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Neo-Carbon Core Concepts

in Exploring Transformative Energy Futures 2050

Finland Futures Research Centre (FFRC)

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Detail of sculpture at Venice Biennale Azerbajan Pavillion (2015)

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"Die Grenzen meiner Sprache

bedeuten die Grenzen meiner Welt."

("The limits of my language mean the limits of my world.")

Ludwig Wittgenstein (1889-1951)

in Tractatus logico-philosophicus

PREFACE

Neo-Carbon Energy is one of the strategic research openings of Tekes – the Finnish Funding Agency for Innovation. It is conducted by Technical Research Centre of Finland VTT Ltd, Lappeenranta University of Technology (LUT) and Finland Futures Research Centre (FFRC) at the University of Turku.

Neo-carbon energy entails a completely new energy system, where the produced energy is emission-free, cost-effective and independent. Energy is produced peer-to-peer in a distributed energy system of solar, wind, smart electricity grid, energy storages, and novel industrial uses based on renewable energy through neo-carbonization. As a whole, this will revolutionise the entire energy field.

The transformation of society takes place through socio-technological transitions. This signifies shifts in conceptual thinking, lifestyles and values, that are manifested in policies, and are further enabled by economic resources and novel innovations. New opportunities are often built and recognised, when existing patterns of behaviour, structures and concepts through which the world is seen are re-thought.

We see it worthwhile to identify key concepts that can be vehicles towards transformative energy futures. A limited number of concepts have been chosen according to their relevance to the Neo-Carbon Energy project. Some of the concepts presented in this paper are a reflection of emerging issues, while others are already well-established. All these concepts are reflected as regards their relevance to the project.

Research group of WP1 of the NEO-CARBON ENERGY Project
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1. INTRODUCTION TO TRANSFORMATIVE FUTURES

Change is continuous. As time passes, something is always being changed to a greater or lesser degree in society as large, as well as in nature, technology, politics and daily lives of individuals. Change is a natural part of development and progress – as the motto of this report by the pre-Socratic Greek philosopher Heraclitus reminds us "*Panta rhei*" i.e. "Everything is flowing". Heraclitus draws our attention to ever-present change in the universe. His phrase indicates that "No man ever steps in the same river twice". This also means that all the information, knowledge, experience and learning we accumulate *per se* has an impact on the way we see the world, society and ourselves in it.

In futures studies much emphasis especially in horizon scanning is focused on anticipating, identifying and analysing change. Future is about change – continuous change and interconnected change between various sectors and actors in society. On the other hand, the field of futures studies aims at anticipating change but also at having an impact. Consequently, if one recognises a stream of change that is not a desired development, measures can be proactively taken to impede such non-preferred change. This is of equal importance for taking steps to promote preferred futures images and scenarios.

What is transformation then? The term "transformation" has a special meaning in genetics referring to the genetic alteration of a cell.[1] In general language use, transformation means comprehensive and ground-breaking change as a process from one state of things into a changed situation or paradigm. According to Merriam-Webster dictionary "transformation" means a **complete or major change** in someone's or something's appearance, form, etc. Some further definitions of transformation are given as the following:

1: an act, process, or instance of transforming or being transformed

2: the operation of changing (as by rotation or mapping) one configuration or expression into another in accordance with a mathematical rule; especially a change of variables or coordinates in which a function of new variables or coordinates is substituted for each original variable or coordinate.

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[1] Transformation means genetic alteration of a cell on the basis of the direct uptake and incorporation of exogenous genetic material (exogenous DNA) from its surroundings and integrated through the cell membrane(s). This genetic transformation was first demonstrated in 1928 by British bacteriologist Frederick Griffith.

Transformation consists of two root words from Latin (trans + forma). “Forma” means “form” and “trans” means “direction over to something”, i.e. here **move to another form.** Society can thus be characterised as manifesting itself in transformation – in a complete or major change process into another state. Transformation can be used as an abstract expression or as a concrete one. For example, buildings can be depicted as having underwent various transformations over the years. Synonyms for “transformation” are such expressions as “changeover, metamorphosis, transfiguration, conversion”. Related terms for “transformation” include “shift, transition; adjustment, alteration, modification; reconstruction, reconversion, redo, redoing, refashioning, reformation, remaking, remodeling, revamping, revision, reworking, variation; deformation, disfigurement, distortion, mutation, transmutation; displacement, replacement, substitution, supplantation”.

Transformation – whether it is of whole society or of some parts of it – may take place as a result of how drivers of change have played out and to what degree the change has been governed, managed or accelerated towards certain directions and outcomes. Interlinked and long-term processes and dynamics over decades and centuries have shaped our current global system and way of life (Buzan and Lawson 2015). Therefore, achieving transformations for sustainability should actively recognise the necessary changes for power relations such as vested interests, political conflict, and people’s cognitive maps (e.g. Olsson et al. 2004). It is noteworthy that the existing need for transformation may highly vary according to the ends and intentions of different decision-makers and stakeholders. For more on transformation, see Heinonen & Balcom Raleigh (2015).

Jointly recognised, pressing societal challenges and threats may accentuate the need for change and even transformation. In particular, wild card events may disrupt the current regime and catalyse transformational change by revealing the need for change through devastating consequences. In fact, Walsh et al. (2015, 3) propose that wild card events can be used to better understand infrastructure as a socio-technical system, to envision future sustainable infrastructure, and to assist in co-design adaptation measures with various stakeholders.

Transformation of society and communities covers the whole complex system which can be illustrated throughout PESTEC dimensions (political, economic, social, technological, ecological, cultural/citizen/customer). Major transformation needs may be reflected, not only on political, governance, economic systems and new ways of thinking, but also on concrete technical infrastructure systems. Systems must be transformed to be adaptable to long term impacts of climate change such as rise of sea level and extreme weather conditions. Transformations are needed because humans are dependent on healthy ecosystems for their well-being. Walsh et al (2015) point out that infrastructure plays a major role on greenhouse gas mitigation targets. The energy and transportation sectors are currently heavily carbon intensive. New technologies and infrastructure configurations could drastically contribute to mitigation efforts. Moreover, the provision of infrastructure can also induce changes in demographics and behaviour in support of emission reductions.

What is most needed, however, is a societal transformation penetrating the human mind – from short-term thinking to long-term thinking, from a narrow outlook to broad comprehensive, holistic view and systems thinking. According to Garry Jacobs (2015) transition to a new paradigm requires adoption of a different way of thinking – different from the present "blind alley" – that is human-centred, value-based, inclusive and synthetic. On the other hand, we also need a transformation from anthropocentric way of thinking to comprehensive biophilic thinking where humans are part not only of society but of the whole biosphere. Likhotal (2015, 43) crystallises that we are facing a radically new reality, both individually and collectively. He sees change no longer a mere theory, nor just an option, but a reality, a "*condition sine qua non*" of our survival. According to Malaska (1971) major challenges arise from the problematic relation of the ecosystem and our technosystem. The ultimate question is whether the world is better with or without us humans.

It is important to anticipate and to understand change in order to cope with the turbulent conditions and complex world. How we speak about the change and how we perceive the potential embedded in change is either hindered or opened up through the concepts that we use for socially constructing the present and future realities. As Wittgenstein put it, our language and speech give boundaries to our perception. We have to recognise and respect not only planetary boundaries, but also pay attention to using game-changing concepts in mutual understanding for creating better and sustainable futures.

2. CORE CONCEPTS

In the background research of the Neo-Carbon Energy project (WP 1 Task 1 Horizon scanning)[2], the following concepts have been tentatively identified as relevant when exploring transformative energy futures 2050. They have been grouped loosely to follow the wider PESTEC themes[3] such as **politics (P), economy (E), society (S), technology (T), ecology (E), and cultural aspects that concern lifestyles, citizens and customers (C)**, see *Figure 1*. In reality, most concepts intertwine across these dimensions, and could therefore also be placed into another dimension than the one selected here. For each concept, a brief description with some comments and references is provided. In each category, roughly five key concepts, as well as their tentative relevance for neo-carbon future, or its energy system, have been presented (in alphabetical order).

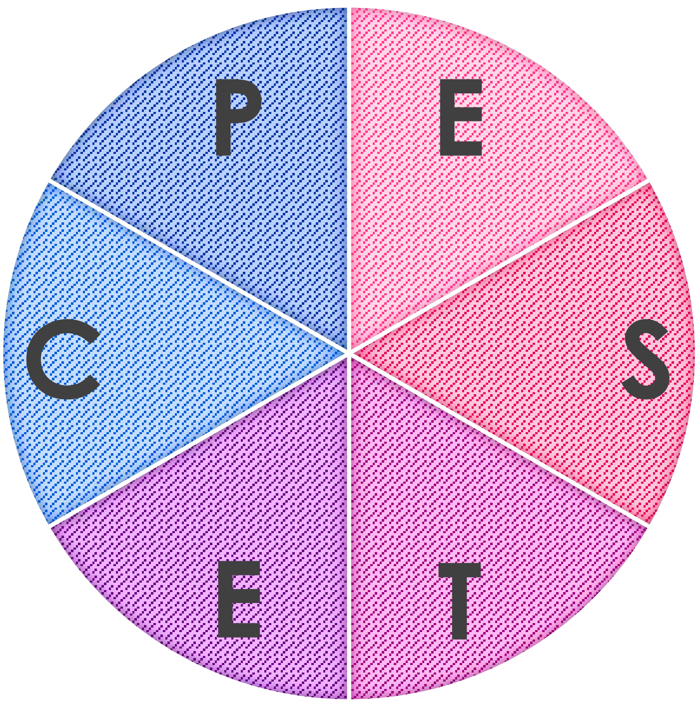

Figure 1: The thematic fields of the core concepts.

[2] www.neocarbonenergy.fi
[3] The PEST method has originally been developed to analyse a business environment. We prefer PESTEC, a modification of it, which includes environmental and cultural aspects, to split the big scenario picture into smaller components.

2.1 Politics

Deliberative democracy

Democracy should strive for best possible arguments to ensure the quality of decision-making. Deliberative democracy sees the essence of legitimacy in the authentic deliberations of those affected by a collective decision (Dryzek 2000). Democracy needs deliberation, constructive and critical discussions to be reflexive in its questioning, critical of established power, transnational, open for democratization to emphasize community, equity, ecological limits, and rights.

There are conscious and unconscious reasons why the space for democratic debate gets limited. Public administration has traditionally listened to established industry more than small-and-medium-sized enterprises, communities, or environmental advocacy groups. Energy policy has been a playing field of state-owned enterprises and international companies who provide energy infrastructure. Then again, the language of expertise, terminology, as well as references to mathematical and technical properties of a particular model, may be enough to silence critical questions from groups that do not possess access to models or their data (Luukkanen 1994). In certain regional energy initiatives, it has been difficult for a country to plan for its energy choices without the involvement of the major players. Therefore, industry assumptions as such delimit the range of public debate. Institutions such as ministries that follow conservative energy outlooks may indirectly influence public opinion, and industry lobby may directly "kill" the debate of alternative energy choices.

Historically in Finland, political studies have found the decision-making culture as corporatist and centralised. Already a long time ago, researchers (e.g. Ruostetsaari 1989) have observed close personal relationships between the Ministry of Economy and Employment, large energy companies, and the energy-intensive industry. In climate and energy matters, environmental non-governmental organisations (NGOs) have tended to see Finnish energy policy as cautious and hierarchical. Representatives of renewable energy industry in Finland support such claims and perceive electricity production as a centralised playing field of large companies and big power plants where citizens have had little role (Auvinen 2014).

The deliberative turn and a free flow of information challenges established institutions. Concerns of non-organised, marginalised groups or individual citizens with limited resources feel that their concerns deserve to be heard equally to influential advocacy networks and coalitions. Past democracy theories have struggled to understand the significance of the views of those affected. Energy affects us all. Therefore, in contrast, an aggregate perspective to energy policy tends to drive large energy projects, justified with top-down energy modelling. A step towards the acceptance of a diversity of views in energy policy and energy modelling could be the opening of all assumptions that guide policy-making and model-making. Elster (1998, 8) defines deliberative democracy (or discursive democracy) as participation in the collective decision-making either directly or through a representative by all those affected by the decision through discourse/deliberation where the arguing and listening parties are committed to rationality and impartiality. According to Young (1996, 121), unlike in liberal democracy where preferences are aggregated, in deliberative democracy preferences may change through argumentation and the aim is in common good.

Relevance for NEO-CARBON ENERGY: Decentralised energy production and models of peer-to-peer society challenge historical assumptions and the ways institutions have been used to communicate their views. Small and emerging actors will have stronger resources to be heard. Discussion about the guiding assumptions that shape energy choices democratises energy policy today and prepares for the needs of the distributed energy production in the future.

Energy modelling and energy scenarios

Energy modelling and energy scenarios explore energy futures, which makes them important expert tools that get used in political choices about energy. This is why assumptions that underpin models and scenarios matter. Lund (2014, 54–55) argues that to explore a wide range of future options, energy models should be able to analyse radical technological changes, recognise the limited amount of biomass resources, use of fossil fuels, and the intermittency of wind and solar. Many scenarios fail to foresee the pace of technological change or unprecedented events (Karjalainen et al. 2014). As an example, the rapid fall in the price of solar energy and the industry development has outpaced past predictions and made past forecasting scenarios outdated.

Problematically, energy forecasts typically expect energy use to increase for decades to come, while simultaneously many of their makers are fully aware of the necessity to reduce fossil fuel-based emissions sharply. A positivist techno-rationalistic approach of neo-classical economics reinforced the 20th century modernisation worldview. Energy models in the 1950s responded to the need to develop the industrial economy and detailed techno-economic models in the early 1970s to the oil crisis. Energy forecasts all over the world have served the state and the energy-intensive industries to justify for large, centralized energy plants. This, in part, has also resulted in overcapacity and consequently higher carbon emissions levels (Luukkanen 1994).

Energy models use data from a variety of sources. *Bottom-up energy models* (supply- and demand-side models) include larger shares of renewable energy (RE) and low-fossil technologies. Using these models makes RE technologies increasingly competitive over a long-term period. *Electricity market models* show hourly, daily, and seasonal variations. *Top-down energy models* (computational general equilibrium (CGE) models; econometric models; input-output models; and system dynamics models) use historical energy consumption data, which perhaps explains why they assume that with economic growth also energy demand must continuously increase (NB. forecasting scenarios do, too). *Hybrid energy models* mix the bottom-up and top-down approaches (Herbst et al. 2012; Unger 2010).

Energy scenarios are not policy recommendations; they are meant to help decision-makers explore a range of scientific evidence. Scenarios can be divided into forecasting or backcasting scenarios. *Energy forecasting* describes a series of events from the present into a certain state of future. For example, energy outlooks (BP Energy Outlook, IEA World Economic Outlook, Shell Energy Scenarios) analyse prevailing trends of the society. *Energy backcasting*, in turn, can be used as a strategy tool, and analysis is started from a possible and wanted future. They express a future, often an ideal state of being, and elaborate the obstacles that must be overcome. These include publications such as EU Energy Roadmap 2050, Energy [R]evolutions by Greenpeace or IEA 450 scenario.

Forecasting scenarios or conducting market research of known energy markets is often perceived as 'credible'; while backcasting can reveal where to aim in the future. Because backcasting scenarios typically recognize a carbon constraint, many of them expect a future price on carbon, eradication of fossil-fuel subsidies, a major scaling-up of renewable energy and/or significant increases in energy efficiency. However like forecasting scenarios, even influential backcasting scenarios take little stand on limiting energy demand and changing consumer behaviour. There are also both forecasting and backcasting scenarios that straightforwardly assume the necessity of nuclear power. In addition, political issues, such as who benefits from the model use or what political constraints there are to develop renewables, are rather difficult to model.

In Finland, the Energy Department[4] has used an energy model that researchers and the general public have viewed as a "black-box" model. This means that its assumptions cannot be openly evaluated. This indicates that such a model includes confidential data, i.e. data on individual companies. Another factor that delimits the debate about energy choices is a reliance of researchers and non-governmental organisations of baseline data and assumptions provided by the state and industry. If they want to construct alternative energy models or scenarios, they may be forced to use information they would not even agree with.

Relevance for NEO-CARBON ENERGY: The neo-carbon energy system and neo-carbonization envisions alternative energy futures, which, in turn, requires new types of modelling and scenario approaches. Assumptions in energy modelling and policy-making reflect normative choices of a modeller or decision-maker. In practice, dominant assumptions typically prevail over emerging aspirations. Energy scenarios stimulate the imagination of policy-makers, while energy models are used as a basis for investment plans, legislation and regulation (Unger 2010). In Finland, critics of official energy scenarios have doubted the assumption of continuous growth of energy consumption.

Global governance

Global governance is a movement towards political integration of transnational actors. It aims at cooperation and negotiating responses to problems that affect more than one state or region and studies how global challenges can be solved globally (e.g. Wilkinson 2005, Scholte 2011). Global environmental governance refers to the intersection of environmental affairs. It includes but is not limited to the governance of global commons. (Commission on Global Governance 1995, 3). Global governance tends to take the form of institutions such as the UN. However, these institutions have only limited ability to guide the change whereas the nature of the problems are increasingly wicked. As a consequence, there is a growing criticism on the ability of global governance to drive the change. Slow progress in climate change negotiations has been considered as one of the key failures of global governance in the late 20th and early 21st century. Critics emphasise the potency of nation states or regions - or even cities - as political actors. Thus, local, regional or national initiatives could prove to be the driving force of change.

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[4] Of the Ministry of Employment and the Economy (TEM), until 2008 known as the Ministry of Trade and Industry (KTM).

Supporters of global approaches suggest new concepts that better capture the ethical aspects and all the levels of agency of global governance. Biermann (2007) suggests to replace global governance with "earth system governance" that he defines "as the sum of the formal and informal rule systems and actor-networks at all levels of human society that are set up in order to influence the co-evolution of human and natural systems in a way that secures the sustainable development of human society—that is, a development that meets the needs of present generations without compromising the ability of future generations to meet their own needs".

Relevance for NEO-CARBON ENERGY: Distributed energy production can solve some energy security issues and hence emphasise the role of local governance. One way to balance the intermittency of renewable energy, especially solar and wind, is a vision of a global supergrid. Such a system could bring about new issues of global governance on the agenda.

Lock-in effect

In World Energy Outlook 2011, the International Energy Agency (IEA) suggested that because of the present rate of fossil fuel based energy consumption and infrastructure choices, the world economy is likely to "lock into" a minimum of +2°C degrees global warming trajectory already by 2017. Even with a shift to unconventional natural gas, these fossil fuels will take global warming beyond +2°C (IEA 2011, 42). Updated estimates by the IPCC support these worrying findings.

The trajectory of energy investments spans several decades. Built infrastructure (housing, roads and railways) may define physical reality up to 100 years or more. Therefore, infrastructure and investment decisions limit the availability of future choices. Concerning the economics of climate change, the Stern report (2006) concluded that the further actions are postponed, the costlier they will become later.

Relevance for NEO-CARBON ENERGY: Consider "butterfly effect", where the impacts of an action today can become hugely magnified in the future. Choices made today determine future options and rationales longer than is typically understood. With business-as-usual trajectory and mode of economic growth, global warming will very likely exceed scientifically defined safe limits. Futures-oriented planning through neo-carbonisation can attempt to escape such non-preferred energy future.

Policy-making and behavioural economics

Problem-solving is perhaps the single most general objective of science. But, in a world of decision-making under uncertainty and rising complexity, problems are increasingly "wicked". Rationality, if built upon high standards, should in theory enable the build-up of theories as closer approximations to the truth. It should be possible to understand a phenomenon, when it is embedded in a nomological framework, and a causal relationship from the cause to the effect is accounted (Carrier 2004; Laudan 1977). Then again, psychological factors have been found to play an important part in human behaviour and our interpretations of what is rationale.

Different framings significantly influence the way problems as well as results can be interpreted (Kahneman 2011; Tversky and Kahneman 1981). The public and decision-makers struggle to think statistically in part due to human's limited cognitive ability and several bias. For example, looking at the rate of CO_2 emissions alone may divert attention from humanity's overall resource consumption, as a function of how our global economy currently works, as the root cause of most ecological pressures (Galli et al. 2012). Because people live with 'bounded rationalities' where only a limited amount of information is available, they also tend to react differently depending whether a choice is represented as a loss or a gain.

Relevance for NEO-CARBON ENERGY: In communicating about renewable energy futures, the neo-carbon energy system and related solutions, different framings of scientific results or related policy choices can influence the way they become interpreted by decision-makers or accepted by the general public.

2.2 Economy

Circular economy

The circular economy is a generic term for an industrial economy that is, by design or intention, restorative and in which material flows are of two types: 1) biological nutrients, designed to re-enter the biosphere safely, and 2) technical nutrients, which are designed to circulate at high quality without entering the biosphere. The term encompasses more than the production and consumption of goods and services, including a shift from fossil fuels to the use of renewable energy, and the role of diversity as a characteristic of resilient and productive systems. It includes discussion of the role of money and finance as part of the wider debate, and some of its pioneers have called for a revamp of economic performance measurement tools.

The circular economy is grounded in the study of feedback rich (non-linear) systems, particularly living systems. A major outcome of this is the notion of optimising systems rather than components, or the notion of 'design for fit'. (See Wijkman & Skånberg 2015). As a generic notion it draws from a number of more specific approaches including cradle to cradle, biomimicry, industrial ecology, and the 'blue economy' (see correspondingly). Most frequently described as a framework for thinking, its supporters claim it is a coherent model that has value as part of a response to the end of the era of cheap oil and materials. In Finland, especially Sitra – the Finnish Innovation Fund, promotes this concept.

Relevance for NEO-CARBON ENERGY: Circular economy emphasises systems thinking and eco-systems thinking. In a neo-carbonised society also carbon circles in a closed system where atmospheric CO2 is used as a source of carbon for synthesising hydrocarbons and thus creates new value.

Green economy (cf. Green growth)

Green economy is a model where the environmental impacts from economic growth are minimised. At times, such growth is also coined as green growth. It is recognised that as the invisible engines of sustainability, environmental and social aspects need to be given equal, if not greater weight with economic aspects, in development and economic planning (UNEP 2011; Victor and Jackson 2012). Here, inclusive growth takes into account social considerations to strive to make growth beneficial for the broadest possible number of members in society. See also: Neo-growth, as defined by Malaska (2010).

Several countries have set up policies and strategies for either green economy or green growth. This includes low-income countries, where transitioning towards a green economy has been hoped to enable "leapfrogging", the skipping of an emission-intensive pathway industrialised countries had to take to develop. To make a transition towards a green economy equitable and just, environmental and social considerations can be addressed with appropriate policies and fair practices.

Relevance for NEO-CARBON ENERGY: Neo-carbonisation could provide a robust technological, energy modelling and economic basis for a green economy. Inclusiveness of growth such as fair distribution of benefits and jobs can improve the social acceptability of growth that is generated by novel innovations. In return, green economy strategies and policies in countries can support the uptake of neo-carbon based solutions.

Neo-carbon economy (cf. Low-carbon economy).

Considering the fact that carbon emissions (CO_2) and other greenhouse gases cannot be emitted beyond a certain limit, societies need to look for ways to design a new economic structure. This signifies a re-thinking of how heavy industries, manufacturing and energy production can be sustained in the future. *Neo-carbonisation* refers to a pathway, processes or new technologies of a society where carbon is used in the economy, but not released into the atmosphere. Neo-carbonisation in part refers to chemical processes of carbon capture and utilization (CCU). CCU technologies are different from carbon capture and storage (CCS). *Decarbonisation* envisions a low-carbon economy, where economic actors do not use carbon at all, and neo-carbonisation is a strategy to reach this target.

Relevance for NEO-CARBON ENERGY: In a neo-carbon economy, carbon is not entirely removed from the industry use, but it is strategically used in selected economic activities, where neo-carbon technologies mitigate for the emissions. Neo-carbon economy and low-carbon economy do share a common objective, as both seek to construct a society that can function within scientifically defined climate change constraints.

Neo-growth

Neo-growth (Malaska 2010) is a "positive" version of degrowth. It defines growth anew, while it retains its positive connotations and meanings. Neo-growth signifies economic growth that *1)* does not increase environmental stress; and *2)* increases wellbeing in society. Neo-growth encourages finding new sources for growth, synthesises economic and human growth and the merging of growth with sustainability. A neo-growth society can be seen as a "matured" phase of the information society, in which the potentials of information and communication technologies (ICTs) are thoroughly utilised. In a neo-growth society, ICTs are first and foremost used to "enhance" interaction and cooperation.

Neo-growth is different from degrowth and downshifting. *Degrowth* is a concept and a broader movement that challenges the overriding assumption of economic growth, the hegemony of the economic sphere, and advocates for the decrease of production and consumption to tackle global ecological crises. *Downshifting* is a social behaviour that encourages individuals to lead simpler lives, improve work-leisure balance, escape obsessive materialism, and to think of their life objectives beyond the pursuit of economic success. This is akin to "slow life", where less is more.

Relevance for NEO-CARBON ENERGY: Neo-growth characterises a society where ecological values are a norm and where growth is derived from new sources that are neither harmful to the climate, nor the ecology. The entire concepts of neo-carbon energy, and neo-carbonisation, are normatively compatible with the aims and contents of neo-growth.

Sharing economy

Sharing economy refers to an economic model where peers exchange resources, either through barter as gifts not expecting immediate compensation, or monetary transactions. If consumers share access to assets instead of owning them, consumption could become more sustainable. Paradoxically, sharing economy also expands opportunities of consumption (Martin 2016).

Online peer-to-peer platforms enable several of such practices. When money is involved, the act of "sharing" is often coordinated by a third party such as Uber in the case of sharing cars, or Airbnb when renting an apartment. Whether this counts as sharing economy, can be debated. A more suitable concept for such arrangements is perhaps collaborative consumption, in which individuals share access to products and services.

Sharing economy draws from the idea of commons, resources that are accessible to all members of society. Collaborative commons (see Rifkin 2014) refers to the collaborative nature of markets. Information is increasingly "co-owned", and digital commons such as scientific knowledge co-produced and co-developed.

Relevance for NEO-CARBON ENERGY: If the marginal cost of renewable energy drops near zero, energy becomes a commons and a part of the sharing economy. Zero marginal cost energy decreases the marginal costs of all production, paving a way for an entire economy based increasingly on shared and co-developed resources. Sharing economy has the potential to increase the use-rate of products, and broaden access to resources.

2.3 Social

Antifragility

The future is uncertain. If you want to survive uncertainty you have to find ways how to domesticate, even dominate and conquer the unseen, the opaque, and the inexplicable. Antifragility means that some things thrive and even grow when exposed to volatility, randomness, disorder, and stressors. They "love" adventure, risk and uncertainty. The concept "antifragility" was introduced by Nassim Taleb (2014) to refer to systems that increase in capability, resilience, or robustness as a result of mistakes, faults, attacks, or failures. Antifragility can be applied in risk analysis, physics, molecular biology, transportation planning, engineering, and computer science.

Antifragility goes, however, essentially beyond resilience or robustness. The resilient only resists shocks and stays the same, whereas antifragile gets better (Taleb 2014, 3). We can identify antifragility by using a simple test of asymmetry: anything that has more upside than downside from random events/shocks is antifragile, while the reverse is fragile. Taleb defines antifragility as a convex response to a stressor or source of harm (for some range of variation), leading to a positive sensitivity to increase in volatility (or variability, stress, dispersion of outcomes, or uncertainty, what is grouped under the designation "disorder cluster"). Likewise fragility is defined as a concave sensitivity to stressors, leading a negative sensitivity to increase in volatility. The relation between fragility, convexity, and sensitivity to disorder is mathematical, obtained by theorem, not derived from empirical data mining or some historical narrative. It is a priori. (Taleb 2014).

Societies with more and more "cutting edge" sophistication and specialisation in them become increasingly vulnerable to collapse (Taleb 2014, 34). Nature is antifragile up to a point, which is quite high, to which nature can take a lot of shocks (ibid. 69).

The ability to switch from a course of action is option to change. Optionality is important for antifragility. Option is what makes you antifragile and allows you to benefit from the positive side of uncertainty, without a corresponding serious harm from the negative side (Taleb 2014, 171).

Relevance for NEO-CARBON ENERGY: Neo-carbon system provides an alternative to fragile nuclear energy and polluting fossil energy systems. The transformative Neo-Carbon energy scenarios 2050 may also be assessed regarding antifragility.

Meanings society

Meanings society is a possible next phase of the information society. In the meanings society, society and economy are based on the production, consumption and processing of cultural meanings rather than that of information and knowledge.

In the meanings society, citizens' quest for meaningful living is a main driver defining economy, work, leisure and politics. As traditional sources of meaning, such as the nation state and work, have lost their significance, citizens have to construct their identities by themselves. As an increasing proportion of economic production falls into the category of creative economy, individual identities become crucial factors in value creation.

The main technology in the meanings society is the internet. As an endless source of contents, internet provides the basis for identity construction in a very same way that e.g. the nation state or work did before.

Relevance for NEO-CARBON ENERGY: The quest for meaning is one of the main driving forces for the lifestyles of the neo-carbon society. Peer-to-peer communities create their own meanings, and related lifestyles and social relations.

Ecosystems

The metaphor of "ecosystems" is increasingly used to describe the value chains and organisation of businesses. The core idea of business ecosystems is that companies cooperate and exchange information in a more open manner than before. Business ecosystems include other companies as well as citizens, consumers, governmental organisations etc. The logic is that by the disclosure of information and engaging in rich interactions corporations gain more advantages than by keeping to themselves. In business ecosystems value is added through open innovation and co-creation. Firms and other actors coevolve together. As in biological ecosystems, companies create mutually beneficial ("symbiotic") relationships with customers, suppliers, and competitors.

James F. Moore (1997) describes business ecosystems as follows: "An economic community supported by a foundation of interacting organisations and individuals – the organisms of the business world. The economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments, and to find mutually supportive roles."

Business ecosystems can be seen as a weak signal of a whole society organising as an ecosystem. In this kind of society, all actors exchange information openly and form close relationships with each other. As opposed to *network society,* the "ecosystem society" is more dynamic and stemming from the grass-roots. In an "ecosystem society" people meet, talk, trust, share, collaborate, team, experiment, and grow together. They develop shared patterns of behaviour – shared culture – that streamline the flow of ideas, talent, and capital throughout a system. (Hwang 2014.)

Relevance for NEO-CARBON ENERGY: Ecosystems is a fitting metaphor for the way a neo-carbon society could organize itself. An "ecosystemic society" would be based on sharing and co-development of resources. See also: Sharing economy, Peer-to-peer.

Neo-carbon society (cf. Low-carbon society)

In a neo-carbon society, communities and states enjoy an enhanced quality of life, using digitalized information and communication technologies. Products and services used or consumed are a result of economic activity that is not harming the environment and does not increase greenhouse gases. This has, in part, been enabled by high shares of renewable energy and neo-carbon technologies. More than today, citizens are prosumeristic, which signifies that many produce their own energy with renewables and consume it, too. The level of CO2 emissions has been stabilized in a neo-carbon society (similar to a low-carbon society) to ensure that global warming will not cause impacts detrimental to the ecology or human societies.

Relevance for NEO-CARBON ENERGY: Anticipating futures based on neo-carbon energy is not a technological issue alone, but the way technologies will be taken into use depends on multiple societal factors. Neo-carbon technologies could be taken into use as de-centralised or centralised, by individuals, small communities or large companies. It may also be expected that a neo-carbon society will have products, services, industrial processes and jobs different from the world of today.

2.4 Technology

Biomimicry

Throughout times humans have solved problems with the help of nature. Biomimicry (used often synonymously with biomimetics or biomimics) refers to simulation of nature. The word comes from Ancient Greek, bios/βιος meaning life, and mimesis/μίμησις meaning imitation. In a biomimetic world, manufacturing takes place following the way of the nature. According to Janine M. Benyus biomimicry is *the conscious emulation of life genius* and nature-inspired innovation, making nature is both model, measure, and mentor. (Benyus 1997.) Biomimicry relates to the rise of different new technologies inspired by biological solutions at macro and nanoscales. Biomimic solutions can be found in transportation, energy solutions, architecture, medicine, and communications for example. Benyus states that there are four steps towards a biomimetic futures; 1) immersing oneself in nature, 2) getting to know the flora and fauna as closely as we can, 3) have engineers and biologists collaborate with nature as their model and measure, and finally 4) take care of biodiversity. (Benuys 1997, ch 8.) Gunter Pauli (2009) has presented examples of innovations based on biomimics in his book on Blue Economy.

Relevance for NEO-CARBON ENERGY: Biomimics could moderate the distinction between humans and nature, paving way for a worldview where humans are seen as part of nature's ecosystems. This in turn could promote ecological values.

Cradle-to-cradle

Cradle-to-cradle design, also at times referred to as C2C, cradle2cradle, or regenerative design, is an approach to the design of products and systems that imitates models, systems, and elements of nature. The term "regenerative" describes processes that restore, renew or revitalize their own sources of energy and material. The metaphor behind cradle-to-cradle design is a healthy and safe metabolism where materials are like nutrients that circulate in the system (McDonough & Braungart 2002). It is an economic, industrial and social framework that seeks to create systems that are waste free and efficient – and profitable (El-Haggar 2010). It can be applied not only to industrial design and manufacturing, but to urban environments, buildings, economics and social systems, too.

Relevance for NEO-CARBON ENERGY: Carbon is an integral part of nature. Instead of treating it merely as an emission, a harmful substance, we can use it as a raw material or source for another types of processes.

Energy internet

Energy internet is a broader and more holistic concept than the smart grid (cf. *Smart grid*). A smart grid does not necessitate decentralised production of energy, whereas in an energy internet energy is produced in a distributed and decentralised manner (Boucher 2015). Analogous to the internet, an energy internet would be a peer-to-peer system without a controlling centre, where citizens and companies alike feed their surplus energy to the energy internet. The energy internet supports uploading, downloading and storage of energy – like the Internet. The Internet has plummeted the cost of information near zero, and the energy internet will do the same for energy. Energy would be locally stored in every building and throughout the infrastructure by various energy-storage technologies. Jeremy Rifkin (2011, 50) writes of the energy internet: "This intelligent energy network will embrace virtually every facet of life. Homes, offices, factories, and vehicles will continuously communicate with one another, sharing information and energy on a 24/7 basis." In an energy internet, smart technologies do not only optimize the operation of single devices, but "everything" communicates with "everything", sharing information so that the whole can be optimised. In other words, energy internet does not refer to the energy grid alone, but to everything involved in energy consumption, production and distribution, and connected via ICTs. Energy internet is thus closely related to the Internet of Things (IoT), which refers to devices and objects with internet connection and sensors.

As a holistic concept, the energy internet has implications for the entire society. Just as the internet has led to an abundance of information, the energy internet has the potential to lead to an abundance of energy. This, in turn, can revolutionize our whole economy and ways of living. Low-cost renewable energy could, for instance, lower the barrier of do-it-yourself (DIY) production. As a lateral communication technology, the internet has given new power to the civil society. In a similar manner, the new peer-to-peer model would usher a collaborative era in energy systems as well (Wu et al. 2015). Such a complicated system requires co-development and co-experimentation with various stakeholders, including citizens (Lösch & Schneider 2016). Furthermore, some authors claim that decentralised energy system promotes a more democratized, peer-to-peer society where power stems increasingly from the grassroots (Sovacool & Brossmann 2010; Rifkin 2011). The line of argument here is largely economic: if individuals or communities produce their own energy (or receive nearly-free energy from the grid), they gain independence and are empowered to small-scale.

Relevance for NEO-CARBON ENERGY: Smart grids and the energy internet provide a technical backbone for the distribution of renewable energy production. The energy internet especially holds a promise for abundant and nearly free energy – just as the Internet has done to information.

Internet of things

Internet of Things (IoT) refers to physical objects – buildings, infrastructure, vehicles, devices etc. – connected to the internet and embedded with electronics, software and sensors. IoT enables objects to "sense" their environment, function autonomously and communicate with each other and with human actors. The integration of physical world with computer-based systems results in better user-experience, and improved efficiency and accuracy. IoT provides the infrastructure for a connected world in which individuals can better communicate with each other and their environment, allowing for instance controlling objects remotely.

Relevance for NEO-CARBON ENERGY: The Internet of Things has a central role in a distributed energy system, allowing for the optimization of energy use. The Internet of Things also holds promises for new kinds of peer-to-peer social relations as it promotes a thoroughly connected world.

Smart grid

The smart grid is often defined as the use of information technologies (ICTs) to improve reliability, security, and efficiency of the electric grid. In a smart grid, ICTs are used for dynamic optimisation of grid operations and resources. Through remote control and metering, utilities can balance energy consumption and production especially during peak demand. This also allows for a more efficient use of energy. "Smart" technologies can also be used to optimize the physical operation of appliances and consumer devices. A common element to most definitions is the application of digital processing and communications to the power grid, making data flow and information management central to the smart grid.

Relevance for NEO-CARBON ENERGY: Smart grids and the energy internet provide a technical backbone for the distribution of renewable energy production.

Technology convergence

Technological convergence refers to the process where various technologies converge to form unified entities (e.g. info-nano-bio-cogno). New technology is moving towards single platforms delivering multiple media outputs that can be used to reach audiences. Convergent technology is technology that allows an audience to consume more than one type of media from a single platform.

Relevance for NEO-CARBON ENERGY: Energy-wise technological convergence could mean e.g. devices producing their own energy. In general, technological convergence provides a central feature of future economic production.

Third industrial revolution

The third industrial revolution, as defined by Jeremy Rifkin (2011), states that a fundamental socio-economic change occurs when new communication technologies converge with new energy technologies.

The first industrial revolution (late 18th century) was fuelled by the steam engine and the printing press, and the second industrial revolution (early 20th century) by oil, electricity, telegraph and telephone. According to Rifkin, the third industrial revolution is now being paved by renewables, such as solar and wind, and the internet. Contrary to the previous technologies, both renewables and the internet are *distributed* technologies. Renewable energies are found everywhere instead of certain areas. They are also relatively cheap to exploit. Internet is a networked communication technology without control centres and with low communication costs.

Thus, the third industrial production paradigm promotes a *decentralised society*. In the third industrial phase, the household and communal level will be the main area of production, as citizens produce goods, services and energy by themselves, utilising digital production technologies, such as 3D-printers, and distributed renewable energy resources. Surplus energy is fed onto the "energy internet" (or smart grid). Citizens and micro-businesses use the internet to organise their productive efforts, and societal and economic power is redistributed from large organisations to small-scale actors. Often, the information society (ca. 1970 - 2000) is seen as the third industrial revolution. Rifkin, however, does not regard this as a new industrial phase as it does not include a revolution in energy systems. Those who consider the information society as the third industrial phase suggest that we are moving into a fourth industrial revolution which refers to the new phase of automation and utilising the internet of things in industrial processes, causing a leap in the productivity of manufacturing.

Relevance for NEO-CARBON ENERGY: Locally produced and consumed energy affects not only energy sector, but the whole of society. The neo-carbon energy system could provide the energy building block for the society envisioned of this industrial revolution, in which energy, goods and services are produced locally and small-scale.

2.5 Environment

Clean technology (cf. decarbonisation)

Clean technologies, or environmental technologies, refer to methods of production that are less polluting than the current ones in use. Related solutions can address particular problems such as replace fossil fuel use, minimise environmental impacts, waste or CO2 emissions through entirely new processes or efficiency gains. Cleaner technologies used during the production process compete with existing process technologies and with each other, although they may also support each other (Montalvo and Kemp 2008).

In terms of clean energy technologies that aim to decarbonise the economy, low-carbon technologies include renewable energy, nuclear power and carbon capture and storage (CCS). The construction and use of any energy technology, even a "clean" one carries some environmental impacts (Grandell et. al 2016). It can be further contested, whether all of these are clean technologies based on the risks associated to each technological option are different.

Relevance for NEO-CARBON ENERGY: The principles of neo-carbonisation provide a method of clean technology to replace fossil fuel-based production. Electricity that is generated with renewable energy is used and transformed into synthetic gases, liquids or materials. Based on these principles, synthetic products and services can be created through industrial processes from plastics to medicine.

Deep ecology

Deep ecology is a contemporary ecological and environmental philosophy characterised by its advocacy of the inherent worth of living beings regardless of their instrumental utility to human needs, and advocacy for a radical restructuring of modern human societies in accordance with such ideas. Deep ecology argues that the natural world is a subtle balance of complex inter-relationships in which the existence of organisms is dependent on the existence of others within ecosystems. Human interference with or destruction of the natural world poses a threat therefore not only to humans but to all organisms constituting the natural order.

A core principle is the belief that the living environment as a whole should be respected and regarded as having certain inalienable legal rights to live and flourish, independent of its utilitarian instrumental benefits for human use. It describes itself as "deep" because it regards itself as looking more deeply into the actual reality of humanity's relationship with the natural world arriving at philosophically more profound conclusions than that of the prevailing view of ecology as a branch of biology. The movement does not subscribe to anthropocentric environmentalism (which is concerned with conservation of the environment only for exploitation by and for human purposes) since deep ecology is grounded in a quite different set of philosophical assumptions. Deep ecology takes a more holistic view of the world human beings live in and seeks to apply to life the understanding that the separate parts of the ecosystem (including humans) function as a whole. This philosophy provides a foundation for the environmental, ecology and green movements and has fostered a new system of environmental ethics advocating wilderness preservation, human population control and simple living.

Deep ecology is criticised for its claim to being deeper than alternative theories, which by implication are shallow. When Arne Næss (1973) coined the term deep ecology, he compared it favourably with shallow environmentalism which he criticised for its utilitarian and anthropocentric attitude to nature and for its materialist and consumer-oriented outlook. Against this is Arne Næss's own view that the "depth" of deep ecology resides in the persistence of its penetrative questioning, particularly in asking "Why?" when faced with initial answers.

Relevance for NEO-CARBON ENERGY: a deep-ecological worldview, or one even close to the values of deep-ecology, could prove pivotal in pursuing towards a sustainable society. To truly change the direction of human development, political and technological solutions are probably not enough, but deep-lying values have to change as well.

In its original form deep ecology advocated a "back to nature" lifestyle and was suspicious about technological development and the effects of human civilization on natural ecosystems. In the Neo-Carbon scenarios, however, deep ecology does not refer to such luddite views, but combines hi-tech living with holistic conceptions of nature and humans' place in it.

Industrial ecology

Industrial ecology studies the flow of materials and energy to design such industrial systems that promote environmental improvement. As a multidisciplinary field, it focuses on human technological activity in the context of natural ecosystems that support it (Allenby 1999). A balance needs to be struck between environmental stewardship and industrial profit to achieve this goal.

The field emphasizes a systems perspective in environmental analysis, management, and policy. Environmental gains are expected to be made from the cyclical use of resources. Tools employed by industrial ecology include life cycle assessment (LCA), material flow analysis (MFA), input-output analysis, and design for environment (DfE) (Lifset and Graedel 2015).

Industrial ecology approaches are typically used to study product design and manufacturing processes in the context of ecology. Industrial symbiosis, eco-efficiency, dematerialization and urban metabolism are concepts. Industrial ecology has been employed with exergy analysis to study combined cycle power plants, hydrogen production, and crude oil distillation (Dincer and Rosen 2013).

Relevance for NEO-CARBON ENERGY: Neo-carbon energy system is a novel combination of technologies and resource flows and brings an emerging set-up of industrial ecology. When carbon is captured from the air and used to create novel products and services, the system as a whole can be made carbon neutral.

Limits to growth (LTG)

The Club of Rome published its report Limits to Growth in 1972 (Meadows et al 1972). Using a methodology developed by pioneering systems-scientist Jay Forrester, and under the supervision of Dennis Meadows, a group of researchers at the Massachusetts Institute of Technology produced the first Report to the Club of Rome. In the summer of 1970, an international team of researchers at the Massachusetts Institute of Technology began a study of the implications of continued worldwide growth. They examined the five basic factors that determine and, in their interactions, ultimately limit growth on this planet-population increase, agricultural production, non-renewable resource depletion, industrial output, and pollution generation. The MIT team fed data on these five factors into a global computer model and then tested the behaviour of the model under several sets of assumptions to determine alternative patterns for mankind's future. The Limits to Growth is the nontechnical report of their findings. The book contains a message of hope, as well: Humans can create a society in which they can live indefinitely on earth if he imposes limits on himself and his production of material goods to achieve a state of global equilibrium with population and production in carefully selected balance.

Considered a classic in the sustainability movement, The Limits to Growth was the first study to question the viability of continued growth in the human ecological footprint. It also broke new ground as the first global model commissioned by an independent body rather than a government or the UN. The book still arouses vivid debate on the thematics and problematics of growth thinking. The report presented scenarios, not predictions as is frequently misunderstood.

The central message of this book still holds today: The earth's interlocking resources – the global system of nature in which we all live – probably cannot support present rates of economic and population growth much beyond the year 2100, if that long, even with advanced technology.

Relevance for NEO-CARBON ENERGY: Limits to growth based on fossil fuels have already been reached. In the neo-carbon system, carbon is stored and used as raw material for anything previously produced fossil-wise.

Resilience

Originally an ecological concept, resilience refers to the capacity of an ecosystem to respond to a disturbance by resisting damage and recovering quickly. Outside ecology, it can refer broadly to a capacity to sustain development in the face of expected and surprising change. Resilience emphasises that social-ecological systems, individuals, communities, and the society as a whole, are embedded in the biosphere. Such socio-ecological resilience underlines that social-ecological systems need to be managed and governed for flexibility rather than for maintaining stability for improved human well-being, at the local, regional and the global level. See Folke et al. (2010.)

Relevance for NEO-CARBON ENERGY: As a holistic concept resilience emphasises the role of different actors in mitigating environmental problems and in adapting to them. In a similar manner the Neo-Carbon societal scenarios lay a systemic and holistic view in the energy transition. The peer-to-peer society depicted in the Neo-Carbon scenarios provides a fertile ground for resilience which requires diversity and opportunities for self-organisation. Resilience highlights the ability to live with change and uncertainty, and the Neo-Carbon scenarios are all so called transformational scenarios, meaning that the change has been fundamental.

2.6 Culture

Do-it-yourself (DIY)

Do-It-Yourself or DIY refers to modifying, building or repairing something by amateurs or non-professionals. Wolf & McQuitty (2011, 154) define do-it-yourself as a form of prosumption, consisting of "*activities in which individuals engage raw or semi-raw materials and component parts to produce, transform, or reconstruct material possessions[…]*". In recent years digital technologies have empowered DIY tinkerers, thanks to efficient information sharing and new technologies. Digital manufacturing technologies such as 3D printing and laser-cutting are especially interesting in regards to the future of DIY. Referring to Alvin Toffler's idea of three waves of societies, Stephen Fox accordingly suggests three waves of DIY. The most recent third wave is a paradigm connected to an enabled by the digital design/manufacture and internet, which could result to a situation where anybody anywhere could invent, design, construct, and sell their own goods. (Fox 2014.)

Do-it-yourself practices connect consumption and prosumption with meaning-making, craftsmanship and alternative economic systems. DIY activities are motivated by markets and their evaluation as well as identity enhancement. The motivation may stem from markets, which do not offer a right kind of a product, or a product of decent quality. Furthermore, DIY practices may offer economic benefit for the maker. The motivations connected to identity relate to empowerment, search of uniqueness, community seeking, or fulfilment through craftsmanship. (Wolf & McQuitty 2011, 155.)

Relevance for NEO-CARBON ENERGY: Low-cost or virtually free energy produced by solar and wind could empower DIY producers significantly. If automation replaces jobs, DIY activities could offer citizens new opportunities for productive activities.

Indocollectivism

Indocollectivism is a concept coined by futurist Jim Dator[5]. By indocollectivism Dator refers to emerging social relations which emphasise equally individualism and collectivism. If circa until the 1960s Western societies were relatively homogenous and collective-oriented, and after the 1960s more individualistic, in the future these tendencies could mix. In such a future "indocommunities" of like-minded individuals would come together to spend time, share ideas, learn, and also produce goods and services with each other.

Relevance for NEO-CARBON ENERGY: In a neo-carbon powered peer-to-peer society, indocollectivism could be the prevailing model of social relations and communities. It would combine the best features of both individualism and "communalism", so that the community would aid individuals to reach their potentials, and individuals would provide for the common good.

Peer-to-peer

Peer-to-peer originates from computing networks, in which workloads and resources – such as files, processing power and data storage – are distributed between equally privileged peers (i.e. individuals). Although the concept of peer-to-peer became popular or even synonymous with music sharing program Napster, the idea is said to date back to the birth of internet (Fattah 2002, 11). Within peer-to-peer there are no central and hierarchical coordination; peer-to-peer networks are self-organising. Peer-to-peer networks can be applied as a model for general social structures. In a "peer-to-peer society" citizens cooperate with each other in a non-hierarchical way. Sharing computing power within the network can empower the community around it. Furthermore, peer-to-peer approach may transform the system to better meet the behaviour and approaches of the people using it. (Fattah 2002, 12.) According to Benkler (2002) peer-to-peer, nonmarket and nonproprietary production may become not only possible but the *dominant* form of production and organization in the future due to various economic, technological and cultural drivers. Benkler (2002; 2006) further notes that commons-based nonproprietary peer-to-peer strategies are the most efficient way to organise the economy, which has become structured by creativity and the economics of information.

[5] https://www.youtube.com/watch?v=Wpj5r4AY1pk

Relevance for NEO-CARBON ENERGY: The neo-carbon energy system can be organised in a peer-to-peer way, if citizens are allowed to feed energy produced by them into the grid. In a broader sense, new renewable, distributed and cheap energy can empower citizens to organise along peer-to-peer principles. In such society, everything from work to leisure to decision-making would be conducted among peers.

Prosumerism

Consumers of a peer-to-peer society become "prosumers", when they increasingly participate in the production phase of the economy. The idea of *prosumerism* stems from meshing together the words 'producer' and 'consumer'. Futurologist Alvin Toffler coined the term in his book on Third Wave to depict "proactive consumers" who personally help improve or design the goods and services and expected prosumers to transform the marketplace as well as change the role of the consumer[6]. During the agricultural period people consumed mostly what they could produce by themselves. However, these two realms were split apart along the industrial revolution (the Second Wave), resulting in a situation where a person either produces or consumes. This gap between producing and consuming is bridged by technology using a so-called configuration system during the Third wave, when new technologies are enabling the radical fusion of the producer and consumer into the *prosumer*. This is often close to freelance work. Toffler further states that in some cases, *prosuming* entails a "third job" where the corporation "outsources" its labour not to other countries, but instead to the unpaid consumer, such as when we trace our own postal packages on the internet instead of relying on a paid clerk. According to Toffler prosumers can fill their own needs. (Toffler 1980.) The recent fall in solar PV prices can be argued to have brought prosumerism to the energy sector, and is consequently transferring "power to the people" (van der Schoor and Scholtens 2015). Prosumerism is not a return to premarket economies. Toffler pointed out, that it is a fusion of the First and Second Waves resulting in a new synthesis. The prosumer ethic refers to a state, where instead of ranking people according to their property, they are ranked by what they do. (Toffler 1980.)

Relevance for NEO-CARBON ENERGY: The whole energy system will change when the prosumerism model will propagate. Consumers of energy will become producers of energy, too, and not just for themselves but for others as well.

[6] In some instances, the term prosumerism has also been interpreted as a market segment between a "professional" and a "consumer"

Survivalism

Survivalism (or preparedness) refers to a movement of people or groups anticipating different kinds of futures ahead and preparing to face them (Mitchell 2002). A central part of survivalist activities is the making of scenarios that build on different events such as global extremities, emergencies and disruptions, or everyday challenges and threats. These scenarios are further answered by exercising relevant skills and knowledge as well as acquiring sufficient material. Preparing to survive commonly focuses on collecting items for defense, safety, or nourishment, and on the other hand increasing mental, social, and physical skills to survive. The concrete actions may take many forms, from stocking water, food, and other supplies to more dramatic measures, such as collecting weapons and building shelters. (Becerra Vidergar 2013, 45, 88–89; Rahm 2013.) Survivalist culture connects to alternative ways of organising the everyday, as survivalists often deny the business as usual approaches as insufficient. (Rahm 2013.)

Although the aim to survive has always been a part of human nature, historically the roots of survivalism are often connected to Cold War. Following peaks in the interest towards survivalism happened in 1999 along with the fear of Y2K bug paralyzing the society and immediately after the 9/11 attacks in September 2011. (Becerra Vidergar 2013). A recent wave of survivalism is building in the wakes of several major terrorist attacks and in the anticipation of major scarcities,

Relevance for NEO-CARBON ENERGY: Although references to survivalism can be seen throughout the four scenarios, survivalist ethos prevails especially in Green DIY Engineers scenario, where environmental challenges are solved in local communities and with a practical mindset and bottom-up approaches. Survivalism, do-it-yourself cultures, and maker lifestyles are strongly connected through the concepts of self-sufficiency, creativity, and environmental sustainability.

3. CONCLUDING REMARKS

The previous chapter presents the core concepts that are relevant for the exploration of transformative energy futures 2050 in the Neo-Carbon Energy project. The key concepts are followed with project-specific reflections. As a whole, they address development paths, phenomena and patterns intertwining significantly with the transformation, as a socio-economic transition towards neo-growth futures, which will be based on energy produced mainly with solar and wind, and other renewable energy technologies.

Overall, this working paper aims to provide conceptual tools both to open futures thinking and to support discussion on neo-carbonised futures. As this paper connects to a wider framework exploring change, it is also itself prone to transition. As conceptualising influences the way we see the world, which in turn is under constant transformation, it must be remembered, that this framework is by no means sustained.

We warmly invite you to join these efforts. Conclusively, some suggestions are made. Although the paper is loosely structured presenting the concepts around PESTEC themes, it is necessary to remember, that also in complex futures everything connects. The limited amount of concepts presented in this working paper functions primarily as a framework for further reflections, interpretations and interconnections to be made.

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