ELECTRIFICATION IN PEER-TO-PEER SOCIETY

A NEW NARRATIVE FOR SUSTAINABLE FUTURES

SIRKKA HEINONEN &
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FOREWORD

Dear Reader,

We invite you to travel with us through time towards a future society that is electrified throughout using renewable energy. Due to climate change, it is imperative that we create an emission-free energy system by strongly promoting renewable energies, especially wind and solar. The energy revolution also means more decentralisation and citizens becoming prosumers – consumers and producers simultaneously. These technological developments are intertwined with lifestyle and societal changes when a so-called peer-to-peer society is emerging. Citizens will assume an active role in economic production, creating novel products and services. They will also share knowledge and skills amongst each other as peers.

We describe four transformational scenarios – manuscripts of sustainable futures – where clean energy is abundant and the production of energy is based on renewable energy. This book is science communication – we highlight results from the Neo-Carbon Energy project, funded by Tekes – the Finnish Funding Agency for Technology and Innovation (2014-2017). It is addressed to all those interested in future visions, societal changes and technological advances. Energy is, as elaborated in this book, not only a technological or economic issue, it can also be seen as a cultural and geopolitical topic.

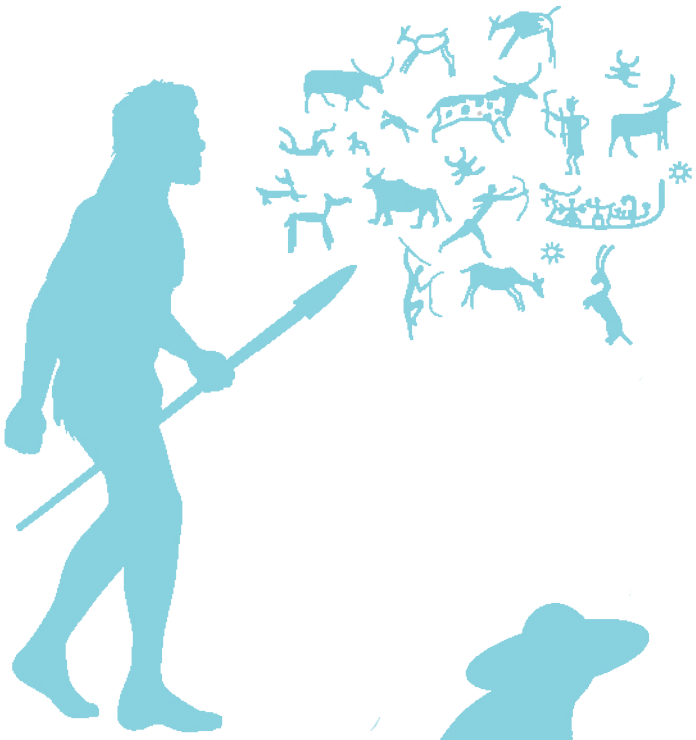
The book can also be used as teaching and learning material at university, vocational school, and high school levels. Our message is to strengthen systematic futures thinking – all stakeholders can do it and in our complex world with turbulent changes such a futures mindset becomes a critical skill for governments, companies, and citizens alike. We hope that the readers will be inspired and enabled by the prospects and concrete steps towards the post-fossil era and a carbon-neutral circular economy.

We are most grateful for the funding for this book, provided by STEK ry, Solar Foods Ltd, and University of Turku. We also acknowledge the valuable research and work done by all involved in the Neo-Carbon Energy project and by the steering group of the original Finnish book. We especially thank Juho Ruotsalainen for his original work on the scenarios, the socio-cultural aspects of the energy transition, and the peer-to-peer vision for a renewables-powered society. Warmest thanks are due to all the experts we have interviewed, to Katja Makkonen, Maiju Kolisoja and Anne Arvonen for the visual design, as well as to translator Osku Haapasaari and editor Morgan Shaw.

Would you like to be involved in making this narrative for sustainable futures come true? We welcome you on this journey of critical importance to the common clean future of humankind. The future is not just coming, it is created through our own plans, choices and decisions.

HELSINKI, FINLAND 10TH OCTOBER 2019

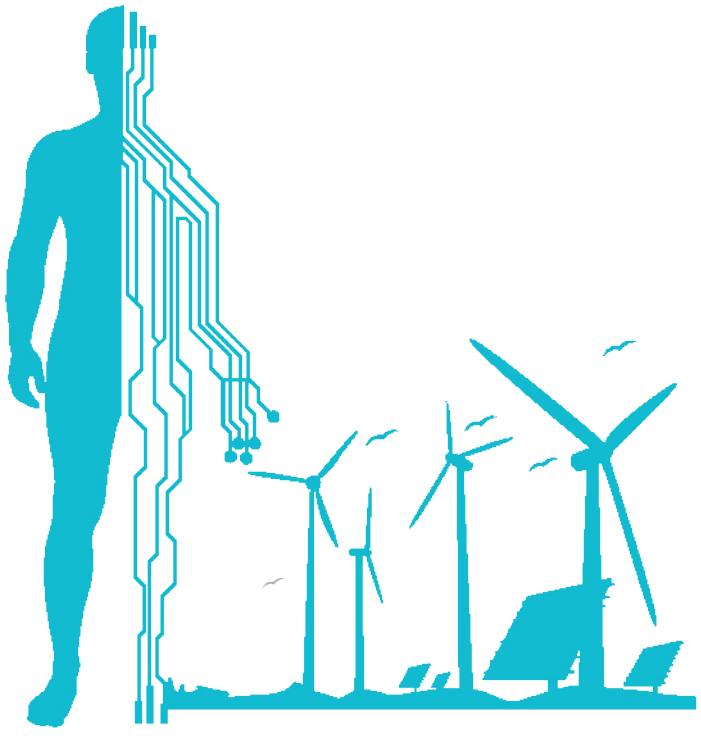
Sirkka Heinonen *Joni Karjalainen*



Four historical stages in the development of humanity with a view to energy futures.

1 INTRODUCTION

Visions of future energy solutions and systems often neglect the social and societal perspectives of the transformations envisioned. After all, energy has to be understood as an issue that is strongly interwoven in the transformation of societies. In addition to technical and economic aspects, we approach energy from a social and a cultural viewpoint. Energy is a part of people's values and way of life. Energy is also a condition for our survival. The "new" great electrification, which this book will explore in detail, is a challenge. When one sector after another is electrified using renewable energy, life can become more emissions-free – step by step. Let us combine with this vision the peer-to-peer society of the future, in which citizens become energy producers. Changes in societies come in waves, now it is time to hop on and surf!



"The purpose of humans is to prove that human life is a precious contribution in general, so that life is richer and more valuable with humans than without them."

PENTTI MALASKA

A NEW DAWN – A NEW FUTURE HORIZON

An increasing number of people are interested in energy, social change and the future. Numerous books are written on energy, for example on the laws of physics and various energy resources, and often a technological or a natural science-focused point of view is assumed. In turn, a historical view looks at past developments and decisions related to energy. Social scientists and other analysts have examined contemporary issues, such as the risks related to energy production, energy safety, energy security, and energy policy. A popular subject in recent times has been an investigation of the role of cheap oil. More recently, a new breed of books addresses the threat and existential risk related to climate change. In parallel, there are numerous handbooks that discuss everyday climate action, energy efficiency and the potential of do-it-yourself (DIY) solutions, for instance on the ways to become a small-scale producer of solar or wind electricity. Many of these books have enhanced the understanding of the prospects for change in the energy sector. So far, though, **a popular title that extensively elaborates on the opportunities related to the adoption of renewable energy sources, while also interpreting anticipated cultural and social changes**, has been missing.

We respond to the challenge presented above with this book. Our aim is to consider the reasons for the rise of renewable energy, and to examine the opportunities and the challenges involved. We address the technological, economic and social preconditions of a wide-scale adoption of renewable energy technologies. What makes this book special is its **futures orientation**. The narrative of this book begins from the observation that in society, there are always a number of underlying, hidden pressures for change. Renewable energy, the many manifestations of its growing uptake, and electrification, remain central throughout the book, as conceptualised and defined by the most recent scientific knowledge. Our purpose is to stir the reader's mind to consider the interaction of three dimensions – technological, economic and social – and their role in the alleviation of climate change.

Our main message is that renewable energy sources, the new great electrification and the principles of a peer-to-peer society open up a new kind of vision for an emission-free future, which has not been previously presented on international arenas. This opens a window for reflecting the future of the energy sector as a whole and in an international perspective. The early signs of changes that we see today are only the tip of the iceberg, with powerful underlying processes of change and widespread, long-lasting and deep currents hiding under the surface. Pressures for change are born from the convulsions of our world: lifestyles change and technology develops. Whether we want it or not, during the following decades we will witness ever accelerating technological advances and experience the effects of climate change in our everyday lives all over the globe. The book introduces scenarios showcasing novel energy futures, alongside factors and forces creating the paths leading up to those futures.

It is worth highlighting that the pressures for change in the energy sector and the implementation of the principles of a renewable energy system can, in time, transform the global energy system – and societies – far more fundamentally that has been thought. At the same time, questions about the desired direction of the future and the ways to move towards such futures emerge: how can an emission-free future be reached on continents, countries and societies that are very different from one another?

ENERGY IS THE ENGINE DRIVING LIFE AND DEVELOPMENT

Energy is life – or even something larger than life. Humans need energy to live, even if life and energy do not necessarily need humans. The first big "energy leap" of humankind happened when we learned to use fire. According to the Promethean myth, a benevolent titan gave humans fire, but was then punished by Zeus, the supreme god, for his deeds[1]. Fire releases light and heat, and symbolises technology and electricity. Energy is manifested in different forms: for example as potential energy, kinetic energy, thermal energy, chemical energy and electrical energy. Electricity is one form of energy, whose history begins with observation of attraction between a piece of amber and a magnetic rock three thousand years ago, long before the theory of magnetism.

Energy is closely interwoven in the transformations of society. It is an issue of technology and economy, but also of culture. Often, energy is conceived primarily as a technological issue, and indeed, there are multiple energy sources, forms, processes and production methods. For this and other reasons, engineers are needed. Energy is also clearly an economic issue. To produce energy, means of production and financial investments are required. Whoever has energy also possesses economic power and wealth. Energy issues concern households, enterprises and the national economy alike. In similar fashion, it is possible to contemplate the effects of energy use in our own life, society, and on a global scale – simultaneously. The environmental impacts of energy use, however, should remain at the centre of considerations.

We can relatively effortlessly approach energy from social and cultural perspectives. As mentioned, energy manifests lifestyles and represents a set of values. We can think of energy by wearing a pair of ethical eyeglasses. Energy influences our way of life, when we consider what energy sources to use, how energy is produced, and what effects these decisions have on our lives. All of a sudden, energy feels very personal! We can also include elements of art and design onto energy. We can even fantasise about energy. What would life be like in a future society, where energy was freely available, emission-free and sustainable? Common to all of these perspectives is the fact that primarily, energy is a condition of our survival.

According to Sergei Kapitza (2006) energy is the most important factor in growth, and a crucial resource for development. In the early 1800s, each person consumed about half a kilowatt of power annually, which is approximately as little as half a horsepower. From 1850 onwards, energy production has increased twice as fast as the world population. From 1850 to 1990 the population of the world grew 4.3-fold, but in the same period, energy production has increased by a factor of 17. In the dawn of the new millennium, an average human being used annually an amount of energy that was equivalent to 2.3 tonnes of charcoal. With roughly this amount of energy, a human being could be sent into space! In today's society, energy is needed for various purposes – heating, cooling, lighting, communications, transportation, industry, construction and agriculture. It is also the dynamo of the information society as well as of digitalisation, powering many emerging technologies.

1 The Prometheus myth helps in thinking about the relationship between humans, nature and technology (Heinonen 2000).

ENERGY IN VARIOUS PHASES OF WORLD DEVELOPMENT

All major strides in history have featured intertwining technological, socioeconomic and cultural shifts. Fundamental changes have always meant a change in both communications and the use of energy. Increased energy production and consumption have enabled the development of more complex societies[2]. With each shift, new communications and media have been required to respond to increasing complexity. Over time, these cyclical changes have revolutionised production methods and also shaped conceptions about humankind and its place in the world. Many changes have spread thanks to networks of interaction and trade, which have mediated ideologies, power, money, and transferred goods from one culture to the other (McNeill & McNeill 2003). The following categorisation is one way to conceptualise the development of societies after the prehistoric era[3]:

Human evolution increased the volume of the human brain, which had begun to process and store growing amounts of information. In spite of this gain, early human societies depended upon their immediate environment. Around the world, hunter-gatherer communities and societies (100,000 to 10,000 BC) nourished themselves either by hunting animals and fishing, or by foraging plants and berries. Concerning energy, the use of fire made possible the preparation of caught fish or meat and provided shelter against cold and wild beasts. Hunter-gatherer societies were typically small and rather mobile, and they organised as groups of local communities or tribes. The development of spoken language helped communication between people.

In agricultural societies (10,000 BC onwards), agriculture formed the basis of economy. The First Agricultural Revolution, also called the Neolithic Revolution, enabled the growth of communities, organisation, towns as centres of trade, and early civilisations. The introduction of new crops diversified the human diet: farmers settled to a single location, grain was stored for long periods, and domiciles were built to be more permanent than in nomadic societies[4]. In agrarian societies, humans learned to develop agricultural plants. The harnessing of animal labour in agriculture made increasingly laborious tasks possible. However, practically the only energy source of agrarian societies was the solar energy gathered by plants. The fact that societies relied on muscular strength limited their degree of complexity (Heinberg 2003). The invention of written language during this era allowed the communication of messages in a new way. This long period of history features the rise of empires, kingdoms, chiefdoms and early city-states.

Our current societies have perhaps most fundamentally been shaped by the many phases of industrialisation. The transition towards industrialised societies from the 18th century onwards started in Britain, and brought with it the widespread the use and reliance on fossil-based energy.

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2 Complexity means that the cause and effect relationships, and their mutual dependencies, that make up our societies are so complicated that it is difficult to understand how a society works. Additionally, a change in one part of the society may cause unanticipated changes elsewhere in the system.

3 Social historians have attempted to define societies and the way they are built. Economic historians, on their behalf, analyse techno-economic progressions that transform societies. Earlier phases in a process of transformation do not disappear entirely, but rather remain; continuing their life as thinner layers. For economic historians, dates are only approximate.

4 Thanks to farming, futures thinking was strengthened. It was more important than before to be able to forecast the weather. In the Nile delta, priests analysed the colour of the water, which could be used to anticipate things that were important for a successful grain crop (Schwartz 1996).

The *First Industrial Revolution* is characterised by an increasing use of coal in steam engines and steamboats. The invention of the spinning jenny symbolised the early industrialisation of weaving, as the efficiency of the weaving process improved by a factor of eight. The factory system started to make increasing use of machinery, and an era of industrial work started. The long hours put in by factory workers were accurately observed. The demand for cheap, mass-produced steel skyrocketed with the development of the steam locomotive and the expansion of railways. When modern rail transport commenced, the introduction of timetables and the invention of the telegraph helped rail safety, and led to the standardisation of time (Ogle 2015).

The *Second Industrial Revolution*, around the year 1870, kick-started the era of mass production. Alongside the development of steel and chemical industry, our attention is drawn in particular to the process of the "first" great electrification. It was marked by the invention of the electric motor, numerous practical applications that used electricity, and an increase in the production of electricity. Already in 1831, English researcher Michael Faraday had succeeded in translating mechanical movement to electricity, discovering electromagnetic induction. With the development of the electric motor, the first industrial generator was built in the 1870s. After the early attempts to develop an electric lamp, Thomas Alva Edison had a central role in the development of the electric light. He succeeded in creating a market for the incandescent light bulb, which started to compete with gas and oil lighting. In the 1880s, the first electric power plants with steam engines as well as electric utilities for electricity distribution were introduced. Electric lights were introduced in factories, theatres and on the streets. In cities, night turned into day, changing people's lives. Before electricity could be widely adopted, the issue of electricity transmission had to be solved. The invention of the alternating current system by Nikola Tesla made it possible to increase the voltage.[5].

Economic growth and the population growth were promoted by many factors, but there is one factor above all, namely oil. Oil is likely the most potent non-renewable natural resource that humankind has so far discovered and exploited. Especially after the Second World War, an increasing amount of oil has been pumped and produced to the global market. The volume of an oil barrel is about 159 litres, which equates to the annual work effort of 12 people. It would take as much as 25,000 hours from a person working in manual labour to match the amount of energy that is in a single barrel of oil. As an energy source, oil is so dense and affordable that it is practically free, even when its price shoots up. The cheap energy stored in oil has contributed to the exponential growth of the world economy and the global population.

One of the features of the industrial era is centralised logic. It is worth noticing that during this era, which still influences our present day, both energy and communications also ascribed to this logic. In the case of energy, many dreamed of the abundant energy that could be obtained from nuclear power. From the 1960s onwards, nuclear reactors and power plants were built around the world. At present, nuclear power accounts for approximately 10 percent of the world's electricity supply – primarily in North America, Europe and Asia[6].

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5 Alternating current came to be the most common system. One benefit of alternating current is that it enables a simple structure for electric motors, the induction motor, later adopted widely, especially for uses in industry.

6 The exploitation of uranium is a Pandora's Box that has created the nuclear arms race and disputes related to it in international politics. Nuclear energy is plagued by its cost and the risks that it involves.

Media was about mass communications. The newspaper, radio, and television; all of them assumed a unidirectional flow of communications. Each in their way captured citizens' attention in kitchens, living rooms, restaurants and bars.

The so-called *Third Industrial Revolution*, which is usually considered to have started in the 1970s, is characterised by the birth of information and communications technology (ICT). The invention of the transistor and the microprocessor created the electronics industry. Many processes in industry and production were automated and information processing intensified. Because of the timing, nuclear power is interpreted to be a part of the third industrial revolution. As is known, in the decades to follow computers took over workplaces and then households (and only later other forms such as cyber-cafes were invented). As a result, the world moved to the era of the information society. Thanks to the internet, the sheer amount of information has rapidly grown, and it is able to spread widely[7]. Billions and billions of integrated circuits with their transistors have become an integral, but largely invisible part of our lives through internet and mobile technology. By the end of the millennium, the globalisation of knowledge and economy, and the increased penetration of networks revolutionised production, trade and communications. Consequently, the marginal costs of sharing knowledge today are nearly at zero – information is available for nearly everyone and practically for free! With the latest developments, especially digitalisation, we are increasingly moving to an era of knowledge societies.

Growing Concern over Climate Change

The actions of human beings are about to leave another type of a lasting mark on the Earth. The global average temperature has risen by over one degree Celsius since 1850. Two thirds of this warming has happened since 1975 – as fast as between 0.15 and 0.20 degrees in the last decades. Global warming will not cease because fossil fuels are depleted – since they will not be running out as quickly as was earlier supposed and warned by some. Instead, resources more difficult to obtain, such as deep-water oil and shale gas, have been sought out and utilised, through technological advances.

The alarm bells are ringing as a sign of urgency, as the climate is changing even faster than has been assumed. In the Northern and Southern Polar Regions, warming is about twice as fast as the average global warming. Many developing countries, in turn, are assumed to be severely affected because of their limited resources to adapt to climate change. In the short and medium term, a rise in global average temperatures is expected. Extreme weather events, such as heatwaves and storms can become more frequent and severe. Simultaneously, it is feared that the spectrum of species and diversity in nature will be reduced (IPCC 2018, IPBES 2019, see also Larsen et al. 2014).

We might face challenges that are difficult to anticipate already in the coming decades, not to even mention the coming centuries. In the absence of action, dystopian images of the future are increasingly dominant.

7 The internet has been developed since the 1950s. The TCP/IP protocol was developed in the 1980s. Tim Berners-Lee has often been considered as the person who invented the internet, as he developed the World Wide Web in 1990.

THE NEXT PHASE OF DEVELOPMENT

Societies change in large phases, cycles or waves. In this book, a vision of the next phase of development is presented. The ingredients of this vision can be seen already around the year 2000, but they reach far into the future. The purpose of this vision is to prepare for the future, anticipate alternatives, and challenge the dominant patterns of thought that arise from the past world. Simultaneously, we argue that the understanding of humanity can be expected to change alongside technological development.

As a guiding principle, societies function more and more like networks (Castells 1996; van Dijk 2012). Communications technologies operate in a networked fashion, which makes communicating possible from all corners of the world. Today, information spreads faster and crosses borders more effortlessly than ever before. Work has become global, networked, and even location independent. The principles of networking have created new practices, strengthened actors who operate at the grassroots, and are creating practices in a society of constant interaction. The flows of information and communications, as epitomised by social media, have become multi-directional. The many consequences and merits of the networked logic are undeniable. Online, people are able to interact as peers, which supports self-direction, and the spread of a great variety of ideas, creating lively dialogue between citizens. When the world is perceived from a "peer-to-peer" perspective, it is also easier to challenge authorities and unjust rule. Of course, not all hierarchies have been disassembled, and this logic has also its disadvantages (Ferguson 2018; Karjalainen et al. 2018).

These deep-seated changes, especially the rapid advances in communication technology, have created a foundation for the models of peer-to-peer production (Bauwens 2005, 2007; Benkler 2017). Peer-to-peer production refers to an operational environment in which individuals and organisations can act as peers to use and produce openly shared and exploitable resources. Famous examples of such practice include the Linux, as an operating system for computers; Wikipedia, an online encyclopaedia that is updated by its users; and more recently, numerous services for sharing music and a range of mobile applications – for instance related to housing, transportation and food[8] – where these practices are applied in almost every aspect of life. Peer-to-peer production and open collaboration are likely to become increasingly common due to the joint effect of economic, technological and cultural factors. More and more economic value is generated in immaterial production and in the creative industry. Technologically, citizens can self-organise, communicate, and have also begun to participate in economic production. Culturally, the values of citizens are increasingly geared towards self-expression, and self-actualisation and openness are globally becoming increasingly important preconditions for success, even when the issue of cultural diversity is acknowledged.

The missing piece in this puzzle that unlocks further steps concerns energy. In this regard, renewable energy offers a logical and plausible answer. Like many emerging technologies, renewable energy technologies are decentralised, have become increasingly affordable as far as costs go, and they produce electricity nearly for free. The number of renewable energy installations can also increase

8 Peer-to-peer production (Bauwens 2005; 2007) has been characterised as the most radical organisational innovation or social practice that the internet era has brought with it.

quite rapidly. In the not-too-distant-future, renewable energy might be nearly ubiquitous. In this regard, renewable energy can be placed in the same group with the internet, social media and mobile devices – as a decentralised, easy-to-adopt, and modular grassroots technology[9]. What is more, electricity generated from renewable energy sources could work as a platform, where practically free and zero-emission electricity is actively shared between citizens, companies and the industry. Should future technological development and infrastructures support such a vision, we could be facing a new great wave of electrification.

A NEW GREAT ELECTRIFICATION IS NEAR

Electricity has innumerable applications in different aspects of life already today. Electricity can be converted with high efficiency to mechanical movement, heat or chemical energy. Electrification makes energy use smooth because of energy efficiency and the ease of transmitting electricity even over long distances. Because of its characteristics, electricity can be used in diverse ways. A new technological trend concerns the electrification of everyday items, services and things. When electricity is increasingly used as the primary energy carrier in the energy system, one must ask how is this energy is produced. If electricity is produced from increasingly affordable renewable energy sources, such as solar or wind power, nearly the whole energy system can become emission-free.

For these and other reasons that will be discussed later, the future of energy is in electricity. The new great electrification opens up a novel opportunity to reduce carbon dioxide emissions that derive from fossil fuel use. That is why electrification can catalyse also other transformations in the energy sector. In fact, it would even be possible to create synthetic fuels using electricity, as described later in the book. Electricity that is converted into synthetic hydrocarbons can act as a substitute for fossil fuels. In other words, such technological configurations are expected to assume a central role in the fight for the survival of humankind. There are already visions of a "clean" energy revolution, in which emission-free energy, novel technologies and new business models enter the market, accelerating this process (von Weizsäcker & Wijkman 2018). In these visions, such future configurations will displace the ways energy is presently produced, distributed and consumed.

CLEAN TECHNOLOGIES DISRUPT THE ENERGY SECTOR

A clean energy revolution refers to a fundamental transformation in energy production and energy consumption (NREL 2015). The proposed energy revolution is connected to the increasing uptake of renewable energy technologies, especially solar and wind power, but also to the uptake of novel engineering solutions, energy storage and the electrification of mobility, such as electric cars, self-driving cars, mobility as a service, and related applications. In order to support this fundamental transformation, an increasing amount – already over USD 300 billion annually – is invested in clean

9 To simplify a bit, non-renewable energy sources are typically centralised, often expensive to exploit and after the energy has been extracted, the infrastructure that has been built for their exploitation is quite laborious to disassemble.

Clean Energy Revolution as a Precursor to New Developments

A *disruption* means a disturbance, division or a state of turmoil caused by an innovation. Disruptions take place in the economy and markets when a transformation in a certain sector begins to topple old practices and to replace them with new ones (Christensen 1997; Seba 2014). Here, technology refers to the processes with which an organization – usually a company – is able to transform labour, capital, materials and information into products and services that are of greater value. Disruptive technologies and innovations can create new kind of value. At best, this new value is financial, social and environmental. The innovation, or a series of innovations, cause the disruption and force its way into the markets or create a new market altogether. Innovations provide new products and services that are more convenient, simple and affordable than those currently in use. Initially, innovations perform poorly, but with time they can get better and challenge the established players in the market.

The history of societies is filled with disruptions that have shaped various sectors. Automobiles famously replaced horse carriages in the early 1900s. The telephone was introduced to households by landline networks, which in turn were made redundant by mobile phones and wireless networks. Already, we have moved on to the era of smartphones. The recording media for sound and music has moved from vinyl records to cassettes, which were superseded by CDs and various digital recording media, storage and file types. Digitalisation has facilitated the rise of online shopping and mobile purchases alongside traditional marketplaces. In transport, mobility is becoming a service, with numerous new applications.

The next breakthrough is anticipated to take place in clean technologies. Various solutions and organisational practices are already in place to minimise environmental impacts. Radical innovations are next sought specifically in the energy sector. The aim of many promising solutions is to take a decentralised perspective and re-think how the energy sector has been organised. Activists, entrepreneurs, firms and startups are already introducing new kinds of ideas, methods, processes, products and services that aim to reduce the reliance on fossil fuels.

energy technologies (BNEF 2019). As characterised by Silicon Valley technology guru Tony Seba (2014), clean disruption is an inevitable and a strengthening force. Surprisingly, the potential of these changes is rarely carefully explored.

First of all, the electrification of the energy system is likely not a straightforward process. Novel principles and ways of organising the energy sector undermine past arrangements, and related resources, technologies, and infrastructure. The promise of a clean energy revolution challenges the present structure of the global energy sector where over 80 percent of energy is currently produced from fossil fuel energy. Secondly, large, global energy companies of "the Burning Age" mainly control the global energy production, organisation and distribution. The ability of states to introduce changes in the markets is weakened by established interactions. In many countries, the primary focus of energy policy is in conventional energy resources, such as coal, gas and oil, and related developments. This is slowing down the envisioned transition.

Fortunately, the low-carbon challenge is an increasingly integral part of future energy visions, strategies and policies. However, limited awareness affects the choice of means, which often manifests as an inability to accelerate promising developments and to recognise opportunities arising out of this new vision.

FORESIGHT SUPPORTS VISIONARY WORK IN THE ENERGY SECTOR

Futures thinking is about foresight – seeing into the future. The future can be anticipated in a systematic fashion and even in a long perspective. Foresight does not mean prediction. Short-term expert forecasts usually rely on current knowledge, whereas longer-term scenario work - the manuscripts for the future - give us the opportunity to investigate transformations and paths that can diverge significantly from the present. Foresight means systematic and careful consideration of various interdependent trends of development and their effects. Utopias, on the other hand, form their own niche in futures thinking, but they are not necessarily supported by evidence or foresight knowledge. Moreover, utopias often stay on the level of sketches of a too distant and vague future. This is why scenarios are needed. The drafting of scenarios – for example concerning the future of the energy sector – is in a more concrete way brought closer to the present while at the same time strengthening futures imagination. Scenarios can be tested in various geopolitical contexts, and they call for assessment and prioritisation on what is a preferred future. This way, futures are used in the present.

This book focuses on deliberating one potential future objective – a future based on electricity and renewable energy, and the paths that can lead towards this future. Radical thinking is required, as academic futures research encourages critical discussion in the real world. It also allows the anticipation of even surprising trajectories that open doors towards new lifestyles, practices and ways of production.

Our book aims to popularise the anticipation of renewable energy futures through science communication. It is largely based on the research work conducted in the Neo-Carbon Energy project by University of Turku, Lappeenranta University of Technology and VTT Technical Research Centre of Finland. It especially makes use of the foresight part of the project, which was implemented at the Finland Futures Research Centre, University of Turku[10]. We will introduce the most significant and interesting findings of this research work on the opportunities related to electrification and the renewable energy system, analysing opportunities, advantages and uncertainties on a wide scale.

The book tells a story of individuals and groups in a changing world – experiencing the pressures of the networked logic, latest technological developments and aspiring for a transformation of the energy sector. It also speaks to the climate change urgency. In addition to energy, we also discuss the economy, work and politics. The science basis of the book owes to techno-economic studies and

10 See www.neocarbonenergy.fi and https://www.utu.fi/en/units/ffrc/research/projects/energy/Pages/neo-fore.aspx for further information.

calculations by researchers based on ground-breaking energy modelling. These studies show, for the first time, that an emission-free energy system based on renewable energy is technologically feasible and economically worthwhile. Consequently, the clean energy revolution studied in this book could take place mostly through harnessing pre-existing technologies. This emphasises the main challenge of the envisioned revolution: instead of technological change, determination and a series of political choices, as social will, are needed to advance this vision – to reach towards a desired future.

At the end of each chapter, there is a set of questions the reader can consider and possibly put into practice. The goal of the questions is also to advance systematic futures thinking. The fifth chapter of the book presents four scenarios. They are a description of different paths of transformation and of the pioneers who with their actions can lead the world to the wide-scale deployment of renewable energy across the world by 2050.

This book and the related public interactions, the questions and the scenarios can be used as learning materials, as they are intended to open up international debate on the new great electrification. The new great electrification can introduce radical changes not only in energy, but in various sectors (mobility, construction, housing), and would advance the implementation of the general principles of carbon-neutral circular economy. We are at the crest of a wave that is still forming, symbolising the early seeds of a comprehensive societal transformation (see the first illustration in this chapter). Why and how will this transformation come about, who will make it happen and how quickly can it take place?

QUESTIONS TO CONSIDER

- What options are there for a new kind of growth, which does not increase environmental stress nor carbon dioxide emissions, but increases social well-being?
- What does energy mean to me, and what dimensions does electrification have?
- What drivers and obstacles does my country have from the perspective of the widespread adoption of renewable energy?
- What drivers and obstacles does the society that I live in have, when the growing significance of peer-to-peer principles is considered?
- How would you characterise the next phase of development that follows industrialised society and information society? What kinds of new motives arise?

In the following chapters we move on to describe the vision that incorporates the new great electrification, a rise of renewable energy technologies and a peer-to-peer society, combined together. To create futures we need visions, as the ambitions of a desired future.

KEY SOURCES AND READING RECOMMENDATIONS

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2 VISION OF A RENEWABLE ENERGY POWERED PEER-TO-PEER SOCIETY

In the year 2050, energy will be nearly emission-free, as energy systems have been electrified and energy is produced almost completely from renewable energy sources. Energy efficiency is considerably higher than today. An abundance of affordable, clean energy is available. An "Internet of Energy" enables the flexible use of electricity, and makes it secure for autonomous and deeply networked citizens. The wide-scale adoption of peer-to-peer principles has shaped the formation of a new consciousness. The adoption of the peer-to-peer practices has accelerated a social transformation, and consequently, a clean energy revolution, where citizens have become energy producers. An energy transformation based on renewable energy has also increased the amount of energy that is globally available.

"If one does not know to which port one is sailing, no wind is favourable."

LUCIUS ANNAEUS SENECA

THE GREATEST TRANSFORMATION YET UNDERTAKEN BY HUMANKIND

It has been long known that the current energy system is unsustainable. In the long term, even if there would be an abundance of fossil fuels available, they will one day run dry. Given the present situation, there is not that much time to wait. The global temperatures are increasing at an accelerating rate. Therefore, the energy system has to be transformed. This transformation needs to proceed more ambitiously and rapidly than anyone could have thought. The history of humankind hardly knows an endeavour of this scale and of such urgency. The mission to send a man to the moon and the space race during the Cold War era do not even come close. In other words, the present energy system is facing enormous pressures. Consequently, there is considerable uncertainty underpinning future energy outlooks and scenarios. Given the entrenched nature of the international energy business, radical alternatives to the status quo are often neglected, met emotionally or even with direct opposition.

These might seem like desperate times, but this is not the first time that a transformation takes place in the ways energy is produced and consumed, as discussed in the first chapter (Geels 2007; Smil 2010; Sovacool 2016; Köhler et al. 2019). What is more, it is easily forgotten that the present era, technological change and novel lifestyles make for a landscape that is different from any historical circumstances. In essence, a massive challenge is also a massive opportunity. In order to meet this challenge, a strong and credible vision of the future is needed. This vision has to recognise technological, economic, environmental, social and cultural perspectives. This chapter aims to describe a vision of a new great electrification in a peer-to-peer society. In this vision that reaches to the year 2050, energy has become emission-free, it is almost entirely produced from renewable energy sources, and is used efficiently. As the outcome of this vision, there will be an abundance of affordable clean energy, which adheres to the principles of sustainable development.

An Internet of Energy (Metcalfe 2009) will serve as the technological backbone of the vision. The details of the concept will be explored in Chapter 3. The future energy system that makes use of this Internet of Energy is expected to support a sustainable and secure society, as a foundation for increasingly self-driven and networked citizens (Ruotsalainen et al. 2017). In this vision, the exploitation of fossil fuels has been stopped completely. We will explore why this vision is likely a preferable one for many citizens around the world and how it can also be made technologically feasible. The next pages will describe and examine what such a future vision could look like.

ABUNDANCE OF RENEWABLE ENERGY

Any energy vision, including one that is based on renewable energy, has to adhere to the laws of physics, which define what is possible. Physics shows that the universe is full of energy. Harnessing this energy for the use of humankind is primarily limited by imagination.

Every year, humans consume approximately as much energy as is emitted by the sun to Earth's atmosphere and surface every single hour. In other words, there is a practically unlimited reserve of solar energy. This is true, even when global energy consumption is increasing as a function of population growth, economic growth and rising living standards. Therefore, an energy system that is economically and environmentally sustainable should rely heavily on solar energy. There is also

The ABC of Futures Thinking and Visioning

Futures thinking consists of three kinds of futures – possible, probable and preferable futures (Amara 1981). Nation states, companies and organisations typically focus only on probable future paths and the future worlds related to these paths. This is unwise because it is of great imperative to explore possible futures as widely and openly as possible (Heinonen et al. 2017). This is because the world is complex and uncountable factors influence the future, not only those in one's close proximity. The mapping of the future and its many alternatives has to start from the following perspective: "What developments or events are overall possible?" A broad perspective widens the futures horizon more than an analysis of probabilities. What is more, a charting of desirable futures can be conducted after identifying possible and probable futures. In fact, this process usually results in a *vision.* Governments, cities, regions, companies, communities and also individuals – all benefit from having a vision. The future does not come; the future is crafted from today's plans and decisions.

For this reason, it is important to think carefully of a future that would be a preferable one. The purpose of a vision is to express future ambition. A vision process should be a collaborative effort that is based on strategic discussions where common future objectives are identified. When stakeholders are involved in the process, they feel more committed to the eventual vision. Alongside conventional strategy work, every organisation and nation should have a *futures strategy*, as a continuous futures process focusing on the long-term perspective. A futures strategy can have a timescale of up to fifty, or even a hundred years! Any futures considerations must acknowledge developments of multiple issues and sectors beyond a single sector view or casual observation. An open and courageous futures process can transcend rhetoric, and generate a bold and future-oriented vision.

Opinions regarding a desired future can differ in different circumstances, for instance, across cultures. Even so, selected issues can be recognised as a basis of further steps even from seemingly distant visions. Each step can open up further opportunities. The most important things in visioning are that each community drafts their vision co-creatively, that everyone is heard and that different opinions are considered, in order for the vision to be owned by as many as possible.

five times more wind energy available than the amount of electricity that is globally consumed. Furthermore, humankind has at its disposal small amounts of other renewable energy sources: ocean thermal energy, bioenergy, hydropower, geothermal energy, and tidal and wave power, as illustrated in Figure 1. Naturally, each of these sources has to be exploited in a sustainable and responsible manner.

It is often assumed that switching to renewable energy sources requires the reduction of energy consumption and would end the era of energy abundance (Heinberg & Friedly 2016). The vision proposed in this chapter begins from the opposite premise: a system that leans on renewable energy sources can respond to increasing energy demand (Breyer et al. 2017a) and open a pathway to a world of abundance "without guilt" (Lord 2014). If humankind could harness as little as 1/1000 of the solar energy that touches the Earth, there would be about six times more energy available than what the humankind consumes today (Naam 2011). Renewable energy passes the scrutiny of physics: it is widely available, the issue is harnessing and using it efficiently. What is more, as shown by recent studies, such a system is technologically and economically feasible.

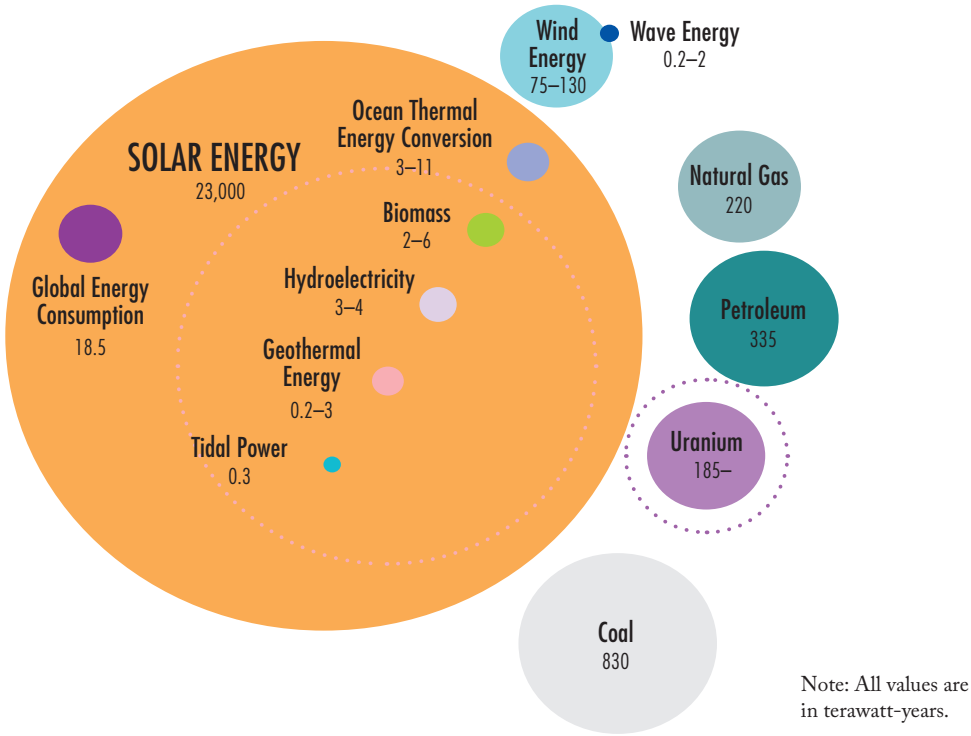

Figure 1. Solar energy is abundant when compared to reserves of non-renewable energy sources.[11]

An energy vision that relies on renewable energy sources may seem like an implausible one for many reasons. Globally, humankind consumed 160,000 terawatt hours (TWh) or over 18 terawatt years (TWy) of energy in 2016[12]. Out of this, the total consumption of electricity was around 25,000 terawatt hours[13]. That same year, the share of electricity produced by solar and wind power was negligible; less than one percent of the global energy consumption. Solar power produced 328 TWh of electricity and wind power 958 TWh of electricity. A quarter of this production, in both cases, happened in China. Given the starting point, the sheer scale of the envisioned transformation is enormous.

A closer look tells that there are promising signs of change. In ten years, the production of wind power grew tenfold, and the production of solar power a hundred-fold (IEA 2018). This implies exponential growth. The experts dispute whether this growth rate will be sustained in the future. Some see these initial trends as signs of a brighter future, others note renewable energy technologies are not adopted fast enough – and some fear that the growth trend will stall. It is useful to think of

11 For renewable energy sources, the figure displays the annual production potential, for non-renewables the figure shows known reserves (Perez & Perez 2015).

12 A terawatt year (TWy) is quite a rare quantity that can be used to describe very large amounts of energy consumption. 1 TWy= 8760 TWh = 8760 * 10^9 kWh.

13 In other words, the total global energy consumption was about 160 petawatt hours. One petawatt hour (10^{15}) is one thousand terawatt hours (10^{12}).

the following questions: what would happen if more and more of solar and wind power was adopted and installed, and at an increasing pace? What if electrification would teach us how energy can be used in a much more efficient manner than before? The promise of the early signs of change is that they will gradually begin to shape society, and eventually, morph into a clean energy revolution that permeates entire societies.

A SYMPHONY OF UBIQUITOUS ELECTRICITY

In a vision that features the sustainable use of renewable energy sources and a new great electrification, by 2050 humankind utilises widely the opportunities provided by sources of renewable energy, especially non-conventional renewable energy sources such as solar and wind power. In a system like this, most sectors in society function on electricity that is produced using renewable energy sources enabled by smart systems. This has an impact on all functions of life. It means rising to a new level – the more numerous the sectors that can be electrified using renewable energy, the more emission-free life becomes. In accordance with this objective everything that can be electrified will be electrified![14] This means heating, cooling, industry, transportation, and even agriculture.

In our vision, energy is harvested everywhere. Many previously neglected physical spaces from rooftops to highway roadsides will be covered in solar panels, wind turbines and other means of energy production, such as trees that use artificial photosynthesis. Built infrastructure gathers energy from its surroundings, and so will clothes, devices, gadgets, and vehicles. Most sectors in society are assisted by the Internet of Energy, which is integrated to intelligent energy networks, optimised energy storage and flexible energy use. Robotic electric vehicles will occupy roads, and electrification will begin to shape the entire transport sector and other forms of mobility. Aviation and freight will not be directly electrified – perhaps at least not by 2050. Instead, they will begin to use synthetic fuels manufactured from electricity based on renewable energy, with the aid of hydrogen and carbon dioxide. Many essential products will be manufactured under these principles.

"We are slowly beginning to understand ourselves as human beings and as social creatures. At the same time, enormous transformations in technology, energy and environment are happening around us."

MARKKU WILENIUS

UNESCO Chair of Futures Learning and Education, Professor of Futures Studies, University of Turku

The changes will not be merely technological, but also social and economic. Housing, food, agriculture and industry will be transformed. Thanks to the development of thin film technology, next generation solar energy technologies could begin to

14 "Everything that can be digitised will be digitised" is a similar popular catchphrase used to describe the spread of digitalisation in the 2000s.

fundamentally change how buildings are designed. In the future, energy production would be integrated into our surrounding structures to an even greater extent than today. Solar panels and thin film solar cells would cover rooftops, windows and even roads. Solar energy would be harnessed in agriculture for productive uses, for instance for pumping water. Due to the recycling and re-use of all materials, nearly zero waste would be generated. The clean energy revolution would also shape how we feel and think about our environments.

Over time, more and more changes would be seen. Architects and urban planners would assume entirely new types of approaches that would influence their designs and plans. When purchasing a house, citizens would compare renewable energy solutions and services, and when necessary, they would 3D print solar panels for themselves. They would also turn to each other, home robots and new enterprises for advice. Novel firms would provide a wealth of services: digital energy applications as well as full-service packages from installation to maintenance. Land use planning would anticipate the novel energy infrastructures as well as the disassembly of obsolete ones, while creating more space for biodiversity at the same time (Dinerstein et al. 2019). Cities would begin to exchange and trade whatever surplus electricity they produce with each other. Civil servants in different departments and levels would assume an enabling role in facilitating the uptake of novel practices. They would assist, for instance, in establishing new startup, innovation and technology networks and by bringing together experts from diverse backgrounds. These transition arenas would help elaborate the new mindset in municipalities, national-level and intergovernmental organisations. The new practices would contribute to the transformation of the energy system and would also advance a peer-to-peer society of the future.

FUTURE LIFE IN THE PEER-TO-PEER SOCIETY

In a *peer-to-peer* society, citizens share knowledge, skills and items freely. They act in numerous groups and networks as peers, rather than hierarchically. They are able to self-organise, independently of traditional hierarchies and social structures. Already, citizens can make use of numerous networks and create entirely new ones using the incredible potential in connectivity and social media platforms. When people begin to act in a networked fashion, their opportunities to interact increase. The significance of peer-to-peer networks was first realised during the internet era, when people were suddenly able to share information and files more effortlessly than ever before. Similarly, in social media interactions, information, ideas and files are co-created and shared openly and spontaneously. The peer-to-peer practices are embodied in information and communication technologies, and later technological developments.

The peer-to-peer principles are a way of interacting non-hierarchically. Overall, the ease of sharing information improves transparency. Citizens and small groups are able to voice their opinions and concerns, and consumers can react to the services they consume and want to express their taste. Consequently, firms have learned to observe and respond more actively to consumer moods and changing public opinion. Enhanced communication technologies have increased reciprocity, and they also make the world feel smaller and more interconnected. Another step forward can come when peer-to-peer production begins to take root. Peer-to-peer production refers to the

spontaneous generation of products and services for various types of needs (Fox 2014). Small-scale energy production and the increased opportunities of citizens to participate in economic production are examples of this. The ingredients of peer-to-peer production are open collaboration, greater self-expression, bottom-up creativity, and quite simply, having fun.

Once the peer-to-peer principles are firmly established, they begin to alter social hierarchies. Multiple new networks will be born and old ones begin to unravel, which will further strengthen the energy revolution. This combined effect can revolutionise the energy sector, which traditionally has been slow to change. What is more, the so-called prosumer[15] model, where consumers also become producers, will finally turn into reality, when decentralised renewable energy technologies, especially solar and wind power, are increasingly affordable. Citizens will transform from passive energy consumers into active energy producers for themselves and for the benefit of others. This will mean a more profound relationship with energy. Small-scale energy production, electric vehicles, charging stations, and novel energy services will increase electricity awareness. Multiple renewable energy and energy efficiency measures will be combined together in so-called hybrid solutions of clean energy[16]. Local renewable energy production will even begin to stimulate small-scale industrial activity. Gradually, the whole energy system will begin to change in a way where it will hardly resemble the system of the past (Biggs 2016).

If the conveyor belt was the symbol of the factory mindset, which also controlled labour performance and shaped the perception of work in an industrial society, the microchip and personal computer are the metaphors of the networked life in the information society. Through internet and social media, our networked lives continue to open up new avenues and agendas. Climate change awareness and the associated risks are understood better and better. The networked era also creates more opportunities and possibilities for humans to realise their ambitions and develop their personal skillset. Humans are full of capabilities, but societies have often failed to make good use of the latent potential (Nussbaum 2011). One of the many advantages of the clean energy revolution is that it will increase the power of citizens over energy issues (Van der Schoor & Scholtens 2015).

Even when the basic needs of a human have been met, she keeps on looking for meaning in the community and the world surrounding her. Surviving climate change and solving the energy challenge are the next great struggles of humankind. Amidst growing awareness lies also confusion. Constant connectivity means that human beings are navigating in a sea of information (Turner 2006; Langlois 2014). These currents of communication are building a new "digital meaning society" permeated by multiple meanings and ecosystemic thinking (Heinonen et al. 2016). These new streams also enable human beings to discover new identities, actualise their dreams and harness their talents. Amidst a global information storm, self-expression is the civil right of the next phase of development!

15 The word "prosumer" comes from combining the words "producer" and "consumer."

16 Air source pumps are used nearly everywhere in the world, while single-household ground source heat pumps have become more common e.g. in Central Europe, the Nordic countries and in the United States.

ESTABLISHING NOVEL INFRASTRUCTURES

Later, it will be easy to outline the many reasons for the looming energy transformation. Multiple rapidly growing cities around the world have become crowded, polluted, and are losing their green spaces. The lack of clean electricity amidst unplanned urbanisation is an emergency call for enhanced urban liveability and one of the major health threats of the 21st century. The price tag for public health is exorbitant. Cities are an example of a physical space where a systemic transformation for a clean energy revolution needs multiple sectors working together. Another catalyst for a new energy system stems from the interdependencies in the global energy system. The dependencies uphold the present energy infrastructure and are a root cause for the systemic nature of energy crises (discussed later in Chapter 6).

The clean energy system aims to be equitable and to enhance energy security. An electrified, renewable energy system can also mean better water and food security. It can establish new infrastructures and even make off-grid lifestyles possible. One of its key drivers are the economic opportunities deriving from the innovative modes of electrification and novel energy services. These solutions also have considerable potential to address energy poverty. Energy poverty is epitomised by deforestation and a lack of reliable electricity in developing countries. Increasingly decentralised, mobile-operated and wireless solutions for electrification can offer energy services for hundreds of millions of people. As a matter of fact, renewable energy solutions are already in use in humanitarian crises (GSMA 2019)!

An interesting feature of the anticipated transformation is that many of its present pioneers are in the Global South. Bangladesh has millions of users of solar power systems and in India, a single solar plant, the Kamuthi solar power project in Tamil Nadu, produces electricity for over seven hundred thousand people. In East Africa, innovative solar energy services are adapted to low-income users, integrated with mobile money and latest technologies. There is more to come. Short-distance travel in urban areas could be organised with electric vehicles. Under the sun, electricity that fuels battery-powered vehicles is free. In the process, the system as a whole becomes smarter. In the future, even power grids may become less important. There are extravagant ideas under study, too, such as attempts for wireless energy transmission and harnessing solar power from space!

Local initiatives can catalyse global changes: from unsustainable to sustainable, from polluting to clean, from inefficient to efficient, and from centralised to decentralised. A clean energy revolution would alter the perception of the energy system: instead of energy utilities, multinational oil corporations and fossil fuel resources, the focus would be on consumer-producers, tens of thousands of renewable energy entrepreneurs, and ultimately, renewable energy sources (Heinonen et al. 2017a; d). In this vision, the amount of energy available will increase significantly. This energy will largely consist of electricity, which will assume a central role in the entire energy system. Consequently, energy will be affordable and available to practically everyone.

For a vision of electrification with renewable energy to be sustainable, circular economy has to be turned into reality. This means that in the future, rare earths and critical metals must be salvaged, fully

recycled or substituted with other materials[17]. What is more, hard-to-abate emissions are globally associated with the production of goods and materials (EMF 2019). When all these elements come together, a vision of a clean, socio-technical transformation unfolds. This could even mean that countries at the "Sun Belt" or latitudes that receive considerable amounts of sunlight all year round are the winners of this revolution, and that heavy fossil fuel consumer or producer countries see a glimpse of an alternative pathway for development.

THE ENERGY WORLD OF THE FUTURE GENERATIONS

Many researchers are interested in how much energy the humankind will produce and consume in the future. Presenting an accurate estimate of future energy production and consumption is challenging for at least four reasons. Firstly, the estimates of the growth rate of the uptake of renewable energy technologies vary. For each renewable energy technology, there are assumptions about the interplay of multiple factors. Secondly, conventional power plants that produce electricity from fossil fuels will not be needed in the renewable energy vision. Thirdly, local and decentralised energy production and consumption, with the Internet of Energy, alleviate the need for long-distance energy transmission. Today, electricity needs to be transmitted from sunny and windy regions to where it is most consumed. Finally, when self-production, flexible and efficient use of electricity change the core principles of the entire energy system, further changes can take place. However, let us turn to some well-founded estimates.

Many expert sources and reports assume that solar energy will become the foremost energy source in the next 15 years. If the described energy revolution would kick off in earnest, there would be roughly 20 times more solar power in 2030 than in the early 2010s. This would mean that solar power alone would generate between 12,000 and 22,000 terawatt hours of electricity. Wind power would be installed *en masse*, and energy storage technologies would mainstream. Imagine that there would be no hurdles whatsoever in the pathway into an energy system based on renewable energy. In just over a decade, solar power could account for more than one third and wind power for almost a third of the entire global electricity supply!

The longer the timespan, the more profound the changes. Think of solar power becoming mainstream like mobile phones in the turn of millennium. In 2050, solar power could be the dominant form of electricity production. Globally, solar energy could produce over two thirds of electricity, and around 40 percent of all energy or perhaps even more. In three decades, the number of onshore and offshore wind farms would greatly increase, so that they would produce almost a fifth of the electricity globally. Wind power would have a significant role in the electricity mix in the northern latitudes, and solar power would assume a leading role in regions close to the equator. The vision would also begin to change the way energy and electricity markets operate. The amount of renewable energy would grow 20-fold between now and the year 2050.

17 In extreme cases, they can also be mined from near-Earth asteroids, while preserving natural resources of the planet. However, this violates the principle of living within planetary boundaries. That is why it is not generally recommended.

Naturally, this trajectory would not just end, but would continue further. This is how the energy world of the future generations could look like. In the dawn of the 2020s, a small amount of hybrid and electric vehicles were in use primarily in technologically advanced countries. In 2050, electric cars and electric mobility would be a part of everyday life all around the world. Between 2050 and 2100 renewable energy installations would still quadruple. At the end of the century there would be 80 times more installations of renewable energy than today (see Ram et al. 2017; Breyer et al. 2017b). During these decades, the children born today would assume political office and live through these changes. Eventually, in the year 2100, perhaps one percent of Earth's surface would be covered in solar power plants, which people might deem acceptable. Nearly a third of Earth's surface is desert, and inventing a global, sustainable energy system a truly massive endeavour.

The new great electrification would use renewable energy and increase both electricity production and the share of electricity in the global energy mix, while improving energy efficiency. Technological developments could accelerate and support the vision further. The production of hydrogen could considerably increase[18]. The most could be made of fuel cell technology, micro-turbines, and the production of synthetic fuels. Fuel cells convert energy from a chemical reaction into electrical energy, heat, and water. Micro-turbine generators are small, self-contained high-speed power plants that drive an electrical generator. Synthetic fuels can be used as a substitute for conventional fuels. With these three elements combined, it would be possible to use solar and wind power year round even in latitudes that only receive seasonal sunlight.

FUTURE LIFE IN A COMPLEX WORLD

This vision describes a future objective that can be vigorously pursued. It describes a rise in the standards of living and material prosperity, and is no utopia. In historical perspective, growing energy supply has tended to imply further *complicatedness*, where sense making becomes more difficult, and growing *complexity*, where the interconnectedness of things and systems increases. The modern era was unequal in terms of material and social wealth (Orsi 2009), and it is not likely that a clean energy revolution would remove all discontent and eradicate human conflicts. In fact, humans are easily annoyed and could discover new sources of envy. Additionally, while human beings may have ingenious problem-solving abilities, their own actions also tend to create new problems.

Therefore, it may be argued that even after a clean energy revolution and the endorsement of the peer-to-peer principles, the world could still be divided at least in some ways. The peer-to-peer practices, networked lifestyles and interconnectivity would likely help overcome some of the great social divides of today, but other, more deeply rooted ones could still prevail. In a global view, there could still be groups and societies that are open, free, liberal and globally minded as well as those that are closed, patriarchal, authoritarian, and nationalist. Another pertinent challenge of human development is inequality (Alvaredo et al. 2018). Unequal distribution of wealth inside and between

18 The Neo-Carbon Energy project 2017.

nations run for centuries. What is more, capital has a tendency to accumulate[19]. Perhaps many present tensions could be eased, if the spoils of the clean energy revolution were shared by the many instead of the few.

We can conclude that similarly to previous industrial revolutions, the clean energy revolution is a promise of new material prosperity and the emergent dynamics and practices open up numerous opportunities – even to address other, major development challenges. However, overall, **only a series of advances on multiple fronts will propagate a genuine breakthrough of something new and entirely different**. In any case, if the transition from steam engines to electricity is to teach us anything, an increase in surplus energy could lead to widespread social, cultural and economic transformations, and perhaps a more equitable social order, globally.

A PARADIGM SHIFT IN SIGHT

Should the abundance of clean energy be realised, societies could attain a new, multidimensional and "rich" stage of development. In the future, energy would be understood as more than technology or costs; it would have cultural and social meaning bordering on spiritual or existential dimensions as the source of all life. Humans would participate in the creation of a new, common culture, while still searching for new meanings. The way energy is characterised in arts, and even science, would change. The shapes and symbols around the world would tell stories of a new consciousness, influencing what humans think about themselves, their everyday environments, and novel infrastructures. The ways housing, mobility, work, and even leisure are understood would be altered, as would many community activities, interests and values, too.

The transformation would give birth to a new consciousness, which would imply a novel sense of reality. The clean energy revolution in a circular economy, true to its meaning, would shape how human beings see themselves as part of this world. Mindfulness of the planetary boundaries (Steffen et al. 2015) would define human experience. Eventually, only a few would remember a time when the use of modern renewable energy was negligible. An electrified and increasingly decentralised renewable energy system would bring an end to "the Burning Age". A new era of energy production and life in a world of new consciousness would mark a monumental paradigm shift (Kuhn 1962).

The time has come to change the course of humankind's energy vessel. Once these principles are adopted and more and more citizens become energy producers, the vision can be expected to gain more support. In the meantime, pioneering actors are needed to drive and advance this vision. Pioneers are actors who anticipate the future, determinedly explore new possibilities, and act before others (Heinonen and Karjalainen 2019). Their actions also spark hope and inspire others. Humankind needs stories, and one of their advantages is that they can also make a vision feel "real". Typically, stories are written as a part of scenario work as the manuscripts of the future. We will present scenarios in more detail in Chapter 5.

19 Nowadays, 62 richest people in the world have the same amount of assets as the poorer half of the world's population, approximately 3.5 billion people.

Questions to Consider

- How does the vision presented in this chapter differ from other energy visions?
- How can different interests and perspectives become a part of a common, shared vision?
- What ethical considerations do the idea of natural resource extraction from other planets provoke?
- Which are the most important factors in advancing peer-to-peer principles?
- What are some of the areas where the peer-to-peer principles could become more influential? Think about different sectors and themes.

The next chapter examines the rise of solar and wind power, the prospects of energy storage technologies, and explains the fundamental technological principles of the future energy system, as a basis for the vision.

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3 THE RISE OF SOLAR AND WIND POWER MAKE THE NEO-CARBON WORLD

In this chapter, we describe the principles of the energy system of the future, which is based on the use of solar energy, wind energy and energy storage technologies. Electricity will be the main energy carrier in the future, thanks to increased energy efficiency and decreasing costs. Open data and interfaces, information and management systems, smart appliances and electric mobility will assist companies and citizens producing and sharing renewable energy. Carbon, which is typically conceived as a downright harmful substance, can also be used as a raw material in a sustainable way – when the neo-carbon principles are followed. Together, these changes will make the future energy system carbon-neutral.

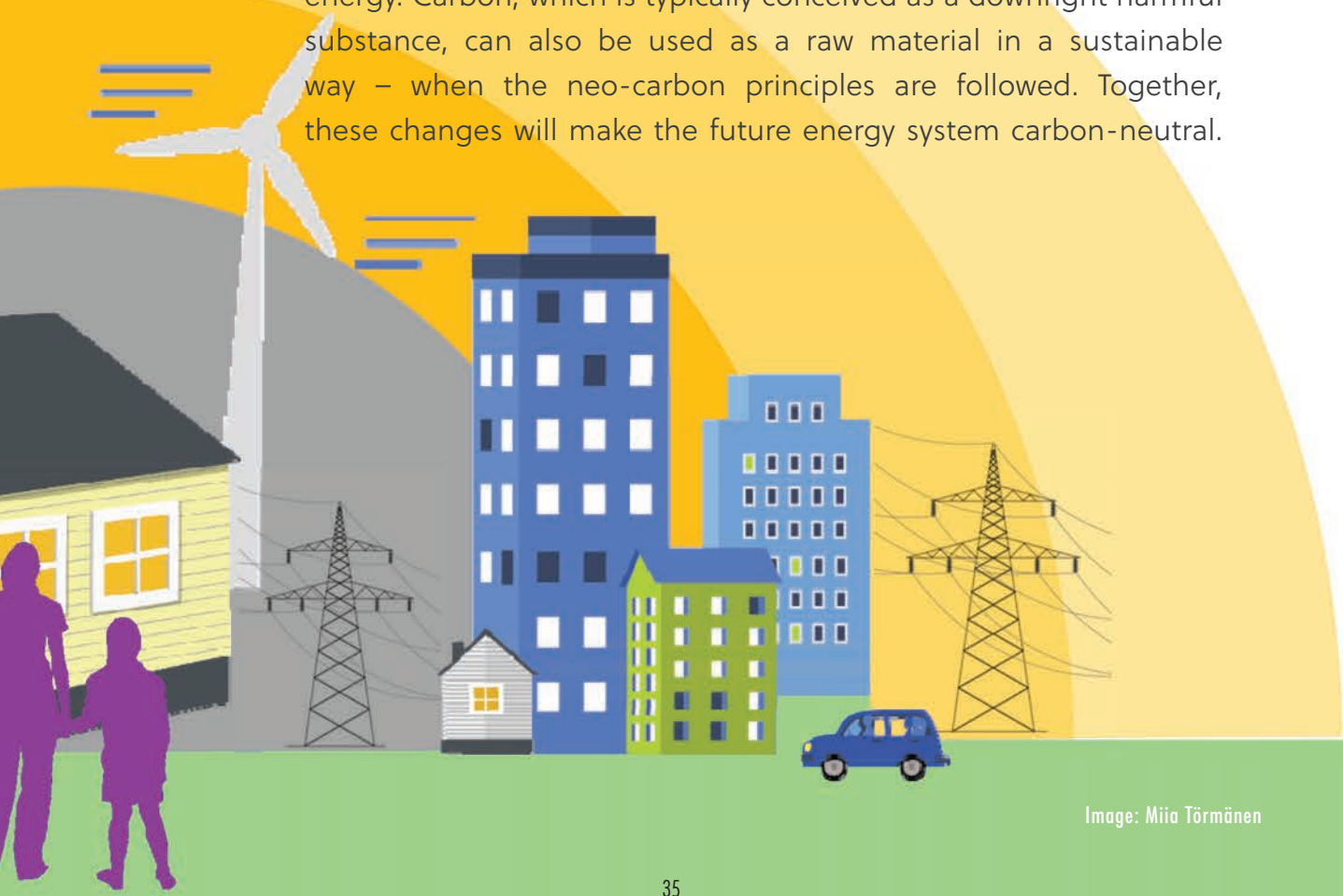

Image: Miia Törmänen

"The secret of change is to focus all of your energy, not on fighting the old, but on building the new."

SOCRATES

SOLAR AND WIND ENERGY TAKE THE STAGE

Solar power is available and plentiful, and has quickly become the most affordable method of producing electricity in large parts of the world[20]. The price of solar panels has dropped to less than one percent of their initial cost in the 1970s. At the same time, their efficiency has increased[21]. The technology itself is simple and is relatively easy to learn. Solar power can be produced at households, cottages, on the roofs of houses and properties as well as in large solar parks[22]. Floating solar plants are already a reality in Japan and China, which is a great example of modular technology. The price of solar energy is expected to continue to decrease and its efficiency to increase. Likewise, wind power has entered a mainstream of energy production methods. Electricity generated by onshore wind farms is getting cheaper and cheaper, while wind farms built at sea are also becoming more common. For example in Europe, wind power is the cheapest form of electricity production when a new power plant is considered[23]. Like solar power, wind power is a modular technology, which can be implemented nearly everywhere – in households, communities, cooperatives, nowadays mostly as large wind farms. Globally, the growth rate of solar energy is twice as fast as that of wind energy, as it is more modular, easier to use and even more decentralised than wind power.

SELF-PRODUCERS AND COOPERATIVES AS PIONEERS

In the history of the renewable energy sector, ideas of pioneering, co-operation and self-production have a significant role. A look at the early pioneers makes for interesting reading. In Europe, local citizen movements have advanced solar energy since the 1970s. The most important example is Germany, where producers, energy cooperatives and farmers are central actors in a story, which much later gave birth to the German energy revolution (*Energiewende*). Energy cooperatives also played an important part in the uptake of wind power in Denmark. Experimenters and civil society organisations have made great efforts in technology uptake and training. There have been experimental projects in Africa, for example in Kenya and Tanzania, since the 1980s. Globally, the spontaneity of citizens has played an important role. In the internet era, the instructions given on discussion forums have accelerated the popularisation of certain devices, improved services and generally helped generate pressure for development in the energy sector.

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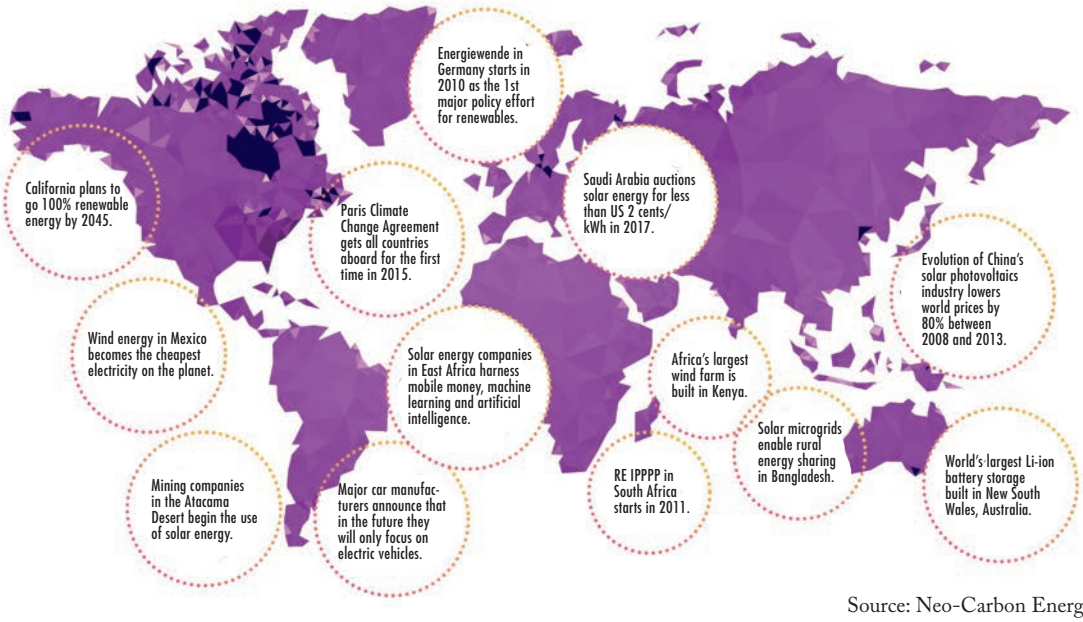
20 In addition to electricity produced using solar photovoltaics (PV), concentrated solar power (CSP) can be exploited. It is used for example in South Africa and in the Noor project in Morocco. Morocco has proclaimed its goal to become in the solar power industry what Saudi Arabia is in the oil industry.

21 The theoretical maximum efficiency of solar electricity is 86 percent. Currently, the highest efficiency that can be reached in the laboratory is 46 percent, and the efficiency of the best solar panels available in the market is about 20 percent.

22 Renewable energy sources do not have the same potential everywhere. There is more sunshine near the equator, and the best wind conditions are scattered in various places around the globe. Biomass can only be utilised up to a certain limit. For example, countries that have many forests have begun to look for bio-based solutions. However, utilising forest biomass to produce energy can only be done in a fashion that is sustainable and does not compromise the forests' capability to capture carbon from the atmosphere and act as a carbon sink.

23 The fall in the price of wind power is due to increased unit size, decreased operation and maintenance costs and extended utilisation period of maximum load.

Far-sighted policies and changes in energy markets have helped get the ball of renewable energy rolling. Germany invested considerable sums in the deployment of solar and wind energy in the 1990s and the 2000s. First, the federal state supported solar energy with a pilot program of 10,000 roofs, and later with a program of 100,000 roofs. Additionally, the deployment of solar energy was supported by developing technological, business and marketing skills. Standard solutions in roof installations developed, and licensing procedures were streamlined. Around the globe, many nations followed Germany's example of setting a guaranteed price – a so-called feed-in tariff – for electricity produced using renewable energy technologies. Thanks to support of this kind, the wind power industry, too, has grown and commercialized. Owing to many types of measures, expertise on renewable energy technologies has spread. The German example catalysed also the solar energy industry in China (Huang et al. 2016). When serial production of solar panels started in earnest in China, in 2008 to 2013 the world market price of solar energy fell by 80 percent.



Source: Neo-Carbon Energy

Figure 2. In the 2010s, there have been many steps forward in the deployment of renewable energy sources.

The period of the mid-2010s has been a tipping point because it marks the global rise of renewable energy, as depicted in Figure 2. In many countries, the levelised cost of solar power fell under the price of electricity in the power grid, related devices became cheaper, and the payback period for equipment installations decreased constantly. First the costs of solar and wind power fell to equal and less than fossil and nuclear energy in India, China and the United States. Then in Chile, solar electricity was auctioned in 2016 for under three cents per kilowatt-hour[24]. In 2017 new records were set, first for solar electricity in Saudi Arabia and then for wind power in Mexico, when the price dropped under two cents per kilowatt hour.

24 In the same auction, new coal power was about twice the price of solar electricity (Bloomberg 2016).

Investments in solar and wind farms are much smaller than those required to build a coal or nuclear power plant. Unlike traditional power plants, after the wind or solar plant is completed, its use is affordable, even nearly free. As has been noted, renewable energy technologies have not reached their current state by themselves; reaching this stage has required research, assistance in deployment and economic support. Incentives, policies and financial support have put the sector on its feet, and slowly we are moving towards a more and more market-led stage of production. In the future, solar and wind power do not necessarily require financial support to thrive. In coal, oil and other power plants (e.g. peat) a large share of production costs comes from the price of fuel. In the future, this will be harmful to their competitiveness when compared with solar and wind power.

CONSUMERS ARE PRODUCERS IN THE INTERNET OF ENERGY

Globally, we have been using a one-way energy system, in other words an energy production structure that leans on centralised power plants. In order to get the maximal utility out of renewable energy sources, we need an Internet of Energy to replace the current electricity grid. This is visualised in Figure 3. The concept of an Internet of Energy resembles a smart grid, which uses ICTs to dynamically optimise the functions and energy resources of the grid, but is more than that. It allows renewable energy to flow in multiple directions. This will be possible thanks to big data and the digital revolution. It is an intelligent, reactive and dispersed network of energy and information flows. More importantly, a smart grid is not necessarily decentralised (Boucher 2015). An Internet of Energy would be to the sharing of electricity from renewable energy sources what the internet has been for the sharing of information[25]. In the Internet of Energy, all devices communicate with each other and their environment. The distributed logic means that energy is produced, shared and controlled without centralised monitoring. Citizens and companies produce electricity from renewable energy sources and feed their surplus energy to each other and into the grid. Energy is also stored locally in buildings and all kinds of infrastructure using various storage technologies.

The Internet of Energy borrows from the notion of the Internet of Things (IoT) where devices are connected to the internet and equipped with sensors. In turn, in the Internet of Energy, all electrical appliances will be connected to one another and communicate with their environment. In the future, all technology will be cloud-based and any device, a domestic appliance or a car, will have its own IP address. This will help make the energy system as a whole interactive and flexible.

"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."

JEREMY RIFKIN

American science and technology author

25 In this chapter, our main reference is "Internet of Energy – beyond the smart grid" by Ruotsalainen (2016).

Learning from Smart Grids, Demand Response and Open Source

A *smart grid* is an electricity grid that uses digital processing and information and communication technologies. In other words, data currents and information processing are the prerequisites for a smart grid. Remote control, measurements and programs ensure that energy consumption, production and the system as a whole is in balance. All of this is especially useful during hours when the demand of electricity is at peak. The same principles can be applied to optimise energy production, storage capacity and grid maintenance. When the production of solar and wind power is at peak, energy can be stored in the built infrastructure, such as buildings, boilers or electric car batteries.

Energy use can also be optimised to meet actual needs. The aim of flexible energy demand is to decrease power demand in the energy system when large amounts of energy are being consumed. *Demand response* means that momentary consumption can either be reduced or re-allocated to a time when more power is available. It is useful in advancing resource effectiveness, as it minimises costs and emissions without compromising the users. This philosophy can also be applied in the design of electrical appliances. The demand response of electricity, heating and cooling reduces the need to run expensive power plants at peak hours of demand.

The energy sector can also learn about *open source development* because openness helps information exchange and learning. The more an electricity grid is opened to the production of electricity from renewable energy sources, the more diverse users can participate in renewable energy production. These principles are also useful for energy use as a whole. In Finland, where a significant amount of energy is used for heating, district-heating networks were opened up to citizens and consumers, so that a consumer can hand over their surplus heat for others.

The Internet of Energy does not only refer to the electricity grid; it encompasses everything from the storage to the distribution of energy. Adoption of these principles can hugely influence the energy sector and electricity markets (IEA 2015).

Civil society has found a truckload of ways to make use of the internet. The Internet of Energy, in turn, is a new collaborative model for the energy system (Wu et al. 2015), which can transform the economic system and support novel lifestyles. It is like a cloud in which all the devices meet. Many consumers are already interested in optimising energy consumption either by choice or with the help of technology. For those using washing machines, doing laundry will be worthwhile on sunny days when solar panels produce a maximal amount of electricity. Electric cars will be very useful in the Internet of Energy because they operate as millions of batteries. An electric car can charge during office hours, or at night before the next drive. Overall, less energy is wasted when electricity assumes a key role in the energy system.

The ease of use that electricity promotes is already easy to see in homes. Lights based on LED technologies are practically everlasting – they will likely replace other lighting appliances nearly altogether during the coming decade. In the kitchen, ceramic and induction stoves are beginning to replace the more traditional cast iron stove. Energy efficiency is an important factor in the electrification of the transport sector. An electric car can be as much as five times as efficient as a

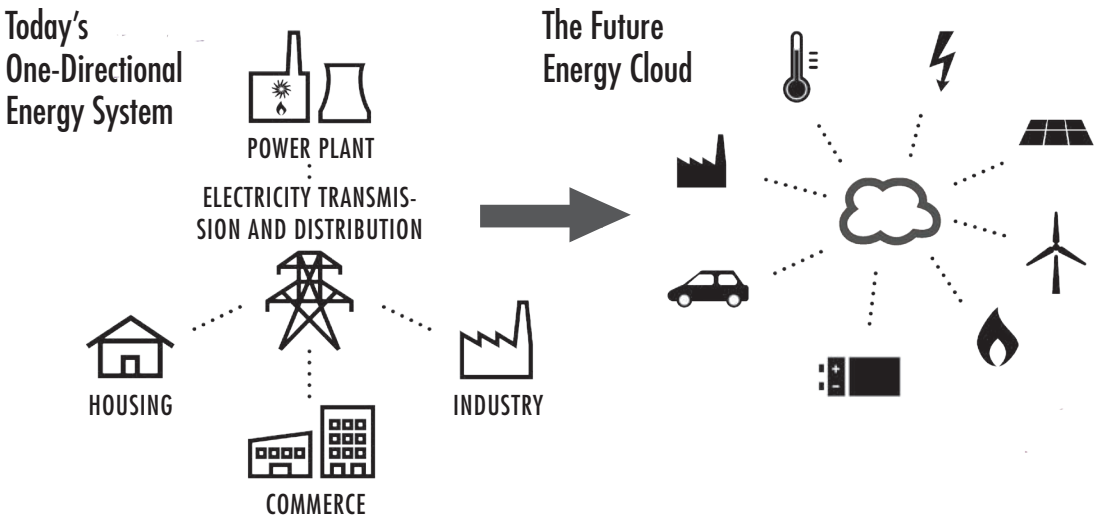


Figure 3. Internet of Energy uses peer-to-peer principles and can also be called a cloud service of energy.

traditional petrol-fuelled car. Electric cars can transform about 80 to 85 percent of the electricity stored in their batteries to kinetic energy. A petrol-fuelled car only transforms about 15 to 20 percent of energy to movement, and the rest of the energy contained in the fuel is lost as heat. In the future, it will not make sense to burn fossil fuels to make electricity.

ENTER ELECTRIC MOBILITY

In the early days of the automobile industry, electric cars were off to a promising start. The invention of the first electric car is often associated with an American called Thomas Davenport around the year 1835. By 1900, electric transport was so popular that a third of the cars in New York were either electric cars or electric taxis. Everything changed, however, when Henry Ford introduced the petrol-fuelled Model T in 1908 and was able to kick-start its mass production. As an interesting side story, the original fuel of the Model T was intended to be bioethanol or ethanol (Rosillo-Call & Walter 2006), but due to cheap oil the majority of mass-produced automobiles converted to petrol. Electric cars were forgotten for nearly a hundred years[26], until after a long struggle electric transportation is making its second entrance. Internationally, a lively discussion has encouraged an increase of the share of electric vehicles. Moreover, in many technology visions new cars are smart cars and nearly all new cars run on electricity.

The first form of the electric vehicle to become common will probably be the electric passenger car. Spurred by the examples of California and Norway it is hoped that the sales of electric vehicles will increase in the 2020s to the extent that it decreases the global demand of crude oil. Many car manufacturers have already proclaimed their commitment for the advancement of electric

26 The Model T turned the automobile industry on its head with its assembly line production: it became the first automobile to exceed one million produced units, exceeding 15 million units in total, according to estimates (Alison et al. 2009).

transportation. One of the first corporations that put electric cars into the spotlight was the Swedish-Chinese Volvo, who promised that all its new models will be either electric or hybrid cars. Many other car manufacturers soon followed suit, with considerable investments. Instead of fuel stations that supply petrol, electric cars will use an electric charging infrastructure. Charging stations can be provided by car manufacturers, other private sector actors and the public sector. The amount of outlets increases when service stations offer novel charging services, department stores offer charging ports for use during shopping visits, and service providers invest in joint use services. The public sector has to then expand the charging infrastructure and develop uniform standards.

When the price of electric cars decreases, their numbers may increase quickly. Advances in battery technology and the interest of customers are accelerating the electrification of transportation. According to one estimate, the annual production of electric cars could increase from the three million in 2017 to 26 to 36 million cars a year by 2030. The global sales of electric cars could surpass the sales of petrol-fuelled cars by 2037. China is perceived to be in a key position in the advancing of electric mobility, but both Europe and North America will also carry a significant role (McKinsey 2018). Bus transportation can be electrified so that in 2040 already 80 percent of buses run on electricity (Xinhuanet 2017; Jackson 2018). A growing number of countries have intentions to gradually give up the sales of petrol and diesel fuelled vehicles altogether.

The future of the transport sector is open. Transportation is more and more commonly understood as a service for mobility, and as chains of travels. Young people's attitudes toward cars are changing. Using a car only when it is necessary and sharing services are becoming more common, exemplified by joint use and car-sharing services for whole city blocks. Perhaps in 100 years, cars will no longer exist, as they have been surpassed by electric transportation robots or "robo-bots". Remember that electric cars and self-driving cars make the energy system more efficient, but they will not solve the problem of traffic jams! Electrified public transportation is also required, for example robotised electric buses. Right now is a critical time to also think how low- and middle-income countries can be assisted in creating new technology infrastructures. By electrifying the transport sector, it is possible to get rid of the aging car pool and to create a new market that capitalises on renewable energy sources. At the same time, enlarging the share of variable renewable energy production is made easier.

A move towards electric water vehicles would transform water traffic: the forms of energy, the distribution networks and the value chains serving it[27]. Electric ferries exist already[28]. In the future, a wide variety of light electric inland water barges can be seen on waterways, lakes and rivers. A further step in electrification would be the involvement of shipping companies, as many cruise-liners still lean on quite polluting technologies and practices. Maritime cargo and air traffic can use synthetic fuels, manufactured with the help of electricity. Growing numbers of consumers, employees and organisations are conscious, and even experience anxiety over their increasing carbon footprint. This creates a higher demand for the electrification of aviation. Because the amount of air

27 Cruise lines have been closely monitored for violations of multiple environmental rules. Their carbon emissions have also come under increasing scrutiny (New York Times 2019).

28 Additionally, larger electric vessels are being researched (E-Ferry Project).

travel is anticipated to double by 2030, improved energy efficiency of air travel alone cannot prevent the emissions caused by the aviation industry. The emission goals agreed by the operators in the aviation sector in 2018 are one step forward (ICAO 2018). Additionally, as a policy instrument, in 2018 Sweden introduced the air travel tax. The techno-economic disruption based on electrification can influence the billions of dollars spent by airplane manufacturers in design, investment and procurement.

Demand for Energy Storage Increases

The intermittent production of renewable energy increases the demand for storage technologies, as these technologies significantly increase the flexibility of the energy system. The most apparent solution is the storage of energy in batteries, which too are a modular technology. Presently lithium-ion batteries are perhaps the best-known option, and batteries come in both very small and very large sizes. Developments in battery technologies are expected to hasten the electric car revolution, and to make them the most affordable means of future transport. The increasing number of batteries also evidently creates a need for re-using and recycling them. Another emerging technology makes use of lithium as a thin film. The use of graphene as a material would make the charging and recharging of batteries even faster. These types of improvements could make batteries lighter and safer than before and any safety concerns of lithium batteries a worry of the past. New battery technologies based on combinations of zinc and air, on superconductors and on fuel cells are not yet ready to be commercialized (McKinsey 2018).

THE RENEWABLE ENERGY SYSTEM AND A NEO-CARBON PHILOSOPHY

An energy system based on renewable energy sources is not only technologically feasible, but it is also probably the most affordable option to build a low-emission energy system by 2050, according to studies by Lappeenranta University of Technology and VTT Technical Research Centre of Finland[29]. The renewable energy system works according to the following basic principles.

A look at a renewable energy system begins from a view on resources. First, the potential of renewable energy sources locally and regionally is estimated. Accurate climate data and weather forecasts are some of the other preconditions of a renewable energy system. After this, the forms of renewable energy to be used are chosen, according to the purpose of use. Next, the production and storage capacities have to be calculated. This means an analysis of the appropriate storage technologies based on availability, for example relying on batteries or synthetic hydrocarbons. As soon explained in more detail, by using renewable energy, water and carbon dioxide extracted from air or from

29 An energy system based on solar and wind power can offer carbon-free power with a 50 percent lower production cost that the competing low-carbon energy alternatives, new nuclear power and carbon capture and storage (CCS). An electricity system that balances solar, wind and gas in a sustainable fashion can be up to 20 percent more affordable than a combination of new nuclear power and gas power plants (Agora Energiewende 2014).

smokestack industries can be used to produce synthetic fuels in an emission-free manner. These fuels can be distributed and stored using pre-existing infrastructure and technologies. The future energy system outlined here is entirely neutral when it comes to carbon dioxide. You can get acquainted with the basic principles of a renewable energy system in an online simulation which describes in detail the use of various energy resources in particular regions: www.neocarbonenergy.fi/internetofenergy.

This kind of an energy system is making economic sense in the 2020s and the 2030s: the decreasing costs of solar and wind power make them profitable in all corners of the world. Besides, solar and wind energy support each other quite well. In Africa, Australia (and Oceania) and Latin America there is a huge potential for both solar and wind energy. For the purpose of illustration, let us use Europe as an example. In a country like Italy, significant amounts of solar power can be produced throughout the year. In the British Isles, more solar power is produced during the light summer months and wind power plays a significant role in the winter. Apparent limitations in weather conditions have to be taken into account: at night, the sun will not be shining, and there might be multiple windless days in a row. Naturally, seasons have an effect as well. Rainfall during the monsoon season decreases the potential solar energy output e.g. in India and Southeast Asia. Countries that experience sub-zero temperatures in cold climates will have to import energy in the winter. Like in any system, limitations have to be well understood. Remarkably, there are no technological obstacles to the realisation of an energy system like this, and energy production in such a system is also economically profitable.

A neo-carbon energy system is an energy system based on renewables. What is meant with the term *neo-carbon* is a closed carbon loop, in other words practices such as the capture and utilisation of carbon (CCU). These are processes or new technologies in which carbon is used in economic activities or industrial processes, and it is not released into the atmosphere. Unlike in the carbon capture and storage (CCS) technology, carbon is not stored. Thus, instead of seeing carbon as only a harmful substance, in a neo-carbon economy it can be used as raw material. When electricity produced using renewable energy is transformed into hydrocarbons, this is a sustainable method of hydrocarbon production. The process of transforming electricity for various new purposes is called power-to-X-technology. The only components of a system like this are electricity, water and air: hydrogen is electrolysed from water and carbon dioxide, which has been captured either from the air or from process gases.

In a neo-carbon energy system, hydrogen is synthesised into hydrocarbons – for example as synthetic fuels. In fact, **nearly all oil-based products, chemicals, plastics, fertilizers and even groceries can be produced using synthetic hydrocarbons**, as shown in Figure 4. According to estimates, this technology will become profitable in the 2030s. It will be tremendously useful in fields that are otherwise difficult to make emission-free. Storage in synthetic natural gas offers an additional alternative for the seasonal flexible storage of energy. At the same time, the principles of fossil fuel energy production processes and downstream infrastructures can be used. Without the conversion of clean electricity from renewables to hydrocarbons, reaching the Paris climate agreement targets would not be possible.

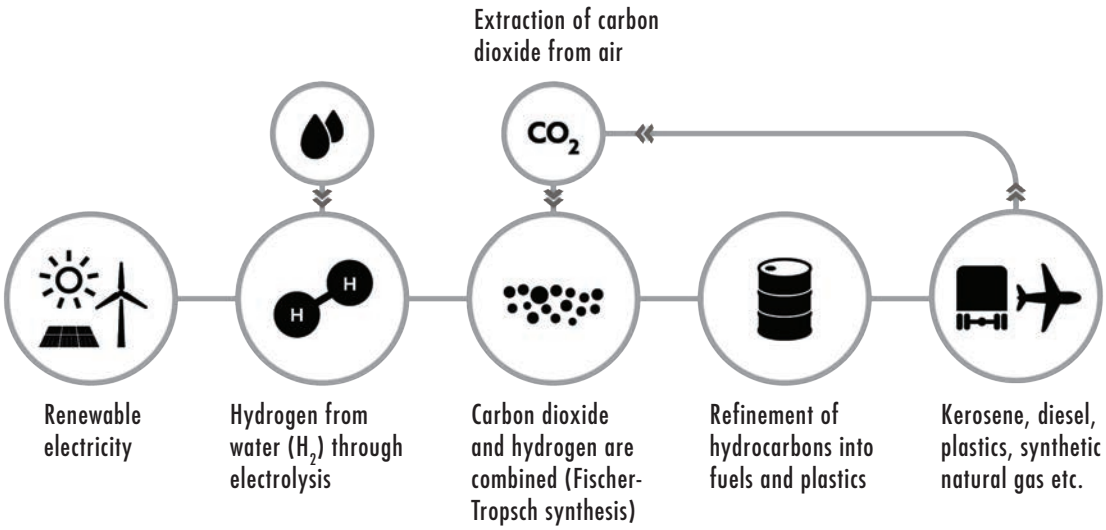


Figure 4. In the neo-carbon energy system, solar and wind power are mainly used to produce energy, which is stored in batteries and converted into synthetic hydrocarbons.

FREE FOOD FROM AIR!

Things can sometimes develop in leaps and bounds. With the help of electricity produced using renewable energy, carbon dioxide extracted from the air and micro-organisms, we can produce protein-rich food without the need for land or raising of cattle. This environmentally friendly method may in the future surpass traditional agricultural food production methods. The agricultural sector is globally the second largest producer of greenhouse gas emissions, after the energy sector. On Earth, new farmland is established by clearing out forests while world population and demand for food increase. According to the researchers' calculations, the efficiency of this new process of creating protein-rich food from air is 10 times greater than agriculture, and 100 times greater than meat production when only environmental consequences are considered. Just two years after the Neo-Carbon Energy study was published, the spin-off company Solar Foods is in full swing to commercialise the process, and is currently starting production[30]. The European Space Agency, ESA, has already expressed an interest in using the technology for space travel. The technology could also have applications in developing countries for addressing malnutrition. This is how short the innovation distance can be between science fiction and an everyday realisation.

30 The approach redefines the basics principles of food production (Forbes 2018). This visionary food tech innovation received the Pentti Malaska Award in 2019: https://www.utu.fi/en/news/news/pentti-malaska-futures-award-to-solar-foods-producing-food-from-air-and-electricity.

Will We Learn from Past Mistakes?

At times, solar parks covering the Sahara desert were dreamed of as sources of electricity for the entirety of North Africa, and even beyond to Europe. If the political atmosphere in the region were to calm, these projects could be designed such that all parties benefit equally, in order for them to gain popular support. The largest wind farm in Africa at the Lake Turkana in Kenya is the product of many years of planning and work, having taken a lot of convincing on its meaningfulness, acceptability and advantages. Upon completion, it produces a significant share of the whole country's demand for electricity. Additionally, a new transmission line had to be built. It created employment, but also complaints. Solar and wind power parks are not complex large-scale projects comparable to mega-dams or many fossil energy projects[31]. However, problems may arise if different parties are not convinced of a project's advantages, the implementation process does not consider all views or it gets politicised. Land use and ownership, often shaped by historical processes, can be especially sensitive and difficult questions.

The proponents of renewable energy visions can learn from the long history of energy policy and planning, and the many mistakes made by fossil fuel developers (Westenberg & Kuai 2018). In certain cases, this is already done. Some wind power companies have made local residents partial owners of their business in order to improve public opinion of the projects on a local level. Co-ownership, as shareholders, creates a relationship between local residents, project developers and the new infrastructures. The opportunities related to such promising practices, and the limitations of past models warrant wider consideration. Besides, certain native peoples and groups residing in remote areas do not recognise the concept of ownership. In these cases, more multi-faceted analyses are required.

Would models of shared or common ownership, and other novel and creative governance approaches be of help? How to ensure that the YIMBY (yes in my backyard) philosophy flourishes?

WHAT MORE IS NEEDED?

The strong increase in the demand for batteries and technological development grow the demand of lithium[32], cobalt and rare earth metals (Grandell et al. 2016; Bardi 2014; Katwala 2018). Globally, lithium is produced practically exclusively in eight countries, the majority of the demand being met by exports from China, Australia and Chile. To achieve sustainability, the social consequences of mining have to be addressed and environmental impacts minimised. Rare earth metals and other critical metals could be completely recycled or replaced with other materials according to the principles of circular economy also in order to reduce waste. Another issue is the material dimension

31 Increasing hydropower production in a sustainable fashion is challenging. The Chinese Three Gorges Dam that was finished in 2001 forced 1.5 million people to relocate. The Great Renaissance Dam that Ethiopia plans to erect on the Nile would impact agriculture both upriver in East Africa and downstream in Egypt. The Inga dam, which has been in the planning stage for decades on the Congo River, is considered both expensive and megalomaniacal, and it would endanger the unique biodiversity of the tropical region. See the Environmental Justice Atlas database for the challenges described.

32 In 2017 four significant mining companies worked in the sector: Talison, SQM, Albemarle and FMC (McKinsey 2018).

of digital economy, which is often invisible to the consumer (Dastbaz et al. 2015). The Internet of Energy is an infrastructure that would consume enormous amounts of energy. Data centres, for example, require cooling. When the use of information and communication technologies continues to expand, electricity consumption increases simultaneously. Already in 2025, information technology may consume nearly 20 percent of the world's entire electricity production (Andrae 2017).

Before electric and hybrid cars, the utilisation of renewable energy sources in transportation was for a long time almost exclusively restricted to biofuels[33]. In the field of heating and cooling, progress in renewable energy still remains slow. In 2015, the share of renewable energy sources in the total production of heat was only approximately 10 percent. The deployment of geothermal heat and solar energy for heating has increased, but in the grand scheme of things, their growth has been modest. Currently, renewable energy sources only have a small role in cooling services despite their considerable potential (REN 21 2018). Worryingly, the demand for cooling devices is increasing, and will increase even faster if temperatures further rise. Thinking about the cities in developing and emerging economies makes a case in point.

The deployment of the Internet of Energy is a complicated and multi-level effort, which demands collaboration and experimentation with citizens and various stakeholder groups (Lösch & Schneider 2016). On the other hand, if a renewable energy system is flexible enough, even basic industry will not need the baseline power generated by large power plants. Now, a show of commitment and character is needed in the international energy sector. So far, when major expert organisations have analysed the pressures for change that concern the energy system, a narrow perspective has been adopted. These views tend to underestimate the opportunities for the extension of renewable energy sources and overestimate their costs (DW 2018). There are also practical challenges. All countries in the world are already using solar technologies, but there are still several countries whose wind resources have not even been mapped. Some national officials gather data about the production of solar or wind energy, but not many study their broader, transformative potential.

PIONEERS REACHING THE CREST OF THE WAVE – DEMOLISHING OLD SCENARIOS

The new great electrification and the Internet of Energy are becoming reality faster than was thought. The transformation happens both on the levels of individual technologies and on the level of the entire energy system. Germany was able to deploy large amounts of solar and wind energy in quite a short time, even though the costs of this energy transition, its inconsistency and the building of transmission networks have been criticised. The developments in California are lighting the way in the United States and in South America, the Chilean, Uruguayan and Costa Rican plans are

33 There has been an enormous amount of hotly contested debate about whether first-generation biofuels truly are environmentally friendly. Novel biofuels aim to take into account sustainability perspectives better than before. These biofuels mostly exploit the waste and secondary flows from agriculture and industry.

worth paying attention to. New off-grid solutions from Africa and Asia are especially interesting, as they generate entirely new practices in the energy sector. It is astonishing that the alternative of an energy system based on renewables was disregarded for so long in the energy sector. Now is the time when many myths will be busted.

Among the experts of the field, the thinking sparked by new scientific knowledge has initiated a lively discussion. Some have been rendered breathless by the goal of producing 100 percent of all energy using renewables, as it has been considered either a radical or an unrealistic starting point (Brown et al. 2018; Child et al. 2018). The first credible, scientific peer-reviewed studies on the topic have already been published and modelling tools in the energy sector, alongside scenario work, are painting a portrait of a vision that is becoming more and more life-like. The energy sector is waking up to the opportunities of a renewable energy system and the urgent needs for further development. At the same time, we need quick steps in practice, as there is indeed no time to waste.

Questions to Consider

- What explains the popularity of various methods of energy production throughout history?
- What new issues need to be taken into account when a decentralised energy system based on electricity is being developed?
- What new issues will follow from the adoption of the Internet of Energy as a dispersed and automated system?
- Are there any social or economic activities, or certain sectors, that cannot be electrified?
- What would help the electrification process along in sectors that are difficult to electrify?

In the following chapter, we move on to describe the key actors of the future energy system, as outlined in this chapter, from the perspective of the economy and employment. We invite the reader to look these actors and to recognise them in their own environment.

KEY SOURCES AND READING RECOMMENDATIONS

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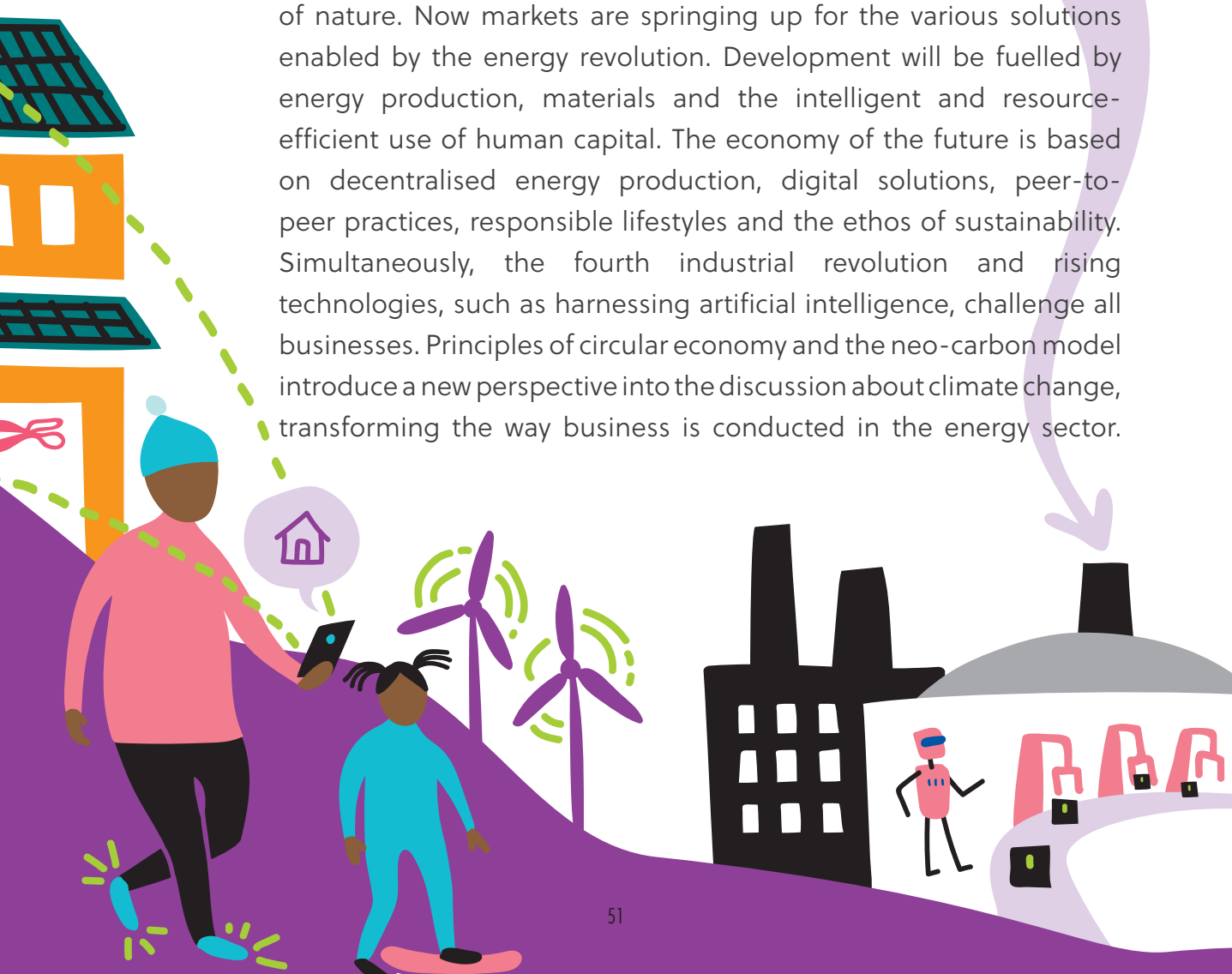
34 These final reports (SGEM 2009-2014 and FLEXe 2015-2016) are an extensive collection of publications and proposals on smart grids and a flexible energy system.

Image:
Katja Makkonen and
Maiju Kolisoja
(Days Agency)

4 ELECTRIFIED CIRCULAR ECONOMY IN A PEER-TO-PEER SOCIETY – WHO ARE THE WINNERS?

Throughout history, humans have solved problems with the help of nature. Now markets are springing up for the various solutions enabled by the energy revolution. Development will be fuelled by energy production, materials and the intelligent and resource-efficient use of human capital. The economy of the future is based on decentralised energy production, digital solutions, peer-to-peer practices, responsible lifestyles and the ethos of sustainability. Simultaneously, the fourth industrial revolution and rising technologies, such as harnessing artificial intelligence, challenge all businesses. Principles of circular economy and the neo-carbon model introduce a new perspective into the discussion about climate change, transforming the way business is conducted in the energy sector.



"Nothing has ever been achieved by the person who says, 'it can't be done'."

ELEANOR ROOSEVELT

WHAT IS ECONOMIC ACTIVITY?

Energy is the engine of economic activity. Historically, when the economy has thrived, energy consumption has also grown. As societies become more complex and complicated, they require increasing amounts of energy to function.

The history of humankind is largely a history of economic development. For hunter-gatherers, economy was mainly local, whereas in agricultural societies production was tied to agriculture and the trade and exchange of surplus. When classical economists wrote their works in the 1700s and 1800s, central concepts for economic activity included land, labour and capital as factors of production. In 1772, Adam Smith described in *The Wealth of Nations* how the economic activity of individuals contributes to the well-being of the economy. The spirit of the industrial age was crystallised in these first textbooks of economics: "Knowledge is our most powerful engine of production; it enables us to subdue Nature and force her to satisfy our wants" wrote Alfred Marshall in 1890[35]. Comparing the levels of development between nations was made possible in the 1930s when gross domestic product was introduced as a measure. Later, it has been realised that other yardsticks are necessary, too. Perhaps the most essential factor of growth and development of societies is energy and its availability. Our civilisation and standard of living depend on sufficient energy supply (Kapitza 2006).

The concepts of supply and demand remain in everyday use, but the world in which the economy operates has changed radically, quickly and irreversibly. The disruption of information and communication technology, the rise of finance capitalism and technological development have dominated the last few decades. The world has grown smaller and networked in ways that people did not have the ability or the courage to imagine. Networks have created the foundation for current engines of the digital era economy. Even though its first-born children, Microsoft, Intel, Google and Apple are based in America, their younger siblings are more commonly Chinese, for example the online store Alibaba and the software company Tencent. The so-called immaterial economy marches forward, but material consumption has still sharply increased (Smil 2013)[36].

THE DIGITAL WORLD AND SHARING OPEN THE DOORS TO A NEW ECONOMIC SYSTEM

Nowadays, instead of the mass-produced goods of the industrial era, more and more customers look for distinction in their products. Communities, collaboration and economic activities have become more diverse than before thanks to innovation, knowledge and technological change. Economic activities increasingly mix the market logic and profit-orientation of the private sector with social relationships, open sharing and models of collaboration. Abreast of these developments, digitalisation has transformed nearly all sectors of

35 Book IV, Chapter I.

36 Additionally, so called immaterial, creative industry is not really immaterial – it consumes energy and resources, as well as produces electronic waste.

society. Digitalisation enables more numerous decentralised or peer-based solutions, which are independent from traditional, so-called centralised models. For example, the blockchain technology has been adopted in many sectors, such as in the form of cryptocurrencies, simultaneously all over the world. There are experimentations with blockchains in the energy sector, as well[37].

In economic production, new principles are emerging. Economic production combines to a greater extent open and closed logic, as a hybrid mixture of these two. In the middle of the titillating promises of the digital economy, people are looking for new ways to guarantee and sustain trust. Production is increasingly based on collaboration, and companies that pursue profit make use of citizens' opinions and their vast information reserves to tailor their services. Companies use data that is freely available to produce services and experiences. Even if the Linux operating system itself is free and open, services based on the operating system and around it are subject to charge. Giant platforms such as Facebook and YouTube, which were originally open, continue to promote sharing, but after growing up, they have started to sell allocated services to advertisers.

The increase in the amount and sharing of information makes possible the creation of new marketplaces and communities based on peer-to-peer principles. Whether you think of neighbourhood recycling groups that are popular on social media, Airbnb as an avenue of renting apartments or actors like Uber in taxi services, they are based on interaction, collaboration and mutual trust made possible by digitalisation. To function, these services only need a platform where people and goods can meet. The proliferation of these activities is called the platform economy. The adoption of the principles of the sharing economy increases the utilisation of individual products, and can unlock opportunities for ecological business. If money is used in the services, sharing and payments often take place through a third party. The success of many novel services is based on offering immaterial and meaningful experiences, and authenticity. Music streaming services, for example, bring indie bands and evergreen classics to the fingertips of the consumer. At the same time, more and more economic value is created in the creative industry sector. Innovation feeds off creativity. Car manufacturer Tesla handed over, in the spirit of open source code, all their patents to their competitors, in order to promote development of the energy and transportation sectors. It seems that this objective has been reached.

MARGINAL COSTS OF INFORMATION AND PRODUCTION CONTINUE TO DECLINE

The production, handling and sharing of new information has been tremendously simplified, and the utilisation of information has become nearly free of charge[38], thanks to the development of information and communication technology. Thus, it is said that the marginal

37 Blockchains are a technology with which actors who do not know one another can co-produce and maintain databases in a dispersed fashion. With the help of the blockchain, its members can trust one another, without knowing each other. The electricity trade conducted in a peer network could be registered in a blockchain. The problem is that blockchains can consume enormous amounts of electricity, which slows down their adoption. The mining of new bitcoins is a very energy-hungry activity.

38 Sharing information through the internet or mobile technology costs only as much as the use of the technology costs (Heinonen et al. 2017a; Cordeiro 2016).

costs of information have decreased to near zero. As futurist José Cordeiro has described, in 30 years, we have moved from memory cards the size of one kilobyte to those with capacities of over one terabyte (1,000,000,000 kilobytes). In 2003, the sequencing of the human genome took 13 years and cost one billion US dollars. In 2015, it took only five days and cost one thousand dollars. In 2025, it is expected that the analysis of the genome will take about a minute and cost 10 dollars. Technology is developing, and consequently becoming exponentially smaller, faster, cheaper and better. Simultaneously, the markets get faster and faster, as goods are transported, services function and transactions are made more fluently (Friedman 2016). The challenge is that it is difficult for our brain to understand the speed of exponential change. If the marginal costs of information have been near zero already for some time, the marginal costs for material production are decreasing as well. Likely, they will decrease even faster as material production is automated.

"The energy system of the future will become more efficient when artificial intelligence and digital data from multiple sources are utilised and optimised."

ERNESTO HARTIKAINEN

Circular Economy specialist,
Sitra, the Finnish Innovation Fund

THE PROMISE OF THE NEXT INDUSTRIAL REVOLUTION

These developments have given birth to the concept of a *Fourth Industrial Revolution*, the effects of which are subject to speculation (Schwab 2016, 2018). It is thought that the fast pace of technological change unlocks multiple opportunities for increases in productivity when billions of people are using interconnected mobile devices with unforeseen processing power, features, storage capacity, and nearly unlimited information access. The foundation of these developments is in connectivity, as opposed to previous industrial revolutions, which were more characterised by changes in production. It is claimed that the current development will challenge previous methods of production, management and administration.

Already, increasing amounts of data are utilised in production processes, and many of their parts can be automated. Automation has the potential to increase efficiency, to reduce the amount of mistakes and to liberate skilled people for tasks of higher added value. Coders these days tend to lean on algorithms instead of straightforward formulas, which enables processes of simple machine learning. Algorithms are helpful in all applications, from simple mobile applets to more demanding production processes. A new universe opens up when these advances are combined with the Internet of Things, robotics and artificial intelligence. At the same time, breakthroughs are brewing in nanotechnology, biotechnology, material sciences, energy storage and quantum computing. To function, these technologies will require enormous amounts of clean energy. Many of their applications remain still mostly in the realm of science fiction.

WHEN ENERGY IS CLEAN AND FREE

One of the most radical thoughts in the transition to a renewable energy system is the *decrease in the marginal costs of energy* (Rifkin 2014, 2011). This means that the production of electricity with solar and wind energy is practically free after their initial costs have been covered – solar panels installed in a rooftop or a wind turbine erected. **Should the marginal costs of renewable energy near zero, energy becomes a part of sharing economy**. Additionally, the decrease in the marginal costs of energy diminishes the general marginal costs of production across the board. This would create the basis for an economy that is increasingly based on co-created resources.

As the marginal costs of clean energy decrease, a new, fascinating force is put into motion, one that has the potential to activate a chain reaction that leads towards an abundant future. Automation, ubiquitous information and communication technology and renewable energy systems with significantly low marginal costs makes a powerful combination. It is easy to imagine an enormous demand of decentralised renewable energy and diverse economic activity at the grassroots level. In addition, there are visions that concern energy in the fourth industrial revolution. In these visions, production is moved from large factories to small-scale workshops and with the help of decentralised renewable energy and digital production technologies such as 3D printing, to local forms of collaboration. Taken to the extreme, this development would disrupt the market logic based on scarcity, related pricing mechanisms and methods of organisation. Instead of scarcity, we would face a future based on abundance *and* clean energy.

THE ENIGMA OF EMPLOYMENT EFFECTS

Colourful and even fearful opinions have been presented about the consequences of more and more efficient technology for employment. Generally, automation, robotisation and the applications of artificial intelligence have the potential to replace many jobs of today. In the dystopic scenarios, automation and robots will increase marginalisation and unemployment. To make things worse, it is thought that developing and emerging economies are robbed of employment prospects even before any jobs are created. On the other hand, new technologies could also help along the growth of productivity in developing countries, as they promise quicker prosperity and help citizens in many tasks, such as easily accessing financial services (AfDB et al. 2018).

Moderate estimates highlight the disappearance of old jobs and the emergence of new ones. In history, technological disruptions have given birth to new kinds of occupations. The disruption of work and technological development can lead to new opportunities in design and the supervision of automated processes. However, such jobs require specialised expertise and know-how (Iraki 2018). New technologies combined with new ways of working could mean a more meaningful working life for some; positive visions foresee liberation from boring routine labour. In any case, the transition of work will most likely be a gradual and slow process, instead of a one-night revolution (Susskind and Susskind 2015).

The Rise of Post-Work – A Promise of the Post-Capitalist Era

If clean energy is plentiful and material production is mostly automated, the role and character of employment change. In a full-fledged service economy, robots would take care of manual work, and the need for human labour is low. Some of the outcomes feel almost utopian. It is claimed that we can move to a post-work, post-capitalist society in which a human being's working hours would, in fact, decrease close to zero (Mason 2015). In practice, if a human chooses to work, it would be considered their hobby! It would not be necessary, nor even possible, to work as much as we used to. Most work would be creative and social, and the borders between work and other spheres of life would be eroded.

Peer-to-peer production would be based on the deeds of humans, not on private ownership and the market logic. For some communities, work, leisure and communal activity would be inseparable, it would be impossible to separate producers from the consumers. People would do things they consider meaningful and which give them pleasure, perhaps "work" as we know it would cease to exist (Glenn et al. 2019). At the same time, the value of imagination and art would increase. Doing good and helping others could be an alternative to salary work as a source of meaningful activity. What remains to be answered is the question of who would get to enjoy this promise of the post-capitalist era? Would this path really be accessible to all?

In this transition, power and ethics have a major role. If algorithms and robots do the work for humans, will power be centralised with the coders, who with their passages of code program our everyday lives and the processes of production[39]?

NEW WORKING METHODS AND UNIVERSAL BASIC INCOME CAN ASSIST SELF-ORGANISATION

The proliferation and increasing demand of renewable energy is situated amidst a transition from a traditional modern society and culture to a post-industrial society and culture. The virtues of openness and organisational structures are based on peer-to-peer principles and technologies. Open networks allow working wherever, whenever, however and with whomever. The resources of work: knowledge, workspaces and tools are shared in networks. Sharing is simultaneously local, regional and global. Work and leisure are everywhere and nowhere, free from temporal and local limitations. When the working life moves towards self-expression and inner motivation, more people want to work in a role that suits them. This strengthens the means and possibilities of working for common good. Organically born structures are superseding stiff bureaucracies. The implementation of these

39 If the technological singularity is ever reached – when the learning capability of artificial intelligence surpasses human intelligence, the questions of the ethics and values of artificial intelligence would be paramount. Perhaps there would be no more need for coders!

principles can be described as the peer-to-peer logic. As has been earlier explained, peer-to-peer logic has been used to describe open digital collaboration projects, but the same principles can be applied to organisations on a more general level, too.

Many companies give people the freedom to organise their work themselves both virtually and physically. In the Netherlands, a company called Buurtzorg produces healthcare services by leaning on peer-to-peer practices (Kurki and Wilenius 2016). Such enterprises harness the principles of self-organisation so that satisfaction, well-being and productivity increase. Self-organisation is a powerful way of organising work, spurred on by technological development and increasing expertise. In order to capitalise on this potential, managers could better support the personal development, self-expression and creativity of their employees. One of basic needs is the need to be appreciated, which is why the importance of empathy and social interaction in the workplace increases. Future employers have to be even more human-centred, show a willingness to learn from failures and to encourage and tolerate a variety of opinions.

Novel, soft ways of working can be introduced in education and re-skilling. What is needed is collaboration across traditional spheres of expertise preparing citizens for environments in constant change. In education, traditional mathematical, natural science or engineering fields can get inspiration and support from the art disciplines and the innovative approaches in the creative sector. In working life, companies and the public sector can anticipate rising fields and help citizens use collaborative tools. In designing policy, it is important to pay attention to the disruption of work. When the concept of work is re-imagined, social protection measures have to be re-visited as well. The increasingly frequent forays into universal basic income an example of a bridge towards a peer-to-peer economy. The universal basic income is proposed because it would guarantee the basic preconditions of life in a turbulent working life.

NEW WINDS ARE BLOWING IN THE ECONOMY AND THE ENERGY SECTOR

Let us now consider the growing role of hybrid economy. It is all the more common that societal challenges, such as climate change, are alleviated through economic means[40]. Hybrid economy refers to economic activities that blend the pursuit of financial gain and creation of shared value. It also means that profit-maximisation is no longer the only goal of companies. Advances in automation could accelerate the development of the hybrid economy even further (Frey & Osborne 2013). Smart and resource-efficient technologies that aim to integrate technology, nature and the humankind exemplify these changes. A new kind of growth does not mean the rejection of technology. For example, the pioneer in futures studies, Professor Pentti Malaska (2010), discussed neo-growth, which would combine immaterial growth, opportunities of the service economy and energy efficiency while simultaneously minimising the squandering of resources and the accumulation of waste. The visions put forth by pioneering firms such as Patagonia and Tesla might only be a foretaste of what is to come (Perez 2016; Wilenius 2017).

40 Climate change has been described as the biggest and most wide-ranged market failure of humankind (Stern 2006).

Startup companies around the world give hints of the future direction of the renewable energy sector. They already offer solar panels, pantiles that produce solar energy, various storage solutions for energy, installations of micro-grids for whole villages and numerous services surrounding these. Innovative business models, new technologies and new ways of working and thinking make them radical. Technology corporations recognise the cost savings that renewable energy can bring, and look for new breakthroughs[41]. Additionally, active research and development work with a transformative mindset is conducted in the energy sector. Water could be purified and saline seawater turned into fresh water with the help of solar energy. This would be a great help in countries suffering from drought. Changes in the energy sector also transform traditional sectors and markets: many mining companies around the world have moved from diesel generators and expensive fuel oil to using solar electricity. In the Atacama Desert, Chile, solar panels enjoy sunshine throughout the year (Karjalainen et al. 2019). Let us think what the effect of the peer-to-peer practices, novel technologies and life-cycle thinking would be in the construction sector[42]! Even heavy industries are looking for novel innovations and paths towards transformation.

DEMAND FOR CLEAN ENERGY GROWS

Soon traditional energy companies will offer a platform for sharing and trading renewable energy. The same enterprises will maintain the Internet of Energy. This will be enabled by new connectivity technologies, increasing productivity, speeding up data transmission and improving energy efficiency[43]. Energy will be conceptualised as a spectrum of various services. Energy products and services will become an integral part of the consumer market. They will guarantee the full-scale optimisation and flexibility of energy production. Some firms will focus, for example, on the optimisation of indoor temperature. Heating and cooling systems and consumer appliances, such as refrigerators, can be switched off for short periods at peak energy consumption without compromising the service quality. Likewise, the storage of electricity will be offered as a service and as reserve power in case of power outages. All energy appliances and infrastructure are designed as aesthetically pleasing branded products. Energy companies sell their services in support of their customers' ecological way of life. Solar energy will be fashionable (Smelik et al. 2016).

When novel energy technologies and services become a part of the daily environment of citizens and a new material relationship is established, a new consciousness is born. Practically all appliances become energy efficient and ecologically intelligent thanks to embedded artificial intelligence and connectivity[44]. At the same time, the total consumption of energy increases when the number of devices and information processing keep increasing. With this development, the relationship between digital worlds, the renewable energy sector and the ecology grows

41 Agile companies that understand renewable energy will rise to be the pioneers (Karjalainen & Heinonen 2018).

42 The steel industry giant Arcelor Mittal has researched radical business models in steel construction and its value chains to alleviate environmental impacts of the steel industry. produced by the company free of charge.

43 Currently, 5th generation (5G) or according to some 6th generation (6G) network technologies are being developed.

44 In the 2010s, internet connections were sold with unlimited data. Tesla has offered charging stations for electric cars.

future, physical and digital living environments are designed with the values and technologies of the world surrounding them. Infrastructures and technologies developed in the 2020s will build the foundation for life in the societies of the future (Glenn et al. 2017; 2019).

AN AMBITIOUS CIRCULAR ECONOMY IS NEO-CARBON THINKING

In biomimicry, humans are understood as an integral part of natural ecosystems. Cradle-to-cradle thinking or regenerative design is a biomimetic approach to the design of those products and systems that model elements of nature. In economy and industry, new systems are needed, as well as diverse and multi-level recycling of materials, enabling us to reach the goal of being waste-free in a profitable and efficient way (Benyus 1997; McDonough & Braungart 2002; El-Haggar 2010). The neo-carbon thinking, described in the previous chapter, supports this goal: carbon dioxide can be captured either from factories or directly from the air. Once the goal of low emissions has been achieved, carbon will continue to be used in certain industrial functions in the neo-carbon economy.

In circular economy, matter and clean energy circulate. Even in a clean energy system, the economy needs raw materials and produces waste (Davidsson & Höök 2016). What we need is partnerships that transcend the boundaries of various fields, sectors of industry and even national borders. Their purpose is to enable the separation of various materials and the recycling of rare earth metals. An advanced and electrified circular economy is in fact extremely complex. In the future, it will have to accommodate even materials that are difficult to reclaim, such as micro-plastics and very small-scale materials used in nanotechnology. At its best, a circular economy can take us to the next level, into an *upcycling* model, in which the recycling of products and services creates added value in a creative way. In a system like this, used materials are not simply raw material for another process or function. Rather, using them also improves the quality of the environment (McDonough & Braungart 2013).[45]

"The dialogue between an electric car and the person charging it is bi-directional and more interactional than that of a customer who is fuelling their car with petrol at the gas station."

PASI VAINIKKA
Adjunct Professor, LUT and CEO, Solar Foods Ltd

The ecological impacts of emerging technologies need to be considered in all economic sectors (Martin 2016). For example in cities, built environments could feed biodiversity, and artificial intelligence in its many forms could monitor the global consumption of energy and materials. Artificial intelligence could also help allocate resources so that the sharing economy functions fluently. Local applications that understand one another would help in closing the loops of materials. Additionally, farming based on LED lighting could increase electricity consumption but

45 The term *recycling* signifies re-use. *Upcycling* means making an existing product better. Its polar opposite is *downcycling*, in which the previous product acts as the enabler of a new product or process, but during which some value is lost, from an environmental point of view.

reduce the need for load following power plants[46]. This is how humankind would stay within set planetary boundaries and on the pathway to sustainable neo-growth. The neo-carbon electrified circular economy keeps the cogs of the economy turning. It has to make sure that the total amount of waste is reduced, monitor that the safe limits for certain emissions are not exceeded and that non-renewable resources are not exhausted.

Will We Drown in Rubbish?

Even if energy production becomes clean, we will still need to consider the consequences of consumption. Even renewable energy can be used to produce a large number of goods, which raises the issue of waste management. There are already millions of tons of waste and harmful compounds to be reclaimed that have been released into the environment. More plastics is produced than ever before – about 320 million tons annually. Only a small fraction is recycled, separated or burned for energy production. Plastics end up crowding the landfills, or as a consequence of poorly organised waste disposal procedures, directly into nature and the seas.

Many developing economies are searching for solutions. In Indonesia, army has been called to collect waste in rivers. In some West African countries only a couple of percent of all plastic waste can be reclaimed. Five enormous garbage patches have been detected in the world's oceans, containing plastics, rubber and glass. Two of these are located in the Atlantic Ocean, two in the Pacific and one in the Indian Ocean[47]. They are so vast that their surface area is greater than large nation states. Thousands and thousands of toothbrushes, shoes and hundreds of millions of pieces of plastic are these days found even on remote tropical islands (Lavers et al. 2019).

Holistic economic and political agendas are needed[48]. The plastic problem has been on the political agenda around the world. Kenya and Rwanda have led the banning of thin, disposable plastic bags in East Africa, and further measures are considered. In India, Mumbai is awaiting the results of the ban on producing, using and distribution of plastics, which came into effect in 2018. In 2019, the European Union and other countries joined the cause. Plastic straws, spoons, plates and bottles were blacklisted. The next question is what to do with the plastic waste that has already been generated? Would it be possible to gather up the tangle of garbage from oceans and re-utilise it as raw material in industry with the help of electrified robot vessels? Could they remove plastic waste from remote locations and the bottoms of oceans as well, reaching 11 kilometres below the surface in the Mariana Trench?

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46 Load following power means that the production capacity of electricity can be controlled. It is needed to balance consumption and production of electricity, to keep the electric grid running. This need is caused by fluctuations in the production and consumption of electricity. Electricity production methods that rely on changing circumstances in nature to function, such as solar and wind power, need a relatively large amount of load following power.

47 According to estimates, 8 percent of plastic waste in oceans is invisible to human eye, microplastics of diameters less than five millimetres (Lebreton et al. 2018). Their health effects are under increasing scientific scrutiny.

48 In an energy context, the Jevons Paradox means that improved energy efficiency can encourage increasing energy consumption. One example of a rebound effect for carbon dioxide emissions could be a decision not to buy a particular service, but instead consume other services or products that actually cause even greater emissions.

Pioneers Under the Sun

Focus on solutions and design thinking can be harnessed as the deciding factors in making ecological business a success. Solar energy companies in East Africa have invented methods for the uptake of solar electricity in low income households. Their success relies on the long-term analysis of consumer behaviour, development challenges and the utilisation of new technologies. They have harnessed user-oriented financing models, mobile money solutions and communications. One of the most famous ones is the pay-as-you-go model of the company M-KOPA Solar. The customer begins by making a prepayment and afterwards pays some tens of cents per day as instalments, until the full ownership of the solar electricity equipment is transferred to the customer. In services like this the solar home system charges a mobile or smart phone, when a larger system powers a radio, television or refrigerator. Technologically advanced solar electricity services utilise machine learning, a simple form of artificial intelligence. This is how they are able to optimise the lighting of interior areas based on the current left in the battery. When a piece of equipment suffers a malfunction or the panel has been covered in dust, the company is notified[49]. These types of companies are employing and training the new generation of the energy sector (GSMA 2017).

WHO WILL WIN THE RENEWABLE ENERGY GAME?

Building a global circular economy that leans of renewable energy requires local expertise and partnerships that transcend national borders. These could alleviate the concerns in many low- and middle-income countries wrestling with unemployment, afraid of the effects of automation on their youths (Sy 2014). Practices, new lifestyles and systemic changes inspired by pioneers provide multiple positive opportunities (Lang et al. 2016; Schröder et al. 2019). When the power of new practices is understood, changes in education can facilitate the dissemination of successful models. New practices will further induce new values, attitudes and behaviour. Creative collaboration can be powerful!

Pioneering is not always easy, especially if there are no incentives. Being a pioneer demands determination. A pioneering enterprise demands innovation, networks and risk tolerance – how to cultivate such resources? For example, startup entrepreneurs in developing countries often need long-term support and mentorship. If there is a limited amount of help available, local pioneers have to rely on external expertise, technology and capital. In such envelope-pushing collaboration, it is important to remember to reward the technology developers as well as to nurture the learning journeys of young and enthusiastic entrepreneurs. Making new solutions available to customers requires decision-making that supports the forming of new markets.

Visionaries have the courage to push their own solutions, when they are not surrounded by political risks or disruptions. With their own actions, nation states can speed up this transformation. They can create enabling frameworks, favourable operational environments and provide early-phase risk investments that aid in the emergence of novel lines of business and the commercialisation of new inventions (Mazzucato 2013, 2018)[50].

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49 If the customer cannot make their payments, the company can shut off the equipment, thanks to a remote connection.

50 Additionally, one of the traditional duties of a nation state is to guarantee that the energy infrastructure and well-being of citizens are maintained.

The role of the market environment is significant. If a fair price is set for carbon (OECD 2014, 53-55), promising energy solutions will be commercialised even faster. The pressures for change already have rigid governmental structures shaking. This is why we need an innovation ecosystem to accompany neo-carbon energy system, formed by a variety of actors that are ready to build a sustainable vision of the future and to recognise the arising economic opportunities (Karjalainen and Heinonen 2017).

Globally, the transformation of energy and the economic system could create millions of new jobs, new business models and new approaches. This becomes possible if energy production, consumption of materials and waste disposal are defined in much more ambitious ways than before. This concerns everyone – the East and the West, the North and the South. Besides, the relationship between the energy transformation, ecological well-being and vision of abundance has not even been conceptualised in a sufficient manner. New leaders and winners of the future are most likely those who best adopt the principles and norms of the new peer-to-peer society and economy. Global pioneers of the transformation are already developing new businesses, technology and innovative regulation (Wijkman & Skånberg 2016; Havas & Weber 2017). If we consider the next 30 years, leaders can be entirely novel agents when compared to our current situation. In the energy sector, this most likely means new actors stepping forward while traditional actors struggle, imprisoned by their obsolete operational models. Winners of the game will be those who early on let go of the practices that have outlived their usefulness and which no longer have their place in the future horizon.

Questions to Consider

- What kind of actors will thrive in the peer-to-peer society of the future?
- What examples of peer-to-peer practices can you think of, which can lead us towards an electrified circular economy?
- Will capitalism remake itself with the peer-to-peer models or will peer-to-peer principles open the way for a new alternative to capitalism?
- How can we make sure that the revolution described above minimises consumption in a smart fashion and does not further add to the amount of garbage and wastefulness?
- How can the energy consumption of emerging technologies be minimised?

This scrutiny of economic activity, the peer-to-peer society, new developments in the energy sector and pioneers leads us to the world of scenarios. The following chapter will paint four portraits of transformations that have taken place by the year 2050. In the future, what kind of a world will we live in?

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5 FOUR TRANSFORMATIVE NEO-CARBON ENERGY SCENARIOS 2050

Scenario-based thinking is central for futures research, and can be considered synonymous with consideration of alternatives. The key actors that have a stake in today's energy system include energy producers, power utilities, electricity grid companies, ministries, regulatory agencies, energy technology companies and project developers, as well as environmental organisations and interest groups. In the future energy system, the number of actors involved will be even greater because households, companies and actors from other fields will enter the energy sector. This chapter introduces four transformational scenarios of neo-carbon society in the year 2050. They are called *Radical Startups*, *Value-Driven Techemoths*, *Green Do-It-Yourself Engineers* and *New Consciousness*.[51] These scenarios use futures thinking to describe different manifestations of the vision introduced in Chapter 2. There is never only one future, but a variety of possible futures. We have to keep in mind alternative scenarios and ideas regarding futures – evaluating and using them to build the future we want.

51 In the Neo-Carbon Energy project Juho Ruotsalainen had the main responsibility for writing the scenarios together with the team. For the purposes of this book, the scenarios have been further modified.

WHAT ARE SCENARIOS?

Scenarios are manuscripts of the future. They are imaginative theatrical stages built with futures thinking for possible worlds, in which certain trends have been strengthened or reached a culmination, or had their course altered by surprising events. Scenarios include all the elements of a drama, such as a plot, actors, acts, ambience, circumstances and events, which together describe a pathway.

Scenarios are not predictions. Instead they are vivid narratives and testing tools for any decision-making in the present that concerns the future. The purpose of scenarios is to shed light on the way towards alternative futures, and to open our eyes to things which we do not know and which we cannot yet even imagine.

According to Jim Dator's (2009) classification, all scenarios belong to one of four categories: growth, collapse, control and transformation. Each of the four scenarios in this book – Radical Startups, Value-Driven Techemoths, Green Do-It-Yourself Engineers and New Consciousness – extend to the year 2050 and represent *transformative* scenarios.

SCENARIOS CHALLENGE US TO A GAME OF SERIOUS MAKE-BELIEVE

The scenarios reaching up to the year 2050 make use of **two distinct axes: ecological consciousness (left) and the level of rootedness of the peer-to-peer principles (bottom)**, as drawn in Figure 5. In the top left scenario, *Radical Startups*, startup companies drive deep ecological thinking and peer-to-peer practices, which spread in the entire society. At the bottom left scenario, *Value-Driven Techemoths* find economic opportunities in social problems, invest in wholly new energy infrastructure and dominate the global culture. Life inside the technology giants differs from that in the rest of the society, though. In the *Green Do-It-Yourself Engineers* scenario (bottom right), neglecting climate change leads to an ecological collapse. Global infrastructure, economies and nation states are in ruins, so people live locally and rely on practical solutions and rudimentary technologies. There is power in the do-it-yourself spirit! In the *New Consciousness* scenario, human development attains a new level. Unrest, conflicts and climate change concern propagate profound changes: emerging technologies are harnessed, and cooperation between people deepens. The pace of climate change is slowing down.

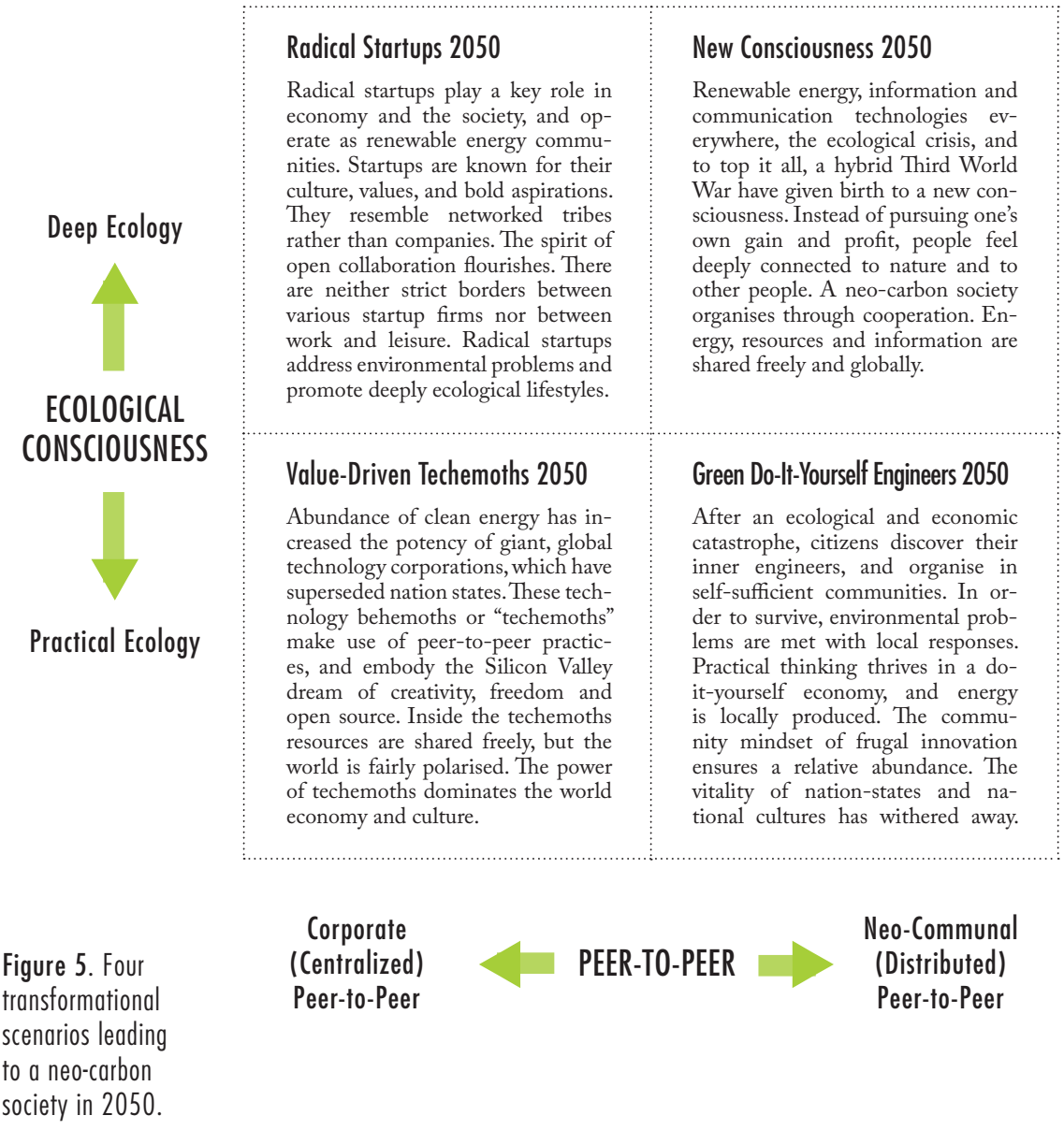

Figure 5. Four transformational scenarios leading to a neo-carbon society in 2050.

RADICAL STARTUPS 2050

Radical startups play a key role in economy and the society, and operate as renewable energy communities. Startups are known for their culture, values, and bold aspirations. They resemble networked tribes rather than companies. There are no strict borders between the various startup firms or between work time and leisure. Radical startups solve environmental problems and promote deeply ecological lifestyles. The spirit of open collaboration flourishes in society.

Image:
Katja Makkonen and
Maiju Kolisoja
(Days Agency)

Startup entrepreneurs are the flag-bearers of creative destruction, in a positive way, as their actions create new processes, services and products. The growth of startup companies requires being radical, perseverance, and a will to observe environmental changes. By doing so, startups are able to propose new products, make use of technologies and identify novel practices. Solar energy startups are an example of such companies. Firms, investors and cities have also an important role in the Radical Startups 2050 scenario. They help in the search of agile and innovative energy solutions. Ultimately, deep ecological thinking becomes a social norm. After the startup revolution, the private sector is no more seen as a selfish actor. The entrepreneurial ethos builds on hacking and open source coding. The media, freelancers and consumers also play a supportive role. The startup world is one of hustle and bustle. Life in the startup societies means coping with chaos, complexity and contradictions.

THE STARTUP REVOLUTION

Startup firms and their networks are frantically searching for new economic activities, and in the process, give rise to a new economic system. In 2050, startups are everywhere. They have dethroned the first-generation technology giants such as Amazon, Apple, Google and Facebook. Three trends have helped the rise of startups. Firstly, after Facebook and Google had attained a near-monopoly position, international legal action demanded the technology corporations to release their data. Because information is the currency of the future, this opened opportunities for small companies to develop new products and services. Secondly, people want to spontaneously be a part of meaningful and authentic lived environments. They also want an opportunity to work wherever they wish. As consumer demand had kept on diversifying, novel services and products aimed at various specialised niche markets blossomed[52]. Agile startups were able to meet emerging demands better than big businesses. Thirdly, the decentralised renewable energy system offers clean and nearly free energy, which has helped the rise of small companies around the world.

Critical Event:

Technology giants are forced provide open access to their data in 2023

In the 2030s, automation and ubiquitous artificial intelligences, powered by electricity from renewable energy sources, have started to take care of production and value creation. Perceptions of work as well as the functions of companies have changed. Startup companies now have a central role in the economy. Earlier startups aimed for fast, exponential growth, but these startup companies are more conservative in their growth expectations. They want to disrupt the world and social behaviour and rarely expect immediate profits. They function in a world of abundance and open data. Therefore, they identify as cultural and social agents, not economic actors.

52 On the contrary, traditional companies most often reach for the masses.

The value of startups is based on cultural and societal value: the ability to create new practices and their reputation. Startups respond to changing consumer demand with new ideas, values, cultural events, in which they specialise. These early-stage companies are radical because they continuously strive to renew culture and ways of social interaction. Their success is measured by an idea's novelty, efficiency, attractiveness and ecological implications. This does not mean that economic considerations are thrown out of the window. The economy of the future is a hybrid between a sharing economy and a monetary economy where utility, market value and ecological implications are intertwined. Scarce goods and services are still exchanged through money, whereas many commodities are abundant and practically free.

The rise of open networks and the principle of open source have transformed the world. During the first startup boom of early 2000s, the growth of many successful startups ceased, or they were purchased by big businesses. In mature startup ecosystems, more and more often they manage to thrive on their own, supported by open collaboration with their peers. The power of startups in society has increased slowly, but in the late 2020s they already shape social relationships and values in society. Startups promote the principles of peer-to-peer culture and practices, and act as the epicentres around which peer-to-peer communities begin to form. As the startup revolution progresses, they transform entire cultures as society rearranges in a horizontal peer-to-peer network where collaborations are constant and efficient.

The culture of openness makes many startups communal. Startup collectives have leveraged the Silicon Valley ethos of individual emancipation, creativity, communalism and networked lifestyles. Dense and dynamic startup networks create an entire ecosystem of innovation. The startup employees have a tremendous level of independence, they can openly express themselves and focus on things they consider meaningful. In such an organisational culture, it is easy to ask a colleague for advice. These firms promote equality, and avoid hierarchies and bureaucracy. In fact, these values have become mainstream in society.

STARTUPS BREAK THE BARRIERS BETWEEN BUSINESS AND THE REST OF SOCIETY

Working in startup firms resembles leisure, and workers are encouraged to bring up both their hobbies and leisure in the work context. Startups can be seen as communities that create business out of the search for authenticity, coming up with more and more convincing and innovative products and services while doing so. In the emerging business culture, startups feed and improve on the hidden potential of individuals as assemblies of human and social capital. One's hobby easily becomes a novel startup idea. On the other hand, dedication has its disadvantages, as work easily claims a large share of people's lives.

During the 2020s, the intellectual borderline between businesses and the rest of society completely dissolves. In companies, consumers seek integrity, a strong moral ethical core and long for aesthetics – just as they expect these virtues from each other. Truthfulness became the guiding star of a new generation of startup companies. New enterprises firmly stand behind what they believe in. In many ways, startups resemble the protest and popular movements of the past; they do not try to appeal to

everyone. "*Doing good rather than doing well*" has become the slogan for many startup entrepreneurs. Recognising the limitations of economic indicators has further accelerated the startup revolution. New metrics of progress are based on comprehensive well-being as a function of the health of the humankind and the environment.[53]

POST-NORMALITY, THE HACKER ETHOS AND THE OPEN SOURCE MODEL

Open source projects are usually in a state of continuous flux and involve many people. In the scenario, these projects are the origins of extensive societal changes. The potential of these practices started to manifest in the 2010s when Tesla, LinkedIn, Facebook and Microsoft incorporated them as a part of their business and development models. Open source slowly spread from the software world to practically every economic sector. An example of an open source pioneer were computer festivals, where anyone could make so-called demos and offer their expertise for open development projects. As a reward, individuals were given a share of a project's profits.

Hacker ethos, in turn, is an effort to understand complex systems – computers, programming code, politics or anything else. The objective of hacking is to improve and modify current practice. Hacking has positive connotations: it can shake established structures, practices and entrenched ways of thinking. The hacker ethos is an important source of innovation, productivity and new solutions, as an engine that accelerates wide-scale change. The vigour of startups is one reason why societies have turned unstable and are in a constant state of turbulence. The radical character of startup firms derives partly from the acceptance of uncertainty. A radical mindset means a way of thinking where the root causes of phenomena and deeply held assumptions are constantly questioned[54]. The forward-looking, purpose-driven and future-oriented attitude of startups has created a society which only has a few stable, maintaining structures. Startups base their business on the expectations about a *wholly new kind of future* and related opportunities.

THE FREELANCE ECONOMY AND THE NEW PRECARIAT

Precarity, the uncertainty about one's employment, dominates in a society of constant change. In 2050, nearly half of the work force are freelancers and subcontractors, and the other half works for companies and associations. Startup firms find gifted employees and freelancers gain regular income with the aid of novel platforms. Then, there are freelancers who create micro-enterprises and perhaps employ a handful of people. Co-working spaces, innovation hubs and office hotels[55] offer freelancers with a community, support and resources. However, a sense of a stable work community, employee benefits and support services have become luxuries for only a handful of people.

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53 Already, progress is measured with The Happy Planet Index (HPI). Instead of gross national product (GDP), the HPI metric takes into account human well-being and environmental impacts. It was originally introduced by New Economics Foundation (NEF) in 2006. An advanced metric has been developed by 2050, namely one that also includes the freedom of expression, human rights, and the right for worthwhile working life.

54 The Latin word radex signifies "a root", *radicalis* means "of or relating to a root".

55 Other names for these spaces include *living labs* and *makerspaces*.

The adverse effects caused by the increased uncertainty are prevented in new ways. Microloans, crowdfunding, impact investing and social impact funds feed the micro-entrepreneurial ecosystem. Startup entrepreneurs and employees often generate income from multiple different sources, which is why networking skills are even more essential than today. Fortunately, everyone has a right to universal basic income, which means that temporary unemployment or business failure is really not a big deal. There are novel precautionary measures to mitigate uncertainty. New business activity can be established fairly effortlessly as the sharing economy keeps costs at bay. Artificial intelligence and robots make sure that resource use is well-organised. A highly effective, clean energy system keeps production costs and living expenditure at a minimum.

Certain startups control uncertainty and constant change with long-term projects. Bearing in mind that the success of startups is based on expectations of a "different kind of future", the most ambitious startups feed on expectations of very long time-scales. Jeff Bezos' atomic clock called *The Clock*, designed to last thousands of years, is an example of this. Investors have a central role in looking at the big picture, and beyond a startup's quarterly result. Individual companies may come and go, but investors make sure there is progress towards a long-term goal. Many traditional energy companies of the early 2000s adopt the role of a futures-conscious investor. Investment funds also create stability in the rapidly evolving landscape. Finance companies are essentially platforms, which govern alliances, connections and the flows of information between companies. Business angels do not just invest – they are visionary mentors who help startups in their business plans.

DEEP ECOLOGY AS A DRIVER OF SOCIETAL CHANGE

By 2050, ecological lifestyles have become mainstream. Most citizens have adopted a deep ecological worldview, where all living beings have inherent value. All beings and forms of life are precious in their own right, and their worthiness is not based on instrumental value for the benefit of humans. Vegetarianism and especially veganism in the 2010s were a weak signal for such a stance because they introduced an alternative set of principles. It has become commonly understood that the existence of life depends on other species that are all part of the same ecosystem. It is thought that a precarious balance of complex relations prevails in nature, and disturbing it has its consequences.

Already in the 2010s, many were looking for deeper meaningfulness and a novel type of spirituality in their lives. Awareness of the looming ecological crisis made deep ecological opinions more and more popular. At first, deep ecological thinking was more of a PR and marketing tool for startups to promote their credibility and moral position. However, it slowly evolved into an integral part of entrepreneurial culture, and startups cemented their position as the vanguards of deeply ecological attitudes. They create new ways of thinking and develop new lifestyles. In the 2030s startups and

civil society started to promote openness in all aspects of life. These startups do not try to own their social innovations, but rather disseminate them as widely as possible. Constant communication in networks reinforces the impression that the future of an individual is tied to everyone else.

By committing to nature and by seeing its inherent value, a feeling of being part of something greater strengthened. Impacts on the environment in production were integrated to the prices of goods and services. But the market was only revolutionised when investment started to flow in full force into eco-intelligent startups. The food and mobility sectors were at the forefront. In the past, consumers chose environmentally friendly products and services when they were practical and affordable. In the world of radical startups, ecological sustainability is by far the most important decision driver. Carbon neutrality and neo-carbon approaches are a business standard for the new breed of entrepreneurs.

Design startups have paved the way for a visual culture that radiates with ecology. Amager Bakke, a waste incineration plant in Copenhagen, Denmark that incorporates a ski slope, is a pioneer of new visual culture. The appearance of the plant does not resemble any traditional power plant. As a special effect, its chimney blows a smoke ring for every tonne of carbon dioxide released into the atmosphere as an everyday reminder to local residents. Architecturally, new power plants are aesthetically pleasing and provide learning experiences for citizens. Most startups are globally-minded, but they primarily address local and regional environmental problems. Deep ecology encourages people to live as locally as possible. Cities have become hubs for startup ecosystems. Cities that attract ecologically innovative companies thrive. This is why most cities specialise: some aim to attract creative firms, others work with energy startups. As middleweight political actors relatively independent of national regulations, cities have accelerated a revolution in politics, culture and the economy.

A WORLD OF NEO-CARBON STARTUPS

The proliferation of renewable energy and the startup boom have transformed the energy sector. The vigorous efforts by thousands, if not millions of startups around the world, have accelerated improvements in the efficiency of renewable energy (as well as other) technologies. The growth of service businesses in the solar energy sector has been unprecedented. The next battle frontier for many firms emerged in energy storage technologies. Radical energy startups have invested in battery technology, neo-carbon storage solutions, artificial photosynthesis and the harvesting of energy from the environment. The market for energy storage has grown, as costs have decreased and profits have increased. New opportunities for specialisation have been created, such as customisable energy storage solutions. Companies collaborate and generate increasing returns in numerous value chains and clusters of energy storage.

In a well-decentralised energy system, an individual or a startup acts as a producer-consumer, and produces the majority of the energy she needs. Startups have used open data for the development of local energy resources, which has accelerated the proliferation of micro-scale energy solutions. Advances in industrial ecosystems have begun to support the utilisation of waste flows even in

small businesses. In the early days of the energy revolution, the lack of investment in electricity grids caused overloads and the growing levels of intermittent renewable energy confused electricity markets. Now intelligent electrical appliances, advanced automation technology and new pricing methods support real time energy trading even between small scale consumers and producers.

In 2050 the mobility of people and goods has decreased compared with the beginning of the millennium. Production is increasingly localised and regionalised, and intelligent digital solutions are widely in use. The new generation of startup entrepreneurs walk, jog, cycle, and use communal electric vehicles to get around in cities. The use of 3D printers in households and industry helps hyper-local, specialised and effective production, such as the local production of solar panels. The birth of deep ecological startups has been an expression of the spirit of the times.

Questions to Consider

- Why do people want to be a part of startup enterprises?
- What can make a startup firm radical? Think of the different aspects.
- How do the startup companies of the future express and put into practice their deep ecological thinking?
- Which skills, networks and support do early-stage companies need from national or international investors?
- How can the cries of radical startups be heard, when corporate lobbyism is conducted mainly by large businesses?

Image:
Katja Makkonen
and Maiju Kolisoja
(Days Agency)

VALUE-DRIVEN TECHEMOTHS 2050

The abundance of clean energy, technological development, low production costs, and effective marketing have increased the potency of giant, global technology corporations that have superseded nation states. These technology behemoths or so-called "techemoths" are large global technology corporations, nurturing of peer-to-peer practices, and embodying the Silicon Valley dream of creativity, freedom and open source. They also use their power to dominate the world economy and culture. Resources are shared freely inside the techemoths, while the world is fairly polarised.

In the Value-Driven Techemoths 2050 scenario gigantic, global technology corporations – "techemoths" as they are called – rule the world. Powerhouses such as Google, Facebook, Alibaba, Tencent, Apple and Amazon already wielded significant power in the 2010s. In the digitalising society they have assumed a leading role and a mission to meet people's needs as well as they can. The uptake of information and communications technologies had meant an enormous growth for their business. In this scenario, they continue to anticipate and respond to changes around them. These techemoths breathe cosmopolitanism and invest in ambitious energy and environmental projects and technologies. Only an exclusive elite – namely the corporate employees[56] – enjoys the very sweetest fruits of development. Once the strategies and actions of these giants begin to have an impact on development, even nation states feel threatened.

THE RISE OF TECHEMOTHS

The early roots of many new technology corporations go back to the 1990s and the early 2000s, but the signs of their real societal power only became apparent in the 2010s. They have become economic heavyweights whose profits exceed the gross national products of many countries. In the information economy, their activities have expanded to cover most aspects of life, including private life. What used to be known as an online store or search engine, their platforms became an integral part of intelligent cities, learning solutions, leisure time and even industrial activity.

Freedom and creativity are a vital part of the identity of the techemoths, and they invest strongly in these virtues. These massive corporations also use their considerable resources for bold and experimental science projects. There are no useless questions. How to make self-driving cars, find solutions for aging or travel to space are only puzzles to be solved. Experiments in completely new sectors, such as combining geographic information with big data on climate emissions and artificial intelligence, create new business. The unmatched power and resources of these techemoths is also a cause of concern. Their sheer size affects the economy and cultural life. Additionally, while praising common good they get closer and closer to ordinary citizens. They acquire, store and analyse detailed information about the behaviour of citizens, firms, organizations, and diverse technological systems. It is indeed this wealth and depth of data, which tells a techemoth apart from the global corporations of the past.

56 Peer-to-peer production through peer networks can also be organised in a "centralised" fashion. Any company can lean on the peer-to-peer principles to give their employees the opportunity to organise spontaneously. At the same, these companies can collaborate openly with other companies, exchanging (at least non-vital) information. Companies benefit from peer-level practices as it is beneficial to them to harness the various motivations of gifted individuals, and to control the delicate balance between inner and social motivation on the one hand, and material gain on the other. They also benefit from offering social sanctity by protecting common knowledge, identity and a social meaning that act as glue that keeps groups together. This is the advantage of a company that is based on peer-to-peer principles when compared to ad hoc networks.

VALUE DRIVEN TECHEMOTHS GATHER SPEED

In the early days, Facebook was a simple social media platform that encouraged open sharing of information, status updates, likes and comments between friends. Later, it acquired Instagram to Whatsapp and has grown into a combination of multiple platforms. Essentially, it turned its attention to the power of peer communities. The corporation saw that they encourage and mobilise action and interactions in the physical and digital worlds. In 2017, Facebook's CEO Mark Zuckerberg introduced a manifesto, which outlines Facebook's vision. The vision portrays the techemoth as a guiding star and its platform as a tool for the benefit of the whole world. The manifesto also outlines Facebook's developmental mission:

> *"Our greatest opportunities are now global – like spreading prosperity and freedom, promoting peace and understanding, lifting people out of poverty, and accelerating science. Our greatest challenges also need global responses – like ending terrorism, fighting climate change, and preventing pandemics. Progress now requires humanity coming together not just as cities or nations, but also as a global community."*

Facebook's tremendous expansion was temporarily halted when the techemoth found itself from a collaboration with a disreputable corporation called Cambridge Analytica. Data extracted from Facebook had been misused, even to manipulate elections around the world. This led to an unexpected loss of trust. Now, the company had to double their efforts in proving its intent as a force for good.

Another techemoth, Amazon, had started in the 1990s as an online bookstore. In the coming decades, it got involved in just about anything – online retail, groceries, voice-activated personal assistants, video streaming, music and games, fashion, production studios, large-scale delivery, food deliveries, and digital education services. One of its key assets were its cloud computing services. Combined with an impressive logistics infrastructure, the corporation established an umbrella for an enormous amount of activities from industries to grassroots-level activity. In its platform, Amazon also let nearly anyone sell just about anything, for a price.

Perhaps the most ambitious of all of them, though, has been Google, with its parent company Alphabet. The conquest of new frontiers has been led by its founders and directors. They have had free hands thanks to Google's governance model, which limits the powers of its shareholders. In the 2010s, Google/Alphabet embarked on ambitious long-term projects. It got interested in immortality, applications in advanced robotics, and even took an interest in emerging energy technologies. In

Critical Event:

Techemoths decide to employ their massive profits for the research and development work and promotion of clean energy technologies in the early 2020s.

2017, it decided to focus on artificial intelligence. In the coming decades, its AI solutions expanded rapidly. By 2050, they are a part of people's everyday lives, like a second, nearly superhuman set of brains. Industrial production without the services of Google/Alphabet will be impossible.

During the 2020s and the 2030s the world became increasingly technology-led. At the same time, the community focus of techemoths led to their growing attempts to influence social relations. The techemoths started to take care of activities operated before by the public sector and small companies. In China, the home of Alibaba and Tencent, only a handful of techemoths handled nearly all the mobile payments in the country. The accumulation of resources, information, and social capital puts the techemoths in a privileged position. They begin to make use of the latest technological advances from artificial intelligence to renewable energy technologies. In the 2050s, the techemoths are the main provider of healthcare services from prevention to aftercare, and even funeral services.

PEER-TO-PEER GOES BIG

The techemoths embrace peer-to-peer practices. In a creative and immaterial economy, peer-to-peer production has proven to be the most effective way to organise production. The techemoths conceive themselves as centres of constant buzz, which revolves around ambitious plans and business success. Already in the early 2000s, Google employees had a chance to dedicate one day a week to their own projects with its so-called 20 percent work time policy. The techemoths offer their employees a nearly full freedom to pursue their own interests, and a platform for their identity projects. Earlier citizens identified with national cultures, but these days the cultural influence of the techemoths is far more potent.

The technology campuses of the techemoths are an eclectic mix of efficiency, optimisation, joy, gamification, surveillance and freedom. Expertise meets in these enormous campuses; they make fertile soil for spontaneous and self-organised projects. The companies' knowledge workers take their families for recreation and leisure. For visitors, there are semi-public spaces with amenities from children's play areas to boutique dog hotels. By 2050, the campuses have become city-like oases, which have tens or even hundreds of thousands of inhabitants. With their own legislation, decision-making and governance bodies, they are like city-states of the 21st century.

Regardless of their open decision-making culture, techemoths do not adhere to the same democratic principles as nation states. The techemoths trace each and every bit of data used by their employees, and privacy has turned into an archaic concept. Employees, as members of these corporations, do not really mind, though, as they are deeply committed to their corporations. Paradoxically, the peer-to-peer principles flourish, but so does extensive surveillance.

FROM NATIONALISM TO COSMOPOLITANISM

The culture of techemoths is cosmopolitan and their markets are global. The growth of the global middle class supplies them with willing workers. The middle class values creativity, freedom and independence of their work, but also wants stability and a predictable future outlook. Techemoths offer both of these. The grandiose missions of the techemoths are the opium of the people, and a long-awaited response to weakening national cultures.

The needs of the techemoths influence national legislation heavily and their actions undermine the sovereignty of nation states. Even so, states manage to act as a balancing force. States prevent the rise of monopolies, offer capital, and provide collateral for early stage companies. Their funding model resembles low-interest student loans. Nation states are also in charge of the disbursement of basic universal income, which is financed through heavy corporate taxation. Even so, they leave the values, culture and practices to be dictated by corporations. Legislation secures techemoths with intellectual and patent rights and prevents anyone from rebelling against them. Nation states are the night-watchmen of techemoths' interests.

In a business-run world, cosmopolitanism and globalism have also shaped the political sphere. In the world stage, techemoths have become the de facto decision-makers. Corporate executives and their business networks resemble a breathing, living, self-appointed global government. The world trade favours corporations. Neo-carbon technologies and related components are traded freely and are exempt from import duties for the foreseeable future. The United Nations has lost its place as a global body, which has caused a global power vacuum. In a regionalised world, the technology campuses of the techemoths bring colour to otherwise homogeneous cosmopolitanism.

The electricity markets are integrated – globally. A super grid has been completed, and it evens out the variable electricity generated from renewable energy sources. Decentralised and emission-free energy is traded globally, which makes markets efficient and reduces the cost of energy. The abundance of affordable energy, improved efficiency of production, and rapid global economic growth have caused a serious rebound effect: material production and consumption have increased significantly. This is why the environmental policy of 2050 mainly focuses on the excessive consumption of natural resources.

WIDENING INEQUALITIES

Poverty is relative in the future, as advanced technologies provide nearly all citizens a life in abundance. In terms of material well-being, there are only developed countries. Still, in one way or another, those who are not connected to the techemoths are often in less privileged positions. In 2050, the share of employee contribution to the gross national product is at a record-breaking low despite basic universal income. The world lives a new golden age, but wealth and social status are inherited. The income gap between the rich and the poor is large. The civil society is free, but small and passive. There are nonetheless attempts to question the power of techemoths. As a counter-move, the techemoths have appropriated the term terrorism to describe any initiatives that challenge their value-based leadership.

The counter-cultural projects of the civil society often have elements of hacking. Crowdsourcing and crowdfunding are vital tools in such do-it-yourself projects. Initiatives from techemoth-independent innovation hubs are a weak signal whose effects are still uncertain. Any attempts that seem too quirky or revolutionary can get labelled as terrorism. As strange as it may sound, the techemoths sometimes secretly fund some of the underground projects. After all, the virtues of curiosity and radical nature are also required in their own ventures. By providing funding, the techemoths can also control any revolutionary elements. Only a few rebels are able to stay true to their ideals and resist the temptation of co-optation.

The greatest paradox of the coming era is that citizens and communities are seemingly more independent and affluent than ever before, but still, they live in the shadow of their "patron saints". The developments have created a social class of technology millionaires who are a progressive force in society. These modern-day Medicis purchase social and cultural status by investing in risky but often ground-breaking projects as well as arts and media. The super-rich invest in culture and innovation, which helps them have their name in the annals of history. They fund for example the transfer of solar energy from space to the surface of the Earth.

TECHEMOTHS IN THE ENERGY SECTOR

Investment behaviour started to change in the 2010s. Experimentation in the energy sector started being taken seriously and the whole sector started quietly to prepare for a transition. Environmental enterprises started gaining a foothold in China. The German energy company E.ON split its business into conventional energy business and services in renewable energy. In the US, the Texas energy cluster strengthened and many companies started to develop energy storage technologies. Presidents come and go, but initiatives catalyse new initiatives. In trade visits to African countries, North American technology companies signed large supply agreements for solar energy. Car manufacturers decided to invest in electric mobility. Large businesses were encouraged enough to re-evaluate their business models and strategies.

Once the ball had started rolling, there was no way to stop it. In the 2020s and 2030s, the private sector started to invest in low- and neo-carbon technological solutions. The techemoths rushed to the energy sector and largely displaced old energy companies' activities. They specialise in full service packages, which resolve issues such as water scarcity and zero waste as one whole ecological problem. Their energy services deliver energy storage technologies, clean electricity and other renewable energy installations, such as customised geothermal systems and mini-hydro projects as services. Internal combustion engine cars are no longer produced.

Little was known about the energy consumption of the service sector before big data. Now, data is the basis of the energy products and services provided by the techemoths. This data is then used to optimise any energy use – small and large. Seemingly free of charge, citizens have to grant the techemoths a permission to use their personal data. The techemoths use artificial intelligence with smart technologies to gather incredibly detailed data on behaviour, which is then sold to third parties. Consumer profiles also support the tailoring of energy services. The techemoths put the brightest minds of their interdisciplinary teams to work, and are also heavily involved in cutting-edge research and development activities.

In 2050, technology solutions based on electricity and neo-carbon principles are used for the purpose of neutralising carbon emissions. Despite intelligent technologies, the humankind has far exceeded its carbon budget and energy demand is high. Citizens are not too committed to energy issues, which can be partially explained by the highly automatized energy systems. People value breakthroughs but assume that somewhere else someone has the know-how. There are also quite a few beyond the reach of intelligent technologies. Relatively poor infrastructure outside the technology campuses results in wasted energy.

An early techno-utopian fantasy of the clean energy revolution as one that unravels the power structures of societies never materialised. Instead, the clean energy revolution became elitist and techno-futurist. Decentralisation, electrification and the peer-to-peer ethos revolutionised the world, but only technologically. In the process, the vitality of the grassroots-level and inequalities were cast aside.

Questions to Consider

- Which large corporations do you perceive to be deterrents to transformation? Why?
- Which large businesses have catalysed positive social changes with their activities? How did they do it?
- How to ensure that the private sector acts as a change agent towards the transformations required by an emission-free world?
- If the headquarters of large technology corporations become futuristic city-states where employees even spend their free time, what happens to the rest of society?
- If you worked for a value-driven techemoth, what bold initiative would you propose in the work towards a renewable energy revolution?

GREEN DO-IT-YOURSELF ENGINEERS 2050

After a global ecological and economic catastrophe citizens organise into self-sufficient communities. In order to survive, they discover their inner engineers. A mindset of frugal innovation provides for a relative abundance. In a do-it-yourself economy, practical thinking flourishes and futuristic solutions are improvised. Energy is locally produced and local applications are invented to tackle environmental problems. The established order has collapsed.

Image:
Katja Makkonen and
Maiju Kolisoja
(Days Agency)

Engineer-minded citizens are the main actors of the Green Do-It-Yourself Engineers 2050 scenario. They organise locally after severe economic and ecological collapses and respect the harsh environment they are forced to live in. After severe turmoil, communities learn to survive in the middle of the upheaval. Do-it-yourself (DIY) thinking is identified as a strategy for survival, and a form of art and amusement. People depend on localised neo-carbon applications, working together and renewable energy sources. Most communities lean on one another in the post-catastrophe era. The scenario has many similarities with the three other scenarios and their images of the future. However, this scenario does not express a desired future. It envisions a survivalist world that has suffered epic destruction. Nevertheless, people are still able to cope and lead local lives.

A RECIPE FOR AN ECOLOGICAL CATASTROPHE

Natural gas and oil exploitation have continued. They are sought ever deeper, more expensively and from new regions. Each new resource discovery gets the politicians' hopes up. Short-sighted policies and nationalistic rhetoric have prolonged the use of fossil fuels. Expert and activist warnings have been ignored. There is no plan B for a looming catastrophe. Temperatures are rising beyond any safe limits. Global warming has led to an aggravating and irreversible ecological crisis, with dramatic economic repercussions. The world as we know it is no more. The effects of the catastrophe are more severe than even the doomsayers dared to predict. The global temperature has risen by +3°C, and twice as fast in the Polar Regions. Snow has escaped from mountain tops and ocean warming and acidification have annihilated the last coral reefs. The Arctic and also the Antarctic are melting. In addition to the rapid accumulation of human-induced greenhouse gases, and carbon dioxide in particular, researchers discovered that the sun is more active than in 8,000 years.[57]

The humankind has been sleepwalking towards a disaster. Initially, people noticed only minor changes in their local climate. Certain animals changed behaviour or moved to new areas, farmers complained about unpredictable rains and winters were becoming less harsh in cold countries. In the decades to come, more was to come. The glaciers have retreated in front of locals and tourists' eyes, the sea levels have risen, and videos of the mayhem circulate the social media. The world is in a humanitarian and ecological crisis, witnessing food shortages and disease epidemics. There are severe droughts, oppressive heat waves[58], and damage to the forests. Unexpected ecosystem collapses have led to the extinction of several species. Many parts of the world are inhabitable, and tens of millions of climate refugees are searching for habitable areas. When one is found, it soon becomes overcrowded. Desolate city ruins are a part of the collective imaginary of citizens across the globe. World trade is in its deepest recession, livelihoods have been lost, business has collapsed, and most nation states are paralysed.

57 It is difficult for humankind to influence the amount of radiation that comes from space. According to some researchers, this makes it difficult to limit the rise of global average temperature to 1.5 degrees. See Solanki et al. (2004).

58 For the past 30 years, extreme heat has already been the leading weather-related cause of death in the United States (Lopez et al. 2018).

Critical Event:

A global heatwave in 2032 and an enormous wave of migration led to the loss of innumerable lives. At the eleventh hour, no action was taken.

LOCAL APPROACHES

Citizens live locally. The do-it-yourself style is the only actionable strategy in order to survive. Most people live in self-sufficient communities in the rural areas. Local internet imitates wireless bluetooth technology and is highly resistant to external shocks. Communities are densely built and have many shared spaces. Usually they are well connected to each other and cooperate in various ways, but some are off-grid and totally self-reliant. Health hazards are aggravated by the downfall of public services and an inhospitable climate in many places. The rise of carbon dioxide in the atmosphere has not stopped. A small minority of the global population lives in city ruins, but cannot access traditional food production chains. In the concrete jungle, vertical farming caters for food and thin film solar mats are used to produce energy.

Families make tight communities within the small communities. Abandoned farms, family homes and summer houses are converted into permanent residences. Long-distance travel beyond the neighbouring community is rare and air travel is nearly non-existent. Reliance on decentralised and flexible renewable energy production is a widely accepted standard. All materials are recycled and almost zero waste is generated. Food is produced seasonally and consumed locally. The principles of the Australian permaculture – "permanent agriculture" – have been popularised, and utilised to the full. Permaculture meshes agriculture with social activity, and puts to use models and characteristics familiar from natural ecosystems. Permaculture and biomimicry, the technology imitating nature's structures and processes, become one in the 2030s. A new agro-industrial paradigm is born.

PRODUCTS ARE PERSONALISED TO BE BETTER

Frugality drives innovation in society. Do-it-yourself experiments in synthetic biology and biotechnology create crops that can produce very high yields. Bioprospecting, the commercial use of new bio-based products that relies on biochemical and genetic information offers a livelihood for many. At night, one can gaze at artificial fireflies, which light up the sky. Bio-based materials and synthetic hydrocarbons are used to produce plastics, chemicals, medicine, and construction materials such as organic bricks. One of the major advances that has contributed to the do-it-yourself revolution has been the uptake of graphene. This extremely flexible and durable nanomaterial now assists in the creation of bio-products, and even helps in all types of energy storage.

In the 2030s, the so-called marginal costs of production have decreased steeply. Decreasing marginal costs mean that after a solution has been developed, its production costs are quite low. An extremely effective circular economy is especially important in a do-it-yourself economy because it means

that new resources are only occasionally needed. Communities do not only recycle materials and existing products, but choose to upcycle them, meaning that they are also enhanced and new uses are invented. One of the benefits of the combination of creativity and a do-it-yourself ethos is that the novel products that make use of recycled materials are better quality and more desired than the originals.

DO-IT-YOURSELF ENGINEERS MASTER SOLUTIONS

A life in rough conditions has called for a new alliance of technical skills, practical thinking and communality. Every day, problems have to be solved using the equipment and those parts, which happen to be available. Learning by doing and imitating one's peers are the main modes of education. At times, communities also try to train their own technical experts; while formal training in institutions has become rare. New technologies excite children and young people, and their animated minds give birth to innovative energy solutions. Do-it-yourself engineers are amateur artists. The required skills, props and expertise are defined individually and together. As the struggle is shared, everyone can focus on making use of their own skills.

Even in the most dismal situations people fare relatively well. Many communities have developed practical, affordable and relatively simple technologies from building materials to medicine and energy production. They invest especially in what they see as essential. The sharing of goods and services is useful because this way the most can be made of the use of resources. In communities where resources are scarce, sharing is a better option than private ownership, which easily causes quarrels. Bio-bots, robots with living tissue, help in the search for survivors in the case of accidents or disasters, which the communities often have to deal with. Everyone has their own place in a community, and there is no unemployment. An entrepreneurial attitude is an intertwined part of one's identity. Entrepreneurial efforts serve local needs and the assembled solutions often have demand in the neighbouring communities, too. Communities do some trading with one another, and commonly compare best practices.

COMMUNAL NOMADS HELP ONE ANOTHER

Unlike in traditional rural communities, these communities are not shackled to their plot of land. The do-it-yourself people are communal nomads, who continuously develop new projects and help one another. The survival attitude is a source of excitement and pride, even in threatening environments. The DIY communities own their own sources of energy. Old houses have been renovated with the help of technology to withstand unexpected weather conditions. People often live in relative abundance, as energy and materials are mostly renewable.

The everyday life of a do-it-yourself human being in their community is very active. The community members innovate together, fight determinedly against waste and design high-quality environments in the spirit of continuous improvement. When all efforts are combined, individuals have better chances for survival. Many communities resemble green oases, carefree safe havens in the middle

of the malevolent outside world. This attitude is inspired by the Japanese kaizen philosophy, which signifies the determined change towards good. Local mobility consumes little resources, and even kinetic energy is largely stored – an enlightening example of how responsible the use of resources is. At times, wandering travellers visit the settler communities. These nomadic adventurers document environmental changes, exchange knowledge, and sometimes carry dangerous missions.

AMATEUR ARTISTS COMBINE BEAUTY AND JOY

The mind of an excited and curious amateur[59] combines practicality with beauty and joy. At the threshold of apocalypse aesthetic beauty and play remind of the sanctity of life. *Homo faber* (lat. *Man the Maker*) and *Homo ludens* (lat. the *Playing Man*) are considered equal ideals. Everything that is produced has utility and function, but often solutions also offer entertainment, laughs and pleasure. Cultural symbols signify joy of new ideas and resilience against a harsh climate. Technology is considered a manifestation of art and culture, and an extension of skills and perception. Techno-cultural mentality is perceived as a fruit of development.

The eyes of the world have turned to Africa, the continent that was long known for its skilful amateur inventors. Now African do-it-yourself solutions are idolised. After all, the popular narratives about the region's art and visual cultures usually focus on craftsmanship. The influence of African cultures is especially apparent in the design of new tools and items. African works of art often have a practical function e.g. as a part of a ceremony or a ritual, which symbolises the union of science, art and tools. The unexpected empowerment of the continent is globally a significant political and economic asset.

INSPIRATION FROM SELF-SUFFICIENT NEO-CARBON SOLUTIONS

In the post-apocalyptic world, there are thousands of small-scale electricity systems that rely mainly on local resources. Nation states barely exist anymore and high voltage grids or massive regional structures would anyway be too unreliable in extreme weather conditions. Investment decisions for new energy solutions follow community decisions, not market demand. Do-it-yourself engineers tinker and optimise small-scale neo-carbon solutions in their own groups. The sharing of information

59 The word *amateur* means "lover" in Latin. *Amare* means to love.

locally strengthens the commitment to various decisions about energy. Energy production has cultural value. Energy efficiency is treasured, as little of energy as possible is used, and the waste of energy and resources are a downright taboo.

There is a diverse selection of energy sources and variation in energy solutions because the communities are geographically spread out and the solutions have to be tailored to local conditions. Still, they usually remain reasonably priced. Local wind and solar electricity production and a sustainable use of biomass are the most important sources of energy. Because of scarcity, the communities observe closely the capability of the biomass to renew itself. Waste is used for energy, too, although typically materials are recycled. Scarcity strengthens community identity. Do-it-yourself batteries are built with pride from the recycled batteries of laptop computers and energy is stored separately for each household.

UNITED WE SURVIVE

Earlier, do-it-yourself thinking was a necessity in some parts of the world, but in many other places, it was mainly a hobby or a source of excitement. Extreme conditions have given birth to a new way of acting together. Building on what has already been learned, the power of example has become a method of everyday learning. Even though many experiments lead to failures, they provide valuable information of what works and what does not. These experiences and new modes of action are shared with other members of the community. Various alternative scenarios are imagined to find novel, unexploited opportunities and to prepare for various threats. A new kind of survivalism is a combination of fighting mentality, self-sufficiency and creative, intelligent frugality.

The ethos of survivalism was born when the traditional order collapsed. Nation states, enterprises and scientists were scrambling just to get by. When the chaotic events unfurled, the do-it-yourself practices were born almost out of necessity. Emergency training, survival skills, novel technological combinations began to be valued, taught, and ultimately developed as basic subjects and skills. The union of biomimicry and permaculture fitted well with the DIY attitude, and helped the moulding of the environment with self-made tools. The main objective is to preserve and strengthen the community and group – out of necessity and out of a will to look for better vistas. Localised lifestyles do not mean that other communities are seen as a threat.

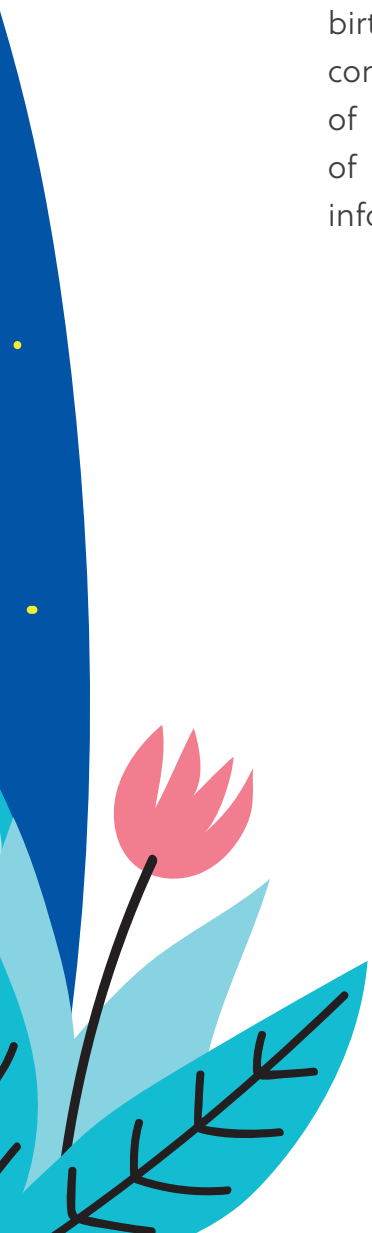
The unfolding of the catastrophe was discussed in an animated fashion in the public eye, in the social media, and elaborated in popular media shows. A collective catalogue of catastrophes developed in people's minds. The 20th century was no longer a story of wars, sovereign states and social development, but a story of a surreal mess created by the humankind. In time, the ecological catastrophe would be documented in history books. When people looked backwards, climate change was perceived as a continuum of malpractice – a recipe for accidents, conflicts and disasters. Resource scarcity and the new world order forced people to adapt to new, radically different ways of thinking. Global problems and smaller threats had to be solved together based on individual skills in communal electricity grids and information networks. The ethos of survivalism turned into a marriage of creativity and collaboration. After the devastating consequences of the turmoil, the popular opinion began to demand better preparedness for the future. People started to continuously ask the question "What if?"

Questions to Consider

- Do you consider yourself a do-it-yourself engineer or do you know smart tinkerers who resemble the characters in this scenario?
- How could society help the creation and dissemination of do-it-yourself based ecological solutions?
- How could the skills of an ecologically-minded do-it-yourself engineer be promoted from the very lowest levels of education onwards?
- What initiatives could promote a do-it-yourself mindset in neighbourhoods, cities and districts, especially for the harnessing of renewable energy?
- What does the culture of experimentation mean to you? Think of practical examples.

NEW CONSCIOUSNESS 2050

Ubiquitous information and communication technologies, renewable energy, ecological thinking and the scars of the Third World War give birth to a new level of human consciousness. People feel deeply connected with other human beings and see themselves as a part of nature. In the newly-conscious neo-carbon society, the pursuit of personal gain and profit is secondary. Energy, resources and information are shared openly and globally.



In the New Consciousness 2050 scenario, growing awareness that makes use of information and communication technology networks leads to the rise of deep ecological thinking. Slowly, societies and people themselves begin to change. It is difficult to identify a single actor or a group of agents responsible for the deep changes in the scenario. Information is flowing increasingly freely and across global borders, which has invited citizens globally to join the fight against climate change. Citizens already form effortlessly new communities, networks and entirely new social movements. Uncountable information and communication flows are heightening the consciousness of global problems and novel, untapped solutions. Eventually, climate change and environmental concerns will trigger a radical, global transformation. Multiple novel economic and social models emerge which adhere to planetary boundaries and internalise climate change. The fight for the common good leads to people pursuing lives full of meaning, creativity and productivity. In the process, a new economic logic gains ground.

LIFE IN GLOBAL NETWORKS

In 2050 it is taken for granted that human beings are deeply connected to each other and to their natural surroundings. Humans and nature are not two separate entities. Consciousness and identity are also not limited by the human body: they connect with society, technologies, nature, and even space. The idea of a shared consciousness is not thought of as mysticism or New Age spirituality. Science has proven that the human ego is shaped through interactions with the surrounding physical – and virtual world. Human beings have transformed into post-human cyborgs in the technological and metaphorical sense, just as Donna Haraway proposed already in 1984.

Identities are in a perpetual state of change. Especially virtual environments offer new information and transform continuously. Identity is not defined by one's immediate physical environment, but a web of influences relayed from everywhere in the world. The thought of an immutable and independent ego is hopelessly outdated, and interpreted as an idea of the eras of Enlightenment and industrialisation. In fact, the immaterial economy demands openness and the liberation of the ego. An open personality helps an individual cope in a changing world. Because of automation, artificial intelligences and robotisation, many masculine traits, such as rationality and physical strength, are less important. Empathy and emotional openness, formerly viewed as female assets are the norm. The negative aspects of masculine behaviour have largely disappeared.

Harnessing renewable energy around the world has contributed to the breakthrough of a post-capitalist economic system, which is based on creativity and abundance. The logic of decentralised renewable energy sources itself has started to modify people's comprehension of their own location. If energy production used to be nearly invisible to citizens, in the system of renewable energy it is communal, decentralised and interactive. Each citizen, household and company recognises their role in the society. The consciousness of the individual of her role means the internalisation of personal responsibility locally, regionally and as a part of a global renewable energy system. Selfish, independent and greedy individuals fit this mould poorly. Not all traditions have been abandoned; some have been attributed with new value.

THE PRELUDE TO NEW CONSCIOUSNESS

The transition to a shared consciousness started to accelerate in the 2010s. Fundamental changes were backed by, in addition to the phenomena discussed above, increased awareness of a threatening ecological crisis and numerous clashes. The conflicts of hybrid warfare accumulated and began to resemble an actual world war. Droughts and hurricanes in the same decade around the world were a prelude to the worsening effects of climate change and manifested underlying social tensions. In order to shake the older generations from their waking dream, young people voiced their concerns. Schoolchildren around the world went on strike, inspired by the Swedish Greta Thunberg. Even the Pope of the Catholic Church could no longer stay silent.

Human beings noticed that they are living amidst an intellectual, cultural and political chaos. The effects of global warming started to actualise earlier than climate models predicted, and suddenly even dystopian scenarios had unprecedented relevance. Local ecosystem collapses fuelled food shortages, and floods and tsunamis destroyed entire communities and islands. The threat of an ecological catastrophe started to be understood as a systemic issue – a cultural symptom of the relentless drive of individuals towards increasing fulfilment. Simultaneously, military and geopolitical threat were fuelled by state and non-state actors alike with their endless attacks relying both on the means of traditional and hybrid warfare.

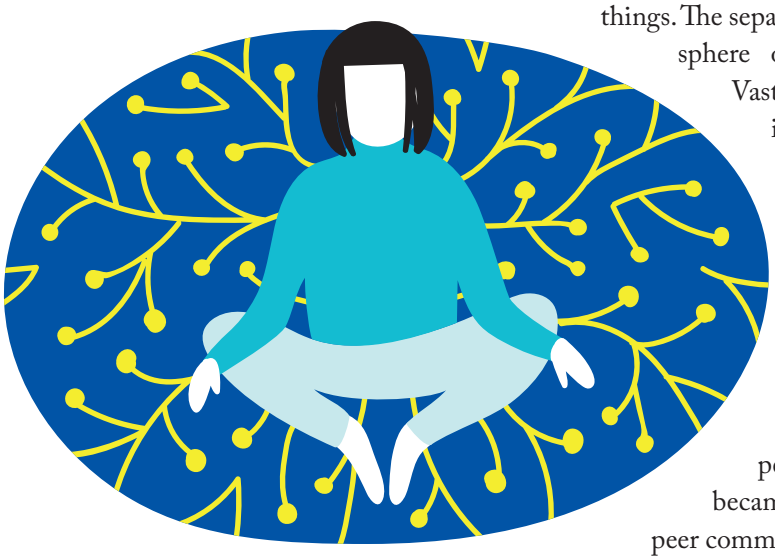
The growing sentiment that the climate catastrophe is inevitable finally awoke a new kind of sentiment of connection and dependence between people. Emotional security, solace, and rapid actions were in demand. Various religious communities began to translate the urgency of transformation into a language the people could understand. This time, people chose not to resort to nationalism or populism. They understood that acting alone, they are simply too weak. They started to reach for others over cultural and national borders because something had to be done.

THE THIRD WORLD WAR AS A TSUNAMI OF TRANSFORMATION

In the 2010s and the 2020s the world was full of various glocal conflicts, in other words conflicts which were simultaneously both local and global. The effects of these conflicts felt like an endless flood: the civil war in Syria, the terrorism and intention of Isis to establish a fundamentalist Islamic state at the expense of innocent lives, the separatist movements supported by Russia in many countries and the unrest in many conflict-ridden countries. The world could hardly keep up with the crises. The difficulties with the United Kingdom's exit from the European Union took a hard toll on both of them. Power politics seemed to return to the international stage. China considered regional displays of power important and North Korea continued to be defiant in a pompous fashion. As if this was not enough, the internal division of the United States led to unpredictability and an endeavour to strengthen its international military power. This was like pouring fuel to the flames. And that was not all – fake news, digital identity thefts, and cyberterrorism fuelled by nationalists turned the social mood increasingly sombre. Cyber-attacks against states and companies became more and more common.

In the late 2020s this seemingly endless chaos was dubbed the "Third World War". Unlike the First and Second World Wars, in this hybrid conflict no single nation simply declared war against any other state. Many regular citizens were involved in the battles one way or another, for example as the targets of information warfare and online attacks. Most popular targets for attacks were digital energy systems. In the middle of the hybrid military operations, people came up with scapegoats, and slandering was common. Forged images and audio were shared in the messaging services of social media, and the border between truth and fiction was blurred. The straw that finally broke the camel's back was the collapse of the global finance system. Warnings of deep flaws in the global economic system had too long been left unheeded. As the instability of the world economy got worse, world politics got heated. The spirit of the times became hostile and paranoid.

As wars often do, this Third World War eventually sowed the seeds of changes. By the end of the 2020s connectivity had reached a new level. Everything was literally connected with everything – other people, organisations, enterprises, items and things. The separation between the public and private sphere of life was practically impossible. Vast masses of information, artificial intelligence, augmented reality and advanced geographic information systems made surveillance and manipulation easier. Humans started to look for peace in closed communities, such as the kinds of discussion groups, where personal and intimate experiences were shared between friends, as peers. The identity of an individual became more open and malleable, when peer communities of the virtual world interacted more intimately than ever before.



Curiously enough, the global tensions ended in the proliferation of empathy. The situation brought to mind the global peace movements that had followed earlier wars. Millennials, the representatives of the Y generation born in the 1980s and 1990s, were the pioneers of the new empathy. They were more tolerant and had more solidarity than their parents – a consequence of having used computers and the internet their whole lives. They saw themselves as equals, and as a part of numerous peer groups, and possessed multiple identities. They were the first generation that genuinely valued participation and transparency over privacy, and creative collaboration over competition. Perhaps this was because they had been born into a world that to them was global and interdependent. Accordingly, they valued international efforts that focused on the solving of global challenges through collaboration.

The generation that came after the millennials were such a heterogeneous group that it is difficult to nominate single events or instances that would define them. They came of age after the 9/11 attacks, the digital revolution and Obama's presidency. Generally speaking, representatives of this

generation trust themselves and their own actions over institutions, and as such are even more collectively aligned than millennials within their own spheres. The "post-generation" cohort lives in a world in which digital electronics are ubiquitous.

They themselves are defined by the networked nature of the internet: diversity, multi-directional communication flows, support of globalisation, individualisation (personalisation) and freedom of choice. They take equal rights over issues such as race, gender, sexual orientation and lifestyle for granted. When other people with different identities were no longer perceived as "others", this slowly led to the development towards a shared consciousness. In the new consciousness, the values and practices of the Internet age define both material and digital realities. Information is considered the base unit of everything which unites the whole spectrum of life. Hypertext, the structure of connections between websites, is the dominant metaphor of culture as a whole. The energy system has become like an Internet of Energy, with its multi-directional flows of renewable energy based electricity.

DEEP ECOLOGY AFTER THE ECO-CATACLYSM

Ideas of deep ecology sit well in the worldview featuring new consciousness. Problems are seen as interconnected and they can be solved in networks. In the linear economy, humans used enormous amounts of energy and left behind them a trail of plastic waste. Plastics were being discovered even in human excrement[60]. It was realised that the relationship of humans and nature, animals and to themselves had to be revised. Partial optimisation and isolated technological solutions were not enough to overcome enormous environmental and social problems. Once the tipping point was reached, it did not take long before the ideas and values of deep ecology cruised on digital highways. In deep ecological thinking, everything is in nature and everything is interconnected. The rise of ecological awareness meant that people began to see themselves as an inseparable part of their environments. Nature was deemed to have her own universal rights, just as humans do.

Biophilia means an orientation towards nature, and the characteristic tendency to focus on life and living processes[61]. Everything there is, is considered life, which represents itself. In the new biophilic ideology, the separation of technology and nature seemed artificial. Already for a long time, people had used biological and nature-based metaphors of computers and peripheral devices: current, mouse, clouds, memory, viruses, worms, streaming and surfing. Even DNA in itself is a piece of digital code. Human beings were found to react to virtual reality environments as if they were outdoors in real nature. Digital communication technologies became the Great Unifier between human beings and nature. Instead of turning off the computer, taking e-sabbaticals or detoxing from social media, people started to think them as elements of a single life in a single world.

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60 Microplastics (or microbeads) and nanoplastics are very small plastic-based particles. Whereas microplastics are at maximum 5 millimetres in diameter, the size of nanoplastics is smaller than 0.001 mm. The smaller the size, the less visible they are to the human eye.

61 The concept of biophilia was originally created by the German social psychologist Erich Fromm, and further developed by American biologist E.O.Wilson (1984). It has been proven that experiencing nature lowers blood pressure, alleviates stress and even helps the recovery process after a surgery.

New consciousness started to deeply transform human behaviour. Spirituality was re-defined and represented a mainstream principle where everything is interconnected. It has less to do with religious ideas or belief in a higher power. The novel spirituality was an experience of being integrated in something greater than oneself, and transcending the borders of the ego. Buddhism and its associated ideologies became a world leading philosophy and worldview. Humankind let nature recover whenever it was possible. The state of the environment and social well-being improved in a way technological or political fixes could never have brought.

The world economy had been struggling during unstable times, but was finally reinvigorated. Investments in renewable energy sources and to build a new, decentralised energy system based on electricity underwent a period of explosive growth. The experiences in forerunner regions such as California and East Africa as well as countries such as Germany, Finland, Japan, Chile, and Costa Rica[62] were carefully studied. It was recognised that the actions of pioneers had begun to lay the groundwork for upcoming transformations already in the 2010s and the 2020s. The renewable energy system was from the 2030s onwards considered more than a technological system – a metaphor for an entire new era. Solar coins were adopted as the new global virtual currency. This laid the foundation for a world economy, which was much more sustainable than its predecessors. The door to a post-oil era was opened.

Critical Event:

Artificial general intelligence and new consciousness begin to merge in 2035 and dissipate old, competing forms of "being".

In 2050, *United Biophilic Intelligences* has superseded the United Nations. The global government is elected in a worldwide election. Politics is based on lively discussion combining forms of direct and indirect democracy globally, regionally and locally. The preparatory and anticipatory work of global-level decision-making is open to each and every one. The Internet of Energy is optimised on a global scale in real-time. Every second, renewable energy is produced where it is most affordable, and information is processed in data centres that consume the least energy.

THE POST-CAPITALIST ERA

The world is seen as a type of Star Trek utopia or socialism that genuinely works. The total transformation has been technological, political and cultural. Shared ownership of property and resources helps their optimal use. New consciousness and global interconnectedness mean that less funds are required for weapons armament than before, which has freed resources towards poverty alleviation, research and cutting-edge innovation activities. The appreciation of taxation in society is

62 In Saudi Arabia, the world's largest state-owned oil company Saudi Aramco, has plans to invest billions of US dollars in solar and wind power projects.

high because it is considered as support of one's peers. High-quality public health care and education systems, alongside nearly equal distribution of wealth have curbed population growth. In a highly technologically advanced, near perfect democracy where everyone's basic needs are met, society can be described as a "fully automated luxury communism".

Extremely advanced robots and artificial intelligences take care of essential production. People focus on their own interests without the limitations of work. Leisure time and labour have become one. Work and the economy, in the industrial sense of the words, have lost their meaning. The notion of entrepreneurship is a downright anachronism, situated in the wrong era. Innate "creatorship" emerges instead. People create productive communities without apparent economic objectives or incentives. The members of these communities get great pleasure from complicated tasks and creative pursuits. In the newly-conscious working life, most meditate and focus on spiritual aims.

The new energy system enables an extremely mobile way of life. The world is one global village, as originally envisioned in the 1960s by Marshall McLuhan, although some people choose to remain in hyper-local communities. People can live anywhere in the world and move according to their needs, as most of the built environment is co-owned. Thanks to advanced virtual reality, the physical and virtual worlds are inseparable from one another. In this sense, society is independent of location. Virtual reality simulates all senses – not only vision – in a realistic fashion. The cosmopolitan citizens also travel in the traditional sense of the word, and even more than before. Neo-carbon fuels are used in airplanes, and aviation no longer causes carbon dioxide emissions. Meetings are often organised in a holographic virtual reality.

In such a scenario, production and economy need to be very efficient. Automation makes material production of this world ever more efficient. New materials and the introduction of quantum computing have provided new explanatory power to Moore's Law[63]. Most production is immaterial and its added value is high. In a deeply spiritual world, production also does not consume as much energy as it would in an economy that leans on material values.

NEO-CARBON PHILOSOPHY SPARKS NEW CONSCIOUSNESS

Generally, citizens are very committed to energy issues and any high-level decisions on energy policy. It is self-evident that energy is a very personal issue. After all, clean energy is understood as the source of all life, a nearly sacred entity. Citizens are highly energy-conscious and do not use excessive amounts of energy. When energy policy is discussed, all parties come together in an open fashion, regardless of their social status. In any issue, long-term impacts receive particular attention. The principle of openness in preparation and decision-making processes leads to commitment and a development path, which is consistent and predictable to all parties.

63 Gordon E. Moore, the founder of Intel, noticed already in the 1960s that the amount of transistors in affordable integrated circuits is doubled every two years. The so-called Moore's law is a general principle stating that the computational capacity of computers is doubled approximately every 1.5 years. Moore's law has survived for decades, but it is a question of debate whether it holds in the future, too.

Energy is harvested from everywhere in people's lived environments. Solar, wind and kinetic energy are each used in an even more versatile fashion than before. Information about new energy innovations is shared globally, and new technologies are continuously tested. As little biomass as possible is utilised in energy production, and deforestation has been stopped. Forests are no longer cut down for energy, but biomass and synthetic biomass are still used as materials. Technological development and related industries are financed and governed through shared global effort. Investment decisions are agreed based on social grounds almost like in centralised planning and state monopolies.

The demand of energy is very high in the new consciousness scenario despite very advanced energy efficiency. Millions of global networks in constant interaction are, in fact, the main source of energy consumption. Energy is consumed by a significant amount of travel, artificial intelligence and extremely advanced virtual realities, which are in everyday use. Cutting-edge virtual realities demand enormous processing power and cooling in data centres. Even though the new energy system generates zero carbon dioxide emissions, large energy consumption – primarily the consumption of electricity – still causes environmental impacts.

Questions to Consider

- How can the interest of citizens to experiment with new technologies be harnessed to disseminate experiences and learning as widely as possible?
- How can artificial intelligence and big data be geared to the advancement of renewable energy and electrification?
- How can knowledge about renewable energy sources help to further the cause of deep ecological thinking? What other means are needed?
- What is the meaning of planetary boundaries to you? How does energy consumption affect your everyday life?
- Can humankind as a whole transform without catastrophes? How?

The following chapter considers what the chances are for the realisation of these scenarios. The end game of the fossil energy era is reflected through scenario thinking and by anticipating surprises and identifying factors that warrant special attention. The chapter looks at how alternative developments can take into account the elements of surprise and energy security, as a broad objective.

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Image:
Katja Makkonen and
Maiju Kolisoja
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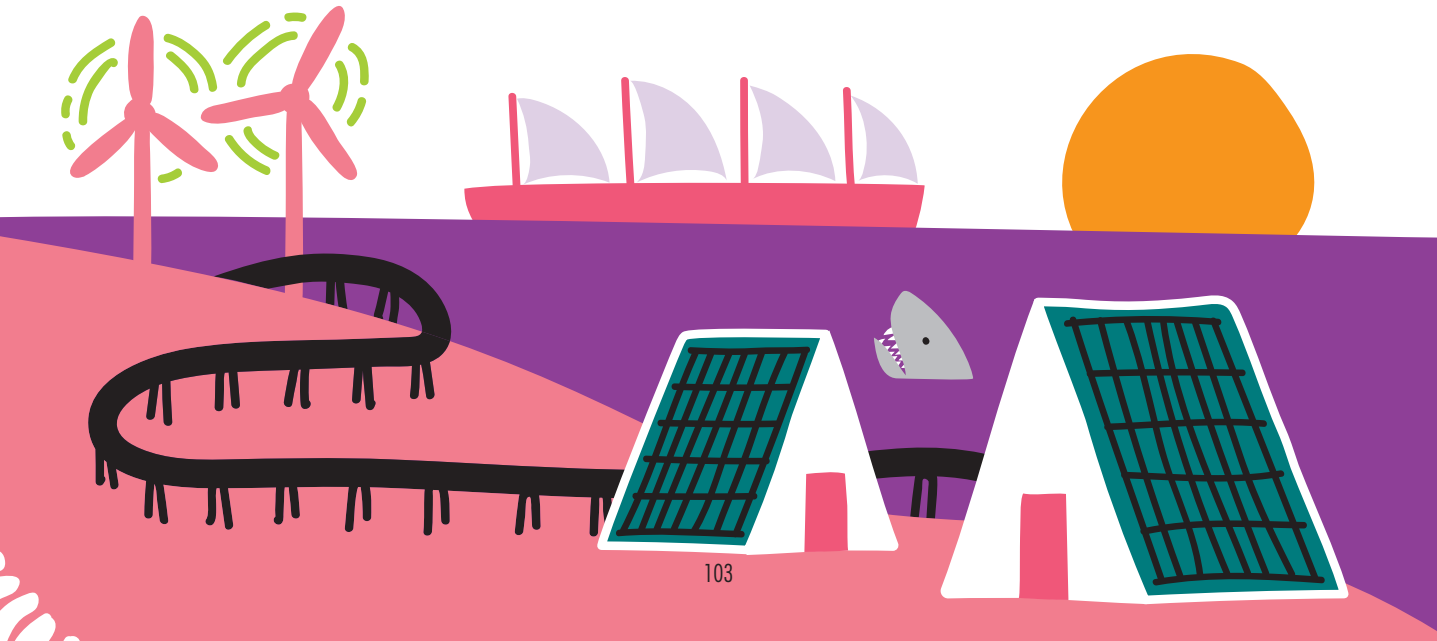
6 SURPRISES ARE THE NEW NORMAL – ELECTRIC SECURITY

Surprising events and their repercussions shape society. If the speed of change increases, from the point of view of futures thinking surprises become the "new normal". In light of history, surprises shake the foundations of society and the resulting transformations are nearly inevitable. According to Nassim Nicholas Taleb, surprises have an even greater impact on society than trends. Instead of resisting change, it is possible to learn to anticipate transformations, to tolerate and to gain from them. We need to develop futures resilience, a kind of tolerance for changes that the future brings. It is worth considering the proliferation of renewable energy from a long-term perspective also because energy is interconnected with multiple kinds of interests and politics. This chapter maps the first steps in the end game of fossil energy. We also ponder how to prepare for surprising developments in the triumph of renewable energy and new great electrification.



"The world changes the most through surprises."

NASSIM TALEB

MEMORIES GROW FONDER WITH TIME

Historical eras are typically characterised as relatively consistent periods. They are depicted as predictable, even stationary, and steered by traditions. The sense of continuity speaks to the idea of normality. For example, there are periods when the economy is growing steadily, people live in stable communities, life feels meaningful, and the future is more or less secure. Then again, throughout history, people have also had to endure uncertainty and to adapt to sudden, dramatic and unpredictable events. Upcoming fierce disruptions are difficult to notice simply by following trends. After all, the very idea of a trend incorporates the idea of continuity. It is better to challenge and to interpret trends: we can ask how long they will last, how and why they will end – and what could take their place. Additionally, it is possible to look for discontinuities and critical junctures as moments when a dominant orientation is overturned.

The last decades were characterised by many kinds of far-reaching transformations. In fact, many of them still continue and evolve. In the era we currently live, technology has permeated many aspects of our life. The social media is constantly mutating, which reflects developments in communication technology and adapting lifestyles. If the previous chapters focused on energy and transport, there are pressures of change also in many other sectors, such as health care, education, food production and housing. Changes in one sector easily spill over to other sectors. In the future, faster and faster innovation cycles and economic change can be expected – to the detriment of decision-makers. In fact, extreme events and their far-reaching consequences can be considered a symptom of these transformations.

INDIVIDUALS AND GROUPS HAVE THEIR SAY

The modern and postmodern eras have also been described as post-normal because of the accelerating pace of change (Sardar 2010). Post-normality, as interpreted here, relates intimately to the erosion of traditional hierarchies. Many significant institutions of the modern age are already under attack. Traditional professions are disappearing, as the transformation of work changes the very idea of work. National identities are in flux. Some defend the nation state with fierce patriotism, whereas others feel the use of national symbols is past its due date. People are discovering that they possess multiple identities, and that there are more than one way to live. When deeply entrenched positions of power and related networks are contested, new actors and centres of power emerge by their side.

One major difference between our current world and the past is the multiplication of voices. These days, almost any actor has the means to take part, to express her opinion and to be engaged. Even if this is not the case in the entire world, this ideal is profoundly altering the perception of society. As a consequence, the multi-faceted character of society, its many inequalities and contradictions, are felt more genuinely than earlier. Traditional institutions have to react to these changes. It is more difficult for a sovereign to propagate indivisible powers with simplistic stories. Those wielding power will face a choice: to look past emerging issues or to reach for new narratives. This also opens up new opportunities for office-bearers to build a reciprocal relationship with their subjects. In fact, citizens and various groups are the experiential experts of their own lives.

Rapid changes, new trends and extraordinary events make society feel complicated and uncertain. Suddenly, the world can seem chaotic or downright unpredictable. Many individuals are able to adapt and find opportunities, but others will long for cohesion and continuity. For the latter, the search for stable, secure and close-knit communities gains popularity. Some changes can simply be overwhelming. Paradoxically, this is happening in a world that has to reconcile multiple values, needs and identities. Already, the digital networks have given rise to new peer communities, but they have also created social bubbles. Life in these bubbles means that interaction is fragmented, the chances of talking past each other increase, and the public discussion is polarised. Some people even question the role of officials and lose trust in expert knowledge.

The adoption of renewable energy sources can be perceived as a part of a continuum of a long-lasting and gradual process, namely one of cultural transformation. The old, one-directional energy system is questioned, while the new energy system, its principles, models of collaboration, practices and a new culture of energy consumption are about to be established. In this sense, **the proliferation of renewable energy sources can be examined as a historical trend, but also with a future-oriented perspective**. This means that we need to think already deeply about the transformations that we will be facing in the future[64]. In the very least, there will be significant surprises that are connected to societal changes and political events. This is why we propose a new perspective into the energy transition debate, one that insofar has gained relatively little attention: by anticipating alternative developments, it is even possible to prepare for challenges that are not yet noticeable in today's world.

BYE-BYE, CARBON POWER!

Creating anything new severs the material, social and cultural bonds with the old infrastructure and the ways of using it. An energy transition into a new clean energy system means that old infrastructure becomes obsolete. The first industry to feel the effects of the looming transformation is the coal sector, which is losing its competitiveness. As mentioned in Chapter 3, new coal power is more costly than new solar or wind power, and will get more expensive as solar and wind power become cheaper. This threatens certain jobs and professions. In the mid-2010s, nearly half of the jobs in the United States coal industry vanished in just five years (Fox 2018). Many a small town has been built around coal, oil and gas – the economic and social history of the United States tells as much. Coal workers' strikes tend to be political incidents (unlike for example the oil industry strikes) despite the fact that the sector actually employs fewer people than is often thought (Dannreuther 2017). The coal industry is a major player at least in Australia, South Africa and China. In turn, countries such as Japan, India and South Korea import large amounts of coal (ITC 2019).

The lack of an alternative plan can mean precarious developments. An increasing carbon risk could even lead to a carbon bubble. Investing in carbon-intensive sectors would become financially risky, and some assets could be stranded entirely, if the markets accounted for the true price of harmful carbon dioxide emissions. Stranded assets are, essentially, investment portfolios that become worthless. This would result in severe financial losses for both institutional investors, such as

64 Many kinds of surprises from multiple different directions can target the energy sector (Heinonen et al. 2017c).

state-owned pension funds, and small investors, the average Janes and Joes around the world. Some are already campaigning for a wake-up call. On campuses, students have called for their universities to divest. The World Bank incorporates the carbon risk in its project finance, which has shifted its development emphasis. The Norwegian Oil Fund, one of the world's largest funds, has divested from some carbon-intensive sectors. Many banks and investment funds have also started a search for low-carbon investment opportunities to alleviate potential market risk and to respond to consumer demand.

THE ESTABLISHMENT STANDS UP

In the efforts to solve the climate challenge, social and political dimensions of energy are crucial (Burke and Stephens 2018). Especially, economic arguments are an effective rhetoric device. Recent political elections are a healthy reminder of this fact. In the 2016 U.S. Presidential Elections, Donald Trump's campaign appealed to the notion of the American Dream and directly addressed the coal workers of the Midwest. In France, the yellow vests movement (*le mouvement des Gilets jaunes*) has protested against fuel tax increases and accused the government of being favourable to the well off. Moreover, the huge rainforest fires in Brazil in 2019 show how vulnerable ecosystems can be to political clashes. Traditional leaders see themselves as the defenders of the establishment and assume matching agendas. In contrast, the startup entrepreneurs and social movements act with the future on their mind. The "fossil imperium" will not give up without a fight, even though in the end game of energy it has no future[65].

Transformational leaders are visionary and see beyond the conventional. Transformations are seldom clear-cut endeavours or their pathways known in advance. The actions of pioneers will invite followers, new supporters join the cause, and ideas will develop further. There will be reactions and counterforces will arise. Therefore, a transformation can resemble a stop-go movement or a set of waves that throw it back and forth. The disruptions of the post-normal era intertwine with various tensions. Liberal values face conservative ones and nationalist sentiments keep colliding with globalism. Progressions introduce novelty and fuel unpredictability. All of a sudden, visions that were once far-fetched become reality. Who could have thought that the political divide in the United States would lead the world on the brink of full-scale international trade wars!

The multiplicity of various interests and cultural factors is often overlooked when analysing transitions – perhaps because their interplay is not straightforward. Certain sectors, nation states and cultures are more prone to transformations, while others attempt to resist changes more forcefully. Climate change illustrates moral dilemmas. The energy revolution is coming, but we also hope that it will be a just one (Swilling & Annecke 2012). What would we think, if all of a sudden large amounts of renewable energy was installed through authoritarian means? Or, what if the venture funds that channel investments into renewable energy technologies decide to guide their profits into international tax havens? These are reasons why the fruits of the energy revolution should be shared as widely as possible.

65 For further information on this, see Heinonen et al. (2017a; b; e).

STATES AS AGENTS OF TRANSITIONS

Nation states are a diverse bunch – there are young and old, small and large, poor and wealthy countries. Some are landlocked, some coastal, and others consist entirely of islands. Some are major energy exporters, whereas others depend on imports to meet their energy needs. For many of them, though, one thing is common. States have traditionally looked at energy sector planning (including production, distribution and infrastructure) from a centralised viewpoint. This approach has some limitations.

When a country's economy relies heavily on a single commodity, such as oil, this can cause a so-called resource curse and make their economies struggle. When the global oil price fluctuates, all economies are affected, but especially so oil-dependent economies. Oil economies include many Middle Eastern states and Central Asian countries. There are also producers, for instance in Africa, that have discovered oil recently. The challenges may assume different characteristics. Nearly the entire national budget of Nigeria comes from oil and gas revenues, but its 200 million citizens suffer from a continuous shortage of electricity! In the case of Venezuela, the country could spend heavily when the oil price was high. After the oil price collapsed, the country went bankrupt, which resulted in a severe humanitarian catastrophe.

Formulating Carbon-Proof Visions

The renewable energy vision interrogates present outlooks and opens up new possibilities. What would make Russia, for example, interested in the renewable energy system? After all, the country has an abundance of wind energy, and it could be adversely affected by climate change – and even more so if the Siberian permafrost melts. Saudi Arabia is investigating avenues for economic diversification and seeking to increase its solar energy capacity radically. Some countries have started investing their resource wealth into the forerunners of a carbon-proof economy. What will other countries with conventional energy resources do, and why will they choose to do so?

SPROUTS OF NEW INFRASTRUCTURE

International relations and geopolitics give an entirely new perspective to the peer-to-peer vision and the renewables-based electrification. All nation states have some renewable energy resources. In principle, a dispersed energy system and a diversified energy portfolio promote energy self-sufficiency and security of supply. Compared with the present global energy system, a large number of countries will become electricity producers and consumers, which could alleviate geopolitical tensions. In fact, increases in renewable energy production can create prosumer countries (Scholten and Bosman 2016). Countries will also need to cooperate, for instance to manage the production and consumption of renewable energy through electricity trade. In the future, some countries will begin to produce synthetic fuels from renewable energy. Over time, the entire balance of power can change.

When new energy resources receive increasing focus and new technologies are implemented, this can cause existing energy strategies to be re-assessed. An electrified, renewable energy system will make use of some of the existing fossil energy infrastructures. In the future, synthetic fuels are produced where the sun shines, or where especially strong winds blow. New production facilities will be constructed to produce synthetic diesel oil and synthetic natural gas in areas where renewable energy is plentiful like Patagonia in Southern Argentina and the Horn of Africa (Fasihi et al. 2018). Synthetic natural gas can be consumed regionally, but also shipped overseas, exactly like natural gas is traded today. This way, synthetic fuels that are produced with renewable energy will also start to compete against their fossil counterparts – and gradually replace them.

ELECTRIC SECURITY IN A DIGITAL WORLD

In anticipation, understanding of wide-scale phenomena is a "must". In the previous century, and in the era of cheap oil, energy and defence experts focused on topics such as the flow of oil from the Middle East and analysed related threats. In the present day, nearly a fifth of all the oil used daily in the world passes through the Strait of Hormuz sea passage. A similar type of analysis can be applied and adapted to the energy system of the future. With anticipation, one can identify future risks and improve the resilience of the renewable energy system. By doing so, its capacity for recovery can be improved in the event of any disruptions or even catastrophes.

If a renewable energy system is flexible enough, it can balance the peaks and troughs in energy production. Variable renewable energy production also has to be taken into account in energy markets and energy trade (Salovaara et al. 2016). Nowadays, countries fear the fluctuations of global commodity prices. Soon, more and more worry will be caused by the availability and price fluctuations of lithium, cobalt and rare-earth metals (see Bardi 2014). Then, there is digitalisation, which underpins the Internet of Energy. Digitalisation has practically transformed every sector it has spread to, and brought along its own operating principles. Attacks against the Internet of Energy will not be targeted against physical power plants. There are simply not enough military forces or malevolent hackers to destroy every solar power plant or electric car. Instead, the logic of cybersecurity is emphasised. In the virtual world, wars are not declared. They begin.

In the future, crackers and terrorists could aim to attack the Internet of Energy and the billions of electric appliances. In the event of a cyber-attack, a decentralised energy system that leans heavily on solar and wind power would probably still be easier to return into operation than our current energy system. Additionally, technological development continues to bring more and more dispersed and decentralised practices. These could be used to diversify risk. It is good to remember that in addition to the things outlined above, the renewable energy system in itself promotes energy security – from the perspective of the preservation of the climate, the environment and humankind. In contrast, the current model of energy production places a large stress on future infrastructure[66].

66 Additionally, it is suspected that the side effects of climate change cause social unrest and migrations.

Slumbering Towards Collapses and Energy Crises

There is a story about a frog that is placed in a kettle of cool water. To begin with, the frog enjoys being in the water. When the stove is turned on and the water begins to heat up, the frog does not notice and slowly cooks to death. This metaphor warns about the threat of slow change.

A fascinating mystery relates to the downfall and collapse of the Easter Island civilisation, often partially attributed to deforestation. When times got hard on the Easter Island, what was left was an island without trees, and consequently its thriving civilisation collapsed (Diamond 2005). It is speculated that one reason for the collapse was the problem of managing common land or pasture. When everyone has a right to common resources, no one is in charge of their sustainable use (Hardin 1968; Ostrom 1990). Ugo Bardi (2018) has written a whole book on the rapid pace of collapses. He calls it the Seneca effect, the fact that the pace of growth is slow but a collapse happens suddenly[67].

Energy crises are unforeseen events that compromise the availability of energy. A sum of multiple factors led to the international oil crisis in 1973. The crisis was an outcome of growing political tensions in the Middle East, which caused the Arab countries to close their oil taps, and an international shortage of oil. Energy savings measures meant that even in cold countries candles and only few street lights were lit and radiators were turned down. Energy crises can also be caused by catastrophes. The Idai cyclone in Mozambique and tropical hurricanes such as Wilma, Irma and Dorian in the Caribbean are examples of entire nations losing their power supply. Sometimes energy crises are extended. South Africa has been suffering from an electricity crisis already for many years, occasionally finding temporary solutions for it. Examples of actual energy disasters are the Exxon Valdez and the Deepwater Horizon oil spills in Alaska (1989) and the Gulf of Mexico (2010), and the Three Mile Island (1979), Chernobyl (1986) and Fukushima (2011) nuclear accidents. Energy crises and catastrophes make citizens and the energy sector re-evaluate their own relationship with energy.

THE BREATHTAKING PACE OF CHANGE

In the future, large amounts of electricity will be consumed by the introduction of artificial intelligence and the tentacles of the Internet of Things, which reach all corners of society. Big data, synthetic biology and new environmental technologies will be commonly used. When there are tens, if not hundreds of sprouts of technological development (Linturi & Kuusi 2019), we need to pay attention to energy consumption from the very early stages. Radical technologies unlock new practices, products and services that make our everyday life easier, but many unknown side effects also become possible. On the one hand, this can mean more efficient public transportation, improved healthcare and better air quality, but on the other hand also more numerous opportunities for spontaneously organising bullies and troublemakers.

67 Bardi refers to the classical Roman philosopher and author Seneca. According to Seneca, cities are built or get built slowly, but can collapse suddenly (for Seneca's thoughts on humankind's relationship with nature and technology, see Heinonen 2000).

The idea of what it means to be human is also changing. Technological singularity is the moment when artificial intelligence reaches human intelligence and even surpasses it. Ray Kurzweil (2005) anticipates this to happen by 2045. Singularity, the fusion of human and machine, would be a technology-driven progression[68]. Access to technology might soon divide us. In societies permeated by technology, those who have plenty of technologies at their disposal might be better off than those without. There are also other threats. Without checks and balances, it is possible that algorithms inaudibly begin to manipulate reality. Alongside or instead of technological singularity, we would need human singularity, a deep understanding that we are a part of nature. Human singularity sees technology as our extension, not the *primus motor.* Human singularity also implies serious reflection on multiple future trajectories for humankind in this nexus of humans, nature and technology.

The entrepreneurial ecosystem of Silicon Valley in California gave birth to the powerhouses of information technology and created many of the services we enjoy today. Soon, the era of analogue thinking will come to an end, and bits and electrons will digitalise the fossil- and atom-based energy industry. The renewable energy system, its principles and the many related changes are a trailblazing idea. It could mean a true neo-carbon revolution. Electrification would replace energy use based on the processes of burning. The internal combustion-engine cars and fossil fuel based power plants would disappear. Decentralised logic and peer-to-peer principles could become a part of our lives, in a more intimate way than before. **We could begin to talk about a new logic – one of a peer-to-peer industrial revolution**.

THE BURNING AGE IS EXTINGUISHED

The beginning of something new, which ends other things, is called a discontinuity. Discontinuities are gradual, long-lasting and deep processes of transformation, interconnected with trends, weak signals and entirely new issues. They are a characteristic of complex systems. The many discontinuities anticipated in this book, with the help of the scenarios, describe a future that looks very different from now. As explained, the anticipation of the future is challenging because of non-linear developments and accelerating change in an increasingly complex world. Therefore, political fluctuations and the effects of climate change are just some of the things that influence the presented scenarios.

It is unlikely that life would be a bed of roses even in an emission-free future. Even if we could solve the ecological crisis, address the uneven distribution of material wealth, and secure an abundant life for everyone, unlikely factors can create winners and losers. The peer-to-peer society will be more complicated, and in its own way unstable and unpredictable. The problem with the sense of insecurity could remain unsolved. In the light of history, surprises and unimaginable transformations are nearly inevitable. However, power could be more evenly distributed in the peer-to-peer society. What is more, it is possible to learn to live with uncertainties, and use them to get along well prepared.

68 The transhumanist tradition promotes the uptake of future technologies to enhance quality of life and functions of the human body.

Would anyone still accuse the society of today of being steady and boring? In the future, the multiplicity of possibilities enabled by technology will bring new suspense, entertainment and experiences into our daily lives. A profusion of clean and nearly free energy can further deepen the post-normal sentiments. However, when the new energy system is finally ready, we can imagine a new era of stability and continuity. Life in a deep ecological consciousness, in which members of networked humankind live as peers, and understand their place in the world, would be a part of the beginning of post-humanity. In post-humanity, humans live better and longer lives in abundance. The peer-to-peer industrial revolution, in turn, would stop the burning of fossil energy sources and run on renewable energy. This in itself would be quite a surprise.

Wild Cards and Black Swans

In a world of accelerating change, the future includes more and more uncertainty, risks and surprises. In futures thinking, the goal is not to overcome these factors, but to prepare for them and to improve futures resilience, the ability to survive whatever surprises the future may bring. *Wild cards* are surprising and very unlikely events. Nassim Taleb (2007) refers to nearly the same kind of surprises when referring to so-called *black swans*. They are not only rare and unexpected events, but also ones that have dramatic effects. The flight of black swans and their consequences can be either positive or negative. That is to say, the black colour of a swan does not signify negativity but rather the degree of surprise.

In the industrialised world, the myth about the whiteness of swans was busted in the 1600s when it was realised that in Australia there were also black swans. A black swan challenges the level of existing knowledge and can change it once and for all. The anticipatory skillset includes the skill to figure out where the metaphorical black swans take flight, what effects they have and how we should prepare for their coming. They show that the future does not progress in a linear and fully predictable fashion no matter how much information we have. Real foresight knowledge is born from recognising discontinuities and possible black swans. Examples of black swan events are the 2001 terrorist attack on World Trade Center, the mortgage crisis in the United States that was a prelude to the global financial crisis in 2008, and the chaos in the European aviation industry caused by a volcano erupting in Iceland in 2010.

The possibility of these kinds of events can be deliberated in relation to the energy sector. We can also try to look for upcoming black swans and their effects. Some black swans could include the methane bomb caused by the melting of permafrost, the collapse of a significant superpower, the backlash of the reeling fossil industry, a robot uprising, a cyber-attack targeting the Internet of Energy or electricity grids and a breakthrough in harnessing clean energy (Heinonen et al. 2017b; c). Are some scenarios portrayed in the previous chapter more resilient when it comes to various black swans than others?

Questions to Consider

- What discontinuities – things or phenomena that seem to disappear in the "past horizon" – can you think of? Which ones of them are surprises?
- What kinds of factors explain the way things are changing at an accelerated pace?
- Why is the death of coal industry predicted to take place first? How will this disruption differ from the possible effects on other fossil fuels, such as natural gas and oil?
- Think of an unpredictable surprise, positive or negative, that could accelerate the transition to the implementation of a renewable energy system.
- What kinds of positive or negative surprises could come about in an electrified peer-to-peer society where only renewable energy sources are used?

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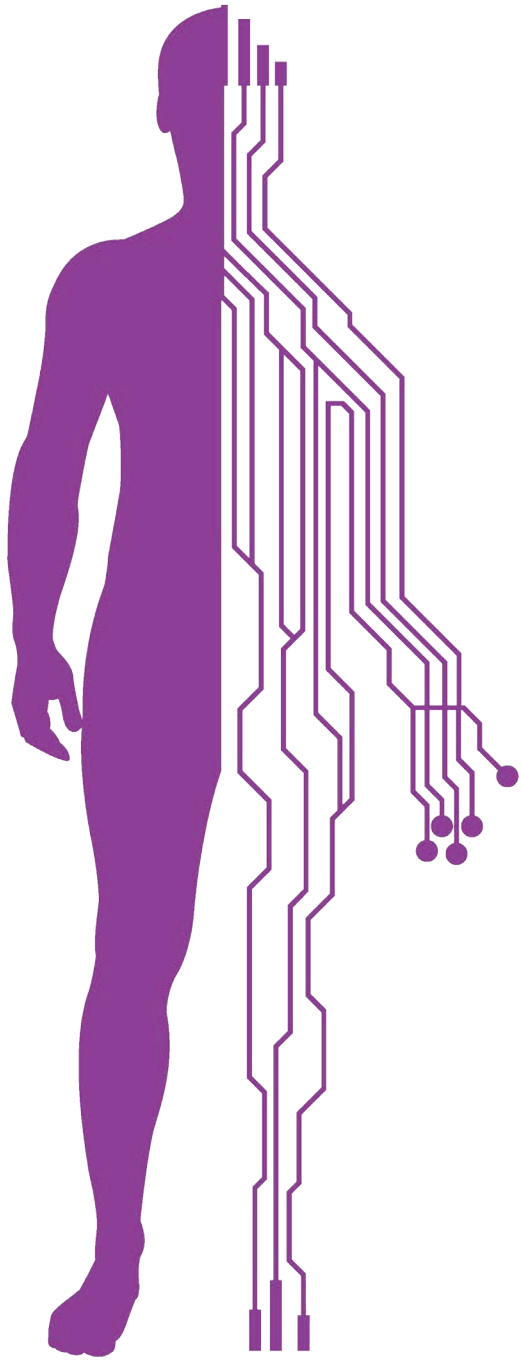

In the future, humankind and machines will produce and consume energy without emissions.

7 CONCLUSIONS AND RECOMMENDATIONS

In this book, we have focused on the principles of electrification and neo-carbonisation, and reflected on the transformation that a renewable energy system can bring. The birth of a renewable energy system and the comprehensive electrification of society are supported by emerging peer-to-peer models. The contradiction between the hierarchical and the networked logic will be defused when the peer-to-peer logic is strengthened, and the many grassroots level models are in everyday use. Actions are needed to endorse the peer-to-peer principle in the process of advancing the energy revolution. It can help create the energy system of the future, as exemplified by today's innumerable digital sharing platforms. Additionally, new innovative and responsible practices and visionary leadership will be needed to take us to the peer-to-peer society. The renewable energy future will be a decentralised one where grassroots activities and initiatives blossom.

"The best way to predict the future is to create it."

PETER DRUCKER

THE TECHNOLOGICAL BACKBONE OF RENEWABLE ENERGY

An electrified neo-carbon energy system in a peer-to-peer society is an idea that amounts to a new techno-economic paradigm. This kind of a future energy system also supports and creates new collaborative models and social practices, which will change the way people relate to energy. The renewable energy system is expected to electrify the world and utilise the exciting opportunities unlocked by the neo-carbon approach, as described in Chapter 3. Consequently, many of our unsustainable practices of energy use are stopped. The new energy system, based on renewable energy sources, will maximise the use of the largely untapped potential of sun and wind. People will lead their lives as peers using the Internet of Energy in an abundance of emission-free energy. The sharing and circular economic principles also mean business. The energy transformation will encompass new, smart energy services, electric mobility, energy storage solutions, and many more, even for industrial needs. In the long term, these changes propagate a withdrawal from the use of fossil fuels altogether.

THE MANY PATHWAYS TOWARDS AN EMISSION-FREE FUTURE

A vision cannot be built in a dictatorial fashion. It must appeal to people from various backgrounds, environments and with diverse worldviews. The four scenarios in this book show how the transformation into a renewable energy system can take place and how it intertwines with the peer-to-peer principles and ecological concerns that manifest in many different ways. The transformations can be hyper-local or deeply global, even when the technological premises remain the same. The societies that harness these new technologies all have unique concerns. Therefore, it is likely that the energy revolution assumes different modes around the world. In fact, decision-makers may have to prepare for multiple, simultaneous and even competing transformations (see also Scoones et al. 2015). However, there is no shortcut to energy paradise.

The cocktail of openness, grassroots activities and peer-to-peer principles, in our judgment, is the most responsible and secure way to promote the renewable energy vision described in Chapter 2. One reason is the fact that open and active knowledge-sharing and new experiments help raise awareness. The citizens have the rights to actively criticise, learn, participate, and test before subscribing to any high-level promises. In any case, in order to pave the way for a post-fossil era, many current actors need to be involved and space has to be cleared for entirely new actors – to kick-start the transformation.

Pioneers make other people endorse a vision, while working as peers increases excitement over the novel principles. The vision can gain traction from the sharing of knowledge and experiences. Entirely new groups can be created and opportunities will open up for non-governmental organisations and interest groups to explore the vision. Their efforts can increase its acceptability and focus on the ethical aspects and the transparency of decision-making. One crucial gain in elaborating the vision from a societal perspective is a better understanding of renewable energy sources and technologies and the transformative opportunities that arise from this understanding. When advancing the vision, one also needs to anticipate!

ENDORSING TRANSFORMATIONS AND PEER-TO-PEER APPROACHES

Transformations can be noticed from many signs – new values, lifestyles and practices, and their surprising combinations. Guiding citizens, companies and many other actors whose enthusiasm can speed up the energy transformation is a positive challenge. Peer-to-peer principles are already dominant in the civil society, and spreading in the private sector, whereas the energy sector is only at the start of its transformative journey. The novel principles will shape how energy is understood, and also influence other fields, such as transport, construction and food sectors. Unless the private and public sector actors begin to anticipate the future in an open manner today and consider their own activities, the future energy world can take them by surprise.

Identifying and following transformations are focal tasks in anticipation, but the practice will fall short without interpretations and conclusions. In the energy sector, the transformation can be recognised in visions, strategies and plans. If the peer-to-peer logic is properly adopted, it is possible to monitor its local, regional and national effects. Citizens producing, consuming and storing energy, startup endeavours with their radical innovations, cross-sectoral collaborations, and changes in existing markets are the beginning of this journey. Disruptions of work and the economy are also shaking the status quo, while intertwining with energy. Technological disruptions, such as artificial intelligence, electric cars and self-driving vehicles, bring new services and influence lifestyles. How will emerging technologies harness ecological demands while adhering to peer-to-peer principles? This insight is the key for re-thinking any business activity.

PIONEERS SHOW THE WAY FORWARD

The transformation promises to empower the grassroots. Prosumerism, the peer-to-peer principles and the Internet of Energy seek to make these actions increasingly meaningful. Given how different our societies are, it will still be a challenge to leap into a peer-to-peer society. The transformations described here do not happen overnight or by themselves. Many are already taking everyday action and hoping to battle against climate change. Citizens will need help in realising the vision. More specifically, if the environment and culture are favourable, citizens are encouraged to take action. They can even search for the way and craft an entirely new future, if they have the necessary space. Here, energy corporations could lend a hand. Let us observe whether citizens are allowed to lead, if companies and politicians dictate the direction or whether technology dominates the march forward. Who will aim to intervene, at what point, and on what grounds?

"The greatest problem humankind is facing should finally be brought to the hard core of policy-making."

MARI PANTSAR

Director of Carbon-Neutral Circular Economy at Sitra, the Finnish Innovation Fund

Pioneers are entrepreneurial and determined explorers who search for new opportunities. The pioneers of the new great electrification and the renewable energy revolution are many. They are activists, companies, civil servants, artists, and many ordinary citizens, who are already making use of creative, social and ecological thinking, with alternative futures in their minds. They are ready to clear the way for novel practices and to use new technologies and innovations to create a future climate-proof society and economy. Awareness precedes the meaningful efforts of building a new energy system for humankind. Because the virtual and the physical will mesh in future societies, analysing alternatives will remain a critical task. Sometimes, seemingly small initiatives and experiments can become trailblazers for their successors.

The seeds of the upcoming transformations are everywhere. A tonne of new ideas sprout in neighbourhoods, workplaces or as scientific pilot projects. Both successes and failures create new stories and open up new discussions, which can be learned from. Promising ideas need to be developed further and tailored[69]. One way to advance the development of the future energy system is to collide together actors from multiple fields. Even if only a couple of pioneers are needed to light the sparks of transformation, one person cannot write a heroic saga. Pioneers need more systematic help than what they currently receive. This is how the passion and mindset of pioneers can be maximised and utilised in the spirit of visionary leadership.

WE ARE IN A HURRY, BUT SHOULD NOT RUSH WITHOUT AIM

Pioneering actions are the early signs of efforts to address the enormous gap between the vision presented and current practice. Despite many pledges to fight climate change, ideas of what could happen in the future are often not so radical. If current plans were followed, energy systems would be transformed far too slowly. We know that the transformation of the energy system takes time, so the planning of a new vision needs to start now! The ambition of any vision is defined by the magnitude of the changes it proposes. At the same time, we need to remember that sudden changes can scare citizens, and that the sense of urgency and hurry should not cause a stop-go motion. We should aim for foresight and target-oriented change coolly and determinedly. So the question for any decision-maker remains, is it possible to spur on these progressions without rushing?

There are many means available; we need to pick the most suitable ones. Citizen-centred practices are important especially in promoting wind power, which tends to attract more suspicion and criticism than other energy projects. In some countries, consumers are financially supported in solar energy installations. If electric cars were made tax-free and the charging infrastructure extended, the car pool could be electrified much more rapidly. In many nations, citizens would be interested in alternative energy solutions, but the innovative players who offer these services are missing.

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69 All countries have their characteristics. Some have high-level expertise and others do not. Some countries have cold winters and four seasons, while in many warm countries life is paced by the dry and rainy seasons. In international energy sector collaboration, it might be difficult to understand circumstances that differ from one's own, and the practices that derive from those circumstances.

Learning from forerunner countries, novel skills have created smooth services, and really changed consumers' perceptions. New investments have been successfully accelerated through crowdfunding and challenge funds both nationally and internationally. How to use these lessons, and what more needs to be learned?

It will be very interesting to see how the peer-to-peer principles will be promoted. There are at least lessons to be learned from many unsuccessful support programs for energy technologies. Blind optimism, excessive government control, overt technology focus or forgetting the users have been sure recipes for failure (Lauttamäki 2018). In policy design, soft and hard incentives can be used, and mixing them can have a stronger effect in promoting a desired transformation. Outdated acts can be superseded by new regulation, financial incentives can alter taxation, and raising awareness can encourage citizens to familiarise with multiple new practices. The more radical a proposed measure, the more dialogue is needed to guarantee the approval of the ideas. If the citizen-led perspective is allowed to blossom, this puts citizens in the driver's seat in designing the energy future they want.

THE TIME HAS COME TO REVAMP NATIONAL PLANS

Political debates allow many actors to express their energy interests. Now, leaders and politicians have an opportunity to profile themselves as experts of these emerging issues. Visionary leadership, determined goal-setting and shifting investment to support of the future energy system are needed. Energy is an urgent topic for the foresight activities of governments in all countries. Election results and the actions between elections give the politicians a mandate to voice their opinions about the long-term perspective of energy and climate policies. Politics also shapes other relevant policies. Additionally, civil servants can anticipate and contemplate on a time-scale that is longer than the electoral period, as multiple simultaneous interconnected transformations disrupt the energy sector. Both can also promote opportunities for regional collaboration.

Typically, national energy and climate strategies mainly focus on technologies of energy production. On their part, we can set objectives to increase the amount of electric cars, to develop electricity markets, to improve the flexibility of the demand and supply of electricity and the overall system-level energy efficiency. However, in many ways the transformation is also about putting new ideas into practice. In new energy strategies, it is worth bringing up not only the advantages of a decentralised approach, but also the peer-to-peer principle. This way, the vision of the Internet of Energy and the significance of data can be acknowledged, and help build the energy system of the future. To support these developments, and to act as a tool in thinking about change, innovation policies can be harnessed (Schot & Steimüller 2018)[70]. In addition to these measures, insight and foresight processes help keep the visions up to date. Additionally, roadmaps and action plans translate ideas into practice.

In various visions of the energy and electricity sectors, people have begun to conceive the role of the consumer in a new light. In the past, the energy sector actors did not really focus on the consumer. To be fair, they also lacked the infrastructure of the information society to make their

70 After all, innovation work itself is shifting towards the ethos of sustainability and participation, as shown by the search for solutions to complicated and serious problems.

relationship with customers truly interactional. Recognising the presented vision can develop new kind of expertise. A new level of knowledge can increase creativity and productivity among citizens, the civil society and in the business world. Already, there are many innovative and active pioneers in the energy sector. New opportunities arise for example from manufacturing electric car components, charging technology, software and services. Multiple fields are expected to become growing markets, e.g. efficiency electronics, automation and intelligent operating systems. Additionally, changes in the energy sector will spill over to other sectors.

LET US IMMERSE OURSELVES INTO THE FUTURE IN THE PRESENT

Emerging issues shape prospects of the future, the assumptions of energy scenarios and truths that are considered generally accepted. Renewable energy sources already have an influence on today's electricity and energy markets. All of the effects of the transformation are not yet known. Neo-carbonisation could fundamentally alter our energy views. In 2050, the use of fossil fuels might well be rigorously regulated or banned. A changed market situation and political risk might make their use altogether unprofitable. The presented progressions challenge planning and policy endeavours, and the current energy modelling practices. Are we really ready for the peer-to-peer revolution? We can expect lively discussion, as we should.

Scenario thinking and visionary work help in mapping alternative futures. An open attitude towards new initiatives helps the efforts of continuous and collective learning. If alternative futures are not contemplated, it can lead to ignoring important, strategic alternatives. **Scenarios are a safe way to test possible development paths, to accumulate experience and to practice while keeping an eye on the future**. With the help of these activities, we can gain insights into emerging cause-effect-relationships, new conclusions and agree upon the upcoming developments. Anticipation should be systematically included in planning and decision-making processes on all levels, while inviting all parties to join the discussion. In fact, the capability to anticipate change is useful to anyone who wants to increase her futures awareness and to use it in improving strategic work!

The deeds of the present moment have an impact on the future. In order to have a zero-emission energy system in 2050, the planning and financing needs to begin right now, and its construction as soon as possible. The longer we wait, the harder will it be to prevent climate change. That is why what we do now is so important: the following 10 to 20 years will define a lot for the alleviation of climate change. Investing in the envisioned transformation is an enormous opportunity financially, both now and in the upcoming decades. Long-term investments and commitments are also important because otherwise it is difficult to reach the preferred future. It is doubtful that all steps taken from now on will be forwards and none of them backwards. Promising paths are continuously eroded by uncertainty and shaped by encounters with the new.

ACTION CARRIES US TOWARDS THE FUTURE

In this book, we have described a vision of the future, four different scenarios that reach towards it, and examined the preconditions for this transformation. We have analysed the principles of electrification and neo-carbonisation, and reflected on the field of energy transition, related language

and concepts. The renewable energy system and the Internet of Energy make up the technological backbone. The peer-to-peer principle, which can be considered a new type of social organisation, describes the long-term transformation. The endorsement of renewable energy sources anchors these principles in society. In a peer-to-peer society, people organise spontaneously and collaboratively. We anticipate that peer-to-peer production and open collaboration become more common thanks to economic, technological and cultural drivers. This is how we have analysed the current system and what the future system could look like.

Our goal has also been to promote discussion about the preconditions of the upcoming transformation. Active discussion is an essential part of any transformation, because without it, we do not know or understand where we are going. We affix our attitudes and values to technology. This is true also in the energy sector. Therefore, we have the kind of future we deserve. We have the kind of energy system we deserve. Besides pioneers, we need visionary leadership that will direct our eyes to the horizon of the far future, in order to understand the systemic nature of the world and interconnectedness of everything. Simultaneously, these visionary leaders clear the way with their own example towards a new, better world (Hoyle 2006).

The energy solutions of the future emerge partly from the change in social values and partly from technological development. This is why they differ from any past models, and do not resemble their successors. An electrified, neo-carbon energy revolution challenges many established practices: the presented peer-to-peer vision is a proclamation of creativity, technological development and new lifestyles. If we imagine what is behind the visible futures horizon, our minds are unshackled of what is possible. And, thinking for example beyond the next 100 years, we can imagine quite wild energy futures.

On a long term, we are concerned with the transformation of the global society into an ecological civilisation that finds balance between the well-being of humankind and the biosphere. One of the writers of the original Club of Rome publication *Limits to Growth*, Dennis Meadows (2016), calls for systems literacy as a precondition for this astonishing goal of transforming civilisation. The ball of energy is now on our side of the court, and where we decide to cast it decides the future of the planet. With systemic futures literacy and the emergency of climate change, we understand humans as a part of nature, energy as a part of society and the interconnectedness of everything.

Only one thing seems certain, and that is the urgency to take action. Consequently, the Club of Rome proposes a Climate Emergency Plan in its new programme. A couple of generations from now, societies and the world as a whole will, in many ways, be different from today. Steps that have the potential to prevent problems have been taken too slowly. Most recent reports warn about the threats of accelerating climate change with more urgency than ever before. The future of communities as peer-to-peer societies combines humanity, nature and technology, while making possible a life that is secure and meaningful. **We invite everyone to develop and to spread this narrative and use it to take action**.

The neo-carbon and low-carbon approach have a shared agenda, as both aim to construct a society that can continue to function within the limits set by climate change and planetary boundaries.

Questions to Consider

- What types of political actions would best promote peer-to-peer production and the move towards the implementation of a renewable energy system? What would need to change in the current policy environment?
- In what aspects can your country act as a pioneer? How?
- How can a variety of actors promote the implementation of a renewable energy system and innovations on an international scale?
- Visions often forget the gradual nature of change. How can we act to promote long-term objectives while the world continues to change around us?
- How can we notice that a new phase of societal development is brewing, and how can we participate in shaping it?

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INDEX

Electrification in Peer-to-Peer Society – A New Narrative for Sustainable Futures is a time travel journey to a future when renewable energy, electrification, and a peer-to-peer ethos are intertwined. The use of fossil fuel resources is ending.

An emission-free vision for 2050 is illustrated through four transformational scenarios: Radical Startups, Value-Driven Techemoths, Green Do-It-Yourself Engineers, and New Consciousness. The scenarios serve as testbeds for what kind of futures we want to live in. Futures have to be explored with a long perspective, but the decisions for preferred futures have to be made today. All major sectors in society have to be transformed to stay within the limits of the Paris climate goals.

This book highlights results from the Neo-Carbon Energy project, addressing all those interested in future visions, societal changes and technological advances. It can also be used as teaching material, or as inspiration for concrete steps towards the post-fossil era and a carbon-neutral circular economy – for governments, companies, and citizens.

Professor **Sirkka Heinonen** and project researcher **Joni Karjalainen** are with the Finland Futures Research Centre (FFRC) at the University of Turku.

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