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The Pioneers of Renewable Energy are Around the World – What Can We Learn from Them?

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Abstract

Climate change is causing major pressures for energy systems to change, which is making low-carbon alternatives based on renewable energy sources increasingly attractive. This article used a hybrid methodology to identify and learn from the pioneers of renewable energy around the world. First, weak signals and emerging issues were identified to craft socio-cultural scenarios, which describe how societies could change, while adopting high shares of renewable energy. Four transformative scenarios "Radical Startups", "Value-Driven Techemoths", "Green Do-It-Yourself Engineers" and "New Consciousness" until the year 2050 were constructed. Pioneer analysis was then used to identify scenario-relevant pioneers in case study countries. The findings of an international expert survey describe present pioneers who are leading ecological lifestyles and the adoption of renewable energy technologies. The findings can be used to think of leverage points for systemic change. The article finds pioneer analysis as a useful method to obtain foresight knowledge of anticipated transformations.

Keywords: Pioneer analysis, Weak signals, Renewable energy, Solar, Wind, Transformation, Scenario.

Introduction

Climate change is already advancing more rapidly than has been anticipated, exacerbated by human-induced carbon emissions (IPCC, 2014; Le Quéré et al., 2017). The Paris Climate Agreement requires the global average temperature to be held well below 2°C above pre-industrial levels and to pursue efforts to limit the increase even further to 1.5°C. In reality, without carbon emission reductions far greater than Paris voluntary commitments, the planet could warm by 2.5 °C this century and 5 °C in the long run. To avoid this,

instead of the Paris 2°C target, Dunlop (2017) considers it imperative to stay below the 1.5 °C Paris aspiration, requiring dramatic interventions at a scale that has not been seen since the Second World War. The task is daunting, considering that around 80 % of the current energy supply is based on fossil fuel technologies (IEA, 2017).

This implies major pressures for the present energy systems. Consequently, it is expected that major transformations will take place this century to meet the presented targets. Any efforts to meet such demands implies changes in the present energy mix influenced by broad-based cultural, economic and social changes (Miller et al., 2015; Ruotsalainen et al., 2017). Innovation and foresight scholars have suggested that the next economic wave could be one of sustainability-driven efforts (Perez, 2016; Wilenius, 2017). Should such transformations occur in the coming years, diverse pathways are likely to be taken (Negro et al., 2012; Wiek & Lang, 2016; Scoones, Leach, & Newell, 2016) because while these wicked problems are global, they evoke different local and regional manifestations. Glocalisation refers to the way that drivers, impacts and elements of global nature are related with local and regional features or context (Robertson, 1995). This paper presents the results of a foresight exercise, which identified pioneers around the world who are expediting the adoption of renewable energy and ecological lifestyles.

The motivation for the article derives from the need to identify actors and actions that already drive the adoption of renewable energy and ecological practices. This article specifically chose to focus on the role of pioneers, as they are actors who are always expected to make the first interventions. Where, how and what kinds of change could potentially emerge in the forefront? Pioneers can be described to express anticipatory behaviour since they use the future for resulting action (Poli, 2017), whether consciously or intuitively only. They seek to affect the future by building activities on the goals that they see meaningful and promising for the future. This makes pioneering an interesting topic for anticipating transformations. Studying pioneering actions provides interesting research material to learn from the geo-cultural variations around a common futures topic. With the aid of transformative scenarios and an international survey, this paper is an effort of identifying such pioneers.

Pioneers in renewable energy opening transformative scenarios

There are multiple futures, but this paper focuses on such futures that could affect changes in the energy landscape. More specifically, the focus is on the pioneering efforts in the field of renewable energy. This aligns with the one of the nine purposes of futures studies, namely studying multiple futures, while advocating for a specific future (Bell, 1997, 111).

Aspirations for futures based on a renewable energy system

Transforming energy systems away from fossil fuel based energy sources is increasingly topical. An energy system based on renewable energy sources is a more and more debated low-carbon alternative (Lund, 2014; Jacobson et al., 2017; Brown et al., 2018). The viability of this option has been aided by falls in the prices of solar and wind energy (Huang et al., 2016; Klingler, 2017). A growing number of studies describe how renewable energy technologies could be used in the future in far larger scale than in the present (Bogdanov & Breyer, 2016; Noel et al., 2016; Gulagi et al., 2018; Barasa et al., 2018). To achieve an emission-free economy, unsustainable consumption and production patterns must also change. It is not entirely clear how such a low-carbon economy, and a social metabolism that embodies a sustainable re-use of materials, can be achieved. A green economy aspires for growth in sustainable ways (UNEP, 2011; Victor & Jackson, 2012), neo-growth emphasizes service economy, immaterial growth, energy-efficiency and avoiding resource waste (Malaska, 2010), whereas degrowth thinkers have questioned or rejected the growth imperative altogether (Kallis et al., 2015).

Transformative scenarios as an analytical framework

This foresight work used a socio-cultural approach to scenario-making in order to study the actors who are driving the transition to a renewable energy system and the adoption of ecological lifestyles[1]. Scenario planning is a process of knowledge acquisition around a problematic situation (Ramirez & Wilkinson, 2016). Vervoort et al., (2015) perceive scenarios within a "worldmaking framework" where scenarios are "worlds" that are embraced through diverse, contrasting futures instead of just attempting to reduce uncertainty. Scenarios are evidence-based, logical stories about futures that are different from each other and from the present state of things (Ralston & Wilson, 2006, 121). In contrast, in the field of energy, scenarios have often focused only on technical and economic issues. There are recent calls for socio-cultural and participatory approaches to energy scenarios for the purpose of strategic dialogue (Sarrica et al., 2016; Upham et al., 2016; van der Heijden, 2005).

In this foresight project, scenarios were used to explore the alternative worlds that principally rely on the use of renewable energy. We can call the crafted manuscripts to be hybrid scenarios, as they combine on one hand exploratory and normative features, and on the other hand elements of forecasting and backcasting. These scenarios lean on megatrends, trends (forecasting), emerging issues and weak signals, while sketching the future worlds as openly as possible (exploratory). These scenarios describe a world of renewable energy (normative) and alternative routes to its greater adoption, bearing in mind the goal situation (backcasting). The scenarios were constructed and clustered on the basis of horizon scanning, which emphasised emerging issues and weak signals (Day & Schoemaker, 2006; Ralston & Wilson, 2006). Weak signals are seeds of change present today that point to emerging issues that may strengthen or not (Hiltunen & Heinonen, 2012; Lesca & Lesca, 2011; Rossel, 2012). By definition, weak signals reveal fresh insights but also embody a great deal of uncertainty.

All the scenarios were constructed as transformational, as the most radical category of Dator's (2009) scenario archetypes, in light of the magnitude of anticipated changes in the energy field. Such scenarios often see change happening as a combination of radical technological and cultural changes. In foresight projects, an ideal number of scenarios has been suggested to be between four and six (see e.g. Amer et al., 2013). In this case, four transformational scenarios were constructed (described in section 3). By nature all of them are possible, and to a varying degree probable. However, the probability was not the starting point for any of the scenarios. The scenario worlds vary considerably, as change can begin from various sources by multiple driving forces and actors. In each scenario, energy is produced with renewable energy (normative) but in different ways (explorative). The scenarios were constructed as generic narratives, not tied to a specific geography, to be used as testbeds in different places, sectors and actor-contexts.

Pioneers leading the way for future changes

In this article, scenarios were used to provide context in the study of pioneering actors that exist in the present. After all, while scenarios can describe transformations, real-life actors actually make scenarios happen (Wangel, 2011). Learning from pioneering and innovative actors has been perceived to be increasingly important in scenario-efforts and other exercises to produce insightful futures knowledge of how societies could be transformed over time (Bennett et al., 2016; Pereira et al., 2018). In futures research and anticipation studies, pioneers are studied to understand how present actions shape the future and vice versa (Miller, Poli, & Rossel, 2014; Poli, 2017).

Pioneers, almost synonymously called forerunners, are determined explorers of new innovation or possibilities who operate between the 'push' of the present and the 'pull' of the future (Heinonen & Karjalainen, 2018; Nygrén et al., 2015; Inayatullah, 2008). They are change agents who operate and can perform within weak systems regardless of limited support (Nehring & O'Brien, 2012).

Pioneers are not a homogenous entity, as they may have different motivations and means on how they plan to achieve their goals. They are individuals, groups of people, collective entities – organisations, states – or even entire cultures. Pioneer analysis assumes that like by observing weak signals, by identifying and observing pioneers, glimpses of a possible future society may be visible (Heinonen, 2017). Whereas weak signals are countless, only a few pioneers can typically be identified.

Pioneers do things differently from others and launch initiatives in the margins. Therefore, pioneers are sometimes compared to and considered as outliers. In futures studies, a growing interest is given to such outliers as bearing foreknowledge of futures. Inayatullah (2008) highlights the role of a creative minority in catalysing transformation. Pioneers imagine a different future, and inspire others to work toward it. Lead users are those who are familiar with conditions which seem to lie in the future for most others, and whose present strong needs can be expected to become general in the marketplace months or years into the future (von Hippel, 1986). Through the lens of pioneers, futures become palpable for the rest of the actors. Their efforts may be merely glimpses of a possible future society, as pioneers are often ahead of their time, which bears a risk of their ideas and actions not being accepted, adopted or appreciated.

From the perspective of adoption, innovators have been found to play a gatekeeping role in the flow of ideas into a social system (Rogers, 1962, 248), but early-adopters can also be clearly seen as pioneers, as sometimes some of the early users. While the two interact closely, innovations mainstream only when they are adopted by the early majority (Moore, 1991). Pioneering ideas brew in niches, and if they are able to surpass critical thresholds or 'tipping points', they may be accepted to the dominant regime (Geels & Schot, 2007). However, an innovation has to be of value, its communication channels functional, the timing right and the social system supportive (Rogers, 1962). Multiple ideas are proposed in times of technological change, and not all of them are necessarily adopted.

Experimentation and learning precede up-scaling and widespread diffusion also in the energy field, and bypassing or overcoming political and institutional forces is of particular importance (Nilsson et al., 2011; Wilson & Grubler, 2011). This makes pioneers, niche innovations and innovative practices an interesting research topic of alternative energy futures. It is assumed that by studying pioneers, insights and identification of potential leverage points for systemic change can be obtained (Abson et al., 2016; Meadows, 2008).

International survey for identifying local pioneers

Different types of real-life pioneers were searched with an international survey as part of an experimental hybrid methodology (Lang et al., 2016).

As a starting point, transformative scenarios until the year 2050 were used to provide context for the identification of pioneers. It was assumed that actors that resemble those mentioned in the four transformational scenarios may already exist in the present. The aim of a qualitative survey, which targeted international experts, was then to identify local pioneers and to learn from their motivations, actions, needs and challenges. It was not known in advance whether the respondents would be able to identify such actors. The aim of the survey was to explore how people locally relate to changes and drivers that are global by nature. The survey respondents were provided with summarised narratives of the scenario sketches as background reading (Heinonen et al., 2016). The hypothesis was that more information can be obtained about the studied phenomenon by immersing the participants into the future. In the survey instructions, they were encouraged to interpret the scenarios and think of actors in their local context that would resemble those in the scenario narratives. Of course, how the respondents actually positioned themselves cannot be determined without gaps. In return, more detailed futures knowledge was assumed to be obtained by identifying forerunners.

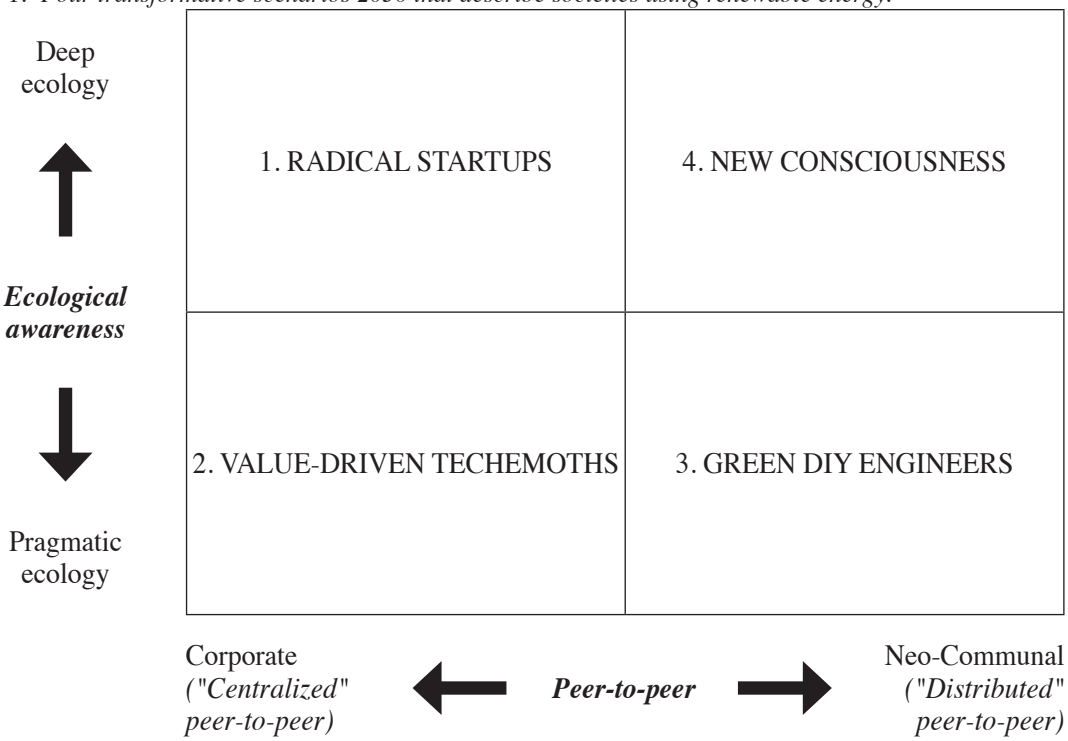
In the survey form, the respondents were also asked to discuss the possibility, probability and preferability of the scenarios. They were not asked to validate the scenarios, and the aim was rather to discuss the possibility and preferability of the scenarios in different local and regional contexts than their probability. Gordon & Glenn (2018) even claim that no scenario is ever seen as probable. The proper construction of scenarios is based on openness – even boldness. Scenarios can be evaluated for "futures reality checking" (e.g. Van der Heijden, 2005, 118). As whole-of-society frameworks, the scenarios describe radical changes into the future, whereas the survey responses would express expert understanding of the seeds of change that are already brewing around the world in the present. The purpose was therefore to also test the relevance of our framework[2] (Heinonen et al., 2017a).

The survey addressed entrepreneurs, energy experts, innovation actors, and an international expert community of futurists, among them members of two major global think-tanks i.e. the Club of Rome, and the Millennium Project. In total, the questionnaire was sent to 160 recipients, and the response rate was 29% with 39 respondents in 14 countries.[3] A summary of the responses, when organised into tables, generated 30 pages of qualitative text materials that was analysed. In light of the survey size, the findings are indicative rather than statistically significant. The respondents were from Kenya, Tanzania, South Africa, China, Korea and Australia, USA, as well as European and Latin American countries. As a result, it was found that almost all respondents were able to identify pioneers based on the scenarios. The findings provide numerous examples of individuals, companies, communities and initiatives around the world.

Glocal insights – international survey findings

The scenarios assume a long-term timeframe until 2050 to explore how a future society and economy could be organised, acknowledging how slowly energy systems change, and to an extent lifestyles too. Based on evidence gathered from a horizon scanning process, which emphasized emerging issues, weak signals, and actors already aspiring for certain types of future lifestyles, the scenarios accept certain assumptions. In terms of societal progress, they are proposing how societies could change for the better. Progress is defined as the degree of emancipation and autonomy of citizens and their communities, while staying within planetary boundaries. This aligns closely with the logic of neo-growth, which is discussed in Section 2.1. The scenarios assume declining costs of energy and technologies, which are promoting more self-organising societies, and describe changes towards a more decentralised energy system, which could be (almost) entirely based on renewable energy. Two critical uncertainties, which underpin the four transformative scenarios are 1) *ecological awareness* (x-axis), as either pragmatic/shallow or deep/profound, and 2) *peer-to-peer organising* (y-axis), within existing organisations, or as a broad-based, neo-communal approach. Each scenario also anticipates shortcomings. For instance, progress could advance the complexity of societies.

Table 1. *Four transformative scenarios 2050 that describe societies using renewable energy.*



The idea was to utilise the scenario framework as a context to a survey to make observations of pioneering actors and practices in the present, by posing specific questions about the scenarios. The survey form included a nutshell description of the scenario narrative and how energy is produced and consumed in the scenario. Each respondent was provided with 17 questions: three for each scenario and their local applicability to identify and examine local change-makers. The respondents were asked to name pioneers that resemble the scenario actors and describe them. The aim was to create a contrast between the present and the transformations anticipated by scenarios, and also to think what type of pioneers could emerge in the future. The possibility, probability and desirability of the scenarios were also asked from the respondents. All responses were categorised, clustered thematically, and then organised geographically.

The scenario nutshell descriptions and results of the findings are presented below.

Radical Startups 2050 scenario

Table 2. *Radical Startups 2050 scenario*.

 RADICAL STARTUPS	*In the Radical Startups scenario society is business-oriented, but economy is driven by a multitude of small-scale startups known for their radical values and approaches. Peer-to-peer is realised in startup networks. Their selling point is promising to do societal and environmental good, and offering workers opportunities for self-expression. Environmental problems are solved first and foremost commercially. Businesses are drivers of new, deep-ecologically oriented lifestyles.*

At first, the respondents were asked to identify local actors that resemble the radical startups in the *Radical Startups 2050* scenario (Table 2). The three questions asked were: Who is radical? What makes the actor radical, and stand out from the others? And, how could society support the efforts of these startups in order to make them flourish?

In their answers, the respondents had different views about startups, radicality and pioneering. According to the respondents, startups can be radical because of their business model, technology, an ability to introduce new thinking or disrupt markets. This allows them to set an example for others. It was noted that an entrepreneurial mindset that drives startups is relevant also in other social experiments and movements. The majority of respondents named technology companies whose products or services are connected to renewable energy: batteries, solar panels, mini-grids, rooftop solar tiles, portable biogas units for organic waste treatment, and drinkable energy-efficient meals.

Solar energy companies, which electrify remote, rural, and low-income areas were named as forerunners by the African respondents. Energy for Development Network forms cooperatives and acts as a micro-finance institution to install mini-grids. Rainwater is also harvested and power sold to businesses, households, schools, and health centres. Jamii Power and Solafrique provide mini-grid systems, Juabar operates a network of solar entrepreneurs and Strauss Energy has introduced solar PV integrated roof tiles. In East Asia, the rapid growth of Internet-based startups was mentioned. An online transaction platform by DiDi Enterprise Solutions has eased traffic congestion and reduced transportations. In Korea, many ecological enterprises were rather considered as social enterprises.

Australian respondents named Sunwiz, AAE AgriEnergy and Tractile. BioBowser Renewable Technologies produces portable biogas units for biowaste. Excellatron, Calera, Aurora Biofuels, and Johansson Global Technology (JGT) were perceived to possess technologies that could change the energy game in other countries. Solar Impulse 2, the solar-powered aircraft, was mentioned as well as Sustentator blog on sustainability solutions, with its over 1 million followers. GoiEner cooperative in Spain uses renewable energy, and in the area of food Growing Power in Milwaukee, US creates community food systems, whereas Ambronite drinkable meals are based on real food ingredients such as nettle leaf, blueberries, spinach and spirulina. Duara Travels provides more equitable and localized travel experiences and gives travellers access to local everyday life in Africa, Asia and Latin America.

In the respondents' view, innovative startups need support, networks and venture capital to realise their projects. In this regard, governments were considered to play an important role. They can provide incentives, remove regulations and taxations that hinder emerging actors. In their energy strategies, they can allow electricity grids to be opened to competition, encourage the use of renewables, and decide to end coal dependence. Chinese respondents, for instance, anticipated the future market power of startups, and argued that governments are in charge of enforcing norms and strengthening networks, whereas startups must use their know-how and pricing strategies to ensure their success. In Korea, some startups were forced to close after a fall in the price of natural gas. It was also mentioned that the advocacy and power of incumbent energy companies should be made more transparent.

Value-Driven Techemoths 2050 scenario

Table 3. *Value-Driven Techemoths 2050 scenario*.

 **VALUE-DRIVEN TECHEMOTHS**	*In the Value-Driven Techemoths scenario, peer-to-peer approaches are common, but they are practiced within large technology corporations. These "techemoths" represent the Silicon Valley vision of emancipation, freedom, creativity and open source. The vision is, however, somewhat self-contradictory. Techemoths cherish the "libertarian" hacker ethos, but at the same time confine their employees tightly within corporate walls. In this scenario, markets take care of environmental issues. Techemoths invest in ambitious energy, technology and environmental projects.*

The questions for the *Value-Driven Techemoths 2050* scenario (Table 3) were the following: Who is value-driven? How do values show in the company's work? And, how could society support these actors and make them interested in the development of renewable energy based solutions and services?

Many respondents named large technology companies and multinationals whose core business is not necessarily energy, such as General Motors, Boeing, Ford, Toyota, Huawei, Lenovo, Samsung, LG, IBM, Phillips, Google, and Unilever. Traditional energy producers and distributors were also identified: Shell, Exxon, BHP Billiton, Exxaro, Neste Oil, Origin Energy, Powershop, Energex and Ergon, PJM, Kenya Power Company, Edeanor and ISA. Technology and telecommunications companies were mentioned especially by the African survey respondents. One explanation refers to the role of technology companies in introducing mobile phones and mobile money, which have transformed lives across the African continent. The respondents also named Mondragon, a federation of workers' cooperatives and China's environmental protection company. Several renewable energy companies were also named: Panax Geothermal, Gamesa, Epuron, Sky Solar Holding Co, D.light, Mobisol, and Mumias Sugar Company. These operate across technologies, such as solar, wind, geothermal and bio-fuels. M-Kopa Solar, which offers a pay-as-you-go model for solar energy in East Africa, was perceived by some a radical startup, whereas other respondents viewed it as a techemoth.

Companies were perceived to become interested in renewable energy because of business logic for profit or cost-savings. This may drive investments in areas such as energy efficiency and R&D, including development of new spin-offs (in ecological business), partnerships, and sponsoring of students. Some companies also build solar farms. It was suggested that when large companies achieve economies of scale, energy solutions can become more affordable. Companies can value their staff, customers and communities and some are reinventing themselves to take advantage of new technology. However, many were cautious of the values of large companies, as in the past large companies have protected their market position by blocking climate change legislation. The public was seen to have an important role in pressuring large companies, so that they can realize their potential for greater social impacts.

Again, the respondents viewed government leadership to be important. A range of measures were proposed, as summarised next. In addition to the catalysing role of carbon tax, possible financial measures include incentives, subsidies, tax breaks, and grants for early stage projects. Access to finance would help investment in green technologies. Overall policy support mentioned rewarding companies who produce renewable energy, access to national grids, and a conducive legal environment that supports renewable energy auction schemes. Governments could be more responsive to private sector initiatives, such as provide fast track procedures for renewable energy

producers, steer public investment in research and development (R&D), and engage in public-private partnerships (PPPs) in investment and production from renewables. Other mentioned measures included the availability of expertise and the reliability of statistics provided by the government.

Green Do-It-Yourself Engineers 2050 scenario

Table 4. *Green Do-It-Yourself Engineers 2050 scenario*.

 **GREEN DIY ENGINEERS**	*After an ecological collapse, society is organized around thriving local communities. Do-It-Yourself economy and practical mindsets flourish, and engineer-oriented citizens live off their skills and knowhow, spread through mesh networks. Tinkering, smart scarcity, local energy production, self-sufficiency and upcycling of products are trending. Nation states and corporations fade away.*

The three questions regarding the *Green Do-It-Yourself Engineers 2050* scenario were: Who is a green do-it-yourself (DIY) engineer? What motivates green DIY engineers? And, thirdly, how can society support green DIY engineers?

The responses describe a diverse range of do-it-yourself activities, which take place in communities, universities, research institutes, schools, but are also promoted by non-governmental organisations, think tanks, individuals and even companies. Ecological farmers, eco-architects, urban gardeners and solar prosumers work, design and conduct research on renewable energy solutions. In Korea, an agriculture technology school inspires their students to practice innovation. DIY communities consist of eco-villages, permaculture and rural off-grid villages, and transition towns that adopt cooperative principles. The culture of Kalahari Bushmen to keep their clans alive or the DIY assertiveness prevalent in Australia examplify mindsets of entire cultures. Such activities can be used to classify DIY as a mentality, activism, learning, statement, business, fun, or a necessity. These effort reflect enthusiasm, values, energy needs, income opportunities and job creation.

In Australia, Tyalgum community aims to cut itself off the electricity grid, the Byron Bay area hosts green, artistic and spiritual communities, and the handymen from the Grey Army can be hired to fix things. Sustainability Institute in the Lynedoch Ecovillage is an experimental space in South Africa, whereas Kitonyoni is an off-grid rural market village in Kenya. RegenVillages is a Tesla type concept of eco-villages proposed by an architectural firm based in Denmark. In China, Home of China Electronics DIY is a community that has registered members who want to showcase their work, including solar-powered lamps, desktops and electronic amplifiers. Incubators or relaxed community spaces can also act as innovation hubs. Tiancunlu community of Haidian District in Beijing is being renovated in collaboration with residents in a way to revitalize its economy while preserving the area's uniqueness.

A few examples of do-it-yourself spirited individuals can be given from the African respondents who emphasized the role of women innovators and informal sector DIY activities. Chebet Lesan makes charcoal from urban waste, David Kinyua installs pico-hydro systems, Diana Mbogo has transformed her skills into an energy business, and Laurian Mchau provides hybrid renewable energy systems. Kibera Lighting Project trains youth in a Nairobi slum to assemble solar lamps. In South Africa, Ugesi Gold SolarTurtle converts shipping containers into mobile solar power stations

in off-grid communities to stop solar energy systems from being vandalised. Innovation hubs such as Kenya Climate Innovation Center (KCIC) and BUNI Hub in Dar es Salaam also help new knowledge to be formed and shared.

The efforts of green DIY engineers could be helped by mentorship in supportive skills, such as how to raise venture capital and enhancing creative and engineering skills, especially in higher education. Connecting education and business sectors was also perceived of importance, and referred to the role of competitions, awards and grants. In the educational sector, entirely new curricula could be created. The respondents interpreted a lack of information of such fringe alternatives a bigger obstacle than technological bottlenecks. Only in extremely harsh environmental conditions, technological breakthroughs beyond what is currently known could be required. This would signify rapid innovation and product development in materials, technology and their operational security. The DARPA tabletop semiconductor factory or NASA research on minimal workable ecologies are present examples that could inspire future initiatives, such as enabling local 3D printing of solar energy.

New Consciousness 2050 scenario

Table 5. *New Consciousness 2050 scenario*.

 NEW CONSCIOUSNESS	*Threat of an ecological collapse and ubiquitous information & communication technologies have led to a new kind of consciousness. Human beings are deeply intertwined with nature and with each other. They do not conceive themselves as separate individuals but form a "global brain". The world is connected by a global super-grid. Environmental problems are not seen as practical issues, but calling for deeper changes in values and mindsets.*

To interpret the *New Consciousness 2050* scenario (Table 5), the survey asked the following questions: What drives new consciousness? Who pioneer new consciousness? And thirdly, how can citizens express their lifestyles through energy solutions?

According to the respondents, the scenario is already driven by environmental degradation, air pollution, water shortages, and the effects from climate change. Some are tired with their governments. There is often a social dimension to environmental issues, which is at times ignored. People begin to search for alternatives because of unreliable energy supply and energy scarcity caused by deforestation, power cuts or price spikes. Especially oil price fluctuations have drastic economic impacts for ordinary people. Before they act, people must first feel a genuine danger.

The scenario forerunners are primarily civil society actors. The anti-nuclear movement is active around the world, and Greenpeace, WWF, the Green Belt Movement (GBM) and Global Alliance for Clean Cookstoves are internationally organised. Community groups, centres, women groups and youth groups act locally. Examples of these are Lighting Manyattas Initiative and Mandeleo Ya Wanawake in Kenya.

Where religious beliefs are strong, spiritual communities, religious movements and churches, such as the Roman Catholic Church and the Quakers, play an important role. The Project 90 by 2030 in South Africa or Dodo ry in Finland are examples of local non-governmental organisations (NGO). Almost all countries have environmental law firms, renewable energy associations, ministries of energy and their sub-divisions. The Space Movement, driven by curiosity to expand civilization beyond Earth, was also mentioned.

Citizens can make informed lifestyle choices: consume ecological products and services, favour

selected companies, choose a vegan or vegetarian diet, reduce energy consumption, use electronic devices less, minimise waste, use and install renewable energy, and choose public transport or car-pooling. Local home-owners can demand for zero energy houses, but living in harmony with nature can also mean traditional lifestyles. African farmers collect cow dung to feed biogas systems. Ethical investment re-allocates economic flows. Public figures, movie stars or business leaders can popularise change agendas. Active individuals have developed measures to assess the carrying capacity locally. Social media creates new groups and networks. In many societies, citizens are able to turn their values into action by joining interest groups, becoming politically active and voting for change-makers.

New consciousness relies on success stories and examples. In Australia, a TV show called Grand Designs presents off-grid houses with distinct architecture, while Ubongo Kids is an edutainment cartoon that teaches science to children in East Africa. African respondents also emphasized the learning aspect of companies' renewable energy products and services. The Internet+ agenda in China promotes digitalisation and the adoption of mobile phones has connected people around the world. Public sector can enforce plans, policies, norms and new practices to motivate mindset change. There were calls for systemic solutions in the spirit of circular economy principles and rurbanisation to ensure self-sufficiency and optimising resource use. Those in Australia noted that even if solar installations have mainstreamed, thinking overall has not changed.

Possibility, probability and preferability of the transformative scenarios

This section presents the respondents' thoughts of the scenarios in terms of their possibility, probability and preferability. Again, it has to be borne in mind that none of the scenarios was constructed on a probability basis. The core idea was to learn from the evaluations that the respondents from different countries and cultures give to the scenarios.

Not a single respondent found none of the scenarios possible, and most found at least two of them possible. This suggest that the while the scenarios are transformative, they are not utopian. A fifth of the respondents used cultural reasons in their arguments and referred to how a scenario connected with a local social system, such as beliefs, customs or habits. Economic reasoning and logic showed in the views that perceived Value-Driven Techemoths 2050 and Radical Startups 2050 as possible scenarios. Several respondents expressed dissatisfaction with the current politics, underscoring political reasons. Related examples are provided below.

> *"Radical startups and Green DIY engineers will most probably increase as people get more fed up with existing systems." Respondent, Kenya (Radical Startups 2050, Green DIY Engineers 2050)*

> *"With the rapid development of China's economy and society, more and more people are conscious and have the ability to participate in entrepreneurship and environmental causes." Respondent, China (Radical Startups 2050, Green DIY Engineers 2050)*

> *"We have a business environment that encourages radical start-ups and innovation ecosystems. The Deep Ecology philosophy would not be as strong here as, say, New Zealand." Respondent, Australia (Radical Startups 2050, Value-Driven Techemoths 2050, Green DIY Engineers 2050)*

Assessments of the probability of different scenarios often mirrored the respondents' responses. If explained in another way, evaluations of probability seemed to align with a respondent's experience and worldview, suggesting certain bias. This illustrates why it is difficult to assign scenario probabilities. Almost half the respondents viewed Value-Driven Techemoths 2050 scenario

as the most probable one, emphasizing corporate power. It was also mentioned that today's radical startups can become tomorrow's techemoths, and techemoths can incubate new startups. East Asian respondents placed their bets across several scenarios. A few respondents considered the scenarios improbable, but possible.

> *"Ordinary citizens still believe in "natural hierarchy/leadership", and the average person will most likely expect solutions from a higher power/authority, rather than being proactive and personally responsible. At least this way there will be guaranteed tangible results." Respondent, Australia (Value-Driven Techemoths 2050)*

> *"There is already a way in which the startups are driving the society. […] They have also shown changes in the society and also changed some of the rural areas to [become] town centers." Respondent, Tanzania (Radical Startups 2050)*

> *"The leading companies in renewable energy sources have been growing in the last decade and it seems they will continue becoming global companies." Respondent, Spain (Value-Driven Techemoths 2050)*

The respondents' had clear preferences over the scenarios. Over two thirds preferred deep/profound ecological thinking: 41% of respondents favoured New Consciousness 2050 scenario, and 31% chose Radical Startups 2050 scenario. Most evaluated the scenarios based on their ability to advocate for transformative change. Value-Driven Techemoths 2050 scenario was preferred by less than a fifth of the respondents. Green DIY Engineers 2050 scenario was the least favoured, possibly because its scenario pathway describes an environmental catastrophe as a turning point.

> *"To me self-control, self-esteem, open mind and self-regulation are the elements that make new consciousness preferable for China. These traits can make public to think and try new methods and keep going until the final result." Respondent, China (New Consciousness 2050)*

> *"Due to cultural reasons (social inertia, individualism, consumerism), Argentina is a society that needs to be shaken to breakdown with well-entrenched practices in most domains of social life." Respondent, Argentina (Radical Startups 2050)*

> *"Green DIY scenario with increased local community participation provides a viable option for survival of vulnerable communities." Respondent, Kenya (Green DIY Engineers 2050)*

Discussion

The survey investigated pioneering in the present, as similar types of actors already exist – as sowers of the seeds for the coming transformation in the field of renewable energy and ecological lifestyles.

We expected the survey respondents to look at the scenarios from their own perspective. The answers show that most respondents were able to identify many types of pioneers and niche practices. Pioneers were identified who live and lead by example, bring people and experts together, bring about new, alternative values, and drive environmental awareness. The off-grid movement makes a good example. Many of the initiatives and future visions challenge also capitalism in its present forms. It seemed surprising to discover that the actors and initiatives named by the respondents were less radical than the organisational models given to the respondents in the scenario

narratives. On hindsight, this illustrates the temporal aspect of pioneering. Today's pioneers grapple with different problems than those in the future.

The purpose of the survey was to focus more on possibility and preferability than evaluating probabilities. The respondents favoured New Consciousness 2050 scenario, which was identified as a basis for the realization of all other scenarios. A question arises, whether the Green DIY scenario of local, self-sufficient renewable-energy based communities would have been more highly appreciated, if the scenario pathway had been free from collapse. The notions of preferability and probability contradicted, as expected. The respondents seemed to assume rather effortlessly a logic of referring to local or national characteristics, and even to stereotypes. What was considered positive or negative seemed to depend on the respondent's own background, and the methodology generated responses that emphasized the cultural added value that makes a scenario fit a particular context.

The respondents' views are a helpful starting point for understanding what may advance or stop the scenarios. This makes the findings useful also in any efforts that seek to envision desirable social practices. There were similarities, for instance, in the needs of startup entrepreneurs and do-it-yourself engineers. Further research could investigate how governments can catalyse and reward pioneering initiatives for them to have room to flourish. Many respondents were frustrated, such as one respondent in Australia who complained the government's inability to envisage "a plausible post-capitalist, post-growth, world operating system. Many hoped their governments to step up, and drive new sustainable visions for their countries. States have investments in the energy sector through state-owned enterprises, parastatals and other arrangements that need to be changed.

For some respondents, imagining a transformation of a major scale seemed overwhelming. New practices challenge stakeholders due to general resistance to change and a feeling of unease, when stepping out of the mainstream box. However, exploring new paradigms is a central part and task of strategic foresight (Lustig, 2015, 136). It provides "future proof" i.e. better preparedness for futures when actors consider how the new paradigm affects their organisation. This emphasizes the nexus of foresight and action, and according to Lustig (2015) the practice of strategic foresight is all about action. Masini (2006) also advocates "acting for the future", and reminds that preferred futures must not be utopias, but linked with the required action and actors. Masini (2006) further highlights underlying values and subsequent choice. Our future must not be foreseen and dreamt of, but also chosen and built.

The exercise engaged experts across a number of countries to a foresight project and allowed testing the practicality of the transformative scenarios. The initial scenarios were actor-focused, but the role of forerunner actors in them was at most implicit. As an analytical approach, pioneer analysis expresses the potential of pioneers in driving scenarios. In this case, even entirely new types of actors not discussed by the scenarios were identified, such as the role of churches and religious groups in enhancing climate change awareness. Pioneers are not necessary industry leaders, and can be even more anonymous to others outside that field. The exercise also provides grounds to study the identified pioneers and their strategies in more depth. The scenario-relevant pioneers could also studied comparatively, for instance within or across countries or regions.

In a field where transformations are anticipated, studying pioneers in the present may provide insights of future worlds, and illustrate the gap between the present and what is envisioned. Pioneers aim to reach realize their preferred futures. To sum up, as Smil (2017) reminds us, energy transitions and related transformations are a complex and evolutionary issue, full of national and regional differences. Anticipated transformations in the energy sector are often described in a narrow techno-economic sense, but were here described through the socio-cultural scenarios as immersive narratives. In this case, the scenarios emphasised the role of information and communication technology. The chosen methodology of using pioneer analysis with transformative scenarios allowed studying change as a fundamentally socio-technical process (Wangle, 2011b) and draws our attention to agency.

This methodological experiment suggests that the identification of pioneers has to be combined with monitoring how they can make and are making change happen in the forefront. Any efforts to achieve lasting change need not only ask who are change-makers or change-enablers. They must also carefully examine how the change is being made, and then carry those efforts forward.

Conclusions

This article identifies pioneers around the world who are leading the adoption of renewable energy technologies and ecological lifestyles.

The pioneers were identified with a hybrid methodology of transformative scenarios whose actors were anticipated to become focal actors in future societies and a hypothesis that it is useful to explore them more deeply. Transformative elements were captured throughout the research process – from the phase of collecting weak signals in horizon scanning, crafting socio-cultural energy scenarios and in the pioneer analysis based survey. Four transformative scenarios until 2050 describe how societies, which adopt large shares of renewable energy, could change. A qualitative expert survey was then conducted to search for local pioneers that are potentially driving such futures. A number of pioneers were identified compared to the initial scenarios, which only mention few forerunners. The purpose of the exercise was not to test the accuracy of scenarios or the power of forecasting. The methodology allowed more to be learned from these pioneering efforts.

The article finds pioneer analysis as a useful method in exploring transformations. This methodology connected transformative scenarios with an expert survey in order to explore a series of local narratives, trends and issues. The findings cast light on a multitude of arguments about the changes required for transforming the energy system and the economy, which are in present deemed to operate at an unsustainable mode. The expert responses illustrate how different actors around the world perceive their societies and the possibilities for change. The efforts of real-life pioneers also show that there is a gap between present initiatives and envisioned future transformations, which could be studied in more detail. In this case, the strength of scenarios is in how vividly they can show manifestations of possible alternative futures.

Can governments appreciate the work of pioneers and the value of eccentric initiatives? Change starts from somewhere – often on the fringes of existing regimes. In this respect, the key questions are *what* can be learned from the pioneers promoting renewable energy or innovating novel social practices, and *how* can those pioneers be supported. If a renewable energy system is adopted in the future, it could change societies as a whole. Vice versa, as multiple steps exist between the present moment and alternative futures, individuals, groups and nations will shape the trajectories of such transitions. Only after persistent efforts, some of the initiatives evolve or catalyse related efforts, which begin to disrupt the status quo over time.

The findings support the view that pioneering activities, present and future ones, are required for tackling major global challenges. If some of the pioneering efforts succeed, it is possible that they can also become the drivers of alternative energy futures.

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Endnotes

1. Neo-Carbon Energy research project, read more at: www.neocarbonenergy.fi/library (whole project) and https://www.utu.fi/en/units/ffrc/research/projects/energy/Pages/neo-fore.aspx (foresight part of the project).
2. The scenarios were finalised later in the foresight project (see: Heinonen et al., 2017b).
3. The response rate can, however, be considered good when bearing in mind the long background report (over 80 pages) that the respondents were asked to read.

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