The Combined Energy Options Ontario project has been proposed by OSEA in partnership with the German Fraunhofer Institute IWES. The research project shall investigate comprehensively and in detail Ontario's sustainable energy resources and today's energy systems, and based thereon develop a scenario, simulation and model for a future 100% sustainable – low carbon, combined energy system in Ontario. OSEA seeks to establish an industry-academic-consortium with the goal of a joint research grant application.

OSEA

The Ontario Sustainable Energy Association is Ontario's premier and relentless advocate for distributed and democratically owned sustainable energy systems.

Our vision is of a prosperous Ontario with a thriving sustainable energy sector, good jobs, resilient communities and healthy environments powered, heated, cooled and moved by portfolios of sustainable energy.

OSEA raises public awareness, advises decision makers and establishes forums for new market opportunities and collaborations for its members and stakeholders. OSEA has been instrumental in establishing Ontario's Green Energy & Green Economy Act and its very successful programs for procurement of renewable energies.

Background

Ontario, along with many other jurisdictions around the world, has recognized the urgent need to respond to the threats of climate change by taking impactful and immediate action towards reducing the provinces greenhouse gas (GHG) emissions. In the recent past, the provincial government has passed a number of legislations, policies as well as action plans to support the province's goal to significantly and rapidly reduce GHG emissions. Together these initiatives aim to effectively decarbonize the electricity system, the heating & cooling systems, as well as the transportation sector and industrial processes.

Figure 1 OSEA's guiding principles for the CEOO study

Challenge

How can we understand what our future energy systems must look like to meet the 100% sustainable goal in 2050? At OSEA we believe that we must look at it from a fully integrated systems perspective. There are already many aspects of such a system established, such as apps for remotely controlling our building systems, agricultural and industrial processes as well as commercial operations. Soon we should be able to call our self-driving cars to pick us up or to start charging while electricity rates are low.

The Internet of things undoubtedly must and will expand to the entire energy sector. Yet, our current energy generation, transmission and distribution infrastructures are based on ideologies, concepts, technologies and systems developed decades before the arrival of the internet and the advanced communication and data processing technologies we enjoy today.

It is therefore not surprising that many of us have difficulties imagining that we will be able to meet all our society's energy needs through a very different, more complex, but also a more individualized and flexible system.

At OSEA we anticipate that future energy systems will build on portfolios of integrated, distributed and embedded renewable energy, involving much smaller than utility scale generation. This combined energy system requires flexible and smart transmission infrastructure, innovative storage, and energy conversion and control technologies. Altogether, it will be a very different energy system from our present disconnected and inflexible one-way electrical, gas and mobility systems.

Our provincial and federal governments have committed us to meeting our climate targets as laid out in the Paris Agreement – it is unquestionable that we will not get there by merely improving and refurbishing our old energy infrastructure.

Objective of the CEOO project

The proposed CEOO consortium will conduct the project as a comprehensive interdisciplinary research project to evaluate Ontario's sustainable energy resources and today's energy systems, and based thereon develop a simulation and model for a future 100% sustainable – low carbon, combined energy system to be realized by 2050. The research plan for the CEOO project is designed after a similar project led by the Fraunhofer Institute in Germany, the so-called Kombikraftwerk 2 study (see Annex 2).

The study, and its results, documentation, and models will:

- help us understand how and under what circumstances such an energy system can be realized,
- investigate economic, environmental and societal opportunities,
- identify technological and political barriers to implementation,
- support public communication and education of our politicians and public officials about the chances and opportunities of such an energy future.

We have been optimizing our current, centralized systems for decades and we have met and solved so many challenges in these systems that it can only appear to be an insurmountable task to entirely re-envision and rebuild them. OSEA is aware of this barrier and acknowledges it.

A major objective of this study therefore is to jointly arrive at an understanding of how this new vision can be realized, what behavioural changes it requires, and what the social and economic impacts will be. Furthermore, the findings and analysis of this study will be shared with our stakeholders and politicians to help make evidenced-based decisions when developing Ontario's future Long-Term Energy Plans.

Vision

Collectively we have developed a vision of a future energy system and with the CEOO we will be able to put this vision to the test:

In our combined sustainable energy systems of the future we envision households and industry to be Prosumers rather than Consumers, meeting the majority of their own energy demand through embedded generation, and smart energy management solutions. Prosumers feed excess thermal and electrical energy they produce into local district energy systems or microgrids. These local grids are controlled and supply and demand are managed by local distribution companies (LDCs) whose responsibility it is to operate the energy distribution, storage, conversion, and DSM infrastructure. These local energy systems are interconnected and part of larger regional grids connected to each other through nodes and to our neighbouring jurisdictions through transmission infrastructure, so that we can achieve overall load and supply balance in the province.

Assumptions

Entering the CEOO study, a number of assumptions will have to be made. These include areas of political will, availability of resources, innovation & technology, consumer behavior, economic and climate development. The validity of these ingoing assumptions will be scrutinized and maybe either confirmed or revised during this study.

Examples of possible ingoing assumptions:

- Ontario is dedicated to successfully mitigating Climate Change and the present priorities expressed through the current and proposed legislations and policies remain unchanged.
- Ontario will move from a centralized electricity system to a more efficient, distributed and combined energy infrastructure with diverse ownership.
- Conservation and efficiency efforts will have priority and significant efforts will be made to achieve the provinces targets.
- The local and regional availability and feasibility of sustainable energy resources such as wind, solar, hydro, geothermal, and bioenergy determines the supply mix of the future combined energy system.
- Nuclear Energy, in its current form, is not a sustainable energy source and new build centralized nuclear power generation is not part of a future energy system.
- Cost effective local storage solutions and energy conversion facilities (e.g. power to gas, etc.) will be essential components of the 100% sustainable energy system.
- The transportation sector must be decarbonized/electrified to effectively reduce carbon emissions.
- Ontario's northern and remote communities can be a driver of innovation in energy systems.

Project Plan

In the spring of 2016, a detailed project plan has been developed in collaboration between OSEA's CEOO working group (see Annex 1) and the lead scientists of the German Kombikraftwerk projects at the Fraunhofer Institute IWES in Kassel Germany.

We expect the project to be completed in 3 years and anticipate starting the work in 2017.

Tasks and Deliverables

The project plan foresees 8 work packages, each consisting of a list of defined tasks and deliverables, together resulting in the achievement of a major milestone of the project. Tasks and deliverables are to be carried out by dedicated teams of researchers from Ontario's academic institutions and supported by a team of experts at the IWES and IB institutes.

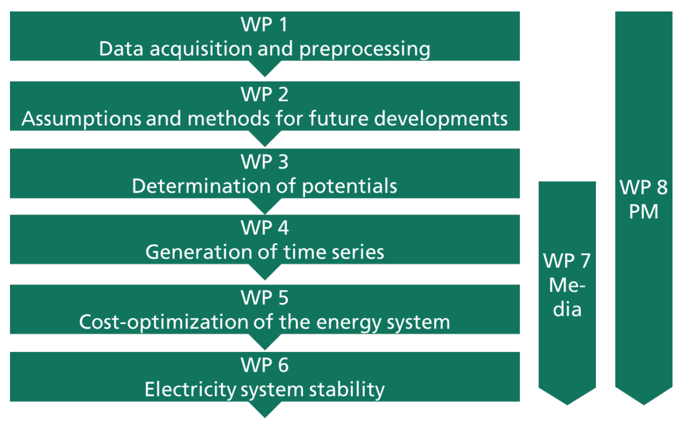

Figure 2 Work packages

Milestones of the CEOO project

Milestone 1 - Baseline Data Acquisition and pre-processing

- Renewable Fuel Resource mapping of Ontario
- Modeling of current energy demand, supply & infrastructure in Ontario
- Cost of Energy, Political Targets and Ownership Structures

Milestone 2 – Testing and Finalizing Assumption of the CEOO Study

- Development of electricity demand and costs
- Methods to define the development of energy demand in the transportation sector as well as heating and cooling
- DSM applications
- Characteristics of PV and Wind installations
- Energy storage
- Ownership structures

Milestone 3 - Potential for generation of electricity and heat from fluctuating renewables; upper boundaries for optimization

- Understanding the potential for generation of electricity and heat from fluctuating renewables.
- Determine the upper boundaries for optimization.

Milestone 4 – Generation of Time series

- Wind power feed-in time series
- Shading effects and Photovoltaic time series
- Time series of wind power and PV forecasts
- Hydro power time series
- Electricity demand time series
- Heating/ Cooling demand time series

Milestone 5 – Cost Optimization

- Definition of the energy system optimization problem
- Determination of regions and net transfer capacities within Ontario
- Model adaptation and validation, configuration of unit commitment model for the Ontario energy system (system tests)
- Modeling Ontario's neighbouring energy systems
- Optimization according to costs
- Allocation of the optimization results to high voltage (HV) grid nodes
- Modeling of two alternative/transitional scenarios on path to a 100% sustainable energy system

Milestone 6 – Electricity System Stability Testing & Analysis

- Reviewing present regulations
- DC power flow calculations
- Demand for dynamic frequency control in the scenario and meeting the demand for dynamic frequency control in the scenario
- Demand for operating reserve and simulation of meeting the demand for operating reserve in the scenario
- AC power flow calculations
- Analysis of voltage stability in the scenario

Milestone 7 - Media and Communication Package

As part of the study the following tools and resources will be developed to engage and educate the general public on the importance and the pathway to developing a 100% sustainable energy system by 2050:

- Interactive map of potentials
- Interactive map of the scenario
- Animation of the 100% sustainable energy system
- Economic Impact Analysis
- Movie about a 100% sustainable Ontario energy system

Project consortium

OSEA proposes to conduct this study as a consortium of partners from **industry**, **academia** and **government agencies**. The consortium will apply for a government grant and provide additional funding to achieve, for example, the project's non-research related deliverables, such as PR, media and communication and education.

Academic partners

The project is designed as an interdisciplinary research partnership between Canadian researchers and a team from the Fraunhofer IWES and Fraunhofer IBP. A group of academic partners from Ontario's research institutions in the field has been approached and a workshop with interested partners was conducted in June 2016.

The following experts in the field will participate in the research of CEOO project:

Dr. Stefan Bofinger, is head of the department "Energy economics and system design" at the Fraunhofer IWES in Kassel. He received his degree in electrical engineering in 2002 and joined the weather service provider Meteocontrol for five years where he was responsible for wind power and photovoltaic projects. Stefan here established the division for yield analysis of PV systems and due diligence. In 2007 he became head of division Large Scale Energy Systems at the Fraunhofer IWES and completed his PhD on "Energy systems with a high share of PV electricity: potentials, forecasts, grid integration".

Britta Zimmermann is an associate researcher at Fraunhofer IWES in Kassel, Germany. She received her engineering degree in Energy and Process Engineering/ Energy Engineering from the Technische Universität Berlin in 2009. Since 2012, she supports the Fraunhofer IWES with her technical and methodical experience in electricity and heat generation, renewable energies, modelling and planning of facilities and (future) energy systems, as well as project management. Her work within the group 'Business Models and Market Integration' focuses on unit commitment planning, the development of future scenarios, energy concepts and regional energy supply integrating Geographic Information System (GIS) methods.

Dr. Bala Venkatesh, is both founding academic director and head of the Centre for Urban Energy (CUE) at Ryerson University. He is also a tenured professor in the Department of Electrical and Computer Engineering.

He specializes in electric power systems with interests in transmission and distribution systems, renewables, energy storage and smart grids. He works with several companies such as Hydro One, Toronto Hydro, Ontario Power Authority, Schneider Electric, eCamion, Temporal Power, Electrovaya and New Brunswick Power. In total, his extramural funding is over $10 million. In the last two decades, he has worked on over 30 consulting and research projects in India and Canada.

With a Ph.D. from Anna University (India), Dr. Venkatesh is a registered professional engineer in Ontario, Canada. Currently a Ryerson professor, he has also taught at the University of New Brunswick, Multimedia University (Malaysia) and Anna University since 1994. Dr. Venkatesh has extensive journal publications to his credit and has supervised over 50 MASc and PhD theses.

Bob Singh, IESO Distinguished Research Fellow at the Ryerson University Centre for Energy (CUE), has over 35 years of diversified experience in the electric utility industry. His areas of expertise include electrical transmission & distribution planning, design and operation; renewable generation integration studies; energy storage; micro-grids; and related policies/strategies.

Bob worked in various positions at Hydro One including Manager Research, Development & Demonstration (RD&D), Manager Asset Management, Manager T&D Generation Connections, Manager T&D Development (Planning) and Manager Distribution Development. Under Mr. Singh's direction, connection impact assessments for thousands of MWs of renewable and non-renewable generators were carried out as part of generation connection process to Hydro One's transmission and distribution systems. Prior to joining Hydro One, Mr. Singh worked at Toronto Hydro as Manager Engineering Services, at former North York Hydro as Manager Standards and at Newfoundland and

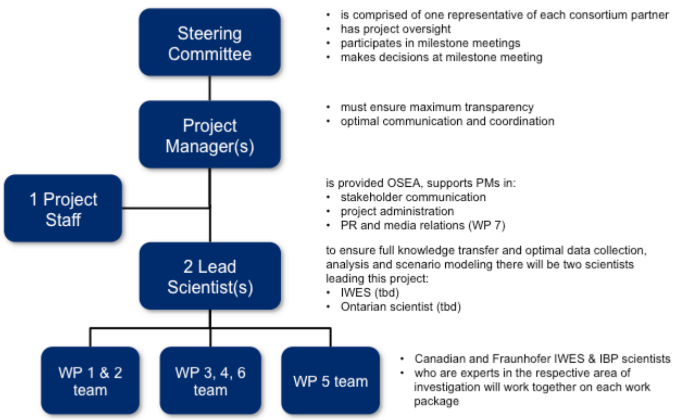

Figure 3 Proposed project organization

Labrador Hydro as Senior Protection & Control Engineer and as Transmission Planning Engineer.

Mr. Singh is a member of the Professional Engineers of Ontario (PEO), Electric Power Research Institute's Energy Storage Integration Council (ESIC), and Standard Council of Canada's Mirror Committee of IEC Systems Committee IEC/SyC for "Smart Energy".

Madeleine McPherson is a PhD candidate at the University of Toronto, where she specializes in renewable energy integration, including renewable resource characterization, optimization modeling, and energy systems analysis. Madeleine's work has focused on the development of a new electricity system model SILVER for the Strategic Integration of Large-capacity Variable Energy Resources. More recently, Madeleine has been applying SILVER to investigate a variety of research questions pertaining to large-scale variable renewable energy deployment on electricity grids.

Dr. Kirby Calvert, is Assistant Professor, in Geography at the University of Guelph. His research is working toward the development of a standardized resource-reserve classification system for renewable energy resources. The system would serve the same purpose as the resource-reserve classification system that is currently used in the fossil fuel industry: to assess and communicate realizable renewable energy potential through a consistent framework that accounts for changes in policy and technology. For this project, the classification system will be applied in a geographic information system environment, providing base-line data into the location at which new renewable energy resources might be recovered, and the quantity of energy available at that location, across Ontario. This spatially explicit approach will reduce uncertainly about renewable energy availability. Perhaps more importantly, it is critical to efficient land-use and infrastructure development in an energy system that relies more extensively on renewable energy resources.

Dr. James Cotton, is a Professor of Mechanical Engineering at McMaster University. He is also the Associate Director of McMaster Institute of Energy Studies. He leads a research initiative on integrated community energy systems, which focuses on developing, modeling and experimentally validating technologies and engineering tools to advance the integration of energy management solutions such as tri-generation (electricity, heating and cooling) systems. He is a co-investigator with the NSERC Smart Net-zero Energy Buildings Strategic Research Network and has been involved in many community energy studies which included assessing the potential for achieving net-zero energy community developments for cities in Ontario including Burlington, London and Hamilton. Jim's research encompasses all sectors of the energy system including developing energy management solutions for automotive applications and has partnered with Ontario steel mills on developing industrial energy harvesting technologies.

Kelton Friedrich, is a Research Engineer at McMaster University coordinating the Integrated Community Energy and Harvesting System initiative. He specializes in local integration at the community level of decentralized energy resources to meet local energy service requirements while also balancing grid wide daily variations. This work includes developing tools to optimize the capacity of decentralized tri-generation (electricity, heating and cooling) and electrical and thermal storage to balance the intermittence of both local and centralized renewables. In addition to source side planning, Kelton works to identify synergies between technologies to improve energy efficiency and allow for demand response management, to both conserve energy or reduce peak demand.

Ontario Sustainable Energy Association

Project Budget

A preliminary project budget has been developed and the estimated costs for the project are expected to be in the range of $2.5 to $3.0 Million.

Item	Detail	Amount
Research	IWES & IBP research staff: 120 Person months ($ 70K FTE)	~ $ 600,000
	Ontario research teams	~ $ 800,000
Project Management	IWES (lead scientist)	~ $ 200,000
	OSEA (project staff and Project Manager)	~ $ 400,000
Travel	Scientists exchange and travel of PM and lead scientists to workshops and conference	~ $150,000
Expenses	Video, website, promotional & educational material development, etc.	~ $300,000
Socio - Economic Impact analysis	Independent third party analysis of socio-economic impact of CEOO	~ $200,000
Total estimated costs		**~ $2,650,000**

Figure 4 Estimated project costs

Benefits for Participants

Partners in the CEOO research consortium are part of a broad-based and representative group of stakeholders of Ontario's sustainable energy industry that already strongly influences evidence-based approaches to policy making.

The study will leverage European Best Practices on energy systems transformation research and tailor it to the Ontario context, thus providing the participants with first hand and in-depth knowledge of the future market structure and opportunities.
The knowledge transfer between academic and industry partners across disciplines and jurisdictions will be highly exportable to other regions and establishes the partners as leaders in energy systems transformation.

Ontario itself will benefit from the CEOO's integrated, intersectorial analysis by identifying drivers of cost efficiencies and economic and societal opportunities and challenges across the combined energy system.

The project partners will have access to the models and tools developed within the consortium as well as to all media and educational/promotional materials developed as part of the study.

Expected Results

We expect the study's approach, its lessons learned along the way by all consortium partners, as well as the communication of its results to all stakeholders to provide a credible and solid basis for public discussion and political decision-making in Ontario.

We anticipate the scientific results to be acknowledged by all stakeholders as an unbiased and long overdue research into what Ontario can actually achieve and needs to do to reach its climate target. We further expect that its recommendations will be reflected in future policymaking and long-term energy planning.

Ultimately we hope to inspire Ontarians to take energy systems development into their own hands by encouraging them to participate in the building of microgrids and district heating networks as well as the usage of all available technologies such as solar thermal and PV, geothermal, cogeneration and many more to become energy self-sufficient. This would have be preceded by an effort to reduce consumption through energy conservation and a careful rethinking and changing of mobility, consumption and food habits.

Annex 1

OSEA's CEOO team

Nicole Risse, Executive Director OSEA, Nicole is a specialist on sustainable energy, with a particular focus on the Ontario energy sector. She was instrumental in driving forward the Ontario Green Energy Act Campaign, and regularly engages with the OSEA membership, as well as policy makers and regulators, to advance the sustainable energy sector within the province.

Dr. Christine Koenig, Managing Partner at Ontario Sustainability Services, Director of OSEA, where she also co-chairs the Policy & Regulatory Advisory Committee. Christine is a founding director of wind, biogas, and solar co-operatives across Ontario, and an unrelenting advocate for community energy in Canada and Germany. Christine has a PhD in Biochemistry from the University of Göttingen, Germany and specific expertise in various fields of biotechnology and bioengineering.

Chris Young, Stoked Power Generation co-founder. Developer of innovative micro-CHP technology. Chris led the introduction of a major European renewable firm (Enfinity) into the North American market with over 33 MW of Solar constructed, advised on >$1.2B of early stage solar, wind and biogas projects, is a former Board Member of the Ontario Sustainable Energy Association and advised: The Senate of Canada Standing Committee on Energy, the Environment and Natural Resources on Solar Energy.

Garry Spence, EverGreen Energy Corp., President, licensed distributor of Small-scale Biomass CHP Generators (50 to 1,000 kWe), Watermills (150 kW to 10 MWe) and StatiqCooling systems for greatly conserving energy for heating and cooling since 2003.

Marion Fraser, President Fraser & Company and the former Content Coordinator for Ontario's Green Energy Act and Senior Policy Advisor to the provincial energy ministers, leading practitioner and consultant since 1985.

Kristopher Stevens, Centre of a Circle, Sustainability & Innovation Advisor Canadian Union of Skilled Workers, Past Executive Director Ontario Sustainable Energy Association. Kris is the Founding Chair of Ontario's Green Energy Act Alliance.

Rick Hendriks, Rick Hendriks is the Director of Camerado Energy Consulting. Rick has over fifteen years of technical, environmental, regulatory and policy knowledge and experience of the electricity sector in Canada. He provides management consulting, strategic planning, research, negotiation, training, and consultation services to clients across the country.

Ilana Kelemen, is the Director of Communications and Government Relations at Senvion Canada Inc. She holds a Masters in Communication from Concordia University, with nearly 5 years of experience in the Canadian wind industry.

Harry French, is a Managing Partner at Ontario Sustainability Services. He has developed a unique approach to community engagement processes that achieves sustainable change by focussing on helping communities take on ownership for their future. Harry was the Director, Community Power Services Group (CPSG) at OSEA and is a former ADM with the Ontario government. Being a former Research Director at the Conference Board of Canada and VP Planning at Marshall, Macklin, Monaghan (MMM Group) he understands public policy at the municipal and provincial levels and has experience in projects requiring synthesis of complex data into implementable actions.

Kieran O'Neill is a Smart Energy Business Strategist at the Sault Ste. Marie Innovation Centre. He is an active contributor to the development of solar photovoltaic projects across Ontario and North America and is very passionate about teaching. He currently trains solar PV professionals in the North American Board of Certified Professionals certification in solar PV installation. Kieran has in depth knowledge of the energy challenges and opportunity in Ontario's north and is an active force behind resilient communities and healthy environments.

Ian McVey is a Project Manager with the Toronto and Region Conservation Authority (TRCA) where he is responsible for the Ontario Climate Consortium (OCC). In that role Ian is responsible for facilitating collaborative research endeavours with academic partners, and policy practitioners that support the transition to a low carbon climate resilient society. Ian is heavily engaged in policy research and communications projects investigating the links between climate change and policy areas, e.g. land use planning and electricity policy.

Dawn Lambe sits on the board of OSEA, chairs its Green Heat Working Group, and is Executive Director at the Biomass North Development Centre, where she is leading the implementation of the Northern Ontario Bioeconomy Strategy. Developed in partnership with the Union of Ontario Indians and with the input of northern communities, industry leaders and academic researchers, the strategy focuses on regional economic development through sustainable bioenergy solutions, biocomposite and biochemical innovation, and the development of demonstrations projects across northern Ontario.

Annex 2

Executive Summary of the Kombikraftwerk 2 research Project

Authors:

Fraunhofer IWES: Kaspar Knorr, Britta Zimmermann, Dirk Kirchner, Markus Speckmann, Raphael Spieckermann, Martin Widdel, Manuela Wunderlich, Dr. Reinhard Mackensen, Dr. Kurt Rohrig

Siemens AG: Dr. Florian Steinke, Dr. Philipp Wolfrum

Institut für Energieversorgung und Hochspannungstechnik, Fachgebiet Elektrische Energieversorgung der Universität Hannover: Thomas Leveringhaus, Thomas Lager, Prof. Dr.-Ing. habil. Lutz Hofmann

CUBE Engineering GmbH: Dirk Filzek, Tina Göbel, Bettina Kusserow, Lars Nicklaus, Peter Ritter

In the autumn of 2007, the project "Kombikraftwerk 1" proved that a purely regenerative power supply [in Germany] is basically feasible. With the specially developed regenerative virtual power plant, the 'Kombikraftwerk', intelligently interlinking power producer and user and storage, a plant park of 36 renewable energy plants was able to meet the actual German electricity requirements in a ratio of 1:10.000.

After it had been proven that renewable energy sources (RE) when combined with storage were able to make power available on demand at any time, the question arose whether the grid stability indispensable for security of supply in a power system using 100% renewable sources could be guaranteed at all times.

It involves ensuring that the voltage and frequency lie within designated limits at any place within the grid and at all times. Major deviations of voltage can only be remedied locally, i.e., by nearby plants, deviations in frequency require especially a very rapid response. These measures to maintain grid stability are called ancillary services. Thus for our future power supply, the following questions arise: whether the plants likely to be available to the system are connected to the grid at the correct places in order to maintain the voltage and whether their technical abilities are sufficiently well developed to react rapidly to deviations in frequency. In many quarters it is feared that a power supply system based 100% on renewable energies could not cope with these tasks.The research project "Kombikraftwerk 2" had the task of investigating what future demands of ancillary services there would probably be and how a purely RE-based power system could deliver these in future.

In order to adequately model grid stability, initially a consistent future scenario of power producers, consumers, storages and the grid was modelled with a high temporal and singularly high spatial resolution regarding the position of power producers and storage. Within the framework of this scenario and using simulations, tests were carried out to determine whether the system could deliver sufficient control reserve to maintain frequency, and reactive power to maintain voltage stability, whether grid congestions can be avoided or else rectified and whether producers of renewables could possibly take over the restoration of supply if the grid were to break down. At the same time, possibilities were explored how RE-plants could deliver these services necessary for grid stability. The solutions were demonstrated at the actual wind energy, photovoltaic and bio-energy installations of the regenerative Kombikraftwerk.

The result of the project shows: Grid stability can be ensured at any time! These theoretical conclusions were successfully confirmed by a laboratory test on the restoration of supply as well as several field tests.

However, to reach the goal of an energy transition, several political, economic and technical efforts will have to be made during the next years and decades. The challenges of maintaining grid stability which are raised by the change in electricity supply are less to be seen in RE which, in principle, fulfil the necessary technical requirements now already. The new types of structure of prospective power production and distribution demands require rather a rethinking of the organisation of the system. It is a matter of transformation of the system, which will put the fluctuating feed-in from wind power Summary 6 and photovoltaic (PV) facilities in the centre, as an essential supporting pillar. Flexible biomass facilities (biogas and solid mass) and bio-methane facilities form an important part of the energy system and contribute to a secure service. An appropriately adapted expansion of the grid with all its components, adapting regulations and the creation of both adequate flexibilities and a power storage system are important pillars for the turnaround in electricity supply.

In summary, the most important outcomes of the project are the following:

- A secure and stable future electricity supply for Germany from 100% renewable sources is technically possible if renewable production, storage and backup power plants with renewable gas work together intelligently.
- Even now, RE can provide technically important ancillary services. At the same time, they are able to react extremely quickly. However, the general conditions of market and system integration would have to be adapted so that market participation is possible for all RE-installations.
- In order to guarantee grid security, decentralised RE-plants, too, would have to be monitored and steered by secure and efficient communication standards. Linking virtual power plants will increase the room for manoeuvre. The disadvantages of the individual plants, such as faulty forecasts, schedule deviations or outages can be absorbed by the group and thus the services offered can be rendered reliably, with a minimum of external communication requirements.

The project was supported by the Federal Ministry for the Environment and built upon the project Kombikraftwerk 1 which was implemented in 2007. The duration of the project was in excess of three years and ended in December 2013.

The project consortium comprised representatives from the areas of research, industry and services. CUBE Engineering, the German Weather Service (DWD), ÖKOBIT GmbH, SIEMENS AG, SMA AG, SolarWorld AG, the Institute for Energy Supply and High Voltage Technology of Leibnitz University Hannover (IEH) and the Agency for Renewable Energy (AEE) worked together as project partners under the leadership of the Fraunhofer Institute for Wind Energy and Energy System Technology (IWES)