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New consciousness: A societal and energetic vision for rebalancing humankind within the limits of planet Earth

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ABSTRACT

Humankind has reached a level of ongoing crises, which is mainly due to an unsustainable energy system and the non-acceptance of planetary boundaries. On a more fundamental level the crisis is caused by the prevailing worldview and values. Universally accepted values of today emphasize material wellbeing and growth, consider nature only as resources to be exploited by humans, and neglect the notion that humans are connected to each other and to nature on a very fundamental basis. Currently, 140% of the resource and absorption capacity of planet earth is required for human activities and the trend is against rebalancing. The dire consequence will be a collapse of the hosting capacity of our planet, as a simple matter of fundamental environmental facts.

This article draws a world which is mentally and ethically aware of the fundamental limits and the requirement to live in harmony with planet Earth. This describes an evolutionary development of humans and can be called a 'New Consciousness' scenario, akin to the concept of the Global Brain. Growth in this kind of a world is called neo-growth: it is environmentally sustainable and emphasizes social, immaterial and "spiritual" growth. Such an environmentally, economically and socially sustainable society is sketched and on that basis a very first estimate is given on the requirements and consequence for a fully sustainable energy supply which needs to be initiated now and fully realised in the second half of the 21st century.

The technologies required are already available and their respective economics are no obstacle. It remains unclear and from today's perspective even improbable whether humankind is able to go for that evolutionary transition in the future. However, nearly all other options might end in a collapse scenario in the dimension of geological history.

1. Introduction

Further development of human welfare is at crossroads. WWF (2014) annually reports that for several decades humankind has needed the capacity of more than one planet Earth, based on the fundamental findings of Wackernagel et al. (1999, 2002). About 50% is due to resource exploitation and emissions of the energy system. There are limits to growth on our planet (Meadows et al., 1972), but humankind does not seem to keep within planetary boundaries as defined by Rockström and Klumm (2012) to show a "safe operating space for humanity". Diminishing energy fuels (EWG, 2013) have caused in the past and will cause in the future dramatic economic, social, political and military shocks. Poverty in the world needs to be tackled not only for humanistic reasons but also for rebalancing the births and deaths annually in order to stabilize the world population and keeping global warming within the 2 °C target on the mid- to long-term (Rogelj et al., 2013). Kaya and Yokobori (1998) concluded that the world population is the key driver for global resource demand of humankind, confirmed by Raupach et al. (2007). The experience of the last decades has shown that growing standards of living reduce population growth most effectively (UN, 2013). However, this goes hand in hand with a fast increase in energy demand (Breyer, 2012). Kapitza (2006, 172) points out that energy is the most significant factor in growth, since it is the main resource for development, determining besides industry food production, transport, housing and communications. Like the population, energy production is additive and readily quantifiable.

There is a sense of urgency to tackle the wicked problem of growing unsustainability and breaking the planetary boundaries. Based on the interlinkages of climate change, energy resources and economic growth Dunlop (2011) argues for an immediate need for global risk management. Kanninen (2013) claims the world needs a survival agenda. Futures research should focus its major efforts on addressing it. From the framework of 15 Global Challenges by the Millennium Project, five challenges are directly dealing with this issue (sustainable development and climate change, energy, science and technology, clean water, population and resources) and the rest 10 challenges are indirectly concerned as well (Glenn et al., 2015).

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To simultaneously supply for increasing energy demand and mitigate CO_2 emissions a new energy system is needed. In the Neo-Carbon Energy system, being studied and developed in the Neo-Carbon Energy project,[1] energy is produced mainly by wind energy and solar photovoltaics, used directly whenever possible, and stored in synthetic methane, other synthetic hydrocarbons or batteries. Carbon dioxide and hydrogen can also be used as feedstock for chemicals and materials.

The effects of the new energy system would not be restricted to energy production only, but would have consequences for the whole society. This is mainly owing to two reasons. First, the development of societies in history has always required a significant increase in energy production and consumption. Increase in the energy input of society correlates with a higher level of organisation and complexity in social structure – which is in general terms called "development". (Last, 2015.) Second, contrary to non-renewable energy production, a renewable energy system would probably be more local and distributed. The Neo-Carbon energy system has the potential of providing the energy building block for a distributed society, in which economic production, and thus lifestyles as well, would be more distributed and local than today.

To set the Neo-Carbon energy system in societal context, four transformational scenarios have been constructed for 2050 (Heinonen et al., 2015). All of the scenarios share as predetermined factors the following: energy is provided mainly by solar photovoltaic and wind energy converters, ecological values prevail, and the society is organised around peer-to-peer networks. The scenarios are: 1) Radical Startups, 2) Value-Driven Techemoths, 3) Green DIY Engineers, and 4) New Consciousness.

This article concentrates on the fourth scenario, "New Consciousness", which is the most transformational of the four scenarios. It is the hypothesis of this article that this scenario represents the future information society, in which ubiquitous ICTs have ushered towards a Global Brain (Heylighen, 2013), and an ecological consciousness is achieved. Schwartz (1998, 209) stresses the importance of scenarios in perceiving the holistic "bigger picture" - interconnectedness of e.g. international economic relationships, our ecological footprints and the globe-spanning technologies, notably ICTs. The concept of Global Brain refers to a planetary system of collective intelligence and self-organising coordination enabled by the use of ICTs – it is a decision-making system to solve global challenges (Heylighen, 2013; Last, 2014). As a holistic concept, the "Global Brain" would have consequences for not only decision making but also for culture, identities and human consciousness. Thus the article develops the Global Brain as a cultural and sociopsychological concept besides technological, political and economic one.

In the New Consciousness scenario the threat of an ecological collapse and ubiquitous information and communication technologies have led altogether to a new kind of consciousness – a sociopsychological "Global Brain". Humans do not conceive themselves only as separate individuals, but also as deeply connected with each other and with nature. An individual's identity is increasingly defined by shared values and shared consciousness. Values of deep ecology prevail, as "de-individualised" people see themselves as part of nature and do not seek self-interest as much as they used to but act in a more altruistic way.

Consciousness is often defined as all modalities of sensory perception, memory, thinking, and emotionality (Niedermeyer, 1994). Identity, in turn, is seen as a further component of consciousness (ibid.), and as divided into self-identity and social identity. Self-identity refers to the psychological features that distinguish a person from others, make him or her unique. Social identity, in turn, refers to those features a person shares with others. Shared values and cultural meanings are vital parts of both self- and social identity – they create a social reality, which makes living existentially meaningful (Berger and Luckmann, 1966). In this article and in the New Consciousness scenario we understand consciousness in broad and general terms: as referring to identity and shared values and meanings. In other words, we see consciousness as a socio-cultural rather than a psychological concept. When society – its technologies, economy, politics etc. – changes, so does people's consciousness. However, the psychological conception of consciousness is important to point out, because a cultural consciousness is rooted in the cognitive processes of a human mind. Cognitive-symbolic processes are vital for social learning and key components of (socially constructed) individuality; a person's cognitive activities interact with the changing conditions of his or her life (Mischel, 1981).

In the scenario, "shared consciousness" has two layers. On the first layer, people identify with various communities, physical, virtual, and often both. Communities are not coercive: individuals belong to many different communities and are free to choose their entry and exit. The second layer is global: although societies are divided into different communities to a much larger degree than today, people have developed a global consciousness and identity as well. Thus the system can be described as both differentiation and integration. A wholly global identity may be a contradictory in terms, because identity is always relational. A person's identity is defined by how he or she is similar to and different from others, and the same applies to groups and their identities (Fraser, 2000). In the scenario, differentiation takes place through communities, in which people construct their identities. Global information networks, interconnectedness and interdependence in terms of economics, politics, and culture, and shared awareness of the global ecosphere, in turn, have integrated individuals and communities so that they perceive themselves as parts of the global humankind and have forged a cosmopolitan identity (cf. Pichler, 2011).

The shift in consciousness has been facilitated by three factors in particular. First, as people are constantly connected to the internet through mobile and wearable devices, thoughts, ideas and information are being shared in a continuous flow. This undermines the notion of the "self" as the source of identity and emphasizes social identity. Second, due to the rise of the service and creative economy, collaboration and sharing have become prerequisites for economic value creation. This too has eroded the role of separate, individual actors and highlighted open communication and collaboration. Third, the looming ecological crisis has forced nations and citizens to question the sustainability of individualism as unrestrained freedom to pursue one's interests.

In the world of New Consciousness, humans have loosened their individual egos and the individualistic worldview. Furthermore, they have become more environmentally conscious than ever since the industrial revolution. People see themselves as a part of nature instead of conceiving nature through human-nature dichotomy. The concepts of "growth" and "progress" have also been redefined. Since the industrial revolution of the 18th century, growth and progress have been understood as increasing material well-being and the emancipation of individuals. In the New Consciousness scenario, these are partly taken for granted, and partly seen as the root causes of the environmental disaster. Something new is thus needed in their stead. Malaska (2011) calls this kind of new, "post-modern" concept of growth "neo-growth" (see chapter 3).

The "New Consciousness" scenario uses highly sophisticated information and communication technologies – as the platform through which humans connect, communicate and merge with each other – in a complex, networked, and global social structure. Most of material production is automated, leading to material abundance. Drexler (2013) claims that using nanotechnologies and atomically precise manufacturing (APM), material abundance is possible to reach in a way that is low cost and environmentally sustainable. All of this requires a marked increase in the energy input of societies. As the scenario world is highly environmentally conscious, the energy system must be carbon neutral and sustainable in all dimensions.

[1] Neo-Carbon Energy is a joint research project of Lappeenranta University of Technology (LUT), Technical Research Centre of Finland (VTT) and Finland Futures Research Centre (FFRC), University of Turku.

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The structure of this article is as follows. Chapter 2 presents the dilemma of limitless growth in a limited world, and how the modern idea of progress is one of the root causes of nearing environmental collapse. Chapter 3 outlines a new notion of progress and growth for the New Consciousness scenario. Chapter 4 sketches how society and its economy would be organised in the scenario, and how consciousness could transform from today's individualistic conception to a more shared one. Chapter 5 illustrates how it is possible to combine an increased energy demand with sustainability mainly through solar photovoltaics and wind energy.

2. Age of crises — Energy, planetary boundaries and the idea of progress

According to Malaska (2001), the modern idea of progress is at the heart of the current environmental crises. Modern progress can be summarized as the pursuit of ever-increasing material wellbeing and individual liberties. It has its structural-material basis in the market economy (Stevenson, 2002), whereas the market economy is shaped by the ethos of individualism and the self-profit maximizing of individuals. Weber (2002) famously traced the birth of modern capitalism and the whole modern culture back to the protestant ethic, which emphasizes self-discipline, prudency, conscience, and the central role of individuals in interpreting the bible. In other words, the protestant ethic gave birth to masses of individuals as autonomic actors and thus laid the groundwork for modern market capitalism. Hard, self-disciplined work and frugality led to the accumulation of capital and to the individualistic ethos, without which the current, highly competitive, "progressive", and innovative market economy would not be possible.

Malaska (2001) gives modern progress the following features. First, it is based on the notion that societies thrive best when individuals are given the freedom to follow their inherent ability for rationality and reason. One should get rid of unquestioned authorities and collective traditions. Second, modern progress emphasizes the acquisition and accumulation of knowledge, in other words natural sciences and the scientific method. The more we know about the world and the nature, the better we can control and utilize them. Third, modern progress strives for democracy, which is realised in the nation states and their political system of representative government. Distributed power is considered more rational than centralized and unquestioned power. Fourth, modern progress seeks to increase material wellbeing. This is pursued through technological innovations, industrial production, and the market economy.

The core value and goal of modern progress is emancipation (Malaska, 2001). It is emancipation which is thought to be achieved with the above mentioned four features of progress. Modernity aspires to liberate the individual from the constraints of authorities and material conditions – so that he or she is able to seek for what is best for his/her. Modern progress and emancipation are first and foremost about negative liberty, i.e. liberty from external restraints.

Modern progress, however, has its internal contradictions, which hinder the realisation of emancipation. These contradictions should be overcome to realise "neo-growth".

First, the emphasis of modern progress on individuals – of individual reason and profit-seeking – forestalls cooperation. This contradiction is highlighted in the era of immaterial production, which is fundamentally based on open collaboration between individual actors (Benkler, 2006). Malaska (2011) writes about an "interaction society", which he sees as the next societal development after the information society. In an "interaction society", economic value stems from services and the creative industries, and it is fundamentally based on collaboration and interaction between companies and individuals.

Second, the emphasis on knowledge and rational thinking downplays the significance of other forms of human thought and experience. Weber (2002) has illustrated this contradiction in his famous concept of the "iron cage": the modern culture emphasizes goal rationality, rational calculation, and control at the expense of value rationality and other forms of human experience. Goal rationality is instrumental in nature, and thus "soulless". It gives tools to achieve goals, but is unable to define the content of these goals. Technological, organisational and economic efficiency are the only absolute values in modern progress, defined by goal rationality.

Third, representative democracy made other forms of democracy hard to obtain. The nation state and national cultures became unquestioned and restrictive authorities themselves. A new, "post-modern" political system could mean for instance direct democracy, peer-to-peer political organisations, and global democratic institutions.

Fourth, the modern quest for material prosperity and control over nature has led to the current ecological crises in the Anthropocene (Ruddiman, 2013), which does not threat only modernity itself but the whole humankind. Furthermore, it has led to the neglect of other forms of wellbeing. In a neo-growth world, economy should not be above communal and cultural life, and ecology – instead, economy should serve other human goals and values, instead of being a value in itself. All growth should be ecologically sustainable, and ecosystems of our planet should be given a value of its own.

Because of these internal contradictions of modern progress, the meaning of progress should be reconstructed. First and foremost, progress should be given new goals. These goals can be defined "objectively", in the sense that "progress" should be aimed towards satisfying current topical needs. Modern progress sought to increase material prosperity and emancipation of individuals, because these were not (and, of course, for most of human population still are not) satisfied well enough. In the "New Consciousness" world of material abundance, progress should strive to satisfy immaterial needs of self-realisation and interaction in balance with the limits of planet Earth.

3. Neo-Growth — defining growth and progress anew for the new consciousness world

Growth and progress – the belief in the constant improvement of humankind – have been central features of the Western civilization for nearly three thousand years (Nisbet, 1980). It was not until the Renaissance, the industrial revolution and the modern society that growth and progress were understood primarily as the growing of material prosperity. Furthermore, from circa 18th century onwards, growth and progress were seen as stemming from individuals seeking for their self-interests (Weber, 2002; Durkheim, 1997).

The ecological crisis in the anthropocene and the one-dimensionality of the modern notion of progress have led to the critique of progress, often manifested as the insistence of abandoning growth, i.e. as *degrowth* (Muraca, 2013). However, Malaska (2001) discards the notion of degrowth as it lets go of growth altogether – the positive connotations of growth alongside the negative ones. Malaska (2011) tentatively "redefined" degrowth as *neo-growth*, which seeks to mesh economic growth with human growth in general, is based mainly on immaterial production, and is ecologically and socially sustainable. The human-centred perspective is adjusted within the human-nature system taking also into account that no human wellbeing can be possible in a destroyed environment.

Neo-growth can be characterized by the following features (Heinonen and Ruotsalainen, 2013):

- Growth should have a deeper meaning than mere economic growth. Economic growth should enhance human growth and development, and vice versa.
- All growth should be ecologically sustainable: more has to be produced out of less, and of higher quality and negative environmental impacts have to be reduced as close as possible to zero. Nature preservation should be on the same level as social and humanistic targets such as fight against poverty.

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- Economic growth should be based mainly on immaterial production or on emission-neutral material production. A neo-growth economy is a highly developed service economy. Material production would be mainly automated, and materials recycled.
- Work, sources for growth and the mode of production should be defined anew. This could mean for example prosumerism (the merging of producers and consumers), and ecosystems as the organisational principle.
- Lifestyles should be based on ecological values, and on the merging of individualism and collectivism as *indocollectivism* (Dator, 2012)
- The division between work and leisure will become increasingly or even totally blurred. Everything people do, everything they learn, every skill and all knowledge they have can be turned into a productive power.

As neo-growth depicts "post-modern" or post-industrial growth, it is closely related to the concept of the third industrial revolution. According to Rifkin (2011) any industrial revolution requires two interlocking developments: a new mode of energy production and a new set of communication technologies.

The first industrial revolution of the 18th and 19th centuries was fueled by the steam engine, coal and the printing press. Inexpensive print technology and state schools gave rise to a print-literate workforce with the skills to manage and coordinate the increased commercial activity. The second industrial revolution (early to mid-2000th century) was ushered by oil, combustion engine, nuclear, electricity, radio, television and telephone. Society became centralized and bureaucratic and thus highly efficient. Mass production and mass consumption emerged. (Rifkin, 2011.)

According to above logic, the "information society" (appx. From 1970s to early 2000s) cannot be understood as a separate phase of an industrial revolution, as it did not involve a new energy technology. Furthermore, the internet began to spread not until mid-1990s. The information society was thus defined mainly by the computer, not by the internet as a new communication technology. In this light, the information society could rather be seen as a late phase of the second industrial revolution, in which the efficiency of industrial production was greatly enhanced and globalized by the use of computers.

The third industrial revolution is now being paved by renewables such as solar and wind, energy storage technologies, the internet and new digital manufacturing technologies such as 3D printing. Contrary to the technologies of previous industrial revolutions, renewables, the internet and new manufacturing devices are *distributed technologies*. Renewable energies are found everywhere instead of certain areas. They are also relatively affordable to exploit. Internet is a networked communication technology without centres of control and with low costs of communication. Thus, the third industrial paradigm promotes a decentralized society.

In the third industrial period, the household and communal level will become the main areas of production. Citizens produce goods, services and energy by themselves, utilizing digital production technologies and distributed renewable energy resources. Surplus energy is fed onto the "energy internet" (smart grid). Citizens and micro-businesses use the internet to organise their productive efforts and to produce and attain information. Societal and economic power is redistributed from large organisations to small-scale actors. (Rifkin, 2011.)

Each industrial phase not only revolutionizes production, but changes values, needs and cultures as well. The first industrial revolution developed hand in hand with the nation state, scientific worldview, and Western liberalism. The second industrial phase was marked by mass production and consumption and rationalized bureaucracies. The third industrial revolution will be characterized by niche markets, glocal (global and local) cultures, "immaterial" and creative economy, systemic worldview (seeing the world as interlinked systems, as a whole where everything is interconnected) and the combination of individualism and collectivism ("indocollectivism").

The most fundamental feature of the third industrial revolution could be the ubiquitous internet, which will connect everything and everyone in an integrated global network. The internet becomes a nervous system (van Dijk, 2012) for the whole globe. On the internet, all communication takes place through the same medium and in the same 'environment'. Castells (1996) calls this feature of the internet *symbolic isomorphism*: on the internet, different cultural expressions, institutions and spheres of life are morphed into each other.

If the industrial notion of growth and progress were fundamentally based on individuals and individualism, future notion of growth could be based on overcoming individualism. In recent years this development has been increasingly conceptualised as the Global Brain, which describes a distributed, self-organising planetary intelligence achieved through the use of ICTs (Heylighen, 2013). The concept of Global Brain is mainly used to depict collective problem solving and decision making, but it can also conceptualise the process of producing an emerging global consciousness (Last, 2014).

To achieve the above mentioned features of neo-growth, and to overcome the internal contradictions of modern progress described in chapter 2, the conception of the self should be understood as more social, shared and fluid than today, and ecological values should prevail. In order to get rid of individualistic mindsets, deeply networked organisation models have to be developed. From these perspectives, the concept of Global Brain could be extended to cover consciousness as well as problem solving and decision making. These topics will be dealt with in the next chapter.

4. Social ecosystems as a way to new consciousness

Anthropocentrism is the view that the nonhuman world has value only insofar as it serves human interests (McShane, 2007). The anthropocentric worldview is one of the fundamental causes for why humans tend to treat nature instrumentally and without having any value itself (Wapner and Matthew, 2009). Anthropocentrism is also a central factor behind overconsumption (Kjellberg, 2008).

Nolt (2013) argues that anthropocentrism and egoism, the ethics of maximizing one's good, are akin. According to Nolt (ibid.) anthropocentrism is egoism "writ large", egoism of the human species. Individual liberties and increasing material prosperity – egoism in practice – are in turn often seen as the main causes of current environmental crises (Jasanoff, 2002; Macy, 1996; Muraca, 2013).

Anthropocentrism can be traced back to the human-nature dualism in Western thought (Moore, 2015, 4). Ervin Laszlo (2001), in turn, states the separation of individuals from each other and from nature, and the disjunction of their own interests from the interests of others, as the great myths of the industrial age. This kind of ethos is a characteristic of the market economy, which is based on the competition between individuals and enterprises.

Besides market relations, the "selfishness" of modern citizens has prevailed due to the lack of communication between individuals. The more individuals communicate with each other, the more altruistic they behave – and vice versa (Mérő, 1998, 28–45). The same can be applied to organisations and firms. The rise of modern, industrial enterprises was partly due to high transaction and communication costs. When the costs of communication, coordination and transactions are high, it is economically feasible to organise production within a bureaucratic enterprise. When these costs fall, as has happened due to the development of ICTs, it is often more profitable and efficient to distribute production to a network of specialized producers, and to collaborate in such an open manner that short-term self-interests are relinquished. (Benkler, 2006.)

There are signs that the age of self-sufficient organisations, isolated from each other, is setting. This development has consequences for the broader culture, as the way in which we organise our economic efforts is deeply linked to our values. In recent years the concept of business ecosystems has become increasingly common in describing

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emerging business and organisational models (Westerlund et al., 2014). A business ecosystem consists of all of the actors within an industry: individuals, organisations, companies, and clients. The ecosystem is based on collaboration between actors, on their 'symbiotic' relationships. The actors of an ecosystem openly share information and strive to reach shared goals. Value is created from complex interactions of the actors in the ecosystem.

An ecosystemic economy is based on the information and communication technologies that have dramatically decreased the costs of producing, processing and distributing information – i.e. transaction costs of production. Westerlund et al. (2014) link the emergence of business ecosystems to the Internet of Things, that its, to ubiquitous ICTs: when our environment and our devices are all connected to the internet, a complex platform of information sharing and collaboration is created. The ubiquitous internet enables a much more open and networked cooperation between actors than before.

The ecosystem model is not restricted to economy only, but can be used to describe the future organisation of society in general. A socially transformational feature of the ecosystem model is that it melts the division between different actors and between economic production and other spheres of life, such as leisure and the civil society (Ruotsalainen and Heinonen, 2015). In the value chains of immaterial production, organised around ecosystems, everything – social relationships, ideas of individuals, media contents and so on – has the potential to be used as a source of value. Constant communication and collaboration between actors has the potential to give rise to more altruistic and "collectivist" modes of economic operation (Mérő, 1998; Wiltermuth and Heath, 2009).

It is especially in these respects that the ecosystem model can be used to realise the concept of neo-growth – to merge economic growth with cultural, personal and other aspects of general human growth, in an ecologically sustainable way, and to erode the individualistic mindset that places self-interest above any other goal.

Consequently, a "new consciousness" could emerge. In an ecosystem society all actors would be part of the same "connective tissue". Through ubiquitous ICTs people would be constantly connected to global information networks. As a result, the borders between individuals could become more porous than today. If today identity and consciousness are seen as features of an individual, in a future of pervasive communication identity and consciousness could be conceived as more collective and shared. Identities would become more fluid, shaped by a global network of information flows.

In a way identities have always been social and shared. A person's identity is in part defined by different roles he or she performs, and by the relationships one has with others (Mead, 1934). However, social identities have traditionally been confined to private or local settings, as they have been tied to physical environments. In physical settings different roles rarely collide, and they are relatively stable. A major feature of the networked era is the bringing together of previously segmented roles and networks (Boyd, 2008). Information and communication flow regardless of physical constraints, across different networks and contexts (Meyrowitz, 1985). Identities become fluid and defined by a global network of information flows rather than one's immediate, physical social settings (Boyd, 2011). If (social) identities were previously constructed mainly through physical one-to-one communications, in the age of pervasive, interactive media identities are increasingly established through networked many-to-many communications (Davis, 2010).

Ubiquitous ICTs do not foster collective identities only through the networked distribution of information and symbols (i.e. the building blocks of identity), but through simultaneous communication as well. The Internet enables real-time interaction of individuals and groups across distances. The Internet is also used to spread news and information immediately, compared to the slower news cycle of pre-Internet media. Both real-time interaction and immediate distribution increase the *synchronicity* of different individuals and groups globally. Synchronic action and experience weaken the psychological boundaries between the self and the group, and thus increase the willingness of individuals to contribute for the common good. (Wiltermuth and Heath, 2009.) When individuals have a shared temporal experience, they become a part of something larger than themselves. "Television events", in which a large proportion of a population gathered to watch the same broadcast at the same time, had a crucial role in creating national cultures (Oswell, 2006, 193). Now with the synchronicity through the Internet, an analogous phenomenon can be anticipated to take place on a global scale.

A collective consciousness has the potential of increasing ecological consciousness, as it might encourage people to let go of their self-interests for the good of others and the environment, and to see themselves not only as a part of global networks but as a part of nature as well. If anthropocentrism is egoism "writ large" (Nolt, 2013), then letting go of the egoist conception of the self could have the potential to steer people towards seeing themselves as part of nature instead of dualistically separating humans from nature altogether. Macy (1996, 171) calls this kind of wider-than-ego construct of identity an "eco-self", which is co-extensive with other beings and the life of our planet. She (ibid., 159) cites the founder of general systems theory and biologist Ludwig von Bertalanffy, who illustrates how all living beings are created and sustained by the dynamics of the larger systems of our universe.

Human beings are thus fundamentally "one with nature", and realising this matter-of-fact should expand the circle of empathy from other human beings to life and nature in general. Jeremy Rifkin (2011, 235) anticipates that distributed ICTs, together with distributed renewable energies, are paving the way for a biosphere consciousness, in which the "circle of empathy" broadens to include not only strangers from across the globe, but the whole biosphere. Humans would see themselves not only interconnected and interdependent with each other, but with our common biosphere as well. As people realise how connected they are to each other regardless of their immediate surroundings, they are better able to see the connectedness of *everything*. As Rifkin (ibid.) puts it "*we are as interconnected in the biosphere as we are in the blogosphere*".

An "eco-self", or a biosphere consciousness, however, are not sufficient as such to realise a sustainable society. A carbon-neutral energy system is also needed. The next chapter illustrates how a wholly renewable energy system, enabling energy abundance, can be realised.

5. The role of renewable energy in a new consciousness world

The New Consciousness scenario implies to find as solutions for different major energy problems (see Introduction) a fully sustainable energy system, which is able to cover an accelerated long-term demand for energy. The two key resources for very large-scale renewable energy (RE) harvesting is the wind resource and the direct solar resource (WBGU, 2003; IIASA, 2012; IPCC, 2011; Perez and Perez, 2009). The wind resource may cover up to five times the total primary energy demand (TPED), whereas the solar resource may cover up to 100 times the TPED humankind may require in the 21st century. However, these resources will be complemented by hydropower, bioenergy, geothermal energy and ocean energy – each of these sources may account for about 3–10% of the TPED for a world of 10 billion people living at today's energetic wealth level of Europe.

Kaya and Yokobori (1998) and Raupach et al. (2007) established the Kaya identity, which describes well the demand for energy based on wealth (gross domestic product) and energy intensity, driven by the population. Assuming a good development of access to modern forms of energy, health services and education, the world population may stabilize at about 10 billion people according to the UN (2013). An upper limit for energy demand by the year 2100 may be the per capita primary energy (PE) demand of today's European Union for all people in a population stabilized world. More and more researchers and institutions conclude that an efficient and least (societal) cost energy system

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will be based mainly on electricity (Palzer and Henning, 2014; Bogdanov and Breyer, 2016; Greenpeace International, 2015), but according to Connolly and Mathiesen (2014) the PE demand per capita may be stabilized at current levels of the well developed world. A such derived long-term RE demand needs to be better understood in its temporal growth pattern, which can be done well by applying a logistic growth function in its generalized form (Eq. (1)), where the abbreviations stand for time (t), lower asymptote (A), upper asymptote (K), growth rate (B), parameter affecting near which asymptote maximum growth occurs (v), scaling parameter depending on f(0) (Q) and time of maximum growth (M).

$$f(t) = A + \frac{K - A}{\left(1 + Qe^{-B\cdot(t-M)}\right)^{1/v}} \quad (1)$$

Estimates for a stabilized world population are according to UN (2013) in the median at about 10 billion people. The primary energy (PE) demand per capita in the European Union is currently about 40 MWh_{th}/cap (IEA, 2014). This leads to an estimated TPED of about 400,000 TWh_{th}. As pointed out earlier, more and more researchers conclude that an efficient and least cost energy system will be based on electricity but for the same order of PE per capita as today in the developed world, about 400,000 TWh_{el} might be needed.

If such a scenario became reality, then the RE power generation would have to grow by a factor of 17 (until 2050) and 83 (until 2100) compared to the RE generation in the year 2012 (IEA, 2014) to reach this proposed level of sustainability, as shown in Fig. 1 and Table 1. The years of the highest annual relative growth in RE electricity generation would be in the decades of the 2020s to the 2050s with a cumulated average annual growth rate (CAGR) of about 7.7%, which would be not an unrealistically high growth rate since the CAGR of the period 2007–2012 had been already 6.1% (Metayer et al., 2015). The additional RE electricity generation per year would grow in absolute numbers as a consequence of the stable CAGR from 293 TWh (2012), to 680 TWh (2020), 1410 TWh (2030), 2960 TWh (2040), 6130 TWh (2050), 10,200 TWh (2060 and 2070). The year of the highest absolute growth would be in the 2060s. The required installation numbers for solar PV and wind energy can be roughly estimated based on lifetime and full load hours assumptions and on the relevance of the two technologies, which may be in the order of 40% of new RE electricity generation each. The ratio of 40% for solar PV and wind energy reflects the high resource availability of both resources (WBGU, 2003; IIASA, 2012;; IPCC, 2011; Perez and Perez, 2009) and the limited resources of the other RE sources, but also the already achieved low cost level of both technologies (BNEF, 2015) and the further expected cost reductions (Vartiainen et al., 2015; BNEF, 2015). BNEF (2015) expects that concentrating solar thermal power (CSP) loses its competitiveness in the short-term, which is indirectly confirmed by Vartiainen et al. (2015); Hoffmann (2014) and Nykvist and Nilsson (2015) since they expect an ongoing step decline in costs of solar PV and battery technology being the more competitive substitute for CSP. The similar ratio of solar PV and wind energy is attributed to their complementarity as stated by Gerlach et al. (2011) and comparable findings in other studies (Greenpeace International, 2015; Bogdanov and Breyer, 2016).

This could lead to a steady increase of new installed capacity for solar PV and wind energy, respectively, of about 158 GW and 109 GW (2020), 328 GW and 226 GW (2030), 688 GW and 474 GW (2040), 1425 GW and 981 GW (2050), 2373 GW and 1634 GW (2060 and 2070). The annual installations would vary a bit in the following decades but due to the reinvestment demand they would be stabilized on an annual market of about 1600–2700 GW for solar PV and about 1600–1800 for wind energy. The total installed capacities could be very roughly estimated at about 3.0 and 2.1 TW (2030), 7.5 and 5.2 TW (2040), 17.3 and 11.9 TW (2050), 66 and 46 TW (2070) and 92 and 63 TW (2100) for solar PV and wind energy, respectively. These estimates are rough numbers, but reasonable for the chosen assumptions. Neither solar PV nor wind energy is limited in its resource potential to reach such numbers.

The area requirement for derived large capacities may be a remaining limit. Vartiainen et al. (2015) assumes a solar PV module efficiency of 30% in the year 2050, whereas the today's solar cell efficiency world record is already at 46.0% (Green et al., 2015) and the theoretical physical limit is calculated by Vos de and Pauwels (1981) and Marti and Araujo (1996) to 85.0–86.8%, depending on assumptions. This may lead to a solar PV module efficiency of about 40% in the end of the 21st century, compared to the today's 16% (Vartiainen et al., 2015). The current area efficiency for ground-mounted solar PV power plants is 0.02 km^2/MW (ZSW, 2014). This leads for the derived 91.6 TWp to about 732,800 km^2 required area representing about 0.5% of global landmass area of 148,900,000 km^2 as an upper limit for the land requirement. A fraction of it will be installed on zero impact areas, such as rooftops, landfills, old military sites, etc., and barren land may be well suited for solar PV power plants. The standard wind turbine size of new installed capacity in the 2010s is about 3 MW and may grow to 5 MW in the mid-term. This would translate the derived 63 TW into 12.6 million turbines, which would require roughly the same area density of the wind turbine density of Germany in the year 2014 on a global level, since the about 24,900 turbines (Deutsche Windguard, 2015) translate into an average density of 14.4 km^2 per turbine. Lu et al. (2009) conclude that about 80,000 TWh could be harvested by offshore wind turbines for a capacity factor of 40%, which represents about 50% of the required wind electricity according to Table 1. It can be concluded that neither solar PV nor wind energy is limited in its area requirement for reaching the required long-term RE requirements in a New Consciousness scenario.

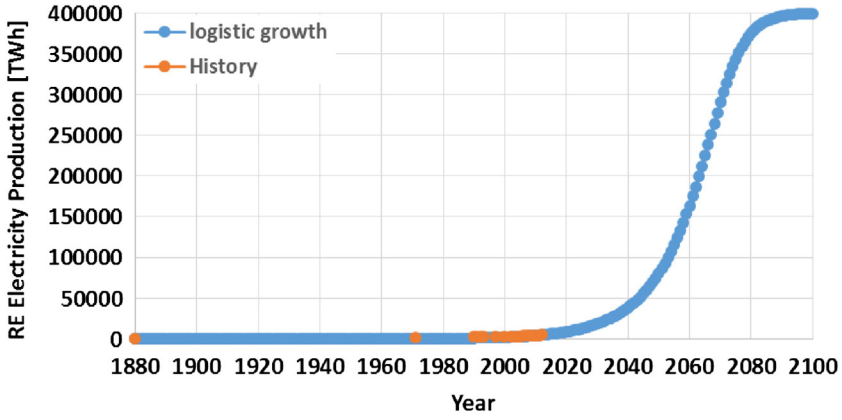

Fig. 1. Logistic growth for potential development of RE electricity production. The historic data (IEA, 2009; IEA, 2014; Metayer et al. 2015; Everett, 2012) are plotted as well (orange). The parameters for the logistic growth function are according to Eq. 1: A (8 TWh), K (400,000 TWh), B (0.2), v (2.7), Q (75) and M (2050). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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Table 1
RE electricity generation from the year 2000–2100. Tabled are the total annual generation based on Fig. 1, cumulated average growth rate (CAGR) of the respective five previous years, additional RE electricity generation, new annual capacity requirements per year and total cumulated installed capacity for solar PV and wind energy. Assumptions: full load hours of 1721 (PV) and 2500 (wind energy) and lifetime of 40 years (PV) and 30 years (wind) according to Metayer et al. (2015) and Gerlach et al. (2015).

	RE electricity generation	CAGR of previous 5 years	Additional RE electricity generation per year	80% of new additional RE PV and Wind		80% of new additional RE PV and Wind (incl. reinvest)		Total installed capacity for 80% of new additional RE	
Year				PV	Wind	PV	Wind	PV	Wind
	[TWh]		[TWh]	[GW]	[GW]	[GW]	[GW]	[TW]	[TW]
2000	2899	2.20%	64						
2005	3320	2.70%	90						
2012	4808	6.10%	293						
2020	8800	7.68%	680	158	109	158	110	0.8	0.9
2030	18,400	7.68%	1410	328	226	328	236	3.0	2.1
2040	38,500	7.68%	2960	688	474	688	521	7.5	5.2
2050	80,400	7.62%	6130	1425	981	1493	1090	17.3	11.9
2060	163,800	7.22%	10,210	2373	1634	2531	1859	36.7	25.2
2070	290,400	5.25%	10,210	2373	1634	2701	2107	66.1	45.5
2080	375,500	1.78%	3920	911	627	1599	1608	85.9	59.1
2090	396,300	0.31%	690	160	110	1585	1744	90.7	62.4
2100	400,000	0.04%	90	21	14	2394	1648	91.6	63.0

Realising that the transformation of the energy system has to be considered seriously, as it is assumed in the New Consciousness scenario, would lead to significantly higher projections of RE electricity generation than stated by the World Energy Outlook reports of the International Energy Agency (IEA, 2014; Metayer et al., 2015), as projected by applying logistic growth functions (Eq. (1) and Fig. 1). However, WBGU (2003) and Komoto et al. (2013) assume for the year 2100 larger installed capacities of 168 TWp and 133 TWp, respectively, for solar PV as summarized by Gerlach et al. (2015) but for a larger share of the TPED of 73% and 58%, respectively, compared to the 40% assumed in this work.

The results in Fig. 1 and Table 1 indicate that the New Consciousness scenario is not unrealistic, since the renewable energy resources are much higher than ever needed, the required technologies are already commercially available and they can gain continuously increasing market shares as their competitiveness further increases and the tremendous subsidies of harmful emissions for the current conventional energy system have to be phased-out (IMF, 2015). Due to the shift to power megatrend and the very high resource availability of solar and wind energy it is very likely that these two resources and therefore solar PV and wind power will dominate the energy mix in a New Consciousness world.

6. Conclusions

This article had three aims: 1) to show how the concept of neo-growth could overcome the internal contradictions of the modern, industrial notion of growth and progress, 2) how a "new consciousness" world of shared or collective identities – a sociopsychological "Global Brain" – could aid in achieving neo-growth, and 3) to show that future growth and progress are possible to achieve by increasing the energy input of societies in a carbon-neutral and sustainable way.

The article concludes by summarizing how neo-growth and the "new consciousness" can solve the internal contradictions of modern growth, and by suggesting some concrete actions towards such future. The conclusion also shows how a "new consciousness" can aid in this pursuit and to offer new goals for progress, as well as deals with the question of how the gradual emergence of "new consciousness" could change the cultural and political landscape so that a renewable energy system can be achieved.

The first internal contradiction of modern progress is that it is based on individuals and individualism, which forestalls cooperation, often a crucial prerequisite for successful action. In a neo-growth world of immaterial production growth and progress are achieved through interaction, open collaboration and exchange of information. This in turn demands for a less individualistic culture than in the industrial times – a "new consciousness" of shared and fluid identities. A concrete action towards such future is an application of the principles of "open source" – collaborative utilization of co-owned, free resources – to all production, not only to software development.

The second contradiction is that modern progress emphasizes knowledge and rational thinking, downplaying other forms of human thought and experience. In the neo-growth paradigm of immaterial production, everything people do, everything they learn, every skill and all knowledge they have can be turned into a productive power. Economic growth requires a holistic use of human capabilities, not only highlighting rational thinking. One's development as an economic actor requires development as a person – economic and human growth are enmeshed. This is allowed by the holistic and systemic nature of the new consciousness or the Global Brain. As a concrete action such shift in work would require today's organisations to allow more self-organising of their workers.

The third contradiction is that in the paradigm of modern progress, representative democracy has made other forms of democracy hard to obtain. As a consequence of the new consciousness, the culture and social structure of a neo-growth world is based on the merging of the individual and the collective as indocollectivism (Dator, 2012). As this kind of social formation enables a more egalitarian social structure, other forms of democracy, such as applications of direct democracy, become easier to realise. This requires not only developing new forms of democratic decision-making and participation, but also tackling marginalisation and inequalities in terms of economic, cultural and social capital.

The fourth contradiction is that the modern quest for material prosperity and control over nature has led to the current ecological crisis. In a neo-growth world, all growth would be ecologically sustainable. More has to be produced out of less, and of higher quality. Negative environmental impacts have to be reduced as close as possible to zero. Material production is automatized, and the recycling of materials is efficient. Economic growth stems mainly from immaterial production – ushered by the "sharing economy" of the new consciousness and the Global Brain (cf. Heylighen, forthcoming). As concrete steps to achieve this, robotization and automation technologies should be researched and developed intensively, and future opportunities for creative labour studied and anticipated.

The goal of modern progress is to emancipate the individual from material and social constraints. As these have been reached, at least in the so called developed countries, a new goal of progress is needed. This new goal could be to *overcome* the modern ethos of individualism, as it has become a hindrance to growth and progress. A "new consciousness" of collective identities enables new ways to produce economic value in ecosystemic organisation models, allows for an enrichment of culture and individuals' identities through ubiquitous interaction, and makes possible an ecological consciousness which sees humans as

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part of nature, and nature having an intrinsic value. This kind of transition has the potential to increase the meaningfulness of existence, as meaningful life of purpose and value requires seeing oneself as a part of something bigger than the self (Baumeister et al., 2013).

The New Consciousness world would force the current unsustainable energy system towards a very high level of sustainability. Based on the megatrend of the shift to power, this would lead to a significant growth of RE-based electricity generation as projected by applying logistic growth functions. The historic cumulated average growth rate for RE electricity for the years 2007–2012 reached already 6.1% but it needs only further increased to about 7.7% for the decades up to the 2050s to follow the proposed logistic growth of RE electricity generation for a sustainable energy supply in the world. There are neither resource limitations known for an energy supply fully based on renewables nor technical limits, as a growing base of scientific publications show. However, a missing will of policy adaptation can be stated. The New Consciousness world may overcome the current political barriers to reach a long-term sustainable energy system for rebalancing the energetic requirements of future humankind to the limits of our planet Earth.

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References

[BNEF] – Bloomberg New Energy Finance, 2015. New Energy Outlook 2015. BNEF, London (June 23).
[EWG] - Energy Watch Group, 2013. Fossil and Nuclear Fuels – The Supply Outlook. EWG, Berlin.
[IEA]– International Energy Agency, 2009. The impact of the financial and economic crisis on global energy investment. IEA, Background Paper for the G8 Energy Ministers' Meeting 24–25 May, Paris.
[IEA]– International Energy Agency, 2014. World Energy Outlook. IEA, Paris (www.worldenergyoutlook.org/).
[IIASA] - International Institute for Applied Systems Analysis, 2012y. Global Energy Assessment (GEA). IIASA, Laxenburg (www.globalenergyassessment.org).
[IMF] – International Monetary Fund, 2015. How Large Are Global Energy Subsidies?, IMF Working Paper, WP/15/105. IMF, Washington (www.imf.org).
[IPCC] – Intergovernmental Panel on Climate Change, 2011. IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN). IPCC WG3, Geneva (www.ipcc.ch).
[UN]-United Nations, 2013. World Population Prospects – The 2012 Revision. UN, New York (http://esa.un.org/wpp/).
[WBGU]– German Advisory Council on Global Change, 2003. World in transition – towards sustainable energy systems (Berlin).
[WWF] – World Wild Fund for Nature International, 2014. Living Planet Report 2014: Species and Spaces People and Places. WWF, Zoological Society of London, Global Footprint Network, Water Footprint Network, Gland.
Baumeister, R.F., Vohs, K.D., Aaker, J.L., Garbinsky, E.N., 2013. Some key differences between a happy life and a meaningful life. J. Posit. Psychol. 8 (6), 505–516.
Benkler, Y., 2006. The Wealth of Networks How Social Production Transforms Markets and Freedom. Yale University Press, London.
Berger, P.L., Luckmann, T., 1966. The Social Construction of Reality: A Treatise in the Sociology of Knowledge. Anchor Books, New York.
Bogdanov, D., Breyer, C., 2016. North-east Asian super grid for 100% renewable energy power supply: optimal mix of energy technologies for electricity, gas and heat supply options. Energy Convers. Manag. 112, 176–190.
Boyd, D., 2008. Taken Out of Context: American Teen Sociality in Networked Publics. University of California-Berkeley, Berkeley.
Boyd, D., 2011. Social network sites as networked publics: Affordances, dynamics, and implications. In: Papacharissi, Z. (Ed.), Networked Self: Identity, Community, and Culture on Social Network Sites. Routledge, New York, pp. 39–58.
Breyer, C., 2012. Economics of Hybrid Photovoltaic Power Plants Dissertation Faculty of Electrical Engineering and Computer Science, University of Kassel, pp. 43–49.
Castells, M., 1996. The rise of the network society. The Information Age: Economy, Society and Culture Vol. I. Blackwell, Oxford, UK.
Connolly, D., Mathiesen, V., 2014. A technical and economic analysis of one potential pathway to a 100% renewable energy system. Int. J. Sustainable Energy Plann. Manag. 1, 7–28.
Dator, J., 2012. On the futures of the information society. Interview of James Dator by Sirkka Heinonen. Helsinki 15th August.
Davis, J.L., 2010. Architecture of the personal interactive homepage: constructing the self through MySpace. New Media Soc. 12, 1103–1119.
Dijk, J.v., 2012. The Network Society. third ed. Sage Publications, London.
Drexler, E.K., 2013. Radical Abundance. How a Revolution in Nanotechnology Will Change Civilization. Public Affairs, New York.
Dunlop, I., 2011. Climate change: what it means in terms of energy. Conference on the Future of Energy and Interconnected Challenges of the 21st Century, Organised by the Club of Rome and City of Basel. Switzerland 17–18 October.
Durkheim, E., 1997. 1893. The Division of Labor in Society. Free Press, New York.
Boyle, G., Peake, S., Ramage, J., 2012. In: Everett, B. (Ed.), Energy Systems and Sustainability: Power for a Sustainable Future, second ed. Oxford University Press, p. 342.
Fraser, J.T., 2009. Time, globalization and the nascent identity of mankind. Time Soc. 9 (2–3), 293–302.
Gerlach, A., Breyer, C., Fischer, M., Werner, C., 2015. Forecast of long-term PV installations – discussion of scenarios ranging from IEA to the solar economy. 31st EU PVSEC, Hamburg http://dx.doi.org/10.4229/31stEUPVSEC2015-7DO.14.1.
Gerlach, A.-K., Stetter, D., Schmid, J., Breyer, C., 2011. PV and wind power – complementary technologies. ISES Solar World Congress 2011, Kassel, 2011, August 28 – September 2.
Glenn, J., Gordon, T., Florescu, E., 2015. 2015–2016 State of the Future. Millennium Project, Washington D.C.
Green, M.A., Emery, K., Hishikawa, Y., Warta, W., Dunlop, E.D., 2015. Solar cell efficiency tables (version 46). Prog. Photovolt. Res. Appl. 23, 805–812.
Greenpeace International, 2015. Energy [r]evolution – a sustainable world energy outlook 2015. Amsterdam, a Report commonly Published with GWEC and SPE.
Heinonen, S., Ruotsalainen, J., 2013. Toward the Neo-Growth paradigm of the sixth-wave era. FFRC eBOOK 1/2013. www.utu.fi/fi/yksikot/ffrc/julkaisut/e-tutu/Documents/eBook_2013-1.pdf.
Heinonen, S., Karjalainen, J., Ruotsalainen, J., 2015. Towards the third industrial revolution. Neo-Carbon energy futures Clinique I. Finland futures research Centre eBook 6/2015. www.utu.fi/fi/yksikot/ffrc/julkaisut/e-tutu/Documents/FFRC-eBook-6-2015.pdf.
Heylighen, F., 2013. Return to Eden? Promises and perils on the road to a global superintelligence. In: B., G., T., G. (Eds.), The End of the Beginning: Life, Society and Economy on the Brink of the Singularity (http://pespmc1.vub.ac.be/papers/brinkofsingularity.pdf).
Heylighen, F., 2016. Towards an intelligent network for matching offer and demand: from the sharing economy to the global brain. Technol. Forecast. Soc. Chang. http://dx.doi.org/10.1016/j.techfore.2016.02.004 in press.
Hoffmann, W., 2014. PV as one of the major contributors to a future 100% renewable powered world – importance and evidence for cost effective electricity storage. 29th EU PVSEC, Amsterdam.
Jasanoff, S., 2002. New Modernities: reimagining science, technology and development. Environ. Values 11, 253–276.
Kanninen, T., 2013. Crisis of Global Sustainability. Routledge, New York.
Kapitza, S., 2006. Global Population Blow-up and after. The Demographic Revolution and Information Society. Report to the Club of Rome, Hamburg.
Kaya, Y., Yokobori, K., 1998. Environment Energy and Economy: Strategies for Sustainability. United Nations University Press.
Kjellberg, H., 2008. Market practices and over-consumption. Consum. Mark. Cult. 11 (2), 151–167.
Komoto, K., Breyer, C., Cunow, E., Megherbi, K., Faiman, D., Vleuten van der, P. (Eds.), 2013. Energy from the Desert: Very Large Scale PV Power – State of the Art and into the Future. Earthscan, London (publication of IEA-PVPS Task 8).
Last, C., 2014. Global brain and the future of human society. World Futur. Rev. 6 (2), 143–150.
Last, C., 2015. Human metasystem transition (HMST) theory. J. Evol. Technol. 25 (1), 1–16.
Laszlo, E., 2001. Human evolution in the third millennium. Futures 33 (7), 649–658.
Lu, X., McElroy, M.B., Kiviluoma, J., 2009. Global potential for wind-generated electricity. Proc. Natl. Acad. Sci. 106, 10933–10938.
Macy, J., 1996. The greening of the self. In: Kotler, A. (Ed.), Engaged Buddhist Reader. Parallax Press, Berkeley, pp. 171–180.
Malaska, P., 2001. A futures research outline of a post-modern idea of progress. Futures 33 (3–4), 225–243.
Malaska, P., 2011. A more innovative direction has been ignored. Understanding Neogrowth - an Invitation to Sustainable Productivity. TeliaSonera Finland Plc, Helsinki, pp. 200–210 (www.sonera.fi/media/13069ab55806de22e8955bc2a3f1afeab17b28bd/Understanding_Neogrowth.pdf. Retrieved October 16, 2015).
Marti, A., Araujo, G.L., 1996. Limiting efficiencies for photovoltaic energy conversion in multigap systems. Sol. Energy Mater. Sol. Cells 43, 203–222.
McShane, K., 2007. Anthropocentrism vs. Nonanthropocentrism: why should We care? Environ. Values 16 (2007), 169–185.
Mead, G.H., 1934. Mind, Self, and Society. University of Chicago Press, Chicago.
Meadows, D., Meadows, D., Randers, J., Behrens III, W.W., 1972. Limits to Growth. Universe Books, New York.
Mérő, L., 1998. Moral Calculations: Game Theory, Logic and Human Frailty. Springer-Verlag, New York.
Metayer, M., Breyer, C., Fell, H.-J., 2015. The projections for the future and quality in the past of the world energy outlook for solar PV and other renewable energy technologies. 31st EU PVSEC, Hamburg http://dx.doi.org/10.4229/31stEUPVSEC2015-7DV.4.61.
Meyrowitz, J., 1985. No Sense of Place. The Impact of Electronic Media on Social Behavior. Oxford University Press, Oxford.
Mischel, W., 1981. Personality and cognition: Something borrowed, something new? In: Cantor, N., Kihlstrom, J.F. (Eds.), Personality, Cognition, and Social Interaction. LEA, New Jersey
Moore, J.W., 2015. Capitalism in the Web of Life: Ecology and the Accumulation of Capital. Verso Books, New York.
Muraca, B., 2013. Décroissance: a project for a radical transformation of society. Environ. Values 22 (2013), 147–169.
Niedermeyer, E., 1994. Consciousness: function and definition. Clin. Electroencephalogr. 25 (3), 86–93.

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Nisbet, R., 1980. History of the Idea of Progress. Basic Books, New York.
Nolt, J., 2013. Anthropocentrism and egoism. Environ. Values 22, 441–459.
Nykvist, B., Nilsson, M., 2015. Rapidly Falling Costs of Battery Packs for Electric Vehicles, Nature Climate Change, 5, 329–332.
Oswell, D., 2006. Culture and Society: An Introduction to Cultural Studies. Sage Publications, London.
Palzer, A., Henning, H.-M., 2014. A comprehensive model for the German electricity and heat sector in a future energy system with a dominant contribution from renewable energy technologies – part II: results. Renew. Sust. Energ. Rev. 30, 1019–1034.
Perez, R., Perez, M., 2009. A fundamental look on energy reserves for the planet. The IEA SHC Solar Update Volume 50.
Pichler, F., 2011. Cosmopolitanism in a global perspective: an international comparison of open-minded orientations and identity in relation to globalization. Int. Sociol. 27 (1), 21–50.
Raupach, M.R., Marland, G., Ciais, P., Quéré Le, C., Canadell, J.G., Klepper, G., Field, C.B., 2007. Global and regional drivers of accelerating CO2 emissions. Proc. Natl. Acad. Sci. 104, 10288–10293.
Rifkin, J., 2011. The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World. Palgrave MacMillan, New York.
Rockström, J., Klumm, M., 2012. The Human Quest: Prospering within Planetary Boundaries. Princeton University Press.
Rogelj, J., McCollum, D.L., Riahi, K., 2013. The UN's 'sustainable energy for all' initiative is compatible with a warming limit of 2 °C. Nat. Clim. Chang. 6, 545–551.
Ruddiman, W.F., 2013. The Anthropocene. Annu. Rev. Earth Planet. Sci. 41, 45–68.
Ruotsalainen, J., Heinonen, S., 2015. Media ecology and the future ecosystemic society. Eur. J. Futur. Res. 3 (9), 1–10.
Schwartz, P., 1998. The Art of the Long View. Planning for the Future in an Uncertain World. John Wiley and Sons, New York
.
Stevenson, N., 2002. Consumer culture, ecology and the possibility of cosmopolitan citizenship. Consum. Mark. Cult. 5 (4), 305–319.
Vartiainen, E., Masson, G., Breyer, C., 2015. PV LCOE in Europe 2015–2050. 31st EU PVSEC, Hamburg http://dx.doi.org/10.4229/31stEUPVSEC2015-7DO.15.1.
Vos de, A., Pauwels, H., 1981. On the thermodynamic limit of photovoltaic energy conversion. Appl. Phys. 25, 119–125.
Wackernagel, M., Onisto, L., Bello, P., Linares, A.C., Falfán, I.S.L., García, J.M., Guerrero, A.I.S., Guerrero, G.S., 1999. National natural capital accounting with the ecological footprint concept. Ecol. Econ. 29, 375–390.
Wackernagel, M., Schulz, N.B., Deumling, D., Linares, A.C., Jenkins, M., Kapos, V., Monfreda, C., Loh, J., Myers, N., Norgaard, R., Randers, J., 2002. Tracking the ecological overshoot of the human economy. Proc. Natl. Acad. Sci. 99, 9266–9271.
Wapner, P., Matthew, R.A., 2009. The humanity of global environmental ethics. J. Environ. Dev. 18 (2), 203–222.
Weber, M., 2002. 1905. The Protestant Ethic and the Spirit of Capitalism. Penguin Books, New York.
Westerlund, M., Leminen, S., Rajahonka, M., 2014. Designing business models for the internet of things. Technol. Innov. Manag. Rev. 4 (7), 5–14 (http://timreview.ca/article/807).
Wiltermuth, S.S., Heath, C., 2009. Synchrony and cooperation. Psychol. Sci. 20 (1), 1–5.
Windguard, D., 2015. Status of land-based wind energy development in Germany, Varel. www.wind-energie.de/sites/default/files/attachments/page/statistics/factsheet-onshore-statistics-germany-2014.pdf.
ZSW, 2014. Stromerzeugung aus Solarer Strahlungsenergie – Vorbereitung und Begleitung der Erstellung des Erfahrungsberichts 2014 gemäß § 65 EEG. Study Conducted by Zentrum für Sonnenenergie- Und Wasserstoff-Forschung Baden-Württemberg, Fraunhofer-IWES, Bosch & Partner, GfK on Behalf of Federal Ministry for the Environment Nature Conservation Building and Nuclear Safety, Berlin, p. 136.

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