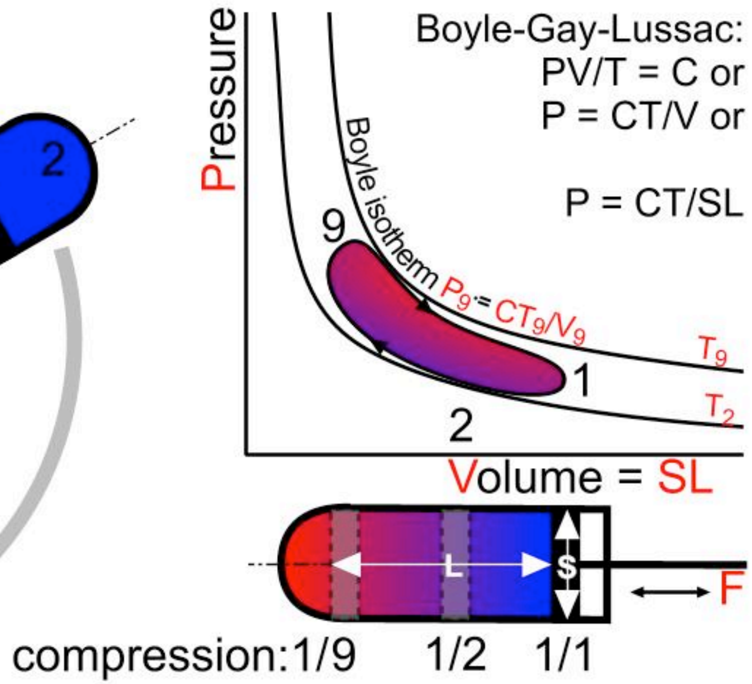
Exergy



100
80
60
40
20
0
% maximal work out of heat
1
10
100
1000
10000
100000
°C temperature difference ΔT

Carnot





$F = S \times P$ S= Surface piston (bore, Dutch: boring)

$F = SCT/SL$ L= Length (stroke, Dutch: slag)

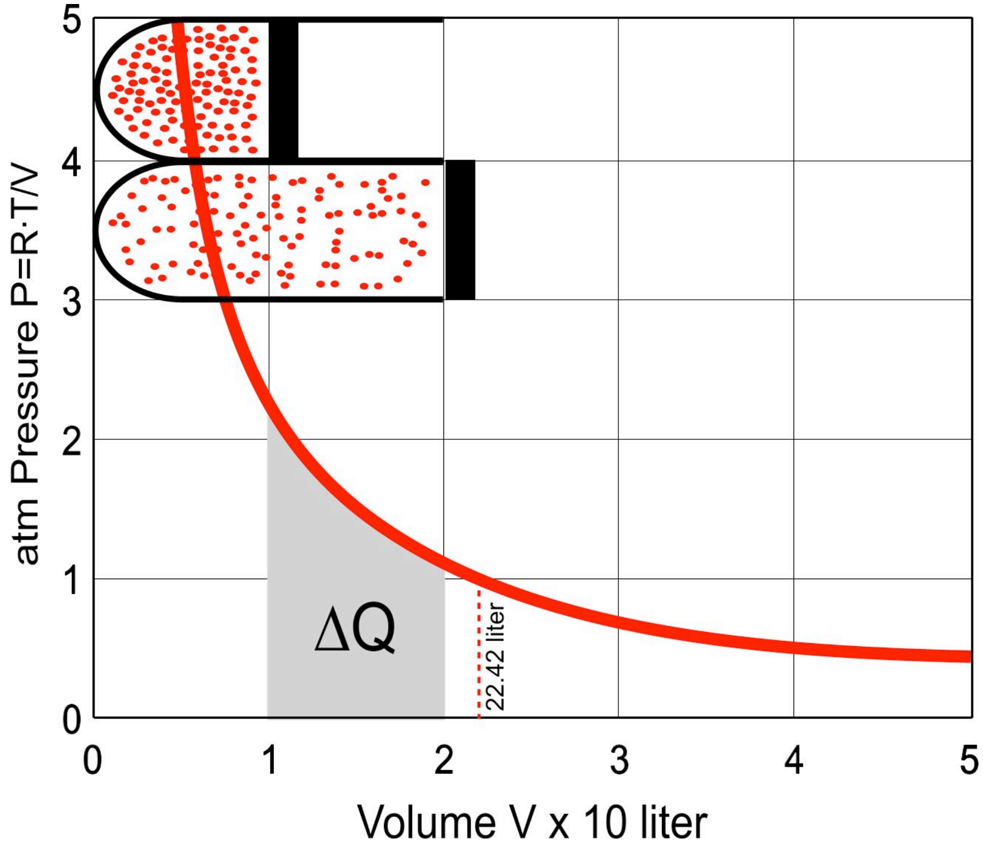
$F = CT/L$

$\Delta E = F \times \Delta L$

$\Delta E = C \Delta T \Delta L / L$

ΔQ=specific heat x mass/ΔT

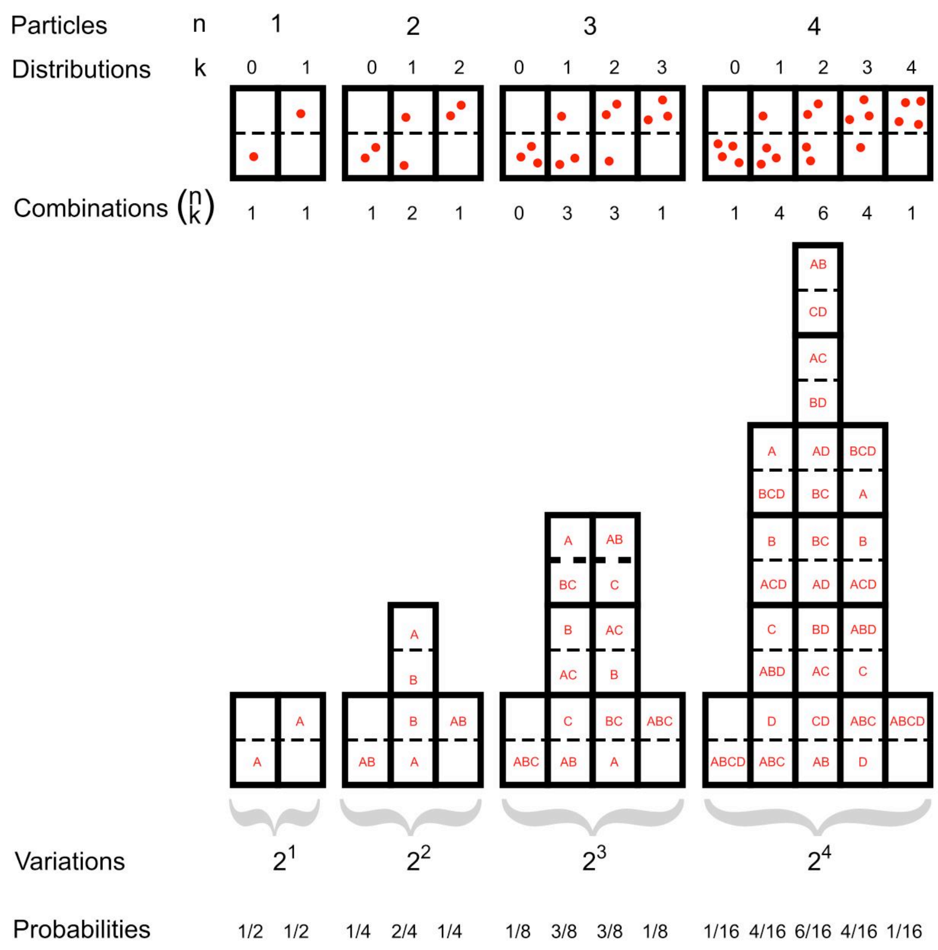
Added energy and entropy by sprawl



A mole of gas expanded at constant temperature increases heat content and entropy.

Urban sprawl causes increased movement and 'disorder'. Is there any relation?

The probability of sprawl

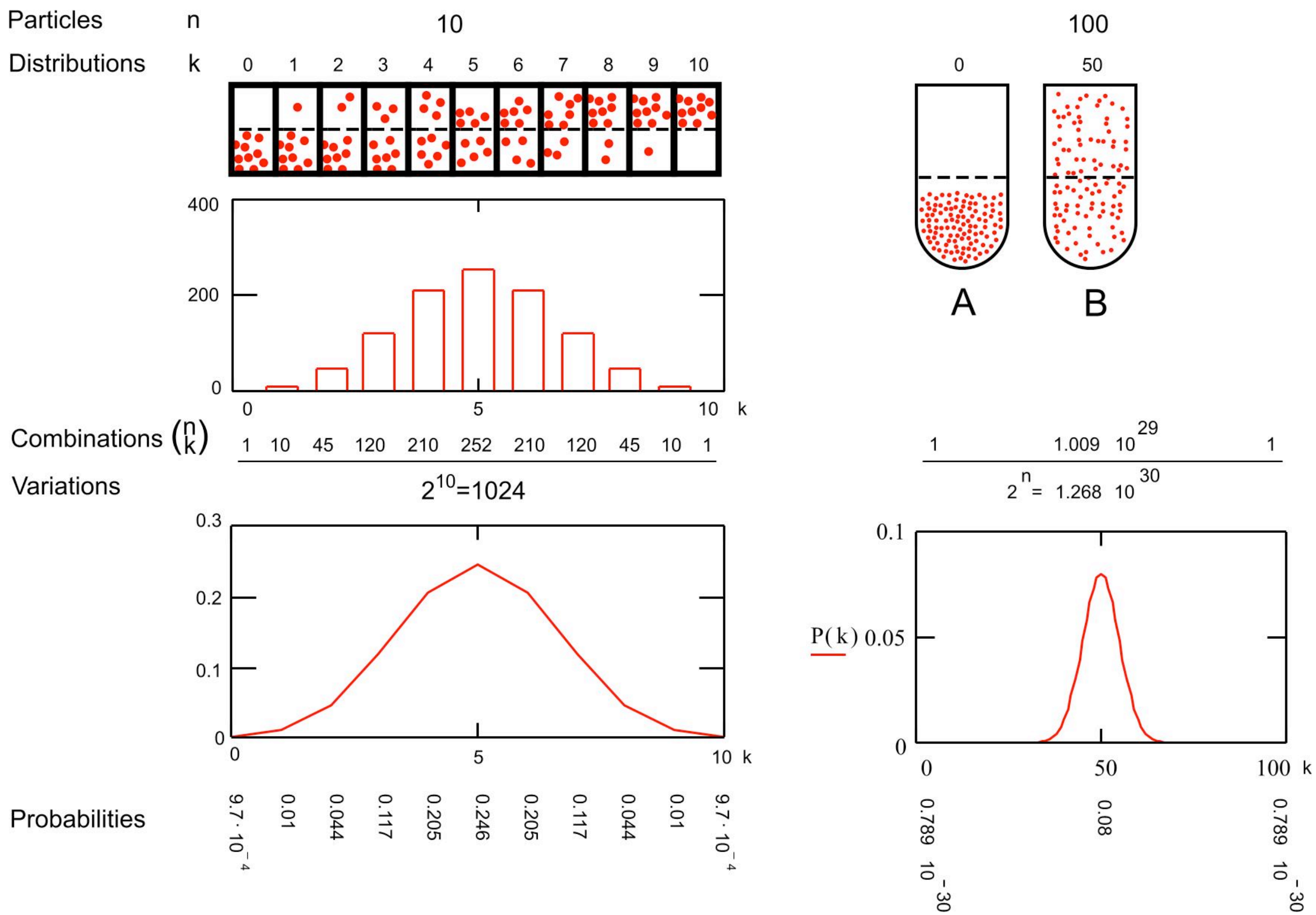


$$\binom{n}{k} = \frac{n!}{k!\cdot(n-k)!}$$

$$\sum_{k=0}^{n} \binom{n}{k} = 2^n$$

$$P(n,k) = \frac{\binom{n}{k}}{2^n}$$

Entropy



Particles
n
10
100
Distributions
k
0 1 2 3 4 5 6 7 8 9 10
0
50
A
B
400
200
0
0
5
10
k
Combinations (n k)
1 10 45 120 210 252 210 120 45 10 1
1
1.009 10^29
1
Variations
2^10=1024
2^n = 1.268 10^30
0.3
0.2
0.1
0
0
5
10
k
0.1
P(k) 0.05
0
0
50
100
k
Probabilities
9.7 · 10^-4
0.01
0.044
0.117
0.205
0.246
0.205
0.117
0.044
0.01
9.7 · 10^-4
0.789 10^-30
0.08
0.789 10^-30

Energy use

Table 1		Earth	The Netherlands	
coal	TW	3	0.02	0.45%
oil	TW	4	0.03	0.77%
gas	TW	2	0.05	2.14%
electricity	TW	2	see fossile	
traditional biomass	TW	1		
total	TW	13	0.1	0.73%

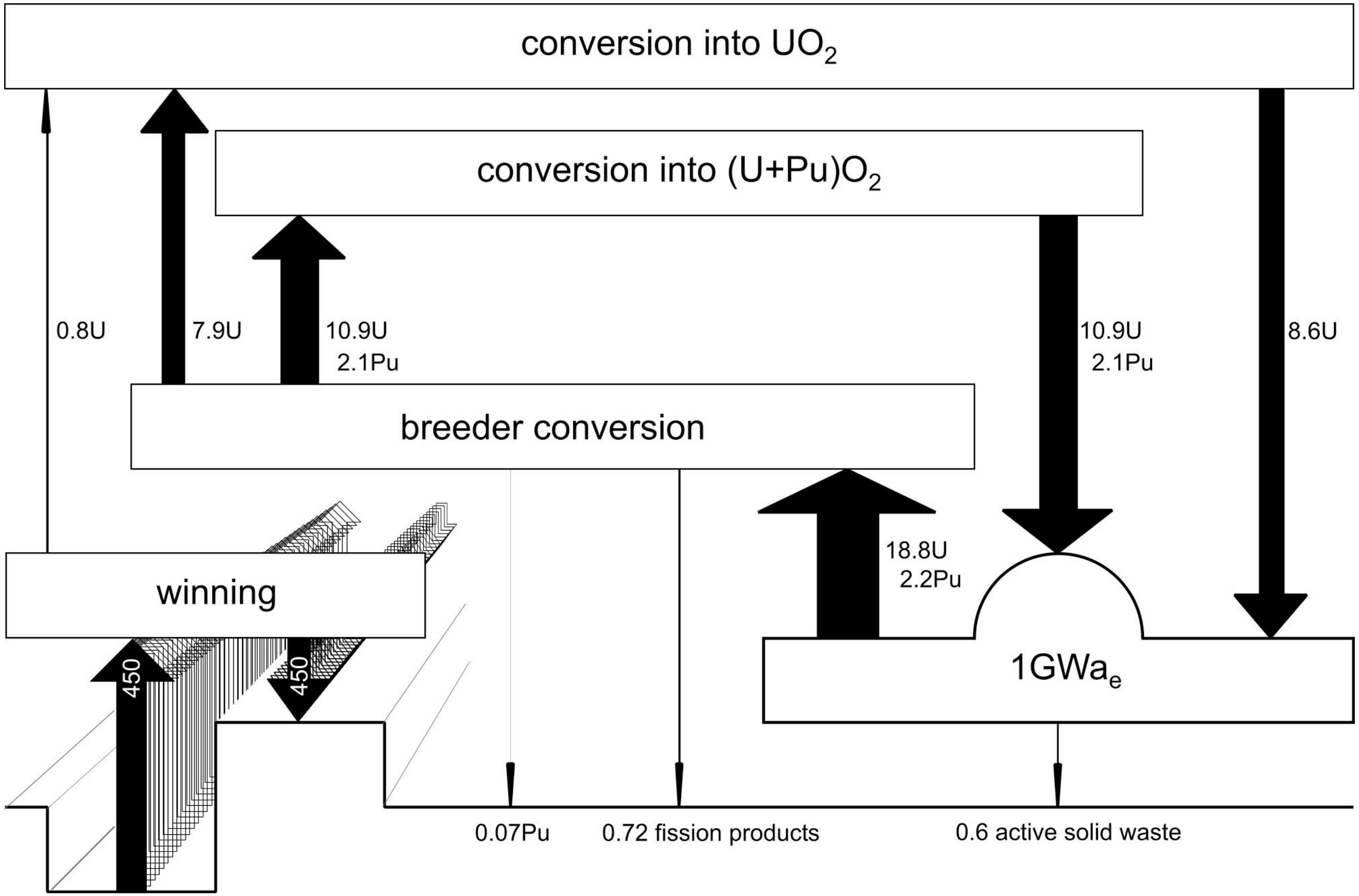
Fuel energy stock

Table 2		Earth	The Netherlands	
coal	TWa	1137	0,65	0,06%
oil	TWa	169	0,03	0,02%
gas	TWa	133	1,6	1,20%
total	TWa	1439	2,28	0,16%
Use per year: 13 Twa				

What we recieve from the Sun

		Earth	The Netherlands	
radius	Mm	6		
profile hit by sun	Mm^2	128		
spherical surface	Mm^2	509	0.1	0.02%
solar constant	TW/Mm^2	1353	832.99	61.57%
solar influx	TW	172259	33.83	0.02%
from which available				
sun 47% or 100W/m2	TW	80962	10.00	0.01%
wind 2%	TW	3445	0.68	0.02%
fotosynthesis 0,02%	TW	34	0.01	0.02%

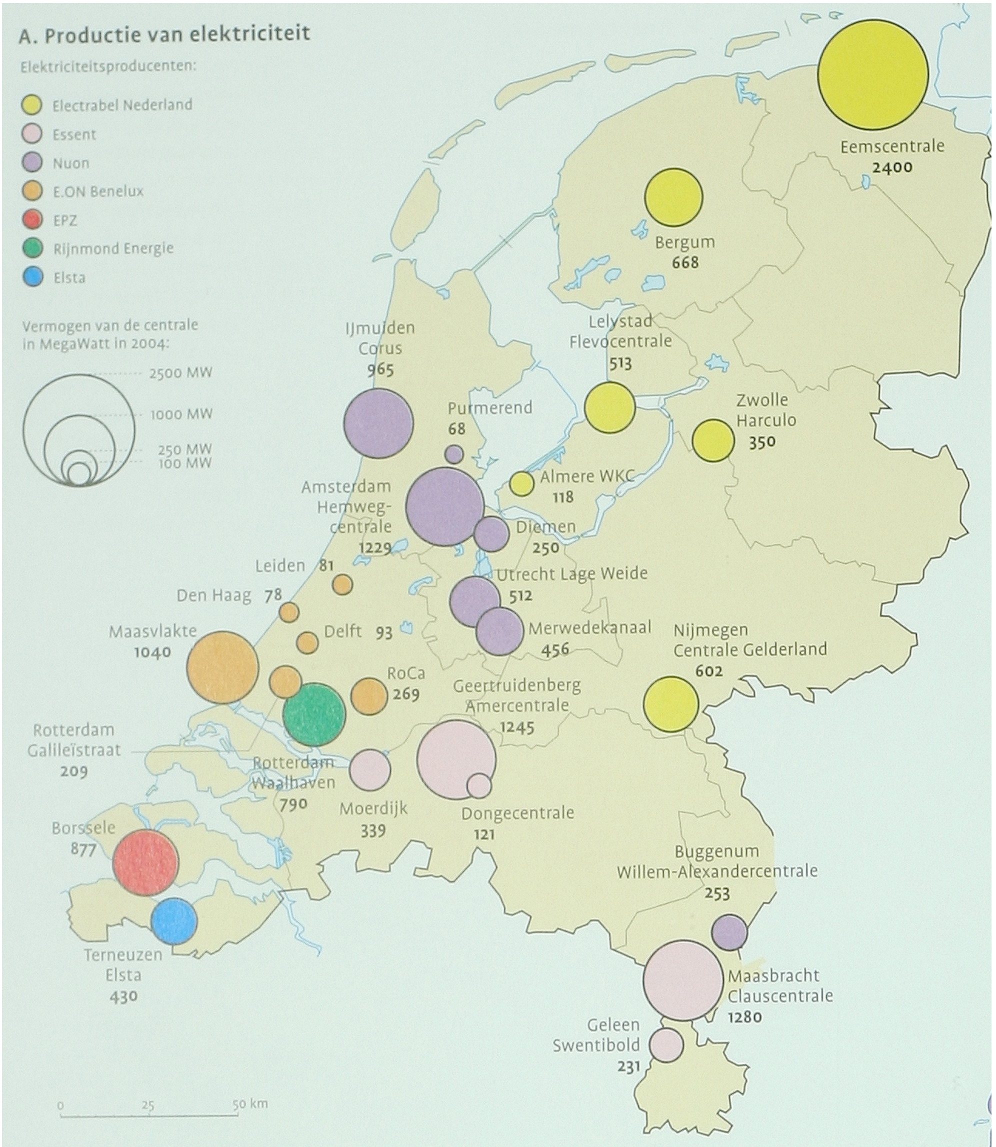
Nuclear energy



Wind, sun, biomass

			W/m^2
rounded total Dutch energy use	100000	MW	1
rounded Dutch electricity use	10000	MW	0.1
WIND			
over The Nederlands blows at le	680000	MW	6.8
after reduction by 0.03	17340	MW	0.17
required surface	577%		
SUN			
The Nederlands receives	10000000	MW	100
after reduction by 0.1	1000000	MW	10
required surface	10%		
BIOMASS			
The Nederlands receives	10000000	MW	100
after reduction by 0.01	100000	MW	1
required surface	100%		

Power stations



Flows of energy