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Key actors and actions towards Neo-Carbon Finland 2050

Building blocks for roadmap and action plan

December 2017

NEO-CARBON ENERGY WP1 WORKING PAPER 2/2017

NEO CARBON ENERGY

VTT

LUT Lappeenranta University of Technology

Turun yliopisto University of Turku

FINLAND FUTURES RESEARCH CENTRE

The report is available online: http://ty.fi/neofore

ISBN 978-952-249-490-0

Cover Photo: Shutterstock

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PREFACE

This document is part of reporting of the results achieved during the second funding period of the *Neo-Carbon Energy* project Work Package 1: *Neo-Carbon Enabling Neo-Growth Society – Transformative Energy Futures 2050,* Task 1.3: Neo-carbon energy market & game-changing actors. The second funding period was run between 1.7.2016-31.12.2017.

As a targeted outcome of the actor analysis in NCE project, a robust action plan with needed stakeholders and other actors will be created. To serve this goal, in the second funding period, especially the questions of the most important next steps in Finland and who are the most important actors are approached, aiming to deepen the results achieved in the first funding period.

This document describes the actor analysis research conducted in the second tunding period. As its core part, a workshop was designed and implemented to kick-start the research and boost collaboration on February 23rd, 2017 in Espoo, Finland. The results of the workshop are presented and further analysed in this report.

Neo-Carbon Energy project is one of the strategic research openings funded by Tekes – the Finnish Funding Agency for Innovation. The project is carried out in cooperation with Technical Research Centre of Finland VTT Ltd, Lappeenranta University of Technology LUT and Finland Futures Research Centre FFRC at University of Turku. The authors wish to thank advisory group and research colleagues for valuable comments and inspiring discussions.

Research group of WP1 of the NEO-CARBON ENERGY Project

Espoo 1 December 2017

EXECUTIVE SUMMARY

The results on the most important next steps in Finland and who are the most important actors for the realisation of "Neo-Carbon Finland" are approached in this report. The results are based on workshop, organised on February 23rd, 2017 and participated by 16 experts from different disciplines of the energy sector.

A substantial share of suggested pioneer actors falls under categories of business, citizen movement and new type of community actors. In business sector, the role of startups and new type of business actors was particularly highlighted in suggested development of non-energy companies entering the energy business. The public actors were reflected more concretely as cities or city-owned companies. In addition, different governmental actors were particularly emphasized as executors of the actions considered. Further, the role of funding and related organisations was highlighted repeatedly. Both international and national funds, as well as crowdfunding were mentioned.

The results provide a basis for designing a roadmap and action for Neo-Carbon Finland. Especially, the next electoral terms and Governmental Programmes were suggested as concrete steps for actions in Finland. A list of concrete actions suggested include e.g. *bans on fossil fuels, new intended nationally determined contributions (INDCs), subsidies or the termination of harmful ones, reforms in taxation, campaigns, refocusing national strategies, R&D support, a renewable energy (RE) minister, free public transport, and boosting ecological lifestyles*. The full list of ideas is presented in the end of this report. Citizens are suggested to be empowered, when they act through citizen movements. Citizens appear particularly strongly as pioneer actors, when they make their voice heard in online communities. *Involvement, concretization, learning, influencing attitudes* are mentioned as examples from actions targeted at this group.

Despite the relative significance of non-technological actors and actions, Electric Vehicles and related technologies are interpreted as the strongest signal of the actors and actions in the technology development field. This is justified by the fact that it was highlighted by all the groups participated in the workshop.

It may be concluded that the action plan should aim to achieve change and aim to empower the identified key actors to help change the status quo. This is where political will and a supportive policy environment can play their part. Envisioned change could mean the rise of new business actors as well as further empowerment of citizens and communities, breaking conventional boundaries. Aided by a culture of experimentation, these initiatives can together help drive the adoption of emerging neo-carbon energy technologies and principles.

LIST OF ABBREVIATIONS

CCU	Carbon capture and utilization
CLC	Climate Leadership Council
CHP	Combined Heat and Power
DIY	Do-It-Yourself
EU	European Union
FFRC	Finland Futures Research Centre
FP	Funding Period
INDC	Intended Nationally Determined Contribution
LUT	Lappeenranta University of Technology
MaaS	Mobility as a Service
NCE	Neo-Carbon Energy
NGO	Non-Governmental Organization
PESTEC	Political, Economic, Social, Technolgical, Environmental/ Energy, Cultural/ Customer/Citizen
P2G	Power-to-Gas
PV	Photovoltaic
RE	Renewable Energy
RES	Renewable Energy Sources
UN	United Nations
UTU	University of Turku
VC	Venture Capital
VTT	VTT Technical Research Centre of Finland Ltd.
WP	Work Package

CONTENTS

1. INTRODUCTION

Goals and background of the report

A move towards 100 % renewable energy based system highly based on solar and wind is a high-level topic of the Neo-Carbon Energy (NCE) project. Neo-Carbon Energy project is one of the strategic research openings funded by Tekes – the Finnish Funding Agency for Innovation. The project is carried out in cooperation with Technical Research Centre of Finland VTT Ltd, Lappeenranta University of Technology LUT and Finland Futures Research Centre (FFRC) at the University of Turku.

During the course of the project, started in 2014, there have been various strengthening indications of development turning in the aforesaid direction. Most importantly, the Paris Climate Agreement signed in late 2015 can be mentioned as a major milestone. Consequently, over the last few years, there has been plentiful of debate of accelerating technological development of renewable energy sources (RES) and adjoining, for example, battery technologies, to boost the evolution. What is more, there has also been a lot of discussion on strategic moves of, for example, industrial players and funds, as well as nations and nation groups that all could be seen strengthening the development.

As its core mission, the Neo-Carbon Energy project aims at studying completely new type of clean energy system. The methodological portfolio of the NCE project includes a wide assortment of methods to tackle the issue. Often, however, the discussion is concentrated on techno-economic analyses, and only a superficial consideration of actors who could have an impact on necessary developments. Consequently, in the first funding period of the NCE project, we mapped methods that could be used to study the actor dimension – i.e. briefly turning the focus to a question of *who* instead of *what*. The results of the first funding period clarified the concept of actor analysis for its tailored use to serve the goals of the NCE project.

According to a review conducted in the first funding period (Similä et al. 2016), actor analysis methods were identified to often being based on interviews, workshops, focus group discussions, and other qualitative methods, or questionnaires potentially relying on statistical analysis. Often, the application of these methods concerned local and more specified questions rather than global megatrends. Consequently, it was concluded that further collaboration with the NCE business case studies of the Neo-Carbon Energy project – and potentially the actual identified key actors - might provide with the most promising opportunities in deepening the actor analysis. On the basis of this finding, a workshop was designed and implemented to kick-start the research of the funding period 2. The results of the workshop, which was organised on February 23rd, 2017 at VTT in Espoo, Finland, are presented and further analysed in this report. The reporting of the workshop as a whole is presented in the Appendix.

Key actors of the future are not necessarily today's incumbents. One study during the project examined how renewable energy pioneers around the world are driving change

and nurturing a sense of urgency (Lang et al. 2016). A questionnaire addressed an international expert community of futurists, energy experts and entrepreneurs. The survey results suggest that an entrepreneurial mind is needed whether starting a social experiment, a movement – or a startup. It also suggested that support is needed to those pioneers identified as making a preferred future to be realized – locally and regionally. In providing the necessary support, much was expected of governments. On one hand, to lead the way, and on the other, to create a conducive environment that facilitates desired transformations.

As a targeted outcome of the actor analysis in the NCE project, a robust action plan with needed stakeholders and other actors from national perspective will be created. To serve this goal, the questions of the most important next steps and the most important actors for Finland are approached. Clearly, this task calls for appropriate governance and policy analysis and has a linkage to energy and climate strategies.

The ideas on key actors and actions presented are based on the workshop results and ideas suggested by its participants representing e.g. research, company, foundation, and funding actors in the field. Furthermore, the goal of the report is also to deepen the actor analysis and validate the results suggested by the research of the first funding period.

The report is organised as follows: Chapter 2 links the work to the earlier phases of the project and discusses how a vision developed is formulated as a basis of actions in Finland. Chapter 3 reports and analyses the results of a workshop arranged on February 23rd, 2017 to identify the key actors and actions for Neo-Carbon Finland. Chapter 4 summarizes and discusses the significance of results.

2. VISION OF THE NEO-CARBON PROJECT AS A BASIS OF ACTIONS

Terminology and concepts

As this work aims at identifying the key actors and actions for Neo-Carbon Finland as building blocks of the roadmaps and action plans, we first briefly discuss the related terminology.

It is safe to say that terms "*roadmap*" and "*action plan*" are used in several meanings in public media. Also, there are many definitions in the literature. Roadmap, generally presents a plan to achieve something: it "*describes the stages, through which the destination is planned to be achieved*". Action plan, on the other hand, *may help us turn our dreams into a reality. Furthermore, it assists us to find a way to make sure our visions are made concrete and describes the way how strategies are used to meet objectives,* as Similä et al. (2016) reviewed. Thus, immediate specification needs emerge when considering key actions and actors for Neo-Carbon Finland.

- Whom should an action plan concern? I.e. who is the "owner" of an action plan and whose destinations, dreams or objectives should be addressed?
- Should the actions be somehow restricted? That is, should we concentrate on actions that are under control/controllable of "the owner"?

Generally, *a vision* describes a desirable state of future. In the Neo-Carbon Energy project, there has been a lot of work on making descriptions on the future both in global and Finnish contexts. Methodologically, both qualitative and quantitative approaches have been used to map different future possibilities to outline the prerequisites of the vision.

Key actors can consist of individuals, communities or organisations in the public, private sphere, third – or the fourth sector[1]. In this project, pioneering actors have received particular attention. Pioneering draws from the innovation diffusion model and emphasizes the role of problem-solving to overcome bottlenecks to change. Only a few are needed to initiate changes and the rest will follow, if the circumstances make it possible.

The significance of earlier results of the project

As an overall target of the actor analysis and the action plan, added value in the techno-economic analysis carried out in many of the sub-tasks of the NCE project, is targeted. The results achieved in earlier phases (Table 1) are utilized in the task in the manner we discuss in the following.

[1] A new, fourth sector of the economy is suggested to consist of both for-profits, advancing social goals, and non-profit organisations using market-based approaches. To advance societal benefits, the 4th sector operates at the intersection of the traditional sectors. See e.g. https://www.weforum.org/agenda/2017/09/fourth-sector-chance-to-build-new-economic-model/

Table 1. Phases for identifying and adding actors and developing an action plan for Neo-Carbon Finland.

	RESULT		
	Actor Analysis methods	Vision	Key actors and actions[2]
Phase	Funding period (FP) I	Funding period (FP) II	Funding period (FP) II
Focus	Global, four different futures	Global, one desirable future	Finland, one desirable future
Methods/ knowledge base	Scenarios developed, word analysis, review of computational methods	Synthesis of other results, literature	Workshop-based
Documented in	Similä et al. 2016	Ruotsalainen et al. 2017	This report
Actor dimension	Long list of potential actors, preliminary suggestions for their significance, classifications	- (Implicit)	Identification of key actors and actions from the perspective of Finland

Table 1 classifies the phases of the research in NCE project to identify the key actors and actions for Finland. The main result described in this report is given in the right-hand-side column that is, identifying key actors and actions for Finland. The effort builds on other parts of the work as illustrated in Table 1.

The efforts of adding actors in the global Neo-Carbon scenarios in the first funding period were mainly based on scenarios developed by UTU/FFRC. These scenarios are qualitative narratives that describe possible transformations towards a neo-carbon powered future to be more deeply examined. Similä et al. (2016) dealt with the scenario narratives drafted in Heinonen et al. (2015)[3] and considered different methods to identify and add actors to scenarios of that nature. Thus, the actor analysis (Similä et al. 2016) in the first funding period was based on foresight methods and also to a lesser extent on collaboration with research on business cases. As a result of the effort, the key actor types and differences between the scenarios with respect to actors could be suggested somewhat preliminarily and descriptively. That is, a long list of suggestions of actors could be defined for each of the global meta-scenarios (*Value-driven Techemoths, New Consciousness, Radical Startups, Green DIY Engineers)* each outlining a set of different type of transitions towards the neo-carbon energy system. Further, classifications of key actor types were produced. These results are reflected in Finnish context in discussion section of this report.

[2] Results on key actors and actions can be used as components of action plans and roadmaps.

[3] At the end of the Neo-Carbon Energy project a final scenario report was published with storylines and narratives (Heinonen et al. 2017).

Vision and its enablers

Importantly, if an action plan draws from scenarios, the different descriptions of the future outlined in the scenarios must be carefully considered. Despite the fact that any scenario describes a state of the future, they are not self-evidently straightforwardly utilizable in developing an action plan. As an extreme example, it is difficult to see the benefits of preparing an action plan to achieve a "worst case scenario". Thus, an action plan, when drafted, clearly, must reflect a relevant target from a certain viewpoint or for certain actor. For this purpose, a vision, in contrast, describes a *desirable* state of the future by definition and thus appears as a natural basis. Thus, the vision developed by Ruotsalainen et al. (2017) in the Neo-Carbon Energy project is considered a good starting point for defining an action plan. Figure 1 presents the key points of the vision developed.

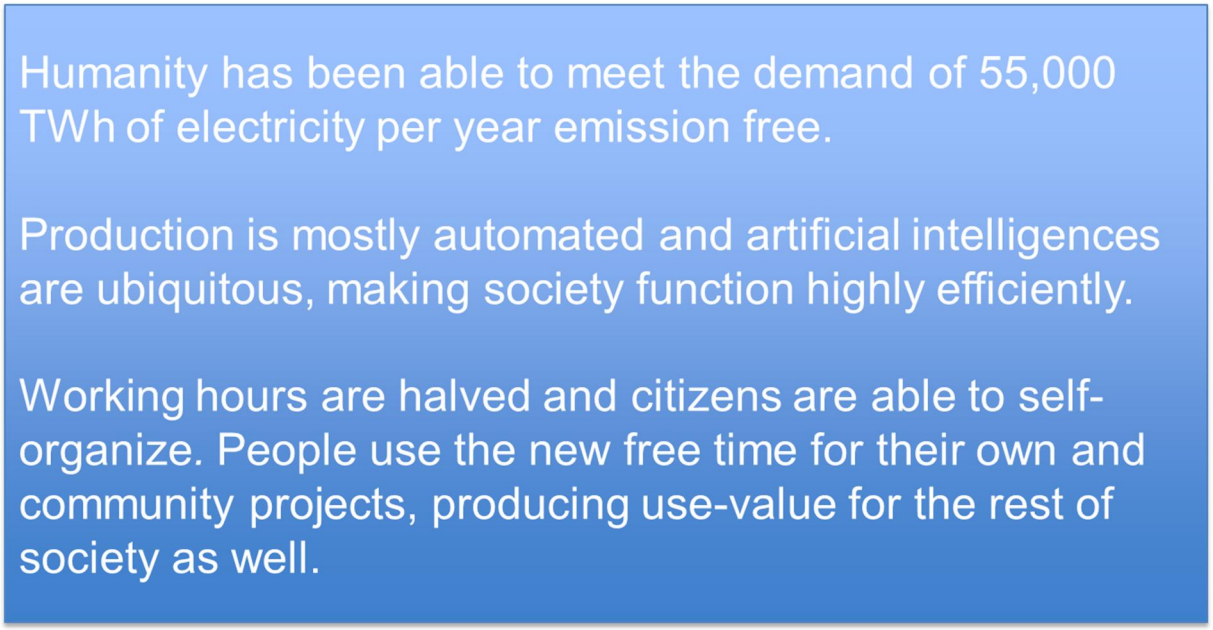

Figure 1. Global societal vision 2050 (based on Ruotsalainen et al. 2017)

The vision depicted in Figure 1 can be characterized as generic. That is, as a societal vision is discussed, one must aim for something that can be widely accepted. In this respect, increased leisure time, efficient functioning of society and emission-free electricity supply outlined in the vision seem relevant characteristics. In principle, they can be conceived to be desirable social goals. To identify concrete steps and make the vision more specific for examining the energy system transition, a need for further processing can be identified, as will be done in the forthcoming parts of this report.

To bring the vision nearer to actors and actions for Finland, Figure 2 depicts a high level Neo-Carbon vision – formulated for Finland. It describes *Finland as a front-runner in Paris Agreement implementation.* This formulation includes an idea of Finland becoming a "net beneficiary" in energy system transformation, and follows the vision expressed in Figure 1. In this way, the inevitable changes e.g. in energy and industrial production systems, transportation, and consumer behaviour, which are characteristic of a future neo-carbon based economy, are targeted to be turned positive from the viewpoint of Finland. *Transformative leadership* is seen as a high-level mode of strategic planning in targeting this societal vision. In the envisaged operational environment, it is expected that *new actors*

and a *new industrial organization* emerge in one way or another. As a final layer in Figure 2, consideration of what kind of *piloting* would be needed or seen supporting the achievement of the target, is understood to be relevant.

Figure 2. Vision and its enablers.

National *governance and policy* have a clear influence in the operational environment in all the layers depicted in Figure 2. On one hand, national-level policies can reflect transformative leadership to different extent; on the other hand, e.g. financial support policies concerning piloting can directly impact the realisation of these often capital-intensive activities. Figure 3 presents the high-level elements of the Energy and Climate Strategy 2030 for Finland that was being introduced in November 2016 by the Government of Finland. As can be seen in Figure 3, the strategy includes several targets that are parallel to and can support the implementation of a "NCE type" energy system highly based on wind and solar energy.

For this report, the Government strategy was a starting point for the discussion and thinking process. That is, do the strategies appear sufficient to steer developments to support the adoption of a Neo-Carbon Energy system – or is something else needed, especially when a long-term future until 2050 is considered? In case of the latter, what could the concrete actions be? These questions are addressed in the following chapters of this report.

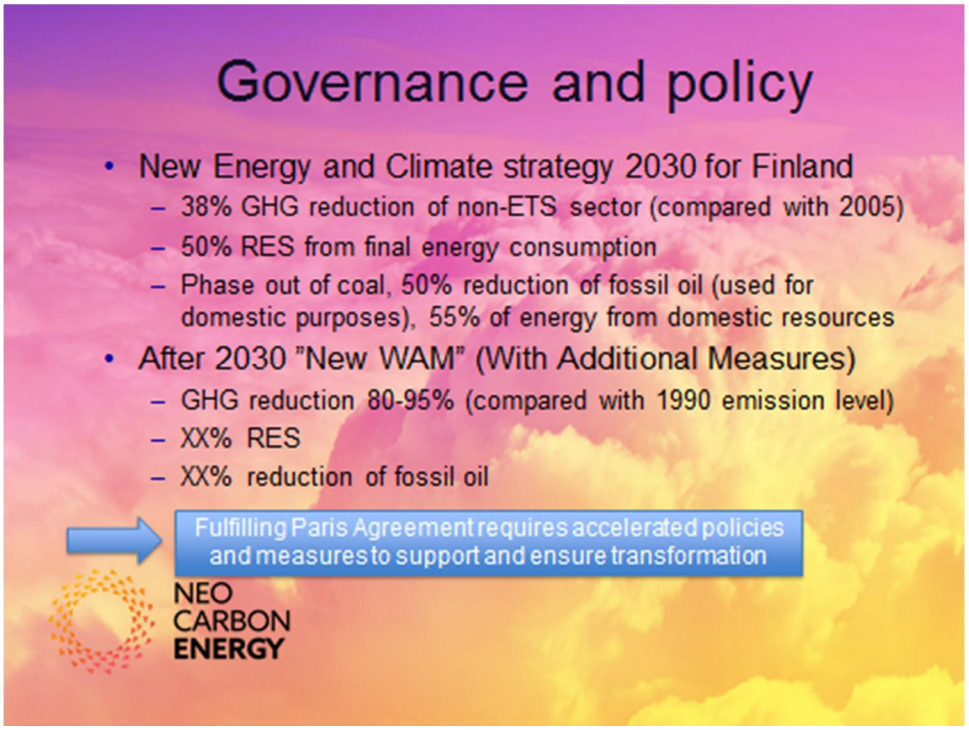

Figure 3. Governance and policy framework in case of energy system transformation in Finland until 2030 and 2050.

3. FROM VISION TO ACTION

Working process

The key actors and actors presented in this report are based on the Neo-Carbon vision that was elaborated in a workshop organized on February 23rd, 2017 in Espoo, Finland (see Appendix and Chapter 2). The event was participated by 16 experts from different disciplines of the energy sector. The key results of the workshop are presented in this Chapter.

The aim of the workshop, organized as group work, was declared as '*to define building blocks for roadmap and action plan for "Neo-Carbon Finland 2050"*'. As a guideline, the participants were instructed to think of Finland as a front-runner in climate change mitigation, implementation of the Paris Agreement and the "new economy" characterized by robotization, environmental businesses, et cetera. Noteworthy, the starting point embraced possible positive outcomes of the energy transition. This way, the target was to identify opportunities for Finnish actors.

The following questions were addressed to the participants to brief them in working:

- *Who are or could be the key actors? What actions would be needed?*
- *Potential actor types include businesses, public governance organizations, citizen organizations, consumer groups, etc…*
- *Potential actions appear in fields of policies, technology development, piloting…*

The issues were worked by three individually organized groups consisting of representatives from research, funding, industrial, and other organizations involved in the scope of the Neo-Carbon Energy project (see detailed agenda and participants in Appendix). The participants were primarily recruited from the advisory board of the project. This selection verified an appropriate level of knowledge of the project and enabled that the focus could be efficiently turned in the more specific research questions this report is about.

The workshop utilised established futures research methods, *Futures wheel* and *PESTEC table*, which were tailored for the event by researchers from VTT and UTU/FFRC in January-February 2017. Futures wheel is a method appropriate for structured idea creation and brainstorming on future-oriented issues (Glenn 2009). PESTEC table is a futures table, which allows ideas to be structured across six dimensions: political, economic, social, technological, ecological, and cultural/citizen/consumer (Heinonen and Ruotsalainen 2013, 6). The target of identifying the key actions and actors was divided in two main phases, the results of which are presented in the following sections: that is, (i) key actors, and (ii) key actions were dealt with.

Who? Key actors

An established futures research method of *Futures wheel* was used in studying the "*who"* dimension in order to identify the key actors. The groups were instructed as follows:

- Discuss the issues in groups
- Each writes his/her thoughts on post-it notes and places them on the futures wheel
    - Inner circle: identify who are or could be the pioneer actors today – existing and imaginary. Especially, identify the most important actors to make Finland a front-runner and "net beneficiary" in climate change mitigation.
        - If/when you come up with imaginary actors, describe briefly what they do or produce. What kinds of actors are currently missing in Finland?
    - Second circle: Products and operation models
        - What products and services do they offer? What are industrial organisations like? How do they operate to reach their goals? Etc. (2020-30)
    - Third circle: How could the actor(s) develop by 2050? What could the business ecosystem be like in 2050?

To avoid interfering with the participants' thinking process, the suggestions of key actors developed in the earlier phase of the project (Similä et al. 2016) were not specifically introduced to participants. This also makes it possible to compare the results and analyze the validity of results achieved earlier in FP1.

To serve the goal of achieving unbiased reporting, the following summary presentation is based on the work by two researchers who worked independently with the materials. That is, one researcher worked on the basis of notes of oral presentations delivered by the groups, whereas the other studied the written notes produced by the groups. Furthermore, this selection aimed at filtering the most important conclusions of the groups as in the summaries, choices had to be made from the abundance of ideas generated in the futures wheels and PESTEC tables. When in brainstorming mode a wealth of ideas is produced, promising ideas can be lost, unless carefully documented. In the following, conclusions that target at robustness as being supported by both the approaches, are presented. The products of the groups as a whole are provided in the Appendix.

Actors and their roles identified

Table 2 summarizes the findings based on the researcher's summary of the notes produced by the three groups in the workshop (see complete results in Appendix). Naturally, the brainstorming of dozens of experts intrigued plentiful of suggestions. In the compilation of Table 2, the ideas are classified and their suggested drivers, barriers and role presented based on actor groups identified in earlier report by Similä et al. (2016).

Table 2. Actors classified: What actors could be needed to enable a "Neo-Carbon style" energy system transformation?

Types of actors, e.g.	Actor (list who?) Make notes on role	Change needed/ Driver	Barriers	Timeline (<5 years, ~10 years, 20-30 years)	Importance (low, medium, high)
Businesses	Venture capitalists (VCs), Startups (e.g. CO2 esto, Joukon Voima), renewable funds	New business ideas that foster green growth, investment in green technologies	Market mechanism: investing in a cleaner future means everyone get the benefit –how can the investor profit?	Starting now; very important over the next 15 years	Important now to get the ball rolling.
Research and technology	Methane synthesis, CO2 capture and utilisation	Driver: the need for energy-intensive fuels with no emissions.	Expenses. How to attract investments?	Research now under way. Commercial solutions available in 2050.	High
Authorities	Legal: make laws enabling of a carbon-neutral future; Political: promote not only ecological but also social and economical sustainability	Large changes needed, consistency in policy is important, important not to forget about other societal aspects when pushing for the big emission reductions	Polarized political playing field, protectionism, fear, alternative facts.	From now until the goals are reached	Very high
Organisations, NGOs	Climate Leadership Council (CLC), World Wildlife Fund (WWF), Smart & Clean Foundation (S&C)				Important in showing the way and creating momentum
New services	Mobility as a Service (MaaS), a bank card that measures your emissions, energy as a service	Empower and engage consumers.	New meters & infrastructure needed for energy as a service?	<5 years, more for energy as a service	Important now to get the ball rolling. Could be very important in 2050?
Consumers	Online communities (Uusi energiapolitiikka & Energiaremontti Facebook groups),VCs, city "champions", crowd funding of RES	Driver: people's will to participate & do good	Bureaucracy, knowledge gap: what actually needs doing?	Starting now, growing in importance over time	Increasing over time.

A look at Table 2 suggests significantly new type of actors compared to traditional energy system actors who are heavily relying on the elements of centralized operation. The traditional energy system actors can be stated to include, for example, energy producers, transmission and distribution utilities, and end-users of energy in different end sectors such as buildings, industry, and transportation.

According to results of the workshop, a major share of the suggested pioneer actors fall under categories of communities, citizen movement actors, or new type of businesses. Startup companies were seen as the prime mover in business sector. Perhaps the surprisingly small appearance of traditional energy sector businesses is worth noticing. The role of new type of business actors was particularly highlighted by a note of Group 2 that pointed the development of non-energy companies who are entering the energy business. Further, the role of funding and related organisations was highlighted repeatedly. Both international and national funds, as well as crowdfunding were mentioned.

Despite the suggested rise of new types of actors, the role of authorities is still considered very significant according to the evaluation presented in Table 2. Here, consistency in policy is pinpointed while it is also vital not to forget about other societal aspects when pushing for the big emission reductions. The role of consistency in policies and by authorities was pointed out. It was perhaps particularly underlined with the global phenomena discussed during the time of the workshop in early 2017. That is, the world is seen having increasingly elements of a polarized political playing field, protectionism, fear, and alternative facts. Such phenomena have been epitomized with the political developments and public opinion divides in the U.S.

The role played by citizen movements appears to be particularly strong in the different forms of online communities. New communication technologies are also seen to leverage new services and funding mechanisms such as crowdfunding. That is, new services such as MaaS, Mobility as a Service, and energy as a service are seen important to "get the ball rolling" and consumers engaged to leverage the energy system transformation. What is more, non-governmental organizations such as Climate Leadership Council, Smart & Clean Foundation and WWF are seen as examples in having a role in in showing the way and creating necessary momentum.

Drivers and barriers

According to the summary results presented in Table 2, the key driver or change needed for businesses in comparison to the current state emerge as new business ideas that foster green growth. Additionally, investment in green technologies is seen driving the development towards a neo-carbon energy type of energy system. As a barrier, the functioning of the current market mechanism was discussed. That is, although investing in a cleaner future means that the benefits are divided between everyone in society, incentives for an investor may not be tempting enough. A vital issue from investors' point of view is that the investor can profit – in the short-, medium- or long-term to recoup his investment – which cannot be taken for granted in the light of current market mechanisms.

For research and technology actors, the workshop participants valued the need for energy-intensive fuels with no emissions as a key driver. In contrast, expenses of R&D and the question of how to attract investments were seen as barriers.

The authorities' role was seen in keeping consistency in policy as large changes are expected and needed. It was also considered important not to forget about other societal aspects when pushing for the big emission reductions. A polarized political playing field, protectionism, fear, and alternative facts can act as barriers to social cohesion. That is, in such an environment it is easy to weaken people's trust in policy. This can also mean that it is more challenging to push through whole-of-society changes that aim to boost the evolution of the energy system towards the envisioned NCE direction.

Empowering and engaging consumers was seen as a primary driver in the appearance of new services. New meters & infrastructure - or a lack of them - that may be needed for energy as a service were assessed as a potential barrier. This barrier can be seen referring to devices enabling various smart functionalities. Meters and infrastructure allowing controllability and information exchange for electricity, heat, or other relevant quantities on broader basis, shorter time intervals and/or more detailed measurements, can be seen examples of these. There are several technological, cost-related, or regulatory barriers that can be envisaged to hinder the needed developments.

People's will to participate & do good are seen as a driver for the consumers' actor group. Bureaucracy and knowledge gaps, in contrast, can hinder their actions and were identified as potential barriers.

Several technological developments were identified as enablers/drivers for actors. In the following, the ones supported by the strongest signals in the studied materials, are introduced:

- Electric Vehicles, which were highlighted by all groups
- Storages, distributed and off-grid generation, and artificial intelligence (AI)
- District heating as a Finnish specialty
- Methane synthesis, CO2 capture and utilisation[4]

Whereas electric vehicles, different types of energy storage and methane synthesis are quite commonly referred as key technologies for an energy transformation based on the neo-carbon energy principles, district heating as a Finnish specialty is perhaps not that often discussed. That is, as the energy supply of Finnish cities is largely built on district heating infrastructure with long lifetimes and combined heat and power solutions, this has an impact on the vitality of new, competing technology solutions. This also means that cities as actors have a big role in the envisaged NCE evolution. The suggested city-driven

[4] Carbon capture and utilization (CCU) has so far been poorly understood as an option that could be introduced for reducing carbon emissions. Instead of treating CO_2 as waste, as is the case with carbon capture and storage (CCS), the CCU process converts it into commercially viable products such as bio-oils, chemicals, fertilisers and fuels.

growth of Electric Vehicles market and the population density of cities, making them attractive for many suggested new services, strengthen this view. The workshop results also suggested a view on artificial intelligence (AI) having a groundbreaking effect in many respects of an NCE type of society. Boosting digitalization, increasing the efficiency of production and supply chains, and freeing human resources could be envisaged as examples of these effects.

An interesting observation on drivers/barriers is related to the fact that events even decades ago may play a role in public acceptance ("Energy memory"). This may materialise, for example, if an unsuccessful pilot or a severe accident takes place in a case of introduction of certain technology. This kind of event, in turn, may influence key actors - such as citizens, politicians, and businesses – operational decisions, and, consequently, the development and take-up of new solutions even though the arguments as such might be outdated.

Timeline, strongest signals and new ideas

Table 3 further classifies the ideas presented regarding actors in futures wheels. That is, the ideas of actors' roles that were present by many groups are arranged according to timelines (Existing already, 2020-2030, 2030-2050). If more than one group suggested the same idea, it was interpreted as an indication of the robustness of the idea. Further, especially new ideas compared to "business-as-usual" development, are under attention in the compilation of Table 3 that summarizes the overall results (Appendix). In this type of development, established actors such as companies in the energy sector and in governance follow more or less a trend-type of evolution.

Strongest signals: many groups suggested that Finland becomes an attractive environment for companies and for RES investments, having an effect on large international players such as Tesla cold weather tests, or Google data centres entering Finland. Going further in the future towards 2050, cyber security was seen as an important issue and it is connected to the way our societies get their energy. Thus, it was speculated if more distributed systems will have a boost for safety reasons. Thanks to electric vehicles, Uber and other innovations, it was suggested that private car ownership and driving decrease significantly in the OECD. Also grassroots leaders and communities are suggested to have more power in the timeframe until 2050.

New ideas: relevantly for new ideas, as a more cultural and systemic issue, the benefits of a culture of experimentation, was identified. Furthermore, an idea of new role models in ecological and green lifestyles and leadership to be recognized and awarded publicly, was suggested, e.g. "city champions" and "energy awards". In longer term, having an effect in 2020-2030, changes in dietary habits were suggested as a factor shaping the behaviour and organisation of actors. Even further, the third circle in the futures wheels encompasses the actors' development by 2050 and the appearance of a business ecosystem by 2050. Going that far, carbon sink and reuse companies, as well as industry as a carbon provider may appear as new types of key actors. Ultimately, the decisions in 2050 are seen to be steered by emissions in the same way as prices influence them today.

Table 3. Key actors suggested classified in timeline.

Timeline	Ideas about who the actors are that came up in many groups	New ideas for who or what the actors could be
Existing already	The Neo-Carbon Energy project and brand	MaaS (Mobility As A Service)
	Startups: EkoRent, Joukon Voima, CO_2-esto	Non-energy companies enter the market (e.g. Telia Sonera)
	Mobility and energy as a service	Culture of experimentation (for instance "Nopeat kokeilut" in the Climate Street project)
	Communities (e.g. "Uusi Energiapolitiikka", Energiaremontti, different Facebook groups, energy producing communities and local food –circles)	"City champions" and "energy awards" – new role models in ecological and green lifestyles and leadership are recognized and awarded publicly
	Funds (e.g. Fortum)	
2020 - 2030	V2X (from vehicle to X) – EVs as mobile electricity storage to increase flexibility	Changes in dietary habits
	Citizens have become empowered by digitalization (e.g. increased demand response through a mobile application, increased awareness)	
	Finland has the image of being an attractive environment for companies and for RES investments, e.g. Tesla cold weather tests, Google data centres.	
2050	Cyber security is an important issue and it is connected to the way our societies get their energy; more distributed for safety reasons? Off-grid solutions?	Carbon sink and reuse companies, industry as a carbon provider
	EV Uber / private car ownership and driving has decreased significantly in the OECD	Emissions steer decisions in the same way as prices do today
	Grassroots leaders / communities have more power	

Discussion

Interestingly, according to the authors' interpretation, technology developers as actors were not particularly highlighted in the results. The suggested pioneer actors, to a surprisingly large extent, consisted of citizens, online communities, and startup companies. Electric vehicles and related technologies can be interpreted as the strongest signal in the technology development field, justified by the fact that it was highlighted by all the groups. It can be speculated if the relative scarceness of technology developers in the group work reflects the participants' belief in the view that technological hurdles are manageable and they can be overcome, and, as a result, key actors lie in other sectors of society. Also, having the viewpoint set at Finland can have an effect due to the fact that much of the technological development work is done globally outside of Finland.

Based on the observation on the significance of actors other than technology developers, a question rises if we can conclude that the workshop participants' believe that technology readiness will be achieved in line with the target of a neo-carbon type of energy system. Also, this observation could reflect a strong reliance in technology developers once an appropriate operational environment in other parts of the society exists. Another interpretation could relate to the fact that technological development is spread between so many actors in the society that no single, identifiable actors rises above the others.

Key actions

An established futures research method of *PESTEC table* was used in studying the key actions through which the vision could happen ("*how").* The groups were instructed to:

- Fill in the PESTEC table to identify the actions in different sectors of society needed to make your vision happen (so that the actor(s) prosper)
- Focus in the viewpoint of Finland
- "What could be the actions needed in different areas"
  - Political
  - Economic
  - Social
  - Technological
  - Environmental
  - Cultural/Citizen/Customer
- What could be the key pilots for the vision (including political, technological, social…)?

A very diverse set of answers was created by the three working groups (see Appendix).

Conclusions by the groups

The conclusions presented are drawn from the oral presentations of the groups. This method aimed at minimizing the effect of researcher's own interpretation of the results, and, furthermore, to efficiently filter the most important findings from the abundance of suggestions. Consequently, the following viewpoints were selected by the researchers to represent the most robust/strongly supported actions:

- Actions under control of Governments were strongly highlighted.
    - Next parliamentary elections and Government Programmes (2019-23, 2023-27, 2027-31) were raised as key pillars for the action planning and implementation in the case of Finland[5] by one group.
    - The groups suggested many alternatives of what the actions could concretely be (see Appendix). Actions mentioned included e.g. bans on fossil fuels, new INDCs[6], subsidies or their termination, reforms in taxation, campaigns, refocusing national strategies, R&D support, a renewable energy (RE) minister, free public transport, boosting ecological lifestyles.
- Role of citizens is considered major, especially as pioneers
    - The actions of Cultural/customer/citizen area mentioned by the groups (see Appendix) often fell under categories of "softer" means such as citizen activation and awareness increasing, influencing in values. Generally, the timeframe was concentrated to the coming decade, 2020-2030.
    - Citizen movements appear particularly strongly in forms of online communities. New communication technologies are also seen leveraging new services and funding mechanisms such as crowdfunding. Involvement, concretization, learning, and influencing attitudes were mentioned as examples from actions targeted at this group.
- "Climate Pearl Harbor": an idea of a big, unexpected event (that can also be positive) to turn the atmosphere more progressive for actions.
    - As an addition, there are well-known examples in energy sector of such events (e.g. nuclear accidents).

[5] Government programme is a declaration of a government's political activities, plans and intentions relating to concrete causes for an entire legislative session. In Finland, it is typically expressed by the Prime Minister who acts as the Head of Government, once a new government has been formed and assumed office after the parliamentary elections. In Finnish: *Hallitusohjelma*.

[6] Prior to the historic international climate agreement, adopted at the U.N. Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP21) in Paris in December 2015, countries publicly outlined what climate actions they intended to take under the new international agreement. These commitments are known as Intended Nationally Determined Contributions (INDCs). These actions largely express whether the world aims to achieve the long-term goals to tackle climate change.

- Actions are driven increasingly by events in multilateral and dispersed world
    - This observation relates to the fact that there seems to be turbulence in international, coordinated efforts (NB. workshop timing in February 2017)
- Both market logics and values assessed as a frame for actions identified
    - Changes in electricity markets were seen necessary for needed actions

Discussion

Both market logics and values were recognized as frameworks for actions identified. As common features of the results of all groups, the results of the task strongly highlighted the actions under control of Governments. This is reflected in the measures under control of the Government of Finland but also in the failure or success of international climate negotiations. Especially, the next electoral terms and Governmental Programmes as concrete steps for actions in Finland were highlighted.

Another identifiable group of suggested actions concerned citizens. This can be considered natural in comparison with the previously stressed importance of citizens as an important actor group. Here, according to the workshop results, involvement, concretization, learning, influencing attitudes mentioned, are seen the key actions to boost the development.

Interestingly, an event not necessarily under direct control of any actor, "a Climate Pearl Harbor" was suggested. This referred to a big, unexpected event that would turn the atmosphere more progressive for actions, and was suggested as one factor necessary to make a breakthrough.

As a general trend, actions were suggested to be increasingly driven by events in a multilateral and dispersed, fragmented, tribalised world. That is, the actions are seen less consensus-based than in the past times. Recently, this development is highlighted by Trump's USA and, for example, its withdrawal from international collaboration and agreements.

4. CONCLUSIONS AND DISCUSSION

The results on the most important next steps in Finland and who are the most important actors for the realization of "Neo-Carbon Finland" are approached in this report. The results are based on a workshop, organized on February 23rd, 2017 at VTT in Espoo, Finland, which was participated by 16 experts from different disciplines of the energy sector.

Results on key actors and actions

According to the results expressed in this report, a major share of the suggested key and pioneer actors are citizen movements appearing in forms of new communities, or in the business sector with a novel structure in regards to energy sector. In the business sector, the role of new type of business actors was particularly highlighted. It was suggested that non-energy companies would enter the energy business. Startup companies are seen a strong actor in the business sector. Further, the role of funding and related organizations was highlighted repeatedly, signaling the importance of related institutions as important actors. Both international and national funds, as well as crowdfunding were mentioned. The public actors were reflected more concretely as cities or city-owned companies. Also, different governmental groups or individuals were to a lesser extent named as pioneers. They were particularly emphasized as executors of the actions considered in the oral summaries of the groups.

Especially, the next electoral terms and Governmental Programmes were suggested as concrete steps for actions in Finland. A list of concrete actions suggested include e.g. *bans on fossil fuels, new Intended Nationally Determined Contributions (INDCs), subsidies or their termination, reforms in taxation, campaigns, refocusing national strategies, R&D support, establishing a position of a renewable energy (RE) minister, free public transport, and boosting ecological lifestyles*. The richness of these individual ideas, discussing new products, services, ways to operate and organizational models, are presented as Appendixes to this report.

Citizens are suggested to be empowered, when they are part of citizen movements. Citizens can pioneer particularly when they interact through online communities. *Involvement, concretization, learning, and influencing attitudes* are mentioned as examples of actions that can be targeted at these groups.

Discussion

The use of results in roadmap and action plan

To consider actions in the short-term future, the inner circles of the futures wheels drafted by the groups were assessed as the most logical frame for actions over the period of the next few years. Here, a major share of named pioneer actors fall under the categories of business, citizen movements and new type of community actors. In the business sector, the role of startups and new type of business actors was particularly highlighted, when it

was suggested that non-energy companies will enter the energy business. The surprisingly small appearance of traditional energy sector businesses is perhaps worth noticing, whereas startup companies and funding actors are seen as strong movers in business sector. The public actors were reflected more concretely as cities or city-owned companies. Different governmental groups (or political parties) were particularly emphasized as the executors of the actions considered.

As the results are prepared to provide groundings for designing a roadmap for Neo-Carbon Finland, it can be seen justified that the roadmap designed for NCE Finland should emphasize the elements of policy and public actions and citizen involvement, as well as startup companies and funding in the business sector. However, as the roadmap "*describes the stages, through which the destination is planned to be achieved*", it should reflect the authors' belief/suggestion on the "best" or "prioritised" way. Whatever the exact choices are, it can be questioned if they could be made otherwise? How "reliable" is the roadmap? How to ensure/judge, if the actions are "right" or efficient enough?

The questions raised above were partially tackled by the design of the workshop and its analysis. That is, wide agreeance on the elements was tackled through three independent groups working on the issues. Two researchers studied the results separately and the strongest indications were backed by both analyses. These selections aimed at strengthening the robustness and reliability of results.

However, it remains to be seen if the actions are efficient enough to make the Neo-Carbon Energy Finland real. Controversially, someone might argue that markets will take care of future developments, Finland will have a neo-carbon energy system in place, and no particular attention to actions by policymakers is necessary. Thus, it becomes a key point to track if actual developments follow the envisaged ones, dealt with, for example, in many of the modelling studies conducted in the NCE project. The "owner" of the roadmap must further be specified. Also, as a large part of the implementation is placed on public bodies, the actions will partly depend on political will. That is, even though there is a wide political support towards zero emissions, it must not be taken self-evidently that the democratically chosen public bodies end up in prioritizing the boosting of a neo-carbon type of an energy and production system over other available alternatives.

Results reflected in comparison to the earlier results

When we compare the workshop results to the initial scenario narratives and on-going country-based developments, we may reflect how the different proposed means can help the neo-carbon energy system to emerge and related goals to be achieved. An international survey that studied the local perceptions of the scenarios emphasized "a new consciousness", new awareness and knowledge, as the basis of the vision to materialize. In their part, the workshop results emphasize concrete policies, programmes and plans, such as the forthcoming Government Programmes. They pay attention to the fact that markets should change – or to be changed. In light of the suggested key actors, how can citizens be enabled to act and contribute in building radical startups or techemoths – progressive large companies driven by values – to find profits in emergent technologies, jointly shaping a new economy?

The actor analysis produced in the earlier phase of the project (Similä et al. 2016) identified a long list of potential actors and produced preliminary suggestions for their significance, summarized in Table 4. Thus, it is interesting to discuss how the results discussed in this report appear in comparison. However, it must stressed that the set-up of the earlier study was global (*instead of focusing on Finland*) and the aim was to illustrate four different (*not all necessarily desirable*) futures. It cannot be expected that these results match by 100%. However, interestingly, a major part of the elements that were provided by the workshop participants appear also to be present in the earlier results.

As a first result of the workshop, a rise of significance of citizen movement actors, and new communities as key actors to was seen. Citizen movements are present in practically all the scenarios dealt with in earlier analysis. Furthermore, in the "Radical Startups" scenario, a part of citizens' efforts extends beyond the civic sphere, and is channelled into building new startup companies as drivers of social change.

As a second result of the workshop, newly structured business sector, visible in role of startup companies and non-energy companies entering the energy business, was clearly identified. Servicification, signaled by concepts of e.g. Mobility as a Service, and energy as a service, can be regarded as an additional phenomena identified in business sector. These features can be seen largely present in "Radical Startups" scenario. Furthermore, global technology firms were often referred to as important for test sites and RES technology investments in Finland, as well as the significance of firms coming outside traditional energy sector. These features are present in "Value-driven Techemoths" scenario, at least.

In addition, in the workshop, a role of public and policy actors as executors of the actions, was suggested. This is shown in both the role of Government in executing the actions, as well as in cities and city-owned companies suggested as key actors. Compared to the earlier results (Table 4), policy and public actors appear strongly reflected "New Consciousness" scenarios, and to an extent also in the "Radical Startups". Only in the "Green DIY Engineers" scenario, it was assumed that citizens and communities self-organize independently of the state – merely because they have no other choice.

As there seems to be a lot in common between citizen and business sectors, key players suggested in the workshop, and the development outlined in "Radical Startups", a question arises if it describes a world having synergies from Finnish perspective. Furthermore, it can be discussed if elements of this scenario provide a solid basis for developing a roadmap for Finland.

Table 4. Actors and their role in the Neo-Carbon scenarios (Heinonen et al. 2015) presented in Similä et al. (2016).

Scenario	*Key actor characterization*
Radical Startups	Startups, companies, investors, workers, cities, and entrepreneurs are suggested as key actor types, potentially having a role in the field of small-scale and innovative energy solutions, for example. Media, freelancers and consumers are suggested as categorized as other stakeholders identified.

Value-driven Techemoths	The scenario considers large technology companies "Techemoths" as main drivers of the development as Google, Facebook, Apple and Samsung are mentioned as exemplary of this type of companies.
Green DIY Engineers	Relatively few actors are identified in comparison to others. As the nature of the scenario as being driven by self-made and communal efforts, local communities, people, and "DIY engineers" are suggested as key influencers in the scenario.
New Consciousness	Global systems face a radical transformation and as the actors identified are most diversified. The role of international collaboration and global systems is assessed as evident. International organizations can be seen as enablers of this development.

There are also differences between the suggested actors presented in earlier results (Similä et al. 2016) and this study. For example, the role of funding organizations and the national government(s) is more emphasized in the current report. Partly, this is naturally explained by different focuses of the approaches. Some proposed actions concern so-called fourth sector type of activities – new grassroots or sharing economy business models, such as co-ownership of wind farms, which combine for-profit and non-profit aims. Also, it is interesting to note that large and giant companies are not particularly represented as pioneers from the perspective of Finland in the workshop results. This can reflect the fact that despite their indisputable influence, they must be to a large extent taken external or "as given" from national perspective. Also, energy companies that currently hold a dominant market position do not strongly appear in the results. Identifying key actors did not discuss technological development, but the significance of the adoption of key technologies does not need to be ignored. Actually, it has been widely analyzed by other efforts conducted in the NCE project.

The workshop results provide interesting food for thought for Finland. It seems appropriate to conclude that through different initiatives, the action plan should aim to *achieve change rather than to uphold status quo* and *enable new actors – both business actors and civic networks across conventional boundaries – to surface, aided by an experimental culture and political will that supports these goals*. A fit-for-purpose action plan could help a desired vision to be realized as well as support the work by key actors to achieve lasting change.

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Futures wheels

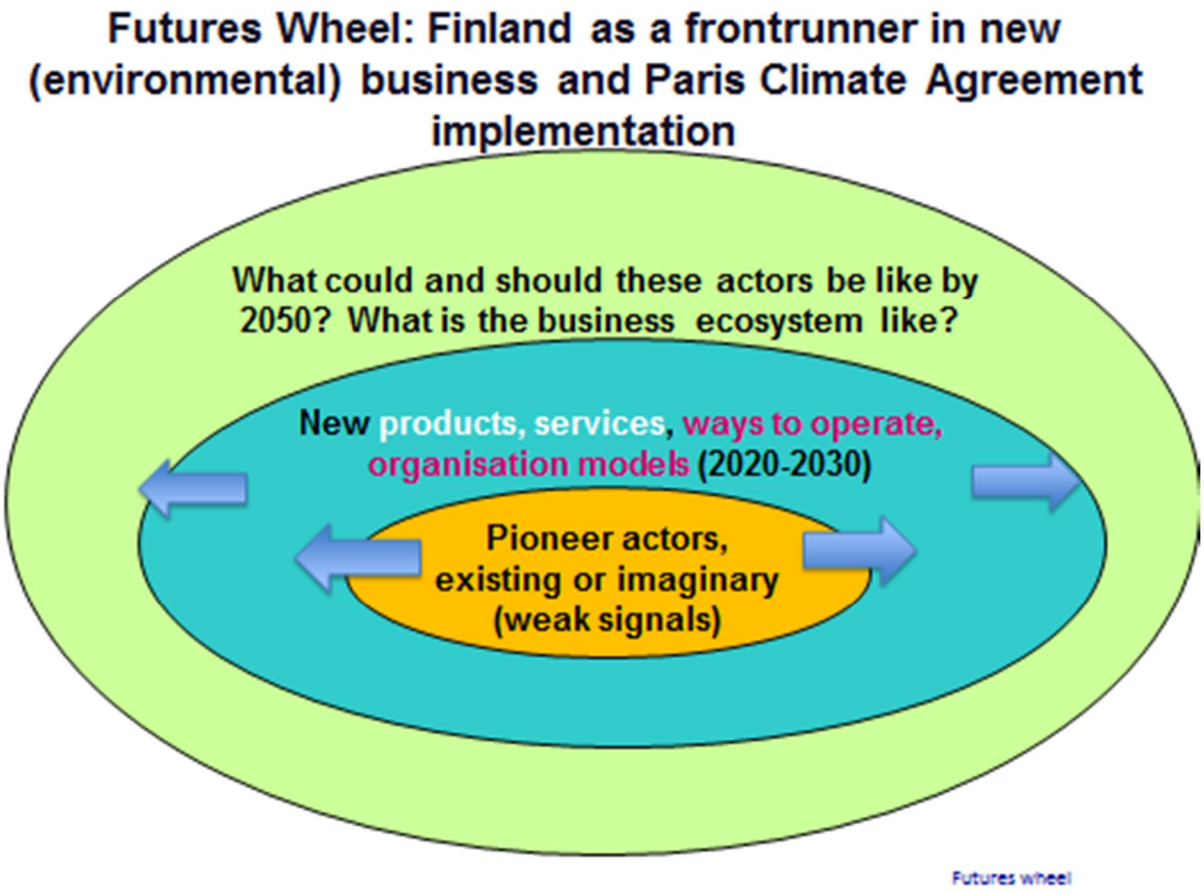


Figure 4. Futures wheel template delivered to the working groups.

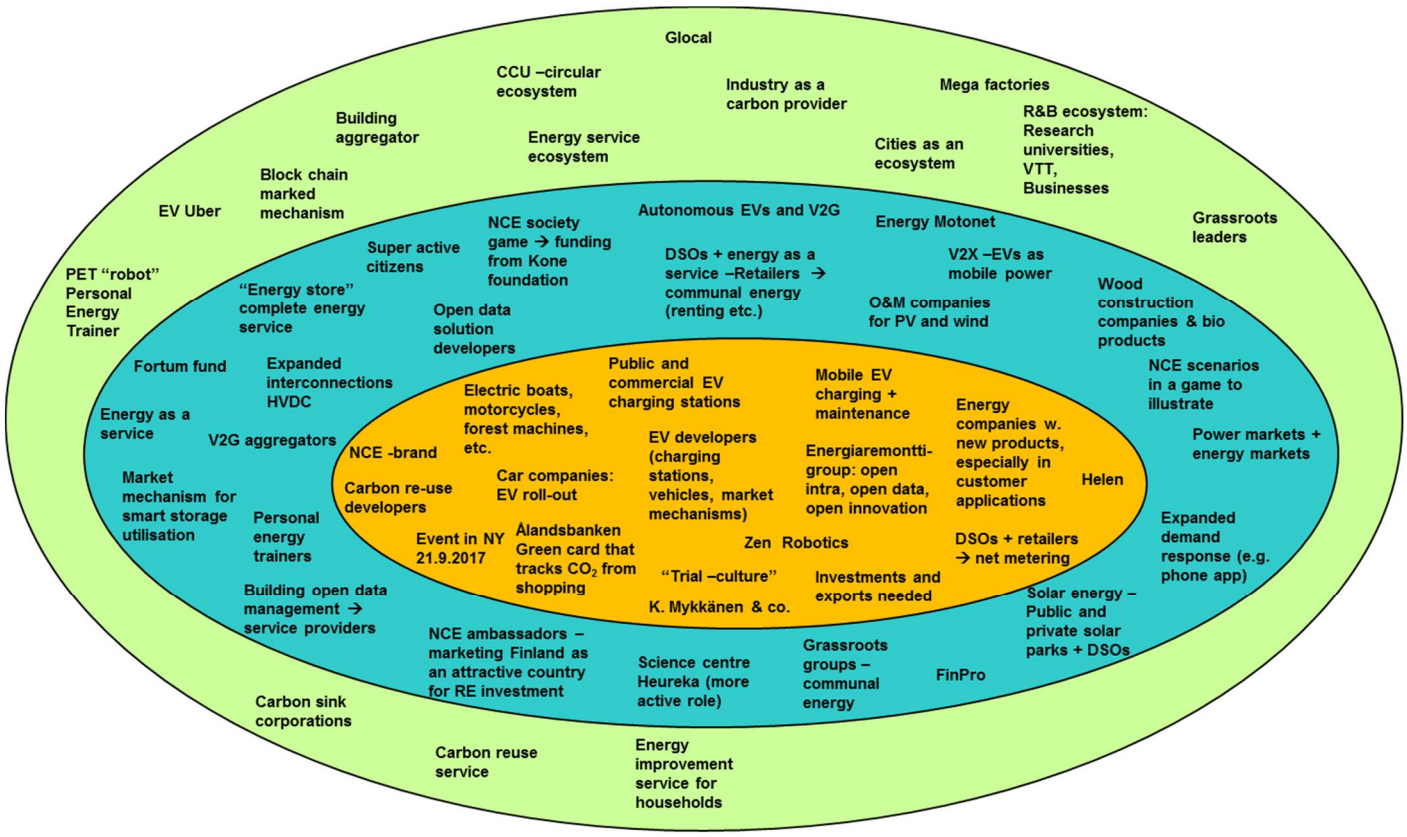
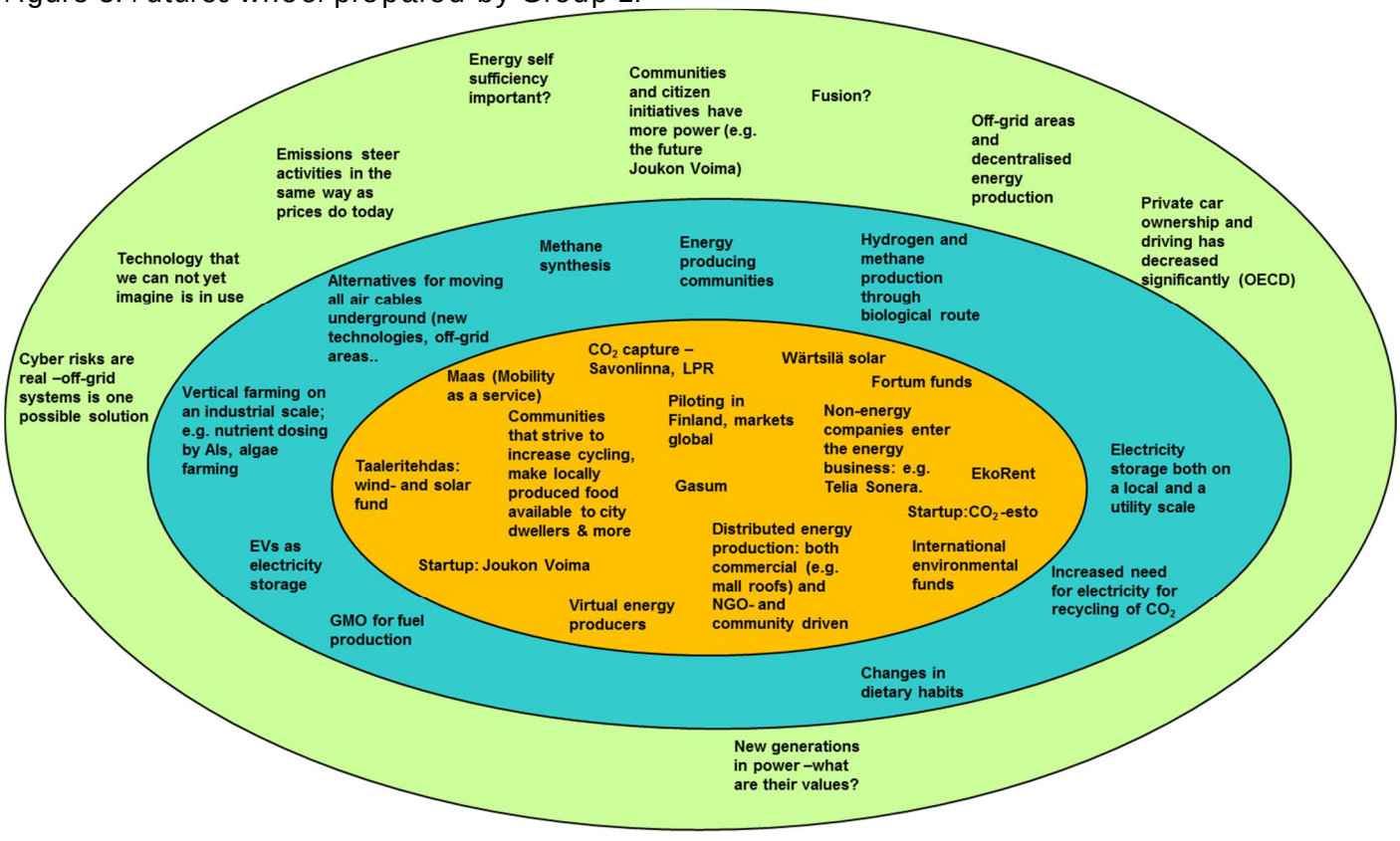


Figure 5. Futures wheel prepared by Group 1.

Futures wheel: Group 1



Futures wheel: Group 2

Figure 6. Futures wheel prepared by Group 2.

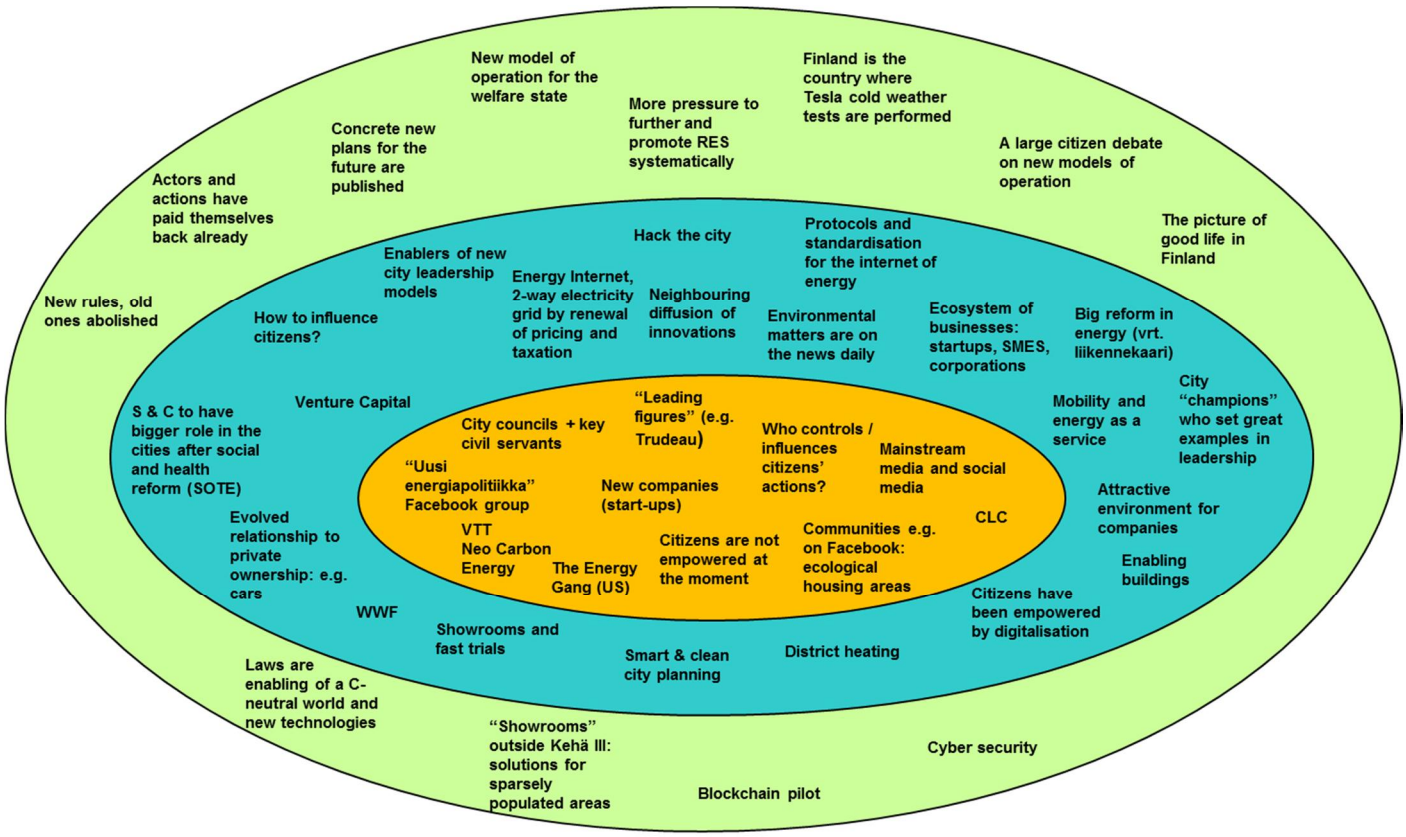


Figure 7. Futures wheel prepared by Group 3.

PESTEC Tables

Table 5. PESTEC table prepared by group 1.

PESTEC	2020-2030	2030-2050
Political	NCE party: green business party mitigating climate change Update INDC's 2018 or 2023 Reduce / eliminate EV tax Taxation model for distributed energy supply Ban ICE vehicles Consumer EV prices subsidized Campaign for Finland to become the most attractive investment environment Enable net metering No fossil subsidies RE minister Free public transit	Ban fossil fuels: 1. Coal + peat 2. Oil 3. Gas New, realistic INDC Military type action plan to scale down fossil and implement renewables Achieve goals of Paris Agreement Re-focus Finland's bio strategy
Economic	Create "climate biz" governance body Develop sharing economy biz models Attract new technology investments to Finland Develop "energy service" markets & mechanisms Develop grassroots business models	Show where the money from the carbon tax goes
Social	Energy-health-wellbeing story developed Develop "a relationship with energy" for citizens Visualising catastrophes as early warning to make actions happen Develop education program fro schools (focus on transition) Slush, Hack, etc. forums for NCE Visualising solutions & making the NCE world attractive	
Technological	Grids support distributed generation More R&D support for innovation & new technologies Smart EV charging infrastructure everywhere Continued development of gas storage + network Open data platforms to be developed Develop storage capacity GIS apps for emission free Finland Develop new heating options	Kinetic energy harvesting from all built environment Autonomous vehicles on demand
Environ-mental/ Energy	Develop XXX new heating options Expanded sustainability labelling (e.g. swan) Energy audits and certificates Finland → a model for "one earth" living – plan / campaign needed	
Cultural/ Customer/ Citizen	Ze Day (21.9) for global citizen activation Divest from fossil fuels "Model citizens" awarded in media ("Energy gala") Focus on energy efficiency + demand reduction Acknowledge urgency of climate change mitigation Energy community "Demos" eco-village Open source innovation	Carbon footprint –based taxation / pricing. True cost of carbon 100€/t

Table 6. PESTEC table prepared by group 2.

PESTEC	2020-2030	2030-2050
Political	Politicians who make ecological lifestyles mainstream Harnessing the welfare state's existing mechanisms to further ecological sustainability Carbon tax	Global carbon tax Global cooperation on environmental issues How to ensure order and common rules in a polarised world? A new legitimate power user?
Economic	Certificates of origin for energy, also products produced with fossil fuels must disclose this information Electricity markets work now, but not in the long run without modifications	It should no longer be pay off to be a free rider (new markets/ new mechanisms)
Social	Increase awareness: speaking in schools, online campaigns etc. Communication: positive and engaging Several new, specialised media channels are needed in Finland	Grass root -level movements and increasing importance of communities Negative drivers (e.g. air pollution) are the best at spurring action: there is an imperative to act. Information wars must be prevented
Technological	Small, easy to install PV systems to increase private citizen PV ownership Demand flexibility Affordability of small – scale energy storage New technologies to feed energy to the grid Energy storage	Efficiency and functionality of large, regional transmission networks (e.g. Europe –wide)
Environ-mental/ Energy		Methane emission shock to the atmosphere?
Cultural/ Customer/ Citizen	Environmental values even more strongly present in marketing There's a need to reach also those who are not in the "green citizen – bubble": how to get rural residents to live more ecologically?	Demand flexibility: getting used to the idea Citizen support for the political system and authority Human greed, own interests always at the centre Creating a new "common culture", breaking bubbles Is the internet – generation more altruistic than Homo Economicus?

Table 7. PESTEC table prepared by group 3.

PESTEC	2020-2030	2030-2050
Political	Parliamentary elections 2019 2023 2027 Government programs 2019-23 2023-27 2027-31 "Pasi –ideology" (radical thinking) Spearhead projects R&D support for both large and small companies Getting away from culture of insignificant small-scale actions Courage to renew oneself Increased understanding and identification of the benefits for each party	Climate "Pearl Harbour" → reassessment of the sovereignty of nations
Economic	Entrepreneurship Basic income (perustulo) Operational environment What is the "Neo-Carbon Maternity package" that can be shipped off to the world? Business funding and venture capital Co-ownership of wind farms	"Basic energy income" Markets are where there is scarcity Markets of change
Social	Citizen –driven initiatives for new laws concerning renewable energy From polarisation to a new consensus New consensus –new "truth" Engagement and involvement of citizens	
Technological	Citizen engagement and involvement happens through digitalisation Pilots: -Blockchain -District heating Price of PV and wind turbines goes down	Internet of energy Filtering masks for outdoor activities when CO_2- levels are too high
Environ-mental/ Energy	Environmental and energy values (readings) made visible by sensors +3 C warming becomes a fact	500 PPM .. 1000 PPM CO_2
Cultural/ Customer/ Citizen	Make the terminology familiar, keep facts at the centre Citizen initiatives "Clean city initiative" Municipality – level entrepreneurs, frontrunners in service and financing	

Suggested dynamics between the key actor groups by a participant

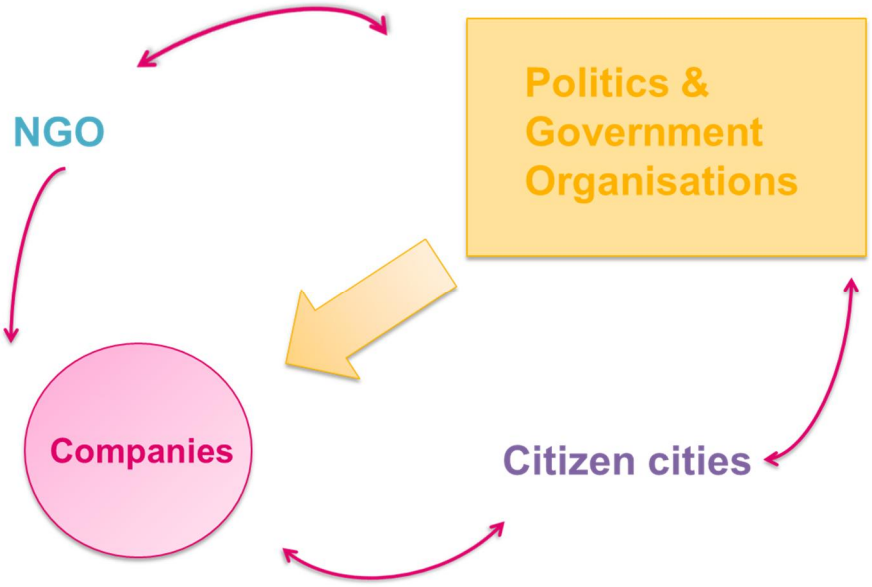


Figure 8. Suggested dynamics of the key actor groups by one participant. As a key message, companies that focus in short-term operation and maximization call for incentives set by politics and government organisations to develop new solutions. Citizens (or/in) cities, in turn, can have an influence in through their consumption behaviour or, alternatively on politics to stress set new incentives.

Agenda of the workshop

9.00	Introduction to the workshop and futures wheel
9.15	Futures wheel: actors
9.45	Summary and wrap-up of futures wheel
10.15	Break
10.30	Introduction to PESTEC method
10.45	PESTEC: actions
11.15	Summary and wrap-up of PESTEC
11.30	Wrap-up of today and next step
12.00	Lunch

Participants of the workshop

Group 1	Group 2	Group 3
Tiina Koljonen, VTT (moderator)	Juho Ruotsalainen, FFRC (moderator)	Joni Karjalainen, FFRC (moderator)
Jouni Keronen, CLC	Peter Buhanist, Fortum	Heikki Ilvespää, UPM
Michael Child, LUT	Petteri Laaksonen, TuuliSaimaa	Pasi Vainikka, VTT
Jaana Pelkonen, Smart & Clean Foundation	Osmo Kuusi, Aalto, FFRC	Samuli Honkapuro, LUT
Sirkka Heinonen, FFRC	Amanda Björnberg, VTT	Lassi Similä, VTT
		Tiina Kähö, Smart & Clean Foundation

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