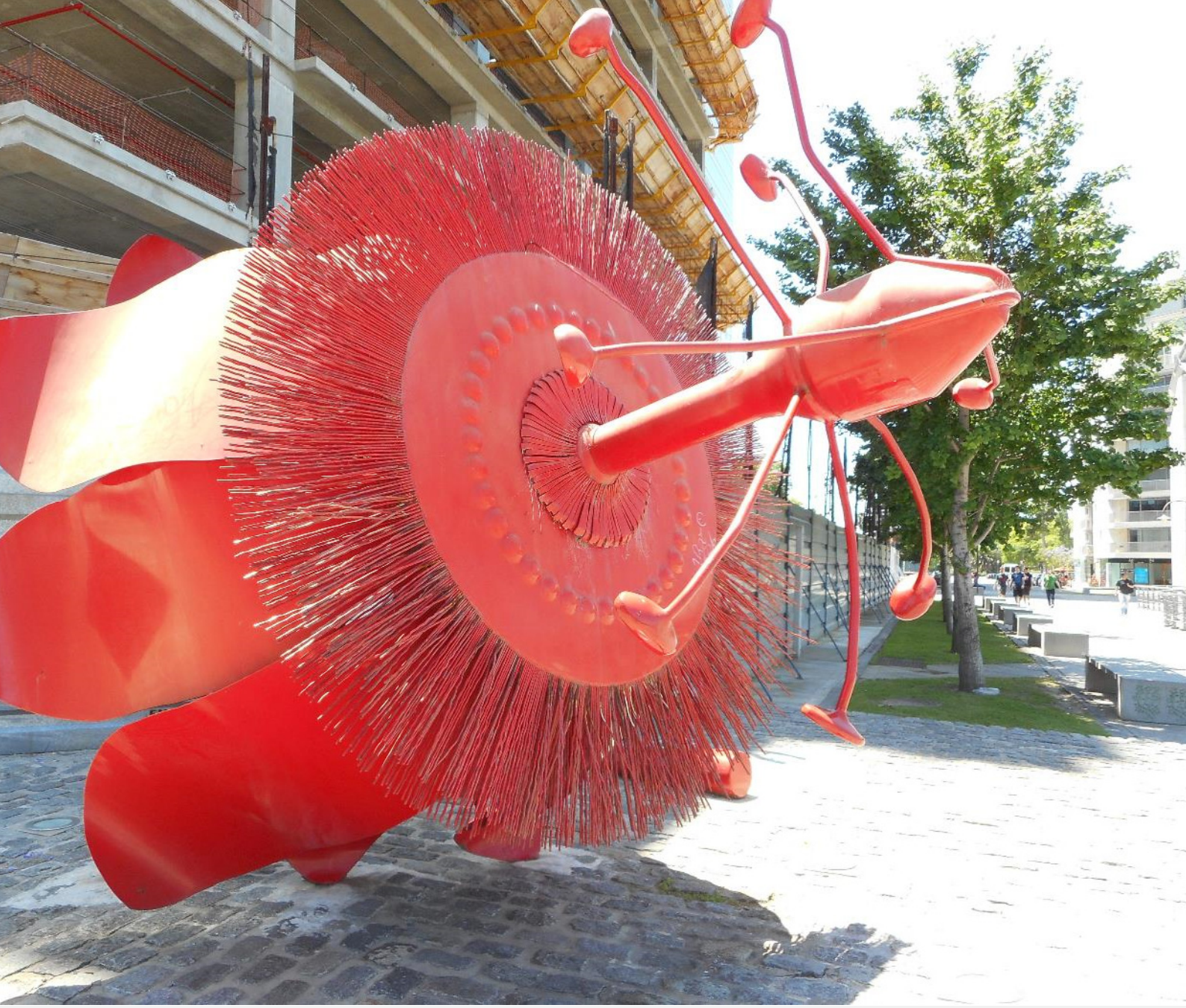

Sirkka Heinonen, Joni Karjalainen, Aino Helle and Sakari Nisula

ARGENTINIAN ENERGY LANDSCAPES

Case Study of the Neo-Carbon Energy Project

FINLAND FUTURES RESEARCH CENTRE
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NEO CARBON ENERGY

Turun yliopisto
University of Turku

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Reality is not always probable, or likely

Jorge Luis Borges
(1899–1986)

CONTENTS

PREFACE

Argentina is a country of huge potential in many ways. It is also a country of contradictions, as the undeniable vast potential is sometimes mixed with less than perfect execution of those opportunities – as the lovely Argentinians themselves are fast to recognize.

The Embassy of Finland in Buenos Aires has supported the Neo-Carbon Energy research project as case study in Argentina in November 2014. In this research project, Finland Futures Research Centre FFRC at University of Turku, Technical Research Centre of Finland VTT and Lappeenranta University of Technology LUT are developing a new renewables-based energy production, storage system and products that are carbon neutral.

Energy issues are of outmost importance for the future of Argentina, as it is struggling to develop into a country that exports rather than imports energy. The potential of Argentina in renewable energies is immense, as this study clearly shows. The real question is how to execute those opportunities in a sustainable and profitable way, in order to start moving towards the preferred future of the Argentinians. This research project and country study - underlining the need for future cooperation with foresight institutions and energy experts - offers a useful tool for that discussion.

Teemu Turunen
Ambassador

March 2017, Embassy of Buenos Aires

RESUMEN

Este informe es un estudio del país de Argentina y pertenece a la parte prospectiva del proyecto de NEO-CARBON ENERGY. En este proyecto de investigación se están desarrollando un nuevo sistema de producción y almacenamiento, y productos de energía basados en energías renovables por parte de VTT, el Centro de Investigación Técnica de Finlandia, la Universidad de Tecnológica de Lappeenranta (LUT) y la Universidad de Turku – Centro de Investigación de Futuros de Finlandia (FFRC). En el sistema neo-carbono, la energía se produce por la tecnología solar y eólica y se puede almacenar en metano sintético. Los productos creados en base de los fósiles combustibles están sustituidos por procesos sintéticos basados en la electricidad renovable. Estos procesos también se llaman las tecnologías de power-to-X.

Los futuros de energía no se consideran como el afán de las tecnologías de producción de energía solamente sino toda la sociedad será también afectada por este nuevo sistema de energía. Además, el sistema energético del futuro y el panorama energético serán influidos por los valores y estilos de vida de la gente. Es importante explorar diferentes escenarios de cómo el sistema de energía neo-carbono podría tener efecto en una sociedad, los negocios, la vida y las relaciones del individuo. Además, las decisiones tomadas hoy en día pueden hacer que el futuro neo-carbono prospere.

En este estudio de caso se exploran y analizan los futuros de las energías renovables de Argentina. El desarrollo y la política del pasado, afectados por los factores económicos y políticos, han construido un escenario para el país que no permite que se capture todo lo posible de lo que ofrecerían las energías renovables. Sin embargo, en 2016 Argentina ha lanzado programas extensos para cambiar la situación. Aun más, el estudio presenta los resultados de una encuesta de expertos que investiga lo potencial de las soluciones de energía neo-carbono en Argentina.

EXECUTIVE SUMMARY

This report is a country study of Argentina of the foresight part of Neo-Carbon Energy project. In this research project, a new renewable energy based energy production, storage system and products are being developed by VTT Technical Research Centre of Finland, Lappeenranta University of Technology (LUT) and University of Turku – Finland Futures Research Centre (FFRC). In the neo-carbon system, energy is produced mainly by solar and wind technologies, can be stored into various forms, and fossil-based products are substituted with synthetic processes based on renewable electricity. These processes are also called power-to-X technologies.

Energy futures do not only concern energy production technologies because an energy transition affects the whole-of-society. The future energy system and energy landscape are influenced by people's values and lifestyles. Therefore, it is important to explore different scenarios of how neo-carbon energy system can affect a society, businesses, individual's lives and relationships. In this case study, Argentina's renewable energy futures are explored and discussed. The study also presents results of an expert survey and explores the potential of neo-carbon energy solutions in Argentina.

In Argentina, past energy policies, economic and political drivers, created an energy landscape that did not allow the country to benefit from its renewable energy resources. Macroeconomic crises and political risk have reduced trust in the country in the international credit market. The price of energy has for long been kept artificially low with subsidies, which has hidden the 'real' cost of energy to citizens, and fuelled a culture of energy wasting. In the recent years, Argentina has sought to explore, exploit and attract investment in shale gas and oil production, after a decline in its conventional gas production since 2002, and also engaged in the production of biofuels.

Argentina has exceptionally high renewable energy potential and is becoming more aware of their possibilities. As the global prices have fallen, wind and solar are becoming increasingly attractive also for countries that have not seriously harnessed them before. With a change of government in the late-2015, Argentina aims to increase the uptake of renewable energy sources. The country has launched a programme called RenovAr that awards tenders for renewable energy projects, and has now set a target to produce 20% of the country's electricity with renewables by 2025. If the country continues to develop the sector determinedly, Argentina could have the potential to become one of the leaders globally, and Latin America as a whole has a strong potential to explore the option of a 100% renewable energy system as a continent that has robust renewable energy resources.

Argentinians and their future policymakers will decide whether Argentina will be among the leading and exporting countries of clean renewable energy. Foresight-oriented innovation could enable Argentina and its neighbouring countries to seize such emerging opportunities. It has been claimed that Latin America was not equipped for the major transformations of recent decades. Decisions made in the

present can make a renewable energy based future a more attractive option, and pave the way for a neo-carbon energy system and related solutions. Finland Futures Research Centre welcomes future cooperation with Argentinian foresight institutions and energy experts that could benefit both parties bilaterally and bi-regionally in research, education and innovation.

LIST OF ABBREVIATIONS

CADER – Argentine Chamber of Renewable Energy (Cámara Argentina de Energías Renovables)

CAMMESA – Wholesale Electricity Market Administration Company (Compañia Administradora del Mercado Mayorista Eléctrico)

CFEE – Electric Power Federal Council (Consejo Federal de Energía Eléctrica)

CIECTI – Interdisciplinary Research Centre of Science, Technology and Innovation (Centro Interdisciplinario de Estudios en Ciencia, Tecnología e Innovación

CTI – Science, Technology and Innovation (Ciencia, Tecnología e innovación)

ECLAC – Economic Commission for Latin America and the Caribbean (of the United Nations)

ENARSA – National Energy Company (Energía Argentina Sociedad Anónima)

ENRE – Electricity National Regulatory Entity

EU-LAC – The European Union, Latin America and the Caribbean

FFRC – Finland Futures Research Centre

FiT – Feed-in tariff

FLACSO – Latin America Faculty of Social Sciences-Latin America Social Science Harvester (Facultad Latinoamericana de Ciencias Sociales Sede Argentina including the National University of Quilmes y National University of General Sarmiento)

Formin Finland – Ministry for Foreign Affairs of Finland

GAIN – Global Agriculture Industrial Network

GENI – Global Energy Network Institute

GENREN – Auction for Renewable Energies (Licitación de Generación Eléctrica a partir de Fuentes Renovables)

GFN – Global Footprint Network

HPI – Happy Planet Index

IEA – International Energy Agency

IFA – International Foresight Academy

IMF – International Monetary Fund

IPCC – Intergovernmental Panel on Climate Change

IRENA – International Renewable Energy Agency

LCOE – Levelized cost of electricity

LUT – Lappeenranta University of Technology

MEM – Wholesale Energy Market (Mercado Electrico Mayorisia)

MINEM – Ministry of Energy and Mining (Ministerio de Energía y Minería)

MP – The Millennium Project

MW – Megawatt

PPA – Power Purchase Agreement

PRONUREE – National Program for the Rational and Efficient Use of Energy

RE – Renewable Energy

SADI – Argentine Interconnection System (Sistema Argentino de Interconexión)

SIP – Interconnected Patagonian System (Sistema de Interconexión Patagónico)

SNG – Synthetic natural gas

STI – Science, technology and innovation

SWH – Solar water heating

UN – The United Nations

UTU – University of Turku

VTT – Technical Research Centre of Finland Ltd (Teknologian Tutkimuskeskus VTT Oy)

WEF – World Economic Forum

WTO – World Trade Organization

WWF – World Wildlife Federation

YPF – Yacimientos Petroliferos Fiscales – an Argentinian Energy Company

1. INTRODUCTION

1.1 Neo-Carbon Enabling Neo-Growth Society – Transformative Energy Futures 2050

NEO-CARBON ENERGY[1] (2014-2017) is a research project where a new renewables-based energy production and storage system is being developed by VTT Technical Research Centre of Finland (co-ordinator), Lappeenranta University of Technology (LUT) and the University of Turku – Finland Futures Research Centre (FFRC). This four-year joint research project was started in autumn 2014 and is one of the strategic research openings of Tekes – The Finnish Funding Agency for Innovation. In the neo-carbon system, **energy is mainly produced by solar and wind technologies, can be stored into synthetic methane, and fossil-based products are substituted with synthetic processes based on renewable electricity**[2]. As a whole, this makes the system carbon neutral.

Energy production is not solely a technological issue. In the foresight part of this interdisciplinary research project, Finland Futures Research Centre (FFRC), University of Turku (UTU) is exploring possible futures enabled by the neo-carbon energy system in a peer-to-peer society.[3] The foresight focus of a possibly distributed energy production system is on economic, political, cultural and social changes, driven by neo-carbon technologies and emerging issues such as prosumerism (prosumer = "a producer and a consumer merged together"). This affects the entire society and the ways how energy is produced and consumed. The future energy system we have and the broader energy landscape are also affected by socio-cultural changes in values and people's lifestyles – how energy is perceived. The future of energy systems and societal transformation are consequently examined in tandem.

A neo-carbon energy system can provide the material basis for the future network society and economy based on co-creativity and ecological lifestyles (Breyer et al. 2016a). Solar and wind are currently the only sufficient and infinite energy sources and also expected to be the most cost-effective production methods in the largest energy markets as soon as 2020. Radically new innovations, services and practices could emerge as a result of the "Third Industrial Revolution" (Rifkin 2011). If production shifts to energy independent local communities and peer-to-peer networks, the entire social and power

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[1] See www.neocarbonenergy.fi; https://www.utu.fi/en/units/ffrc/research/projects/energy/Pages/neo-fore.aspx: http://facebook.com/neocarbonenergy; and https://twitter.com/neocarbonenergy

[2] This is also referred to so called "power-to-X" technologies, which signifies that electricity has been generated with renewables and been converted into gases, liquids or synthetic materials (e. g. human-made polymers)

[3] Neo-Carbon Enabling Neo-Growth Society – Transformative Energy Futures 2050, See here: https://www.utu.fi/fi/yksikot/ffrc/tutkimus/hankkeet/Documents/NEO-CARBON_NEO-FORE_Brochure.pdf . For the full scenarios, see Heinonen et al 2016.

structure of society could change. Therefore, the research investigates what kinds of new business opportunities, organisational models and lifestyles the neo-carbon powered peer-to-peer society enables for companies and citizens. **The emerging peer-to-peer society is driven especially by peer-to-peer production that is also changing the concept of work and production** (Ruotsalainen et al 2016a; Ruotsalainen et al 2016b).

The Neo-Carbon Energy research project bases its pragmatic philosophy on the novel concept of "neo-growth", which has been proposed by a Finnish pioneering futures researcher professor Pentti Malaska (2010). According to him, neo-growth signifies growth defined anew – one that is environmentally sustainable and serves the overall well-being of citizens, instead of solely aiming for the attainment of conventional economic goals. Mere growth is not necessarily progress. **Neo-growth is, however, positive post-modern progress, since it improves the quality of the environment, the profitability of companies, and the wellbeing of citizens.** The idea of progress is a belief in the continuous improvement of an incomplete humankind that dates thousands of years.[4] Progress is about change, and a post-modern idea of progress is emerging. According to Malaska (2001, 234), post-modern progress includes an awareness of modernity gone astray. This means that modernity is leading the humankind to unprecedented threats and problems that are contradictory with the original idea of progress – the development of science and technology, democratic social reconstruction, as well as freedom and autonomy in knowledge inquiry. The problems of bureaucracy, undemocratic governance of states, and environmental degradation are obvious challenges to the post-modern idea of progress. Neo-growth (Figure 1) will tackle such challenges without abandoning the original idea of progress.

[4] The idea of progress is particularly relevant for the interaction between humans, nature and technology. See e.g. Heinonen (2000).

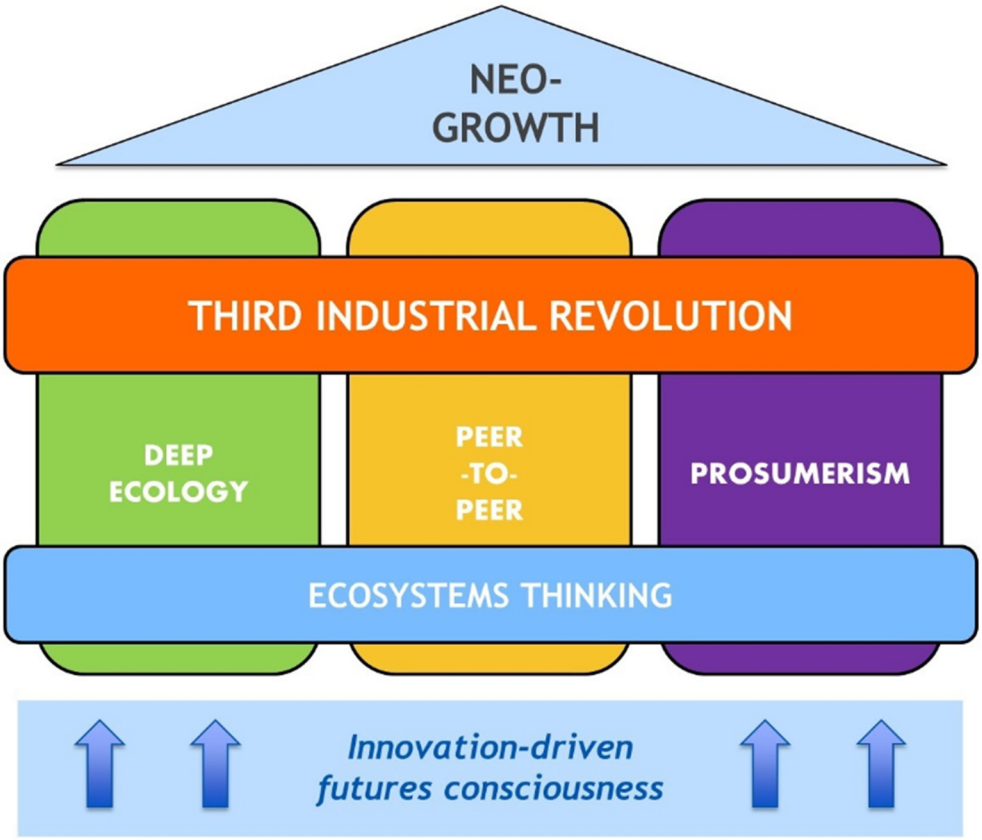

Figure 1. *Neo-growth as the direction of the third industrial revolution, deriving from innovation-driven futures consciousness.*

Future is about change. Futures research empowers actors and decision-makers through the strengthening of futures thinking, by applying various foresight methods, and by creating futures awareness. Creating futures awareness enables a systematic, holistic and long-term anticipation of future change. As previously described, in the course of the Neo-Carbon Energy project, possible socio-economic consequences of and prerequisites to the neo-carbon energy system are anticipated. The theoretical framework is positive post-modern progress through neo-growth, supported by ecosystems thinking and complexity thinking. The main foresight method used in our Neo-Carbon Energy project is scenario technique, in a specifically modified mode of exploring transformation. Futurist professor Jim Dator (2009) categorises all scenarios into four generic categories: *Growth, Collapse, Discipline*, and *Transformation*. These are the so-called archetypes of scenarios. In the Neo-Carbon energy project we chose to construct four scenarios that all fit the most radical category "Transformation". Accordingly, **four transformational neo-carbon scenarios until the year 2050 have been constructed as alternative descriptions of possible future worlds** (see Figure 2). The transformativeness of the scenarios allows the exploration of changes that are significant enough in terms of magnitude. This enables not being too cautious or conventional in exploring futures. With transformational scenarios, we are able to get a better understanding and open up reflections of the significance and

possible roles of neo-carbon in future societies – across the world.[5] These scenario sketches are presented in detail in the report "Radical Transformation in a Distributed Society – Neo-Carbon Energy Scenarios 2050 (Heinonen et al 2016).[6]

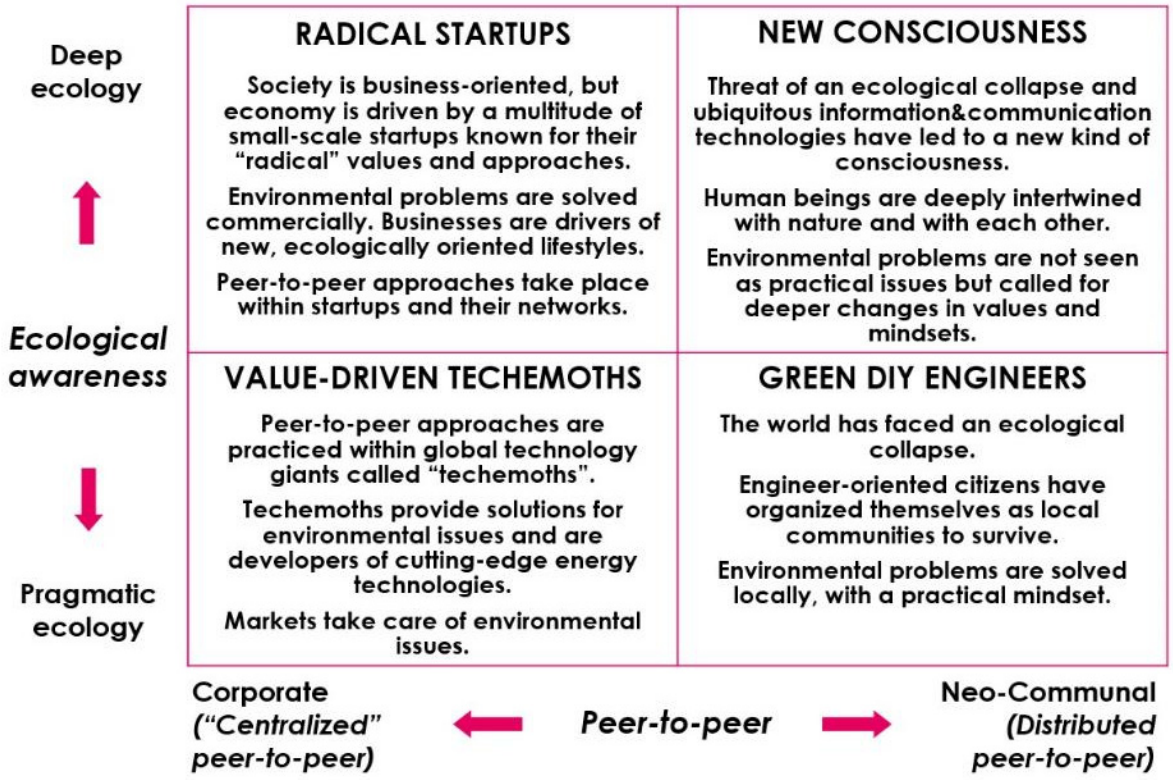

Figure 2. Four transformational neo-carbon energy scenarios 2050.

[5] The futures can be explored in three different main modes – as possible, probable or preferred futures (Amara 1981). Too often, emphasis is given to efforts to address probable futures only. By making scenarios transformational, we can go beyond the probable and open up avenues to possible futures i.e. highlighting emerging opportunities and risks as well. The main idea of scenarios is to show alternatives – the scenarios are never meant to be predictions (focusing on the probable only).

[6] These scenarios are tested throughout the project within the Futures Clinique Process, see for example "Towards the Third Industrial Revolution" (Heinonen et al 2015), available here: www.utu.fi/fi/yksikot/ffrc/julkaisut/e-tutu/Documents/FFRC-eBook-6-2015.pdf. The titles of the other three Futures Cliniques are Fuzzy Futures of the Neo-Carbon Work (April 2016, reported in Ruotsalainen et al 2016b), Clean Disruption of Renewable Energy (June 2016, report forthcoming), and Surprising Energy Futures – Testing Resilience of Renewable Energy World with Black Swans (May 2017, report forthcoming).

1.2 International foresight activities of the Neo-Carbon Energy project

The opportunities and concerns of neo-carbon energy futures vary from one place and region to another. This means that future techno-economic and socio-cultural change can have different manifestations across the world. For this reason, from the beginning of the Neo-Carbon Energy research project, international perspectives have been gathered across different continents to be reflected with the project results. **There are country cases or groups of several countries studied from regions around the world – South America, Asia, Africa, and Australia (Oceania)** – (Table 1). The countries that have been chosen vary by their location, geography, size, population, government, polity, systems of governance, culture, as well as by their past and current modes of energy production. Each country in this study also has their particular cultural, social and political history. We argue that recognising this is important because it influences the perceptions of both local and national decision-makers, the citizens in each country, and the local ability to foresee economic potential in emerging technologies. As a whole, these factors also shape the interest in and expectations for the options on emissions-free energy. This research continues throughout the foresight work.

Table 1. *International reflections from selected case countries.*

Asia	Latin America	Africa	Oceania
China South Korea	Argentina Chile	Kenya South Africa Tanzania	Australia
			

These country-based reflections are used to produce dynamic feedback on socio-technical change. The findings can provide insights on the weak signals of local or regional change and explain emerging trends. The country reflections can be used to identify and raise several types of issues related to neo-carbon energy. These include:

- how could the neo-carbon energy system be adopted and adapted to local energy needs in a particular area, country or region, and what obstacles might have to be considered;

- how geopolitics, national politics and policies influence the uptake of novel energy solutions;
- what kinds of new sources of economic growth could emerge, and what kinds of emerging business models should be studied further;
- what is the role of social considerations such as employment, gender, or ownership;
- what technological know-how and skills exist and what are still required;
- what technological or social innovations might be needed;
- what environmental considerations should be paid special attention to and through what kinds of means;
- how should culture be understood and contextualised;

And finally:

- in what ways could there be mutually beneficial collaboration on these questions between the country under study and Finland in the private, public or third sector, by research actors as well as through related networks?

The international case studies of the Neo-Carbon Energy research project provide also insights to the project's transformative scenarios, in at least two ways. First of all, the Neo-Carbon Energy scenarios until the year 2050 were initially sketched as generic meta-scenarios. This way, the relevance of the scenarios can be reflected or "tested" on a particular country or region. In return, findings from different countries create a feedback loop to stimulate and to deepen the scenario sketches. Together, this kind of cross-fertilisation of tentative research results improves the understanding of country-specific and regional dynamics as well as enhances the policy relevance of the transformative scenarios. For results of an international survey made with the idea of looking for and identifying pioneers or forerunners of renewable energy futures and possible early echoes of neo-carbon energy futures, Latin America included, see Lang et al 2016.[7]

Based on this iterative process, it is possible to examine possible pathways of change, and then later support decision-making of the desirable ones. For making transformation happen, strong transformational leadership is needed, too, at government level, business, academia, and civil society, preferably within all of them.

[7] Replies to the questionnaire were also received from Argentina.

Case Argentina – research exchange

In the Latin American region, Argentina is a case country in the Neo-Carbon Energy project.[8] A research visit to Argentina was conducted in November 2014 by Professor Sirkka Heinonen, leader of the foresight part of the project at the FFRC.

During this one-month visit, information and preliminary results of the research project were disseminated on several occasions – in meetings and presentations – to Argentinian experts and stakeholders. The contents of the research project were explained in a guest lecture delivered in the University of Buenos Aires[9]. From among the audience, insightful comments were given. For example Dr Gilberto Gallopin wanted to share information about Argentina being the only country in the 'Latin' world that made a response to The Limits of Growth model that was produced by the Club of Rome. What followed was called "The economic model in Latin America", which was conducted in Argentina with the participation of other Latin Americans.

Dr Gallopin worked in the exercise together with Hugo Scolnik of the Department of Computer Sciences (Departamento de Computacion) at the University of Buenos Aires. Dr Gallopin also pointed out that in the last 10 years or so in Argentina, at least two scenarios that concern the future for Argentina have been published, in 2004 and in 2011. The 2004 scenario exercise was conducted by a foundation, while the second, 2011 work, was produced by the National Institute of Agricultural Technology, INTA. In addition to these two scenario works, a third scenario was produced by the Economic Commission for Latin America and the Caribbean (ECLAC), at the United Nations. The study on Argentina, conducted by Gallopin and held in Santiago, was set up by request of the Ministry of Science and Technology.

Discussions concerning the Neo-Carbon Energy research project were also held with the members of the Argentinian Node of the Millennium Project, e.g. Miguel Gutierrez, and of the Argentinian Chapter of the Club of Rome, e.g. Silvia Zimmermann. The main contribution from the Neo-Carbon Energy research project was a presentation in a panel discussion in an international seminar about science, technology and innovation (STI) policies that was organised by CIECTI in Buenos Aires, Argentina (Heinonen 2014b). A visit to Uruguay to the UPM plant in Fray Bentos was also completed.[10] FLACSO

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[8] Later on, an opportunity arose to include Chile as well in the project as a Latin American country where we could interact with the Neo-Carbon Energy project, for example by organizing a renewable energy-related Futures Clinique in in Santiago October 2016 (a separate report is forthcoming, Karjalainen et al. 2017).

[9] See video lecture by Heinonen (2014) on "What is Futures Research and Scenario Thinking?" at University of Buenos Aires (UBA), Departamento de Computaciónat www.youtube.com/watch?v=cY4NGAfdhJU

[10] In June 2016 UPM organised a photo exhibition at Bioforum, UPM's showroom at the UPM Biofore House, to celebrate the company's 25 years in Uruguay. The exhibition showed Andrés Bartet's photographs from the UPM's plantation operations and community engagement activities of the UPM Foundation. UPM has played a major role in the development of the Uruguayan forest industry since the early 1990s. In addition to certified eucalyptus plantation operations the company produces pulp and energy in one of the world's most modern

Argentina[11], a university-network, was a hosting institute for this research visit.[12] On behalf of FLACSO and CIECTI the research visit was hosted by Miguel Lengyel and Blanca Maria Pesado. Mr Lengyel also took part in the subsequent international survey of the Neo-Carbon Energy research project.[13]

CIECTI – a centre for science, technology and innovation

CIECTI (Interdisciplinary Center for Science, Technology and Innovation Studies) is a civic association, which pursues to strengthen national capacities to design, implement, monitor and evaluate science, technology and innovation (CTI) policies. The main activities of CIECTI are organised through:

- interdisciplinary research,
- monitoring and impact analysis,
- the preparation of publications, and
- the organisation of seminars and workshops.

CIECTI is a space under construction, open to the participation of entities from the scientific, productive and social world, committed to discuss and formulate policies of science, technology and innovation.

International Seminar "Dialogue on the New Context for Science, Technology and Innovation Policies" was organised by CIECTI in November 27 and 28, 2014 in Buenos Aires, Argentina in the presence of leading national and international specialists. The aim of the seminar was to provide insights on the contemporary debates and priority issues in the agenda of science, technology and innovation (STI) policies of different countries, and to present the work of CIECTI (see Appendix 2).

This seminar was attended by national and foreign speakers who participated in panels, round tables and special conferences. Among them were presented: Dan Breznitz of the University of Toronto,

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pulp mills in Fray Bentos. The company could benefit from neo-carbon energy solutions in plant. UPM was also invited to act as a case company for scenarios that were constructed during the Scenario Thinking Course in Master's Programme in Futures Studies at University of Turku in 2014. Students made their assignments in groups, supervised by Prof Sirkka Heinonen, and got the chance to present their final scenario work to UPM and get direct feedback. The subsequent case companies for the course, respectively, have been Fortum in 2015 and Wärtsilä in 2016.

11 FLACSO = Latin America Faculty of Social Sciences-Latin America Social Science Harvester (Facultad Latinoamericana de Ciencias Sociales Sede Argentina including the National University of Quilmes y National University of General Sarmiento). See http://flacso.org.ar/. FLACSO is a Latin American Social Sciences Institute and the American and Caribbean countries that currently subscribe to the FLACSO agreement are: Argentina, Bolivia, Brazil, Costa Rica, Cuba, Chile, and Ecuador.

12 Ms Leena-Maija Laurén from FFRC also had the opportunity to visit Argentina and FLACSO within the IFA project as Marie Curie Programme. She contributed material to the Neo-Carbon Energy project as well.

13 This survey provides insights on renewable energy forerunners across the world (Lang et al. 2016).

Canada; Manuel Castells of the University of Southern California, USA; Sirkka Heinonen of the University of Turku, Finland; Raphael Kaplinsky from the Open University, United Kingdom; along with other major exhibitors.

The dialogues in the seminar covered sectoral approaches to natural resources, the intriguing potentials and interlinkages of biotechnology including when applied to the transformation of industrial structure, the role and implementation of ICTs in business and society, new organisational paradigms as well as novel ways of sharing of information. The seminar also addressed the role of public policies and regulatory frameworks for innovation from the perspective of social inclusion. These issues were reflected in the light of **the current context and future challenges; global productive dynamics and strategic options for developing countries; leading technology sectors: biotechnology and ICT; new policy approaches and institutional initiatives for innovation;** among other issues.

The seminar also gave an opportunity to present the Centre for Interdisciplinary Studies in Science, Technology and Innovation (CIECTI), whose mission is to contribute to the design, implementation and evaluation of science, technology and innovation policies through interdisciplinary research and the development of institutional and professional capacities within a framework of public-private dialogue and agreements.

Figure 3. *CIECTI seminar on Science, Technology and Innovation in Buenos Aires (see Appendix 2).*

Figure 4. *Lecture on futures studies and Neo-Carbon Energy at the University of Buenos Aires.*

Expert survey on energy futures

After the visit, the Neo-Carbon Energy research team, led by professor Heinonen, continued with a survey questionnaire about energy futures in Argentina. The purpose of the survey was **to examine how energy experts in Argentina understand the current energy policy and see the potential for renewable energy based options in the future**. The survey was sent through the Embassy of Finland in Buenos Aires (see Preface) and targeted local energy experts. The Finnish Embassy – with the Ambassador Jukka Siukosaari and First Secretary Sara Henttonen – helped the Neo-Carbon Energy project group to identify potential respondents for the survey. After the first round of enquiry, a reminder was sent to the recipients and additional experts were contacted. The survey questionnaire, drafted in Finland Futures Research Centre FFRC by project researcher Joni Karjalainen, is presented in Appendix 1.

Out of the targeted pool of energy experts, five responses were received (n=5). Based on the responses, indicative considerations can be drawn, in spite of the small number of respondents. The respondents had been instructed to either reply to all of the provided questions or to focus on the themes they felt most familiar with. These survey results are presented in Chapter 4.1. They were analysed by Joni Karjalainen and during summer 2015 by Aino Helle from the University of Helsinki who worked as Research Intern at the Helsinki office of the Finland Futures Research Centre. Ms Helle also contributed to Chapter 3 that discusses the political and economic history and the energy landscape of Argentina.

In the final research phase, the country case study received comments from the Neo-Carbon Energy project research team. The research team of Christian Breyer, Professor of Solar Economy at Lappeenranta University of Technology (LUT) has analysed the potential for 100% renewable electricity system for South America. Reflections on the LUT research findings and the neo-carbon energy based solutions in Argentina are highlighted in Chapter 4.2.

1.3 Foresight for innovations

Innovation systems are required to seek solutions for increasingly complex problems amidst the megatrends of globalisation, urbanisation, digitalisation, demographic change, et cetera. This approach of realising the importance of conducting foresight and seeking for innovations is needed in a rapidly changing world facing global challenges and trying to tackle complex issues. This also challenges conventional models of learning and leadership.

Even a single megatrend such as globalisation, climate change, population growth, or ageing of the population, is a huge challenge for societal development and merits closer inspection when exploring future prospects for a country. **Not to mention the task of analysing several megatrends together and especially their interconnections.**[14] Transformation evolves through megatrends. Perhaps the megatrend of digitalisation is the one that has been packed with most expectations, even hype on one hand, and with illusions and risks, on the other hand. Jordan (2015) has called Latin American institutions to "instil and install digital and innovation mindsets" to keep up with the digital revolution.

The importance of foresight activities in today's world facing complexity is crucial. Foresight is a pragmatic and problem-orientated part of the field of futures research or futures studies (Heinonen 2014a). Further, it is important to make the difference between the concepts of foresight and forecast:

- foresight = to see something before it emerges; whereas
- forecast = to make an extrapolation of a future thing.

Thinking out-of-the-box by understanding complex systems

The main question, at the basis of foresight, can be how to think about the problem. This is essential when we bear in mind the Gordian Knot untied by Alexander the Great by a sword, not by ordinary measures. It is often from an unexpected angle that a solution is offered to a problem at hand. Foresight also means out-of-the-box thinking – seeing things through totally different eyes or spectacles.

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[14] Besides analysing megatrends, you can also use the framework of Millennium Project's 15 Global Challenges where the interrelations between various challenges are emphasized (see chapter 2).

Complexity is a way to describe a multifaceted problem or a complex situation. The goal of futures thinking is to reduce uncertainties about future and complexity. The concept of complexity can be described by Irene Sanders as follows:

"Complexity arises in situations where an increasing number of independent variables begin interacting in interdependent and unpredictable ways."[15] To understand and analyse this, "complexity science is moving us away from a linear mechanistic view of the world, to one based on nonlinear dynamics, evolutionary development and systems thinking. It represents a dramatic new way of looking at things; not just looking at more things at once". Understanding complexity changes your mental models.

Understanding complexity means systems thinking, seeing things as part of a complex system where different parts of an entity are interconnected inextricably. The parts of a system culminate in a higher order of emergence greater than the sum of its parts. Just like there is no absolute definition of "intelligence", there is no absolute definition of "complexity"; the only consensus among researchers is that there is no agreement about the specific definition of complexity. However, a characterisation of what is complex is possible.[16] The study of these complex linkages at various scales is the main goal of complex systems theory. There is a growing interest in combining complexity and social sciences, as well as reflections on the future of whole humanity (see e.g. Byrne 2014; Burger 2016; Boulton et al 2015)

Understanding futures thinking means seeing things flow in a time continuum not as a linear extrapolation but as a kaleidoscope-like turbulence of alternatives and options that start to be realised based on the decision taken at a given moment, hopefully based on the experiences and lessons of the past.[17]

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[15] See www.complexsys.org

[16] See Wikipedia.org

[17] This text on complexity and innovations dwells on Heinonen & Daldoss (2006) who analyse the presentation given by Irene Sanders in Helsinki on February 15th, 2006 as invited by the Ministry of Environment. See www.complexsys.org.

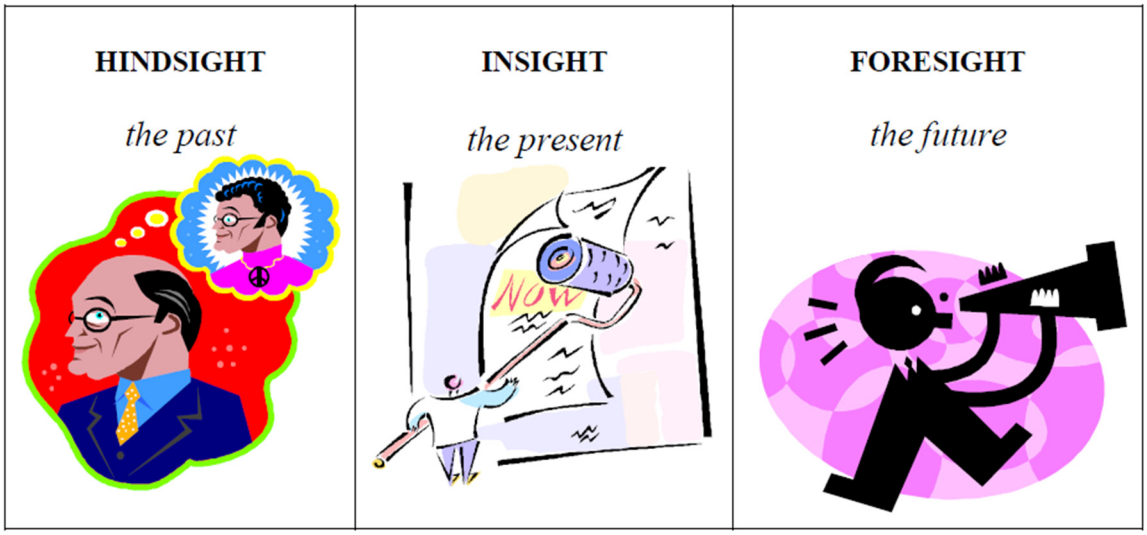

Figure 5. *Foresight as one dimension of time is an effort to perceive the future, as insight is to grasp the present and hindsight is to understand the past.*

Futures-oriented thinking beyond conventional strategy

Futures thinking at pragmatic level is all about strategy and for decisions to be made. Foresight should be better integrated to strategic work in order to support decision-making. Kuosa (2014) claims that strategic intelligence is created on the basis of successful strategic foresight activities. Strategic futures-orientated thinking can be seen as composed by the following seven points:

1. vision
2. mission
3. environmental scanning
4. goals
5. objectives
6. action plans
7. implementation

These elements of strategic foresight are intended to create a more comprehensive understanding of change than is usual in conventional strategy work. Foresight also ends up presenting a spectrum of development alternatives instead of just one forecast (Kuosa 2014). Foresight has a lot in common with the broader scientific field of futures studies (Heinonen 2014a) which seeks to envision a better world and make a change towards it. Futures studies is an academic discipline with its specific theoretical approaches, basic principles, and methodology (regarding the discipline see Bell 1997; Masini 1993; as for the methods, see Glenn et al. 2009; Kuusi, Heinonen & Salminen 2017). Foresight, instead, focuses on helping decision-makers seeing various options and taking then steps towards the changes required (Kuosa 2014).

The relation of strategic foresight to complexity is that of an enabler. Strategic thinking should be able to help understand and manage complexity. The seven principles of strategic thinking from the point of view of complexity are the following:

1. Look at the whole system, not just their parts.
2. Complex adaptive systems are self-organising and pattern-forming.
3. Small changes can create big results.
4. Maps, models and visual images make it easier to see connections, relationships, patterns of interaction.
5. Scanning across disciplines, forces, agencies, etc. is the key to see subtle changes, emerging conditions.
6. Non-linear thinking is critical to recognize clues about changes in the environment.
7. Perspective is important. You have to know what you are looking at (local/global), place in context.

Complexity thinking is a fundamental shift in thinking, a new worldview, a theory-driven framework for thinking about the future. To be an effective leader, you must understand and develop the skills of complexity thinking. The future is happening today and the challenge in any type of planning process is to see and understand the dynamics of the big picture context in a realistic and coherent way.

We just have to learn to see emerging signs of the future. Both foresight and creativity-based innovations are enabled by new, systematic ways of looking, listening and learning. Thus companies can become alert, adaptive and agile as regards innovation generation and new opportunities. (Heinonen & Daldoss 2006). Innovations are new solutions which add value to their users in terms of lower costs, higher sales, reduced risk, and improved convenience. Innovations can be both radical and incremental. A company is said to survive and develop through continuous incremental innovations, whereas it is through radical innovations when a company really changes. The same could apply to nations. However, it must be born in mind that new ideas that form the basis of innovations are not so common. The yield of really new ideas is quite low, only 1:1000 will produce a "golden egg". (Andersson 2006). In search of new ideas and innovations it is worth paying attention to the following observations (ibid.):

- Ideation requires good practical working methods and tools
- Customer research and objective observations are critical
- Different skills and backgrounds – the "Medici – effect"
- Importance of concepts – experiments and options
- Openness, need for realistic feedback from different viewpoints
- The importance of "innovation midwives"
- Advance "round by round" not "step by step" – keep business focus
- "Fail often but fail fast".

Innovation-oriented companies could also develop their peripheral vision. Metaphorically, a company's vision is often focused primarily on its core business, while important things may be emerging within its peripheral vision. The human eye, instead, can more effectively handle the peripheral areas of vision. In human vision, the majority of retinal cells are devoted to peripheral vision, whereas in a typical organization, the majority of resources are focused on its central task. Both visions, focal and peripheral, are crucial for foresight and innovations. (Day & Shoemaker 2006).

1.4 The structure of the report

This report consists of an introduction to the Neo-Carbon Energy research project, depiction of its international activities and discussion on the role of foresight for innovations. Chapter 2 contextualises our research approach and summarises recent futures studies conducted in the Latin American region. Chapter 3 provides an overview of the country case of Argentina, introduces its energy policy and the potential for renewable energy in the country. Chapter 4 presents the findings of the expert survey as well as provides some reflections about potential neo-carbon energy solutions. Conclusions are presented in the end of the report.

In order to attend to the needs of quick reading, an Executive Summary is given in the beginning of the report. This report contains several references to other case studies and research of the Neo-Carbon Energy research project. Those who are interested in following the results of this project are advised to visit the Neo-Carbon Energy project website to check up the most recent publications, see www.neocarbonenergy.fi and www.utu.fi/en/units/ffrc/research/projects/energy/Pages/neofore.aspx.

2. FUTURES IN THE LATIN AMERICAN REGION

In the early 21st century, several Latin American countries will celebrate two hundred years of independence. Already in this new millennium, several major developments have taken place. Brazil has increased its international influence across international arena, become coined as one of the BRICS countries, and has hosted the Rio+20 conference for sustainable development in 2012[18]. Costa Rica[19] and Cuba are often showcased, when the world seeks for countries that perform well in measures on ecological sustainability and well-being. The economic performance in Chile and Uruguay in particular has been widely applauded, and recognized as plausible development pathways for the rest of the continent. The peace process in Colombia after years of instability creates space for a more stable future.

When we say that the world today is increasingly complex, what is meant is that our societies, economies and environmental systems are interconnected, and subject to change, uncertainty and unexpected crises. **However, it has been claimed that Latin America was ill-equipped for the major transformations that took place in the last two decades.** Information and communication technologies (ICTs) and the rise of the internet have shaped societies and the entire global economy. Technological leadership of the digital transformation has been in the Western economies and in Asia. During the same period, the world has also witnessed the rise and novel potency of China. With the growth of the Chinese economy, a related commodity boom caused tremors across several regions and influenced global markets. Finally, two major financial crises of systemic nature – the Asian crisis in the late 1990s and the financial crisis that spread from the U.S. to Europe since 2008 – surprised also Latin American policymakers, even if Latin America was not directly impacted by them. (Bitar 2015.)

The long-term perspective and the Latin American region

Policy design and policy planning in Latin America have typically suffered from insufficient strategic depth and the lack of a long-term perspective. In terms of policy implementation, as suggested by Baena Paz (2015), typically either too many actions are conducted at once, or alternatively urgent matters are attacked too late. Poor planning limits the ability of policymakers to anticipate risks, increases

[18] As well as the FIFA World Cup in 2014, and the Rio Summer Olympics in 2016. For more information on the Rio+20 Conference: https://sustainabledevelopment.un.org/rio20

[19] In September 2016, Costa Rica had been running on 100% renewable energy for two months according to a report. While this achievement is undoubtedly impressive as proof that a range of renewable energy sources can lessen a country's reliance on fossil fuels, one must bear in mind that Costa Rica's success can largely be attributed due to its relatively small size, a total area of about 51,000 square kilometres and a population of just 4.9 million people. Furthermore, Costa Rica's needs to make changes in its transport sector in order to avoid future increase of oil dependence.

costs and as well as makes it difficult to take advantage of opportunities. There have also been numerous challenges in collaboration between the Latin American countries, despite proposed ideas of deeper regional integration (e.g. O'Toole 2010).

Mendoza (2015) advocates for conscious anticipation, a change of thinking and a paradigm shift "in the way of understanding and interpreting reality". The researchers of Latin America must understand where the continent is (*perspective*), what has already been done (*retrospective*), where the continent is going (*futures*), and what can we do about it (*strategic possibilities*) (Rodero 2015). Another framework for exploring a country's futures is to pay attention to past *perspectives*, identify today's *opportunities*, and come up with future-making *solutions*.

Those involved in a futures exercise on Latin America need to profoundly understand their subject, not merely apply futures methods. There are a diversity of worldviews and cultures, social groups and interests that operate in multiple levels of society, and distinct cultural features and traditions with histories that have evolved over a long period time. Today, a number of policymakers, academics, consultants and practitioners are involved with foresight activities in the Latin American region. Long-term scenarios are one means of elaborating the challenges societies are faced with. Scenarios can help bridge the dynamics between what is taking place locally, regionally and globally.

Figure 6. *Scenarios make bridges between past, present, and future, as well as between local, regional and global reflections.*

2.1 The Millennium Project and its Argentina node

The Millennium Project (MP) is an international network and an independent global think tank of over 1 000 futurists, scholars, business planners, scientists, and policy-makers. They work for international organisations, governments, corporations, non-governmental organisations and universities to improve humanity's prospects for building a better future. Founded in 1996, its aim is to promote futures thinking, as well as, to connect individuals and institutions to conduct research addressing to important and global challenges. The Millennium Project is spread to over 50 countries and it is organised into Nodes, a group of people and institutions that are connected geographically, for instance, the MP Argentina Node.[20]

The Millennium Project publishes an annual report called *The State of the Future* that is an overview of the globe's present situation, as well as, challenges and opportunities of the future. It also maintains The Global Futures Integration System (GFIS) that is a collective intelligence system that brings together The Millennium Project's research, methods and experts to create synergies for better global foresight.[21] In the core of the GFIS is a framework of **15 Global Challenges as the greatest present global challenges for humanity**, presented from the past 17 years, and it is possible to follow the developments of each challenge. All of the challenges are transinstitutional and transnational, meaning that not one nation or institution can address them by acting alone and collaboration across boundaries is needed. The MP Global Challenges have Clean Water as their Challenge Number 2 and Energy as the Challenge Number 13. What is unique in the MP Global Challenges framework is its vivid illustration of the interconnectedness of the challenges over the globe and inside a country (see Figure 7). It can be noted that the United Nations (UN) has created a comparable framework for global challenges that are called the "Sustainable Development Goals[22] – 17 goals to transform our world" that address similar major issues, such as energy. The Goal number 7 for the UN aims to ensure access to affordable, reliable, sustainable and modern energy for all[23].

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[20] Helsinki Node is so far the only node in Nordic countries. It is hosted by Finland Futures Academy FFA and Finland Futures Research Centre FFRC. Currently, it is co-chaired by Sirkka Heinonen, Juha Kaskinen, Osmo Kuusi, Sari Söderlund and Toni Ahlqvist. The Helsinki Node has launched the concept of Millennium Forum i.e. an open seminar or event promoting research done by MP. The most recent Millennium Forum was jointly organized as Summer School for Finland Futures Academy (FFA) by the Neo-Carbon Energy project in June 2016 in Helsinki.

[21] See millennium-project.org

[22] www.un.org/sustainabledevelopment/energy

[23] By 2030, UN SDG7 seeks to (7.1) to ensure universal access to affordable, reliable and modern energy services; (7.2) to increase substantially the share of renewable energy in the global energy mix; (7.3) to double the global rate of improvement in energy efficiency; (7.A) to enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced

The Millennium Project also publishes an annual State of the Future report and with it, a State of the Future Index (SOFI) as an indication of the 10-year outlook for the future, based on historical data of selected variables for the previous 20 or more years and on judgments about the best and worst plausible 10-year outcomes for each variable. The Millennium Project was selected as one of the Top 10 think tanks in the world for new ideas and paradigms by the 2013 and 2014 University of Pennsylvania's GoTo Think Tank Index.

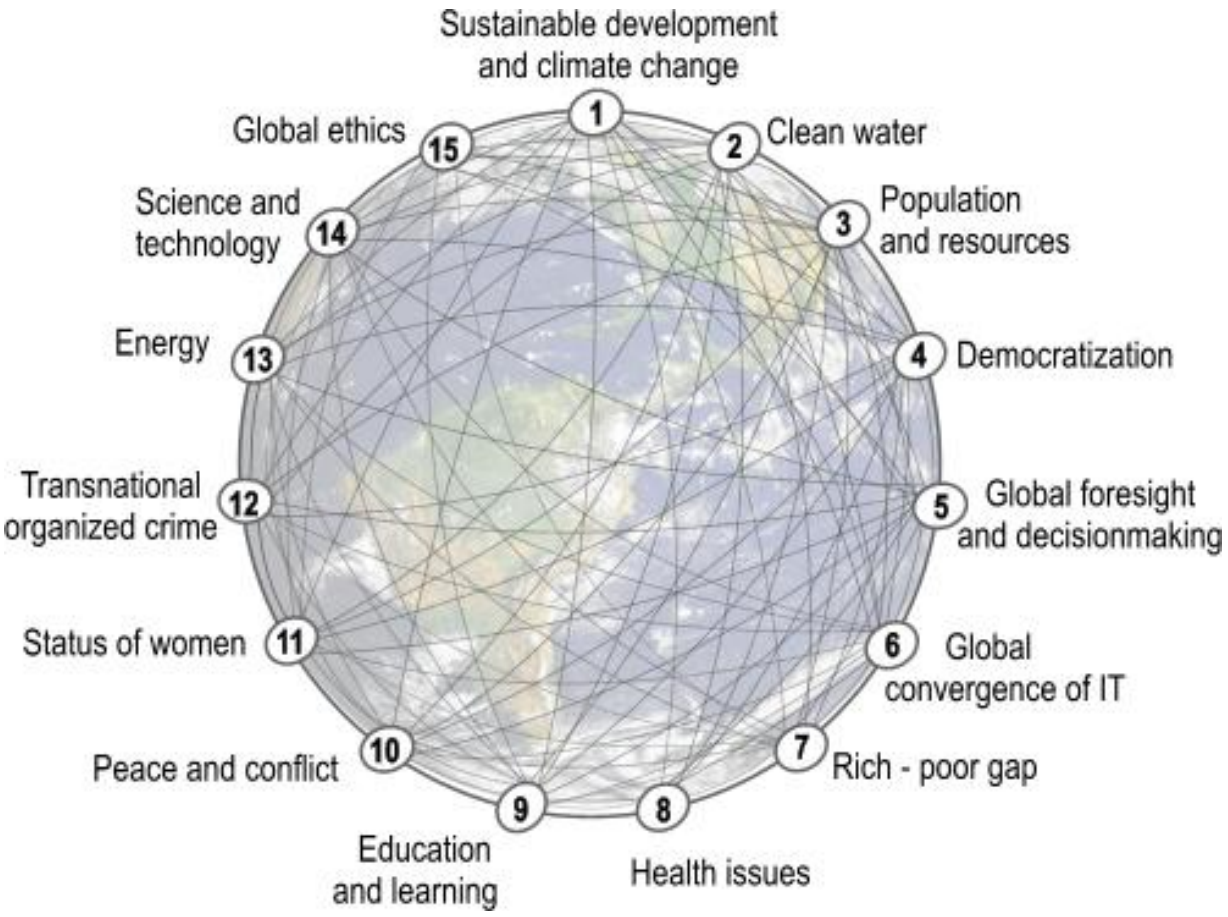

Figure 7. *The framework of 15 Global Challenges presented by the Millennium Project. (Glenn et al. 2015)*[24]

Among the over 50 nodes in the world, CeLGyP – Latin American Center for Globalization and Prospective (Centro Latinoamericano de Globalización y Prospectiva) is the Millennium Project Node

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and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology; (7.B) expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support

[24] www.millennium-project.org/millennium/challeng.html

in Argentina. It was formed in 1996 as the first Latin American node, in order to promote the dissemination and consolidation of the project. The Argentina Node has been recently working closely with the Uruguay Node, for instance, in coordinating a Future Laboratory of FLACSO, the Latin America Faculty of Social Sciences - Latin America Social Science Harvester[25] in order to develop activities of research and teaching with anticipation and foresight approach. The director of the Node, Dr. Miguel Gutierrez[26], is also an active actor of the MP and in 2015 gave a speech on a topic "Anticipation governance and Collective Intelligence Systems of the Millennium Project" in the 12th National Congress of Political Science that was organised by Argentine Association of Political Analysis (SAAD).

Finland Futures Research Centre (FFRC), which is the Millennium Project Helsinki Node, has worked to overcome some of the forementioned challenges in its own studies of future environmental, social and economic prospects in the Latin American region. Energy, MP Global Challenge Number 13 as mentioned above, is also one of the key issues in FFRC's research agenda. FFRC is a consortium partner in the Neo-Carbon Energy research project, where a 100% renewable energy system is explored also for Latin America.

Energy as a Global Challenge

The State of The Future report of the Millennium Project discusses the challenges and solutions to address the energy issues that the world is facing now and in the future. As the major challenges, the most recent report mentions **the triple dilemma of an urgency to tackle climate change due to rising greenhouse gas levels, 1.3 billion people who currently do not have access to energy, and population growth which is expected to add still another 2.5 billion people more to the planet by 2050**. The report states that solar and wind energies are already competitive with traditional fossil fuel sources and that they can be replaced with combinations of renewable energy. State of the Future report lists some innovations that will support solutions addressed to the Challenge 13 i.e. energy. These innovations are the following:

- drilled hot rock geothermal;
- buildings that produce more energy than they consume;
- night time energy left unused is used to charge electric and plug-in hybrid cars;
- metal air-batteries;

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[25] FLACSO – Buscador Latinoamericano de Ciencias Sociales

[26] He has also been supporting creation of Futures Committee for the parliament in Argentina, as well as, in Uruguay. www.congresodelfuturo.cl. Finland is frequently benchmarked for this kind of public foresight units. Finland has a permanent Committee for the Future in the Parliament since 1996. Another major foresight unit is Prime Minister's Office, which makes so-called government foresight reports during each election period.

- halophytes, algae for food, and liquid fuels production; and
- compact fluorescent light bulbs, light emitting diodes nanotubes that conduct electricity. (Glenn et al. 2015)

The findings in the State of the Future report can be compared with other influential studies on energy. In 2011, the Intergovernmental Panel for Climate Change (IPCC) energy scenario work estimated in one of its scenarios that renewable sources could reach 77% of global energy demand in 2050 (IPCC-SRREN 2011). This work, however, was largely conducted prior to the recent fall in the cost of solar energy. For a while already, Greenpeace and WWF have stated in their reports that a 100% renewable energy scenario is reachable. The International Energy Agency (IEA), taking a purely economic perspective, has calculated that it would take USD 48 trillion to serve all the energy needs between now and 2035 and that 90% of the needs will be in non-OECD economies. This calculation, of course, does not take into account the economic benefits of transitioning into a cleaner energy system and the potential savings of avoiding climate change. The transition of energy systems is a grand challenge, as the amount of fossil fuel subsidies is at a staggering $5.3 trillion yearly compared to the subsidies for renewable energy that currently stand only at $0.12 trillion, as estimated by the International Monetary Fund (IMF).

The State of the Future report and the Latin American region

The implications of the *State of the Future* report for Latin America and *Latinoamérica 2030* scenarios are summarised next. According to the 2015-16 State of the Future report, the Latin American region could face a $100 billion annual loss by 2050, if the global temperature rises +2°C over pre-industrial levels. In Latin America, 68% of the region's electricity has originated from hydroelectric sources. The melting of ice in the Andes would affect hydroelectric dams, as well as agriculture and urban water supplies (Glenn et al. 2015). At the same time, it is estimated that 85% of the Latin American region will be urban by 2030, and that cities will be the major hubs of future innovation. This poses a double-pinch for the region: ***how*** **to transform and counter increasing energy consumption and the environmental pressures of urbanisation, while advancing human development and well-being?** Another seeming trade-off seems to concern food production and biodiversity: South America has 40% of the planet's biodiversity and an estimated half of the world's carbon stored in tropical forests, but it also seeks to add value to its agricultural sector and produce biofuels. Solving these problems will require careful thought as well as considerable investments into increasingly sustainable urban infrastructure and agricultural techniques (Glenn et al. 2015).

In 2010, earlier State of the Future report (Glenn et al. 2010) concluded that when making scenarios for Latin America until 2030, *at least* these ten possibilities should be considered:

1. The potential doubling of food prices;
2. The possibility of wireless broadband communications connecting all major cities;
3. Great increases in tourism;
4. GDP per capita increases by as much as 50%;
5. The region holding to its leadership position in biofuels production;
6. The impact of organized crime and it being even more powerful than some governments;
7. A high growth pattern of CO_2 emissions;
8. A potential rise of protectionism;
9. Perceived uncertainty of the ability to reduce corruption in the region; and
10. A recognition of around 50% chance that within the next 20 years Latin American countries follow the European Union model of regional integration.

Latin America 2030

Latin America 2030, (originally: Latinoamérica 2030) (Cordeiro et al. 2012)[27] is an expert Delphi study where some 800 participants from 70 countries around the world were interviewed. The report found that **with regard to visions for future development there was less consensus in the Latin American region than in developed regions**. Such diversity in views could at least partially be explained by differing views of ethnic, cultural, economic, social and political origin. Other studies have found that public trust in institutions is low, and citizens trust institutions significantly less than the elites (Doyle 2011; Corral 2011). Therefore, disagreements across social groups are commonplace across Latin America.

Cordeiro's report suggests that the Latin American region needs to address two driving forces. The continent needs to better prepare for the emerging future and policy-making should more strongly ensure that the needs of future generations will be met. At the same time, the diverse cultural history in the continent needs to be recognised. The heritage of ancient and present cultures will need protection in order for them to be preserved. The globalising world and digitalised interconnectedness is already present in Latin America. The number of portable devices is increasing sharply and they are making their way also to low-income communities (see eg. GSMA 2014; World Bank 2014). However, modernisation and novel technologies can disturb the "traditional" social and economic order and surface tensions.

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[27] Latinoamérica 2030 created four scenarios *"Mañana" es Hoy: Éxito Latinoamericano"*, *"La Tecnologías como Ideología: Creyentes y Escépticos"*, *"Región en Llamas: Pesadilla latinoamericana"* and *"La Red: Muerte y Renacimiento"*

Both studies acknowledge that Latin American countries will need to address a range of social concerns ranging from health, education, skills, poverty and segregation to insecurity, "the war on drugs" as well as deep-rooted sentiments of corruption. After all, the richest 10% are receiving about 48% of total income, while the poorest are getting only less than two percent (Glenn et al. 2015). A vision of regional integration is often mentioned, but many hurdles remain because of the questions of identity and social concerns. Another identity-related issue concerns the view of Latin American and Caribbean countries in a global perspective. These countries should not merely be compared with Europe, even if this has been typical in political studies (see e.g. Maihold 2007) or high-level narratives. **A "rejuvenation" of Latin America could await, but potential solutions will need active deliberation to successfully balance between the nexus of people, environment and technology**.

2.2 Alternative energy futures in Latin America

The potential of decentralised renewable energy (RE) futures across Latin America has recently been opened up. Capacities are gradually increasing, albeit the region is starting from a low base. Latin America has already more than doubled its installed wind capacity, mainly thanks to Brazil and Mexico. Globally, as the costs of solar energy production have come down, countries like Chile are increasingly making use of solar energy technology. The main drivers for alternative energy futures are the search for cost-competitive alternatives for electricity generation, growing demand, energy security, and in some cases a potential for exports. There are also countries like Venezuela, which have suffered from the fluctuations in oil price. In the Caribbean region, full of small island states, solar and wind energy based solutions could help curb the high cost of energy. Between 2006 and 2013, the Latin American and Caribbean regions together attracted a cumulative investment of $132bn for biofuels, biomass, geothermal, solar, small hydro up to 50MW and wind, of which $93.4bn went to new projects (Climatescope 2014).

IRENA – The International Renewable Energy Agency (2015) reports that 19 out of 20 Latin American countries they studied have at least some type of policies supporting the development of renewable energy in place. Out of these 20 countries, four have public funds or facilities designed for RE projects; 13 use actions and fiscal incentives in the electricity sector; net metering is used in 10 countries; preferential grid access is in place in 13 countries. In the transport sector, biofuel blending mandates were in place in ten and fiscal incentives in 8 countries at the time of the study. However, for heating – both commercial and industrial – policy support has been limited, and policies have mostly addresses solar water heating (SWH) and improved cook stoves.

IRENA views the region as a pioneer especially in the biofuel mandates and auctions. Latin America has been projected to become a major biomass producer for the global markets. Brazil is the world

second largest producer of ethanol[28] and Argentina has also become a large producer of biodiesel and biofuels. However, as mentioned earlier, **biomass production for renewable energy sources raises concerns of food security**. Further questions of the sustainability of the industry are connected to environmental degradation, biodiversity, health, environmental governance, energy security, and how an equal and non-discriminatory access to resources can be secured.

How Latin America will manoeuvre in a changing global energy landscape, will be seen in the years to come. New investments in renewables will be necessary to meet future energy demand and to keep atmospheric CO_2 concentrations below 450ppm in order to limit global warming. The International Energy Agency (IEA), typically conservative in its estimates, has in recent years revised its assessments for the potential of solar energy upwards and in 2014 published a Technology Roadmap for Solar Photovoltaic Energy. Technological changes such as new solutions for carbon reuse and capture are amongst some of the top research priorities, while policy changes will likely also be needed to adapt to the emerging future (Glenn et al. 2010).

Some countries in Latin America are already taking steps to acknowledge the climate change constraint. Chile has approved a carbon tax to start in 2018 and in its *Energía 2050*, the energy policy strategy for the country, Chile aims produce at least 70% of all its consumed energy with renewables by 2050 (Gobierno de Chile 2015). Mexico has set a climate change law with legally binding emission reduction goals: 30% below business-as-usual levels by 2020 and 50% below 2000 levels by 2050. There are some signs of the private sector interest, too. In 2012, already some 40% of Brazilian businesses reported emission reduction targets. (ibid.)

In Argentina, the social mood of high hopes was marked by the historical moment when President Alfonsín inaugurated the Argentinian democracy back in 1983. Now the high expectations of deepening democracy exist again in the post-Kirchnerian era. The quality of the decisions would make a "big bang" in governance if best quality and transparent talent were driven by the shared mission of:

1) Reaching the Zero Poverty goal

2) Governing in a transparent and honest way, and

3) Integrating Argentinian citizenship through quality institutions (understanding this as respecting the rule of Law)

So it seems that such an Argentinian dream for Argentina and its citizens could happen (Bril 2015).[29] The country could start moving towards Human Progress and Development after decades of volatile downwards evolution. Bril's appeal is that in 2016 both Argentinians and the world will stop

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[28] Consequently, most automobiles produced in Brazil are flex-fuel, so they can use ethanol or gasoline, which supports Brazil's biofuel production.

[29] Lisandro Bril's e-mail on December 31, 2015.

"crying for melancholic Argentina". He conveys a message "that love and passion in what you do is a key necessary condition to make things happen". Improving the state of humankind and our planet is one of the key aims in futures studies and gives motivation for foresight activities in different countries. According to Pentti Malaska (2010) we must challenge the status quo when and where it is not decent enough for people or sustainable for the planet. He used to say “What an optimist believes and a pessimist fears: That we live in the best possible world. We must be brave enough to challenge these views”.

3. CASE ARGENTINA

3.1 Background for Argentina

Argentina (Argentine Republic, Spanish: La República Argentina) is a federal republic, located in the Southern Cone of South America. The name originates from a Latin word for silver *argentum*, and the area is named by the estuary Río de la Plata, meaning the River of Silver, located between Argentina and Uruguay.[30] Argentina is the second largest country in South America and the eighth largest in the world by geographical area (Figure 8). Argentina has a low population density compared to many Latin American countries.

Basic Facts	
Population	38,592,000
Capital	Buenos Aires
Area	2,780,400 km^2
Language	Spanish
Religion	Roman Catholic
Currency	Argentine peso
Life expectancy	74
GDP per capita	USD 10,500
Literacy percent	97

***Figure 8**. Argentina is the second largest country in South America by geographical area.*

It may be observed that during the past 50 years, the biocapacity of Argentina has decreased. This shows human pressures on the environment. Environmental problems in urban and rural areas include

[30] See basic facts on Argentina as a country in: https://en.wikipedia.org/wiki/Name_of_Argentina & https://en.wikipedia.org/wiki/R%C3%ADo_de_la_Plata

deforestation and soil degradation, like in other industrialized countries. Argentinians were reported to have an ecological footprint of 2.7 ha (2012). (GFN 2015, HPI 2012.)

History of Argentina

In the 16th century, Río de la Plata was named by the explorer Sebastian Cabot. Cabot was exploring the rivers in the area and got inspired by silver objects traded in the area, and by the myth called "Sierra de la Plata" that was a mythical source of silver in the interior of South America.

The written history of the area begins in 1516 alongside the Spanish domination, when the first Spaniards arrived. Poor of silver and gold, the region was of little interest to the early settlers, and Argentina remained a part of the Viceroyalty of Peru (Virreinaito del Perú) until 1776 when the Spanish Crown established the Viceroyalty of Río de la Plata (Virreinaito del Río de la Plata). The new viceroyalty stretched from Bolivia through Paraguay, Uruguay and Argentina. A great majority of the native population died of European diseases. Today, the population is over 95% of European origin. In the first decade of the 19th century, political unrest on the Iberian Peninsula was reflected across the Atlantic, giving a stepping stone to the May Revolution of 1810. This led into the Argentine War of Independence and the formal independence was issued on July 9, 1816.

Figure 9. *In Patagonia, Indians greet a European traveller ca. 1820–1830.*

Argentina, which today is the third largest economy in Latin America, was one of the world's wealthiest countries already some 100 years ago. **For Spanish, Italian, German, and other immigrants, often scientists, artists, intellectuals, in the late 19th century, Argentina held great promise**. Early decades of the 20th century were the Golden Age for Argentina.

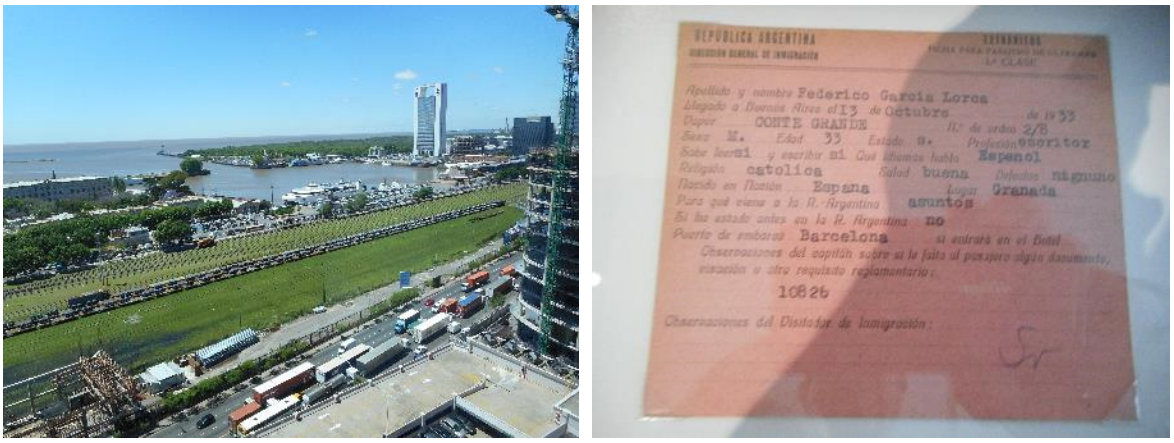

Figure 10. *Building on the left is immigration office. Archives still have e.g. Federico García Lorca's registration of entering Buenos Aires in 1933 from Barcelona.*

The economy of Argentina in a glance

Through most of the 20th century, Argentina suffered badly from economic crises. Inflation, external debt and capital flight led the country into a deep depression and an ever growing debt. This culminated in 2001 and was followed by what is considered possibly the most severe crisis in the country's history. By the end of that year, the government defaulted parts of its national debt. (Honoré 2004.) The crisis, not only economic, but also political and social, led to massive demonstrations and public dissatisfaction. The devaluation of peso, the national currency, alongside with financial rearrangements allowed for the recovery to begin. An annual economic growth of 7-10% lasted until 2008. The world economy fell into a crisis and government policies held back exports. In 2010–2011, rapid economic growth continued again, but after this economic growth has been slower.

Argentina has had difficulties in accessing the international credit market ever since defaulting on its bonds in 2001. Argentina's problems were exacerbated in the 2010s, when the country was caught of the manipulation of inflation rates, which in reality were suggested to reach as high as 40 percent. In addition, foreign currency regulations, access to financing, corruption, tax rates, policy instability and government bureaucracy have been considered as problems for doing business in Argentina. Consequently, in the 2014 Global Competitiveness Index, Argentina was ranked only 104th out of 144 economies (WEF 2014).

The economy of Argentina today is increasingly service-driven. It has an export-oriented agricultural sector and a diverse industrial base. The main economic sectors are manufacturing, commerce and tourism, and agriculture. (Coremberg 2014, INDEC 2016.) The main trade partners of Argentina

are Brazil, China and the United States. The presidential election of Mauricio Macri at the end of 2015 has led to a significant change in Argentine economic policy.

The country's landscape is varied: approximately 54% of the terrain is plains, 23% is plateaus, and 23% mountains. Nearly half of the country's population of 42 million people lives in the city and the province of Buenos Aires. The republic is comprised of 23 provinces and the Federal District of Buenos Aires, all of which host their own governments.

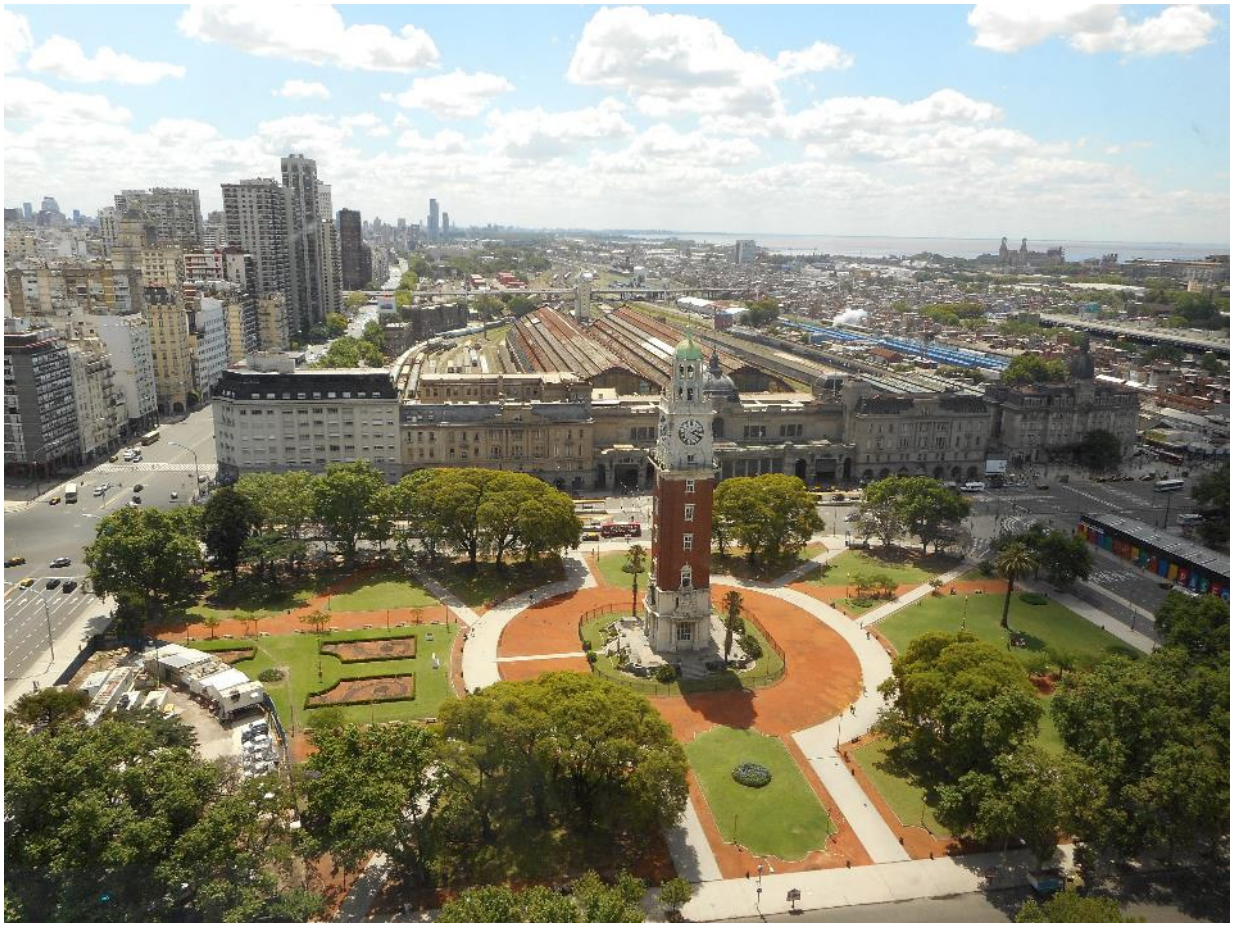

Figure 11. *City view over Buenos Aires.*

The President of Argentina is the Head of State and of the Government. Cristina Fernández de Kirchner was elected in 2007 as president to follow her husband Néstor Kirchner as president, and was re-elected in 2011. The Argentinian legislation only allows two consecutive terms as president, meaning Fernandez de Kirchner could not run for re-election. Argentina voted for a new president and congress in autumn 2015. Already before the election, changes of one sort or another were expected take place. **Mauricio Macri was elected as the president of Argentina to follow Fernandez de Kirchner in**

November 2015.[31] Already in the beginning of his electorate period, Macri has been changing the former populist policies practiced by Kirchner, including removing currency controls and increasing energy rates (Otaola et al. 2016).

3.2 Argentinian energy landscape

For the past few decades, Argentinian energy landscape has been dominated by change. Waves of privatisation and re-nationalisation have shaped energy markets, while the country has been shaken by one crisis after another. Several programs have been launched to address energy consumption and production. Low renewable energy production capacity in Argentina can be explained by an unsupportive energy landscape and energy culture, related governance and energy policy. Low political will, weak regulatory frameworks, as well as financial and economic aspects have limited the growth of the renewable energy sector.

From privatization to economic and energy crises

Argentina, like the rest of Latin America, was at the forefront of the electricity sector liberalisation and reform in the 1990s (IRENA 2016). In 1992–1993, Argentinian electricity was largely privatised in order to improve the quality of service (GENI 2009). YPF, Yacimientos Petroliferos Fiscales, a national energy company that is involved in many phases of energy production, was privatised.[32] Other reforms also took place in 1992, such as the creation of the Electricity National Regulatory Entity (ENRE), Wholesale Energy Market (MEM) and Wholesale Electricity Market Administration Company (CAMMESA). The reforms increased investment in electricity generation capacity, which caused a fall in the wholesale price of electricity. Transmission capacity, however, failed to follow the increase of generation capacity. By 2001, the electricity price in the wholesale market had fallen by 43% compared to the level in 1992.

In 2001, an economic, political and social crisis hit Argentina. Electricity tariffs were converted to the Argentine peso and frozen. Energy companies with debt in foreign currency suffered great losses over the devaluation of the peso of 2001, since their revenues failed to meet costs of production and foreign debt. As a consequence, they deferred making investments. The capacity of production and

[31] See news on Macri's election reported by international news agencies, e.g. www.bbc.com/news/world-latin-america-34899223 and www.economist.com/blogs/graphicdetail/2015/11/mauricio-macri-elected-argentinas-next-president

[32] Privatized in 1993 and bought by Spanish Repsol S.A., YPF became a part of a merged Repsol YPF in 1999. In 2012, President Cristina Fernández de Kirchner initiated a re-nationalization (or expropriation) of the company. Objected by Spain, the nationalization strained the relations between the two countries.

transmission could not keep up with the increasing demand, which, together with a natural gas supply shortage, contributed to an energy crisis in 2004. The crisis did not limit to Argentina, as the suspension of natural gas exports caused severe energy shortages and price increases in Chile, and creates deep mistrust in Argentina's ability to supply their neighbours (S&P 2003, IRENA 2016, Honoré 2016.)

After the energy crisis, political and institutional rearrangements were made. A national energy company, ENARSA (Energía Argentina Sociedad Anónima), was created. In 2006, Energía Plus program was established to address the energy use of households and small-scale industries over traditional industries. In 2007, the government launched the National Program for the Rational and Efficient Use of Energy (PRONUREE) to improve energy efficiency and to promote sustainable development. The program includes consumer education for instance on changing traditional household lightbulbs into energy-efficient lamps (Secretaría de Energia 2007). However, the double-pinch of low energy prices and economic growth have contributed to a rapid rise in energy consumption and a long-standing shortage of generation capacity in Argentina. For a long time, the mismanagement of the energy sector has been seen to underpin the government´s economic woes (Braun 2014). In energy use, Argentina relies heavily on fossil fuels, mainly gas and oil. The country depends strongly on natural gas, which covers nearly 50% of the country's energy demand (Figure 12).

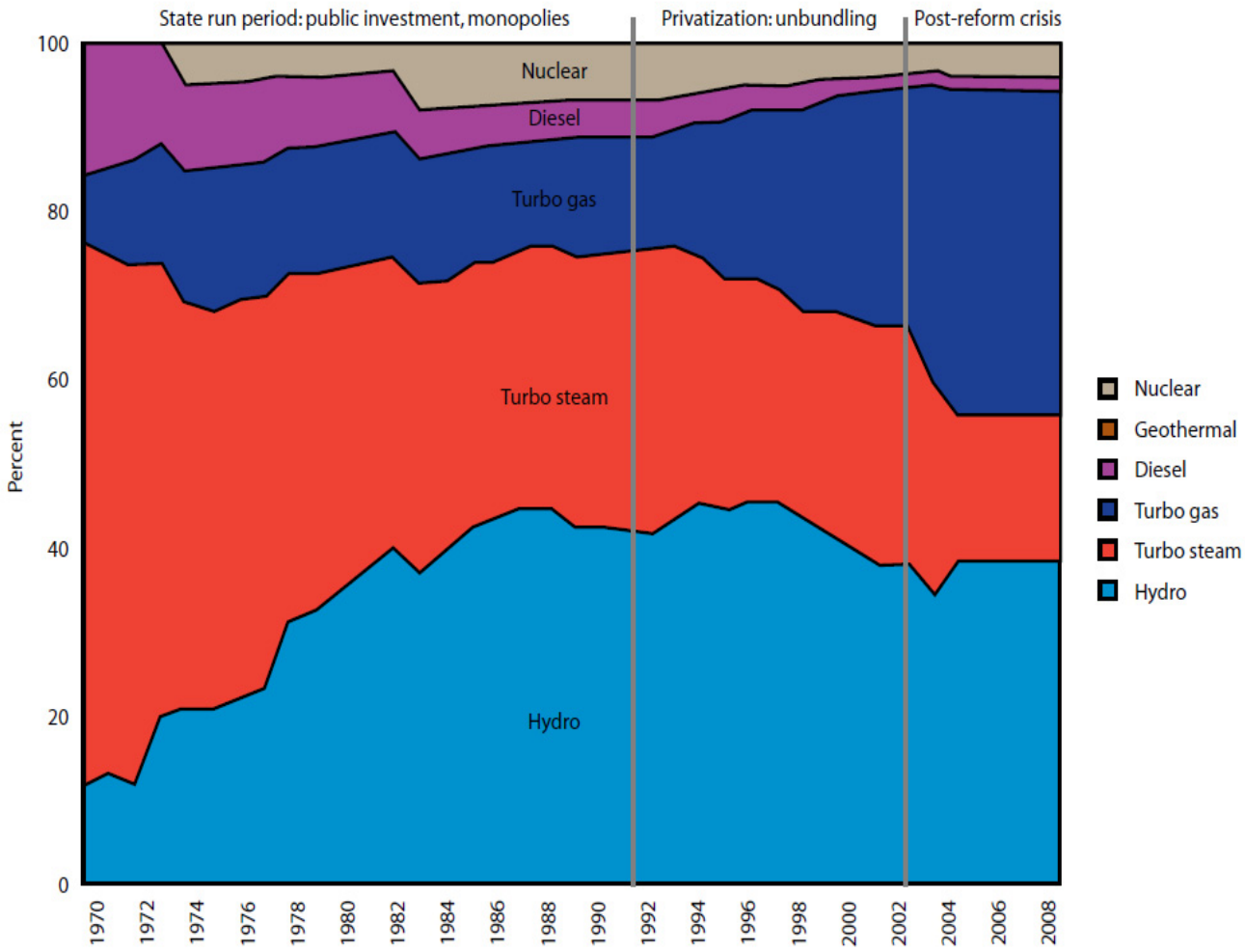

Figure 12. *Electricity generation trend in Argentina by type of technology, 1970–2008 (% of generated total) (Kozulj 2010).*

Energy production and electricity generation

Thermal power plants, which are ran mainly by fossil fuels, produce 64% of the country's electricity. Hydropower covers 31% of electricity generation (Figure 14). Nuclear power accounts for 4% of the total generation, while the share of wind power remains in 0.4%. The share of solar power has been marginal, with a total capacity only at an estimated 15 MW. (Figure 13). Argentina is among the top 30 countries in the world in electricity generation capacity. Despite a power grid that reaches 99% of urban population, rural electrification in Argentina is below 78% (IRENA 2016, Spatuzza 2016).

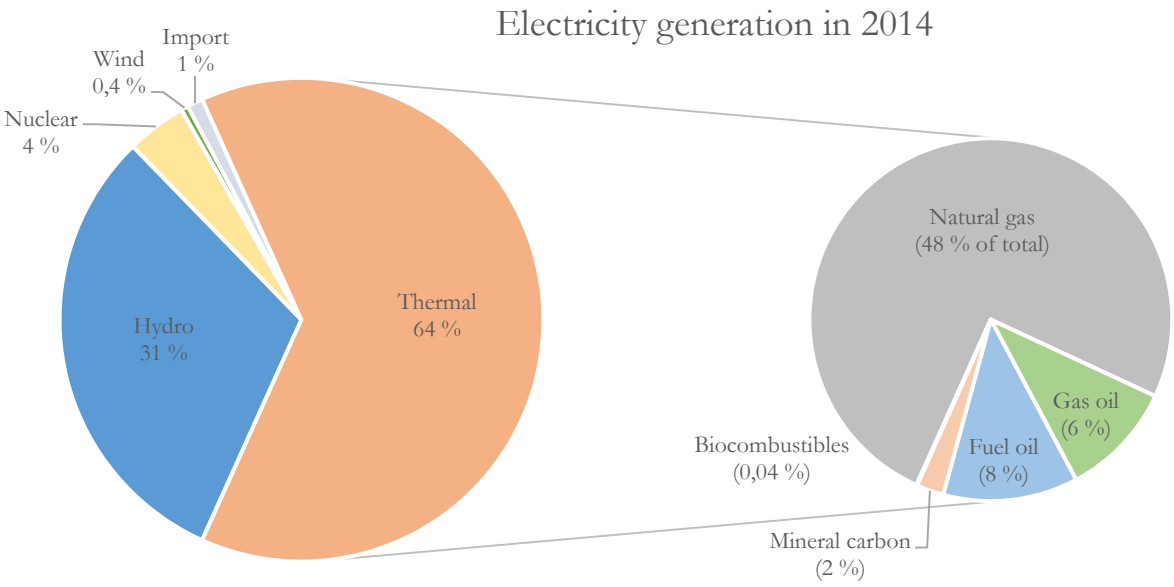

Figure 13. *Electricity generation in Argentina in 2014. The percentages in both charts stand for the share of total generation. (CAMMESA 2015b).*

Most of the country's energy generating capacity is located in the Great Buenos Aires (including the city of Buenos Aires) and Littoral regions, where thermal plants dominate production. This is also where Argentina's nuclear power plants are located alongside with the Central region of the country. Together these regions account for 44% of the country's generation capacity. Hydropower dominates in Comahue and North-East regions. The country's wind energy production capacity is located mostly in Patagonia and in the North-West region. Solar power generation, which has been marginal to date, has mainly located in Cuyo area (CAMMESA 2015a).

There are two interconnected electricity grid systems in the country, the Argentine Interconnection System (SADI), which covers three quarters of the country in the northern part, and the Interconnected Patagonian System (SIP) of Patagonia (Grotz & Decundo 2012). In the late 1990s and early 2000s, transmission links between Brazil, Argentina and Uruguay were realised and has allowed a balancing between the thermal plants in Argentina and southern Brazilian hydropower plants, as well as the different hydrological cycles in Argentina, southern, and central Brazil. Uruguay has wind farms that could benefit from increased energy exchange between Argentina and Brazil. To date, many exchanges in the region have been based on ad hoc arrangements in instances of scarcity. In 2016, Chile started selling electricity to Argentina for the first time in history, has also supplied natural gas. If energy consumption in Paraguay continues to increase rapidly, in the medium- to long-term time horizon it may not be able to export its hydropower produced electricity anymore to Argentina. (IRENA 2016, 35, 66, 132, Esposito 2016.)

Figure 14. *Salto Grande Dam and hydropower plant (Photo: Aino Helle).*

Electricity has been highly subsidised by the government of Argentina. In 2011, Argentina became a net importer of energy for the first time in almost 30 years. Its import bill for oil and gas reached $9.4 billion, which equalled 20% of the country's Central Bank foreign exchange reserves as illustrated in The Economist (2013). Argentina has imported natural gas from Bolivia, liquefied gas from Qatar and other destinations, and fuel oil from Venezuela. In, the energy deficit was still at $6.5 billion (Braun 2014). Consumer prices have been four times less than in the neighbouring country, Brazil. Low consumer prices have contributed to an energy consumption culture that could be described as extravagant, and through economic growth, energy demand has grown constantly (Figure 15). This causes shortages in energy supply especially during hot summer months. Therefore, Argentina remains a net importer of energy.

Figure 15. *Even nights often show empty office space in full lighting.*

Gas industry in Argentina started to develop already in the 1960s. After Bolivia, Argentina is South America's second largest gas producer (40 billion cubic meters yearly) (Figures 16, 17) and the fourth largest oil producer (Figure 18). Oil and gas have made around 98% of Argentina's mining sector (Coremberg 2014). However, Argentina's conventional natural gas reserves have fallen dramatically since 2002. Only between 2002 and 2010, they fell by almost 50% and have continued to decrease (Figure 16). In the 1990s, oil production practically doubled, but between 2004 and 2008, the country's crude oil reserve also fell by 16% (Formin Finland 2009, TITI 2010, U.S. EIA 2017). The decline of large conventional gas reserves created a need for innovation and investments in the gas industry. In 2008, Gas Plus program was launched to facilitate investment in gas production and research.

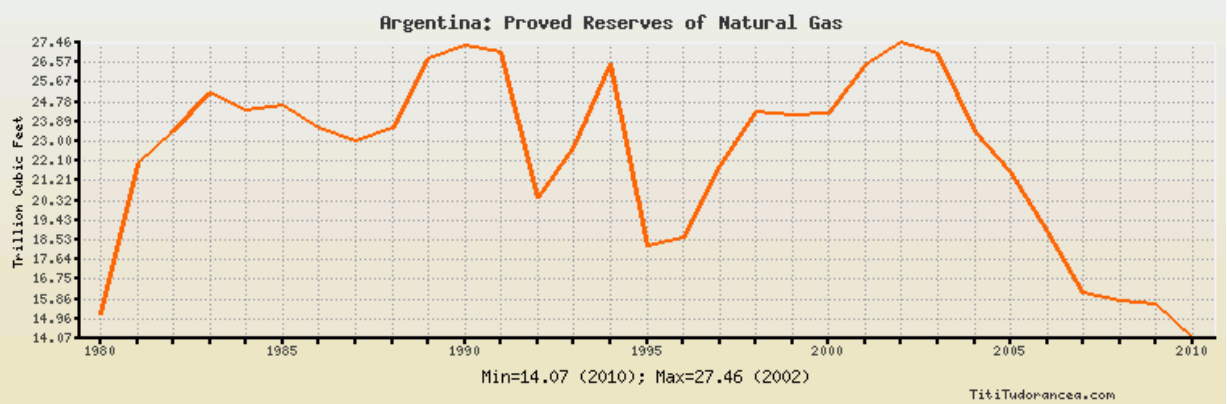

Figure 16. Argentina: Proved reserves of natural gas 1980–2010 (trillion cubic feet). Data: Tititudorancea.com

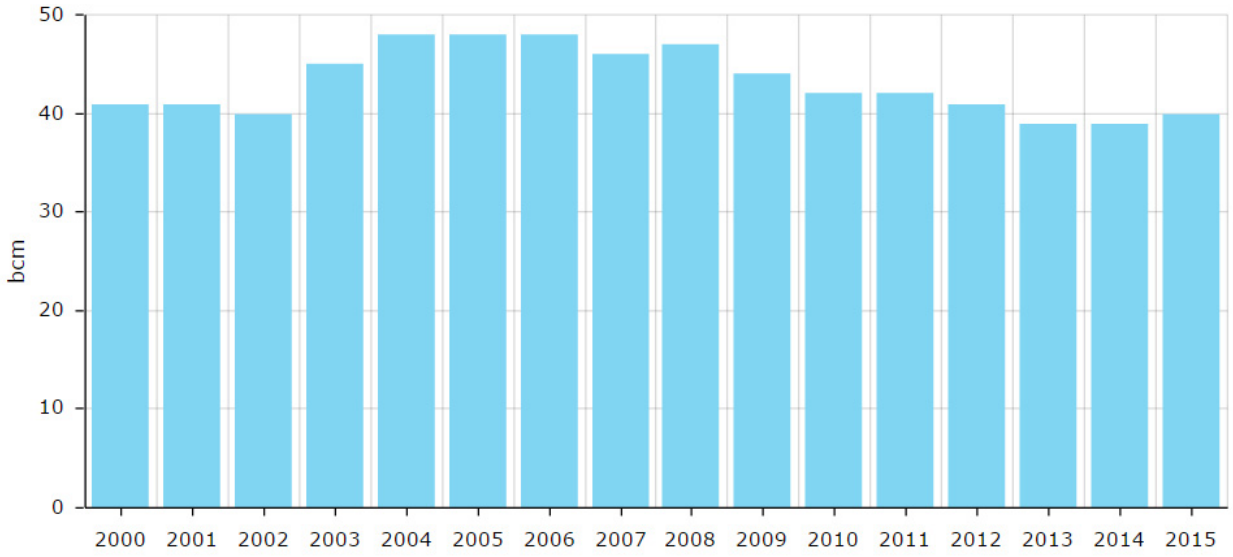

Figure 17. Argentina natural gas production (annually, billion cubic meters) (Enerdata 2016).

After the fall in conventional natural gas reserves, there has been strong economic interest in shale gas in Argentina. Argentina's shale gas deposits in Neuquén province are amongst the largest in the world, only second to China (Braun 2014). Argentina has vast shale gas resources and also has tight-sands gas resources in Vaca Muerta. Shale gas production, using the method of fracking, has been started in 2010. Many foreign oil companies have bought concessions to drill gas wells. Those in favour of production advocate shale gas to be a "game changer" and hope that shale gas would provide Argentina with cheap energy for generations. Shale gas production has been opposed by the Mapuche indigenous community who have stated that it is polluting their land and groundwater. YPF has denied that there is evidence of water contamination (Livingstone 2016.). Expansion of shale gas production would also require up to $100 billion in investment by 2030 (Gomes and Brandt 2016). The decline in oil and gas prices in the 2010s after the commodity boom has undermined the profitability of oil and gas exploration, but also reduced Argentina's energy import bill (Palacios 2015).

Figure 18. Argentina crude oil production (barrels per day, thousands) (Trading Economics, U.S. EIA 2016).

South America has turned to liquefied natural gas (LNG) as a source of additional supply towards the end of 2000s, and received first LNG shipments outside the continent in 2008. Argentina imports annually around 6 billion cubic meters of LNG. Argentina has natural gas pipelines with Bolivia, dating to the 1970s, seven pipelines with Chile were built in the late 1990s, and also with Brazil and Uruguay[33]. It is expected that Argentina, Brazil and Chile will continue to import LNG and will be joined by Uruguay and Colombia. Peru is anticipate to remain as an exporter. There is also a possibility for foreign LNG to arrive to Chile who can then sell it forward to Argentina. (Honoré 2016.)

3.3 Renewable energy sources and biofuels

In 1998, Argentina established a feed-in tariff (FiT) for solar and wind power. In 2006, it was expanded to cover bioenergy, ocean energy, geothermal energy, and small hydropower.

In 2006, Argentina introduced Law 26.190, which is also known as the Renewables Law. It aimed at renewable energy sources (RES) to cover 8% of the country's energy production by 2016, and introduced fiscal incentives, such as VAT refunds for renewables (IRENA 2015a). However, the Law had limited success in promoting the deployment of renewables, in part due to the low level of feed-in tariffs, artificially low energy prices with subsidies and competing energy sector interests.

In 2009, an auction known as "GENREN" was launched by the national energy company ENARSA in order to reach the 8% renewables target. The aim was to introduce 1 000 megawatts (MW) of

[33] For detailed information on the Argentina-Chile pipelines, see Honoré 2016, 22–26.

renewable energy capacity. The target was allocated as follows: wind 500 MW, liquid biofuels 150 MW, urban waste 120 MW, small hydro 60MW, geothermal 30MW, solar 20 MW and biogas 20 MW (IRENA 2015a). The first power purchase agreements (PPAs) were signed in 2010 (Yogi Goswami and Kreith 2015). Due to financing issues and state uncertainty, only around a fourth of the projects have been implemented. Wind energy has witnessed a rapid growth of capacity multiplying ten-fold from a mere 27 MW in 2005 to 271 MW in the end of 2014 (The Wind Power 2015a), but this is still only half of the set target. In 2015, as it seemed like the overall goal would not be met, the Government of Argentina announced to postpone the 8 % target with one further year, until 2017.

Under Kirchner's presidency, the financing of renewable energy projects was a challenge. Interest in investing in solar power in Argentina has been growing but the inability to access international capital has remained a problem. Hundreds of megawatts of renewable energy projects under GENREN have been delayed or stalled due to an inability to receive financing. Argentina's national wholesale electricity regulator CAMMESA, manager of commercial transactions in the electricity market, has been in deep debt. The re-nationalisation of YPF, Argentina's largest oil and gas company in 2012, increased the political risk of investing in Argentina (Bissegger 2013). According to press sources, the required opening fee for new investors on renewable energy projects was four times higher in Argentina when compared to Brazil (Recalde et al., 2015).

Regulation from 2011 has allowed solar power developers to negotiate premium tariffs directly with the government and the grid operator without clean energy tenders, and companies from Spain and China have expressed their interest in the renewable energy markets of Argentina. Chinese Sky Solar Holdings Co. together with ENARSA agreed to build a 20 MW solar complex in San Juan, near the Chilean border. Also Spanish companies have had similar agreements with other Argentinian developers (Roca 2013).

Bioethanol and biodiesel production

In 2007, Argentina introduced a Biofuels Law, which mandated gasoline to be mixed with bioethanol, and diesel with biodiesel, from 2010 onwards. Today, Argentina is one of the world's largest producers of biodiesel. The biodiesel production, mainly in Buenos Aires and Santa Fe provinces, is forecast to reach over 3 billion litres in 2017. Most biodiesel has been exported to the United States, followed by Peru. There have been trade disputes with EU, and Spain specifically, due to anti-dumping duties. Biodiesel exports have had a 5% export tariff in Argentina, but export of soy, the material used in most biodiesel, has been charged 30%, and the EU and Peru have perceived this difference is unfair. However, a favourable trade dispute settlement was ruled in favour of Argentina in the World Trade Organization, which means that exports to European Union could restart. Domestic consumption of biodiesel has also been increasing. Bioethanol production has also increased and is forecast to reach over

1 billion litres for 2017. Argentina has had a blending mandate of 10% for biodiesel and bioethanol in the transport sector, and recently it has been increased to 12%. Recently, also other Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico and Peru – have invested in biofuel production to diversify their transport fuel mix. (Miles 2012, GAIN 2015, 2016, Euractiv 2016, IRENA 2016.)

Renewable energy potential in Argentina

Argentina is said to have some of the best conditions in the world for wind power generation. According to Global Energy Network Institute, wind farms could be installed in more than half of Argentina's natural territory, including plateaus and mountains (GENI 2009). The greatest potential for wind power is in the south of the country. In Patagonia region, winds are constant year round. Over half of the country's land terrain is plains, both grasslands and savannahs, which offer possibilities for extensive solar power production. The country stretches over a wide array of latitudes and climate zones, which adds the potential of solar power. The western regions of Argentina alone get about twice the solar radiation of the entire Germany, which is currently the leading solar market worldwide (Roca 2013). **In Argentina, the potential wind power regions in the south and the solar power regions in the west complement each other. This creates a huge opportunity for a distributed, decentralised, self-sufficient, and democratised energy system** (Sigal et al. 2014), as households and regions would be less dependent on conventional forms of centralized energy production.

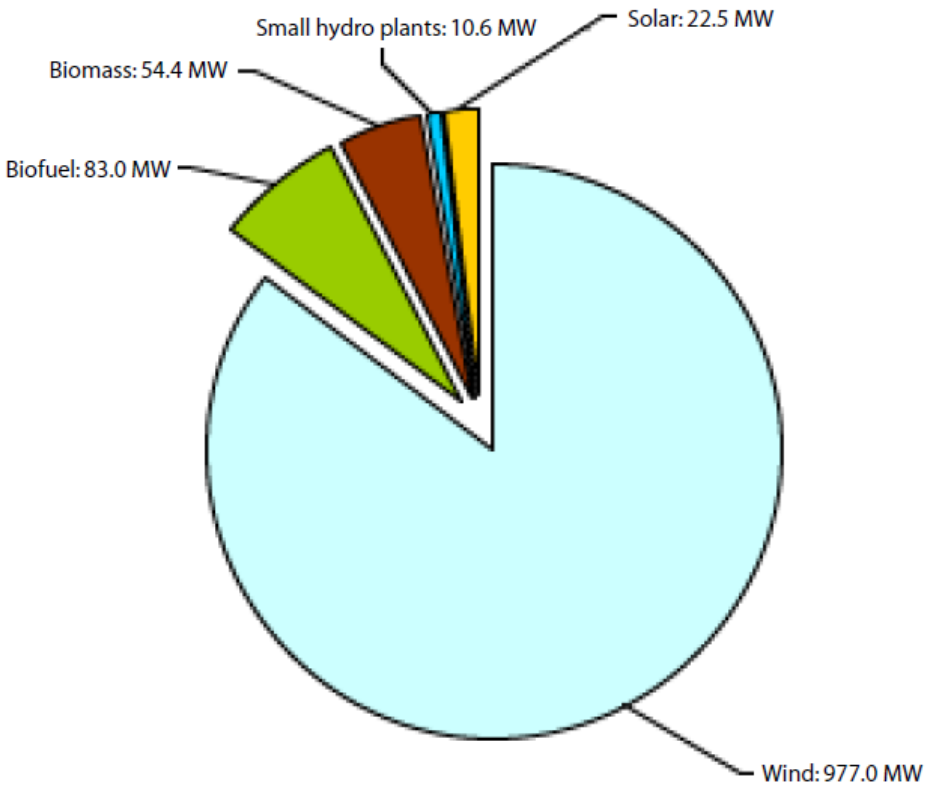

Figure 19. *GENREN program projects at the end of 2009 (MW offered and % of the 1 147.5 MW total offered by 27 private partnerships)*

Argentina's federal laws on renewable energy encourage provinces to engage in the legislation and establish provincial-level incentives and policies. For example, the province of Santa Cruz provides exemption from property tax and provincial taxes for 10 years for the manufacturing of renewable energy equipment, and the province of Mendoza has set a target of 15% renewable electricity consumption for 2023. Provinces of Buenos Aires and Chubut exempt renewable energy projects from province taxes for 10 years and provide financial support (IRENA 2015b).

Peripheral communities in Argentina, such as the Andean communities, are geographically isolated and have difficulty accessing traditional fuel, energy, and only limited amounts of firewood (Escalante et al., 2013). Solar energy could substitute diesel-fuelled sources of electricity in remote areas that remain off the grid or suffer from poor transmission networks. According to ENARSA, about 1 500 MW of diesel capacity could be replaced by solar plants. Small solar power plants have been installed, for instance through World Bank backed programs (Roca 2013).

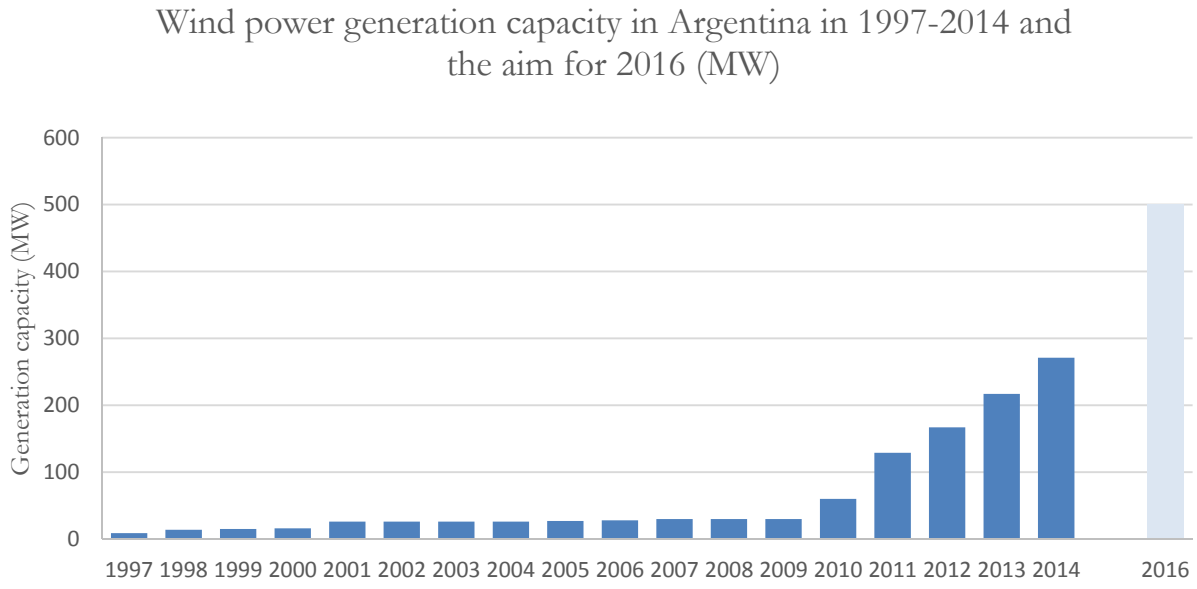

***Figure 20**. Wind power generation capacity in Argentina (MW) in the end of year, 1997-2014 (The Wind Power 2015a) and the aim set for 2016 by GENREN.*

All in all, renewables offer great opportunities to solve energy problems, including energy security and energy poverty. Although the electricity transmission network has lacked investments since the crisis of 2001, according to estimates the current network can support renewable energy projects under GENREN. If high shares of renewable energy developments are installed in the future, investments will be required to also update the country's electricity grid (Grotz & Decundo 2012). Recent changes in Argentina have led a wide range of international and local companies to begin to assess the opportunities for renewables. According to a recent report, companies such as Engie have concluded that natural gas is an energy source that supports the transition from conventional to renewable energy

sources. Energy efficiency will also be a major issue, as well as the role of infrastructure and transport industries as important players for the energy transition. (Institute for the Americas 2016.) With regard to long-term transitions based on renewable energy, if Argentina was to move to a hydrogen economy and produce electricity entirely from renewable energy sources, the total amount of Argentina's fuel importation could be replaced. This would require using only around 10% of that land which has potential for renewable energy projects (Sigal et al. 2014).

Macri's era and RenovAr programme

In November 2015, Mauricio Macri was elected as Argentina's new president for a four-year term. Throughout his campaign, Macri signalled his intentions to revitalize the country's economic outlook, investment climate and the energy sector in particular. (Institute of the Americas 2016).

In 2016, the newly elect President Mauricio Macri launched RenovAr ("To Renovate"), a Renewable Energy Plan, based on a new Renewable Energy Law (27.191) that introduced new, enhanced targets for renewable energy (MINEM 2016a). The new plan modified the old Law (26.190) and **the nation is now aiming to get 8% of its electricity from renewables by the end of 2017. The follow-up targets are: 16% by 2021, and 20% by 2025**[34]. In April 2016, the government also published Decree 531 to regulate the new Law (Diaz Lopez 2015, IRENA 2016). The president and the Ministry of Energy and Mining (MINEM) hope that RenovAr can create a better future for Argentina by increasing energy production capacity from renewable energy resources, attracting investment, and by creating jobs for Argentinians. RenovAr focuses especially on solar and wind energy, and promotes research and development on clean energy technologies. RenovAr aligns with Argentina's commitment to the Paris Agreement on Climate Change from COP21 in 2015.

The short-term target is to incorporate 1 000 megawatts (MW) from renewable energy sources to the country's energy supply in 24 months. 600 MW would be supplied from wind, 300 MW from solar, 65 MW from biomass, 20 MW from hydropower developments, and 15 MW with biogas. Renewable energy will be procured by using a public bidding process. Investors are invited to submit bids, after which contracts are awarded. The government expects investment between $1.5–$2 billion and 5 000 to 8 000 new jobs to be created. In addition, it has been calculated that the country would save 300 million dollars yearly in fuel imports for electricity generation, assuming that the oil price would be at $50 per barrel. **These undertakings would also annually prevent nearly 2 million tons of CO_2 emissions.** This is equivalent to the emissions from about 900 000 fossil-fuel based cars.

[34] The 8 per cent target in Argentina is defined in a way that excludes traditional hydropower plants that are larger than 30 MW in capacity.

The first tender round of RenovAr renewables programme was organised in autumn 2016. For the tender, a total of 123 project proposals were submitted, out of which 59 were on solar energy and 43 on wind energy. As an outcome, 1 142 MW and 59 projects were approved by the Ministry of Energy and Mining. Most of the new projects will be on solar and wind, but there are also some hydropower and biogas projects. International and multilateral financing can play an enabling role in providing investment. For instance, in the end of 2016, Argentina secured $133 million funding through the Green Climate Fund (GCF), managed by the Inter-American Development Bank (IDB) through the Inter-American Investment Corporation (IIC). (Cosentino and Smith 2016, PV Magazine 2016, Tsanova 2016, Morais 2017.)

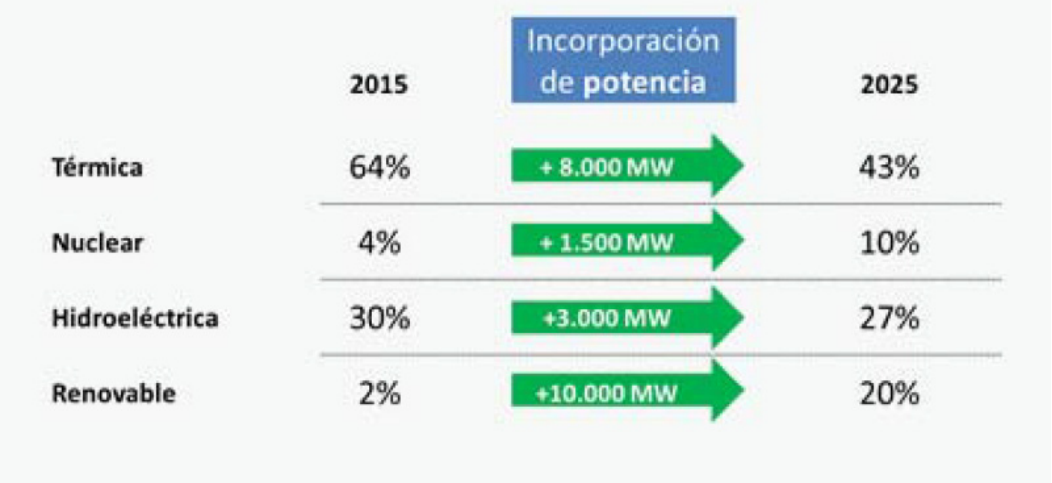

Figure 21. *Macri's government's targets for the year 2025 (Institute of the Americas 2016).*

Macri's government plans to reduce the share of thermal generation in the energy mix with 20%, to double nuclear energy capacity, and to increase the share of renewables with ten times (Figure 21). The government created a Ministry of Energy and Mining with experienced practitioners and energy sector veterans, and abolished the Secretariat of Energy. As part of the new Ministry, several new Secretariats and Undersecretariats were created (Figure 22). An undersecretariat on renewable energy will work to comply with the national goal of 8% renewables by 2017. Another secretariat on energy scenarios will manage energy planning in the medium and long-term (15–40 years). An undersecretariat for energy savings and energy efficiency will seek to reduce consumption by 5% by 2020. This move was applauded by markets and investors. (Institute of the Americas 2016.) More problematic have been Macri's efforts to continue President Kirchner's hydroelectric projects in the Patagonia, which have been challenged over concerns about impacts on the native wildlife and the glaciers (Becerra 2016).

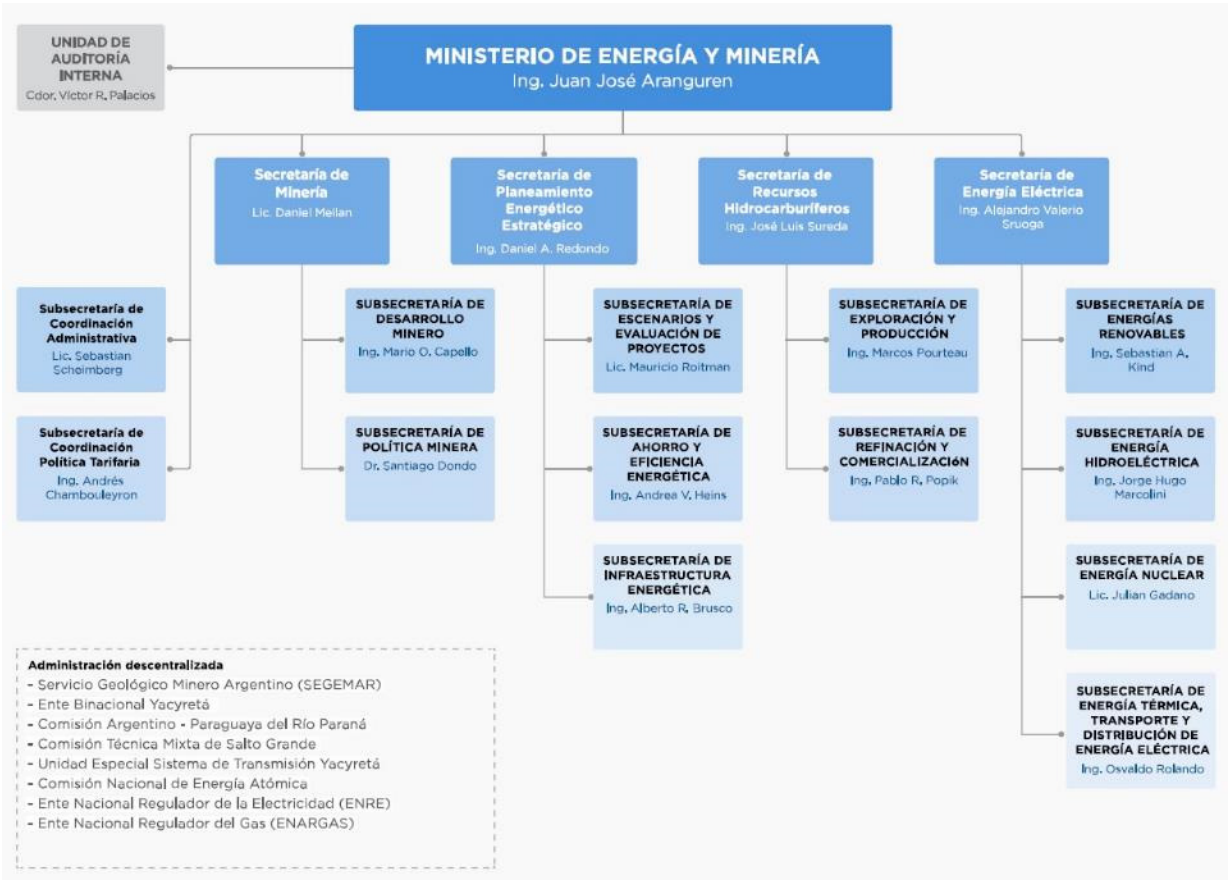

Figure 22. *The organisational structure of the newly established Ministry of Energy and Mining (MINEM 2016).*

3.4 Endeavours for eco-smart cities

Urbanisation is one the modern megatrends. Energy, in its part, plays a major role in the creation of ecologically smart cities. The concept of a smart city, in use since the beginning of the 1990s, is a central concept to desribe a new, rapidly evolving paradigm in urban development, which covers urban planning, policymaking, living, and various other connected sectors. Although urban governance, urban planning, and smart cities are popular research subjects within urban studies, urban planning approaches have been criticised for more than two decades. As we discuss eco-smart cities, and especially Buenos Aires in Argentina, we borrow from Parkkinen & Heinonen (2016) who have recently studied the "urban tomorrows" on future liveable cities.

A smart city is a "conceptual model of urban development based on human, collective, and technological capital for the promotion of the urban development" (Angelidou 2014, 2016). The exact meaning of the concept has not been agreed upon despite several cities calling themselves smart[35]. A

[35] For a detailed discussion on what may or may not be considered a "smart city", see Parkkinen & Heinonen 2016.

smart city is sustainable, connected, liveable, intelligent, innovative, and resilient. No longer limited to ICT solutions, sociality and information also matter (Albino et al. 2015, Shark 2014, Vuolteenaho et al. 2015, 1–4.). In the light of this criticism, it is fair to say that a smart city is genuinely "smart" only when the city is developed in a balanced mode using ICT and smart technologies to result in a sustainable and liveable city as a holistic and complex entity.

Buenos Aires – an increasingly smart city?

Buenos Aires, its literal translation meaning "good weather", is a city that already incorporates the urban planning agenda of creative city and smart city. The city, viewed as a liveable, connected, and a sustainable city, has been referred as "one of the smartest cities" by the National Geographic (2014) and Forbes (2016). Buenos Aires has also become increasingly interactive, and has in place technology that allows it to act in real time upon 30 000 complaints that it receives monthly. For instance, a resident can tweet a picture of a hole in a street in Twitter to the relevant ministry, after which the city will respond to it, and take action.

Multiple initiatives have already been launched. To reduce energy consumption the city changed 91 000 traditional street lights to modern LED lights that illuminate the city. The LED lights are connected to a central system and can be remotely managed, which reduces maintenance costs. A well working lighting of the city makes it also safer for the residents. In addition, Buenos Aires has implemented an early disaster prevention system against flooding that sometimes are even deadly. The city has a remote and automated maintenance system for 1 500 kilometres of drainage pipes to fight against floods. It has been claimed that Buenos Aires wants to have an expanded digital transformation to optimise security, education, healthcare, and transportation (Donato 2016).

***Figure 23**. Buenos Aires has the challenging aim of becoming an ecologically smart city.*

Contradictory views have been also presented on Buenos Aires (Figure 23) to note that it still has a long way ahead before becoming a genuinely smart city[36]. Nevertheless, there is political will in Buenos Aires to strive towards this. To make the city more liveable, connected and sustainable, the city government has started the program Ciudad Verde (Green City) that aims to raise awareness and educate the entire society in waste separation, bicycle use, and responsible water and energy consumption[37]. The city has a new Ecobici system of public eco-bikes that offers city bicycles for people for 24 hours a day and is free. The bikes can be collected from automated stations, when one has registered to the system. In the end of 2016, the plan was to have 182 kilometres of bicycle lane already built in the city. Ciudad Verde also promotes the use of other public transportation like Metrobus, instead of private cars. The program has also introduced a new system for recycling and waste separation. The aim is to influence people to recycle more by making it easy and convenient for them while raising awareness of advantages of the system.

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[36] Leena-Maija Laurén was engaged in the smart city plans of Buenos Aires and has discussed smart city issues during her recent research visit in Argentina.

[37] Ciudad Verde www.buenosaires.gob.ar/ciudadverde.

Future directions – ecologically smart cities

Ever evolving technologies, novel social innovations and their implementation are creating future opportunities for ecologically smart cities. New technologies can be used to increase energy efficiency and to improve the interaction between places of consumption and production of energy. This can help energy being directed only there where it is needed, and avoid it being wasted. Buildings can be designed and built in a way that they produce more energy than they consume (Glenn et al. 2015). Abundance of renewable energy in a city would also make it easier for the residents to choose electric vehicles, which would reduce air pollution and carbon emissions (CO_2). Renewable energy solutions can make a city more liveable and sustainable i.e. genuinely smarter, and play their part in making cities more safe, interactive, connected and self-sufficient, as discussed above.

4. RENEWABLE ENERGY AND THE POTENTIAL FOR NEO-CARBON SOLUTIONS IN ARGENTINA

4.1 Results of the expert survey

An expert survey (see chapter 1.2 for background) by the research team examined how energy experts in Argentina understand the country's recent energy policy and see the future potential for options based on renewable energy. The survey results were analysed and classified in thematically. As these responses were collected in 2014–2015, they illustrate experts' sentiments on energy policy under Kircher's presidency and the previous government (before the current energy policy turn).

At first, we present the considerations of the experts about energy policy and the key stakeholders in the Argentinian energy sector. This is followed by a futures-oriented discussion, where the experts' explain what they consider as possible energy futures in Argentina. They were also asked about their perceptions on the role of gas, wind energy and solar energy. In the end, the experts stated their views about the potential for a neo-carbon based energy transition, what they expect a future energy culture to be like, and what role energy solutions and innovation could have in creating Argentina's energy future. The analysis concludes with some general remarks that emerge from the survey.

Energy policy

In describing the recent history of energy policy in Argentina, four themes emerged from the experts' responses. These are **importing of energy**, **lack of investments**, **overall economic situation** and **state subsidies.** According to an expert, "*the [Kirchner's government's] policy is survival*". In the mid-2010s, there had been a lack of investments in the entire energy sector for over a decade, which had affected also the development of non-conventional resources and infrastructure. One expert mentioned that because of unclear contracting rules, the energy generation sector was in a precarious state. While 75% of the generation capacity is owned by private utilities, the state holds initiative regarding investment decisions.

Importing energy and fuels is a dominant theme in the experts' responses. The amount of imported energy has been increasing and Argentina is considered to remain a net importer in energy for at least another decade. In 2014, 1 390 GWh of energy was imported (CAMMESA 2015b). Imports have originated from Uruguay, Paraguay, Brazil and Chile. Natural gas has been imported especially from Bolivia through a pipeline, and with LNG technology even from as far away as Norway (LNG World News 2015, IGU 2016). Most imports took place in September-November. Argentina exported a total of 6 GWh of energy to its neighbouring countries (1 GWh to Brazil and 5 GWh to Chile) (CAMMESA 2015b).

Because consumer prices have been kept artificially low, this has led into a lavishing energy culture. Cheap consumer prices for electricity have been enabled by state subsidies. This has created an unbalance, where consumer prices remain below production costs. The experts' were highly critical of the energy subsidies and, in general, of the energy policy of the Kirchner government.

According to the responses, Yacimientos Petrolíferos Fiscales, or YPF, dominates the industry with a 35-50% participation. This Argentinian national energy company is engaged in the exploration and production of gas and oil as well as the transportation, refining and marketing of the products. The experts see that through YPF and with international partners, the country intends to return to a mode of higher energy independency.

Stakeholders of the Argentinian energy sector

The state and the public sector have had a strong role in Argentinian energy debate. The respondents named national and provincial governments, the Secretariat of Energy, CFEE (Consejo Federal de Energía Eléctrica, the Electric Power Federal Council), as well as political parties are named as stakeholders to any on-going energy debates. After the survey, Macri's government has changed some of these bodies and abolished the Secretariat of Energy, and replaced it with the Ministry of Energy and Mining. Experts also mentioned CAMMESA (Compañia Administradora del Mercado Mayorista Eléctrico), which administers the wholesale electricity market.

The experts named both public and private actors as advocates for solar and wind energy. Among these are CADER (Cámara Argentina de Energías Renovables), a network of companies and professionals that promotes all renewable technologies and aims to foster a with both public and private actors; and ENARSA, the national company for the exploitation of petroleum and natural gas and the generation, transmission and trade of electricity. The experts also mentioned the GENREN program, a tender process that was set in 2009 to increase the amount of renewable energy projects, and listed obstacles why its objectives had not been met. The Energy Secretariat also introduced the Resolution 108/2011 on power purchase agreements (PPAs), as a structure designed to support the introduction of renewable energies. The results were varied and only modest investments were seen (see chapter 3.3).

Possible energy futures in Argentina

Great uncertainty and variation was involved in the experts' responses with regard to future of the country's energy landscape. At the time of the survey, the Presidential and Congress elections of October 2015 were anticipated to provide a window of opportunity to changes of great amplitude in the energy sector. However, the respondents' did not yet know about the energy policy preferences of the candidates. In their answers, the experts hoped that future would behold a deviation from Kirchner's

energy policy, and advocated for a "genuinely" open market and a long-term vision in energy policy. However, there was consensus on the urgency of infrastructure investments and investments into power generation.

According to the experts, in the year 2030 Argentina is foreseen to depend on fossil fuels and to still use hydropower production. Argentina would have proportionally more wind energy than it currently has. The experts disagreed on the future degree of energy self-sufficiency. Some predicted Argentina to be able to cover its own energy needs with a possibility to export in 2030, but others rather expected Argentina to remain a net importer. Possible future oil and gas imports were predicted to originate from Bolivia. Possible future production surpluses were predicted to be based on the exploitation of untapped shale oil and gas reserves that would allow regional direct exports and overseas liquid natural gas (LNG) exports. The experts considered transmission and distribution systems to require innovation after a decade of under-investment.

A return to macroeconomic equilibrium was considered a prerequisite for large-scale development of renewable energy in Argentina. The natural potential for wind power in Argentina is massive, but on top of the wind power plant investments, also the transmission networks are perceived to require investments to enable energy transmission. Conditions for solar energy are highly favourable in the Central West and North West. According to an expert, at the time of the survey, solar energy was yet to be "discovered", and no significant investments had taken place.

The respondents mentioned a forthcoming decision over a new nuclear power plant. This was seen as a way to provide baseload power to the electricity grid.[38] The experts discussed a need for baseload power, for which hydropower was seen as an uncertain option. It was argued that hydroelectric projects have faced severe delays. Several of them are planned to the Andes region, where the water circumstances might change radically in the future, as climate change induced water scarcity has been predicted in the Andes. The experts consider hydropower projects on rivers as feasible and less vulnerable to changing climate conditions, but mentioned that they too can be prone to environmental and/or political objection. Interestingly, recent research suggests that in a renewable energy based system, baseload power will not be needed in the same way, as in the present energy system (see Breyer et al. 2016a).

[38] Argentina has engaged in talks on nuclear power cooperation with France, Russia, Japan, South Korea, China and the USA (World Nuclear 2016).

Gas now and in the future

Argentina's conventional natural gas reserves have declined since 2002, and were practically halved between 2004 and 2008. Nevertheless, the experts considered the future of gas positive for Argentina. As conventional reserves decline, more investments and exploration both onshore and offshore gas are predicted to take place. The prospects for additional tight and shale gas production as well as other nonconventional gas reserves were considered good. The production infrastructure, the transportation pipelines and distribution grids were seen to require further investment. The current gas distribution grids reach 7.5 million consumers, and the demand has increased. According to some experts, further gas imports are needed in the winter period also in the future.

Wind energy

The Renewable Energy Law (26.190) and the 8% target for renewables have been the main drivers of wind energy policy in Argentina. There is a recognition of untapped wind potential. Wind power projects have been implemented through contracts of supply for a 15-year-period for a fixed dollar price to guarantee the developers and producers a price for the generated electricity. However, the experts viewed the Law defective, recognised that the 8% target would not be met. Overall, the wind energy policy was described as poor by some experts. Costs and lack of long-term incentives were seen to have constrained the growth of the wind energy sector. Unavailability of finance and country risk were also mentioned. Long-term financing was not viewed as possible due to a lack of long-term markets (beyond the state-funded administrator).

The long-term prospects for wind power in Argentina were still considered as relatively good by the experts. The high wind potential of Patagonia was recognized. It was also recognized that hydropower can balance the intermittency of wind power. Wind energy requires a reliable transmission system and a functioning market, inter alia, an incentive program, since consumer prices do not reflect production costs. One respondent viewed wind energy as a welcome option also because it requires "less dollar imports" than the harnessing of new conventional energy sources.

Solar energy

Views on the current situation and the future for solar energy were less optimistic than for wind energy. These views are understandable, considering the fact that solar energy has for a long time had a marginal role in the Argentinian energy palette. Similar to wind power, solar energy providers make a supply contract for 15 years for a fixed dollar price. However, the Renewables Law, the 8% goal, and recognized potential in several provinces, can drive solar development. Unavailability of finance, country

risk, and lack of policy incentives were seen as the main limitations to solar energy's growth. The experts' long-term prospects for solar energy varied. The potential for solar energy was recognized, but the energy policy was argued to require a radical shift. According to these experts, if more was invested in renewable energy sources, wind energy should be prioritized over solar energy.

Neo-Carbon Energy futures: How about an energy transition?

In the survey, it was explained that "Neo-Carbon Energy is a zero-emission energy system based on solar and wind energy. It is realized by peer-to-peer energy trading, energy storage and electricity grid stability. These tools are employed to balance the intermittency (=variability) of solar and wind energy. Solar and wind energy would be stored in synthetic methane in order to close the carbon cycle in the electric power system. In sum, these qualities together make the neo-carbon energy emissions-free."

Despite enormous potential for wind and solar energy in Argentina, the realization of an energy transition based on renewable energy was seen as distant. An energy transition debate did take off in Argentina with a good initial impetus before the year 2010, but weakened since. One expert stated that there is neither public debate over the matter, nor do people see why it would be needed, since for the general public, fossil energy is very cheap. The experts suggested that to begin a proper discussion over an energy transition, a cultural change would be required, and energy pricing should be changed. In general, the experts presented strong criticism to highly subsidised energy pricing where residential consumers pay only 10% of the value of the electricity and industrial consumers pay only 50%.

In general, the expert views differed on the possibilities of a neo-carbon energy system in Argentina. Present conditions and energy policy have hindered these kinds of developments. the existing infrastructure was not considered technically adequate for such long-term objectives, and access to capital was seen as difficult. In most responses considering the use of renewables, costs and the lack of capital were mentioned as limiting factors. However, the experts did also point out that renewable energy technologies would be in the future accessible at a more competitive cost (than they initially were in Europe during "the first wave of renewable technologies"). The experts noted that prices for renewable energy are dropping rapidly. Indeed, also low- and middle-income countries, such as China and India, have recently been taking significant steps towards a future where increasingly higher amounts of renewable energy is in use. Even though the experts in general considered an energy transition unlikely at the present moment, it was considered as a possible part of future planning in the country.

Future energy culture

The preferred future energy culture in Argentina should be, according to the experts, "balanced" and "green". Reducing the current strong dependence on hydrocarbons was considered desirable. Optimising the use of available energy sources would be needed to reach an efficient balance. There were hopes that the post-Kirchner government would have a distinct approach to energy politics. (It seems that some of these hopes have been addressed by Macri's government, as explained in this report.) One expert stated that in the future, some stakeholders will be against the development of renewables because of potential financial damage to their current business.

Energy solutions and innovation

According to the respondents, interesting or innovative energy solutions include hydrogen-based solutions, air-based sources of energy, wind energy, solar energy, and wave energy. The respondents were interested in understanding how they could be promoted with incentives and how they could be made "productive" in a larger scale. Such renewable energy based solutions were seen possible in the long-term future. Currently, Argentina was seen to lack a strategy for renewable energy based industries. The possibility to export solar and wind energy as fuels[39] had not been discussed among the respondents or in their networks. One expert, however, stated that Argentina would have the required professional and industrial networks to set up such industry. The maximization of the potential of natural gas was viewed as a way forward until non-conventional sources are developed further.

Consumer production of electricity (so-called energy prosumerism) and the possibility of clients to sell their surplus energy to the electricity grid were considered important and desirable future innovations. At least according to one of the experts, new rules are needed before a consumer can become an energy producer in Argentina. Using household waste as a source of energy alongside solar panels on buildings were suggested as ways to increase energy prosumerism. For years, Argentina was blocked from international credit markets, which has left the development of the renewables sector to rely on private investments. Since finance is often the main threshold between a renewable energy plan and its implementation, a pool of individual investors for renewables was mentioned as a desirable future.

According to the experts, the single most important thing that would change citizen's perceptions of Argentinian energy futures is changing pricing in the electricity market, which has been highly subsidized. More "realistic" energy prices could change consumer and household behaviour on lavish, even "extravagant" energy consumption. The power of examples also emerged in the responses. Consum-

[39] This is one of the potential applications of the neo-carbon energy system.

ers' awareness of alternative ways of producing energy, such as solar panels in private houses, should be increased.

One expert mentioned Europe as an example. Such a response could be interpreted as an invite to look for best practices from countries that have successfully pushed the uptake of nonconventional renewables. Out of Argentina's neighbouring countries, Uruguay has a radical aim of shifting into an almost 100% renewable clean energy system based mainly on wind energy (Watts 2015) and Chile has recently increased its solar power capacity rapidly. There are, of course, also other interesting country examples on solar and wind from other emerging economies, such as Kenya, China or South Africa.

Summary of the survey results

Overall, the responses speak more for the use of conventional, non-renewable sources of energy than renewable energy. However, as the energy consumption in Argentina is rising and conventional gas and oil reserves are declining, there is space also to develop renewable energy based alternatives. As explained, much was considered to depend on the 2015 elections whose outcomes would influence future energy policy choices, and decisions that are to be made related to e.g. nuclear power. With Mauricio Macri's election, many of the issues the experts mention have been at the heart of the government's debates.

The potential for wind and solar power in Argentina is enormous, yet it is nearly completely untapped. Despite certain incentives, a poor structure of the renewable energy business has prohibited investments, and the introduction of renewables has not been large scale. Generally speaking, a change in attitude would be required for people to get more widely interested in the renewables. In the future, as renewable energy technologies develop and their prices fall further, they may become a more appealing choice. Already, small-scale renewables could serve people who live in remote areas and help them meet local energy generation and consumption.

Highly subsidized consumer pricing and freezing of energy tariffs has created an illusion of "endless" fossil based energy resources. As a side product, a culture of lavish energy consumption has been fuelled. Since cheap prices encourage people to consume high quantities of energy and the government ends up paying a great part of their citizens' and companies' energy bills, the experts did not see the current way of operations sustainable in any way. A better market for renewable energy should be created, even if the elimination of the subsidies would probably face large opposition and protests, since consumer prices would experience a rapid rise. It was suggested that a gradual transition towards a market, which reflects "real" prices would in the long run bring competition, stimulate investments, and most importantly, begin to restrain the culture of extravagant energy consumption. Macri's government seems to have done just so, as they have planned to gradually raise energy prices to partially rebuild earnings of companies and promote investment (EY 2016).

***Figure 24**. El Calafate, Patagonia. Photo: Aino Helle*

The survey answers, despite low in numbers, seem to resonate with several recent studies in the Latin American region. A recent IRENA study (2016) also confirms the experts' views on country risk and elaborates: *"foreign private and development financing institutions generally have been reticent to funds renewable energy projects, and project developers have resorted to the acquisition of debt in local bond markets as a means of complementing the financing obtained from state-owned banks."* (ibid., 101). Low residential natural gas and electricity prices have been seen as the key barriers for the adoption of solar thermal and distributed solar PV in Argentina.

The survey findings are interesting also in the light of recent developments in the Latin American region where solar and wind are experiencing somewhat of a boom. Solar power capacity in Latin America grew with 370% in 2014 and has been expected to grow further. In Chile, great investments are being made in the sector (Clean Technica 2015). In Uruguay, another neighbour of Argentina, wind power has experienced a steep rise from 59 MW in the end of 2013 to 464 MW in the end of 2014, an almost seven-fold growth of wind power production capacity (The Wind Power 2015b). Uruguay, with a land surface area less than 10% of that of Argentina, has more wind energy generation capacity than Argentina. Out of Uruguay's electricity generated, almost all comes from renewables (84% in 2013, 90% in 2014 and 95% in 2015) came from renewables and it also has set goals to produce 50% of its primary energy with renewables (AP 2014, IRENA 2015a, Worldwatch 2017). This trend could continue because the costs of solar PV in Latin America are the lowest for all regions, as reported by IRENA.

Argentina is among the countries with the highest potential for renewable energy worldwide. In Argentina, a change of heart and ambition are required to shift energy policy from what has been mere "survival" into a sustainable and future-oriented direction. This would mean that renewable energy technologies would not be supported *only*, but they would be thoroughly exploited, and even turned into highly profitable businesses. It is up to the Argentinians and their future policymakers to decide whether Argentina will be among the leading and exporting countries of clean renewable energy, or whether the country continues to primarily depend on fossil fuels and imported energy.

4.2 What potential for Neo-Carbon Energy solutions in Argentina?

In the Neo-Carbon Energy research project, Lappeenranta University of Technology (LUT) researchers of the Neo-Carbon Energy research team have calculated that a 100% renewable electricity system could be the cheapest option for South America. The core team had been the PhD students Larissa S.N.S. Barbosa, Mahdi Fasihi, Dmitrii Bogdanov and Professor Christian Breyer.

100% renewable energy system for South America

According to Barbosa et al. (2015), South America embodies a unique renewable energy resource base, and South America has a competitive advantage over other parts of the world to develop a 100% RE system. One of the best wind sites globally exists in Patagonia, the best solar energy sites are in the Atacama Desert, hydropower is already used in large amounts and the sustainable biomass potential is significant. For these reasons, and the fact that not much unsustainable coal power and nuclear power plants exist, South America is one of the most favourable regions globally to shift to a 100% RE system.

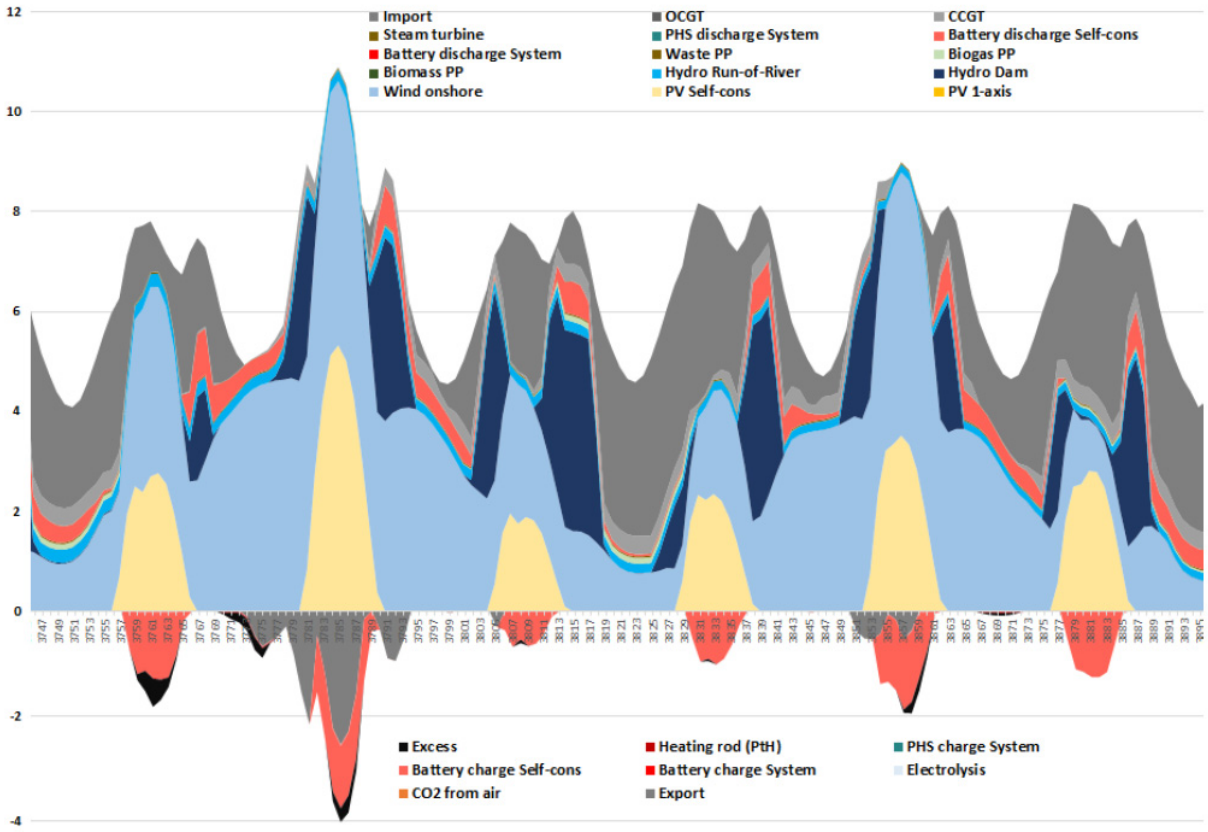

***Figure 25**. In a renewable energy based energy system, this is an hourly generation profile for Argentina Northeast, as an example of an importing region (Barbosa et al. 2015, 27).*

Their research work, as exemplified in Figure 25, shows the principles of a renewable energy based system. Their findings indicate that transitioning to an entirely renewables-based electricity system is possible for South America based on technical and financial assumptions for the year 2030, and that the cheapest electricity production option can be achieved with very few energy storage capacities. The levelized cost of electricity in a 100% renewable energy system ranges between 47 to 62 euros per megawatt hour (MWh), depending on the applied assumptions. In comparison, other options, including new nuclear and carbon capture and storage (CCS), are 75-150 percent higher in cost than the 100% RE option.

In a fully renewable system, the total installed capacity of renewable electricity composes of 415 gigawatts of solar photovoltaics, 144 gigawatts of hydro dams, 39 gigawatts of hydro run-of-river, 17 gigawatts of biogas, 4 gigawatts of biomass and 69 gigawatts of wind power. The abundance of solar and wind power in South America as well as the high capacity of hydro dams signifies that the region does not need many energy storage capacities. Hydropower dams can be used as a virtual battery for solar and wind electricity, i.e. balancing generation and demand during the course of the year, when solar and wind electricity is lacking. In other parts of the world, this would require battery and power-to-gas storage technology. The latter converts electricity into gases, such as hydrogen and synthetic natural gas (SNG), and converting them again back to power.

The study also showed that if the current industrial natural gas demand in South America is replaced by power-to-gas technology, the need for energy storages will plummet. This is called system integration, in which power-to-gas but also other technologies, increase the flexibility of the electricity system without the need for large energy storages. This flexibility lowers the cost of electricity. This integration is estimated to save up to 13 billion euros.

Business case of renewable energy based synthetic hydrocarbons

Fasihi et al. (2016) have studied a business case where a plant to produce renewable energy based synthetic hydrocarbons is located in Patagonia, Argentina, which is among the best places in the world for solar and wind resources. The produced synthetic hydrocarbons are then assumed to be shipped to Rotterdam in the European Union (Figure 26). Their paper introduces a value chain design for transportation fuels and a respective business case that takes into account hybrid PV-wind power plants, electrolysis and hydrogen-to-liquids (H_2tL), which is based on an energy model of real weather conditions with hourly resolved full load hours (FLh). In the business case, the value chain is based on renewable electricity (RE), which is converted by power-to-liquids (PtL) facilities into synthetic fuels, mainly diesel.

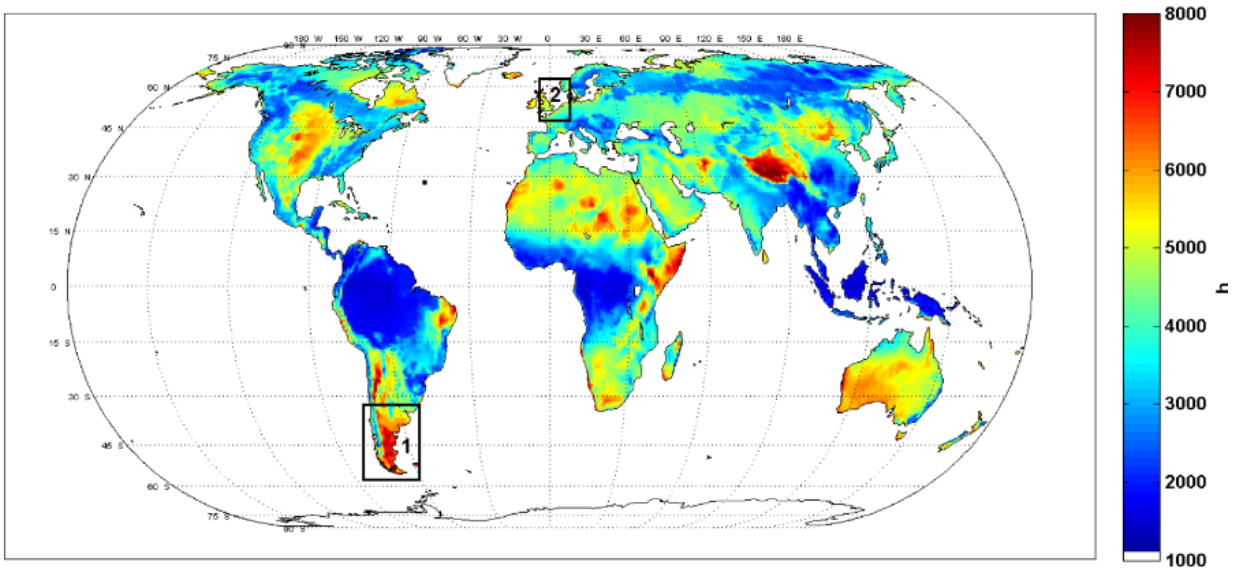

Figure 26. World's hybrid PV-Wind power plant FLh map for cost year 2030. The place of RE-diesel production is marked with (1) and the demand of diesel with (2). (Fasihi 2016, 48)

Their results, based on annual FLh assumptions, show that the proposed RE-diesel value chains are competitive for crude oil prices within a minimum price range of about 79-135 USD/barrel (0.44 – 0.75 €/l of diesel production cost), depending on the chosen specific value chain and assumptions for cost of capital, available oxygen sales and CO_2 emission costs. By using a sensitivity analysis, they conclude that the RE-PtL value chain should be located at the best complementing solar and wind sites in the world combined with a de-risking strategy and a special focus on mid to long-term electrolyser and H_2tL efficiency improvements. They suggest that substituting fossil fuels by hybrid PV-Wind power plants could create a PV-wind market potential in the order of terawatts.

The Internet of Energy Tool – RE system for Argentina?

These two studies are amongst several similar studies that the Neo-Carbon Energy project's researchers have conducted on other regions of the world. Results have already been published for North America, Northeast Asia, Southeast Asia, India/SAARC, Central Asia and Russia, the Middle East and Northern Africa, Sub-Saharan Africa and Europe. These studies have allowed the researchers to highlight regional issues.

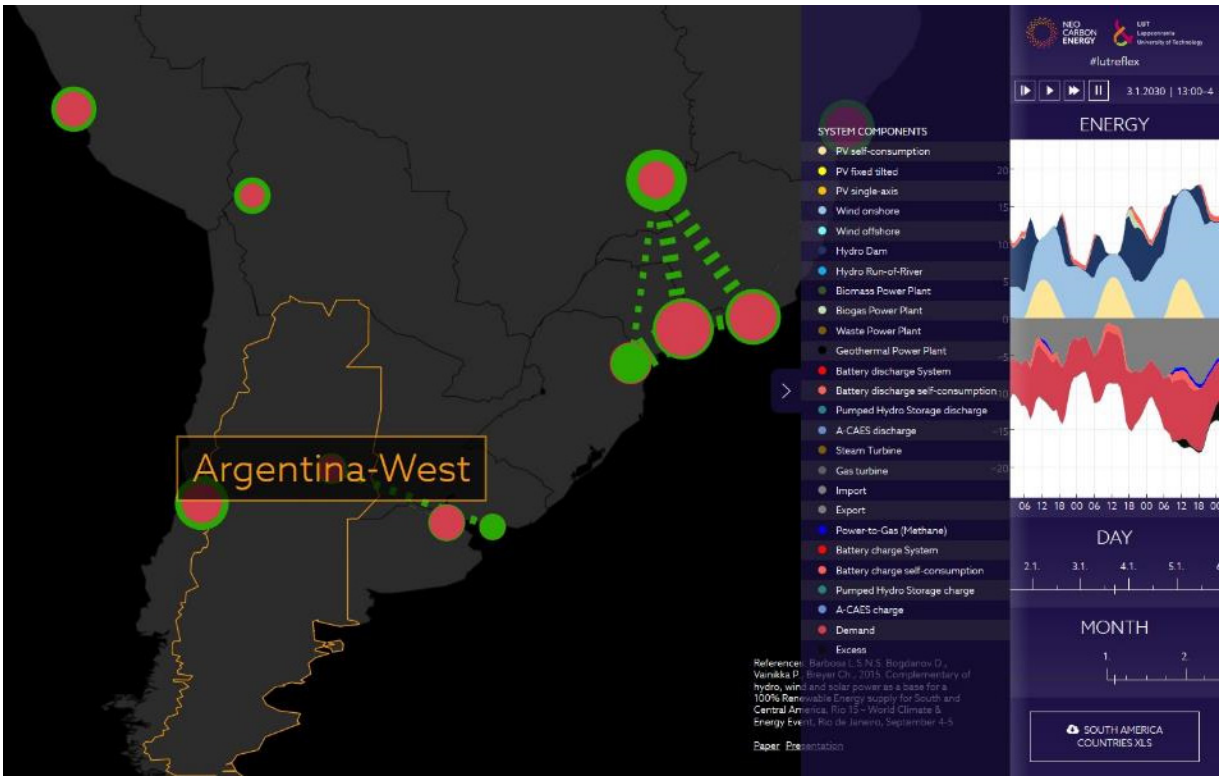

Figure 27. *Renewable energy system in Argentina in the Global Internet of Energy (Neo-Carbon Energy – Internet of Energy Tool).*

One can also test various options with the visual modelling demonstration tool, Internet of Energy simulation (Figure 27): http://neocarbonenergy.fi/internetofenergy/. These studies have been conducted as part of the Neo-Carbon Energy research project, which is funded by Tekes – the Finnish Funding Agency for Innovation, and carried out in cooperation with Lappeenranta University of Technology (LUT), VTT Technical Research Centre of Finland Ltd. and the University of Turku, Finland Futures Research Centre.[40]

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5. CONCLUSIONS

Futures thinking is embedded in the virtuous circle of futures learning both at organisational, national and regional level. In the forward-looking efforts for probing possibilities and potential for renewable energy transformation – even revolution, it is worthwhile to engage in global collaboration and dialogue on topics, aims and means. Some of them are parallel, while some of them may vary between different countries. All in all, studying various stands and aspirations forms synergy. Together, it is possible to come up with solutions that are beneficial not only to economy, but to environment, society and individual citizens as well. This is the ethos of the neo-growth society.

For a long time the energy landscape in Argentina has been highly unconducive for renewable energy sources. Quoting terminology used by Kivimaa and Kern (2016), there have not been policies or policy mixes that would have unsettled the incumbents or enabled creative destruction, not by a mile. When the Argentinian government has subsidized the price of electricity, it has been economically costly, and environmentally, upheld a culture of extravagant energy consumption. Lack of trust in Argentina's political and economic situation has made the investment environment hostile and kept renewable energy projects unprofitable. Taken these issues together, Argentina has become a net energy and electricity importer, despite its relatively high level of electricity production capacity.

But, the energy landscape in Argentina seems now to be changing. After harsh criticism to Cristina Fernández de Kirchner's presidency, Mauricio Macri's election seems to mark a new era in Argentina's political and energy landscape. With updated renewable energy targets and RenovAr program, Macri's government seems to be now taking renewable energy sources seriously. With a tendering round organised in 2016 for renewable energy projects, several solar and wind projects have been set in motion. Argentina aims to increase the share of renewables on a continuous basis. Despite starting from a modest 2% share in 2015, it aims to raise the share of renewables to 20% in 2025. At the same time, considerable challenges remain in the energy sector. In terms of climate targets, while Argentina's natural gas reserves have declined, unconventional natural gas has now become a major lure for the country. However, it is a CO_2 intensive energy source and, eventually, a finite source. Biofuels' exports are growing and nuclear energy is also expected to increase its role in the country's electricity mix.

Argentina holds a huge potential of renewable energy. Patagonia is one of the best wind energy sites in the world. Solar energy is abundant, as in many Latin American countries as well. Renewable energy seems to be getting increasing attention not only in Argentina, but in Latin America more broadly. Energy modelling in the Neo-Carbon Energy research project suggests that South America is one of the most favourable regions globally to shift to a 100% RE system. How this shift happens and how neo-carbon energy system could be taken in place, remains an open question, but it is worth pursuing such efforts further. Overall, it seems that there are reasons to be excited.

Finally, it has been claimed that Latin America was ill-equipped for the major transformations of recent decades. It is up to the Argentinians and their future policymakers to decide whether Argentina will be among the leading and exporting countries of clean renewable energy, or whether the country continues to primarily depend on fossil fuels and imported energy. Finland Futures Research Centre welcomes future cooperation with Argentinian foresight institutions and energy experts in ways that could benefit both parties bilaterally and bi-regionally – Argentina in Latin America, and Finland in Europe. Finland Futures Research Centre is positive towards continuing the opportunity of having Argentina as a case study country in the Neo-Carbon Energy project, and open to other research and education initiatives as well.

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APPENDIX 1: Questionnaire

The survey questionnaire below and also included a deadline for the respondents for their submissions.

NEO-CARBON ENERGY QUESTIONNAIRE

by Finland Futures Research Centre (FFRC), University of Turku

This questionnaire is about the energy futures of Argentina. It is part of a related research project "NEO-CARBON ENERGY" by Finland Futures Research Centre (FFRC). The aim of this questionnaire is to gather expert insights concerning the energy situation and future prospects of chosen case study countries from Latin America, Asia and Africa. All answers are treated confidentially and anonymously at Finland Futures Research Centre (FFRC), University of Turku.

The world energy system is over 80-percent reliant on the fossil fuel economy, which plans to burn approximately 2 795 Gt of carbon, a carbon budget five times too high for the world to stay below +2°C degrees. Investments into the energy infrastructure cause a considerable "lock-in" effect. Conventional energy models and energy scenarios typically assume the structures of an industrial economy.

All respondents will be provided with the final project report. Out of all responses, one respondent will gain a free entrance to the World Conference of Futures Research 2015. http://futuresconference2015.wordpress.com/

Read more about NEO-CARBON ENERGY here:
http://www.utu.fi/en/units/ffrc/research/projects/energy/Pages/neo-fore.aspx

Instructions: Please answer the following questions. You are free to answer all of the questions or to select only those questions you consider most relevant. Please answer to the space provided. There is no maximum word limit. Thank you for your contribution!

1. Your background (Provide basic information)

A. Age ***(use numbers):***	**B. Gender** ***(mark with an X)*** **Male** **Female** **Other**
C. Primary affiliation *(mark with an X)* Consultant Business/industry Researcher Government Non-governmental organization Citizen Other, what?	*If in C. Primary affiliation, you answered "Other, what?", explain here:*

ENERGY POLICY AND ENERGY FUTURES (Section 1 of 5)

Think of the current situation as well as different possible future pathways in Argentina.

Discuss and explain in your own words, you can also provide www-links.
You are encouraged to use your experience and imagination.

2. Energy policy. What is the current energy policy of Argentina?

3. Stakeholders.
Which actors or organisations are the main advocates in Argentina's energy debate?

Which organisations are advocating for solar energy or wind energy?

4. Imagine or anticipate possible energy futures in Argentina.
What changes have you seen in Argentina's energy landscape, and expect in the future, and why?

In 2030, Argentina will be…

In 2050, Argentina will be…

GAS (Section 2 of 5)

Explain in your own words, you can also provide www-links.
Describe both the opportunities and limitations of the sector.

5. Gas.
What is the gas policy in Argentina?

What are the long-term prospects of the gas industry in Argentina (quantities, infrastructure quality)?

SOLAR AND WIND ENERGY (Section 3 of 5)

Wind and solar conditions in Patagonia, Southern Argentina are considered amongst the best in the world to harness wind and solar energy. In the 1980s, it was discussed that Patagonia could be a filling station of hydrogen for the rest of the planet.

6. Wind energy.
What is the wind power policy in Argentina?

What drives the development of wind energy?

What limits the growth of wind energy?

What do you think of the long-term prospects of the wind sector in Argentina?

7. Solar energy.
What is the solar power policy in Argentina?

What drives the development of solar energy?

What limits the growth of solar energy?
What do you think of the long-term prospects of the solar sector in Argentina?

NEO-CARBON ENERGY FUTURES (Section 4 of 5)

Neo-Carbon Energy is a zero-emission energy system based on solar and wind energy. It is realized by peer-to-peer energy trading, energy storage and electricity grid stability. These tools are employed to balance the intermittency (=variability) of solar and wind energy. Solar and wind energy would be stored in synthetic methane in order to close the carbon cycle in the electric power system. In sum, these qualities together make the neo-carbon energy emissions-free.

8. Energy transition.
In Germany, following their energy transition (Energiewende), large amounts of electricity are produced with solar and wind energy. Has there been public debate in Argentina about such an energy transition? Yes/No, explain.

9. Realization of energy transition.
Think of the likely energy future of your country. Do you think that a neo-carbon energy system, that is an energy system based on solar and wind energy (similar to Energiewende in Germany) could be realized in your society? Yes/No, explain.

10. Renewable energy industry.
Does Argentina have a long-term strategy for a renewable energy-based industry?

Has there been, or have you been part of discussions concerning the export of solar energy and wind energy as fuels?

Would you be interested in research collaboration on this issue with the NEO-CARBON ENERGY project? Yes/No.

FUTURE PATHWAYS (Section 5 of 5)

Think of different future developments that could take place in the Argentinian society and energy sector. Explain and discuss freely. Again, you are encouraged to use your imagination.

11. Future energy culture.
Describe what would be your preferred future *energy culture* in Argentina?

Are other interest groups likely to share your view? Why?

12. Energy solutions and innovations.

Tell about an energy solution or experiment in Argentina (or elsewhere) that you consider interesting or innovative.

13. Future innovations.
What energy or energy-related innovation (eg. business model or service) would you like to see in the future?

14.Future of households and consumers.
How could a consumer become an energy producer in Argentina?

15. Unforeseen events.
What kind of an event would shape citizen's perceptions of energy futures of Argentina and change consumer behavior such as household level energy consumption?

CONCLUSION

You are almost finished, these are the last questions.

Is there anything else you would like to mention that was not asked in the questionnaire?

Do you know other experts in Argentina or elsewhere who are working in this field that you would recommend us to send this questionnaire (name, contact information):

Name	***Phone/Email/Website***

Please send your replies to project researcher Joni Karjalainen at joni.karjalainen@utu.fi.
You can also send possible enquiries concerning this questionnaire to the address above.

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Your replies will be treated with confidentiality and anonymity. We will attach an acknowledgment for all those who have contributed to our research (without direct links between answers and persons). If you do not want to have your name in the list of interviewed, please let us know.

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We appreciate very much your contributions and will send you the project reports when the research is completed. Read more about NEO-CARBON ENERGY here:
http://www.utu.fi/en/units/ffrc/research/projects/energy/Pages/neo-fore.aspx

THANK YOU VERY MUCH!

APPENDIX 2: CIECTI Seminar Programme

RECENT FFRC EBOOKS

11/2016 Ruotsalainen, Juho – Heinonen, Sirkka – Karjalainen, Joni – Parkkinen, Marjukka – Laurén, Leena-Maija & Salminen, Hazel: The Fuzzy Futures of Neo-Carbon Work. Neo-Carbon Futures Clinique II

10/2016 Apostol, Oana: Sustainability Best Practices. Benchmarking Results of the SUSTIS Project.

9/2016 Heikkilä, Katariina: Perspectives to Sustainability In The Shipbuilding Network. Interview Results of the SUSTIS Project.

8/2016 Kurki, Sofi – Pura, Minna & Wilenius, Markku: RE-acting the Future. New Ways to Work: The Case of Reaktor.

7/2016 Ruotsalainen, Juho & Heinonen, Sirkka: Intiimi journalismi. Diginatiivit mediat tulevaisuuden journalismin edelläkävijöinä.

6/2016 Höyssä, Maria – Aalto, Hanna-Kaisa – Kurki, Sofi – Minkkinen, Matti – Siivonen, Katriina – Tapio, Petri – Wilenius, Markku & Arvonen, Anne (eds.) Coolest Student Papers at Finland Futures Research Centre 2015–2016. Tulevaisuuden tutkimuskeskuksen valittuja opiskelijatöitä 2015–2016.

5/2016 Hietanen, Olli & Saarimaa, Riikka: VOIMAKAS – elinvoimaa puutarhasektorin uudistumiseen ja kasvuun -tulevaisuusverstaiden tulokset.

4/2016 Ahokas, Ira – Ahvenainen, Marko – Pohjolainen, Pasi & Kuhmonen, Tuomas: Proteiini-kysymys ja sen ratkaisumahdollisuudet Suomessa. Systeeminen tarkastelu sekä kirjallisuuskatsaus järjestelmän nykytilasta ja muutospoluista.

3/2016 Heinonen, Sirkka – Leponiemi Lauri & Parkkinen Marjukka: Futuristiset rakennukset metaforisina viesteinä. Rakennetun kaupunkikuvan tulkintaa tulevaisuusperspektiivistä.

2/2016 Nygrén, Nina A.: Järvien hoito ja kunnostus 2030. Tulevaisuusverstaiden tulokset.

1/2016 Kuhmonen, Tuomas – Saarimaa, Riikka – Nurmi, Timo – Ahokas, Ira – Hyvönen, Katja & Kaskinen, Juha: Paikallisen ruuan tulevaisuuskuvat.

13/2015 Heikkilä, Katariina: Sustainability Studies in Universities – Review on Study Modules of Sustainable Development and Responsible Business in Finnish and some European Universities.

FFRC eBOOK 12/2016

Sirkka Heinonen, Joni Karjalainen, Aino Helle and Sakari Nisula

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