Energetic Changes:
Local Facts & Global Trends

@ Interdisciplinary Winter School 2012 on
"The Future of Energy Systems in Austria and the Czech Republic"

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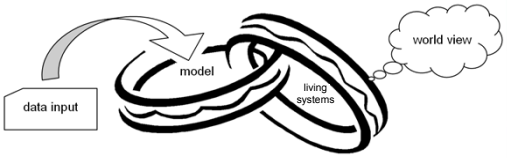
What is the most important in life???



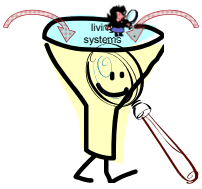
- Which *conclusions* from data through "science"?
- Which *human values* for our civilisations?

How to assess (energy) technologies?

- Simple "technology assessment": Σ_i (weight)$_i$ × (data)$_i$ ⇒ max

values

e.g.: energy...
- safety, security
- availability = f(t)
- price
- admin. structures
- sustainability
- CO_2
- SO_2, NO_x, CO, HC
- ^{137}Cs: radioactivity
- (nuclear) waste



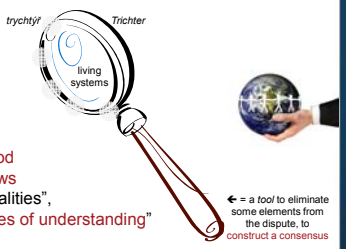
data

e.g.: energy...
- ressources & reserves
- annual, daily load curves
- cost & market data
- unit sizes
- durability, acceptance
- (in)direct emission data
- filters
- (un)attended incidents
- long-term care costs

conclusions

What is going on *in* the funnel?

- A *professional*, co-operative process to negotiate differing views
- A professional evaluation method for divergent views on perceived "realities", based on "cultures of understanding"

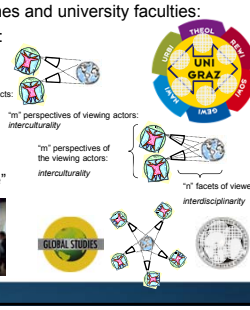


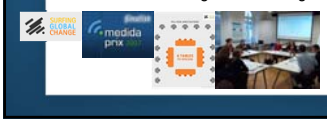
- We might have more in common than we thought ;-)

We might wish to take an "*inter*-..." standpoint

- Contributions from "all" disciplines and university faculties:
- Guarantees multiperspectivism:
  - Interdisciplinary:
  - Intercultural:
  - Interparadigmatic:

⇒ *tool* "Surfing Global Change"

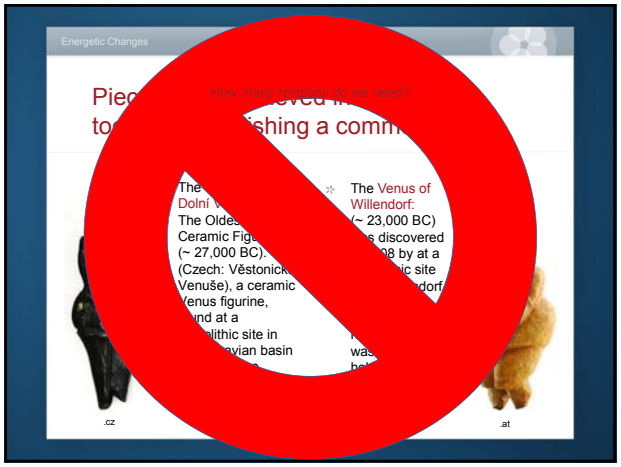




We still live in the age of *tool*-making!

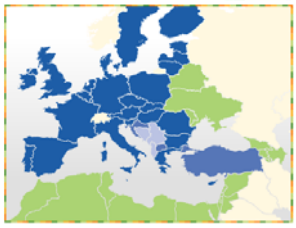
- … we are still a *paleo-lithic* society striving for tools …
- … to produce societal consensus (e.g. on energy)

The geography of (energetic) consensus building

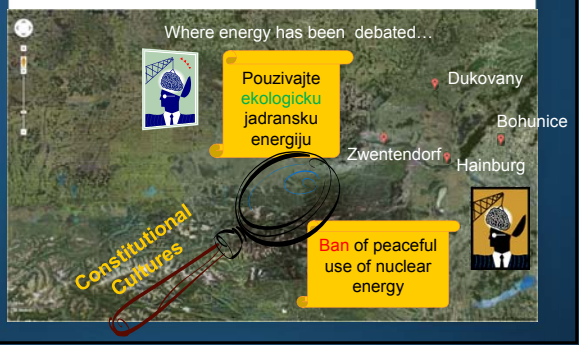


Recent pieces of social art including .at & .cz: Tools for **consensus** finding

- Environmental Impact Assessment (EIA)
- Strategic Environmental Assessment (SEA)
- EU Twinning projects
- European Neighbourhood Policy (ENP)



The geography of (energetic) consensus building



The geographies of partial consensus building

- "*Consensus*" is the production factor that fell to a minimum

Towards the production of societal consensus

- (1) **achieve common values**: e.g., "sustainability" etc.
- (2) **agree on procedures** to practically implement values

- Major "*fuels*" for a future regarding our energy systems are
  - *(a) local facts*: the tool "Energy & Emission Balance" EEB
  - *(b) national plans*: emissions from Toronto to Bratislava
  - *(c) regional burdens:* radioactivity after Chernobyl
  - *(d) continental fuels:* Combined Energy & Biomass Model
  - *(e) global trends*: the "Global Change Data Base" GCDB
  - *(f) evolving values*: a series of structural transitions of needs

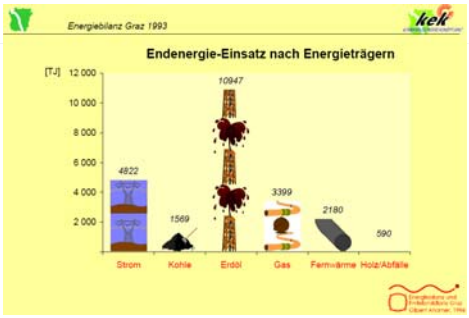
(a) local facts:

the tool
“Energy & Emission Balance” EEB

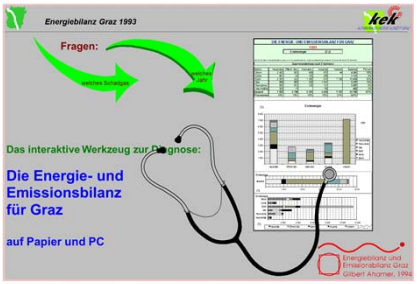
Energy & Emission Balance for a City

- Start from census data on m² housing
- Compute energy demand for heating
- Compute emissions (emission = energy × emission factor)
- Scenarios to evaluate potential measures
- Hand this tool over to decision makers ...
- *We believe: reality = computable **numbers** ;-)*

Energy & Emission Balance for a City



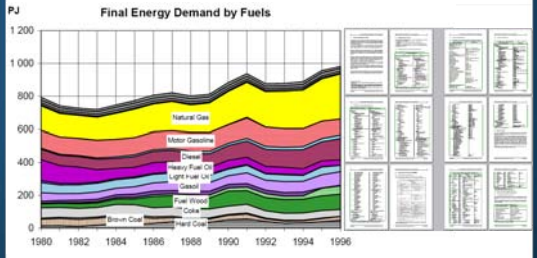
Energy & Emission Balance for a City



(b) national plans:

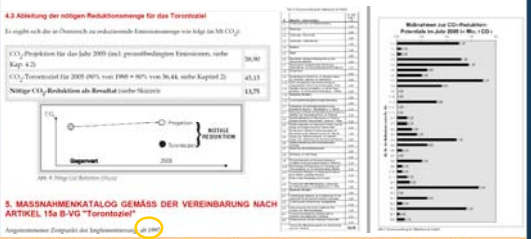
emissions from Toronto
to Bratislava

Energy & Emission Balance for Austria (CORINAIR) for IPCC & EU



Energetic Changes

„Toronto Technology Program“ for CO_2 reduction in Austria

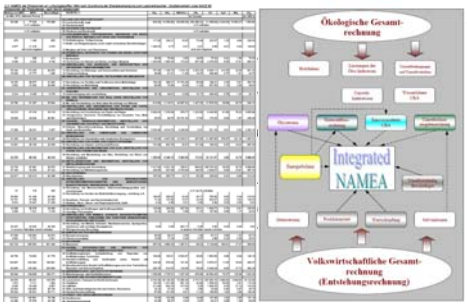


5. MASSNAHMENKATALOG GEMÄSS DER VEREINBARUNG NACH ARTIKEL 15a B-VG "Torontoziel"

- *Fallbeispiel 15a-Vertrag:* Der geplante Vertrag zwischen Bund und Bundesländern über den Klimaschutz, in dem verbindliche Maßnahmen zum Klimaschutz festgelegt werden sollten, ist immer noch nicht unterzeichnet.

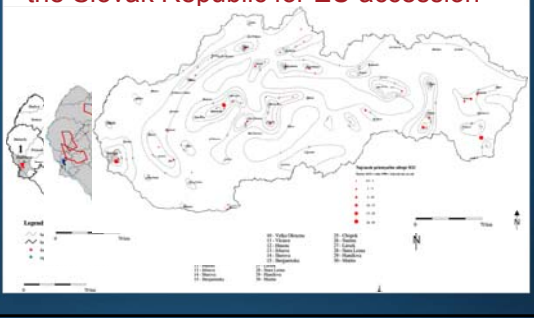
Energetic Changes

NAMEA Austria (= National Accounts Matrix including Emission Accounts)



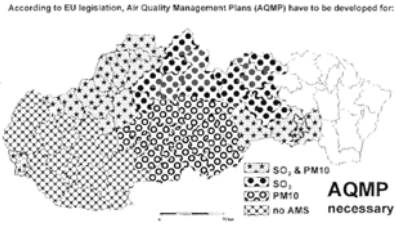
Energetic Changes

Air Quality Measurement Stations in the Slovak Republic for EU accession



Energetic Changes

Evaluation of Slovak plans & measures



Source: Ahamer, G. et al. (2001): EU Twinning on Air Quality in the Slovak Republic, 12 reports.

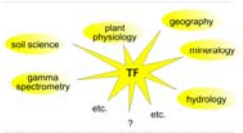
(c) regional burdens:

radioactivity after Chernobyl

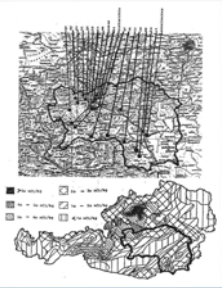
Energetic Changes

Transfer (TF) of Chernobyl cesium from soil to plant

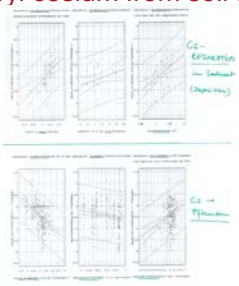
TF depends on what?



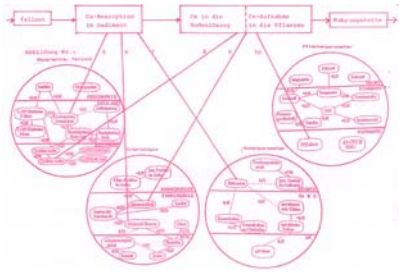
- Priority to experiment, not theory



Experiments on the transfer of Chernobyl cesium from soil to plant



Model building for transfer of Chernobyl cesium from soil to plant



Heuristic formulae for transfer of Chernobyl cesium from soil to plant

(A) Detention + Resorption:

^{137}Cs and ^{137}Cs resorb.

-(fallout [map value])$^{0.5}$ *
(weight loss [%])$^{0.5}$ *
exp (0.1 * muscovite [%])

(B) Transfer:

transfer factors TF(^{137}Cs)

-(Cs activity in sediment)$^{0.5}$ *
(montmorillonite [%])$^{0.5}$ *
(TF for ^{40}K)$^{0.5}$

- *We believe: reality = computable **functions** ;-)*

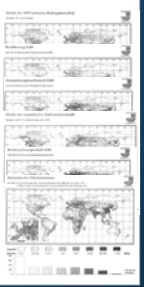
Source: Ahamer, G. (2012) in *Water, Air and Soil Pollution*, Springer.

(d) continental fuels:

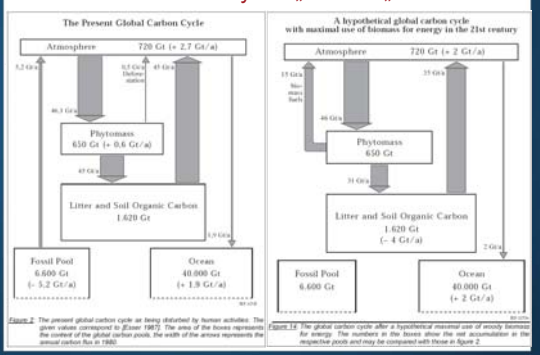
Combined Energy & Biomass Model

Approach: Modelling the global carbon cycle & the energy economy

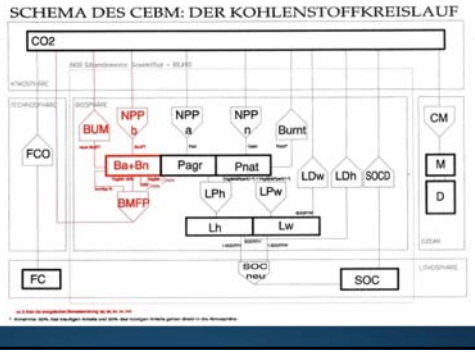
- „Combined Energy and Biosphere Model“
- biospheric part: 2433 grid elements
- energy part: country scenarios
- result: Net C balance ⇒ CO_2 concentration

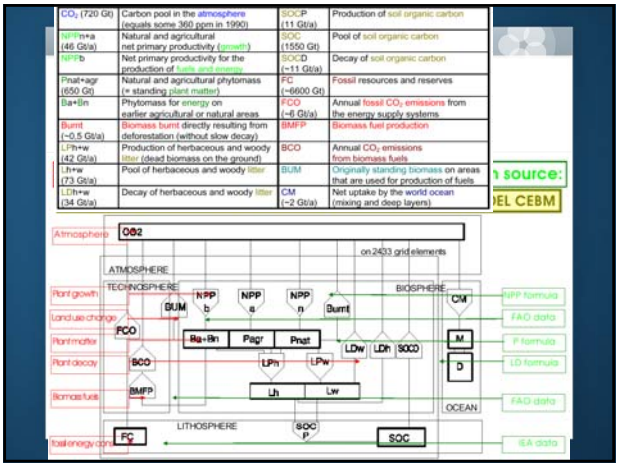


The annual carbon cycle: „now“ & „future“

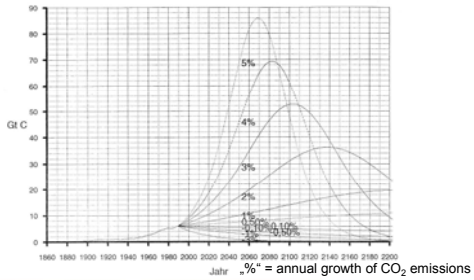


Modelling scheme: annual carbon flows



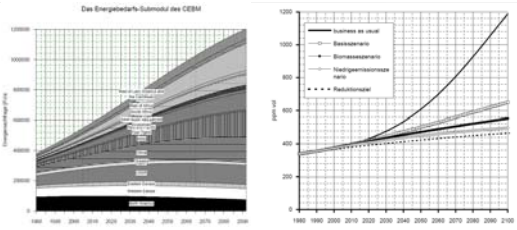


Modelling: sensitivity of energy scenarios



„%" = annual growth of CO_2 emissions

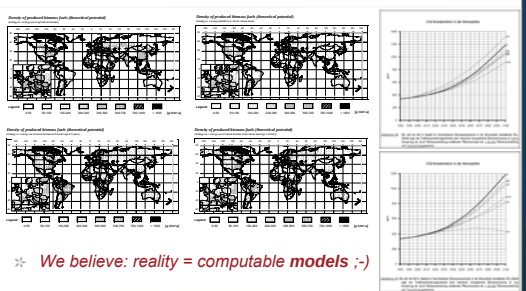
Scenarios for energy demand ⇒ CO_2



CO_2 emission ➔ CO_2 concentration

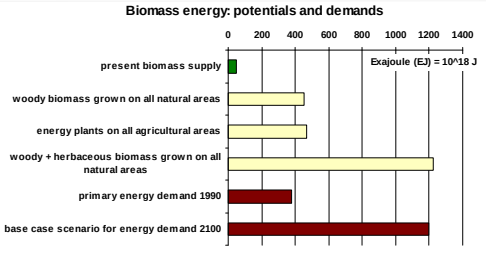
Source: Ahamer, G. (1994): Effects of biomass use on the global CO_2 concentration, several papers & reports.

Theoretical biomass energy potentials



⁂ *We believe: reality = computable **models** ;-)*

Comparison of energy demand & supply



Link (de, 300 p.): http://www.uni-graz.at/globalstudies/deposit/CO2BM_Dissertation.pdf
Link (en, 30 p.): http://www.uni-graz.at/globalstudies/1994_International-Journal-of-Global-Energy-Issues_OriginalLayout.pdf

Results of assessing „biomass energy“

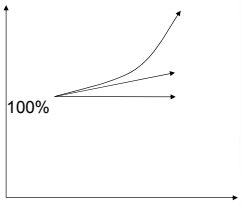
- Biomass alone will not „save the world“
- Biomass energy is a valuable and ready-to-use measure as part of a bundle of measures
- Do not forget about huge transportation needs
- Keep in mind necessity for energy conversion
- Take care in order to ensure carbon neutrality
- Expand the perception beyond carbon
- ➔ *do similar assessments also for other energy strategies!*
- *We believe: reality = computable* ***strategies*** *;-)*

(e) global trends:

the “Global Change Data Base” GCDB

Energy – how to estimate? (methods)

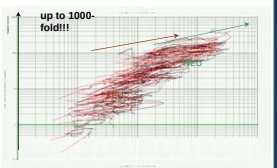
- Basic mathematical options:
  - x = constant
  - d/dt x = constant
  - d²/dt² = constant



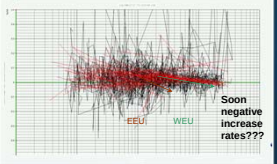
- … simplified approach …

Energy – how to estimate? (facts I)

- Energy per capita



- d/dt (E / cap)



Source: Global Change Data Base

Energy – how to estimate? (facts II)

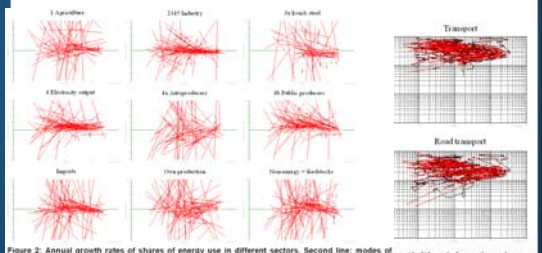
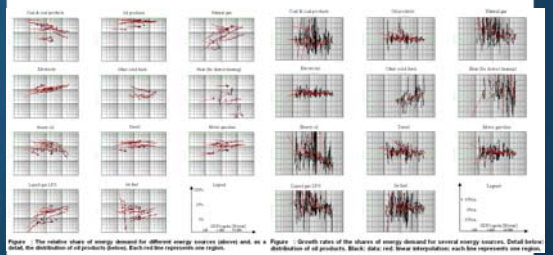


Figure 2: Annual growth rates of shares of energy use in different sectors. Second line: modes of electricity generation. Horizontal axis: GDP/cap, vertical axis: percentage points of share growth. Central green line: +/- 0%; scale from –20%/a to +20%/a. Each red line shows the average growth rate for one country from 1961-91. Legend see in Figure 3.

activities (above) and, as a ie represents one country.

Source: Global Change Data Base

Energy – how to estimate? (facts III)



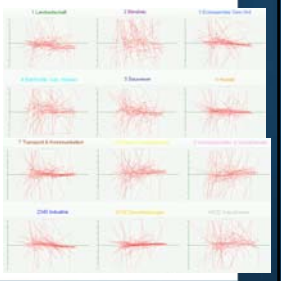
Source: Global Change Data Base

Energetic Changes

Energy – how to estimate? (suggestion)

%GDP in total economy

- Preference of FACTS
- as compared to MODELS
- experiment, not theory!
- ➔ use a pragmatic method
- Combining all complex behaviour of reality:
- „Global Change Data Base“



Energetic Changes

„Global Change Data Base“ (GCDB) quantitative analysis of long-term trends

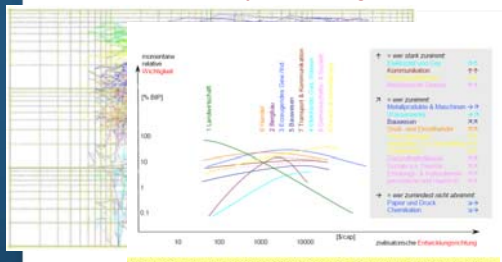


Abbildung 6: Landkarte der techno-sozio-ökonomischen Evolution für die 10 Hauptsektoren. Daten aus GCDB. Beschriftungen: an den höchsten Stellen. Insert: Details für 40 Subsektoren

Energetic Changes

Global scenarios (in G.A. style)

- Trend: we look at the “rate of change” = 1st derivative
- ➔ trends can be arithmetic, exponential, logarithmic
- But: *long*-term scenarios require more intuition!
- We use not only the 1st but also the 2nd derivative and may be capable to discern newly emerging trends …
- “natura saltus non fecit” – compare leading your dance partner early enough ;-)

45

Energetic Changes

Trends ➔ paths of development?

- Is it possible to identify civilisational structural changes based on global data series (such as the “Global Change Data Base”)?
- Could “paths of development” make sense to drive scenarios?
- Long-term trends in socio-economic and civilisational development: are there characteristic dynamic patterns of structural change?
- Could we see in civilisations an overall meta-dynamic regarding targets:
  - from material to non-material targets
  - from von individual to community-oriented targets
  - In brief: growing civilisational structure building towards (increasing?) construction of meaning (may be deduced from GCDB results)
- Genesis of international institutions that are able to generate the needed complex consensus in legitimate way
- Case study climate change: UNFCCC & IPCC as discoursive panels

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Energetic Changes

The “Global Change Data Base” (GCDB): for quantitative analysis of long-term trends

- “As an originally developed graphical method
- the GCDB allows for interdisciplinary analysis,
- generation and assessment of hypotheses
- for global techno-socio-economic evolution”.

- *We believe: reality = cognizable **structural changes**;-)*

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Energetic Changes

We observed the following transitions:

- Population transition
- Land use change transition / deforestation transition
- Agricultural & food transition
- Transition of economic sectors
- Energy transition

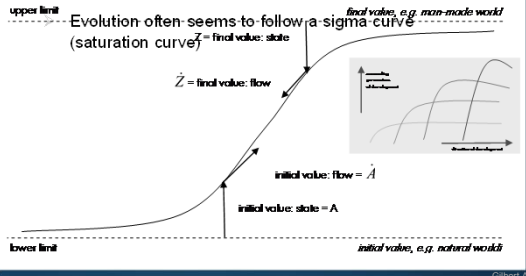
- Nonetheless, we don’t believe in determinism: **design, act and construct the world!**

- *Hope = (voluntary) learning effects*

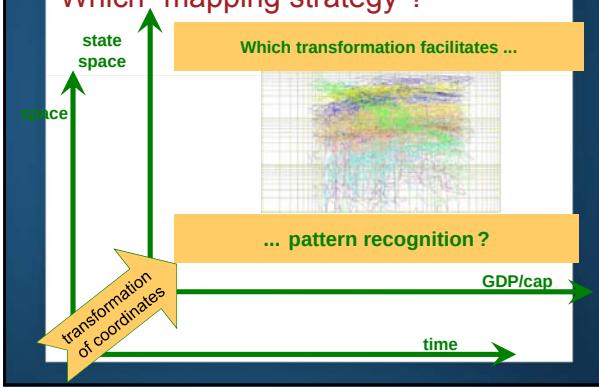
(f) evolving values:

a series of structural transitions of human needs

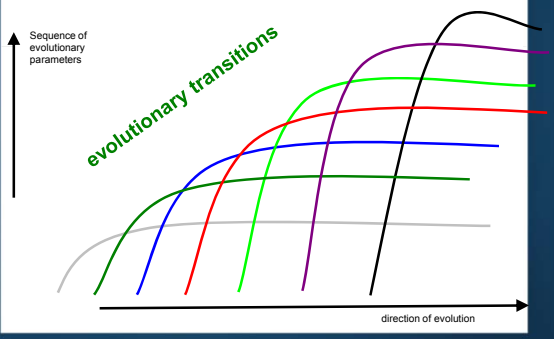
A principal evolutionary pattern?



Which "mapping strategy"?

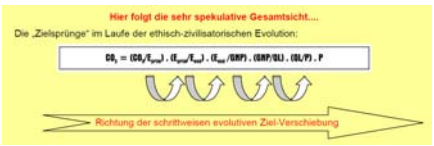


Stylised dynamics of "global change"

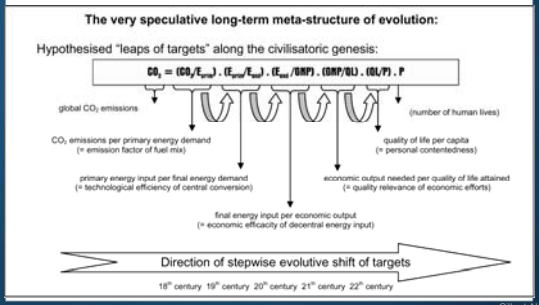


A possible overall view on evolution!

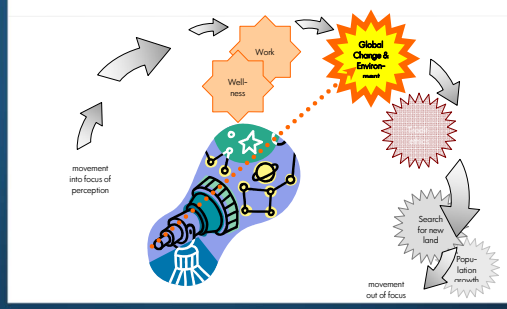
- Do *targets* themselves evolve along evolution?
- ... the more targets are fulfilled, the more they seem to decrease in importance
- We see: *systemic structures themselves* evolve, not only levels



A possible genesis of "targets"?



Shifting foci: a principle along evolution?



Thank you for your attention!

d'! ;-)