Beyond Sustainability towards a Renewable Built Environment

KIVI Homelab 2050

Peter Luscuere

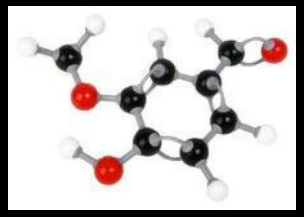
Delft University of Technology

Sustainability, different dimensions

Vectors: Energy, water, materials, top soil

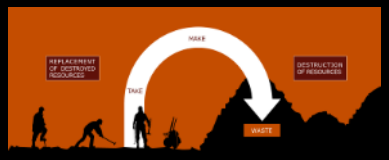
Challenges (Environmental liabilities):

- Biodiversity
- Health effects
- Climate Change
- Scarcity



Scale level, from

- Molecular to
- Biosphere



Non-Sustainable

- Natural resources
  - Depletion
    - Energy
    - Materials
    - Water
    - Top Soil
  - Effects consumption
    - Scarcity
    - Health Effects
    - Biodiversity
    - Climate Change

Non-Sustainable

- Natural resources
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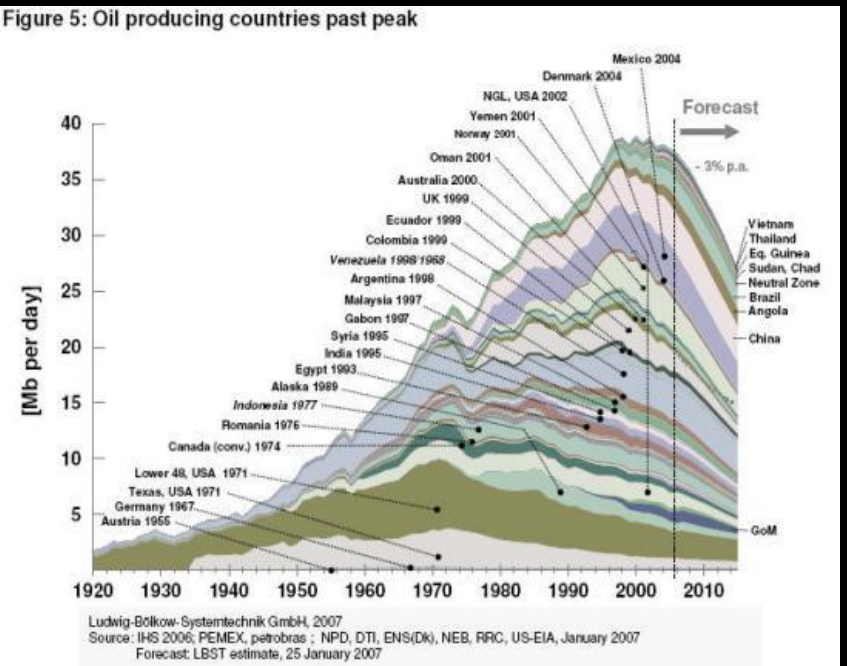
<u>Burning Fossil Fuels</u>
CO_2
NO_x
SO_2
Fine particles



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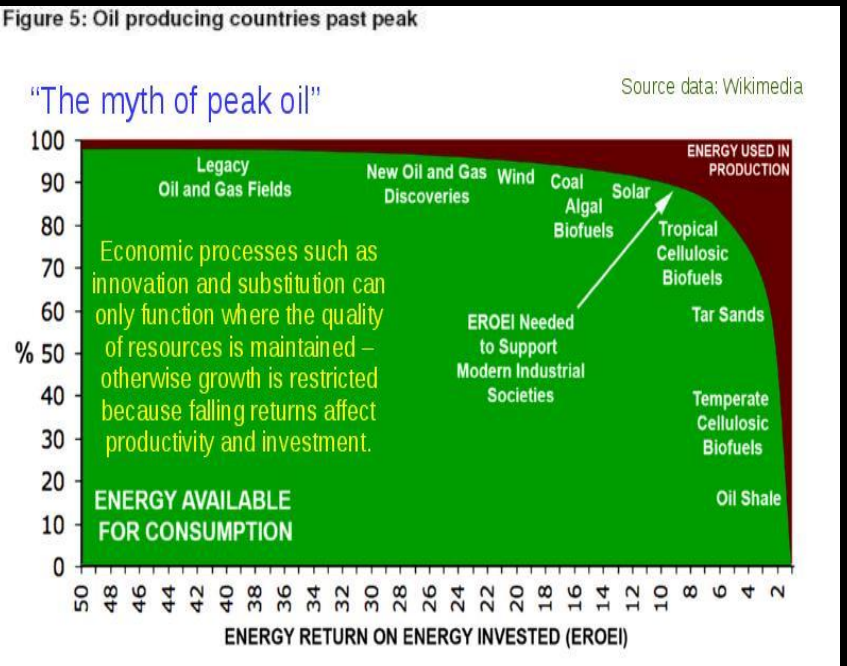

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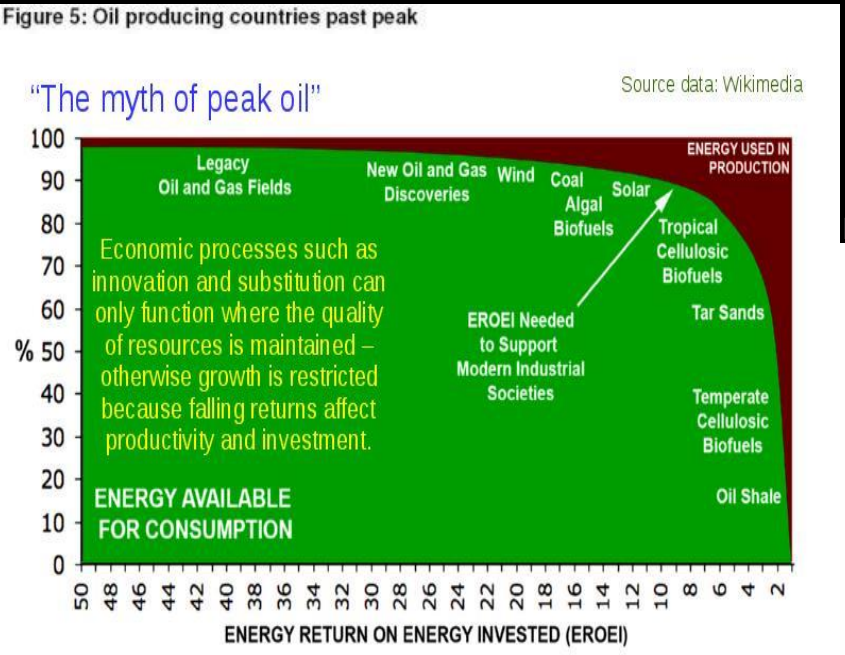
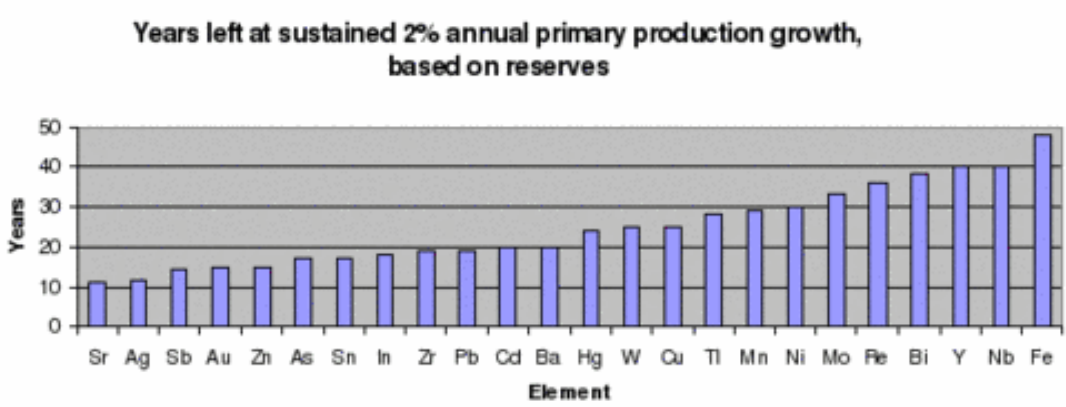
Figure 5: Oil producing countries past peak



http://www.theoildrum.com/



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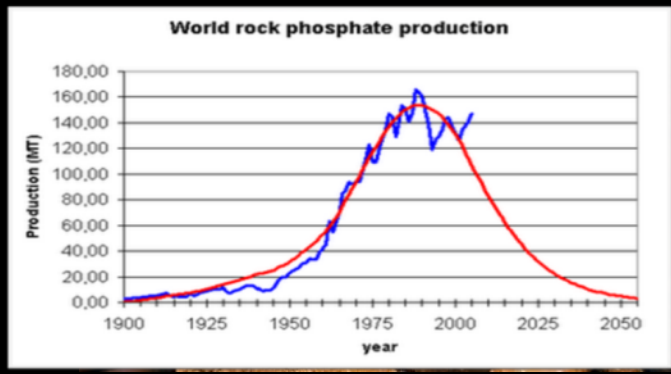

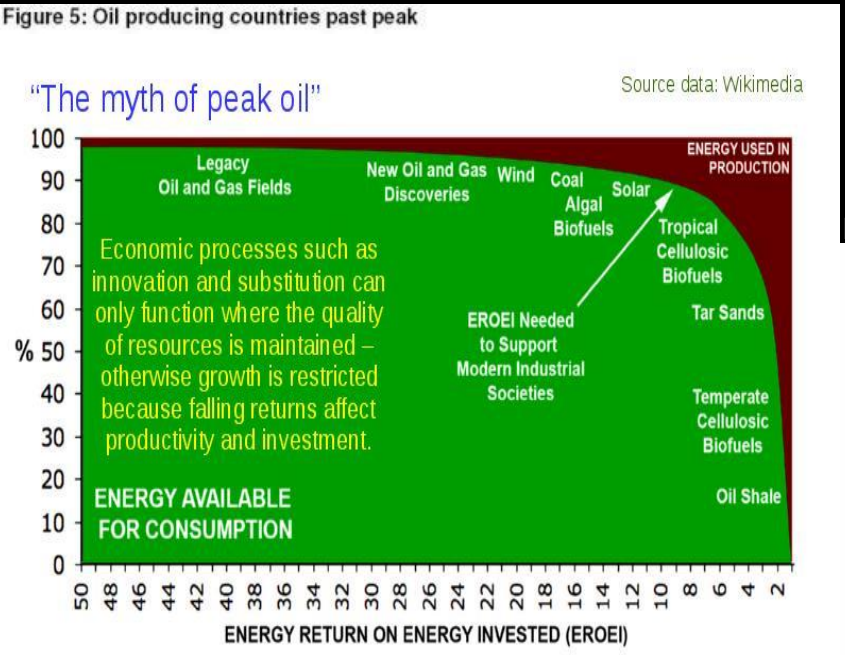

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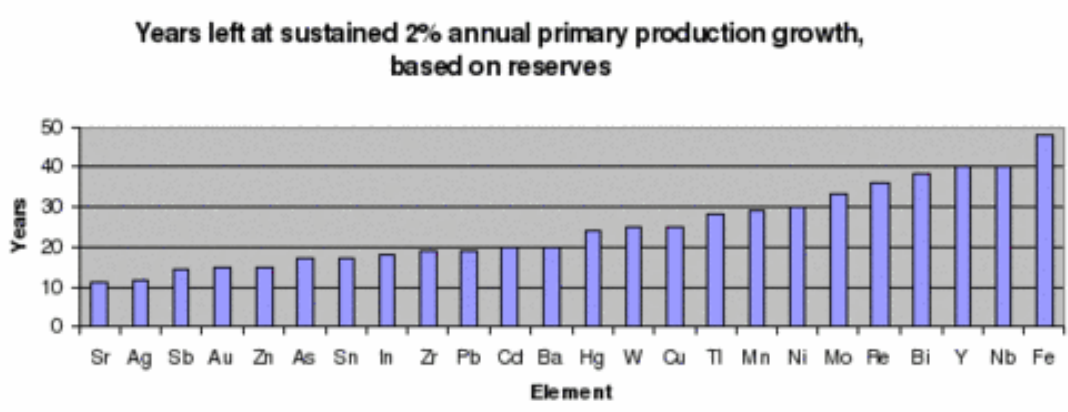

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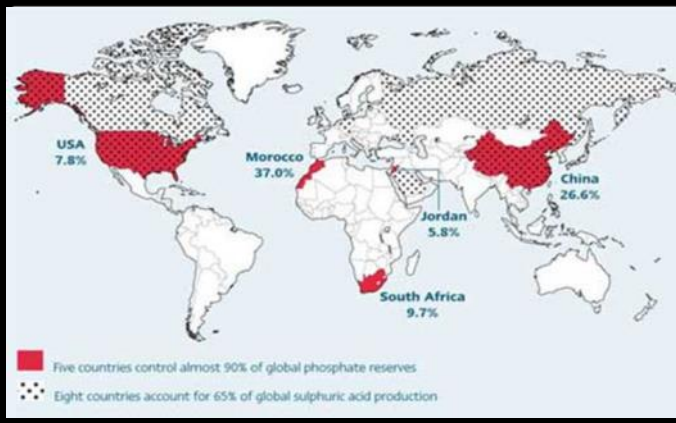

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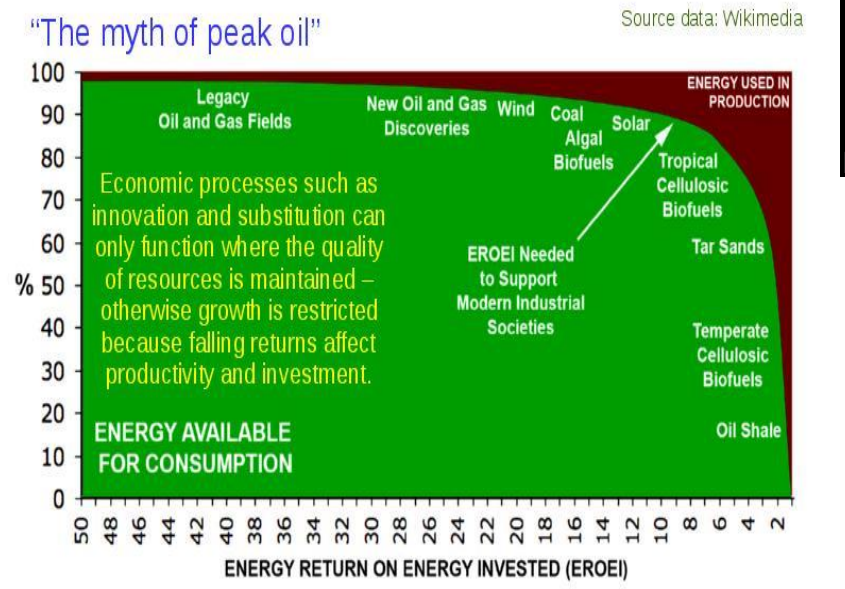

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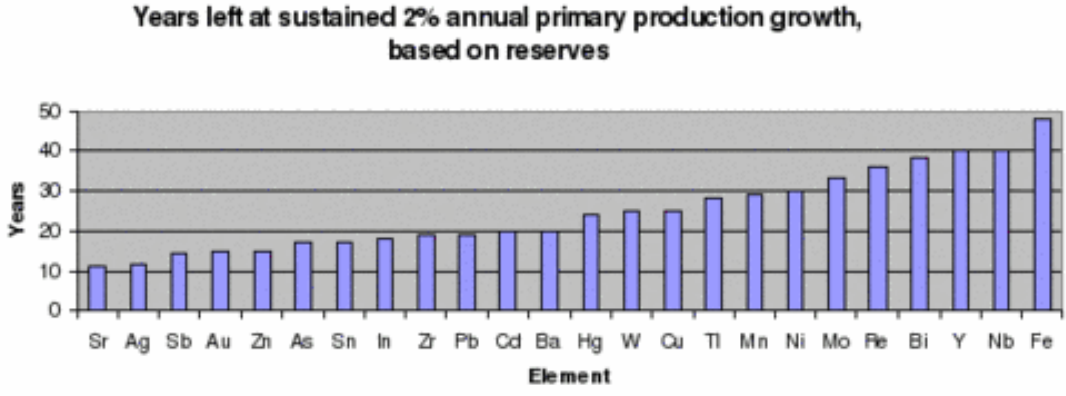

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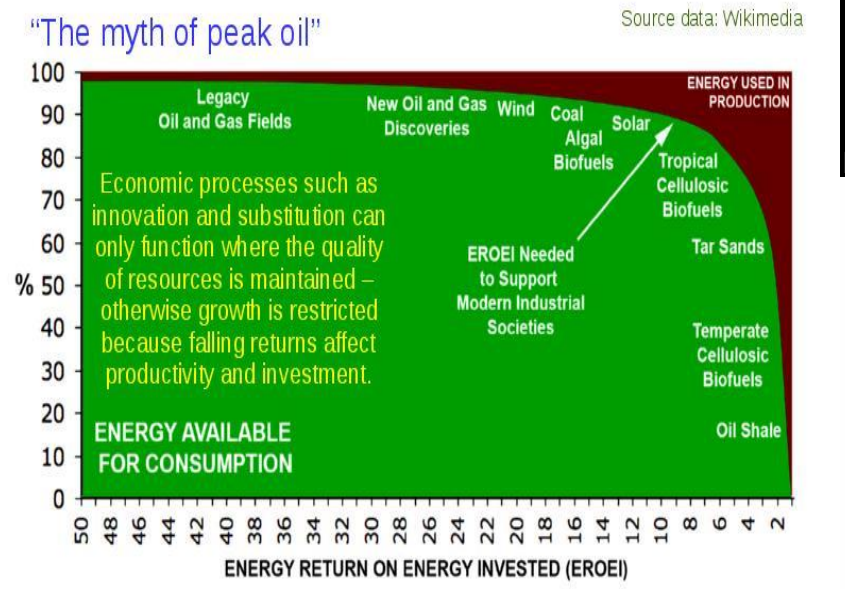

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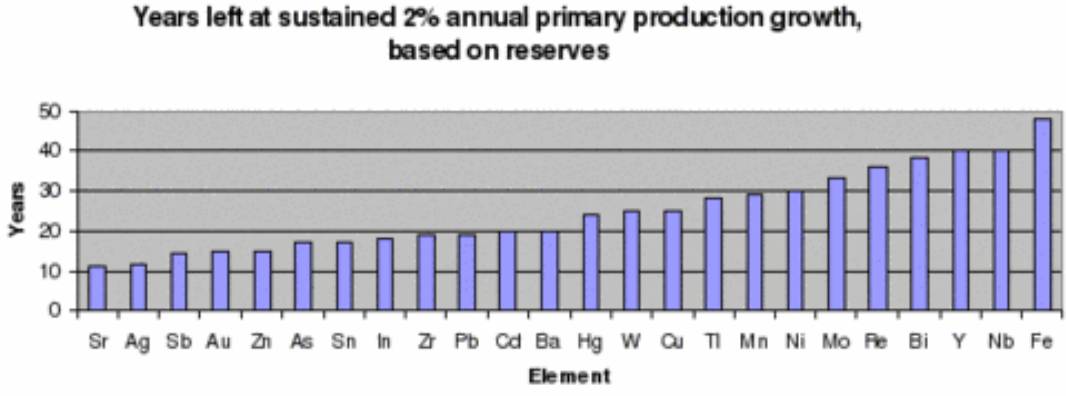

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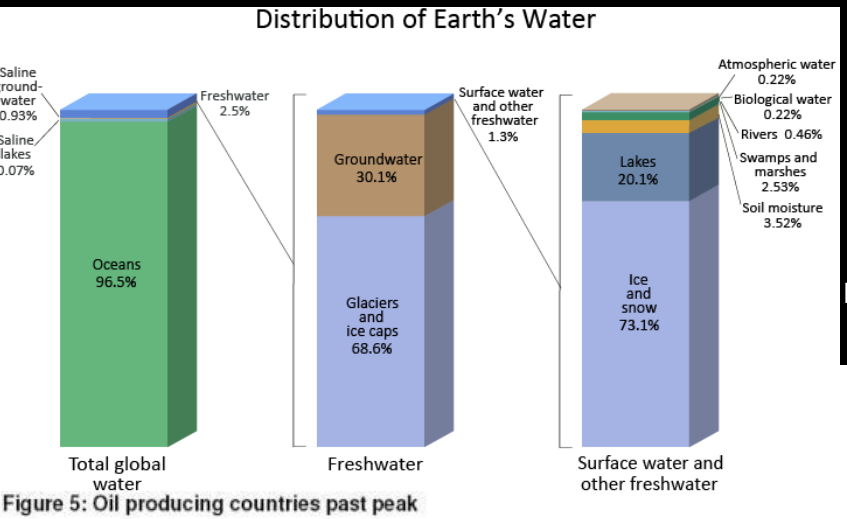


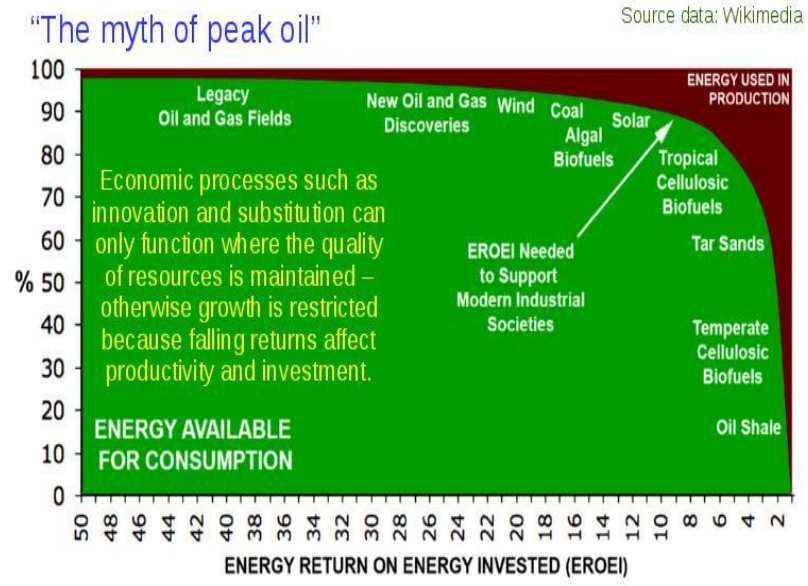
Figure 5: Oil producing countries past peak

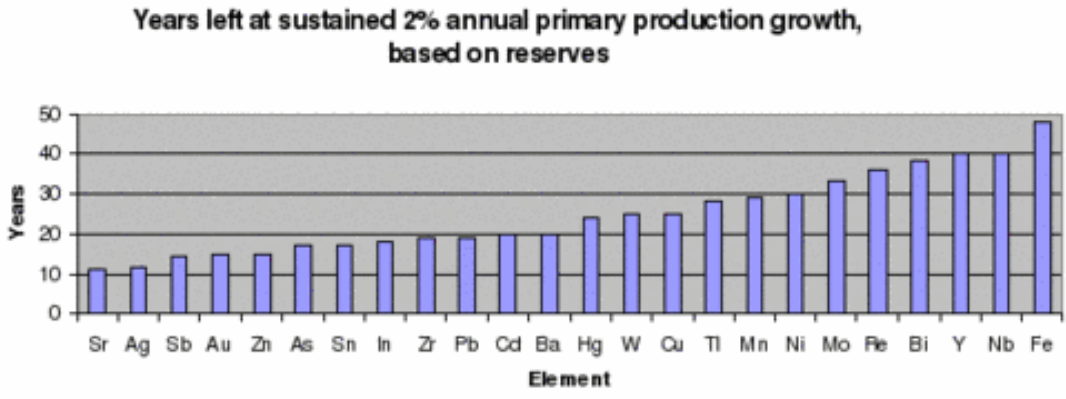
Source: USGS

How many cups of water needed?

Water in the world
2,5 % Fresh
1,3 % at Surface
26,9 % non Frozen

Available:
87 ppm !





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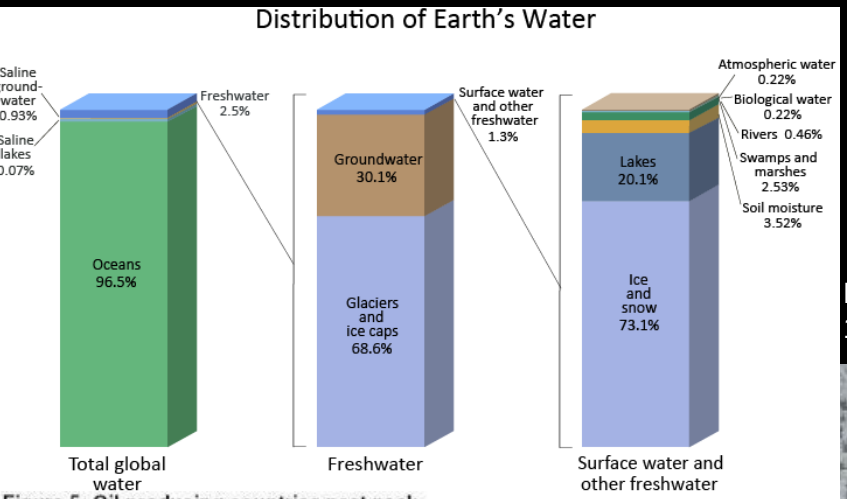
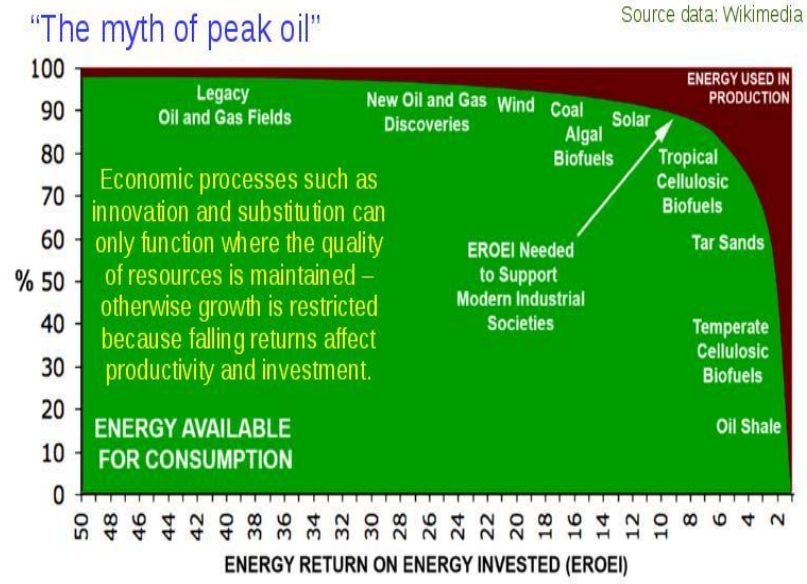


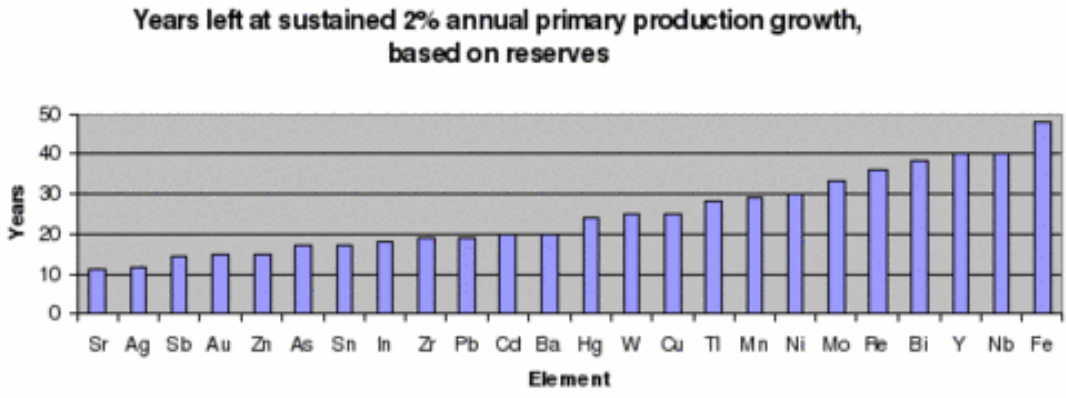
Figure 5: Oil producing countries past peak

Source: USGS

How many cups of water needed?
1,100 !! www.waterfootprint.org

Source data: Wikimedia





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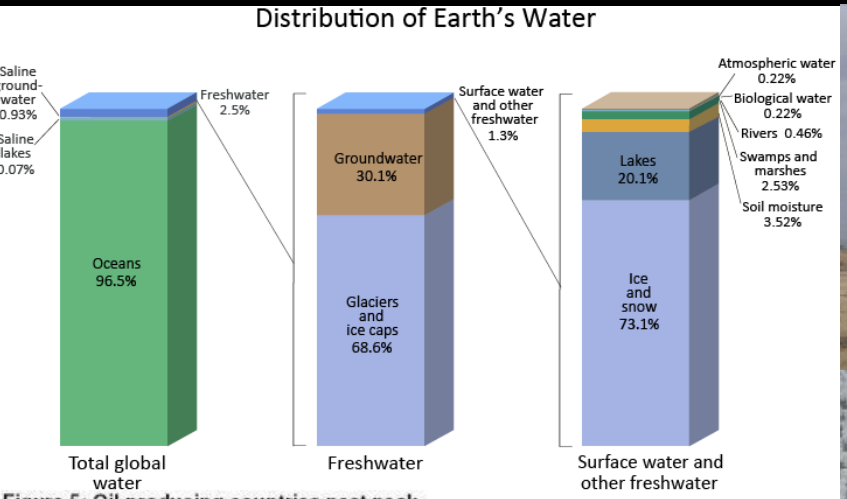

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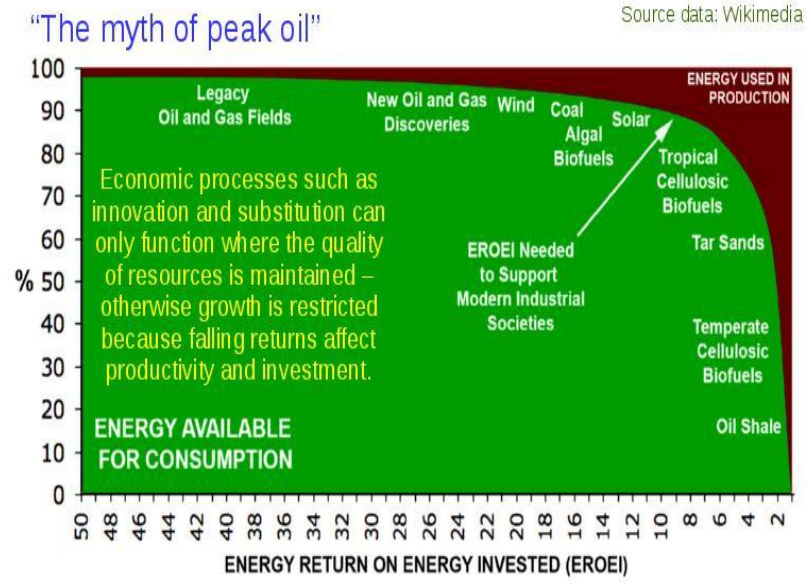
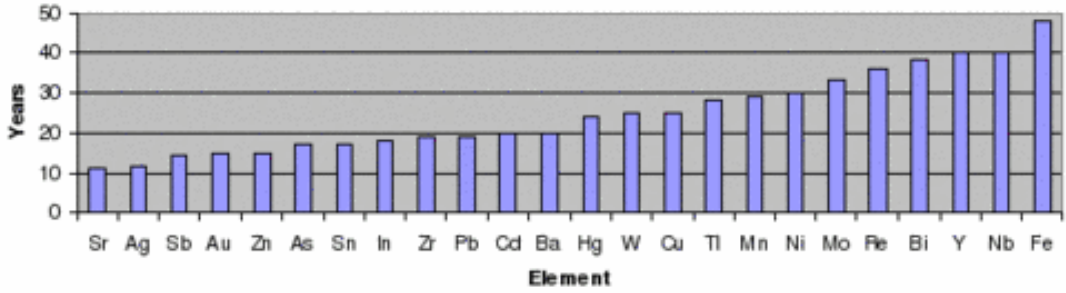


Desertification

Years left at sustained 2% annual primary production growth, based on reserves



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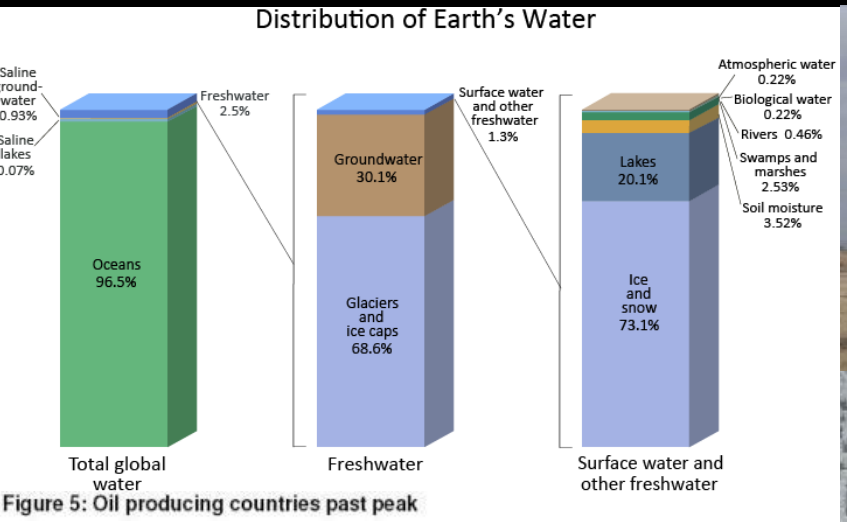
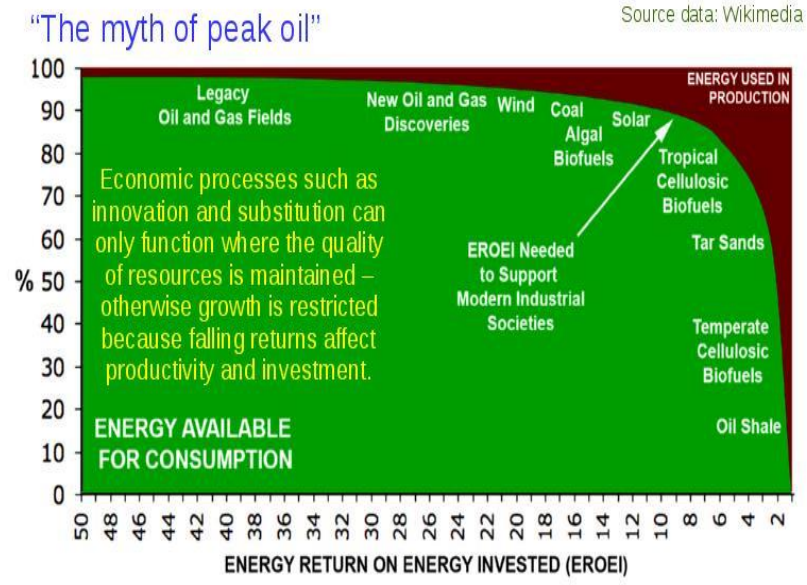
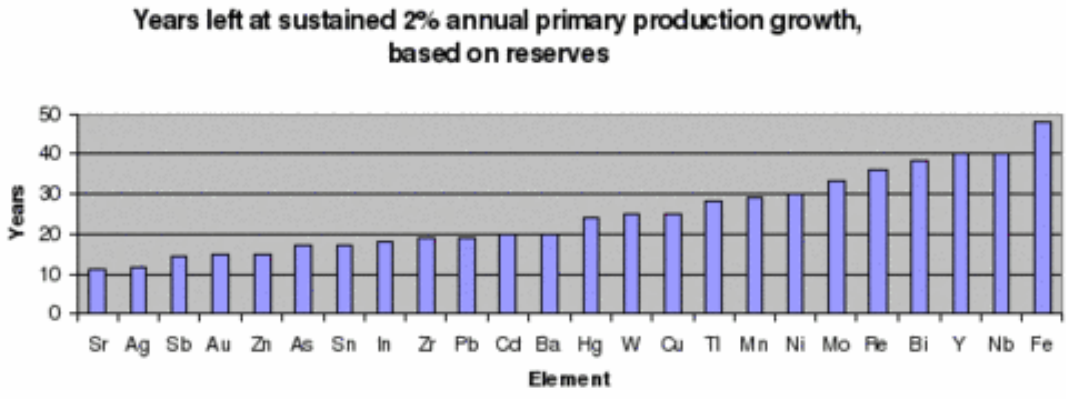


Figure 5: Oil producing countries past peak

Desertification
Deforestation





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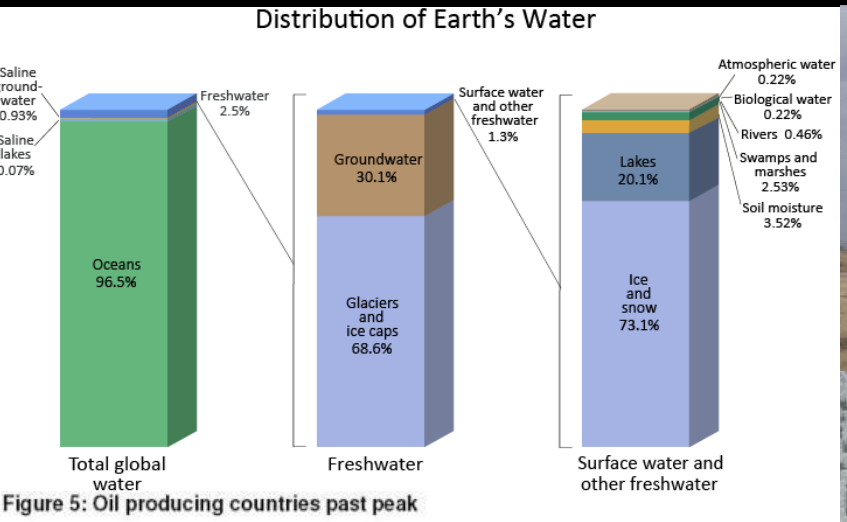

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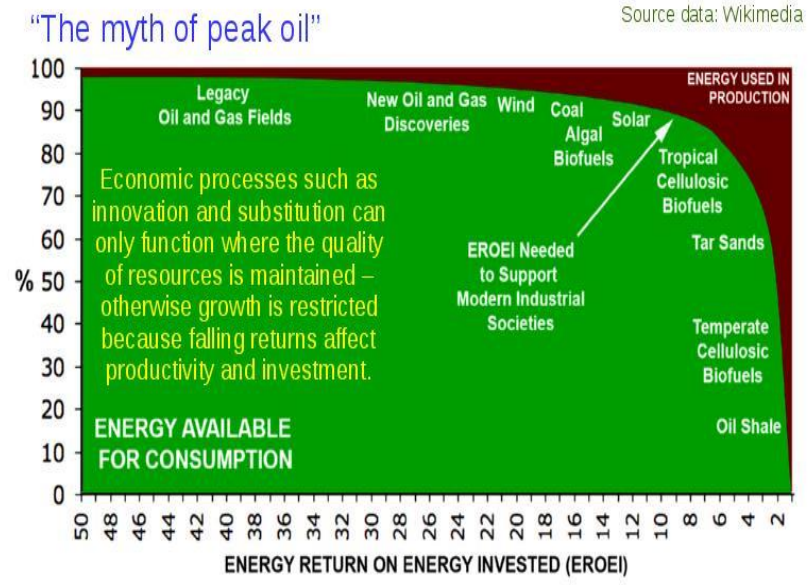
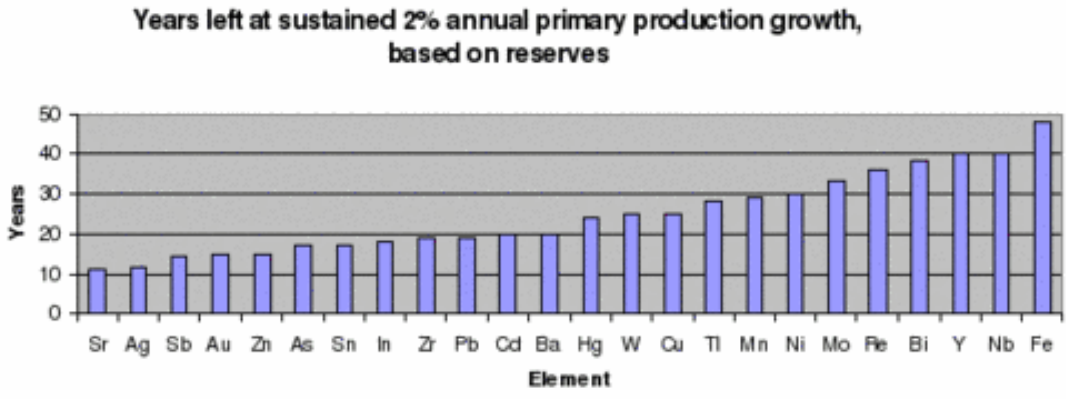


Desertification
Deforestation
Blowin' in the wind



Challenges, Solutions, Ambitions and Judgment

Environmental Challenges / Solutions / Ambitions and Judgment model v 9.2, Prof.ir.P.G. Luscuere December 16th 2014

		VALUES							
		Challenges, Solutions, Ambitions				Judgment			
		Ecology			Economy			Equity	
Vectors		Biodiversity	Health Effects	Climate Change	Scarcity	Cost / Benefits	PR Metaphor	Social Responsibility	Fairness
Energy	Challenge	SO_2, Acid rain	NOx, PM 2.5	CO_2	Fossil fuels	Pay Back Time Life Cycle Analysis Total Cost of Ownership Life Cycle Costing Hard & Soft Costs and Benefits	"Net Positive"	Energy Positive Buildings	"Supergrid"
	Solutions	Solar-, Wind-, Environmental-, Geothermal Energy and Highly Productive Biofuels (Algae)							
Water	Challenge	Contaminated Water	Hormone & Medicine Residues		Fresh Water		"Clean"	Cleaner Discharge as Intake	Over Consumption & Pollution
	Solutions	Algae, Nutrition Regeneration							
Materials	Challenge	Waste *)	Hazardous Emissions	Chlorofluorocarbons	Virgin Materials		"Healthy"	Actively Cleaning Buildings	Illegal Waste Dumps (Proba Koala)
	Solutions	Non-Toxic, -Carcinogenic or –Mutagenic Substances, From Down- to Up-Cycling							
Top Soil	Challenge	Loss & Degradation	Contamination	CH_4 - Emissions	Phosphate		"Fertile"	Positive Contribution to Top Soil Production	Use of Tropical Hardwood
	Solutions	Apply Green Roofs & Walls, Close Cycles, Recovery of Nutrients							

*) Toxic-, Carcinogenic- or Mutagenic

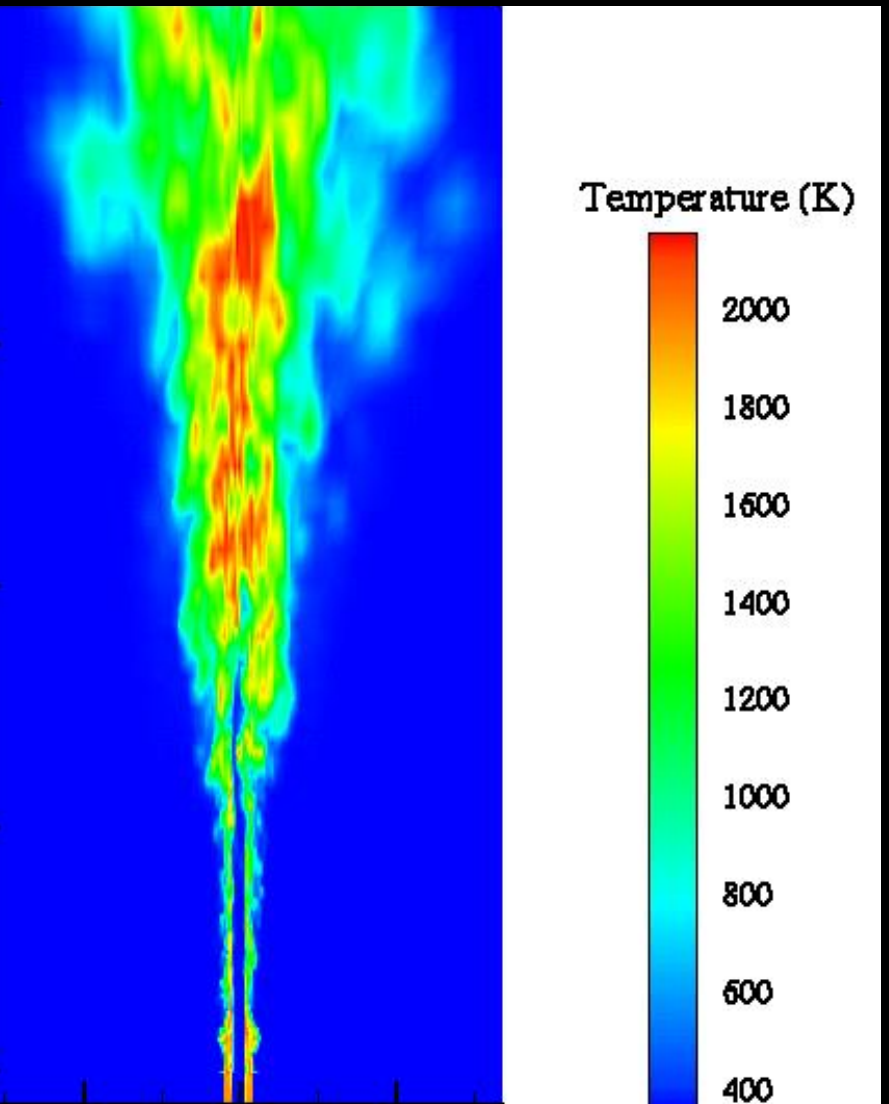
Source: Steven Beckers

Effectiveness

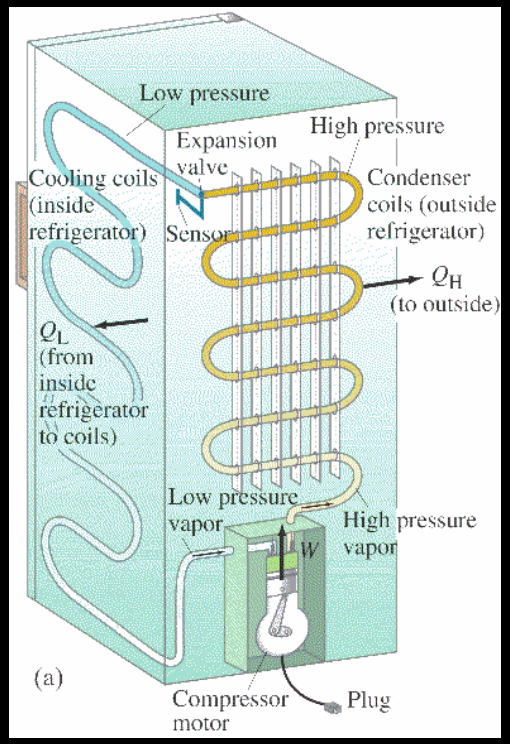
With positive footprints we can realise **effective** solutions which are **beneficial** to us!

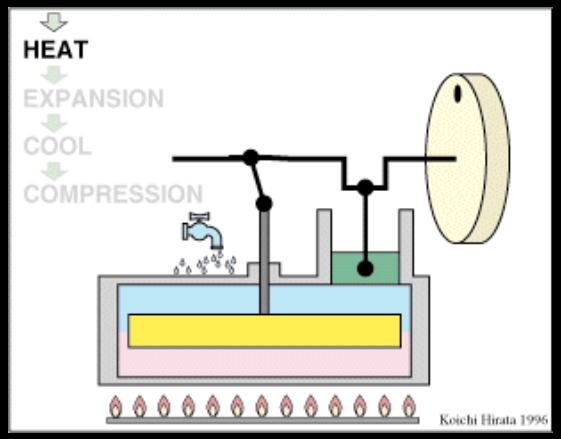
- **Efficiency is doing things right**
- **Effectiveness is doing the right things**

High boiler efficiency, or not?



Exergy of heat





Heat (°C)	Exergy (%)	**Exergy loss (%)**
1200	80	**20**
1000	77	**23**
800	73	**27**
600	66	**34**
400	57	**43**
200	38	**62**
100	21	**79**
80	17	**83**
40	6	**94**
30	3	**97**
20	0	**100**

$Ex(Q) = Q * (1 - T_0/T)$ (T_0=293 K, or 20 °C)

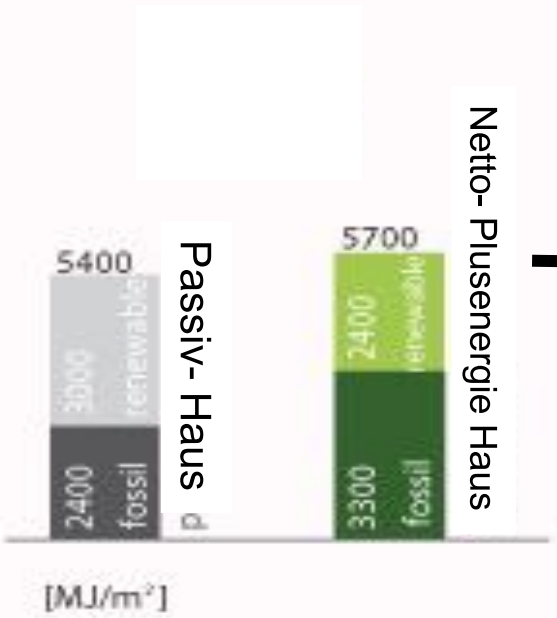
Efficiency vs. Efectiveness

- We are very good in doing bad things very efficient
- So we are doing the wrong things perfectly right!
- We are not very good in doing the right (or effective) things

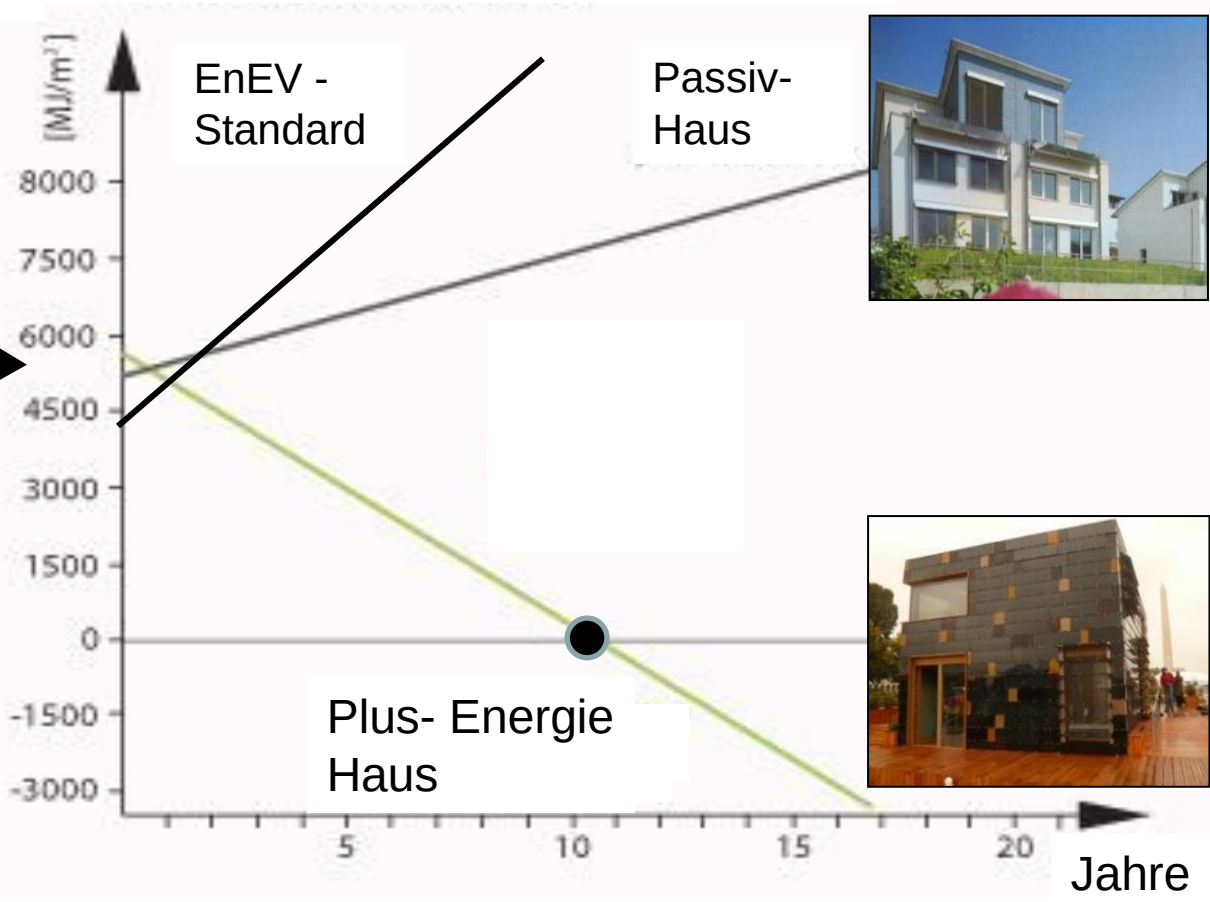
Positive Energy footprint

- Why stop at “nearly zero energy buildings”?
- Produce more renewable energy as consumed by the building
- Including the embodied energy
- Sun is abundent: 10,000 times our current need, is clean and renewable

Primärenergie Bau – „Graue Energie“



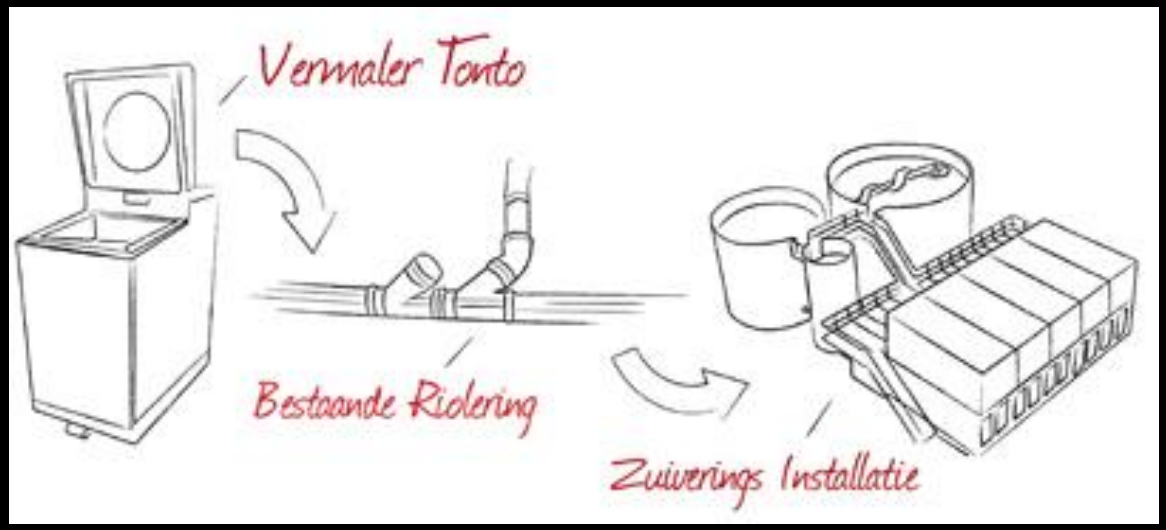
Primärenergie Errichtung und Betrieb



Positive water footprint

- Produce locally a better water quality out as in

Effective hospital waste water treatment



Pharmafilter

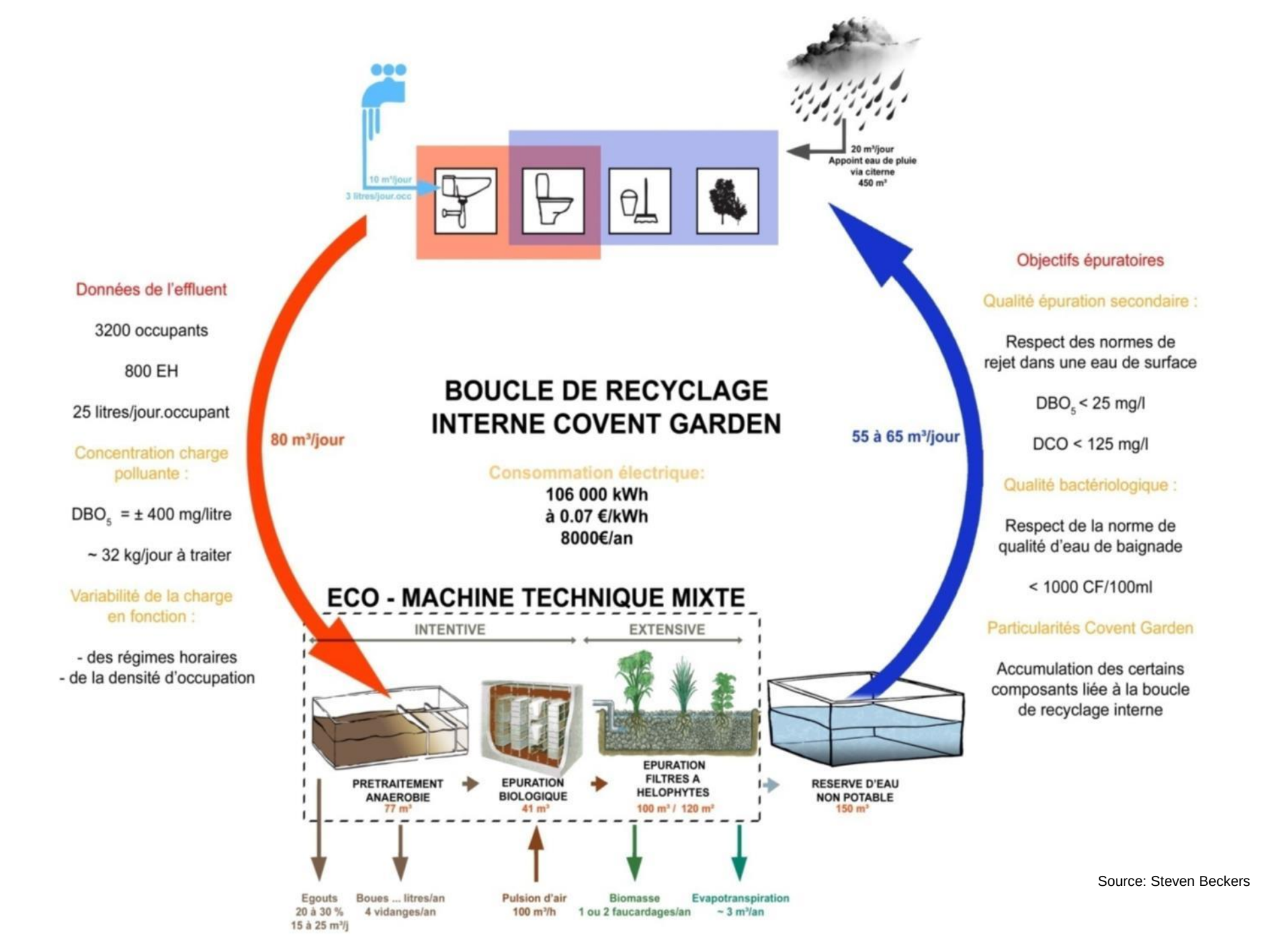
Hoogheemraadschap van Delfland

covent garden

brussels 2007

art build ARCHITECT

Source: Steven Beckers



Source: Steven Beckers

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Positive Topsoil footprint

- Have your project produce more Fertile Soil as is destroyed by the building activity

FORD ROUGE CENTER *storm water strategies*

Source: EPEA

FORD ROUGE CENTER *storm water strategies*

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Positive Materials footprint

- Biobased materials
  - Renewable by definition
- Technological materials
  - Necessity to re- and upcycle
  - Need for disassembly (materials, substances)

Waste

- What do we do with our waste?
  - Put it in landfills ?
  - Burn it ?
    - and call that sustainable energy ?

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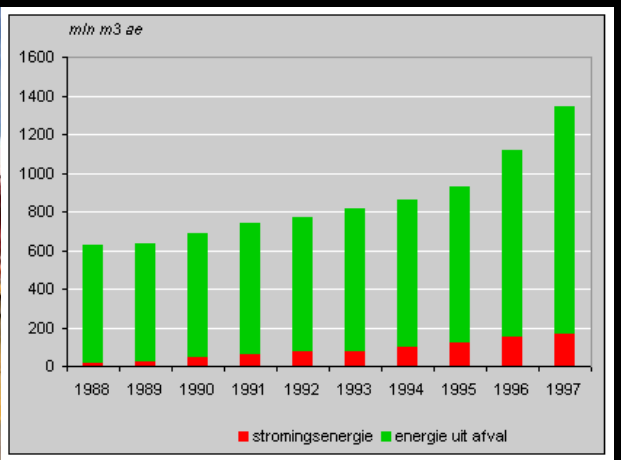
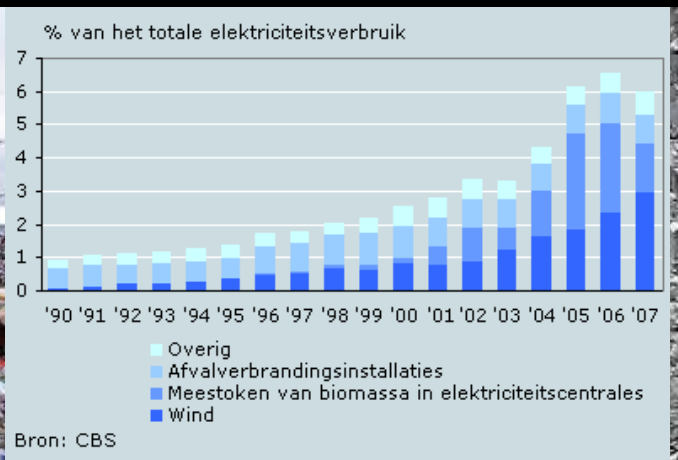


Waste

- What do we do with our waste?
  - Put it in landfills ?
  - Burn it ?
    - and call that sustainable energy ?
  - Down-, Re- or Up cycle ?
- What is the value of our waste ?



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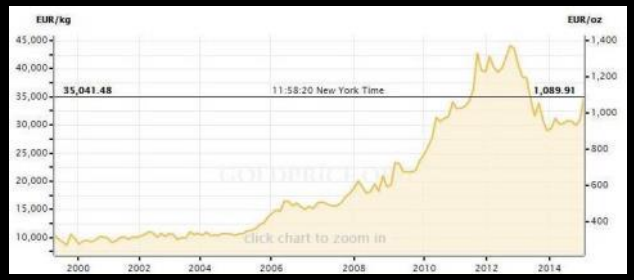
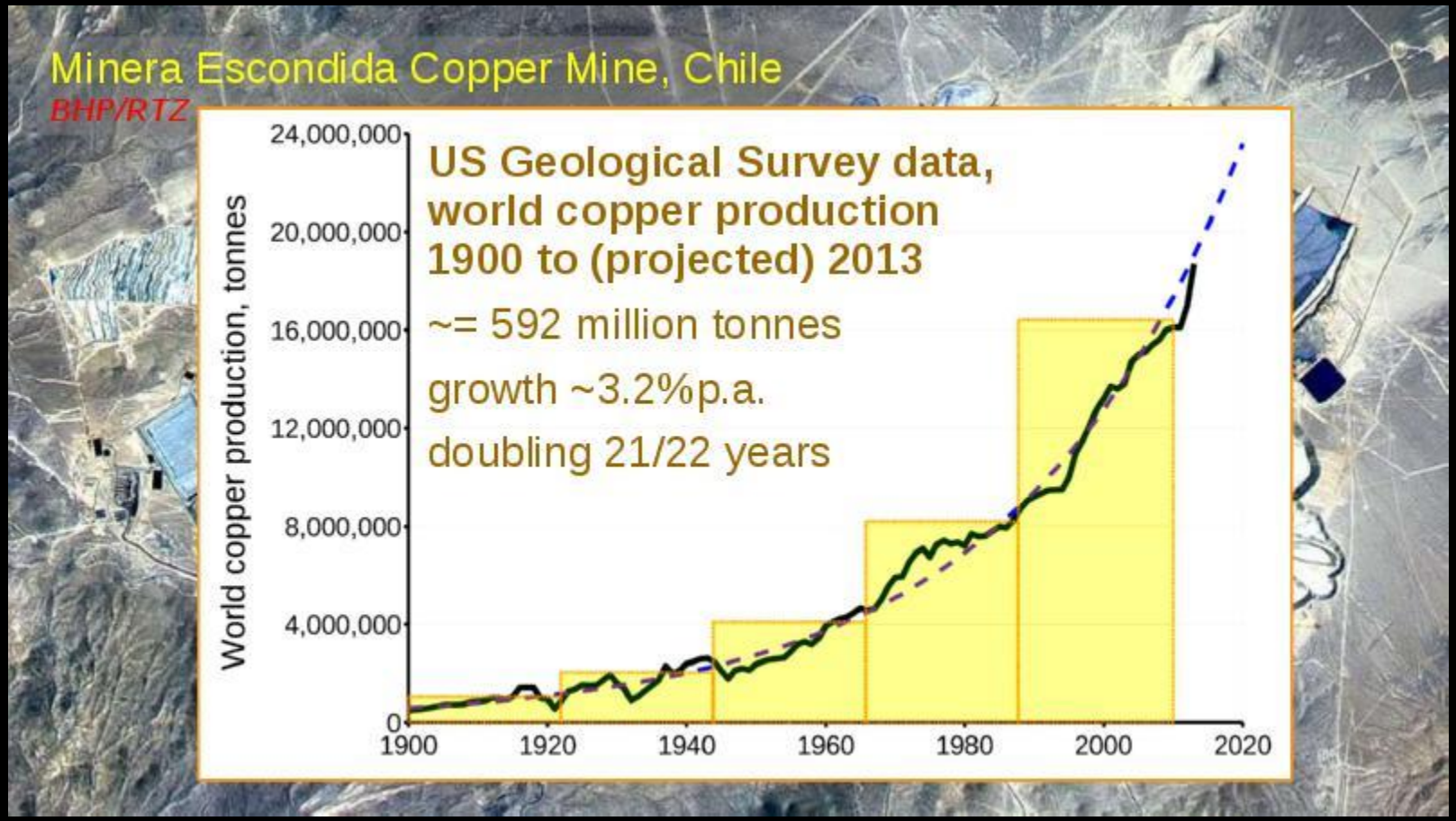


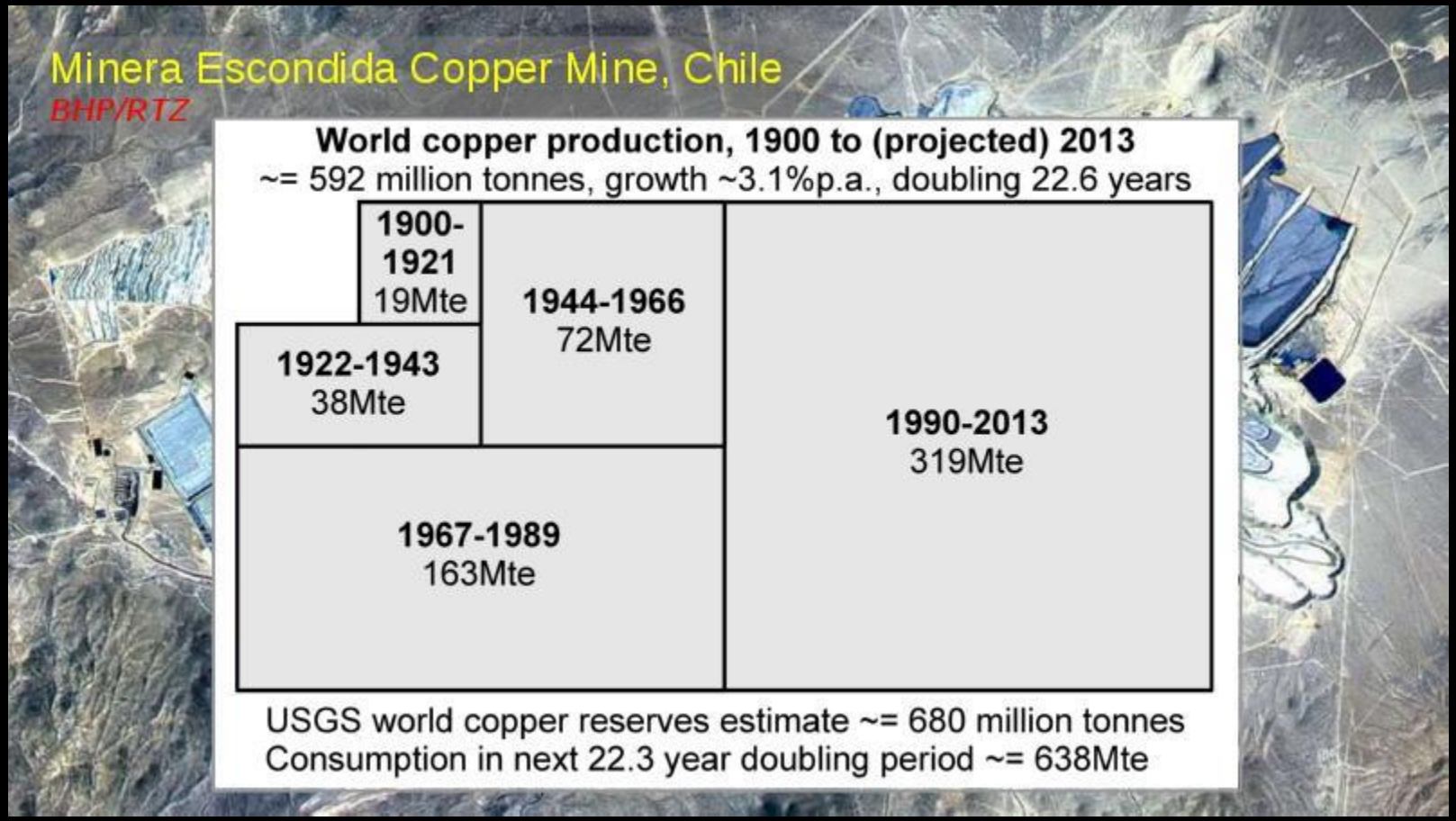
- Gold:
  - 1 kg gold: ≈ 30 k€
- 1 kg of gold comes from:
  - 200 - 1,000 ton ore from gold mines
  - 76,923,077 ton sea water (Cube 425 m)
  - ≈ 3,3 ton of used mobile phones!
  - + 471 kg Cu, 10 kg Ag, 0,4 kg Pd and 10 g of Pt
- Urban mining vs. Thermal value!

Copper, exponential production



Paul Mobbs, University of London

Copper, one doubling left



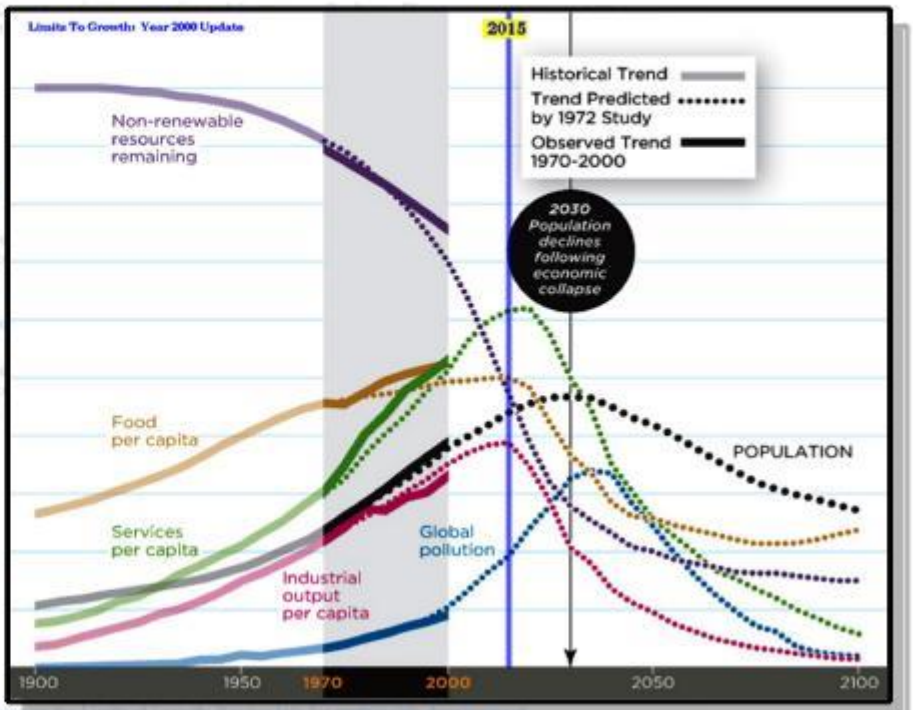
Paul Mobbs, University of London

The limits to growth

"Perspectives on Limits to Growth 2012"

Smithsonian
SERIOUSLY AMAZING®

Looking Back on the Limits of Growth
Mark Strauss, Smithsonian Magazine
April 2012



On the Cusp of Global Collapse?
Updated Comparison of The Limits to Growth with Historical Data, Graham M.Turner

Paul Mobbs, University of London

Beyond Sustainability

- Energy
  - Sun is abundent, fossils are the problem
- Water
  - Clean&sweet water is precious, energy can help
- Top Soil
  - Lost Topsoil can be formed
- Materials
  - These are critical, new technologies to seperate re- and upcycle are required