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Preparing for an energy-scarce future: questions and answers for the communal level and beyond

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Abstract

There is growing evidence that the supply of essential energy sources (especially oil and somewhat later natural gas) will be declining in the near future with far-reaching consequences for human societies.

This hitherto unprecedented scenario results in great challenges for all actors of society, especially for governments at all levels. Reasonable and feasible approaches in this emerging ”after-plenty-of-cheap-energy”-era are needed to be implemented.

After giving an outlook of the energy future, and explaining the probable decline of net energy, we discuss possible consequences of the peaking of fossil fuels in the sectors transport, spatial structures, agriculture and economy. Furthermore, we detail options for action in these sectors, especially aimed at the specifics of local governments, and present recommendations for political reforms for the higher levels of government.

Keywords: peak oil, peak gas, energy crisis, communal level, future scenarios, resilience, spatial structures, economy, options for action

Availability of fossil fuels

The concept of "peak oil" goes back to the American geoscientist M. King Hubbert who published in 1956 an article where he predicted that the oil production of the USA would peak between 1965 and 1970 and global oil production would peak around 2000 (Hubbert 1956). The USA indeed reached maximum oil production in the early 1970-ies.
The term peak oil refers to the maximum rate of the production of oil in any area under consideration, but mostly it is associated with the maximum in global oil production. After reaching the peak production of oil will decline steadily although there may be some fluctuations in the decline phase.
In 1998 Campbell and Laherrere published an article called "The End of Cheap Oil" where they reach the conclusion that between 2000 and 2010 the supply of conventional oil will not be able to keep up with demand (Campbell / Laherrere 1998).
Meanwhile there is a growing consensus that global oil production is right now around its peak and will soon decline. In a recent study Werner Zittel concludes that oil production has already peaked around 2008 with high probability and that in 2030 only about half of today's oil production will be available (Zittel 2010, Fig. 1).
Since 2005 a plateau in global oil production can be observed and many analysts share the view that high oil prices in 2008 triggered the financial and economic crisis starting in that year. A crucial open question is, when a significant decline in oil production will really start and how steep the decline will be.
The main evidences for an imminent peak in oil production are: a large number of oil producing regions have already reached their maximum production (including USA, UK, Norway and many others) and are in production decline, only a few regions might be able to expand their oil production; the discovery of oil fields has already peaked around more than 40 years ago; oil exploration and drilling becomes increasingly difficult, expensive and environmentally risky (e.g. offshore ativities).

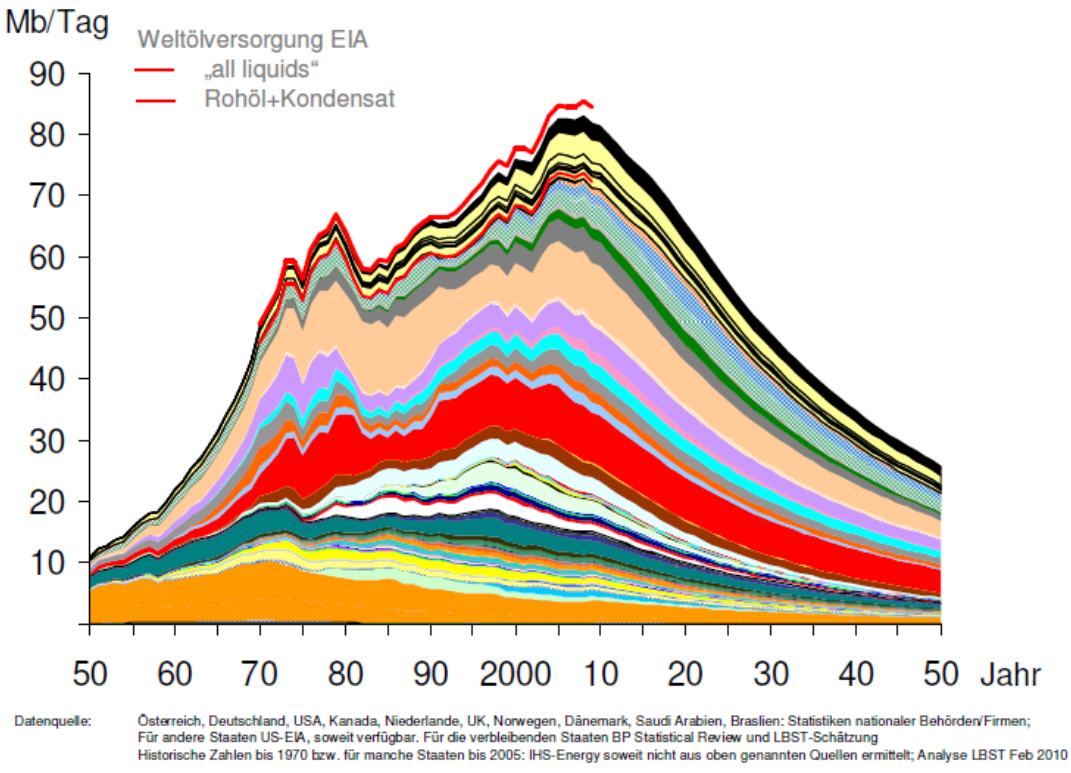

Fig. 1: Oil production from 1950 to 2050. Future production is determined by extrapolating country-specific trends. Source: Zittel (2010).

If we take a look at the availability of natural gas in Europe there are also probably scarcities looming in the future. The amount of natural gas produced in Europe is already declining. For instance, the production of natural gas in the UK has already peaked around 2000, and has declined in 2010 by 40%. An extrapolation of gas production profiles of all European countries into the future makes a clear declining trend visible which means that Europe becomes increasingly dependent on imports of natural gas (even if consumption remains constant) and it is unclear if this growing import demand can be satisfied (Fig. 2). The European gas industry basically shares this view of a growing import demand which is also the reason behind the pushing of several gas pipeline projects.

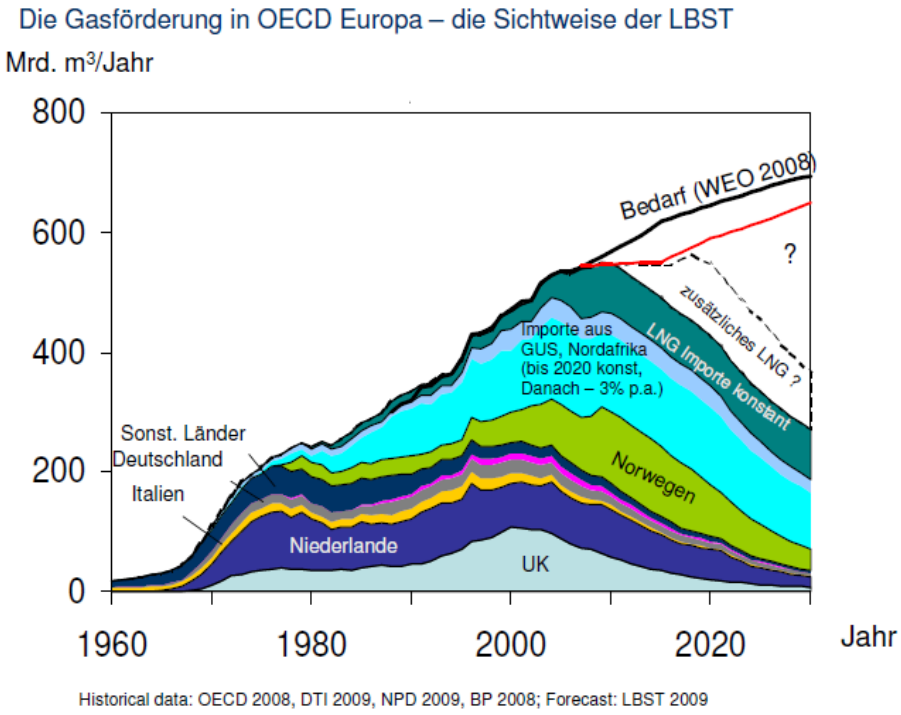

Fig. 2: Supply with natural gas for Europe, 1960-2030. Future projection by LBST. Source: Zittel (2010)

The study „Coal: Resources and Future Production“ concludes that global coal production can be expanded by 30% until 2025 and will decline afterwards (Zittel/Schindler 2007, 7). The worldwide production of coal is limited to relatively few main producing regions: China, USA, Australia, India, South Africa and Russia. The biggest share of produced coal is consumed in the countries of origin. China and India, two important coal producing countries, have already become coal importers due to their high growth in coal consumption.
What is valid for many other resources, is also valid for coal: The best deposits have already been exploited. Accessing the remaining deposits becomes more and more difficult, this means also that the amount of (monetary and energetic) investments has to rise to access these resources. It is quite controversial if ever a significant amount of coal will be liquefied to replace oil. Nevertheless, a rising share of coal for electricity production (e.g. to replace scarce natural gas) might be possible.

Declining net energy

Net energy refers to the ratio between the energy expended to harvest an energy source and the amount of energy gained from that harvest (Heinberg 2009, 11).
Thus, net energy means the amount of useful energy that is left over after all the efforts to harvest energy (like drilling, piping, refining, building infrastructure (including solar panels, wind turbines, dams, nuclear reactors, drilling rigs, etc.) have been subtracted from the total amount of energy produced from a given source. Society relies on the net energy surplus gained from energy-harvesting efforts in order to operate all the activities that keep a society running (e.g. manufacturing, distribution, and maintenance activities).
Net energy gains can be measured by the EROEI (Energy Returned on Energy Invested) factor also known as EROI (energy return on investment). The EROEI is the ratio of the amount of usable energy acquired from a particular energy resource to the amount of energy expended to obtain that energy resource (Heinberg 2009, 10). An EROEI factor of 10:1 means that it takes one unit of energy to deliver ten units of energy, thus in this case nine units of net energy remain.
Hall et al. (2009) have calculated that the EROEI for oil production in the USA in 1930 was about 100:1 and has declined to 10:1 to 20:1 for current oil production in the USA. Hall et al. (2009) suggest a minimum total EROEI factor from 5:1 to 10:1 to keep complex societies functioning.

There is considerable evidence that the total amount of net energy will be declining along with the declining availability of fossil fuels due to at least three reasons:

- (Total) declining supply of fossil fuels.f
- Production of remaining fossil fuels is more and more energy-intensive, thus the EROEI for production of fossil fuels declines steadily.
- There are several limitations regarding the uptake of renewable energy and energy efficiency technologies (which can replace declining fossil fuels). Some of them (especially biofuels) provide little net energy. Within renewable energy technologies wind energy, concentrated solar power (CSP) and hydropower have a comparatively high EROEI (Heinberg 2009).

Consequences of peaks in the supply of fossil fuels

In literature often three or four main scenarios are presented to show possible futures taking into account the peaking of fossil fuel supply – often discussed together with the consequences of climate change.
One example for a mapping of possible future scenarios was done by the “Dynamic Cities Project” (Davidson 2006). He distinguishes four scenarios. These scenarios depend on the one hand on the speed of fossil fuel depletion (rapid depletion versus slow depletion), on the other hand on the quality of societal response (proactive response versus reactive response, see fig. 3).

When assuming rapid depletion of fossil fuels, two main scenarios might unfold:
Lean Economy: There are massive proactive attempts from society to adapt to the situation leading to big changes in culture and lifestyle (e.g. fuel rationing might be an important measure). A transition from a globalised to a more localised economy takes place without major (armed) conflicts.
Collapse: Nations battle for resources abroad and fight unrest at home. Unemployment soars, global travel ceases, investors loose faith in stock markets, currencies and the global economy collapses.

With slow depletion of fossil fuels, the two remaining scenarios are:
Techno-Markets: Renewable energy technologies will be installed with high effort replacing most of declining fossil fuels. Compared to the "Lean Economy" scenario the changes in lifestyle, culture and economy are smaller. This scenario is a version of a "sustainable development" scenario.
Burnout: Society tries to keep up „business as usual" as long as possible. Declining oil and gas will be mainly replaced by "dirty" fuels like coal or tar sands leading to a significant increase of greenhouse gas emissions and to an accelerated climate change.

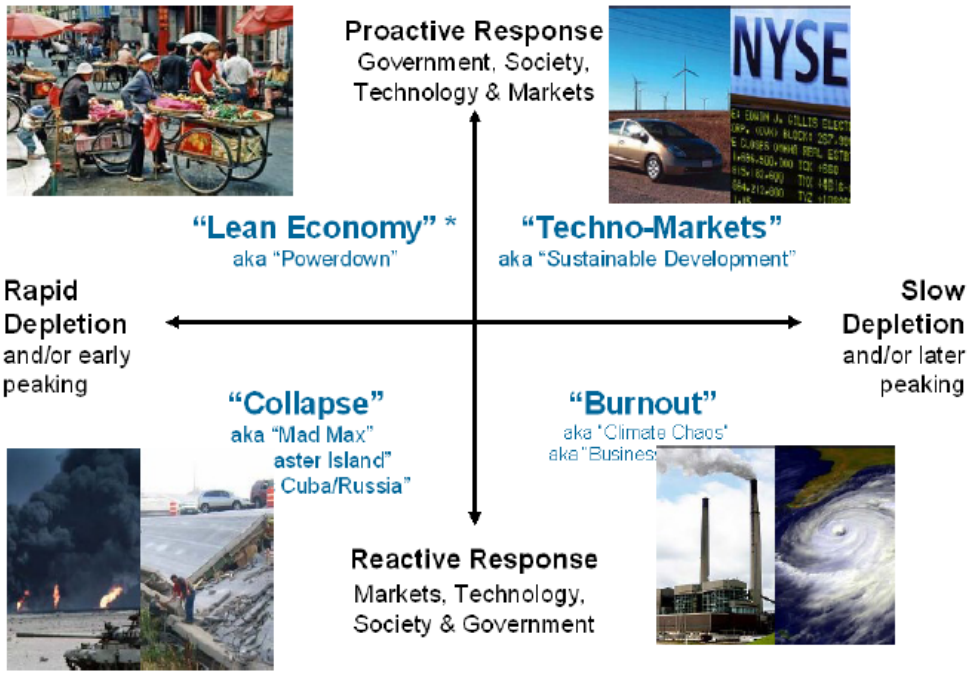

Fig. 3: Future scenarios in the light of peaking fossil fuels and climate change. Source: Davidson (2006), adapted

Our economic system can be characterised by a strong trend towards globalisation in the last decades and a high dependence on economic growth. Both, globalised production and long-term economic growth were only made possible by the availability of rather cheap and abundant (fossil) energy.
In turn, a decline in the supply of fossil fuels (going hand in hand with a decline in net energy) means that economic growth and a financial system depending on economic growth will become less and less feasible (Heinberg 2011). Economic instabilities will rise possibly leading to a systemic collapse (Korowicz 2010).
A scarcity in oil will have eminent consequences for the transport sector which highly depends on fossil fuels. Dramatically rising costs for fossil-fuel based transport are plausible. Fuel rationing seems a possible (and even necessary) measure to mitigate the consequences of scarce transport fuels.
Cheap fossil energy has enabled the development of a car-based transport system and together with this more and more dispersed settlement structures ("sprawl"). Dispersed settlement structures will become increasingly dysfunctional, will be loosing value and may eventually be abandoned.
Today's agriculture is highly dependent on fossil energy inputs. With declining fossil fuels rising prices for food production and food result. Food shortages may be possible resp. more common than they are now. Agricultural productivity might decline which means that more people have to work again in agriculture (reversing a long-term trend). The pressure to produce energy from biomass will rise exacerbating conflicts between production of bioenergy and food (and other usages of biomass).

Priorities for the energy transition

The energy transition is often regarded as a mainly technical topic meaning that the share of renewables has to grow and energy efficiency has to be raised until at some time in the future the whole energy demand can be fulfilled by renewable energy sources.
This view often does not take into account several limitations of renewable energy technologies and technical efficiency (like the need to match supply and demand and the resulting demand for storage, land demand, material demand, net energy balance etc. in the case of renewables, and the rebound effect in the case of efficiency).

We propose that raising efficiency and the share of renewables has to be accompanied by a third principle: sufficiency. Sufficiency addresses the question of "What is enough?" regarding energy consumption resp. consumption in general.
Structural changes are needed to ensure that sufficiency is not contradictory towards main economic and societal principles. If the economy depends on economic growth a greater effort towards sufficiency leading to less consumption contradicts the growth imperative. How a new economic system that is compatible with the sufficiency principle could look like is still a matter of intensive debate although it has to be admitted that this debate is mainly going on outside the circle of "conventional" economists. Keywords in this debate regarding a new economic system are: "post-growth economy" (Paech 2009), "steady-state economy" (Daly 1991), "solidary economy" (Rätz et al. 2011), "Gemeinwohlökonomie"

(Felber 2012). Other important contributions regarding economic reforms were made e.g. by Binswanger (2009), Douthwaite/Fallon (2010) or Jackson (2011).
The design of settlement structures is a second realm where structural changes are of particular importance. The core question is how settlements have to be designed, redesigned and rebuilt ensuring that basic needs can be fulfilled with a minimal energy consumption.

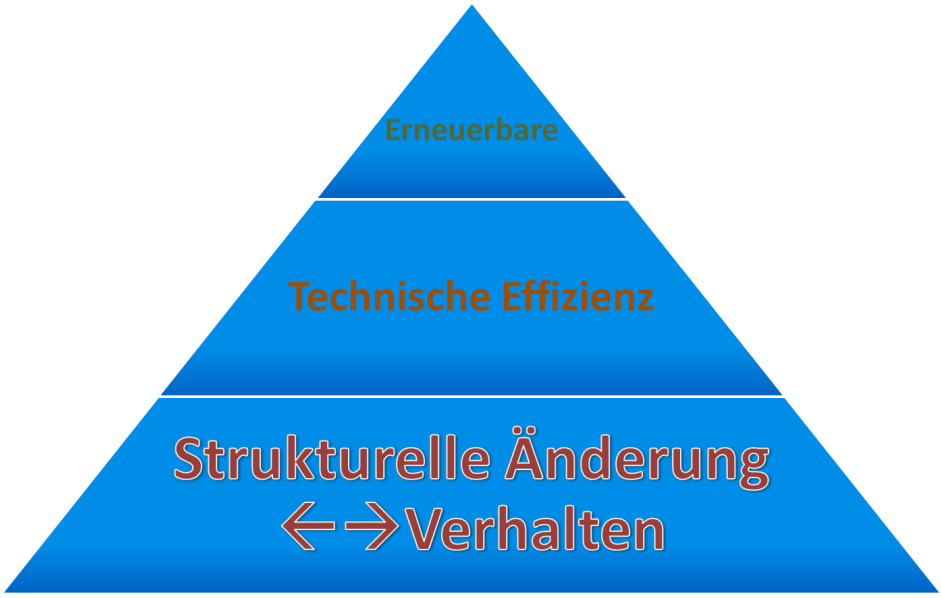

Fig. 4: The "energy transition pyramid". Source: Schriefl et al. (2011)

We propose the following sequence of priorities for the energy transition as shown in the "energy transition pyramid" (Fig. 4).
1. Structural changes <-> behavioural changes
2. Technical efficiency
3. Renewable energy

Structural changes (in the fields of economy and built structures, as discussed above) which are interlinked with behavioural changes form the basis of the "energy transition pyramid". On the one hand, behavioural changes depend on structural changes in that way that behavioural changes will only unfold on a broader scale in an environment where this changed behaviour is inherently reasonable: E.g., in a car-centered environment it takes a lot of effort, sacrifice and motivation to abstain from a car whereas in a pedestrian-oriented environment fulfilling one's basic needs without using a car is an easy option (which can even be associated with a higher quality of life). On the other hand, reforms that implement structural changes need at least the willingness to change individual behaviour. Reaching the goal of a broader change in attitudes and values needs information, argumentation and especially role models (ranging from the behaviour of decision makers to model projects and regions).
Raising technical efficiency is on the second level of the "energy transition pyramid" (big potentials lie in the thermal renovation of the building stock, for instance). On top of the priority are "renewables" meaning that once energy demand has been significantly reduced by structural, sufficiency and efficiency measures, the remaining demand should be covered by renewable energy sources.
The here proposed sequence of priorities does not mean that the different options (structural measures/suficiency, efficiency, renewables) may not be implemented in parallel (e.g,, the diffusion of photovoltaics is still that low that a higher diffusion makes sense anyway) but it means that in any long-term transition strategy they should be addressed coherently.

Options for action on a communal level

In the course of the project "Powerdown" (Schriefl et al. 2011) options for action for the communal/municipal level and beyond were discussed and structured. According to this work, we propose to structure options for action on a communal level into four main categories:

1. First steps
2. Long-term energy transition plans
3. Structural measures (spatial structures, economy)
4. Communal resilience (crisis management/contingency) plans

1. First steps

First steps on the communal level start in its own sphere of influence and could incorporate the following measures:

- Role model function of communal government – Improvement of the communal infrastructures (especially thermal/energetic improvement of buildings, lighting, vehicle fleet).
- Controlling and visualising communal energy consumption: Carrying out a status quo analysis regarding energy consumption, regular monitoring of communal energy consumption, making activities visible for the public and communicating the activities.
- Awareness-raising, offering possibilities for participation. E.g. education of decision makers and employees of the communal administration, organising excursions to model projects/communities, fostering (bottom-up) activities like working groups by offering rooms and other facilities.
- Mobilising key personnel: Searching for and assisting persons within the community who have the willingness and ability to push forward the topics of energy and climate within the community. Ev. creating jobs / specific functions within the communal administration and government for these persons.

2. Long-term energy transition plans

Long-term energy transition plans can be useful tools to assist the process of a local energy transition. We recommend to these plans should be on the "strategic energy pyramid" (as explained above) regarding the sequence of priorities.

Different concepts for developing such long-term plans like "Energieleitbild" or "Energiekonzept" (as these concepts are called in Austria) already exist. An "Energieleitbild" remains more on the level of visions and strategic goals whereas an "Energiekonzept" is more specific and should contain concrete measures in a time frame (and also estimate to effects of these measures). Municipalities are recommended join the program e5 (as it is called in Austria) or "European Energy Award" (as called in other European countries). This program ensures a continuous work regarding energy and climate issues is done in the municipality and that the effects of activities are monitored and evaluated. After joining these programs action plans are developed and implemented.

An „Energy Descent Action Plan" (EDAP) is a tool develop by "transition" initiatives which includes a very intensive participatory process and a holistic approach covering many sectors of communal relevance and is thus extending the range of usual energy action plans. Besides the common topics of energy action plans like energy supply with renewables, mobility and buildings topics like local food production, relocalisation of economic activities, education and others are covered. An extensive Energy Descent Action Plan was developed for the English town Totnes (http://totnesedap.org.uk/).

3a. Structural measures – spatial structures

Implementing structural measures means on the one hand to foster structures which remain functional with a low (fossil) energy demand and to question structures and decisions which contradict this goal (to remain functional with a low energy demand). In the area of spatial planning this means that settlements should be designed in such a way that basic everyday needs can be fulfilled with (very) low energy demand. This includes:

- Fostering spatial proximity – city of short distance trips („Stadt der kurzen Wege“): Implementing measures within a settlement that ensure mobility with short distances offering excellent conditions for pedestrians (appropriate “qualified” density of buildings, an appropriate mix of buildings with different functions, creating a barrier-free path network for pedestrians and cyclists).
- Development of settlements in accordance with public transport: concentration of new compact multi-functional settlements next to public transport stops, extending and revitalising the light rail network.
- Fostering „decentral concentration“: Ensuring a more balanced distribution of population and workplaces. Creation of functional regions to enable cooperation and coordination between municipalities.
- (Re)establishing local supply with goods and services („Nahversorgung“): Creating initiatives to ensure supply with basic goods in town centers, awareness raising activities regarding the importance of shopping behaviour, implementing a multi-functional supplier with basic goods (“Nahversorger”) in small settlements, adapting the size of (shopping) facilities to a “sustainable” catchment area (meaning that the facilities can be reached well without having to use a car).
- Energy-efficient and solar buildings: thermal improvement of existing buildings, south-orientation of new settlements (to ensure maximum solar gains, where south-orientation is not possible buildings should be designed so that they have just mimimum thermal losses). Implementing solar energy technologies (solar thermal collectors, photovoltaic modules) on roofs and facades.

3b. Structural measures - economy

Economic activities on a regional or local level should gain more importance, the growth paradigm has to be questioned. Measures in this realm include:

- Questioning and revisioning current development goals: This is especially crucial regarding development of new infrastructure (roads, buildings, power plants, etc.). Infrastructure with high dependence on fossil fuels should be avoided. Location of enterprises with regard to criteria that ensure good compatibility with a “post-fossil” future.
- Fostering local economic activities: These activities could include the introduction of a supplementary local currency or the strengthening of direct consumer-producer relationships (esp. for food). The role model function of the communal government should actively assist this process, e.g. by buying locally produced goods (for the demand of the community) or by buying from enterprises which operate according to principles of a solidary economy.
- „Energy Resilience Assessment“ for enterprises: In an „Energy Resilience Assessment“ energy costs regarding the products and services (of a certain enterprise) including supply chains are assessed. This assessment could result in a shift regarding business modells, produced goods and services, or locations of an enterprise.
- Re-Skilling: A broad array of skills is an important feature to ensure a high resilience of a community. Skills resp. techniques developed in times when (fossil) energy was not that abundant could be re-assessed and re-developed. The municipality could promote working groups dealing with re-skilling activities.

4. Creating communal resilience (crisis management/contingency) plans

In Austria (and probably almost anywhere else) no contingency plans dealing with possible energy shortages exist on a communal level. We propose to draft such plans for the communal level, as well as for upper spatial levels of government. Whereas several methods for developing energy transition plans already exist (see above) this is not the case for communal resilience/contingency plans (an exception is a framework proposed by Heinberg 2008). Thus, there is still need for pilot activities in this area.

We suggest the following cornerstones for such plans:

- Assessing the vulnerability of infrastructure, defining priorities (Which infrastructures shall be kept functioning with higher priority?)

- Stockpiling and inventory audits: In which amount could stockpiling make sense? Which useful tools exist which allow activities with little energy demand (inventories)?
- Establishing (energy)autonomous systems: Off-grid energy supply for critical infrastructures.
- Mobilising short-term behaviour change: How can short-term energy-saving behavioural changes be assisted?
- Integrating social perspective: How can a minimum supply with basic goods be guaranteed for all, regardless of one's income? How shall communication be done in case of a supply crisis? How can solidarity be fostered?
- Participatory design: Involving the public in drafting such plans. This is also relevant with regard to awareness raising. The confrontation with crisis scenarios can trigger mental processes making it possible to talk about topics like sufficiency or behavioural change that otherwise would not be on the agenda. A delicate matter is informing the public without causing panic (this includes the question for which areas of such a plan public participation makes sense).
- Fostering re-skilling: Education in skills which could be relevant in times of energy scarcities.

Recommendations for political reforms

Another focus of the project "Powerdown" (Schriefl et al. 2011) was a collection of recommendations for political reforms (for the levels of government beyond the communal level). Here the most relevant reform proposals are outlined:

- *Rethinking administrative and regional responsibilities*: This means that the decision authority for spatial planning agendas should be shifted to higher levels (from a municipality to a district/region, from the federal provinces to the federal state). This proposal is specific for the Austrian situation and may be of different relevance for other countries. The current situation in Austria results in a high competition between municipalities for primary dwellers and enterprises leading to sub-optimal decisions and in last consequence, more sprawl. There should be high incentives (or even an obligation) for cooperation between municipalities on a regional level regarding spatial planning. Furthermore, "post-peak oil" regions were proposed because current definitions of regions need not be consistent with the challenges of a relocalised economy.
- *Cancelling problematic investments* (leading into the wrong direction): This concerns all kind of investments in infrastructure that is adapted to a situation of rather cheap and easily available fossil fuels, especially: motorways, oversized shopping centers - especially in peripheral regions, extensions of airports, etc.
- *Eco-social fiscal reform*: This includes several fiscal policy measures, like eco-social tax reform (e.g. raising taxes on energy/carbon emissions, reducing taxes on labour), cancelling counterproductive subsidies (all subsidies that foster a high energy consumption and a high dependency on fossil fuels), redesigning subsidy schemes like the housing programmes ("Wohnbauförderung", subsidising residential buildings) or implememting "Kostenwahrheit" (meaning that the "true" costs of infrastructure should be paid by the users of this infrastructure).
- *Pro-active crisis prevention*: Drafting coordinated resilience/contingency plans on different regional levels (see above). Preparing rationing schemes (an example for an electronic rationing scheme is the "Tradable Energy Quotas"/TEQs scheme (Fleming / Chamberlin 2011)).
- *Information and awareness campaigns*: Enabling a public debate on "What is a good life?" (or "What is necessary for a good life?"). Financing "Simple living" campaigns which are based on positive visions of a post-fossil future. Fostering re-skilling activities (integrating re-skilling into the education system, financing research on the advancement of "traditional" skills and techniques).
- *Socio-economic measures*: Especially in the case of a shrinking economy reduction of labour time is important to fight unemployment. This measure should be communicated positively, in

the sense of gaining more time and quality of life by reducing labour time. For mitigating social conflicts measures against energy poverty are of particular importance. Experimental forms of economies like the solidary economy (which lacks a growth imperative in principle) should be fostered, e.g. by preferring goods from solidary economy enterprises in public procurement.

- *Establishing a comprehensive role model region*: A selected region should serve as a role model for other regions which want to reduce their dependency on fossil fuels. It should follow a holistic approach and structural measures (as outlined above) should be implemented in a progressive way. Behavioural changes should be triggered by participatory processes.

References

Binswanger Hans-Christoph (2009): Vorwärts zur Mäßigung. Perspektiven einer nachhaltigen Wirtschaft. Murmann Verlag

Davidson Bryn (2006a): Our Future(s). 4 Scenarios for the coming energy transition. http://dynamiccities.org/files-documents/scenarios-transition-dynamics/dcp%20scenarios%20-%20draft%20june17.ppt (last access: 31.5.2011)

Daly Herman E. (1991): Steady-State Economics. Second Edition. Island Press

Douthwaite Richard, Fallon Gillian (Hrsg.) (2010): Fleeing Vesuvius: Overcoming the Risks of Economic and Environmental Collapse. FEASTA, The Foundation For the Economics of Sustainability

Felber Christian (2012): Die Gemeinwohl-Ökonomie. Deuticke

Fleming David, Chamberlin Shaun (2011): „TEQs (Tradable Energy Quotas): A Policy Framework for Peak Oil and Climate Change“, London: All-Party Parliamentary Group on Peak Oil, and The Lean Economy Connection, http://www.teqs.net/APPGOPO_TEQs.pdf (last access: 31.5.2011)

Hall Charles A. S., Balogh Stephen, Murphy David J. R. (2009): What is the Minimum EROI that a Sustainable Society Must Have?, Energies 2009, 2, S. 25 – 47, http://www.mdpi.com/1996-1073/2/1/25/pdf (last access: 8.4.2011)

Heinberg Richard (20119: The end of growth. New Society Publishers

Heinberg Richard (2008): „Resilient communities: A guide to disaster management“, MuseLetter #192, April 2008, http://richardheinberg.com/192-resilient-communities-a-guide-to-disaster-management (last access: 16.4.2011)

Heinberg Richard (2009): Searching for a Miracle. „Net Energy“ Limits & the Fate of Industrial Society. http://www.postcarbon.org/new-site-files/Reports/Searching_for_a_Miracle_web10nov09.pdf (last access: 16.4.2011)

Jackson Tim (2011): Prosperity Without Growth: Economics for a Finite Planet. Taylor & Francis

Korowicz David (2010): Near-Term Systemic Implications of a Peak in Global Oil Production. An Outline Review. http://www.feasta.org/2010/03/15/tipping-point-near-term-systemic-implications-of-a-peak-in-global-oil-production-an-outline-review/Tipping_Point.pdf (last access: 16.5.2011)

Paech Niko (2009): Die Postwachstumsökonomie – Ein Vademecum. Zeitschrift für Sozialökonomie, April 2009, 160/161. Folge, S. 28-31, http://www.sozialoekonomie-online.de/ZfSO-160-161_Paech.pdf (last accedd: 6.4.2011)

Rätz Werner, von Egan-Krieger Tanja, Muraca Barbara, Passadakis Alexis, Schmelzer Matthias, Vetter Andrea (Hrsg.) (2011): Ausgewachsen! Ökologische Gerechtigkeit. Soziale Rechte. Gutes Leben. Ein Projekt von Attac. VSA

Schriefl Ernst, Fischer Tatjana, Skala Franz, et al. (2011): Diskussion von Szenarien und Entwicklung von Handlungsoptionen auf kommunaler Ebene angesichts von "Peak Oil" und Klimawandel. Final Report. Programmlinie “Neue Energien 2020”. Wien

Zittel Werner (2010): Ressourcen. Assessment der Verfügbarkeit fossiler Energieträger (Erdöl, Erdgas, Kohle) sowie von Phosphor und Kalium. Teilbericht 1, Arbeitspaket 2 – Globale und regionale Rahmenbedingungen. Studie „Save our Surface“ im Auftrag des Österreichischen Klima- und Energiefonds. München