energy
journal

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SES2019

INTERNATIONAL STUDENT
ENERGY SUMMIT

LONDON, UK
17 - 20 JULY 2019

SUSTAINABILITY

London School of Economics | Imperial College London | University College London | ESCP London

About

The Energy Journal is a biannual publication focused on current energy affairs. It is a collaboration between LSE, Imperial, UCL, and ESCP students, making it the largest student-for-student energy magazine in print. We're working to create a high-quality Journal while creating a community of like-minded people.

Want to get involved?
Email us at energyjournalonline@outlook.com,
or find us on social media.

The Student Energy Summit 2019 (SES 2019) is the leading energy conference dedicated to students. Undergraduate and postgraduate students gather to discuss current affairs in the energy sector. This year, the topic is sustainability; we are inviting a range of students from a range of backgrounds, eager to produce and consume energy more sustainably. The forum will be held from 17th to 20th July 2019, where 650 delegates will meet in London from 100 different countries to discuss the future of energy, along with 60 leaders from industry, academia and policy.

Authors and Editors: Energy Journal

Ayrton Bourn, Madison Cole, Jorge Balanya Echecopar, Humera Ansari, Matt Piggins

Authors and Editors: SES 2019

Muhammad Waabis, Estefania Villavicencio, Geraldine Satre Buisson, Jochen Cremer

SES2019
INTERNATIONAL STUDENT ENERGY SUMMIT

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Co-Chair	**Jochen Cremer**
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Vice-Chair Event Management	**Sohail Mian**
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Vice-Chair Impact and Legacy	**Shane McDonagh**
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Vice-Chair Programme	**Hannah Cardiff**
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SES2019
INTERNATIONAL STUDENT ENERGY SUMMIT

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Events	**Muhammad Waabis** **Bethany Reyniers** **Farin Lari** **Kelvin Chi Cheng** **Komal Mehta**
Impact and Sustainability	**Cécile Farber** **Miguel Lema Botelho** **Lukas Malm**
Marketing	**Estefania Villavicencio** **Tarek Cheaib** **Sara Moubarak** **Fernanda Sapina**
Programme	**Frances Hagen** **Shaun Hunt**
Sponsorship	**Caoimhe Culhane** **Shil Ghosh**

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KATHRYN JAITLY is the editor-in-chief of the Energy Journal. She is a third-year chemical engineering student at Imperial College and has worked at the Journal for two years. This is the first time that she has compiled a Journal, so hopefully it looks alright. Speak to her (and the team) at the Energy Journal stand during SES2019 to find out more

SES Introduction

The great aim of education is not knowledge but action.

About the Co-Chairs

Geraldine is a third year PhD student at Imperial College, working on international climate change policy. She studied sustainable development in France and Germany before coming to London.

"I think climate change is one of the biggest challenges of our time, and obviously the energy system plays a central part in that - around 60% of global emissions come from the energy sector. At the same time, energy obviously fuels everything that we do, so you can't talk about the energy transition without having to consider how it affects the most vulnerable people, or a country's security, to name just two examples.

I therefore think it's both an important and a fascinating topic, and I'm really excited to have joined the SES 2019 to share this passion with other students and get a great momentum going at Imperial College."

Jochen is also a PhD student at Imperial College, researching how to operate the power system when we have a significant share of renewable energy. Before joining Imperial, he studied engineering in Aachen, Germany. Now he is here in London, enjoying the city, researching, playing football and of course, organising SES 2019.

"I hope that SES 2019 will help our delegates to further their understanding of the global challenges of the climate emergency, and help move them forward. SES 2019 is all about connecting people and that everyone afterwards has the feeling of working in the same direction, and can take his own way of contributing to breaking the barriers to sustainable energy. We are the generation that must fix the climate emergency!"

Géraldine Satre Buisson

Jochen Cremer

Helping to organise conferences and events like SES 2019 is like a hobby for me; it's not procrastination if it's related to my research! As my PhD draws to a close, I'm motivated to make an impression on the next generation of students who care about the future of energy.

Shil Ghosh

The world today needs a change
world, social media plays a great
SES 2019 is leading the charge
future. I feel like I am becomin
is going to take the world by st
in the energy industry come to
ideas to the table that could cha

I love a challenge, and there's nothing like the energy challenge the world economy is currently facing. Climate change is real, it's happening now, we all know that. If we want to avoid its worst effects, our energy system has to change drastically, and rapidly. At SES2019, we are working hard to get the brightest young minds from all over the world to come together and make that change happen.

Geraldine Satre Bouisson

Energy is a dynamic, exciting field, constantly bringing up new challenges and opportunities - so is organising SES 2019. SES 2019 is enabling students to engage with Energy and become a part of a sustainable energy future - I want to be part of it too.

Hannah Cardiff

What do
SES me
to you

I find it very exciting to be a part of movement that is trying to break the barriers of the energy transition on a global scale. The key to accelerate the movement against Climate Change is empowering the youth through engagement and education, which is exactly what SES2019 is trying to achieve.

Farin Lari

The energy industry is going through a revolution right now and it is up to us to educate the future generation of engineers. I am playing my part by bringing these like-minded individuals together and inspiring them to be the agents of change who will drive us towards a more sustainable future.

Muhammad Waabis

The energy industry touches every aspect of our lives, regardless of the path we follow. I am a part of SES 2019 to learn, appreciate and influence the role energy plays in my life and help others to understand the intricacies of this industry.

Nicholas Ogilvie

The
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the
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eeds a change in my opinion. In our hyper-connected
ia plays a great component in how we lead our lives.
ng the charge amongst the youth for a sustainable
I am becoming a part of the positive change that
he world by storm and help lead the young leaders
ustry come together and bring new and innovative
that could change the future of sustainability.

Fernanda Sapina

Taking part in the organisation of SES2019 is a great way for me to include sustainability, my absolute passion, to an event that I think is essential. Energy is central to the future of environmental sustainability and being able to include it as much as possible within the conference is a challenge I couldn't refuse!

Cecile Farber

SES 2019 aims to speed up the energy revolution. This is also my personal goal. Young students can make a significant difference, to break existing barriers that stand in the way of the energy revolution. This is what I believe, this is why I joined SES 2019.

Jochen Cremer

We need to ignite discussion and start making decisions for our energy future - SES 2019 is our launch pad! I want to be part of the next generation of energy enthusiasts, exploring the intersection between energy, technology and society.

Kitty Stacpoole

hat does
S mean
o you?

One of the most pressing issues of today is how to cope with an increasing energy demand while transitioning to a low carbon energy system. SES 2019 will inspire students from all around the world and showcase the pathways to sustainable development.

Miguel Lema Botelho

The effects of climate change and pollution are real, and felt by the most vulnerable first, with our plans showing no ambition to tackle the problem in time or effectively. I want to be part of a group that mobilises this generation's enthusiasm to make a difference.

Shane McDonagh

My career aspirations are to support the decarbonisation of global economies. Whether its building sustainable businesses, promoting green buildings or investing in low-carbon energy sources, I want to use SES as a platform to connect like-minded people across the globe.

Tarek Cheaib

News in Brief

JUNE 2018 saw a clean electricity overtake in Britain. For the first time since the industrial revolution, more power was obtained from zero-carbon sources in Britain than fossil fuels. According to the National Grid, between January and May 2019, 48% of electricity came from renewables, nuclear and clean imports, 47% came from gas, coal and imports, and 5% came from biomass. Over the last 10 years. coal use has declined from 30% to 3%, whilst wind power has increased from 1% to 19%.

SUNNICA, an energy firm, aims to create one of the largest solar farm in the United Kingdom. The site, originally earmarked for farmland, is on the Cambridge-Sufolk border, and would span across three sites, taking up the space of 900 football pitches. Concern has been expressed by local residents, but Sunnica argues that enough power will be generated to power 100,000 homes.

BREXIT could put the United Kingdom at risk of an energy shortage, according to industry leader Marco Alvera of European gas industry body, GasNaturally. The United Kingdom imports nearly half of the gas it consumes from Europe, and some 39% of electricity generated last year came from natural gas. There is a risk of shortages, price hikes and tariffs in the wake of Brexit, unless energy becomes an important discussion point.

THE UNITED KINGDOM commits to a 2050 target of net zero greenhouse gas emissions. The first major nation to make the pledge, it is a move that has been widely praised by green groups. However, some are skeptical about whether or not this is actually deliverable. Prime Minister Theresa May, said that it was “a moral duty to leave this world in a better condition than what we inherited.”

CONTROVERSY surrounds a new Chinese coal plant near the Kenyan Word Heritage Site of Lamu. Currently, over two-thirds of Kenya’s electricity is generated by renewables, the planned power station would increase carbon emissions of the country by 700%, with Kenya also responsible for importing the coal. China has pledged to reduce its reliance on fossil fuels, but a quarter of all coal fired power stations planned or under construction around the world are financed by China. Critics argue that China is outsourcing it’s fossil fuel consumption, whilst also providing a market for the coal it produces.

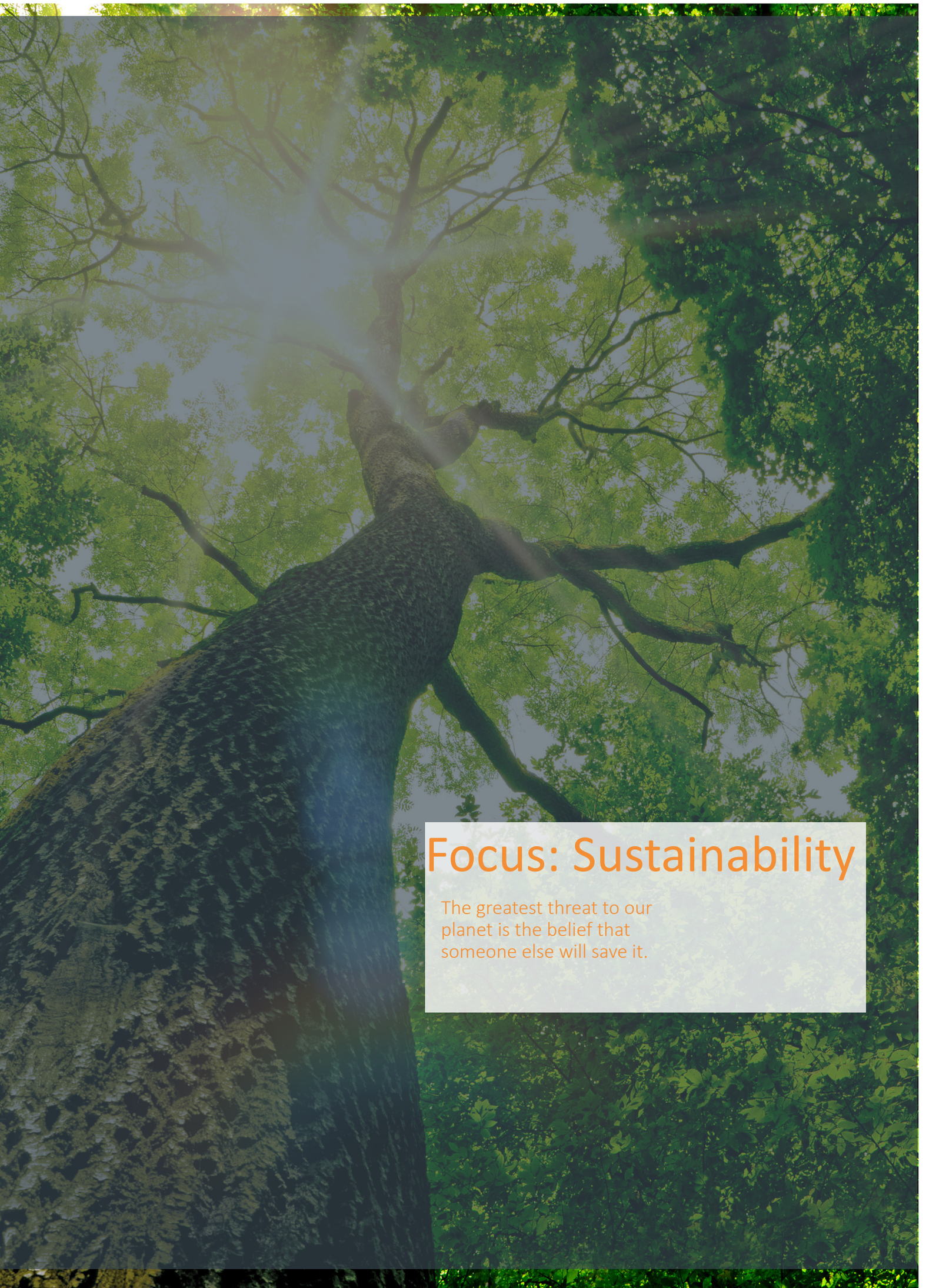
LAST MONTH was officially the hottest June ever recorded, climate experts have confirmed. Temperatures soared across the world, with Europe seeing the mercury rise to more than 2C above normal. The UK's Met Office recently released "HadSST4", the largest update since 2011 to its widely used sea surface temperature (SST) record. The data sheds concerning light on endeavours to limit global warming to 1.5C.

THE UK has set out plans to increase investment in sustainable projects and infrastructure. The UK has announced and laid out its landmark Green Finance Strategy – a step in the right direction for mobilising finance to meet Paris Climate targets

THE ELECTRIC-CAR MAKER TESLA beat analysts expectations and delivered 95,200 vehicles last quarter. The company is leading the charge as the adoption of EVs takes the automotive industry by storm.

THE CONTINUED SUCCESS in price decreases for batteries and solar panel technologies is driving fossil fuels out of the money when it come sto electricity generation. Los Angeles Power and Water recently completed a deal to develop the lowest price and largest system to date.

THE LARGEST OFFSHORE WIND FARM PROJECT in the US has officially gotten underway. The 1.1GW project will be developed by Orsted and indicates a pivotal transition to the adoption of large offshore wind projects in the US. The project highlights the opportunities for growth in the offshore wind market in the US.



Focus: Sustainability

The greatest threat to our planet is the belief that someone else will save it.

World Energy Outlook 2018: A Summary

Ayrton Bourn. University College London
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Each year the International Energy Agency (IEA) develops the World Energy Outlook (WEO), a report based on the insights from arguably the most comprehensive energy model in the world. Aimed at decision makers in governments and industry, the Outlook assesses the evolving energy landscape and creates scenarios based on current actions and commitments. The report also develops a global pathway which has the potential to meet the UN sustainable development goals.

In today's post we'll be looking into the key trends foreseen in the Outlook, the limitations to these forecasts, and the challenges in using large scale energy models.

Scenarios and Key Trends

The IEA produces three scenarios: Current Policies Scenario (CPS), New Policies Scenario (NPS), and Sustainable Development Scenario (SDS). The CPS is based on policies already enshrined in legislation whilst the NPS incorporates announced policies such as nationally-determined contributions in the Paris Agreement. The SDS takes a different approach: it uses the targets set by the Paris Agreement and UN Sustainable Development Goals (SDGs) and attempts to find the least-cost energy transition paths to meet them. From here on we will focus on the NPS and the likely future we face without ratcheting up climate action.

The NPS sees global energy demand rising more than a quarter by 2040. Whilst this may seem like a large increase, demand would more than double if not for continued improvements in energy efficiency. This growth is led by developing nations, primarily India and China, with the rise in EVs and demand for air conditioning and refrigeration making up a significant portion of electricity consumption.

Electricity is set to rise from approximately 20% share in final energy consumption today, increasing at higher rates in countries with light industry which focus on services and digital technologies. Although greater electrification allows us to decarbonise more efficiently, today's grids are ill-equipped to deal with the rapid changes in renewable generation without measures such as demand side response (DSR) being put in place to improve resiliency. The need for greater flexibility will also be met by batteries which are becoming increasingly more competitive with gas, but conventional power plants will remain the main method of keeping the lights on.

Even with less flexibility from gas combustion, emissions fail to peak before 2040, in stark contrast to the sharp decline called for by climate scientists. The Paris Agreement 2˚C emissions limit could be breached as early as 2030 with the NPS leading to a total temperature rise in the region of 2.7˚C . The impacts of this failure are even more significant in the wake of the latest report by the Intergovernmental Panel on Climate Change (IPCC) with projected substantial loss in biodiversity, stronger and more erratic weather, dangerous heat waves and significant reduction in land mass due to rising sea levels.

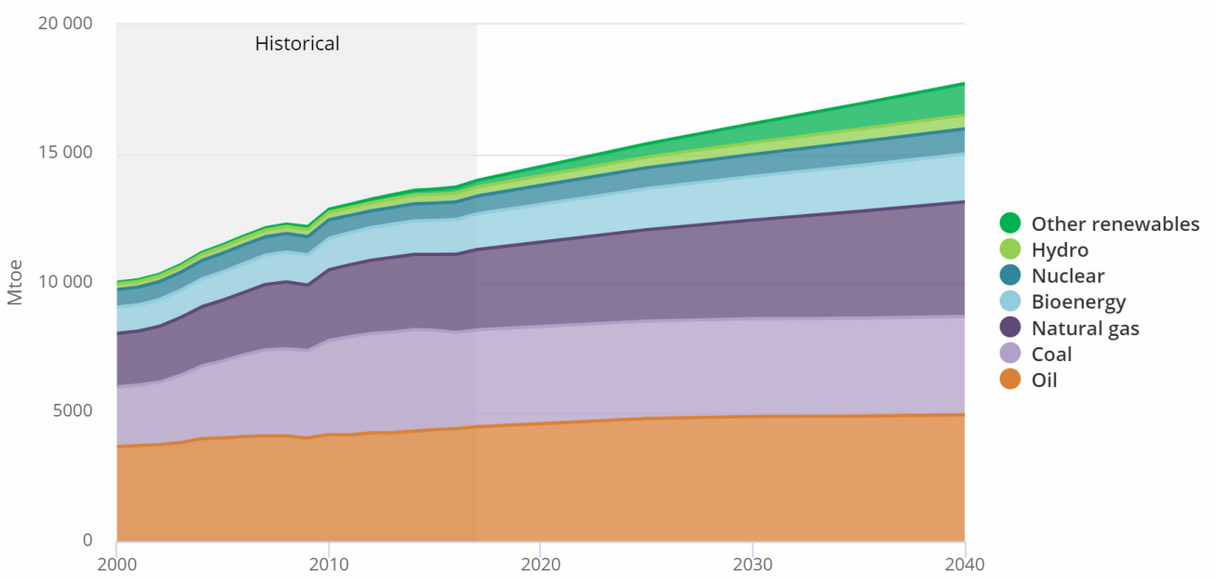

Figure 1: Total primary energy demand sources up to 2040 (IEA/World Energy Outlook 2018).

Scenario Criticisms and the Difficulties in Long-Term Energy Modelling

The NPS is the core scenario made by the IEA; it is also the one which receives the most criticism. This primarily stems from the difference between historic predictions and the realities of the energy mix we see today (see Figure 2). Personally, I believe these critiques to be mostly unjustified. By basing the assumptions for the models on policies which have only been confirmed or assured, the forecasts are unable to take into account the effect of inevitable policy revisions and ratcheting up of climate action over the 20+ year horizons they're made over. It does however highlight a key issue in the two scenarios, namely a lack of communication in what they represent.

The reasoning behind making these assumptions comes down to two key factors:

- Without knowing where their current policies are leading them, governments and industry can't make informed decisions on what to change in order to meet their targets.
- If the WEO models tried to incorporate all of the possible policies which could be made there simply wouldn't be enough time to create meaningful analysis on an annual basis.

The second factor is due to the over-arching issue in long term forecasts, uncertainty. In his book 'Superforecasting', Philip Tetlock discusses the outcomes of a study he ran looking at the response of financial experts when asked whether the economy would improve, stay the same or get worse. To his surprise they were correct less than a third of the time when making forecasts more than 3-5 years ahead, i.e. they'd have performed better by choosing at random. Thankfully the energy sector doesn't face quite the same level of volatility and speculation as financial markets. However, it is nonetheless a complex system with numerous stakeholders and interactions, making forecasting not just difficult but in some cases dangerous.

To get around this the IEA instead creates scenarios which, in their own words, "do not aim to forecast the future, but provide a way of exploring different possible futures", allowing them to observe the effects of large shifts in politics, technology etc. One example which fits this brief is in carbon capture and storage (CCS). Currently CCS is in a deadlock between governments waiting for industry to develop the technology and investors waiting for governments to incentivise its deployment. Technologies such as CCS face massive uncertainty when faced with traditional forecasting methods, but scenario-based forecasting allows the effect of specified subsidies or cost reductions to be quantified with increased confidence.

Parting Thoughts

Despite its limitations and criticisms, the WEO remains the most comprehensive and frequently updated view into the energy landscape's future, with this post merely scratching the surface of the findings in the full report. More information and their other work can be found here . Following the WEO launch, there was key message stressed by the UKCCC, and echoed by the IEA and IPCC. We cannot return to business-as-usual. If we do, we face damaging the environment further and raising costs for governments and businesses. Whilst the Outlook highlights the challenges we face, it also shows us there is a path to a cleaner and more prosperous world, so long as we face up the scale of the issue and act now ●

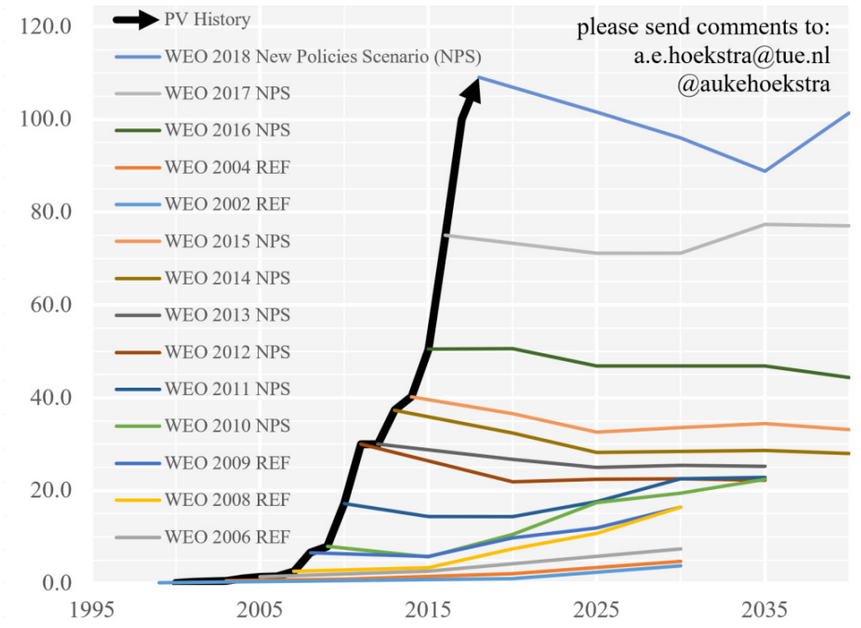

Figure 2: Disconnect between projections and deployment of PV (Auke Hoekstra).

From Concept to Commercialisation: Bridging the Valley of Death

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Political systems must grapple with the role of government in every aspect of public life. The government's role in conducting and supporting scientific and technological research is no exception. At least in the United States, there is widespread agreement that there is room for government involvement in moonshot research programmes – important research agendas that private companies simply wouldn't embark upon independently. In addition to the original moonshot, the government has set ambitious goals in fields ranging from cancer research, to defence technology, to energy.

In 1957, President Eisenhower authorised the Defence Advanced Research Projects Agency (DARPA) [1]. The Soviets had just launched Sputnik and the U.S. was losing the Space Race. DARPA was designed to re-establish American leadership in strategic defence technology by conducting transformative research. By any possible measure, DARPA was a success. The agency's research has given rise to technologies like the Internet, voice recognition software and GPS [1].

Decades later, DARPA's success inspired a bipartisan group of lawmakers to create a similar agency, housed in the Department of Energy, that would be tasked with undertaking high-risk, high-reward research into new energy technologies [2]. Congress authorised the Advanced Research Projects Agency-Energy (ARPA-E) in 2007 and allocated its funding through the American Recovery and Reinvestment Act of 2009.

ARPA-E's mission is to 'create a new tool to bridge the gap between basic energy research and development/industrial innovation.' This gap between 'basic energy research' and 'development/industrial innovation' is particularly perilous for new start-ups and technologies. It is common for a cutting-edge technology to show great promise in the lab but to face a steep climb in scaling up to compete with established players [3]. Competing in the energy sector means contending with traditional energy firms which have the benefit of existing infrastructure and networks. Consequently, the so-called 'incubation period' for energy start-ups is longer than for biotech or software [4]. Venture capitalists are put off by the longer incubation, resulting in a critical shortage of early-stage funding [5]. By providing this support, ARPA-E funding aims to build a bridge over the so-called 'valley of death' between the lab and the market.

"ARPA-E's mission is to 'create a new tool to bridge the gap between basic energy research and development/industrial innovation.'"

For an agency that is by its nature tasked with making risky investments, ARPA-E has a remarkable success rate [6]. As of February 2018, ARPA-E has awarded $1.8 billion to more than 660 projects [2]. Seventy-one of these projects have gone on to form new companies and 136 have attracted more than $2.6 billion in follow-on funding, according to its website. ARPA-E funding has also resulted in 1,724 peer-reviewed journal articles and 245 patents. A 2017 National Academies assessment found that 'ARPA-E is making progress toward achieving its statutory mission and goals [7].' At the time of the review, 25% of teams raised follow-on funding, about 50% published scholarly articles and 13% earned patents. Furthermore, the agency's grant scheme prioritises projects that are in the public interest and fulfil current needs in the energy sector. For instance, as wind and solar capacity grow, storage is increasingly seen as the primary constraint on growth in renewables. In 2018, ARPA-E issued $28 million in research grants for energy storage systems like thermal storage and flow battery technologies [6].

Despite these successes, there is a growing sense among some in the industry that the support ARPA-E offers isn't enough to get emerging technologies off the ground. According to the MIT Technology Review, an ARPA- E grant isn't enough to bring a new energy technology to full-scale production [4]. Compounding these issues is the fact that both venture capital funds for energy technologies and public investment in energy research, development and demonstration (RD&D) have been falling [8]. The National Academies also notes that despite the potential of some ARPA-E grantees, none of them has succeeded in transforming the energy sector (which, the authors note, would be unreasonable to expect in fewer than ten years).

In order to bring new technologies to scale and actually transform the energy sector, ARPA-E may need to undergo structural adjustments that allow longer-term funding. The National Academies assessment recommended a series of improvements, including developing a system for measuring its impact and extending the three-year time frame for projects. ARPA-E could also implement a new funding scheme for projects that have entered the market but need help scaling up in order to compete.

While the agency's success and industry's needs would suggest that ARPA-E should receive more funding and not less, the Trump Administration has, predictably and repeatedly, proposed eliminating the agency entirely. Yet, vestiges the agency's bipartisan beginnings remain, given that Congress has continued to steadily allocate ARPA-E funding since its inception [6]. This is encouraging, but far from a guarantee of its future. As we await budgetary negotiations in the coming weeks, those invested in the future of clean energy should hope for continued funding for this innovative agency ●

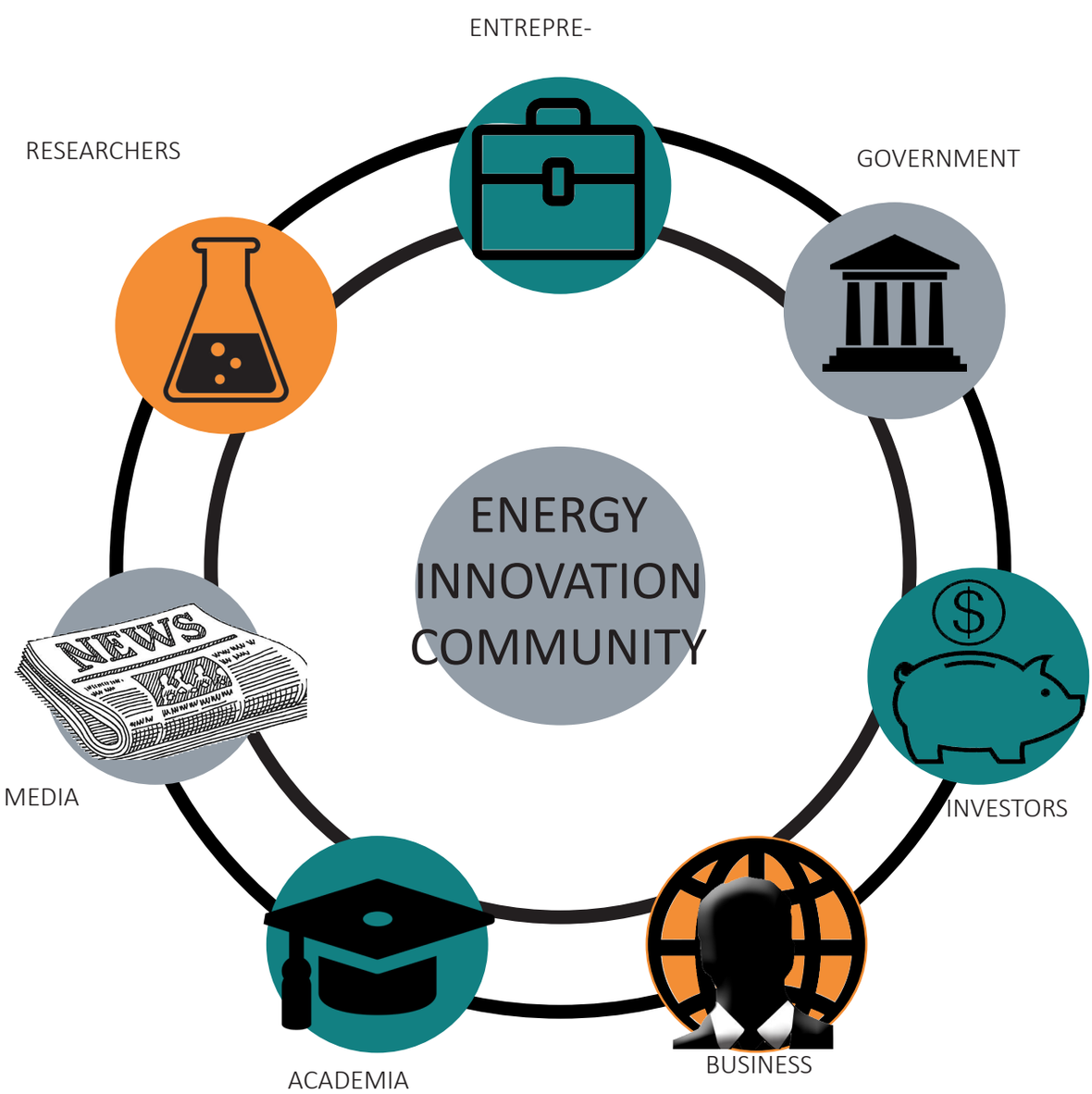

Figure 1: The network of people that ARPA-E aims to link (based on infographic by ARPA-E)

Hype: Developing Energy Technologies

Jorge Balanyá Echecopar
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There is rising concern about climate change. Scientists know it. There has been a remarkable increase in the number of papers on the topic. But the issue is not intrinsic to academia. The public is also concerned with it, and the hype is real.

In the news, in social media, even among friends, the issue of climate change is discussed from time to time. It is something of general concern. The growth of our societies has been based on fossil fuels, and we have come to know that this model has seriously damaged the planet. The good news is that new technologies are being developed, which could potentially lead to a more sustainable and green future while assuring our quality of life… if properly managed.

When asking the general public how the future will look, you will probably hear of solar and wind when it comes to electricity and battery electric vehicles for transportation. The field of heating and cooling is the great unknown: solar thermal will be the best-known technology, but you are lucky if you know anyone who mentions heat pumps or CHP. How come these are the most popular technologies? The hype may well be a big contributor. News and media give us information about these technologies, while other ones are left completely unknown. Media and the general public typically praise their benefits and put them as "the solution" or "the path to follow".

This is not an unknown reaction towards a promising technology. This kind of hype had appeared before, with biofuels for example. It is a proof of the willingness of society to seek better solutions, and the desire to adopt them. Literary creativity, without a comprehensive understanding of the pros and cons of the technology, boosts this effect. Finally, figures like Elon Musk with Tesla and its marketing pro-electric vehicles make a huge contribution too.

There is a beneficial outcome from hype: the more attractive and popular a technology is, the more public interest it gets. This interest often translates into more investment and more research, making it easier for the technology to reach a suitable level of maturity. It also may lead to supporting policies and regulations, which will reduce uncertainties and promote development.

However, this dynamic highlights the potential benefits without taking into consideration the physical, technical and economic disadvantages. This is a problem, leading to a smaller positive impact than expected. Moreover, hype does not only raise expectations of a specific technology but also can eclipse or completely erase the development of others. Breakthroughs, showcased through media, draw public attention and investment. Those specific technologies, widely covered by the media, receive supportive policies, investment and more research time. Therefore, less mature technologies are not given chance to succeed.

Even if technologies are given time to mature, the hype is always subject to change. The transport industry is a clear example. Research is now all about battery electric vehicles, although it was biofuels before, and previously fuel cells; there has never been support at the same time for more than one technology. Furthermore, batteries themselves won't solve the issue with fossil fuels in transportation; there are concerns about their real potential, especially as improvements need to be made to the global energy mix.

The idea I am trying to elaborate here is not that we shouldn't invest in these "mainstream" technologies. There is enough research to ensure that they are a key part in the energy transition of different sectors, and it is important to keep working on their development. However, one has to bear in mind that the hype is not always real.

The kind of transition required cannot be compared to any previous one and is going to require of huge investments in a wide number of areas and technologies, according to the IPCC special report from last October. Strong government support will be needed, as well as learning from the past. There is no point in targeting a single technology, as there is no one that, by itself, can solve all the challenges of climate change.

Regardless of the hype that is naturally related to breakthroughs and developments of a promising field, we need to have a broader scope. Bearing in mind the limitations of a specific technology, we can more easily find a comprehensive solution. A solution that, by acknowledging the gaps in a given technology, can integrate different ones by adding their advantages ●

Figure 1: Wind Power- just a lot of hot air?

Guest Interviews

The only thing to do
with good advice
is to pass it on.
It is never
of any use to oneself.

MARISSA LESHNOV

Communications Assistant, Grid Alternatives

"Our triple bottom line is people, planet and employment. But people come first - ALWAYS"

Q: What is the story behind the creation of GRID Alternatives?

A: GRID Alternatives is the largest non-profit solar installer in the US. We were founded by two engineers, Erica Mackie and Tim Sears, during California's energy crisis in 2001. At the time, they were helping large corporations reduce their electricity bills by switching to more energy efficient practices; they realized that their neighbors could benefit even more from these technologies. After quitting their jobs, they completed GRID's first solar installation in 2004. To date, GRID Alternatives has installed over 52MW of solar benefiting more than 14,000 families. Our triple bottom line is people, planet and employment; but people come first, always. With this platform, we generate wealth through energy savings, generate clean power, and offer hands-on job training that people can use to get a foot in the growing solar industry.

Q: How has GRID Alternatives' model been scaled for different market segments?

A: For many years we focused solely on single-family solar installations, starting in California and then expanding our operations across the nation. Given this growth, we realized that the single-family model did not reach everyone, especially in California with the rising cost of home-ownership. Additionally, not all homes are suitable for rooftop solar, especially homes with older roofs or lots of shading from nearby trees or buildings. That is why we scaled up our model to multi-family and community solar projects. Within our Tribal and International programs, we support energy independence through off-grid solar system installations supported by batteries. Our International Program has been developed in countries such as Nepal, Mexico and Nicaragua.

Q: What have you identified as the main barriers for the deployment of solar distributed generation?

A: Many of the barriers we have encountered while growing our model come down to policy, at least in the US. Our model is unique in the sense that it addresses solar deployment with low-income users at the center. Since our work is centered around equity, there needs to be strong policy on the ground supporting this approach. The state of California has been a leader in low-income solar policy, but other states such as Colorado, Illinois, and the Tri-state area have started building equity into their clean energy policies

Q: How does GRID Alternatives finance its operations?

A: Our project financing comes through partnerships, grants, and individual giving. We partner with municipal and state governments to support their clean energy goals and help their residents access the real, lived benefits of clean energy. Unfortunately, there is a history of predatory sales tactics in the communities we serve, and so partnering with the local government helps to build trust and reach people who might otherwise be skeptical of us when we say we offer solar at no cost to them. Private companies that believe in our mission also support our work either through grants or our sponsored workday program. The latter allows employees to participate in the installation of a system while bonding and learning new skills. Since we are a non-profit, we also rely on individual philanthropy and donations.

Q: What excites you the most about attending SES2019?

A: I am very excited to participate at SES2019 and be a part of the climate conversation on a global scale. The truth is we do not have the luxury of time when talking about the climate crisis. Our transition towards a clean energy economy will require all hands-on deck, including people and perspectives that have historically been denied a seat at the table. I'm excited to meet people from around the world, listen to their ideas and hopefully co-create more whole solutions that we can bring back to our communities. We need to get this right the first time and break down barriers we haven't before to ensure that everyone can participate, everyone is included and everyone benefits.

GRID Alternatives is a certified non-profit organization based in Oakland, California, with nine affiliate offices serving all of California, Colorado, Washington D.C., Virginia, Maryland and Delaware. The organization also have a national Tribal Program, and an International Program serving Nicaragua, Nepal and Mexico. Its mission is to make clean energy technology and job training accessible in under-served communities.

JAY PATEL

Founder/CEO, Enlight Institute

There were NO GOOD TRAINING INSTITUTES *...people could not get hired*

Q: What was the main driver behind Enlight's creation, and how did you come up with the business model?

A: I travelled to Uganda at the beginning of 2015 due to my interest in off-grid solar technology. There, I met Abu Musuuza, a local social entrepreneur who co-founded Village Energy a few years before. I became a new partner and together re-launched the company with a model around last-mile distribution that addresses the fact there are no prepared solar technicians and infrastructure in rural areas to repair PV systems and provide associated maintenance services.

After raising some funds to launch this program, we realized there were no good training institutes and hence people could not get hired. This was not just an issue we faced, but every other company in Uganda as well. Several companies had its own internal training programs, but there was not an industry-wide option, especially for smaller players.

The concept behind Enlight was developed through a GIZ workshop that analyzed what market barriers existed for solar adoption. We came up with the idea of a travelling training academy that could go into rural areas and qualify people to further place them in different solar companies. Enlight became a separate organization at the beginning of 2018 by launching an eight-week course with a technical approach in solar PV systems. Technicians need sales and soft skills, but salespeople need technical skills as well. We realized our business is not just about training, but tackling from a holistic standpoint in-resource needs that solar companies have.

Q: What are the major milestones Enlight has reached since its consolidation, and how does the future look for the company?

A: So far, we have trained 30 graduates in solar technical skills and placed 60% of them in several companies. As a result, we have been awarded with additional training contracts from development agencies and solar companies, so Enlight is actually starting to generate revenue through these activities. I believe the company holds a head start given the four years of experience we have in the industry. Even though I am no longer part of the Village Energy's management team, my participation with them lead to establishing a strong interaction with almost every solar company in Uganda. Thanks to this, we already have all the needed connections to move forward. Our ambition is to use Uganda as a laboratory, refine our model and scale it into different markets. There is a huge need for talent development and soft professional skills in the entire renewable energy industry and this is not unique to Africa or off-grid solar. I think that our ten-year vision goes beyond energy and focuses on youth employability across the formal sector in developing countries. With the automation wave coming, it is important to have this perspective.

Q: What excites you the most about attending SES2019?

A: When I was graduating from college back in 2009, the climate change discussion wasn't that open and there were a small number of jobs in the renewable energy segment. At that time, it was difficult to imagine having a career in clean energy. In the last ten years, this has completely changed as the industry's size has grown and nowadays is more recognized. Solar energy has been deployed in many countries and SES 2019 provides a platform to discuss what comes next.

As a society, we have another ten years to do something about climate change. We are running a race against time to an extent where we are encouraging young people to analyze the impact some of the most damaging industries and find a path to support climate action.

Q: What would you say to any student wanting to dive into clean energy entrepreneurship?

A: Entrepreneurship is complicated. It takes certain level of resources and also to have the privilege to quit your job and create a start-up. Many people are not able to afford this and it is OK. This does not mean that you are not as committed to the cause. Entrepreneurship is important but I would not like to glorify it as the ultimate method to help all stakeholders involved. Nevertheless, my advice will be the following. Firstly, if you are developing a project in a country that is not your own, especially a developing country, you need to consider working locally. The reason I joined Village Energy was because it was co-founded and led by an Ugandan. It is important to keep in mind that at Enlight we are just not trying to encourage entrepreneurship in clean energy, but locally-inclusive entrepreneurship as well. Secondly, financing takes a lot of time. To find the right funding out there, you have to work on your idea for a long time. The cycles for grants, especially the ones that run into hundreds of thousands of dollars, can take close to a year or more. You need to find a way to stand yourself for long periods of time and in the meantime, start implementing your project.

KALI TAYLOR

Co-Founder, Student Energy

It takes a lot of NOES *to get a* YES

Q: What have been the major milestones that Student Energy has reached over the past few years?

A: This year's International Student Energy Summit is not only the sixth edition of the event, but also its 10-year anniversary since we hosted our first conference in 2009. Any organization that is able to continue with its activities for a long time, while still maintaining relevancy and serving the community, sees this as a very special achievement. Throughout these years, Student Energy has reached many milestones. The release of our energy literacy platform, which not only presents energy information in a more understandable and digestible way, but also paints a complete picture of the energy system so that students can make the decision of how they seek to engage in this transition. Our Student Energy Chapters program gives students an opportunity to establish a branch of our organization in their own universities, it has already reached 35 chapters at globally. We also launched our Greenpreneurs program, together with the Global Green Growth Institute, which is an accelerator that supports youth-led emerging solutions to global environmental challenges. This year we hosted the Youth Leaders Forum, running parallel to the 10th Clean Energy Ministerial, where attendees were able to participate in a program alongside Ministers and senior business leaders to advance the clean energy transition. Last but not least, we also hosted our first Indigenous Student Energy Summit, which allowed us to hear the voices of individuals who are not always included in transition discussions. Student Energy has achieved a lot with and for young people in 10 years and has opened channels for their active involvement in the energy transition.

Q: What was the main challenge in turning a student initiative into a global movement?

A: While there will always be challenges, no roadblock we have experienced has been something that we cannot overcome. The movement has created a strong community that is constantly working on our mission, driven by the student's appetite to influence the energy agenda. Resources are always hard to find when you are starting a project and getting credibility takes time, but we need to realize that it takes a lot of "noes" to get a "yes". Having a good plan and being rooted within a community has always been important in our growth. We have learned that being true to your mission and a lot of persistence is all you need to build something that has an actual impact at a global scale.

Q: This year, you created a vision called "Breaking Barriers". What is it all about?

A: We are in an urgent situation where energy and climate - as well as associated systems like food, water, transportation, etc. - require rapid, ground-level action. This year's vision is about finding a tangible way to accelerate this action and the role that youth play in that scenario. The truth is that today's leaders are not doing enough and this is why youth are figuring out how to break these barriers and make it happen before it's too late. In the last months, we have seen climate strikes led by young people taking place all over the world. As a matter of fact, these people are younger than Student Energy's target audience and this is very impressive. The clock is ticking and it's up to us figure out how to overcome the barriers that are holding us back, I think that is what we will be doing at SES 2019.

Q: What tips would you give to students wanting to break these barriers?

A: My honest advice would be twofold. First, look inwards at yourself and see what you can bring to the table; analyze the skill sets that make you special. Secondly, look outwards at your community or your country and identify its more urgent needs. Look for places where you can match these two dimensions – what you bring and what is needed. The crucial approach here is that everyone brings something different to the table and at the end of the day everyone showing up with their piece of the puzzle is how we can we achieve good results and impact our communities and countries.

Q: What are the main drivers of change to deploy a sustainable energy future (in the SDG framework)?

A: What makes UN's 2030 Agenda for Sustainable Development, as well as the Sustainable Development Goals (SDGs), a very interesting topic is that these are interconnected and are universal in nature. The latter means these apply for everyone. Even though they have the

same objective, the pathways will be different among countries, persons and communities. A solution will not be the same for Canada, Mexico or the UK, but what is universal is that we all have to figure out how to make the SDGs work in our own context.

Energy is so interconnected with the other goals. It unlocks productivity and can enable education and empowerment, but its current production has mass impact in our climate, food and water systems. So, what are the main drivers? While there is always room for technological improvement, the solutions are already here. We need to rapidly scale up investment and establish a policy regime that allows the mass deployment of clean energy.

Student Energy is a global not-for-profit building the next generation of energy leaders who will accelerate the world's transition to a sustainable energy future. The organization engages youth in unique programs that empower them to become change agents by working with actors within the energy system to create space for youth to have an impact

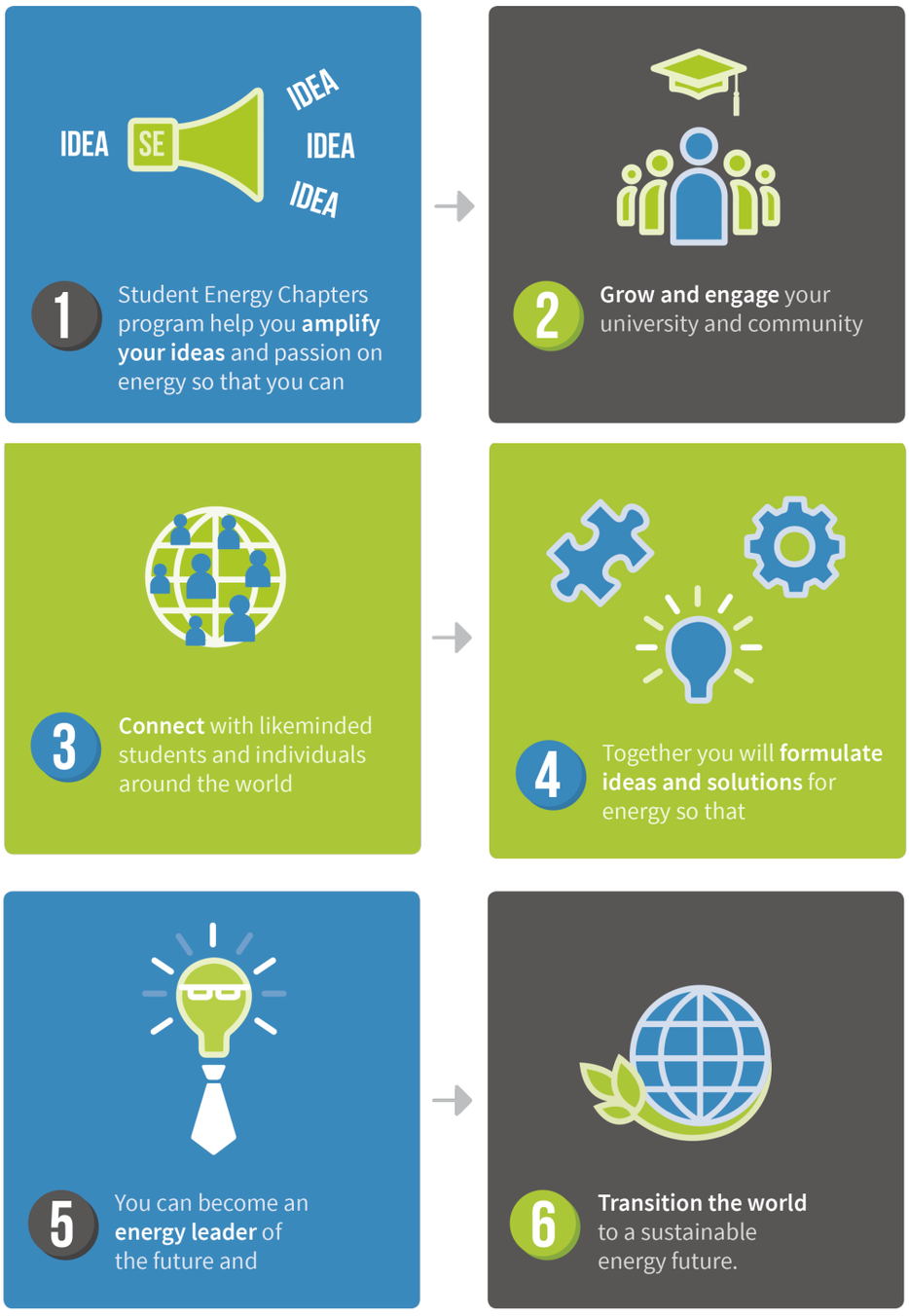

Figure 1: The stages to create a Student Energy Chapter at your university (Student Energy)

LINDA DAVIS

CEO, Giraffe Bioenergy

Ethanol: SAFE, AFFORDABLE, CLEAN

Q: Over 80% of Kenya's population cooks with charcoal and firewood. What is stopping the transition towards cleaner fuels?

A: Kenyans have done a good job to popularize alternative technologies like liquefied petroleum gas (LPG), especially in urban areas such as Nairobi and Mombasa. In fact, people are aware about the usage of this fuel, but affordability is still a relevant constraint. In contrast, low income communities in urban areas use charcoal as its main energy source. This fuel is used by over 75% of the population as part of a practice known as "fuel stacking", where households use a variety of fuels to accomplish their cooking needs. In rural areas, firewood is most commonly used. The environmental cost of charcoal and firewood activity is high, as these trees come from natural old growth forests.

Giraffe Bioenergy's proposal focuses on ethanol, an alternative technology that is increasingly accepted as a safe, affordable and clean alternative to charcoal and kerosene in the urban areas. Ethanol as a cooking fuel does not have a detrimental effect on health and forests. At the moment, the ethanol fuel used for this purpose is imported from the global markets ad there is a massive supply gap from local production. Our aim is to establish local production of ethanol to foster rural development, economic opportunities for small-scale farmers and create a steady market for their crops, specifically the cassava plant.

Q: What are the involved stakeholders for the production process?

A: Looking at the cassava plant value chain, the first stakeholder is the small farmer. Small farmers represent over 75% of Kenya's population, as the African Sub-Saharan region relies mainly on subsistence agriculture. Women would be strongly benefited from having a reliable market for cassava as they are the ones responsible for working the land and act as household energy managers. In addition to establishing a network of small holder farmers to produce cassava, the Giraffe Bioenergy model also includes a state of the art biorefinery producing starch and power in addition to ethanol, so many jobs will surge around its construction and operation.

There are some intermediate processing activities along the value chain. For instance, cassava plant needs to be harvested, peeled, chopped and dried, so there will be many activities surrounding the biorefinery as well. In this sense, I am very keen to develop inclusive policies within Giraffe Bioenergy's overall operations where women are encouraged to learn new skills and have stable jobs. At last, the other key stakeholder are the end-users who tend to be women and children who often have the responsibility of cooking in many households. Finally, last-mile distribution will be facilitated by an established network of off-takers, including large petroleum companies and technology enabled organizations that have streamlined these logistics services.

Q: What was the rationale behind selecting cassava plant as the main feedstock for ethanol production?

A: Every single part of the cassava plant is used during its processing. The peel can be converted into biogas to power the biorefinery and the starch in the root could be converted to ethanol. In addition, sub-products like cassava flour, industrial starch and high maltose syrup (HMS) could be commercialized in local and foreign markets. In this sense, the biorefinery is analogous to the concept of a petroleum refinery as it produces many goods from one source.

Under this scenario, the food versus fuel debate is not relevant for many reasons. Firstly, our approach aims to increase the productivity of small farmers. Small holder farmers growing cassava for the biorefinery will receive associated benefits like learning good farming practices to double or triple its yields after participating in our program. Secondly, as we visualize a good pricing for cassava, the farmer can dedicate additional unused or underutilized semi-arid land for its production. Thirdly, the farmer always has a choice. They can eat the cassava or sell it to the biorefinery. From the point of food concern, the Giraffe Bioenergy program does not represent a conflict, especially when the diversification of food sources from individual farms will deliver income to communities.

Q: How has the market responded to this business model?

A: At this point, ethanol cooking has experienced a demand-driven response. There has been a lot of piloting around ethanol cooking and countries like Aruba are experimenting a relevant growth. Last June, the government removed tariffs on ethanol cooking in Kenya as they recognized the untapped potential it holds for the national market. Now, it is cheaper to use ethanol than LPG, charcoal or kerosene. As demand grows, local supply of ethanol has been insufficient to satisfy the market there stimulating opportunities such as the Giraffe Bioenergy model that will provides a domestic, effective solution to solve the problem of lack of clean cooking alternatives in Kenya.

CAROLINA KARLSTROM

Founder/Director, Jade Advisory

Every stakeholder needs to ACT, *and* ACT NOW

Q: How does Jade Advisory support companies that seek to transition towards a greener operation?

A: I look at environmental sustainability as the impact that organizations have in areas such as energy consumption, water usage, transportation and supply chain. Some of the organizations that I work with have not engaged much in sustainability practices. As some of these might have a purpose on the social sector, they are failing when it comes to manage its own environmental impact because they are not sure on what to do or how to do it. Under this context, I support them in raising awareness about environmental sustainability and how to identify potential areas of improvement.

Nevertheless, reaching success in an environmental program also depends on the efforts in engaging its employees in this conversation. In this sense, I help organizations develop training programs so their staff can learn more about sustainable practices. The main purpose is our clients can implement certain actions that contribute towards a better future, but that also are aligned to their business models.

Q: What are the main reasons companies find difficult to start with this transition?

So far, I have been aiming to work with small and medium-sized enterprises (SMEs). The main challenge is these organizations are not dedicating either time or resources in sustainability, as they tend to see this approach as an expense rather than as an investment. Since these enterprises do not belong to a global corporation, there is a lot of work to do in explaining what is sustainability and why it is good for them.

With this approach, organizations can reduce its environmental impact, generate benefits to their employees and at the same time become a more attractive employer for the acquisition of new talent. All of this while generating profit through energy and other savings. In the UK, this conversation is becoming more attractive among potential clients, businesses and costumers. Every day, consumers are reaching for organizations and suppliers that contribute to a solution, instead of being part of the problem.

Q: How do you foresee businesses taking the lead on climate action in the near future?

A: I have noticed an increasing awareness from our potential clients as they have understood that every stakeholder needs to act, and act now. Taking initiative on climate action is not only up to the government, large corporations or charity. Organizations of any size working on any segment need to be involved as well. In terms of government leadership, a policy-driven approach like setting targets to reduce emissions has already been established, but businesses can lead to a faster transition given the access they have to innovative technologies. This segment is gaining a greater role in leading the example by putting pressure on the supply chain side. Most of the times, SMEs are the ones working in this segment, so it is very important to have financial incentives that motivate more environmentally-friendly practices among the value chain.

Q: What excites you the most about attending SES2019?

A: The opportunity of connecting with students from across the word is very exciting. I have read many reports on what younger generations believe is important in relation to the sustainability agenda, but it is much more interesting to meet them and know what these generations expect from businesses when they start their professional life. This information is valuable for organizations like mine.

I will be participating on the “Supercharging the SDGs – Energy as the Enabler” panel. This topic is very interesting for me as it was my first contact with Student Energy. I organize the SDGs Network Meetup, an event where anyone interested in sustainability and using the SDGs as a framework to identify topics that are of greater relevance can participate in. As SES2019, this event is about connecting people, inspiring to action and raising awareness about the importance of these goals.

Guest Article

Knowing is not enough-
we must apply it.

The Promises of a Global Energy Grid: Achievements and Challenges

Antreas Demetriou
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In the heart of the East Mediterranean, the island-nation of Cyprus will make a small but historic step towards the realization of one of the boldest initiatives in the international energy sector: the creation of a transnational electricity network. Cyprus, the southernmost EU member, is perfectly poised to become the first international electricity hub as it lies close to both Africa and Asia.

The EuroAsia and the EuroAfrica Interconnectors are the two projects that will make this tri-continental link a reality, both beginning in Israel and Egypt respectively, passing through Cyprus, and ending up in mainland Greece. These two projects are only a part of the many plans for the construction of High Voltage Direct Current (HVDC) connections to be made all over the world.

HVDCs are by no means anything rare. More than 70 HVDC connections have been completed since the turn of the century and together these projects are morphing into what is hoped to become a "Global Energy Grid", with the potential to fundamentally change how power generation markets operate, and how we think about the electricity sector in general.

The foundations of this ambitious project were set in March 2016 with the establishment of the Global Energy Interconnection Development and Cooperation Organization (GEIDCO) in Beijing. GEIDCO was the culmination of a campaign started in 2015 by the State Grid Corporation of China (SGCC), which started by seeking to persuade the Chinese leadership of the enormous benefits that an international electricity grid would bring. The main promise of this global grid is the ability for countries to trade electricity, so as to maximize economic, energy, and environmental efficiency.

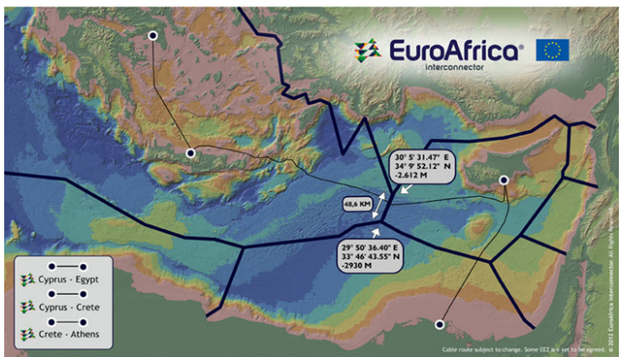
In order to understand why we are now seeing the emergence of a Global Energy Grid, like all major developments in energy, there are four driving factors to consider:

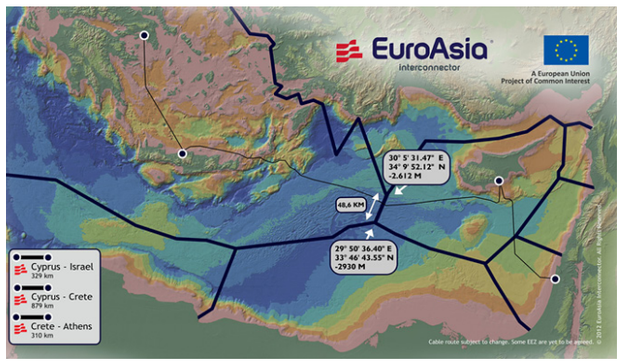
- new technology as an enabler
- economic incentives as a driver
- environmental friendliness as a catalyst
- politics as a gatekeeper.

New Technology

The first of the technological development that has enabled electricity interconnections to reach continental ambitions is the creation of Ultra-High-Velocity (UHV) power lines. UHV is the latest development in the already existing space of High Voltage Direct Current (HVDC) lines. UHV lines are able to carry loads of more than 800kV through Direct Current or more than 1000kV through Alternating Current, making it possible to transport gigawatts of energy across thousands of kilometres.

This new technology found its first practical usage in China, where there is a need to transport electricity in large distances and volumes from the hydroelectric power stations of inner China, in the West, to the energy hungry coastal cities of the East. Thus, from 2009 onwards China embarked on a major spree of investment in the development and implementation of UHV lines, initially adopting foreign know-how, but now being a UHV technology producer of its own. UHV has been rapidly adopted in India as well, very much for the same large-distance large-volumes needs that the Chinese have.





Figures 1 and 2: The EuroAfrica and EuroAsia Interconnector plans (EuroAfrica, 2012 and EuroAsia 2012)

Some of the relevant technological improvements that enabled the use of UHVs are:

- A new valve design which provides extra safety in earthquake prone areas
- Improved cooling methods for thyristors in order to increase their rating (the power of a 12 pulse conversion unit exceeds today 3000 MW)
- Conversion of HVAC lines into HVDC ones due to the right-of-way (ROW) limitations which demands the use of the same couloir to transmit more power

UHV lines have many advantages. They can carry a larger capacity, have a low line loss due to their high voltage (a prominent issue in large distance energy transfer), occupy less land, and are safer than conventional high voltage lines.

The major player in the UHV sector is ABB, a Swiss-Swedish conglomerate, which has been operating in the HVDC space since the 1950s (initially in the form of the then Swedish ASEA). Other major players in this HVDC and UHV space Siemens, General Electric, Alcatel, AEG, Hitachi, Toshiba, Areva, Bharat Heavy Electricals (BHEL) and C-ERPI (the China Electric Power Research Institute, or the Electric Power Engineering Corporation, a subsidiary of the Chinese SGCC).

The second technological enabler of the Global Energy Grid is the development of smart grids, which will allow countries to internationally transmit energy more efficiently. Smart grids' ability to monitor power consumption dynamically (through infrastructure sensors and smart meters), adjust power production and distribution accordingly, and store large amounts of energy in special battery storage systems , open up considerable opportunities for international electricity interconnections. With smart grids, countries will be able to exchange energy according to their "live needs," and to store surplus energy production energy to be traded at a later time.

The third technological innovation is the efficiency improvement of renewable energy technologies, which has reached a point that enables countries to produce electricity more cheaply than fossil fuel alternatives, and even produce surplus energy during certain periods of the year. Through a Global Energy Grid, this surplus could then be exported to distant countries in need to import green energy.

The Economics

The Global Energy Grid promises to bring economic benefits by utilizing three fundamental economic forces: supply and demand, comparative advantage, and economies of scale.

Supply and Demand

A unique advantage of a worldwide energy network would be its ability to quickly transfer electricity across distant areas.

Though usage of electricity, and hence demand for electricity, tends to vary— both by the time of day and seasonally—our supply adjustment is currently rather static , despite the dynamic nature of our demand.

Most power stations supply a fixed amount of energy during their operation. Some of these stations are base-load plants, providing a set amount of energy throughout the day. Other plants are operated on a load following basis, these are used for adjustments of supply to meet demand, usually by running for about 6 to 16 hour intervals when demand is expected to be high. Load following plants operate at a lower efficiency compared to the production of the base-load plants, as they are deployed less often. The third type of plants are the peaking power plants, the least efficient of the three. Peaking power plants operate only to meet peak hours of demand, ordinarily during peak-demand seasons of the year.

By participating in a Global Energy Grid, countries will be able to enter arrangements for trading different volumes of electricity at different times of the day and year. Essentially, this is an arrangement were countries would trade electricity when their power network produces too much, or too little electricity.

If local demand is lower than local supply, a country would export power. If local production is just managing to meet local demand, they could import power to meet their required reserve margin. In the latter case electricity providers often need to use load-following or peaking power plants to meet the extra demand, meaning more environmental pollution and a greater cost of production, as these plants are relatively inefficient. Electricity interconnections will would, therefore, enable electricity providers to lower production costs by not using inefficient power stations during high demand times, and instead importing electricity through a neighbouring or even distant grid, possibly at a considerably lower price.

These interactions are likely to take the form of East-West country exchanges, because of daytime differences, however seasonal variations could also allow for electricity trade between Northern and Southern countries.

Comparative Advantage

The second economic force at play here is that of comparative advantage. Our main energy sources (oil and gas) are established traded commodities, mainly exported by a rather small set of countries which have the comparative advantage of being rich in fossil fuels.

Similarly to fossil fuels, certain countries are more blessed in their renewable energy-production capabilities than others. They have a comparative advantage in the production of renewable energy. This could be because of having more space to dedicate to large renewable energy productions sites or having a more favourable climate or terrain for a certain type of renewable production. These variations mean that, through a Global Energy Grid, countries with more favourable conditions for renewable energy production can use a surplus of green energy as an export, improving the return on their renewable energy investments and making a profit. For the importing countries, interconnections can allow them to rely on getting green energy more cheaply from surplus countries, compared to their own less efficient renewable energy production capabilities.

Economies of Scale

Power stations are costly to build, to run, and to maintain. If a country had the ability to forgo investing in a power station dedicated to covering its pick demand over the year, and instead only used plants that cover its average yearly consumption, energy production costs could drop considerably.

This is because of Economies of Scale in the energy production process, i.e. the fact that bigger plants tend to pay off for their initial and running costs at a better price per watt than smaller plants of a similar type, and thus countries with bigger power plants are able to produce electricity at a lower price per what. This is especially the case when transitioning from a small to a medium sized plant.

Thus, countries that already use relatively large power plants can reduce their cost per watt by using even bigger stations, and can in turn use the surplus power as an export. Additionally, the importing country will be able to leverage the reduced production costs of the exporter to meet its energy needs at a potentially lower price than if it produced that electricity on its own.

Business Opportunities

Beyond the various cost saving benefits that a Global Energy Grid promises there is also a possibility for new business opportunities.

The first opportunity is the creation of new electricity markets. Many national energy markets are rather isolated from foreign competition, often operating under a monopoly or oligopoly of supply. Through the introduction of international electricity interconnections, energy production companies will be able to sell their produced energy to distant customers who previously were physically impossible to reach. Consequently, introducing new power suppliers in national energy markets, breaking previous monopolies, and thus creating more competition. Such a change will likely benefit the customer and the local economy by encouraging innovation and cost savings thus lowering energy prices.

Another business opportunity that arises through the creation of a Global Energy Grid is for companies who have developed an expertise in the HVDC space to bid for the various interconnection projects. Examples of such companies are the well-established Swiss-Swedish ABB, and relative newcomers such as China's Electric Power Engineering Co. (C-EPRI). For example, China has been investing considerable amounts of capital into the development of its own UHV know-how, and will likely welcome the opportunity to export it.

The Environment

Related to the above economic benefits are the environmental benefits that a Global Energy Grid stands to offer. As mentioned above, its creation will enable the trading of renewable energy produced in excess by countries with favourable geographic conditions, which can then be exported to countries with a geography that does not allow for renewable energy production at comparably low prices. For many countries this would be an enormous benefit in helping them meet their emission goals.

Both GENI and GEIDCO envision the Global Energy Grid enabling large scale renewable energy production in productive areas (e.g. wind energy in Siberia, solar energy from Saudi Arabia, or hydroelectric power from the Himalayas - see Figure 3). These renewable energy production centres will then be able to act as exporters of green energy, as described above, which will in turn help to lower global emission levels by substituting fossil fuel consumption.

Additionally, countries can take advantage of efficiency differences in fossil-fuel-based power production in order to leverage economies of scale for environmental benefits, besides any potential economic benefits this involves.

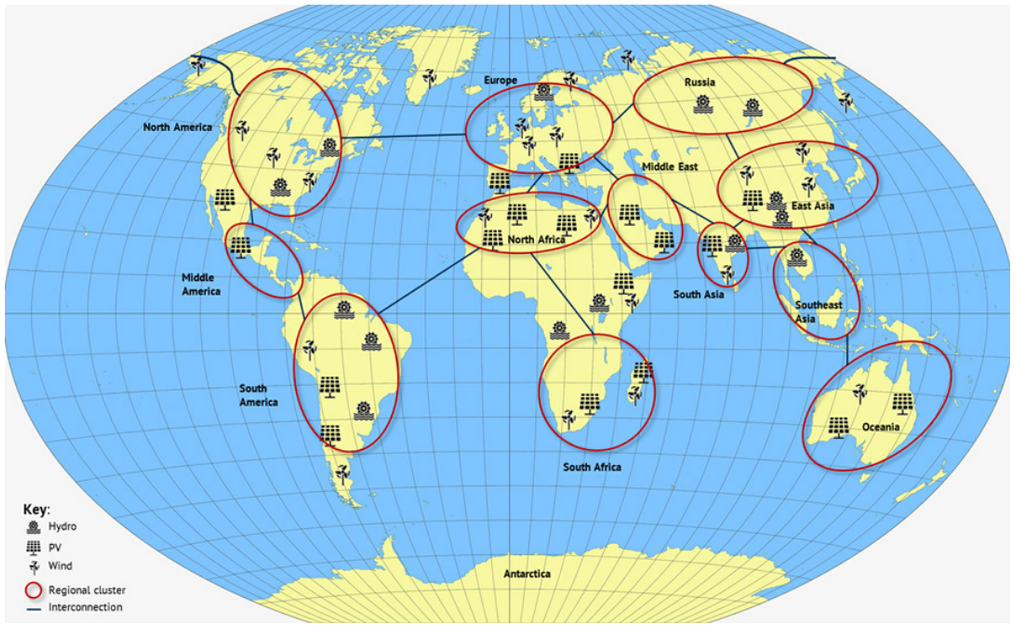


Figure 4: Locations of abundant hydro, solar and wind resources on every continent Source: GENI, 2018.

The Politics

Having explained the technological, economic, and environmental drivers of international electricity interconnections, it shouldn't be lost on us that there are also political factors enabling the emergence of a Global Energy Grid. Specifically, there are three main forces at play.

The first is that of the "Chinese rise." Much like the Belt and Road Initiative, which aims to place China at the centre of the worlds trading routes, Beijing sees this project as a way to showcase its soft power by leading and supporting a new age in the international electricity sector. The numbers support this view, as Chinese companies have reportedly invested more than $102 billion for the acquisition or development of transmission infrastructure in more than 83 projects worldwide. In addition, Chinese Institutions have invested another $21 billion in the development of overseas power grids.

The second force is the growing political momentum of public support for restricting the effects of climate change and embracing renewables. A good example is Japan, where events like the 2011 Fukushima nuclear disaster have further strengthened public support for renewables. Another example is China, whose urban centres experience high levels of environmental pollution, also resulting in public support for renewables and sustainable growth. This political force brought forth by the public has enabled and incentivised political approval of initiatives like the creation of a Global Energy Grid, despite any potential upfront costs and any opposing interests.

Beyond Chinese ambitions for global leadership and public concerns for the environment, there are more structural level political factors encouraging the creation of a Global Energy Grid. These include a drive for ever improving international relations amongst countries , the gradual harmonization of energy standards through bi and multi-lateral agreements, and the need to improve energy security in an increasingly precarious world.

Political motivations have made many administrations eager to fund and garner the necessary political support in order to make these connections. This is especially evident in cases where such connections are planned between countries with historically contentious relations. Examples include the planned Egypt-Saudi Arabia connection, the Turkey-Iran connection, and the Weihai (China) - Seoul (South Korea) connection.

Where things are heading (Conclusion)

The current state of regional HVDC grids shows that there is still a way to go before a Global Energy Grid becomes a reality. Factors such as technical challenges, the need to address complex international coordination problems, lack of sufficient funding, and the absence of appropriate governance structures, cast doubt on the promises of Global Energy Grid advocates.

However, existing and planned international grids also prove that this ambitious endeavour and its potential economic, environmental, and political benefits are far from a fantasy. Involved countries and companies are well are of the benefits to be gained via these networks. The OECD and International Energy Agency (IEA) estimate that by 2025 the number of HVDC interconnections will have double the capacity than what they had in 2016, going from 260GW to 520GW in total.

Currently, there are numerous international interconnections all over the world that have been agreed to, planned, or are under construction. Specifically, more than 35 in Europe alone, five in North America, five in South America, more than 25 in Africa, and at least eight in Asia. The plethora of upcoming and existing interconnections serves as a strong indicator of the benefits that the process of interconnecting national grids stands to offer.

At this point, it is important to bring back to mind the small Cyprus, which is to become the first tri-continental HVDC interconnection hub. It's case stands as a symbol of how national and regional grids all over the world are gradually becoming more and more interconnected soon to be spreading past continents. As this process continues, the Global Energy Grid, and the possibilities it offers, seem to be edging ever closer to reality.

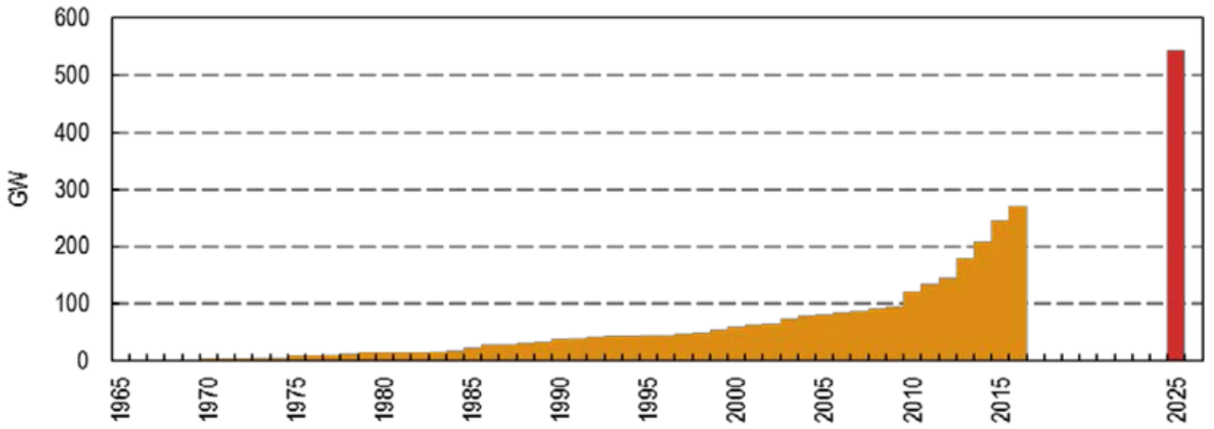


Figure 8: Growth in high voltage transmission capacity Source: IEA, Energy Technology Perspectives 2016

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