

AUTUMN 2018

SCALING DISRUPTIVE TECHNOLOGIES

TO ACHIEVE ENERGY TRANSITION

DISCUSSION PAPER



This publication is part of Friends of Europe's Climate and Energy programme. The aim is to increase awareness of the technological developments and changes which are needed in creating a breakthrough moment to address climate change and accelerate the energy transition.

The authors in this discussion paper contribute in their personal capacities, and their views do not necessarily reflect those of the organisations they represent, nor of Friends of Europe and its board of trustees, members or partners.

Reproduction on whole or in part is permitted, provided that full credit is given to Friends of Europe, and that any such reproduction, whether in whole or in part, is not sold unless incorporated in other works.

The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.



Co-funded by the
Europe for Citizens Programme
of the European Union

Publisher: Geert Cami

Directors: Nathalie Furrer & Dharmendra Kanani

Programme Executive: Raphaël Danglade

Programme Assistant: Adrián Tóth

Editor: Iiris André and Angela Pauly

Design: Elza Lőw

© Friends of Europe - September 2018

TABLE OF CONTENTS

INTRODUCTION	4
PART 1: NATURE-BASED SOLUTIONS	6
Nature-based solutions are key to achieving Europe's ambitious climate change targets	7
Low-carbon, bio-enhancing concrete can give coastal ecosystems a new life	11
Growing light: How biological lighting is the next step	14
PART 2: ENERGY DISTRIBUTION AND TRANSMISSION TECHNOLOGIES	16
The Renewables Grid Initiative brings together pioneers for the energy transition	17
Digitalisation is changing how we produce and consume energy	21
PART 3: DISRUPTIVE LEADERSHIP	24
Scaling disruptive technologies is essential if we want to achieve energy transition	25
Disruptive innovation can make our planet – and Europe – great again	29
Forget top-down European programmes to fight climate change – follow the lead of 21 st century citizens	33
PART 4: DIGITALISATION AS AN ACCELERATOR	36
Recognising the impact of climate action in the financial sector is key	37
Disruptive change in energy sector means new challenges but also new opportunities	41
Combining the winning cards of big players and start-ups to meet the challenges of the energy transition	45
TAKEAWAYS	44

INTRODUCTION

Disruptive technologies transform processes at local, regional or global level. They increase efficiency, while improving life on Earth and empowering citizens. Scientists agree that humanity is close to reaching a number of tipping points: from excessive land-use to biodiversity loss, ocean acidification, air pollution, and climate change among others.

Despite being critically important, one issue with disruptive technologies is that they rarely take the market by storm, often coming from unlikely directions and prematurely. They go against traditional technologies that undertake marginal improvements, only require gradual changes and often maintain the status quo. The reality is that developing and scaling disruptive technologies within the field of energy – which is often associated with taking risks - means drastically rethinking the way we decarbonise, decentralise and digitalise the entire system.

To achieve net-zero carbon emissions in the energy sector, technological breakthroughs are an imperative. This discussion paper shares an array of technological solutions and initiatives that are either under development or currently on the market – and are proven to be successful. By representing disruptive technologies from across a range of sectors, we are able to highlight real solutions, which if replicated and scaled up, could accelerate the energy transition in compliance with the Paris Agreement.

This publication is divided into four parts demonstrating how technologies have become strategic in achieving sustainability objectives and driving societal change - as well as the path of transformation taking place to address climate change and develop a low-carbon economy. Finally, the discussion paper demonstrates how risk-taking and investments in research and development for innovations should be the guiding principles to move towards a more decarbonized world.

1. Nature-based solutions. This section presents solutions that use natural carbon sinks and reservoirs to store and capture carbon dioxide; technologies focusing on bio-enhancing materials that can merge with the natural environment; and others that look at the future of sustainable lighting systems through bioluminescent organisms.

2. Energy distribution and transmission technologies. This section demonstrates how a well-functioning European electricity market, if complemented by sufficient cross-border connectivity, enables balancing services, cost optimisation and a reduction in price differentials across the continent. It also highlights how, through renewable energy systems (RES), such as virtual power-plants, the energy system can undergo a tremendous transformation.

3. Disruptive leadership. Represented by three unique examples of European leadership - institutional, public-private, and citizen-driven - this section outlines the strength of innovation in the energy system in transforming how research and development is perceived; how inclusive and locally-coordinated movements can make room for a new generation of green non-profit actors; and how technological leapfrogging should be seen as an opportunity to be more competitive.

4. Digitalisation as an accelerator. It shows how clean technologies articulated by digitalisation can transform life, business, and ultimately the global economy. From demand response management, where sharing becomes the new norm, to distributed ledger technologies that secure energy transactions, and how well supported start-ups give a new impetus to the low-carbon transition, this section shows a large array of new business solutions that have the potential to drastically modify the way we use a number of technologies.



1. NATURE-BASED SOLUTIONS

Nature-based solutions are key to achieving Europe's ambitious climate change targets p7

Low-carbon, bio-enhancing concrete can give coastal ecosystems a new life p11

Growing light: How biological lighting is the next step p14

Nature-based solutions are key to achieving Europe's ambitious climate change targets

Europe shouldn't waste the opportunity to take a lead in bringing nature-based solutions to scale

Luc Bas, Director, IUCN European Regional Office

Nature is a powerful ally in tackling climate change. Yet it does not receive the attention it deserves in the debate about how to accomplish a transition towards a zero net emission society. Natural ecosystems such as forests, soils and peatlands are the most sophisticated and effective solution we have for capturing and storing CO₂.

To limit global warming to below 1.5 degrees Celsius above pre-industrial levels, and to achieve the EU net zero carbon emissions target for 2050 as proposed by the European Parliament, the largescale removal of CO₂ from the atmosphere will be absolutely crucial.

The Paris Agreement emphasises the role of ecosystems in both climate change mitigation and adaptation. The Agreement calls on countries to appropriately conserve and enhance natural carbon sinks and reservoirs of all types – biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems – in order to fully harness their mitigation potential. It acknowledges the key role of sinks in achieving the goal of reaching climate neutrality, i.e. zero net emissions, in the second half of the century, and recognises that socioeconomic and ecological resilience can be built through the sustainable management of natural resources.

Disruptive approaches to climate change mitigation, such as bioenergy with carbon capture and storage, have been discussed as one potential way to meet the objectives of the Paris Agreement. However, indications are that this approach would consume land on an enormous scale and lead to large-scale land-use changes in tropical regions with weak governance, high biodiversity and high terrestrial carbon stock.

A recent study by the Nature Conservancy on natural climate solutions explores opportunities to reduce emissions and store carbon in the world's forests, grasslands and wetlands, the enormous potential of which is being demonstrated thanks to remote sensing technologies. The publication states that, worldwide, natural climate solutions could reduce emissions by 11.3 billion tonnes per year by 2030, and thus deliver 37% of cost-effective CO₂ mitigation by 2030.

Nature-based solutions are actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing benefits to human well-being and biodiversity. Nature-based solutions, such as the restoration of forests, grasslands and wetlands or sustainable land management activities, can provide governments with effective, long-term and cost-efficient measures to mitigate and adapt to climate change.

These nature-based solutions should not be confused with smaller scale urban green

solutions to reduce carbon emissions, such as green roofs which enable energy savings in buildings, or green bicycle routes which reduce car use. However, all these measures have additional potential to contribute to climate mitigation, while supporting biodiversity and improving the well-being of local communities.

Some European countries have already strengthened their Climate Action plans with measures that support nature-based solutions.

German forests are net carbon sinks that captured 57.7 megatonnes of carbon dioxide in 2015. However, this trend is decreasing due to a shift in the distribution of the age classes of trees and the reduction in tree growth, as well as changes in the use of wood. The German Climate Action Plan 2050, launched in 2016, seeks to preserve and improve the sink performance of forests through CO₂ sequestration in plants and soils, sustainable forest management and use of wood, the conservation of permanent grassland, the protection of peatlands and exploiting the potential of natural forest development to mitigate climate change.

The United Kingdom's Climate Change Act aims to reduce greenhouse gas emissions by 80% by 2050, and forestry is viewed as playing a key role in achieving this. To help meet the target, Scotland's Forestry Commission has a target to extend woodland cover in Scotland by additional 100,000 hectares over the period from 2012 to 2022, locking in an estimated 4 million tonnes of extra CO₂ by 2027, while also providing other environmental, social and economic benefits.

Much of the attention is on forests but soils also form a major terrestrial carbon stock. In fact, it has been estimated that there is more carbon fixed in the soil than in the biosphere and atmosphere combined; however, soil's ability to store carbon is strongly affected by land use and its biological health. Sustainable agricultural methods allow soils to fix carbon, while also protecting the long-term provision of food and other ecosystem services.

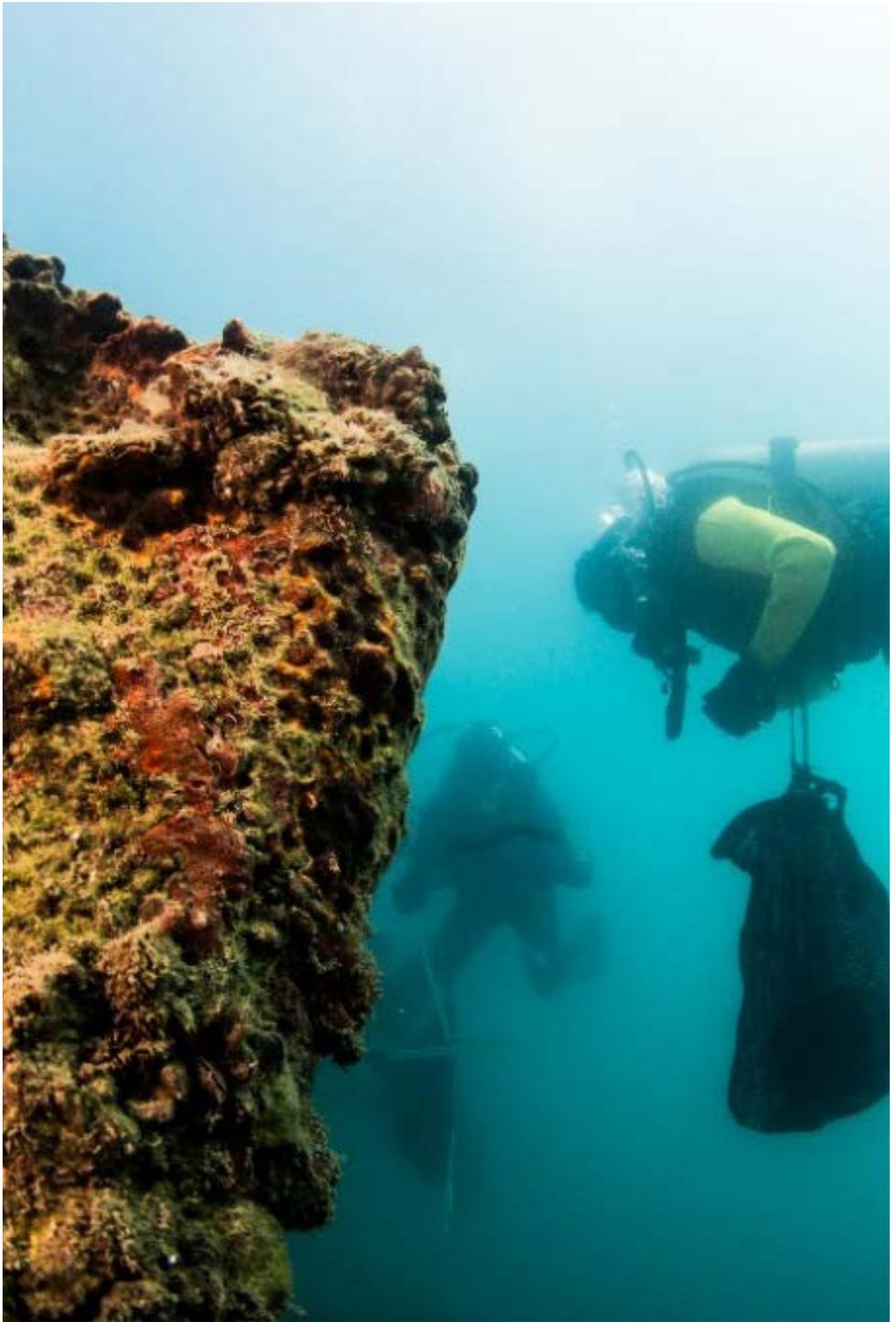
According to research by the US National Academy of Sciences, the plantation of legumes such as alfalfa or soy in pasturelands can help to sequester between 1 and 125 gigatonnes of CO₂ in soils worldwide by 2030. In its analysis of possible measures to meet its climate mitigation targets, the Danish government found that requiring the planting of an additional 240,000 hectares of catch crops on agricultural land would increase soil carbon sequestration and provide additional co-benefits, such as a reduction in nitrogen leaching.

The International Union for Conservation of Nature (IUCN) is at the forefront of the debate on climate mitigation and nature-based solutions. In partnership with the German government, IUCN launched the Bonn Challenge, a global effort to bring 150 million hectares of deforested and degraded land into restoration by 2020 and 350 million hectares by 2030. 47 governments, organisations and companies have already committed to bringing just over 160 million hectares into restoration. Achieving the objective of restoring 350 million hectares of deforested and degraded land would generate an estimated \$170 billion a year in

net benefits and would allow carbon storage of 1.7 gigatonnes of CO₂ annually.

European countries have not made any pledges, but we hope this will change soon considering the potential for landscape restoration in achieving the EU Climate Change commitments and the multiple benefits to the economy and society. Interest in nature-based carbon sequestration has increased lately as a result of the recently agreed LULUCF regulation as the removal of CO₂ through land-use change will be accounted for as part of the process for delivering the EU climate targets. A better understanding of the potential for nature-based carbon retention in Europe is urgently needed.

Nature-based solutions need to be central in any strategy to mitigate climate change. The fact that these solutions do not get the attention they deserve is surprising given their ability to contribute to climate mitigation and adaptation simultaneously, while also providing additional benefits to human health and biodiversity. Europe should not waste the opportunity to take a lead in bringing these solutions to scale on the continent and overseas.



Low-carbon, **bio-enhancing concrete** can give coastal ecosystems a new life

Climate change related threats are key drivers to accelerated coastal development

Shimrit Perkol-Finkel, CEO, EConcrete Tech,
Ido Sella, Co-founder / CTO, EConcrete Tech

Recent estimates indicate that 5-8% of humanity's carbon footprint comes from the concrete industry, from both energy use during production and the released CO₂ from clinker formation, the core ingredient of cement.

Concrete, being the main construction material globally, accounts for over 70% of coastal and marine infrastructure (CMI), as it is used for building elements such as ports, coastal defence structures and waterfronts. CMI that are built from standard Portland cement based concrete support low biological diversity and are typically dominated by nuisance and invasive species.

Climate change related threats, such as sea level rise and increased frequency and magnitude of storms, combined with growing human pressure along urbanised coastlines are key drivers to accelerated coastal development, creating vast environmental impact.

EConcrete®, a science-based technology, was developed to bridge this gap between the growing need for CMI and the need to sustain precious coastal habitats and the ecosystem services they provide. The technology behind EConcrete® utilises preparatory concrete admixture, bio-enhancing concrete products as well as designs that reduce the ecological

footprint of concrete breakwaters, seawalls, dykes and alike, while adding to their strength, stability and longevity.

Apart from direct ecological benefits associated with enhancement of biodiversity, species richness, improvement of water quality through filter-feeding organisms, and the reduction in the number of invasive species, EONcrete®'s innovative products significantly reduce the carbon footprint of concrete, compared to products made of standard Portland cement based concrete. This is due to two factors: the integration of by-products and recycled materials in the admixture and the concrete mix; and the ability of EONcrete® units to enhance biological process such as biocalcification and photosynthesis, both of which facilitate CO₂ assimilation. As a result, EONcrete® products can have up to 86% smaller carbon footprint compared to standard Portland cement based concrete structures.

But how is this possible? By significantly reducing the amount of Portland cement in the mix and by replacing portions of the cement with supplementary cementitious materials (SCMs), EONcrete® is able to address the global need for reducing the carbon footprint of CMI compared to standard marine grade concretes. This way the strength and durability of the concrete are also improved, in addition to reducing the CO₂ embodied in it by as much as 70%, with typical values ranging between 15-40%.

On top of that, the potential carbon storage in calcitic skeletons of marine organisms is vast,

with approximately 120g of carbon stored per each 1kg of calcium carbonate. Growth of marine life on EONcrete® units deployed in the Mediterranean Sea added an average of 2,500g per square metre in one year. Thus, if built from EONcrete®, structures like breakwaters, seawalls, and pier piles - often considered to have negative environmental impacts - have the potential to store up to 300g of carbon per square metre per year until reaching a steady state. Moreover, EONcrete® enhances the growth of algae that actively perform photosynthesis, thus countering additional CO₂ from the system.

With miles and miles of CMI expected to be developed across the Mediterranean as well as globally in the near-, medium-, and long-term future, our product can offer substantial offset for carbon emission issues while having significant, positive ecological impact, such as increased biodiversity, richness, enhanced ecosystem services, as well as added aesthetic and outgreening value.

The calcitic crust formed by ecosystem engineers, such as oysters, corals, and tube worms, serves as a carbon sink and functions as a habitat and shelter for many species. It also serves an important structural purpose, as it increases strength, stability and longevity of concrete based CMI. This obviously also translates into long-term cost savings.

Despite the numerous ecological, environmental, and structural advantages, EONcrete® technologies, similarly to other 'eco-engineering' solutions, are often faced

with limited interest from stakeholders, including port authorities, municipalities, and private developers that actively modify our coastlines. The main roadblocks include lack of policies, regulations, and incentives for developers to “go green”- or blue in this case - and adopt innovation in the field of environmental sustainability. Unlike renewable energy, recycling, and even green construction, which have successfully penetrated into international/national regulations, eco-engineering and the enhancement of CMI have not received similar recognition to date. Clearly, the first step towards removing some of these roadblocks in such an emerging field is to educate stakeholders and policy-makers to recognise the importance of ecological enhancement of CMI in an era of coastal squeeze and hardened shorelines.

There are a few examples of policies that do facilitate such ‘blue technologies’. In the United States for example, every coastal development project requires mitigation actions by law. These can be provided in various forms like habitat restoration (marsh, kelp, etc.), cleaning up polluted coastlines or purchasing mitigation credits from a mitigation bank, thus generating funds for various environmental goals. Eco-engineering (including EConcrete® technologies) has been recently recognised as a component of on-site mitigation, substantially reducing the mitigation requirements.

Hopefully, with time, high-level environmental principles, such as international marine protection conventions or the UN Sustainable Development Goals (SDG) that clearly aim to offset the impacts of climate change and to

preserve marine resources, will translate into regulations that promote eco-engineering and ecological enhancement of CMI. After all, the annual carbon storage capacity of marine and aquatic systems is at least ten times greater than that of terrestrial ones (tropical forests 2.5 g/m², boreal forests 2.2 g/m² versus mangroves 139 g/m², seagrass 241 g/m²).

Technologies such as bio-enhancing concrete have the capacity to serve multiple SDG (Sustainable Development Goals) objectives from mitigating climate change to reducing carbon footprints. We need to make sure that the full potential of calcitic organisms that assimilate CO₂ is taken advantage of, to help our infrastructure better cope with sea level rise and other extreme weather conditions.

Growing light

How biological lighting is the next step

Using living lighting systems is a breakthrough in the industry

Sandra Rey, Founder & CEO, Glowee

What if we could take inspiration from nature to change the way we produce light and illuminate our spaces? What if we could grow our own light?

Electrical lighting is currently responsible for 1.7bn tons of CO₂ every year and makes up 15% of the global electricity consumption.

Meanwhile, nature has already gone through 3.8 billion years of research and development (R&D) to find the most sustainable solutions. The earth is the cleanest and smartest factory, because in nature, waste from one thing is a resource for something else. Fireflies, glow worms, mushrooms and more than 80% of marine organisms actually know how to produce light biologically. These bioluminescent organisms might hold the solutions we have so far overlooked in the quest for sustainable lighting.

That's where Glowee comes in; by using the natural properties of bioluminescence to develop a living source of light, we can reduce the environmental impact of the lighting industry, improve wellness, and create the sustainable lighting systems of tomorrow. This technology will soon replace electrical lighting to enhance public areas, parks and gardens, undergrounds, hotels and spas, and so much more.

Our bioluminescent solution is made from living bacteria. Synthesized genes specifically coded for bioluminescence in squids are inserted into bacteria and engineered for better efficiency of light production. The bacteria are then grown and mixed with a nutritive solution before being encapsulated in transparent shells.

Using living lighting systems is a breakthrough in the industry for several reasons. Nowadays,



most new technologies are developed to be more energy efficient. But a closer look reveals that a lot of solutions (LED, electric vehicles, solar panels, etc.) are focused on low consumption models and ignore the impact of their entire lifecycles. LEDs for example, are made of rare metals, the extraction of which is both extremely polluting and resource intensive.

Our technique, which has a 100% organic byproduct, allows for the production of light while reducing the use of rare metals and fossil fuel resources, and improving wellbeing by reducing light pollution, which currently affects 80% of humans.

Glowee has thus become a provider of a new technological brick, providing energy and water companies with the ability to offer a new service to their clients around biological lighting. It is

both a way for them to create new jobs in the field and generate revenues, while reducing their global environmental footprint. This is another step in the transition of the economic world from products to services, while also diving into bioeconomy.

The key to properly integrating disruptive technologies into the world is education. This is why, after only one year of laboratory work, Glowee unveiled its work to the public. Since then, as we continue our R&D to meet outdoor lighting needs, we also design ephemeral bioluminescent installations targeting future users (retailers, municipalities, architects, energy companies) in order to demonstrate how electrical lighting can be replaced with bioluminescence in each industry.



2. ENERGY DISTRIBUTION AND TRANSMISSION TECHNOLOGIES

The Renewables Grid Initiative brings together pioneers for the energy transition p17
Digitalisation is changing how we produce and consume energy p21

The Renewables Grid Initiative **brings together pioneers** for the energy transition

If we really are striving for an electricity system powered mainly by renewables, we need many more renewable generation sources

Antonella Battaglini, CEO, The Renewables Grid Initiative

Achieving Paris Agreement targets –specifically in limiting the global temperature increase to below 2 degrees Celsius above pre-industrial levels – requires a monumental global transformation of the energy system. The electricity sector plays a crucial role in this transformation and we will need to see an increased deployment of existing as well as new forms of renewable energy systems (RES) onto the grid to meet our climate goals. Political and regulatory flexibility, as well as the courage to build what is needed, will be indispensable. But how can we make this happen?

If we take a look at Europe, it becomes very clear that EU member states must become much more integrated in order to permit a higher share of RES into the system. Regional variations in the suitability for large-scale renewable energy generation, in part due to weather and situational conditions, as well as the likely combination of point and decentralised generation and storage resources moving forward, mean transmission grids will continue to be needed to connect different areas and compensate for regional generation variations. On a larger scale, a well-functioning European

electricity market, complemented by sufficient cross-border interconnection, will enable balancing services, cost optimisation and reducing price differentials across the continent.

Adapting electricity grids to these new requirements and extending the current network have been some of the biggest challenges in the energy transition so far. The lack of public support is regularly named by decision-makers, regulators and grid operators as one of the key delay factors for new power lines in Europe. Around half of the so-called 'Projects of Common Interest,' which are supposed to connect the European internal electricity market, are delayed, mostly due to challenges related to local opposition groups and permitting difficulties.

Local stakeholders and the public have legitimate questions and concerns during all stages of a new grid project, related to both the procedure and its outcome. When there is a need for a new power line, for example, many want to know how grid modellers come to their conclusions, which assumptions lie behind certain scenarios and whether different assumptions, including on deployment of innovative technologies and decentralisation, would reduce the overall need for new transmission capacity. Therefore, to remove the roadblocks to grid development, it is indispensable that grid operators are transparent about their assumptions and models. This includes explaining the language of modellers to a non-expert audience and allowing for more variability in the scenarios considered.

Once the need for a new power line has been defined, local participation in decision-making processes on where and how the new line should be built is key. While there is no one-size-fits-all solution for participation procedures, experience has shown that some key elements should be considered. This starts with the right mindset and mutual respect. Only if project developers consider local knowledge and expertise valuable, will citizens feel that they are being taken seriously and therefore consider the process legitimate and worthwhile.

Moreover, other preconditions for a successful procedure include keeping the public informed about the current status, being coherent in the communication and participation approach, and being transparent on how local input alters the final decision. This does not necessarily mean everyone will be happy with the final outcome, but it increases the likelihood of citizens acknowledging that they have been treated fairly, and that the final decision is based on a legitimate process and a compromise of different views heard.

If we really are striving for an electricity system powered mainly by renewables, we need many more renewable generation sources, along with grid development. This new infrastructure will take up space and – if not planned properly – could impact the natural environment negatively. Project developers and decision-makers should therefore take a holistic approach to planning power generation and transmission. Understanding the possible impacts of these developments to the natural environment under different renewable and grid

scenarios – including spatial ones – as well as understanding how these impacts can be minimised, needs to be considered.

With the right initiatives, these roadblocks can be overcome. The Renewables Grid Initiative (RGI) brings together organisations that have traditionally had opposing views in discussions on grid development: European transmission system operators (TSOs) and environmental NGOs. While both parties have their differences, they share a common goal: a grid built in time that supports the further steady growth of renewables while respecting environmental objectives and citizens' concerns.

Nearly a decade has passed since our initiation, and since then, RGI has proven that a platform where TSOs and NGOs can work together to find joint solutions on key challenges, benefits both groups and the sector at large. They have built the trust needed to challenge each other, with a forward-looking and constructive attitude. Our TSO members incorporate environmental views early in their planning and see that the expertise of NGOs helps them to improve the quality of their projects. NGOs, on the other hand, see that TSOs take their input seriously, and therefore have a much bigger impact than

when they simply opposed new power lines – both on the plans and mindsets of those working for grid operators.

An example of how RGI fosters these relationships can be seen in our current work programme to co-create, together with environmental NGOs and the European association of TSOs (ENTSO-E), a future grid development scenario for ENTSO-E's Ten-Year Network Development Plan. This scenario will present a better understanding of possible pathways for policymakers and the sector at large, towards a system that will be compliant with the goals of the Paris Agreement.

Additionally, RGI facilitates the exchange of knowledge and experiences, which supports good practice in areas such as technology development, stakeholder engagement and nature conservation. We started with a set of principles grid operators and NGOs had agreed upon in the European Grid Declaration, and then looked for good examples on how to implement these principles via our Best Practice work. We have finally reached a point where we can apply them jointly in local projects on the ground.



Digitalisation is changing how we produce and consume energy

The latest technological advancements continue to make waves throughout the energy sector

Paul Kreuzkamp, CEO and Co-founder of Next Kraftwerke;
Elias De Keyser, Energy & Flexibility Expert at Next Kraftwerke

Some thirty years ago if living in Germany, there was only one electricity supplier, and people had no choice but to accept the dictated price which was 40% above the current European average. One electricity utility took care of everything, from production to transport and to supplying electricity to the end consumer. This process was no different in other European countries – after all, power was generated by a few hundred large power plants running throughout the continent, mostly on coal. The disruptive technology of that time? Nuclear fission reactors.

Today's energy landscape looks entirely different. In Germany there are currently more than 1000 energy suppliers to choose from, competing with one another in offering the best deal for the end consumer. In Europe there are now a few million power producing installations and renewables have been installed on a large scale, with sizes ranging from a couple of kilowatts for roof-top solar power systems up to large gigawatt-sized offshore wind farms.

In addition to these mainly policy-driven advancements, another key development has taken place: today, there are billions of fast telecommunication connections implemented to transmit information on who is producing or consuming energy, how much and where, at data point transmission speeds of up to one billion per second.

Next Kraftwerke is a child of this changing energy landscape, and if some of the developments mentioned above had not happened, we would probably not be where we are today. Often labelled as a digital utility, we connect more than 5000 decentralised electricity generation and consumption assets with one another and control this network as if it were one big power plant – accordingly named a Virtual Power Plant (VPP). We monitor the energy production status, consumption levels and technical constraints of every single unit in real time and it does not stop there: we also gather price data from the electricity market, weather forecasts, power plant and line outages, congestion issues, and so on.

Within seconds our VPP algorithms process this data and autonomously decide to either increase or decrease electricity production or consumption of the fleet of installations. In doing so we deliver what is known as control power. Control power helps national electricity grid operators to guarantee that systems operate safely with increasingly intermittent power sources like wind and sun. We are hence paving the way to allow a nearly completely renewable European generation fleet.

Typically, a single small installation cannot deliver this control power because of minimum size requirements and strict technical procedures demanded by the grid operator. However, by bundling the asset with other units in the VPP, it becomes possible to access the electricity and control power markets.

Obtaining this data also allows us to competitively trade energy on the European power exchanges, in particular on those electricity markets that require forecasting and quick reactions. Our technology enables us to trade solar and wind energy with lower financial risks. This eventually leads to more appetite for investors and a sped-up take-up of renewable energy technologies.

Technology is, of course, only one part of the story. Running a virtual power plant requires building trust with all partners and stakeholders. Asset owners hand over control of their installations, whether these are biogas motors, solar installations, industrial electrolysis processes or waste management plants. We meticulously include all constraints in our steering algorithm and additionally make sure that the master control remains with the plant's control system, as an ignored technical constraint and wrong steering signal could potentially lead to thousands of euros in damage. To simply explain the security measures to the client is not enough: trust needs to be built. A customer-centred approach with time to listen to the people on-site is crucial to ensure minimal impact on the asset owners' daily operations.

Many national grid operators in Europe remain sceptical about the reliability of virtual power plants, however. Despite delivering control power in more than five European countries with a compliance rate that even the newest gas-fired power plants have difficulties to keep up with, we regularly experience reluctance from the side of regulators and grid operators to open markets for new players like us. It should come as no surprise that the incumbents of the energy sector are doing what they can to further slow down these evolutions, which challenge their conventional business models.

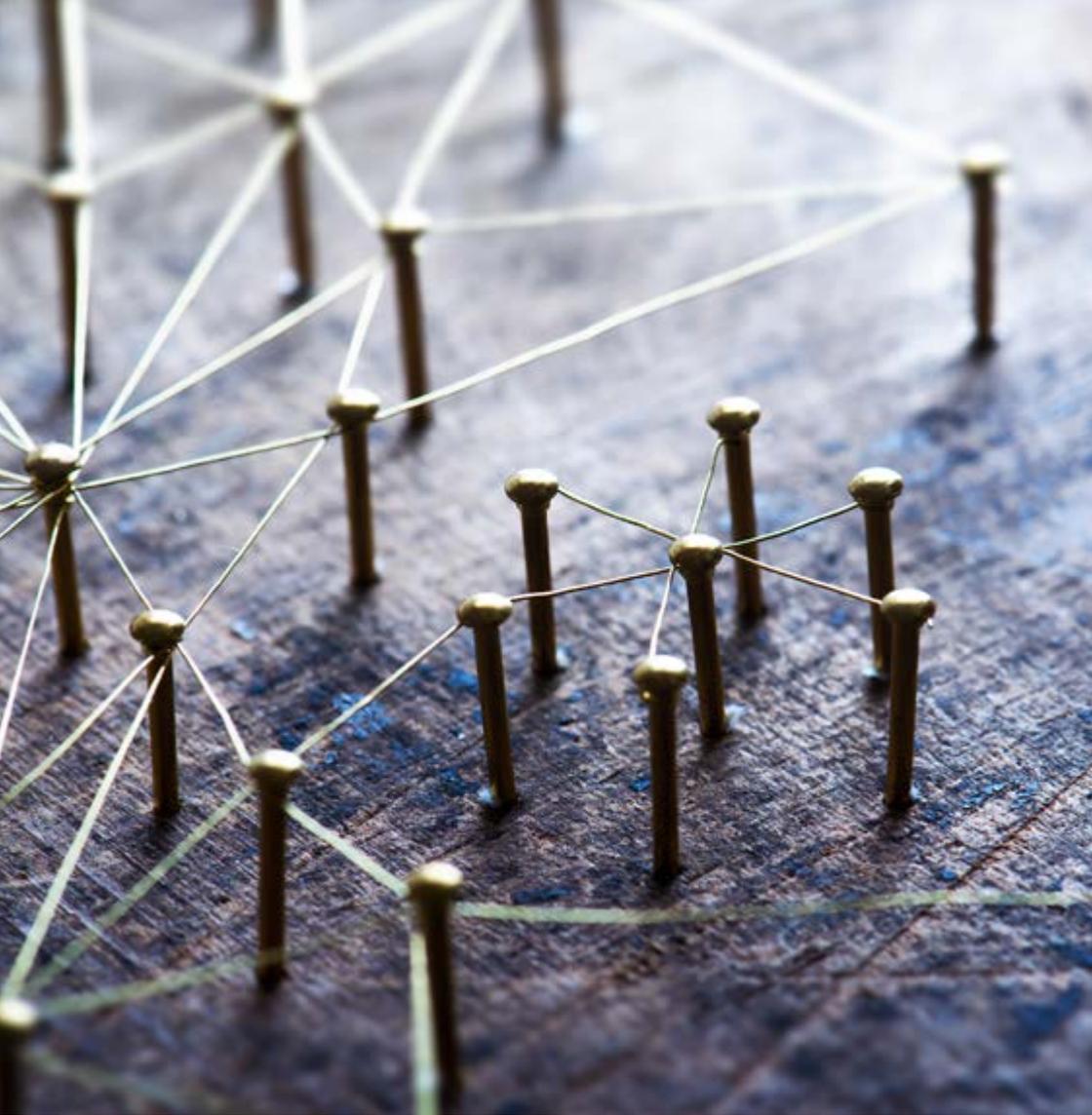
At Next Kraftwerke we manage a large fleet of installations with a young and dynamic team. All of this is possible thanks to a streamlined data collection and to a processing approach which enables a healthy mix of machine-to-machine communication and input by our team.

Meanwhile, the latest technological advancements continue to make waves throughout the energy sector. Fully autonomous trading bots, machine

learning and distributed ledger-based power exchanges are just some examples, and they are all within reach. The more renewables we bring on board, the more automation can take over managing and safeguarding the proper operation of the electricity grid.

Electric vehicles will charge based on predictive optimisation algorithms; washing machines can switch on in the middle of the night; air-conditioning will be swarm controlled to make the most of low energy prices or support system operation. We should stay vigilant to ensure that this energy transition continues to be about empowering the consumer, and not about empowering the machine.

Whatever the energy system will look like two decades from now, one thing is certain: it will be very different from what we ever could have imagined back in the 1970s and 1980s, and even from what we can imagine today!



3. DISRUPTIVE LEADERSHIP

Scaling disruptive technologies is essential if we want to achieve energy transition p25

Disruptive innovation can make our planet – and Europe – great again p29

Forget top-down European programmes to fight climate change – follow the lead of 21st century citizens p33

Scaling **disruptive technologies** is essential if we want to achieve energy transition

Reaping the benefits of the energy transition will require bringing all relevant actors on board

Vladimir Šucha, European Commission Director-General at the Joint Research Centre

The energy transition is a key modernising force of the European economy and is setting it on an irreversible and historic course. Thanks to multiple technological breakthroughs and a visionary EU policy, the cost of renewables is reducing fast, electrification is rapidly expanding to all energy sectors, greenhouse gas emissions are decreasing and the European Union is becoming more energy efficient.

Disruptive and innovative low carbon technologies have also compelled needed social innovation in the form of transformative business models and new behavioural,

organisational and communication patterns. All these developments translate into economic growth and jobs for Europe – and a better world for the next generations.

But this is only the beginning.

Keeping global warming below 2 degrees Celsius requires an acceleration of decarbonisation trends from 2020 onwards, which include increasing the role of electrification in the final demand and significantly increasing the share of low carbon energy sources in the primary energy mix compared to 2015. Such fundamental

changes will allow the implementation of the vision coined by Commission Vice-President Maroš Šefčovič as the '6D model': a decentralised, decarbonised, democratised, diversified, digitalised and disruptive energy system.

Achieving this vision will require systemic, cross-sectoral innovation, enabled by complex policy instruments and financing across the whole technology lifecycle. Technology neutrality – the freedom to choose the most appropriate technology to meet the needs and requirements – must remain a core principle when defining long-term decarbonising options; ensuring the optimisation of the energy system's operation at the lowest possible cost; and maximising the benefits for our society.

This complex regulatory endeavour must be informed by the best possible science. Meeting that science and knowledge need is the ambition of the Joint Research Centre (JRC), the European Commission's in-house science and knowledge service. By carrying out multidisciplinary research, the JRC is capable of flagging, testing and analysing technological breakthroughs and their social, economic and environmental impacts. On a broader scale, the JRC tracks the overall progress of Europe in energy research, innovation and competitiveness and develops innovative tools, such as models used to assess the costs and benefits of decarbonisation. JRC scientific evidence has, among others, underpinned the COP 21 negotiations, the 'Clean Energy for All Europeans' landmark initiatives and Mission Innovation, which aims to reinvigorate and

accelerate global clean energy innovation.

The JRC is placing significant emphasis on understanding the feasibility and impact of game changers on the energy transition. Digitalisation, for example, will enable the large scale deployment of renewables and electric cars and empower consumers to manage their energy demand, which in turn contributes to combatting energy poverty. The JRC was the first to review research and development on smart grids and to launch demonstration projects across Europe, highlighting best practices which can inspire and guide similar initiatives. The JRC also assesses how blockchain technology – a catalyst for consumer empowerment – is transforming the energy sector. Europe is a global leader: over 55% of blockchain and energy activity is concentrated in Europe, mainly in the Netherlands and Germany. Further analyses are needed, however, on the effects of digitalisation on the links between renewables, blockchain and artificial intelligence. Moreover, we also seek to understand societal impacts as well as the emerging needs for new skills and the overall impact of energy transition on the future of work.

Technology innovation requires standards which ensure product quality, reliability and sustainability, in addition to transparent market conditions and investor confidence. The JRC plays a prominent role in contributing to the development of both international and European standards, and one gap in the existing standards we are currently investigating

concerns bifacial modules which can generate power from both sides of the panel.

Researchers, scientists and industry along with small and medium-sized enterprises across Europe can now use our state-of-the-art facilities, such as our energy storage labs, including our battery performance testing lab and high pressure gas testing facility. The latter is a unique public facility in Europe and has been key in the development of the ISO standard on hydrogen refuelling stations. This win-win initiative will contribute to bridging the gap between research and industry and enhancing the dissemination of scientific knowledge.

But what should Europe do to remain a global champion in clean energy technologies? According to recent JRC studies, Europe needs to take a number of actions to boost its global competitive edge: keep up the research and innovation investments (the EU ranks second after the US with €4.5bn public R&I investments in clean energy technologies); strengthen the links between universities, vocational training providers with business and industry and develop an education system which can adapt to job market needs; reform the EU investment environment to bring in the needed capital; ensure the secure, sustainable and affordable access to raw materials and manufactured components; and promote a level-playing field in global trade.

Reaping the benefits of the energy transition will require bringing all relevant actors on board. Local and regional authorities make many of the decisions that affect technology deployment

and innovation, and cities are also the best 'labs' for testing technical innovations. The Covenant of Mayors, a global initiative reaching 680 million people in cities, has already had visible impacts in the fight against climate change. As the scientific and analytical backbone of this initiative, we still need to continue spreading the word and turn all cities into climate leaders.

Furthermore, EU countries, companies, research institutions and the European Commission itself need to coordinate and cooperate in order to improve new, impactful technologies and reduce their systemic costs. This is the goal of both the Strategic Energy Technology Plan for the energy field and the Strategic Transport Research and Innovation Agenda.

The JRC-run open-access information and knowledge management systems (SETIS and TRIMIS) behind both initiatives provide, among others, assessments of emerging technologies and R&I capacities as well as interactive tools. And all efforts are truly worthwhile: our research confirms that energy innovation is a spur to economic growth.



Disruptive innovation can make our planet – and Europe – great again

Technology Innovation can be a source of major value creation while doing something good for the planet

Andre Loesekrug-Pietri, Speaker, Joint European Disruptive Initiative (JEDI) & European Young Leader (EYL40);

Paul Auburtin, Associate, Joint European Disruptive Initiative (JEDI)

Three years have passed since the Paris Agreement was signed. Yet the urgency in finding solutions to climate change remains more acute than ever. Part of an effective and successful energy transition will be driven by new technologies, be it in energy technologies, new materials, storage, smart cities or radically new transportation models.

Unfortunately, what is currently done in Europe in terms of innovation is not effective enough. More than just a money issue, innovation financing is too often characterised by slow decision-making, artificial consortia to achieve

redistribution among member states, small and fragmented investments, lack of urgency and too much focus on research papers when, instead, we would need to decide fast, think out-of-the-box, take massive risks, invest boldly, fail fast and be extremely demanding as well as fast in prototyping. Disruptive innovation is a huge opportunity for Europe to leapfrog, by investing in Moonshots – innovations that are too risky or too long-term for the private sector – and develop the Next Big Things that will change the world and make our planet much less carbon dependant.

Recently in France, the Parliament fell short of confirming President Emmanuel Macron's commitment to ban the use of glyphosate by 2021, following the EU decision made in November 2017 to renew its usage for five more years. Although the herbicide – deemed a carcinogen by the World Health Organization – had been polluting groundwaters, Monsanto was able to convince a majority of French MPs, not willing to antagonise farmers, to reject the ban. Realistically, given that no real budget was allocated to research into viable ecological alternatives, the ban was unlikely to occur. But the French government did not leave it there and decided that France would become a “global leader in the hydrogen technology”, by investing hundreds of millions of euros into “greening” its production and democratising its use throughout the country. Technology Innovation can be a source of major value creation while doing something good for the planet.

This is a concrete illustration of how public bodies may have the financial resources to invest in the future but how the electoral agenda often forces them to have a short attention span, not suitable for long-term decisions. On a different level, the private sector is wealthy, but is not ready to take risks or invest in long-term innovations that would not have direct economic benefits for companies and shareholders. Meanwhile the world is changing fast – and the climate will keep changing with unpredictable consequences if we do not manage to anticipate the challenges of our times and above all, if we do not manage to address them.

This is where JEDI – the Joint European Disruptive Initiative – comes in. This precursor to the European agency for disruptive innovation aims to accelerate Europe's technological leadership by financing and accelerating the development of disruptive innovations. Today, out of the ten largest companies in the world, eight are American and two are Chinese. Seven of them are technology companies, which indicates that growth – and therefore the future of jobs – is increasingly driven by technology. Europe has incredible strengths, both in terms of its industrial base and talent, especially in the environmental sector. Yet it is losing footing on many fronts: it is time to reverse this, as the current technology acceleration is a unique opportunity to reshuffle the cards, provided we test new ways and radically change our methodology.

We believe in a unique and deeply European model to innovation that is driven by purpose and not just for the sake of technology. JEDI has defined four major societal goals – decarbonising the world, improving healthcare, a human-centric digital transition, new frontiers – and is setting big goals to bring positive change to the European society and economy.

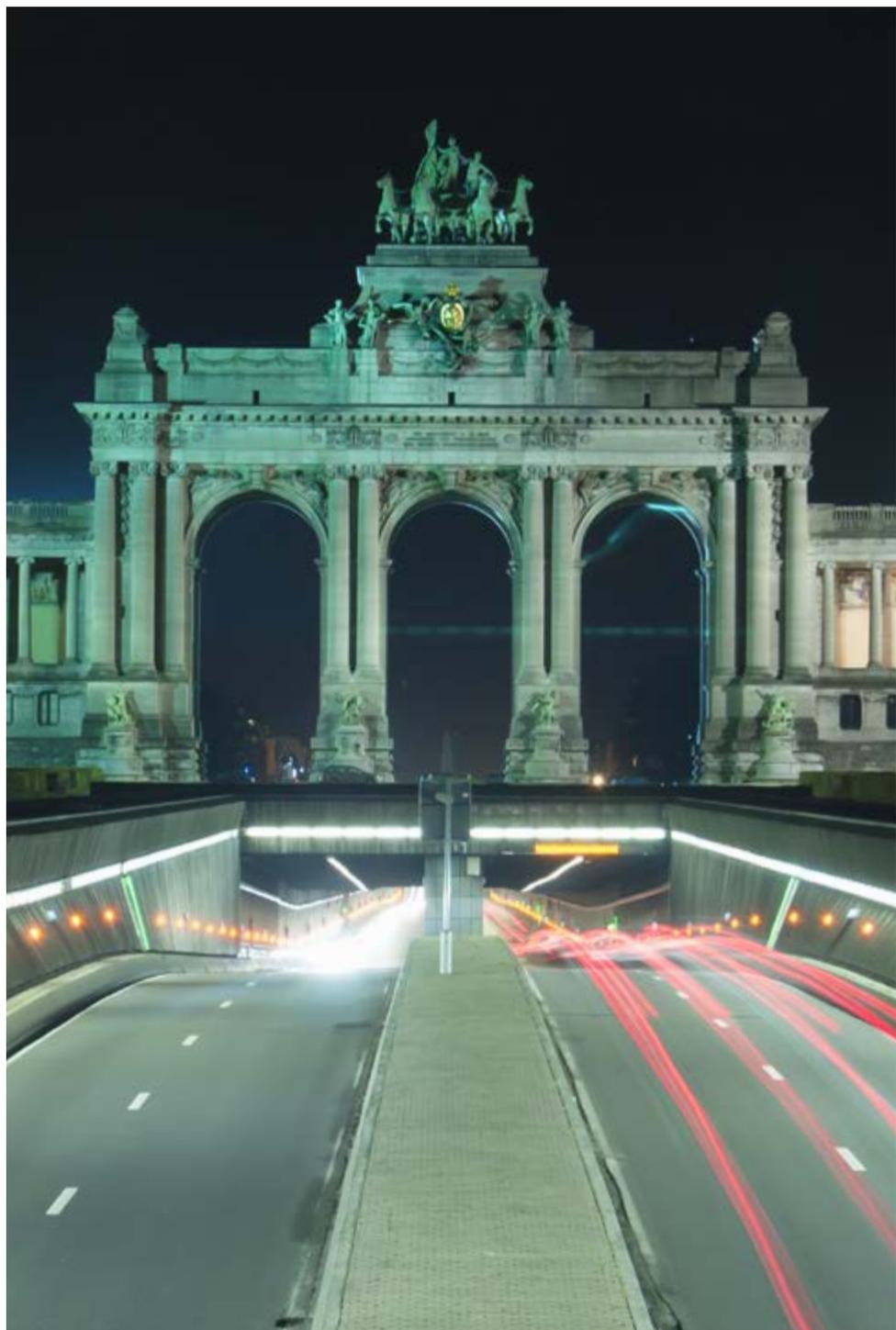
JEDI will be an agile, lean and fast-moving structure in determining the technology challenges that can contribute to the aforementioned goals, launch project calls and actively coach teams working on innovation to push technology frontiers. The idea is to push the envelope as far as possible: if the success rate of the financed projects is more than 10-20%, this may indicate that not

enough risks are being taken. It is this culture of open-mindedness, creativity, disruption and massive risk taking that has previously brought us ground-breaking advances, including GPS, the Internet, driverless cars and SpaceX.

JEDI brings together most of the European deep-tech ecosystem – 120 leaders from different deep-tech start-ups, research centres and tech corporates – with a solid French-German base. It has led the way and been successful in placing the creation of an agency for disruptive innovation high up on the political agenda. Following JEDI's proposal, since early September 2017, several European leaders – including President Macron, Chancellor Merkel and EU Commissioner Moedas – have urged the setting up, without delay, of an agency that would allow Europe to invest in the technologies of the future.

We believe that Europe would benefit massively from JEDI's transformative funding model geared towards obtaining superior, substantive results in the field of disruptive innovation. JEDI aims to encourage a winning mindset through a radical step change in terms of risk-taking, project funding and speed of execution. Indeed, speed is of the essence, if the goal is to stay ahead of the game rather than follow where others lead, given that technology development cycles are getting shorter, especially considering that the United States is giving fresh impetus to the DARPA and China is also developing a similar approach. Europe needs to embark on this innovation train before it is too late.

JEDI aims to complete four main missions, and decarbonising the planet is a major one among them. Starting as soon as 2018, JEDI will launch public calls and finance those projects that manage to prototype new technologies, such as better performing batteries, more efficient hydrogen production from water, environmentally friendly alternatives to glyphosate, blockchains that consume less energy, and so on. These calls will launch a much needed new Pact of Trust between politicians that need to set the vision and the tech ecosystem, and that have the capacity to efficiently implement this radically new approach. We believe this hybrid structure is the solution to Europe's current inertia when it comes to financing breakthrough innovations. And to make Europe great again, we need to make our planet great again.



Forget top-down **European programmes** to fight climate change – follow the lead of 21st century citizens

It is institutions that need to learn how to engage with citizens, not the other way around

Xavier Damman, Co-Founder and President of Open Collective & European Young Leader (EYL40)

Interacting with institutions is a last resort for 21st-century Europeans. Whether it is a question of political parties, organised religion or the concept of marriage, the online generation is more detached from traditional institutions than any previous generation. So what can European institutions do to re-engage them?

A 2018 survey conducted by Deloitte found that 71% of millennials believe that political leaders have a negative impact on society. Over the past two decades, the European Commission has launched countless programmes to

encourage citizen engagement with its institutions. But for the online generation, institutions seem disconnected from the issues they consider to be most important. Why engage with structures you perceive as irrelevant and ineffective?

But in today's reality, the idea of a European programme for citizen engagement is an oxymoron. Young people are turning away from traditional institutions and choosing to build their own movements instead. These movements look beyond national interests and government policies towards long-term

issues that will shape the future of communities all over the world. And we can already see examples of them succeeding.

According to a poll from The Vegan Society, the number of vegans in the UK has grown by 350% over the past decade. Nearly half of them are aged between 15 and 34, suggesting the movement will continue its rise in the coming years. Meanwhile, movements around zero waste and anti-plastic are gaining more and more momentum across Europe. These are initiatives kick-started by millennials and promoted using digital platforms like Twitter, Instagram, Facebook, YouTube and Pinterest.

Millennial entrepreneurs like 23-year old Boyan Slat have demonstrated the 21st-century citizen's drive to work outside traditional structures. When the Dutch inventor first pitched his Ocean Cleanup project in 2013, figures from political institutions and industry were quick to call him naive for believing he could remove 50% of the plastic floating in the world's oceans. Five years later, Slat has created a global movement around his work, proved the viability of his solution, and crowdsourced more than \$31 million in donations to make his vision a reality.

The impact of such movements is significant: citizen-led, they have authenticity, and when they strike a nerve, they can spread like wildfire. Unlike EU programmes that invest time and resources into developing priorities and strategies, these movements organise spontaneously and follow the direction set by the support they receive. The same digital tools

that gave birth to trends like the "selfie" and #foodporn hashtag are enabling 21st-century citizens to organise and turn seemingly small ideas into global movements.

Locally-coordinated movements are engaging young people in ways that institution-led programmes cannot. Through entrepreneurship and civic involvement, often working as a network, citizens are succeeding in reshaping the debate on climate change. The online generation has no confidence that institutions are able to deliver genuine change, so they are taking action into their own hands.

That is not to say that Europe should stop investing in programmes to fight climate change, but rather that those efforts should be more carefully focused. European institutions need to pursue big investments and infrastructure that cannot be tackled by citizens. Policy also has an important role to play, as governmental bans on single-use plastic are showing across the European Union. But initiatives themselves should come from citizens, not from institutions.

If institutions are to help citizen-led movements, they must become comfortable with removing themselves from the decision-making process. They must learn from the world's most innovative start-ups and focus on operating as a platform that facilitates initiatives instead of producing them. They can start doing this right away by committing themselves to match fund every euro crowdfunded by European citizen collectives. But financial backing on its own is not enough to make these initiatives

succeed – what they really need most is more time on their hands.

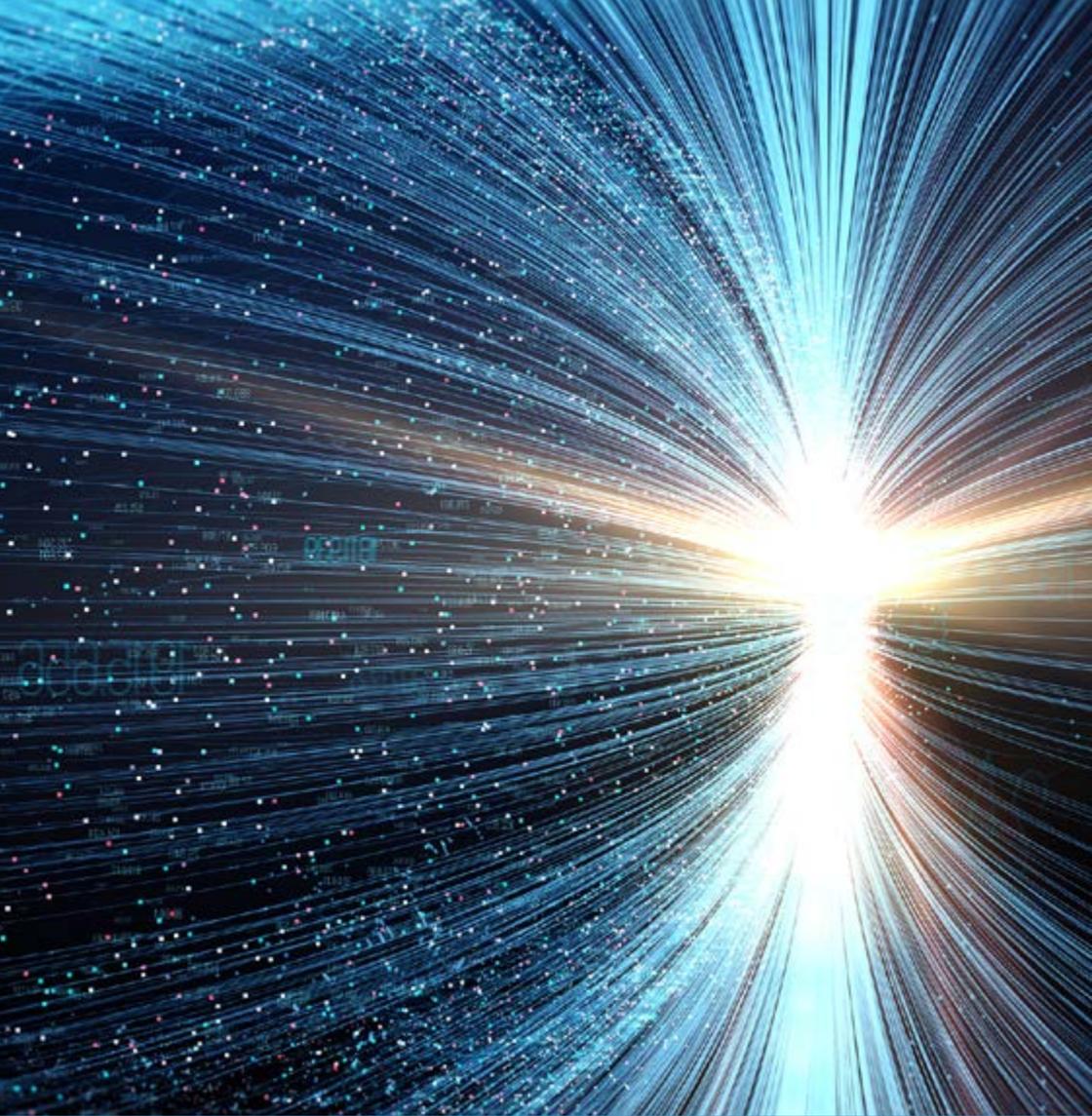
Building a citizen initiative from the ground up can be an exhausting experience. Simply wanting to accept donations may mean that the group has to formally register a legal entity, to write up a legal charter and to learn how to comply with their states' tax requirements. This can be daunting. In France, for example, such a legal entity is called Association de loi de 1901, which tells you everything you need to know about how up-to-date it is.

Europe should create a more agile legal framework for this new generation of non-profits. What if creating the legal basis for a movement was as simple as creating a Facebook group? What if European institutions could directly contribute to the crowdfunding effort already being made by citizens? Not only could this channel much needed money to these causes, but it could also save them a lot of time.

The easier it is for people to start initiatives, the more initiatives there will be. All over Europe, there is desperate need for positive social change that is driven by the people themselves. Global citizen-led movements, such as The New Citizen initiative, have a real and powerful potential to bring about change. Therefore, we need Europe to realise this opportunity and act as an enabling platform for social movements everywhere. Europe started in the 20th century as a platform for big industries; in the 21st century, Europe has the opportunity to become the platform for

citizens. If we can achieve that, we will never have to worry about how to engage citizens ever again.

The new citizens of the 21st-century are driven in their values and goals to create positive change. They are passionate, creative, determined, and they will build movements with or without the participation of traditional institutions. If we wish to help them, we must start by recognising that they can be a very powerful force in the world. It is institutions that need to learn how to engage with them, not the other way around.



4. DIGITALISATION AS AN ACCELERATOR

Recognising the impact of climate action in the financial sector is key p37

Disruptive change in energy sector means new challenges but also new opportunities p41

Combining the winning cards of big players and start-ups to meet p45

Recognising the impact of climate action in the financial sector is key

Monitoring the emissions of future built assets would allow influential stakeholders to proactively encourage greener investment plans

Massamba Thioye, Manager Sustainable Development Mechanism Program, UNFCCC secretariat

The successful implementation of the Paris Agreement necessitates using all available drivers to scale up climate action, including leveraging data and disruptive technologies. One such driver is Distributed Ledger Technology, which can be applied to effectively measure and attribute the impact of climate action by financiers, and incentivise enhanced climate ambition.

It is more appropriate to use a forward-looking approach for measuring the climate contribution of a company. It is based on a comparison of the emission factor of the company's investment

plan with the average emission factor of the technologies to be deployed in the future. Because the baseline is forward-looking, the measurement of companies' emissions cannot be based on existing built physical assets but on those that are planned to take place in future.

Moreover, monitoring the emissions of built physical assets fails to convey the full array of actions undertaken by company stakeholders, including financiers, policymakers, customers, and staff. For example, a shareholder can introduce a motion resulting in a resolution by the Board of Directors to establish a greener

investment plan for a company. Before its implementation, this shareholder may sell its share, and a future annual general meeting may issue a new motion leading to a new resolution which amends the previous one. Measuring the impact of both actions is required, which is not possible by monitoring only the emissions of built physical assets.

Monitoring the emissions of future built assets would also allow influential stakeholders, such as shareholders, to proactively encourage greener investment plans.

Therefore, financiers are expected to measure the impact of their climate action on the investment plans of companies, as a reduction of or increase in greenhouse gas emissions, and any changes made to these investment plans should be transparent so as to avoid any suggestion of tampering.

Climate actions taken by financial institutions occur, by definition, in the financial sector. These can take place, for example in the form of submitting a motion in annual general shareholder meetings or by setting a climate-related conditionality for a loan. Yet, the impact of these actions is monitored in the economic sector, which raises a causation challenge.

There are multiple factors that can drive climate actions by corporates. These include availability of more cost-effective clean technologies, new policies and regulation, pressure from customers and access to competencies. This makes it particularly challenging to disentangle the different influences exercised on a company

and, by extension, to attribute greenhouse gas emission reduction or removal to one of its stakeholders.

To address these challenges, a framework based on the theory of change has been proposed. According to this framework, a financier comprehensively describes the change it expects to induce and why the suggested climate action can lead to the predicted change. The benefits of this type of approach are twofold: it allows establishing that the financier had the intention to induce the change and acted accordingly, and that the intention was appropriately linked with the necessary actions, change and impact.

An example of this theory of change for investors could be to align the greenhouse gas emissions of existing and future assets of investee companies with the climate goals as intend and to invest in research and development related to clean technology as climate action. An external change could make new, more cost-effective clean technologies available or decrease the costs of existing clean technologies; an internal change could mean changing the company's investment plan and aligning the greenhouse gas emissions of its existing and future assets with the climate goals.

The theory of change can be the basis for both assessing the link between the climate action of company's stakeholders and the behavioural change, and attributing the climate contribution to the company and to its stakeholders. For that reason, any changes made to the theory of change should be transparent. This framework

could also provide an option for trading climate contribution units, thus providing financial institutions that either are or are not already aligned with the climate goals more flexibility and incentive for further climate action.

Using Distributed Ledger Technologies addresses the challenges identified above: it provides a reliable validation process that takes place among the stakeholders of the company to attribute the climate contribution and prevent double claiming. Participation in this validation process is one prerequisite for claiming climate contributions. The investment plans of companies and the theory of change of their different stakeholders will be cryptographically sealed in a registry with a time stamp, the related climate contribution, and the stakeholder to whom those contributions have been attributed.

A certain level of transparency is needed for the companies' stakeholders to be able to evaluate their greenhouse gas emissions trajectory while keeping its investment plan confidential.

To achieve this, a digital tool will transform the content of the company investment plan into a greenhouse gas emission trajectory that will be recorded and shared with the stakeholders. A computer protocol that digitally self-executes activities based on defined conditions will disclose the elements of the investment plan at their planned date of implementation.

Measuring the impact of climate action by financial institutions and accommodating the trading of contribution units is possible if Distributed Ledger Technologies are combined with a digital tool that automatically calculates a project's contribution based on its description. The disintermediation that the combination of these technologies induces can streamline the measuring, reporting and verification activities of climate action impacts and increase efficiency and cost-effectiveness. Distributed Ledger Technologies brings climate action incentives down to individuals' level, thus helping everyone to see the results of their climate-friendly actions.



Disruptive change in energy sector means new challenges but also new opportunities

While disruptive changes are known to come along with new challenges, they bring about new opportunities and solutions, too

Francesco Venturini, CEO, Enel X

Today, citizens play an unprecedentedly active role in the energy sector revolution. Yet, less than a decade ago, renewable energy was a niche market, electricity was produced by large and centralised power plants and the role of citizens was relegated to merely end-use consumers alone.

This paradigm is now undergoing a tremendous transformation. Energy systems are becoming cleaner and increasingly decentralised, with electricity generated, stored and distributed closer to the end users. At the same time, the spread of digital solutions has enabled

customers and electricity system operators to manage where, when and how electricity is used. Overall, renewable electricity generation in Europe has increased from 12% in the 1990 to 29.6% in 2016, and is foreseen to grow to almost 100% in 2050. However, as the share of renewables increases in the production mix, electricity generation becomes less predictable, creating a need for a more flexible system.

While disruptive changes are known to come along with new challenges, they bring about new opportunities and solutions, too.

For example, demand response and energy storage can provide flexibility to the power system, contributing to the instantaneous balance between electricity generation and consumption. Demand side response alleviates strain on the electricity system by reducing system load during periods of very high electricity demand, thus limiting the needs for high cost peaking plants. It also shifts demand to times of relatively high renewable generation and low demand. Customer participation in the balance of electricity system is enabled mainly by the role of the aggregators.

As with most disruptive technologies, demand response took off in an unexpected way around 15 years ago thanks to EnerNOC, a Boston-based company that is now part of the Enel Group. What seemed to be merely a regulation loophole at the time, once recognised by the regulator in the United States, was elevated to a practice that nowadays brings a lot of value to the US electricity sector. Since then, EnerNOC has grown to become the world's largest provider of demand response and energy intelligence software with more than 8,000 customers, 14,000 sites under management and 6 GW of demand response capacity.

Utilities and system operators are now using demand response programmes to send signals to customers in order to reduce their consumption when required by the system. Moreover, other flexible uses are currently being designed to allow loads to adapt to varying supply levels of renewables and other market signals in real-time.

Energy storage systems, in particular batteries, are also growing in importance and, thanks to their progressive decline in cost, are bound to play a broader role in energy markets.

Storage is a key technology that can unlock a variety of value stacks for customers, such as cost optimisation, protection against poor grid quality, flexibility revenues from capacity markets and optimisation of unbalances. Storage systems can store excess generation for later use in times of higher electricity prices, optimise cost of energy for customers or dispatch energy services to the system, thus providing flexibility, stability and a more efficient use of power infrastructure, maintaining electricity price as low as possible for all consumers and helping to reduce or defer investments in grid reinforcements.

An interesting example of this integration is the one carried out through DEN.OS, a platform developed by Enel subsidiary Demand Energy, in the Marcus Garvey Village in New York. It comes as no surprise that New York City is one of the most energy-intensive urban environments in the world, but as load grew over time, the network became constrained at different levels.

The Marcus Garvey Village microgrid is an example of how a major city can build an intelligently controlled and distributed digital power grid and provide local resiliency as well as other grid-supporting services. The owners of the Marcus Garvey Village, consisting of 625 apartments, are deploying a first-of-its-kind microgrid integrating solar PV, storage and a

fuel cell with DEN.OS software to manage these distributed energy resources. A key aspect of the project is the ability of DEN.OS to ensure that the Village self-consumes all the energy it generates, without exporting to the grid, allowing the end user to move from a passive role to an active one.

In the coming years, both storage and demand response technologies are expected to grow significantly. The combination of increased energy efficiency, distributed generation deployment and economic incentives will boost the use of demand flexibility to optimise the distribution network load shape and manage local distribution constraints. Demand response solutions, storage technologies, including electric vehicle grid-integration applications, will become a key tool for electricity system operators to manage peak load and maintain reliability of supply.

To face the challenges of the energy transition, Enel promotes an Open Innovability approach based on the idea of sharing. This enables the resolving of business challenges by connecting all areas of the company with start-ups, industrial partners, SMEs, research centres, universities and crowdsourcing platforms, thus co-creating site-specific innovative and sustainable solutions.

Enel has about 200 innovation projects and 126 innovation partnership agreements both globally and locally. It focuses on improving efficiency and environmental care in our traditional core businesses, but also promotes the development of new business models: e-mobility, recharging

infrastructures, energy efficiency, Industrial Internet of Things, smart homes, smart grids and smart meters. And our network is growing from industrial partners, to research partners and start-ups worldwide.

At the moment, eight innovation hubs worldwide – in Moscow, Tel Aviv, Madrid, Pisa, Catania, San Francisco, Rio de Janeiro, and Santiago de Chile – help Enel implement its vision of global reach to catch innovation where it happens. The final goal is to create shared value and new solutions to customers, while improving the necessary technologies and processes.



Combining the winning cards of big players and start-ups to meet **the challenges** of the energy transition

We need to take a broad range of energy options seriously and experiment with a large range of ideas

Michel Vanhaesbroucke, Head of EDF Nouveaux Business

The current energy transition – driven by the need to respond to climate change and the rise of new technologies and social expectations – is shaping everything about our business as a world leader in low-carbon energy. Électricité de France (EDF) is thinking deeply and acting decisively to ensure that we develop the technologies, expertise and networks of partners that will be needed to ensure that energy plays its role in ensuring a safe climate for future generations.

EDF has a long history as energy company: we are now witnessing our third major energy transition. The first was the take-off of coal and

hydropower after World War II, while the second was the mass development of civil nuclear to respond to the first oil shock of the 1970s.

In a sense, we have been here before, but this transition is still very different. The first two transitions were geared towards centralisation and mass production: we were looking to “produce better to produce more”. With the current transition, we have to be more agile and open to different possibilities, both in terms of technologies and business models.

With regard to technologies, we cannot yet know whether biomethane, electric vehicles,

hydrogen, thermal insulation or heat pumps will be the best answer to our energy challenges, or what business models will deliver them. However, we can at least predict that it is likely that all will in some sense be valuable.

Another crucial aspect of the current energy transition is the current society's tendency to favour decentralisation. If in the past the remit was to "produce better in order to produce more", today it is to "consume better to consume less" with more distributed generation and a focus on energy efficiency.

This tendency is supported and extended by digitalisation, which is causing radical change across a wide range of sectors, and particularly in energy. The use of artificial intelligence in data processing, for example, will improve preventive maintenance by enabling actions that are both more targeted and more effective. New business models facilitated by digital advances are also emerging in customer relations that are qualitatively different from the old models.

These evolutions underscore why EDF is reinventing some of its businesses, and in particular the way in which we aim to foster innovation, and are working to accompany bright ideas on the pathway to industrial realisation.

The future is both uncertain and full of promise. That is why we're taking a more flexible and broad-ranging approach to innovation. We need to take a broad range of energy options seriously and experiment with a large range of ideas. At the same time, we the "fail quickly"

principle is applied, so that any projects that are not working out can be wound down rapidly.

An essential part of the process of nurturing innovation is recognising that it can happen both in-house and in small, agile start-ups. For that reason, we are committed to promoting both intrapreneurial initiatives and outside enterprises. Our New Business Division in effect has two complementary roles: it is both a corporate venture capital fund that invests in start-ups and also a business incubation-acceleration programme.

Underlying our activities in this division is our Group's "Cap 2030" strategy, which articulates the company's core long-term priorities: low-carbon electricity, customer service innovations and international expansion.

In line with this strategy, we have four main areas of investment, all of which are central to the energy transition.

First, we are integrating new technologies and services into homes, principally to deliver energy savings, but also to develop smart home and home control technologies. We recently finalised a "silver economy" call for projects that enabled us to identify a number of extremely promising start-ups.

Second, we are boosting our already extensive work with industrial and business clients to improve energy usage. For example, our Metroscope start-up offers industrial facilities a "stethoscope"; artificial intelligence software that helps plant managers identify the root

causes of declines in performance – and not just those related to energy.

Third, we work closely with local, municipal and regional authorities, which is where much of the dynamism around the energy transition comes from. We have supported a number of collective services, such as smart charging for electric vehicles, and there will be many other “mobility as a service” solutions to come in the future.

Finally, we are committed to developing distributed energy management: the energy system of the future will incorporate more renewables, more demand response and more smart grid management. Because this aspect of the energy system involves so many players, we have launched several start-ups that deal with it. For example, Agregio aggregates distributed renewable generation and EDF Store & Forecast delivers flexibility to the grid through storage management.

That, however, is just a small sample of the kind of start-ups and intrapreneurial projects we are helping to develop. Our mission and our goal is to make sure that bright ideas have every chance to become a reality and help us through the energy transition.



TAKEAWAYS

These takeaways draw on the viewpoints and ideas presented by the authors of the articles in this discussion paper.

NURTURE NATURE

Using nature-based solutions as disruptive technology is underestimated, despite their central role in mitigating climate change and accelerating the energy transition. They can provide a safe way to remove carbon dioxide from the atmosphere and ensure that the diminishing carbon budget is not exceeded. In this regard, the European Commission, notably its Directorate-General for the Environment, Climate Action and Energy, should develop policy coherence, have a common approach and emphasize the vital role biodiversity plays in preserving and maintaining a stable climate. The Commission should also develop better investment, research and development capacities to support nature-based solutions. This should be a priority for the next term of the Commission's mandate. European institutions should make more creative use of the various funds available, make them green-proof and engage more vigorously with municipalities, regions, civil society and NGOs to trial, develop and scale innovations based on the natural solutions. Understanding nature's carbon retention potential should be considered a critical piece of the decarbonising architecture to achieve Europe's climate and energy targets and aim at carbon neutrality by 2050.

MORE ACTION, LESS POLICY

In the ongoing energy transition, there is a call from the private sector to the state to regulate and coordinate investments that are made and technologies that need to be scaled up. Nevertheless, the huge bulk of policies that the

institutions produce does not help to accelerate the process of take-up. The policies also reduce the impetus, momentum and creativity brought by the energy transition at European and national level. There is a clear need to shift from policy development to implementation: the new EU mandate should focus on closing the policy book and on taking action, as putting forward new policy proposals alone won't accelerate the energy transition. By taking a more flexible approach to the inclusion and adoption of innovations and new technologies within its existing policies, the EU will create the conditions for the private sector be more agile both in terms of technology adaptation and business model developments. The energy market worldwide is open and fiercely competitive and for the EU to maintain a competitive advantage globally, its focus should be less on process and more on 'doing' and supporting innovation.

CREATE A EUROPE-WIDE DISRUPTIVE TECHNOLOGY SANDPIT

Innovation and energy transformation are key to accelerating the energy transition. Creating a Europe-wide technology sandpit that would mobilise companies, entrepreneurs, start-ups and citizens, and that could be used to elaborate and experiment new solutions, is an opportunity for the continent to experience transformation through innovation. To leverage the necessary funds to realise such action, a co-investment finance fund could be invented to trigger the required capitals and ensure the implementation and scale-up of new technological solutions. This would ensure that talent in the public and

private sectors could help rethink the existing energy system. This type of collaboration would mean that critical innovations can flourish and that their innovators can get the support they need to navigate through regulations and policy bureaucracy rather than be stifled by them. This can spur creativity at European level and enable controlled risk taking in developing disruptive technologies while responding to the need for urgent action on climate change. By being bold and ambitious, the EU can turn bright ideas into reality. For this to happen, the EU and its member states need to locate, test and embrace the risk technological solutions carry and learn to adapt quickly for a full systemic change that is taking place in the energy sector.

FUTURE OF ENERGY IS VIRTUAL

Digitalisation makes it possible to articulate the whole energy system while safeguarding proper operation of the electricity grid. With the inclusion of more renewables, the system can become greener. Digitalisation can also help energy systems to be cleaner and increasingly decentralised, accessible and connected, and it allows electricity to be generated, stored and distributed closer to the end user. Sharing and showcasing best practices on how digital solutions have enabled customers and electricity system operators to manage where, when and how electricity is used is key to fast-forwarding the energy transition. To properly function, member states across the EU need to be much more connected, integrated and open to demand response management in order to permit a higher share of renewable energy solutions into the system. Adapting

electricity grids to these new requirements and extending the current network is one of the biggest challenges in the energy transition. This will require leadership from the EU to remove the roadblocks to grid development and to gain public support. Grid operators in turn will have to be transparent and take a holistic approach to planning power generation and transmission.

NORM GREEN INVESTMENT

Europe has positioned itself as a frontrunner in the area of green and sustainable finance, and its latest action plan on this topic will soon be followed by legislative proposals in member states. The member states need to call for a rapid and substantial redeployment of capital meant for sustainable activities that foster employment, productivity and competitiveness of the EU's overall economy. Many European organisations and institutions are already pushing for a single reform agenda, and it is clear that private sector solutions on norming green investments and setting climate-related conditionalities for loans can be significantly stepped up. To include the recommendations from the Task Force on Climate-related Financial Disclosures, banks and private sector companies should use scenario analysis to disclose the potential impacts of climate-related risks and opportunities and demonstrate how they identify, assess and manage climate risks. Only this way, decarbonising capital allocation and green portfolio design in Europe will be a success.

Image credits:

Cover: Pugun and Photo / Bigstock

p.6: CC/Flickr - CIFOR/Neil Palmer/CIAT

p.10: COURTESY OF ECONCRETE

p.15: bjginny / Bigstock

p.16: jaroslavav / Bigstock

p.20: RoschetzkyPhotography / BigStock

p.24: landio / BigStock

p.28: Inked Pixels / BigStock

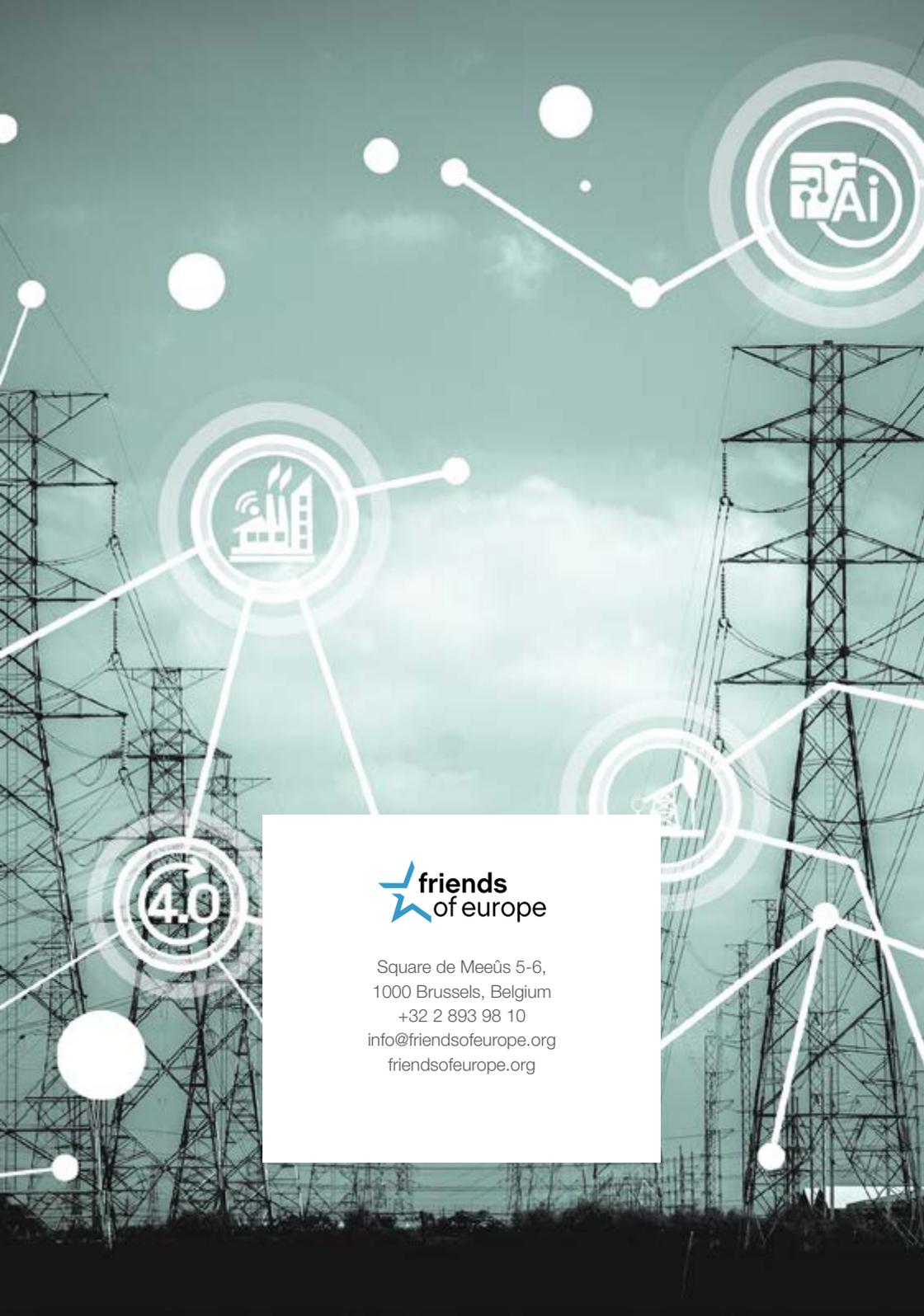
p.32: Bokic Bojan / BigStock

p.36: spainter_vfx / BigStock

p.40: anweber / BigStock

p.44: Natali_Mis / BigStock

p.48: Malp / BigStock



Square de Meeûs 5-6,
1000 Brussels, Belgium
+32 2 893 98 10
info@friendsofeurope.org
friendsofeurope.org