

Plenary Symposium I (Discussion session)

Development towards a sustainable (energy) system;
the local, regional and global boundary conditions

The great transition towards sustainability:

A few slides to initiate the discussion (M.Dittmar)

- My (our?) unsustainable(!) use of oil, gas.. and electric energy
- 20 (40) years of “(un)sustainable development” policies:
a total failure!
- Todays global way of life is unsustainable, at most we can discuss
“development towards sustainability” strategies!
- Quantifying our unsustainable (energy) situation and the success/failure
of our actions.
- Living well within the natural boundary conditions?

Unsustainable energy use (in France)

(my) personal use of Energy during 2013 (four person family house)

- Modern food energy $\approx 2500 \text{ Cal/day} = 10 \times 1000 \text{ kWh/year/person}$
factor 10 (oil and gas) for production, transport and preparation.
- Heating (electric and wood) $\approx 2000 \text{ kWh(electric)} + 1500 \text{ kWh(thermal)}$.
- other Electric energy (at home) $\approx 2000 \text{ kWh(electric)}$.
(4 persons) 15 kWh/day (summer) and 30 kWh/day (winter)
- Oil (for mobility) $\approx 1000 \text{ liter/year} \approx 12\,000 \text{ kWh(thermal)}$.
(This flight to Berlin (and back) $\approx 2\,000 \text{ km}$ and $\approx 100 \text{ liter}$)
- Electric energy (train mobility) $\approx 10\,000 \text{ kWh(electric)}$.
- Production and transport of consumer goods and services:
unknown(?)
- Working at CERN (together with roughly 5000 other people)
 $\approx 1000 \text{ GWh(electric)} \rightarrow 200\,000 \text{ kWh(electric)/person}$
(hm.. so much! Should one divide by 7×10^9 people?)

How humans use energy (a comparison). How to live less unsustainable and more just?

M.D./year: 40 000 kWh_{therm}/year (including work = 240 000 kWh_{el})
average person (EU+CH): 30-50 000 kWh/year (including work/consumption)

M.D. (direct use): “15 000” kWh_{el} and “1000” liter oil per year
average person (7.1 billions today): 3000 kWh(el) and 700 liter oil per year.

Country	electricity kWh/year/person	oil/year/person in liter
World	3 000 (7.4 kWh/day)	734
Europe		
Switzerland	7800	1740
Germany	6700	1720
France	6850	1500
(Our) Resource “exporting” Eastern Europe		
Russia	7300	1300
Ukraine	4000	370
(Our) Resource “exporting” Africa		
Algeria	1000	550
Niger	45	19
Nigeria	115	89

sources: CIA world fact book and BP yearly report 2013

20 (40) years of “Sustainable Development” (1)

UN meetings Stockholm (1972), Rio (1992) and Rio+20 (2012)

“World Remains on Unsustainable Track Despite Hundreds of Internationally Agreed Goals and Objectives”

Guardian Headline (June 12, 2012), about the new UNEP publication “Global Environmental Outlook” (June 6, 2012) at http://www.unep.org/geo/pdfs/geo5/GE05_report_full_en.pdf

Some details from the report:

- Population increased from 3.9 billion (1972), 5.5 billion (1992) to 7 billion (2012) (today 7.1-7.2 billion); and (without “collapse”) 8-8.5 billion people want to live in 2032!
- Non renewable energy resource consumption almost doubled from 1972 to 2012.
- CO2 in the atmosphere: 330 ppm (1972) to 359 ppm (1992) to now almost 400 ppm.
http://bluemoon.ucsd.edu/co2_400/mlo_six_months.png
- The world failed to reach the Millennium Development Goal (MDG) target of a significant reduction in the rate of biodiversity loss by 2010.
“The pressure on biodiversity continues to increase. Habitat loss and degradation from agriculture and infrastructure development, overexploitation, pollution and invasive alien species remain the predominant threats.”
- **Economic growth has come at the expense of natural resources and ecosystems.**
“Many terrestrial ecosystems are being seriously degraded because land-use decisions often fail to recognize non- economic ecosystem functions and biophysical limits to productivity.”

20 (40) years of “Sustainable Development” (2)

UN meetings Stockholm (1972), Rio (1992) and Rio+20 (2012)

Devastating results of “Sustainable development” policies!

More “quotes,details” from “Global Environmental Outlook”, UNEP, June 6, 2012
at http://www.unep.org/geo/pdfs/geo5/GE05_report_full_en.pdf

- Since 2000 alone, forests equivalent in size to the landmass of Germany have been lost;
- 80% of the world’s fish stocks are (close to collapse) fully or overexploited or have collapsed already.
- The Gobi desert is growing by roughly 10,000 square kilometres every year. Each year an additional 20 million hectares of agricultural land become too degraded for crop production, or are lost to urban sprawl (from a total of 1500 million hectares).
- **The world community** has missed all but 4 of its 90 most important environmental goals and **without a new path** of development and a change in consumption patterns, the pressure on ecosystems and poor communities is set to intensify as the global population is projected to rise from the current 7 billion to 9 billion by 2050.

“As human pressures within the Earth System increase, **several critical thresholds are approaching or have been exceeded**, beyond which abrupt and non-linear changes to the life-support functions of the planet could occur. This has significant implications for human well-being now and in the future.”

A quantifiable definition of sustainability

For details see M. D., Science of the Total Environment 472 (Feb. 2014) 282288

<http://ihp-lx2.ethz.ch/energy21/sustainabilitypublished.pdf>

“Sustainability” and “sustainable development” are difficult to define. Lets try a well known scientific method: **defining through negation.**

“Though it seems a contradiction of terms, it is actually possible to give meaning to a term, not only by describing what it is, but also by describing what it is not. This exercise may work better with terms that are abstract or somewhat complicated.” <http://english.tjc.edu/jbru/1301/negation.htm> and <http://en.wikipedia.org/wiki/Negation>

Ansatz (only two possibilities exist):

We are **sustainable** or **we are not!**

What is not sustainable today?

Ansatz: What is not sustainable today?

Today's human **Impact = population × affluence × technology (I=PAT)** is too large (further impact growth makes our problems more and more difficult)!

Unsustainable aspects of our way of life (society/culture):

- **Usage of “non renewable”** energy sources (oil, gas, coal, uranium) and the usage of non renewable mineral resources (if recycling is based on non renewable cheap energy resources).
- **Unsustainable use of (energy) renewables** (water, soil, wood, sun and wind) (e.g. destruction of pristine forests for our timber “needs”)
- **Industrial agriculture destroys** soil, poisons water and oceans and is based on cheap fossil fuels (for a dead zone map see <http://tinyurl.com/pwzg37r>).
- **Non compostables toxic waste with a long lifetime** (asbestos, plastics, chemical and radioactive toxic waste and CO₂) reduces and destroys the remaining natural capital.

A quantifiable definition of “development towards sustainability”

- if parts of a system are not sustainable, the entire system is not sustainable!
- if all parts of a system become less unsustainable one begins to move in the right direction.

→ **“Development towards sustainability”**: A measurable (annual?) reduction of unsustainable practices and at any level of the society.

What is still missing (a problem for the scientist in all of us):

- (1) How large are the remaining reserves of natural capital (like oil)?
- (2) How large is the “carrying capacity” as a function of the natural capital?
- (3) What are the **uncontrollable “tipping points” on the “Titanic”**?
How far away are we from them? (e.g. from which CO₂ content in the atmosphere are we risking a run away global warming?)
- (4) Can we help natural processes to repair damaged/destroyed natural capital?

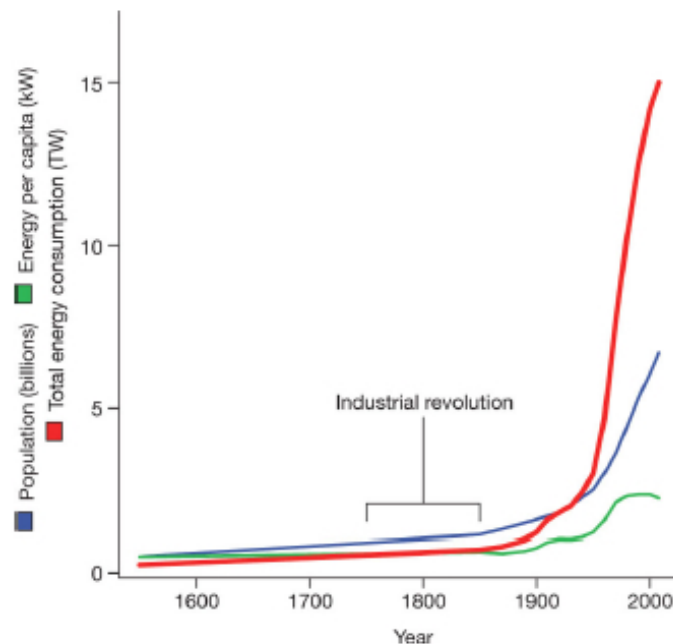
Today's human impact is not sustainable; How much time is left for rational changes?

Knowing that:

- (1) Birth and extraordinary growth of the global industrial civilisation thanks to cheap and unlimited energy (especially oil and electric energy).
- (2) Industrial civilization seems to function (well?) only during periods of economic growth.
- (3) Growth requires cheap/abundant energy (especially oil and electric energy!)
- (4) My guess: The global oil (energy) extraction decline (“peak energy”) will start the decline of industrial civilizations!**

In theory: The decline doesn't have to be catastrophic, but..

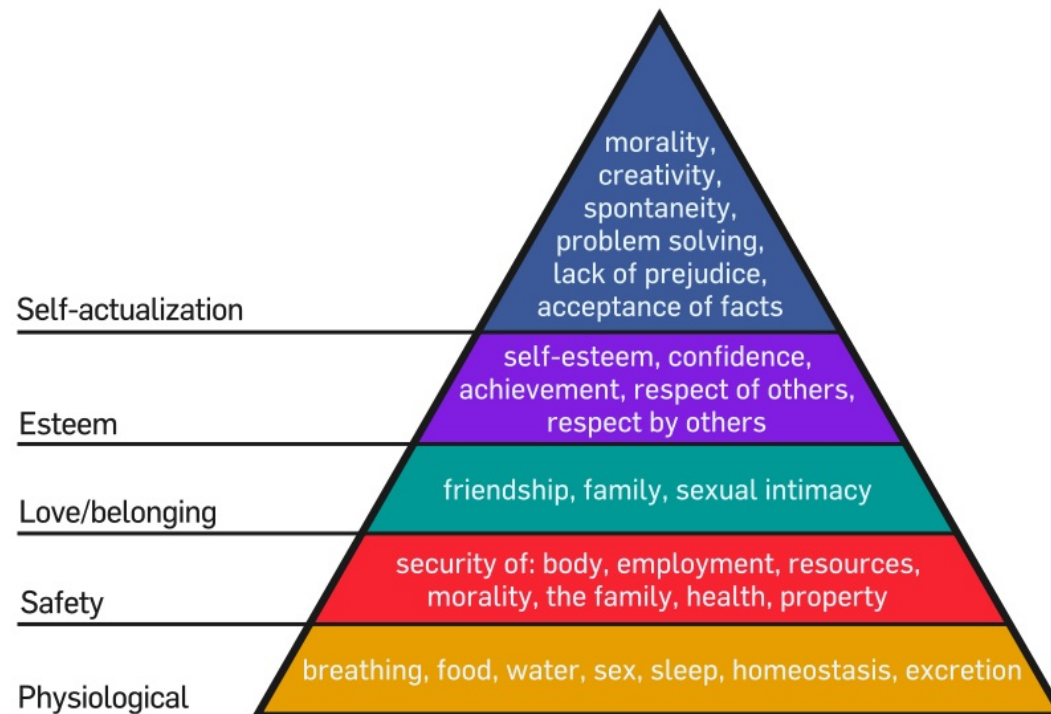
History of growth in world population and environmental impact of *Homo sapiens*, indicated by its surrogates, per capita and total human energy use.



Living well and sustainably: Theoretical Ideas (1)

The minimum requirements for a sustainable and “good” life?

Maslow’s hierarchy of needs http://en.wikipedia.org/wiki/Maslow's_hierarchy_of_needs



Theoretically, most points could easily be achieved in a well functioning society and with little use of energy resources! But, even in rich countries “water” and “shelter” and other basics are not guaranteed for a significant number of people (see latest reports about child poverty in Germany)!

Living well and sustainably: Theoretical Ideas (2)

Food Energy: most critical basic physiological need of human life!

Switzerland as an example: agriculture exploits currently about 400 000 ha (plus “700 000” ha “mountain” grazing land). http://www.swissworld.org/en/economy/farming/facts_and_figures/

To produce all grains/vegetables/fruits/ products **within Switzerland**, roughly 500 000 ha additional good agricultural land required.
(Or per capita: 1000 m²/year with current unsustainable agricultural methods)

In theory: a sustainable bio-intense (manual labor!) local system:

A swiss like vegetable/fruit diet can be achieved with only 100 m²/person/year!
Another 300 m²/person/year are required for grains, vegetable oils and farm animals “cows, chicken etc”.

**Who has the knowledge, time, access to land and
in addition “the wish” to establish prototypes
for sustainable and partially sufficient food production?**

Development towards sustainability Living a good life during the transition period?

If we want to contribute for optimal living conditions during and after the transition towards sustainability, we need to understand (and accept):

1. Natural local and global boundary conditions,
2. Improve our scientific knowledge about the remaining natural capital and distribute this knowledge.
3. Contribute to the conservation of the remaining biodiversity and try to repair damaged ecosystems.
4. Learn (and practice) how to live less and less unsustainably and how to enjoy this.
5. Contribute to the development of small scale sustainable communities. **A satisfactory and sustainable life for future generations can not be achieved in isolation!**

and we need a lot of “Good Luck”

Living well and sustainably: Theoretical Ideas (3)

Perhaps the single most critical basic physiological need of human life:

- About 2500 Calories/day/person are required. Such a diet can be satisfied in many cultural/historical variations and more or less healthy (vegetarian or not).
- Most “experts” think that “healthy food” requires large fractions and varieties of fruits and vegetables.

Sufficient healthy food production: how many people per hectare or per km²?

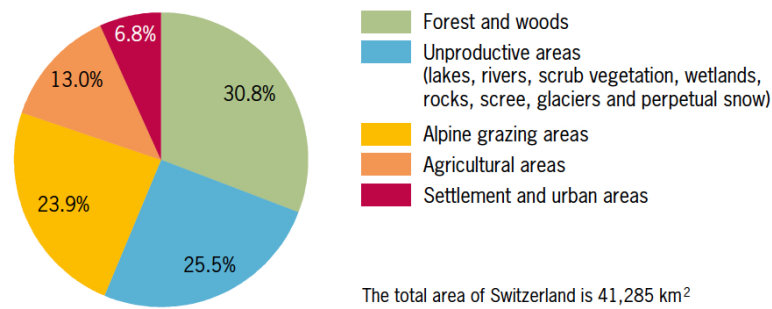
Example Switzerland: More than sufficient “food” is available for 8 million people.

The system feeds about 10 people/per hectare. But, the swiss food system is not sustainable:

- (1) about a factor of 10 calories from fossil fuels are “hidden” in every eatable calorie and
- (2) about 50% of the food is imported (corresponding to about 500 000 “ghost” hectares, often far away!)

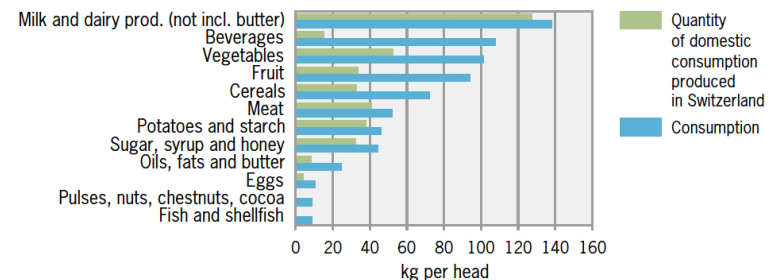
Land use

Areas surveyed between 1992 and 1997



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Food consumption¹, 2009



¹ Does not represent quantities actually consumed as losses (e.g. unsold or spoilt food) are not recorded completely.

Source: Swiss Farmers' Union

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