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CONTENTS

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PRESIDENT'S MESSAGE

In this editorial of the 4th Quarter *Energy Forum*, I suggest that we explore some transformations that our community of economists, in all its diversity, could wish for the energy system of tomorrow.

Since taking over my duties in January 2019, during my numerous visits to the countries in which IAEE has organized conferences, I have had the opportunity to officially intervene in opening or plenary sessions. I also had the pleasure of exchanging views with you, our members, with senior officials from industry or finance, with ministers and with PhD students. I take from our discussions their vision of the role of energy economics in the transformation of the energy sector in the medium to long term. Can we identify a general trend?

Many actors question the lack of consideration of the short term in the work of economists.

The long-term vision is also exposed to many uncertainties. This is unfortunately due to the fact that a minority of economists have built their businesses on pessimism and catastrophism. They alert opinions in the long term, thus creating short-term uncertainty, alarming markets, generating irrationality and creating sterile and disruptive volatility.

Yet there seems to be a consensus among energy economists: we believe that energy is a source of development, welfare and progress. It is therefore desirable to provide access to energy for all, affordable and environmentally friendly.

The balance between the first two pillars (security of supply and costs) is generally guaranteed for economists by the market, supply and demand determining the balance between energy volumes and prices.

The recognition of the environment is more divided in our community.

However, there is a new trend that has not been sufficiently studied and valued: everywhere on the planet, we are witnessing a questioning of the effectiveness of national or federal governments. In many cases, energy policy governance at the level of municipalities, counties or regions would be more effective. Two examples are blatant:

- The fight against **fuel poverty**: it is well known that the allocation of aid to people in extreme poverty and the search for solutions are more effective at the level of municipal services than from a centralised administration.
- The fight against **climate change**: without denying the role of States, we can observe short-term actions taken by cities and large regions of the world for short circuits or promoting sustainable mobility. The ban on polluting vehicles in city centres, the simple elimination of thermal fuel models from car

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President's Message (continued)

manufacturers' catalogues could be much faster solutions than global actions.

Local or global are not opposed but are complementary energy policy solutions that we should evaluate. The conditions for this complementarity are growth, societal and technological innovation.

Christophe Bonnery

Careers, Energy Education and Scholarships Online Databases

IAEE is pleased to highlight our online careers database, with special focus on graduate positions. Please visit http://www.iaee.org/en/students/student_careers.asp for a listing of employment opportunities.

Employers are invited to use this database, at no cost, to advertise their graduate, senior graduate or seasoned professional positions to the IAEE membership and visitors to the IAEE website seeking employment assistance.

The IAEE is also pleased to highlight the Energy Economics Education database available at http://www.iaee.org/en/students/eee.aspx Members from academia are kindly invited to list, at no cost, graduate, postgraduate and research programs as well as their university and research centers in this online database. For students and interested individuals looking to enhance their knowledge within the field of energy and economics, this is a valuable database to reference.

Further, IAEE has also launched a Scholarship Database, open at no cost to different grants and scholarship providers in Energy Economics and related fields. This is available at http://www.iaee.org/en/students/ListScholarships.aspx

We look forward to your participation in these new initiatives.

IAEE MISSION STATEMENT

The International Association for Energy Economics is an independent, non-profit, global membership organisation for business, government, academic and other professionals concerned with energy and related issues in the international community. We advance the knowledge, understanding and application of economics across all aspects of energy and foster communication amongst energy concerned professionals.

WE FACILITATE:

- Worldwide information flow and exchange of ideas on energy issues
- High quality research
- Development and education of students and energy professionals

WE ACCOMPLISH THIS THROUGH:

- Providing leading edge publications and electronic media
- Organizing international and regional conferences
- Building networks of energy concerned professionals

Editor's Notes

The topic of *Stranded Assets* is a popular one. We begin our coverage in this issue and will continue it in the first quarter 2020 issue. There are several articles not on stranded assets that are of interest. We call particular attention to Doug Reynold's article summarized below. Finally, the European Conference in Ljubljana, Slovenia was a great success and we've fortunate to have a summary of it included here. Read on.

Tilak Doshi posits that the impending death of the coal industry is greatly exaggerated. He notes that the opposition to building coal power plants in poorer countries is justified in two ways, both of which are false. He explains that contrary to the otherwise claim, climate change policy does not help the poor. Further, he notes it is a myth to claim that solar and wind power are competitive with fossil fuels. They are at least two to three times more expensive than coal or gas-fueled power.

Jim Krane writes that climate change appears likely to force oil producers to compete for a shrinking oil market. Competitive advantage will be based on companies' ability to cope with low oil prices even as they reduce, and later, offset their carbon emissions. Saudi Aramco, the world's largest oil company, appears well placed for long-term participation in markets under these constraints.

Mamdouh Salameh argues that there will neither be a post-oil era nor an imminent energy transition or a peak oil demand throughout the 21st century and far beyond. That is why oil, natural gas and LNG will keep renewables stranded throughout the 21st century.

Frederic Babonneau, Ahmed Badran, Maroua Benlahrech, Alain Haurie, Maxime Schenckery, and **Marc Viell** discuss how a climate agreement creating an international carbon market, associated with a strong penetration of negative emissions could reduce stranded asset risks in GCC countries, and Qatar in particular.

Simonetta Spavieri reports that a first estimation of fossil-fuel stranded assets in Venezuela under a 1.5°C world leaves 94.1% of Venezuela's reserves stranded which if burned would deplete 64% of the remaining carbon budget.

Doug Reynolds analyses some macroeconomic parallels between the 1970s, the late Soviet Union, and the Early 2000s The historic events look very similar in nature, and can be used to speculate on future energy related macroeconomic events. Banking, currency, de-regulation and migration are scrutinized.

Anna Creti and **Christian de Perthuis** write that stranded assets, broadly defined, are the highest costs of the low-carbon revolution. To meet the Paris agreement target, they must be a reality. However, the latest figures on investment in carbonized assets show that this revolution is lagging behind. Therefore stranded assets are still a myth. We explain this contradiction and survey recent research, arguing that only coherent carbon regulation can deeply transform the economy.

Achim Hagen, Niko Jaakkola and **Angelika Vogt** assesses how climate policies lead to asset stranding and why this phenomenon might prevent the successful implementation of policies by taking recent German climate policy-making processes as an example.

Florent Rousset and **Fernando Rolla** note that oil and gas companies are under increasing pressure to reduce greenhouse gas (GHG) emissions. One mechanism for managing carbon emissions is the implementation of a carbon price applied on a per tonne of CO_2 equivalent (tCO2e) basis, effectively assigning a cost to emissions. They illustrate how this would work.

Wen-Yu Weng writes that as the West begins its turn away from coal under the global decarbonization mandate and investor pressures, many Southeast Asia nations are racing towards abundant, cheap coal to meet their ever-escalating energy needs. He explores the multifaceted story of coal in Southeast Asia.

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IAEE/Affiliate Master Calendar of Events

(Note: All conferences are presented in English unless otherwise noted)

Date	Event, Event Title	Location	Supporting Organization(s)	Contact
2019				
October 17-19	4th IAEE Eurasian Conference *Energy Resources of the Caspian and Central Asia: Regional and Global Outlook*	Astana or Almaty, Kazakhstan	IAEE	Vilayat Valiyev *waliyev@gmail.com*
October 17-18	4th APEEN Conference *Energy Demand-Side Management and Electricity Markets*	Covilha, Portugal	APEEN	Carlos Pinho *cpinho@ua.pt*
November 3-6	37th USAEE/IAEE North American Conference *Energy Transitions in the 21st Century*	Denver, CO, USA	USAEE	David Williams *usaee@usaee.org*
November 18-19	1st SAAEE Energy Economics Conference *Transforming Future Energy Systems to Ensure Sustainability and Climate Protection*	Pretoria, South Africa	SAAEE	Roula Inglesi-Lotz *president@saaee.org*
December 10-12	4th Symposium on Energy Security	Rome, Italy	AIEE	Carlo Di Primio *assaiee@aiee.it*
December 16	1st IAEE Middle East Symposium *The Impacts of Economic Diversification, New Technologies and Climate Concerns on the Middle East Energy Outlook*	Abu Dhabi, UAE	IAEE	David Williams *iaee@iaee.org*
2020				
February 12-15	7th IAEE Asia-Oceania Conference *Energy Transitions in Asia*	Auckland, New Zealand	IAEE	Stephen Poletti *s.poletti@auckland.ac.nz*
June 21-24	43rd IAEE International Conference *Energy Challenges at a Turning Point*	Paris, France	FAEE/IAEE	Christophe Bonnery *Christophe.bonnery@faee.fr*
November 1-4	38th USAEE/IAEE North American Conference *Energy Economics: Bringing Markets, Policy and Technology Together*	Austin, TX, USA	USAEE	David Williams *usaee@usaee.org*
2021				
March 21-23	8th Latin America Energy Economics Conference	Bogota, Colombia	ALADEE	Gerardo Rabinovich *grenerg@gmail.com*
August 29 – September 1	17th IAEE European Conference *The Future of Global Energy Systems*	Athens, Greece	HAEE/IAEE	Kostas Andriosopoulos *kandriosopoulos@escpeurope.eu*
July 25-28	44th IAEE International Conference *Mapping the Global Energy Future: Voyage in Unchartered Territory*	Tokyo, Japan	IEEJ/IAEE	Yukari Yamashita *yamashita@edmc.ieej.or.jp*
2022				
February 6-10	45th IAEE International Conference *Energy Market Transformation in a: Globalized World*	Saudi Arabia	SAEE/IAEE	Yaser Faquih *yasser.faquih@gmail.com*
July 24-26	8th IAEE Asia-Oceania Conference *Making the Transition to Smart and Socially Responsible Energy Systems*	Hong Kong	HAEE	David Broadstock david.broadstock@polyu.edu.hk
September 4-7	18th IAEE European Conference *The Global Energy Transition: Toward Decarbonization*	Milan, Italy	AIEE/IAEE	Carlo Di Primio *diprimio@gmail.com*
2023				
June 25-27	46th IAEE International Conference *Overcoming the Energy Challenge*	Istanbul, Turkey	TRAEE/IAEE	Gurkan Kumbaroglu *gurkank@boun.edu.tr*
2024				
May-June	47th IAEE International Conference *Forces of Change in Energy: Evolution, Disruption or Stability*	New Orleans	USAEE	David Williams *usaee@usaee.org*

In Coal We Trust: The Need For Coal Power In Asia

BY TILAK K. DOSHI

The reigning narrative of impending global environmental catastrophe dominates the airwaves and print media. Short of a drastic reduction in the use of fossil fuels, it is asserted,[1] we are fast approaching the "end of days". The demonization of fossils fuels in general, and coal in particular, has been wrought under pressure from special interests groups and organized lobbies of the climate-industrial complex[2] where aspects of economic reality are caricatured or presented out of context. Complex trade-offs in energy policy are spun into tales of spurious simplicity, leading to misleading conclusions. Nowhere is this more apparent than in the debate over the role of coal-fuelled power generation in the developing countries.

Opposition to the building of coal power plants in the poorer countries has been justified by environmental activists, banks and multilateral development agencies such as the World Bank[3] in two key ways. The first revolves around the claim that climate change mitigation programs carry "co-benefits" for public health in developing countries. The second utilizes the assertion that renewable energy such as solar and wind power are effective substitutes for centralized grid electricity generated by fossil fuels.

Climate change policy does not help the poor

The claim that aggressive climate change mitigation programs helps the poor is egregiously misleading. Modern coal plants are a success story, as pollutants emitted have fallen dramatically with technological improvements over the past several decades. Key pollutants that adversely affect human health include carbon monoxide, lead, sulfur dioxide (SO_2), oxides of nitrogen (NOX), ground level ozone and particulate matter (PM). A new pulverized coal plant, with flue gas scrubbers, fabric filters, catalytic reduction and other control equipment and processes, reduces NOX by 83%, SO_2 by 98% and PM by 99.8% compared to a similar plant without such pollution control features, according to the U.S. Department of Energy.[4]

Ambient air pollution in both urban and rural areas in developing countries is a real problem, but it is primarily due to the indoor burning of solid biomass in cooking and heating. The use of charcoal, wood, dung and crop residues within households is caused by the lack of access to grid electricity and modern fuels such as LPG. The World Health Organisation[5] reports that close to 4 million people die prematurely from illness attributable to indoor air pollution each year. The real solution, as apparent in the experience of the now developed countries, is to remove the need for using traditional biomass by providing affordable electricity and cleaner fuels. Coal power plants also lay the basis for improved public health with adequate clean water supply and refrigeration for food supply chains and the storage of vaccines in hospitals.[6]

Tilak Doshi is a consultant in the energy sector, and the author of "Singapore in a Post-Kyoto World: Energy, Environment and the Economy" published by the Institute of South-east Asian Studies (Singapore, 2015). This article was first published in Forbes, June 7, 2019.

See footnotes at end of text.

The Myth of Renewable Energy

The second misleading claim is that intermittent sources of renewable energy can replace the need for grid-supplied power based on fossil fuels. An endless litany of "green" success stories permeate the mainstream media with the erroneous believe that that wind and solar power are "already competitive" with fossil fuels.[7] Rigorous economic analyses of the hidden costs of unreliable, weather-dependent solar and wind power have countered such claims as an exercise in "magical thinking".[8] According to data reported by energy generators to regulatory authorities in the U.S., wind and solar power are two to three times more expensive than existing coal or gas-fuelled power.[9]

But perhaps the best response to the renewable energy hype is provided by the example of Dharnai, a small village in India's Bihar state, which lacked access to the country's electricity grid.[10] In 2014, Greenpeace activists set up a solar-powered microgrid for the village to much fanfare. Almost immediately, problems emerged with the load put on the village solar "grid" as households began to hook appliances such as rice cookers, electric water heaters, irons, space heaters and air coolers. On the day of inauguration of the solar power system in the village, its inhabitants protested with banners stating "we want real electricity, not fake electricity". As put by the reporter, "By 'real', they meant power from the central grid, generated mostly using coal. By 'fake', they meant solar". In wonderful irony, the embarrassed VIPs present for the gala opening of the Greenpeace-promoted solar showpiece ensured that the village was shortly connected to the coal-fired power grid.

You cannot easily fool people when it really matters

It is no wonder then that the developing countries in Asia have little hesitation in supporting coal power generation as the quickest route to economic development and poverty alleviation. By early 2019, China had announced, permitted or was constructing almost 200 GW of coal power capacity, equivalent to over 75% of the entire operating U.S. coal fleet (the world's second largest after China).[11] The relevant figures for India and countries in Southeast Asia are 95 GW and 75GW. China, India and Southeast Asia together account for 81.5% of global coal power capacity under construction, amounting to over 190 GW.

To the consternation of the climate alarmists, President Trump declared in his State of the Union speech that "we have ended the war on beautiful, clean coal".[12] This was in contrast to the failed presidential-hopeful Hillary Clinton who claimed her biggest regret was in doubling up on ex-President Obama's 'war on coal' and stating in her campaign trail that "we're going to put a lot of coal miners and coal companies out of business".[13]

A similar dynamic was at play in Katowice, the heart of Poland's coal mining country, when the Coal Miners Band struck up a welcome tune to delegates attending the UN's 2018 Climate Change conference.[14] In the convention pavilion, delegates were surrounded by showcases proudly displaying jewellery and cosmetics fashioned out of coal. And in his opening remarks, the Polish President emphasized that the country had no plans to give up on coal.

From the coal industry point of view, perhaps the most striking political event took place in Australia's recent national elections where the centre-right Liberal-led coalition Prime Minister Scott Morrison retained power despite all the opinion polls predicting an easy Labour victory. The re-elected Prime Minister once presented a lump of coal in parliament, saying "This is coal - don't be afraid!"

The opposition Labour party's election strategy to make climate alarmism and anti-coal legislation the key issue badly backfired in what was widely dubbed a "climate election". One commentator pithily remarked: "How to lose the unlosable election: be anti-coal".[15] Days after the election upset, the Labour state government of Queensland promised to overturn all attempts to block the massive Adani coal project, and was said to be "fed-up" with her own party's anti-coal stance.[16]

The coal industry will remain essential to human flourishing long into the future, and reports of its impending death have been greatly exaggerated.

Footnotes

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For Saudi Arabia, the Threat of Stranded Reserves has Spawned a Climate Strategy

BY JIM KRANE

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See footnotes at end of text.

For Saudi Arabia's absolute monarchy, climate action represents a combined threat and opportunity in retaining the oil export revenues[1] that underpin domestic political institutions and the kingdom's international influence. Saudi Aramco, the largest source of greenhouse gas-emitting fossil fuel among all firms worldwide, is exposed to risks around regulations on fossil fuel use. However, Aramco is also the producer with the world's lowest production costs and lowest intensity of greenhouse gas emissions per barrel produced. These attributes suggest that oil from the kingdom should retain a prominent, even favored, role in oil markets, particularly under climate constraints.

The 2019 Saudi Aramco bond prospectus outlines the company's risks and future challenges with climate action. The prospectus also provides responses that, when examined alongside the public statements of its executives, offer a road map of Saudi oil marketing strategy in the era of climate change.

For Saudi Arabia, the scale of hydrocarbon reserves – and the time required to monetize them – necessitate a marketing strategy that differs from those of its smaller competitors, including shareholder-owned international oil companies, or IOCs. Saudi 2018 proven reserves of 260 billion barrels were more than five times larger than those of any of the five major IOCs, ExxonMobil, Shell, Chevron, Total and BP. Saudi Aramco retains at least 52 years of production from domestic reserves at current rates (~11 million barrels per day). Given the strong likelihood of further additions to its reserves, the Saudi government has made allowances for Aramco to maintain its monopoly over the Saudi oil concession for as long as 100 years – until the year 2117. By contrast, IOCs' proven reserves of just over 200 billion barrels would be collectively depleted in nine to 15 years based on current rates of output.[2]

The principle of "intergenerational equity" in reserves depletion has been influential in Saudi Arabia. It implied a constrained approach to production that tended to stimulate global market prices for oil, which, in turn, underwrote generous social benefits for Saudi citizens. Constraints on production are supposed to lengthen the lifespan of the Saudi oil economy and the duration of rule by the al-Saud family. In 2008, King Abdullah noted that he had ordered Saudi Aramco to deliberately leave viable fields untapped on behalf of future generations.[3] In this way, geologic, economic and political factors converged to reinforce Aramco's long-term depletion horizon and underproduction relative to its reserves base.

Shareholder-owned oil companies, by contrast, produce from smaller resource bases at much higher depletion rates. If IOC executives decided to recast their business models, they could run down reserves while shifting investment toward new types of business. Many IOCs have already demonstrated their ability to transform when their foreign oil concessions were nationalized, mainly in the 1970s. The companies shifted oil exploration and production to new parts of the globe, or moved into services and technology businesses, and remained viable. For them, climate change appears like a slow-moving reprise of prior disruptions, rather than a threat to their existence. Significant progress in transitioning to new area of business might be accomplished over a decade or two.

For a large national oil company, a decade is the short term. Given the intensifying pace of climate change – the physical effects as well as public demands for drastic action – multi-generational depletion horizons like those of Aramco face considerable uncertainty.

Climate risk appears to be altering Saudi Aramco's calculations. The statements of the company and its executives have taken on an expansion-oriented flavor, with terms "growth strategy" and "expansion strategy" appearing frequently, even during periods when oil markets were oversupplied. Operating costs and competitiveness have been accorded increased attention, given the possibility of slower oil demand growth and lower prices. There is a sense that the kingdom's actions to rein in the growth of social welfare provision is, in part, to prepare Saudi society for an era of uncertain rents and potential difficulty in meeting the "social breakeven" costs that depend on inflated oil prices.

At the same time, the kingdom's intense summer climate faces the potential of being warmed into intolerability by century's end.[4] Despite the implied climate damage to its homeland, Saudi Aramco is moving to expand, streamline and protect its system of oil monetization, so that the Saudi NOC can produce and market the kingdom's prodigious below-ground reserves "for generations to come," as its prospectus states. The company's statements seek to convey the message that neither oil, nor Saudi Aramco, is going away anytime soon.

"The Company intends to maintain its position as the world's leading crude oil producer by production volume," states the company's bond prospectus of April

2019. "Its reserves, operational capabilities and spare capacity allow it to increase production in response to demand."[5]

The kingdom's energy minister, Khalid al-Falih, said in 2019 that no other oil producer would survive longer than Saudi Aramco. "Saudi Arabia is the most prolific basin for oil and gas. We have the best resources and the best capabilities and we are going to produce the last drop of oil," al-Falih said.[6]

Saudi Aramco has been preparing for the "long game" in oil by backing investment strategies that seek to bolster its advantages.

One is an investment push into non-combustion uses for crude oil and natural gas, particularly production of petrochemicals. For rentier states overseeing large reserves, such "climate compliant" uses for oil and gas look like a revenue lifeline. Oil and gas are mainly used as feedstocks that are converted to plastic resins and polymers, which, as long as they are unburned, retain the carbon content of the fossil fuels within final product.[7]

Another climate-driven strategy is Aramco's ongoing downstream investment in markets, particularly in developing Asia, where policymaking prioritizes GDP growth over environmental concern. It is in these countries where oil demand is likeliest to grow in coming decades, even as it falls away elsewhere. Aramco's downstream investments are aimed at ensuring that Saudi oil has preferential footprints through "captive" ownership and configuration of refining capacity around Saudi oil grades.[8]

Another survival strategy is the "competitive decarbonization" of Saudi crude oil. The idea is to enhance the attractiveness of Saudi oil in a world coping with climate constraints, but where oil remains too useful to eliminate. Upstream decarbonization is partly a facet of fortunate geology., It is being pushed further through reductions in flaring and methane emissions, and through CO_2 reinjection. Recent research, partially supported by Saudi Aramco, has determined that the kingdom's crude has the lowest carbon intensity in the world.[9] If future carbon taxes were designed to differentiate among crude oil by carbon content, Saudi oil products would receive a pricing discount relative to competing grades.

Climate change is beginning to shift energy systems. In oil's case, the shift is taking place in a slow and uneven way. Oil consumption will fall away in some sectors, stagnate in others, and continue to grow in still others. Producer states have ample warning and opportunity for response, and, with oil prices relatively high at the time of writing, some also have ample financial resources to prepare.

The kingdom's case is an important one, but far from unique. Saudi Aramco's competitors are equally motivated and convinced by their own exceptionalist rationales for retaining long-term roles in oil supply. The scale of revenues earned by Saudi Aramco is so large and the level of profitability so high that protecting and retaining the business is a strategic and economic imperative for the kingdom and its ruling family, even at the risk of alienating the kingdom in international relations.

Footnotes

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Oil, Natural Gas & LNG Will Keep Renewables Stranded Throughout the 21st Century

BY MAMDOUH G SALAMEH

Mamdouh Salameh is an international oil economist. He is also a visiting professor of energy economics at the ESCP Europe Business School in London.

See footnotes at end of text.

Introduction

Big Oil is increasingly listening to investors and building alternative energy portfolios, but oil and gas will remain their core business well into the future or at least until returns on clean energy start making commercial sense.

Big Oil's investments in renewables will be guided by three pivotal principles. The first is that there will be no post-oil era throughout the 21st century and probably far beyond. Oil will continue to reign supreme all through.[1]

The second principle is that there will be no peak oil demand either. Peak oil demand has become one of the most contentious and fascinating debates in the oil industry over the past few years with forecasts for the pending peak seemingly creeping closer to the present with every new publication. The precise dates vary. Royal Dutch Shell, for instance, has said that the peak could come within 5-15 years. BP, for its part, says demand could plateau in the 2030s or 2040's.[2] While an increasing number of electric vehicles (EVs) on the roads coupled with government environmental legislations could decelerate the demand for oil, EVs could never replace oil in global transport throughout the 21st century and far beyond.

The third principle is business opportunities. While Big Oil is investing huge amounts in renewables, such investment pales in size when compared with that in oil and gas exploration and production, refining and petrochemicals. The slower pace of oil majors toward alternative energies is due to two key reasons. First, they all say that oil and gas will continue to be needed well into the foreseeable future. And second, and probably much more important, is that financial returns from renewables are nothing compared to the huge bonanzas oil firms are accustomed to rake in when oil prices rise.[3] While renewables accounted in 2018 for 4% of global primary energy demand, oil and natural gas accounted for 58%.[4]

Still, Big Oil does invest in clean energy solutions and has accelerated such investments in recent years partly to be genuinely involved in the clean energy solutions and partly to burnish their environmental credentials but the general mood, at least for now, is as Shell put it last year—we'll move away from oil when this makes commercial sense. Shell's spending on new energy solutions may be huge by some standards at $1-$2 bn. But this is less than 8% of the supermajor's total annual capital spending of around $25 bn.[5]

Yet, there has been a marked decline in spending on renewable energy projects during the first half of this year with spending totalling $117.6 bn, a 14% less than a year ago and the lowest amount for a comparable period since 2013 according to Bloomberg New Energy Finance (BloombergNEF). The decline was evident in all key renewables market particularly so in China. The reason: Beijing is cutting subsidies for solar and wind and trying to make them stand on their own two feet without government support.[6]

Interestingly enough, spending on solar and wind also fell by 4% in Europe where governments and environmentalist groups are particularly vocal about their clean energy plans. In the United States, new renewables spending fell by 6%.[7]

The Myth of an Imminent Energy Transition

With global oil consumption exceeding 100 million barrels a day (mbd), the notion of imminent energy transition looks like an illusion.

In fact, the percentage of fossil fuels in the world's energy mix—coal, oil and natural gas—is still lingering well above 80%, a figure that has changed little in 30 years. In fact hydrocarbons accounted

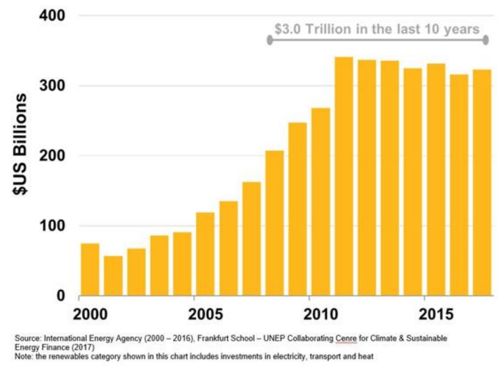


Chart 1 Global Investment in Renewable Energy Supply

Source: Courtesy of the International Energy Agency (IEA)

for 84.7% of global primary energy consumption in 2018.[8] That remains so despite being challenged by serious environmental policies and despite a global expenditure of $ 3.0 trillion on renewable energy during the last decade (see Chart 1). This is a hefty price to pay just to gain only a percentage point of market share from coal.

And whilst wind and solar are being deployed quickly at an exponential rate, renewable energy installations are far too slow to catch the still-voracious appetite for fossil fuels. It is a fact needing acknowledgement in a world of over seven billion people, each of whom is wanting for more light, heat, mobility and gadgetry.

For now, we're in an era of "energy diversification," where alternative sources to fossil fuels, notably renewables, are growing alongside—not at the expense of—the incumbents.

Most oil companies are also investing heavily in chemicals and petrochemicals. Environmental groups would correctly note that this is hardly a strategy for a clean energy transition, but oil companies see global demand for plastics, fertilizers and other petrochemical products contributing more to the growth in global oil demand than the transportation sector. Petrochemicals currently account for 13% or 13 mbd of global oil demand and this is projected to rise to 16% by 2030 compared with 73% for transport.

Impact of Electric Vehicles (EVs) on Global Oil Demand

A few experts have been projecting the advent of the post-oil era within the next fifty years.

Hardly a day goes by without another media report about the impending demise of the Internal Combustion Engine (ICE) as petroleum-powered cars and trucks are replaced by super-clean EVs.

Some experts are now saying that widespread EV use could spell the end of oil. The tipping point, they reckon, is 50 million EVs on the roads. This they believe could be reached by 2024.[9] However, 50 million EVs could hardly make a dent on the global demand for oil let alone replace it.

Currently, electric and hybrid cars combined number under 4 million cars out of 1.477 bn ICEs on the roads worldwide in 2015, or a negligible 0.27%. The total number of ICEs is projected to reach 2.0 bn by 2025 rising to 2.79 bn by 2040 according to U.S. Research.[10]

In 2018 the world used 36.4 bn barrels of oil (bb) of which 73% or 26.6 bb were used to power 1.477 billion conventional cars around the world.[11] Bringing 50 million EVs on the roads will reduce the global oil demand by only 0.9 bb, or 3.4%. This will neither be the end of oil as some experts are suggesting nor a tipping point.

A tipping point for oil could only be reached once 739 million EVs (50% of the current global ICEs number) are on the roads worldwide. This is impossible to achieve within that time frame. One then can only guess how many decades will have to pass before the entire global car fleet of ICEs is replaced by EVs.

Moreover, growth in EV sales thus far has been supported by significant government subsidies. Sales would crash once the subsidies are withdrawn according to a report in April 2017 by U.S. auto research firm, Edmunds.

Furthermore, there will be a need for trillions of dollars of investment to expand the global electricity generation capacity in order to accommodate the extra electricity needed to recharge 50 million EVs. How could such expansion be sourced: nuclear, hydrocarbons or solar?

Other alternatives to ICEs include hydrogen fuel cells (FCVs).[12] However, experts estimate it will take at least 40 years or more before FCVs could have any meaningful impact on the demand for oil.

World Oil Outlook

Oil will maintain its dominance during the 21st century and beyond. According to ExxonMobil's 2017 "Outlook for Energy: A View to 2040", oil is projected to account for 33% of the global primary energy consumption in 2040 as it did in 2017 (see Chart 2).

In the medium-period 2018-2022, oil demand is projected to increase by 2.5 mbd from 99.8 mbd in 2018 to 102.3 mbd. The outlook for long-term oil

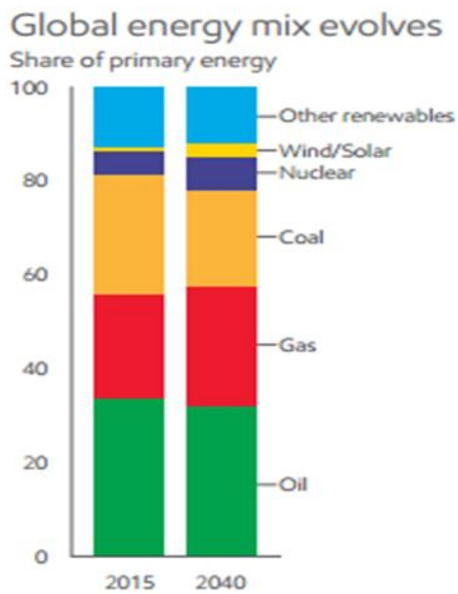


Chart 2

Source: Courtesy of Exxon Mobil 2017 Outlook for Energy

Table 1
Sectoral Oil Demand Growth, 2018-2040
(mbd)

	2018	2020	2022	2025	2030	2035	2040
Transportation	73.0	73.7	74.4	76.1	78.4	80.1	81.1
Industry	17.4	17.6	18.2	18.3	18.9	19.2	19.5
Other uses	9.4	9.5	9.7	9.9	10.1	10.4	10.5
World	99.8	100.8	102.3	104.3	107.4	109.7	111.1

Source: OPEC 2017 World Oil Outlook 2040 / BP Statistical Review of World Energy, June 2019.

demand growth is more optimistic reaching 111.1 mbd by 2040 (see Table 1).

Most of the demand for oil is used for transportation. It is a sector where oil continues to face the weakest competition from alternative fuels. Between 2018 and 2040, the transportation sector will account for 77% of all oil consumed. Nevertheless, demand growth is projected to decelerate on the back of efficiency improvements driven by technological developments, a tightening of energy policies and a wider penetration of EVs.

The Potential for Hydrogen

Some supermajors are looking into hydrogen and its various possible uses as a clean fuel--not only for cars but also for heavy industries and home heating. Still, a meaningful large-scale hydrogen use with low or zero emissions in heavy industries where emissions are the most and the hardest to cut, is years if not decades away. Producing hydrogen from something other than fossil fuels is currently cost prohibitive.[13]

Hydrogen is already used widely, but it is almost entirely produced from natural gas and coal, and its production is responsible for annual carbon dioxide (CO_2) emissions equivalent to those of Indonesia and the United Kingdom combined according to a report last month by the International Energy Agency (IEA).[14]

Still, Japan is boosting the search for new non-fossil fuel sources of energy. It is one of the pioneers in hydrogen technology, with Toyota for example expanding mass production of fuel cell stacks and high-pressure hydrogen tanks as it aims to boost sales of FCEVs.[15]

However, hydrogen on its own can't solve Japan's energy problem. Japan needs nuclear energy, LNG and also solar power for generating electricity. Without them the Japanese economy will come to a standstill. Moreover, Japan's demand for oil for transport could be decelerated with a wider use of both EVs and FCVs. Still, the most significant challenge facing FCVs is the cost and durability of the fuel cell system.

The concept of Japan building a 'hydrogen society' is not new. Icelandic professor Bragi Arnason of Reykjavik University whom Newsweek magazine nicknamed as 'Professor Hydrogen' has had the aspiration of converting Iceland into a 'hydrogen economy' years before Japan.[16]

The Outook for Gas & Liquefied Natural Gas (LNG)

Global demand for natural gas is growing faster than other hydrocarbons and also faster than global overall energy demand. It grew by 5.3% from 3141.9 million tons of oil equivalent (mtoe) in 2017 to 3309.4 mtoe in 2018. 17

A movement to de-commission nuclear power and coal in electricity generation particularly in Japan and Germany and a huge demand from China in addition to environmental concerns are accelerating the global demand for gas.

There are three huge natural gas and LNG markets in the world, namely, the European Union (EU), the Asia-Pacific region and China.

Russia's position in the EU gas market is unassailable with almost 40% market share and growing. Moreover, Russia's share will be enhanced further to 45%-50% with the completion of both the Nord Stream 2 and the Turk Stream which will bring Russian gas supplies under the Baltic Sea and the Black Sea, respectively, to the EU when completed by the end of this year.

The EU demand for gas and LNG is growing fast at a time when European gas production is projected to decline significantly particularly with the planned shutdown of the Groningen gas field in the Netherlands by 2030.

The world's biggest LNG market with the highest prices is the Asia-Pacific region to which the thrust of U.S. LNG exports is directed. In 2018 the U.S. exported 28.4 billion cubic metres (bcm).[18] Still, U.S. LNG will face formidable competition on price from Qatar and Australia which will continue to dominate this market well into the future.

The third biggest market is China. China's gas demand is projected to grow by 33% in the next six years from 283 bcm in 2018 to 376 bcm by 2023 with LNG imports rising by 26.5% from 73.5 bcm in 2018 bcm in 2017 to 93 bcm in 2023.[19]

China became the world's top natural gas importer-including LNG and pipeline - in October last year, overtaking Japan which imports all its gas as LNG.[20] It is set to overtake Japan as the top global LNG importer by 2022.[21]

Solar Energy

China is now the largest investor in solar energy. According to BloombergNEF, nearly half of the world's new renewable energy investment of $279.8 billion in 2017 came from China (see Table2).

China has recently come up with a very innovative way to enhance global electricity generation and reduce demand for oil: solar highways. The solar highways are the next gambit because they take the

Countries	Investment
China	$126.6
U.S.	40.5
Japan	13.4
India	10.9
Germany	10.4
Australia	8.5
UK	7.6
Brazil	6.0
Mexico	6.0
Sweden	3.7

Table 2 New Renewables Energy Investments Made by Top 10 Countries in 2017. U.S. Billions
Source: Courtesy of Bloomberg New Energy Finance

'farm' out of solar and free up the land for agricultural use. [22]

The plastic-covered solar panels cover a portion of highway that is two-thirds of a mile long and is designed to absorb the pressure of some 45,000 cars and trucks that traverse it daily.[23] And this patch of highway is close to an electricity substation, so it can be hooked up to the grid easily (see Chart 3).

There are also new solar markets opening up: Saudi Arabia is one very ambitious new addition to the industry. The Saudi solar market is projected to expand at a compound annual rate of 30% between 2018 and 2024. The UAE is also very ambitious in the solar power department, planning to source a quarter of its energy from solar installations by 2030. It recently launched the largest single solar power farm in the world, the 1.18-GW Noor Abu Dhabi.

Chart 3
Solar Highways

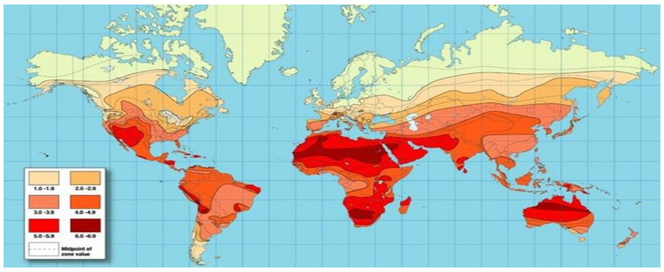
It has been calculated that all of the world's energy needs could be met with solar panels on just 1.2% of the Sahara Desert.[24] A map depicting global solar power resources shows the reason. There is no greater solar resource on the planet than a broad swath extending from the Sahara Desert of North Africa and into north western Saudi Arabia (see Map 1).

Conclusions

It is very probable that oil and natural gas will continue to be the fulcrum of the global economy well into the future.

Decision-makers, environmentalists and futurists may have to accept the notion that there will neither be a post-oil era nor an imminent energy transition or a peak oil demand throughout the 21st century and probably far beyond. Oil and natural gas will continue to be the core business of oil majors well into the foreseeable future.

Map 1
World solar insolation map



And despite a global expenditure of $3 trillion on renewable energy during the last decade, there is not much to show for it. This is a hefty price to pay just to gain only a percentage point of market share from coal.

That is why oil, natural gas and LNG will keep renewables stranded throughout the 21st century.

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How a Climate Agreement Creating an International Carbon Market Could Reduce Stranded Asset Risk in GCC Countries and Qatar in Particular

BY FREDERIC BABONNEAU, AHMED BADRAN, MAROUA BENLAHRECH, ALAIN HAURIE, MAXIME SCHENCKERY, AND MARC VIELLE

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See footnotes at end of text.

In a stream of publications from a recent research project at Qatar University[1], the economic impact for GCC countries and Qatar in particular, of a worldwide policy aiming at achieving a 2°C global warming has been studied. The method is based on a game theoretical competition model calibrated on a CGEM[2] that describes decarbonization pathways for 15 coalitions of countries up to the end of our current century. In this forum, we discuss the main implications of the simulation results that were obtained and how they support the claim that a climate agreement creating an international carbon market, associated with a strong penetration of negative emissions could reduce stranded asset risks in GCC countries, and Qatar in particular.

The concepts of Safety Cumulative Emission Budget (SCEB) and Carbon Dioxide Removal (CDR)

There is a consensus among scientists concerning the influence of cumulative emissions of GHGs on the average surface temperature increase at the end of the 21st century. In a nutshell, it is described by the SCEB of 1 trillion tons of carbon, since the beginning of the industrial era (around 1870), which gives a 60% probability of maintaining temperature increase below 2°C. Approximately, half of this safety budget has been already emitted, so it remains around 500 Gt of carbon to be emitted until one reaches a global zero-net emissions (ZNE) regime. In abatement pathways proposed in various reports based on different Integrated assessment models (e.g., MERGE, WHICH, TIAM, EPPA), attainment of Paris agreement goals necessitates reaching a ZNE regime before 2070 and even as early as 2050. For example, in the Sky scenario developed by Shell Corp[3], ZNE is reached by 2070 and is followed by a period of negative-net emissions to compensate for the overshooting of the cumulative emissions budget in the transition period 2020-2070. The CDR[4] technologies of choice to reach this goal are BECCS[5] to obtain negative emissions. In a transition to ZNE, GCC countries are exposed to stranded asset risk, sometimes described as "unburnable oil and gas".

Stranded asset risks and possible diversification for GCC countries

For several decades, GCC countries have sustained their socio-economic development through a complete reliance on the revenues from oil and natural gas exports. Additionally, the wealth in hydrocarbon endowments have encouraged these resource-rich countries to invest in energy intensive industries[6]. Despite the economic growth achieved from the revenues of exporting hydrocarbons, population growth, energy demand increase, stricter pollution regulations and climate agreement have rendered such economic growth model unsustainable especially in a ZNE regime[7].

Reaching the 2°C objective may imply that a third of oil reserves and half of gas reserves could remain unused[8]. For the Middle East, respectively 38% and 61% of existing oil and natural gas reserves would be stranded. In a recent report, IRENA[9] has assessed the total value of stranded assets across upstream energy, power generation, industry and buildings and found to reach over USD 20 trillion, approximately 4% of global wealth. GCC countries face a paradox: they need to invest in the shorter time in oil and gas infrastructure to manage stranded assets risks but at the same time, they have to finance a new business model outside of oil and gas and to insert GCC countries and Qatar especially in the global economy of energy transition.

Historically energy transitions happened at various speeds from a decade to half a century or more[10]. The pace and scale of the current energy transition is driven by a convergence of political, digital or technological transformations that remains uncertain. As a consequence, demand for fossil fuels and even more for clean fossil fuels remains uncertain. GCC countries may have to develop approaches to manage the potential stranded assets risks. However, only very few projects on CCS including enhanced oil recovery have been implemented, e.g., the Emirates Steel plant in Musaffah or the Saudi Jubail's ethylene plant CCS project. Qatar have postponed the project to capture carbon at Ras Laffan to reinjected it in DuKhan oil field. Significant research on carbon removal technology and especially DAC has yet to be undertaken but GCC countries remain technologically dependent to

European or American research advances. A financing mechanism is needed to launch the deployment of DAC technologies in GCC countries.

Diversification is already at the top of the political agenda for most of the GCC countries although they suffer from deep-rooted reasoning and perceptions that prevent them from acting quickly on sound evidence of the forthcoming stranded asset risks. As such, further diversification of investment from their sovereign fund abroad should target industries resilient to the energy transition or benefiting from this transition[11].

GCC countries as well as all resource rich countries could be more proactive in the political processes associated to transition. As rational actors who look for preserving their country's economic development, they could leverage their association to harness resolutions in their favor. Understanding the future impact of carbon markets, carbon pricing and taxes is becoming a growing part of mainstream conversation in the energy industry when assessing the viability of future projects and the value of assets. The geopolitics of oil are now mixed with the geopolitics of climate change.

GGC countries and climate policies

The GCC countries are among the major contributors to GHG emissions. The GCC countries rely heavily on large oil and gas industries in addition to their relatively small populations. The Gulf States account for 0.6% of the global population but ironically contributes 2.4% of the global GHG emissions per capita[12]. Carbon emissions from UAE are approximately 55 tons per capita, which is more than double the U.S. per capita footprint of 22 tons per year[13]. Added to this, in 2007 Qatar was singled out by the Human Development Report of the UN for the highest per capita carbon emissions in the world, estimated to be at 79.3 tonnes per capita. Such a bad record in relation to the issue of climate change has pushed many of the GCC countries to change their attitudes towards climate change and energy policies. Over the last few years, many of the GCC governments, including UAE, Qatar, and Saudi Arabia have announced plans to invest in new clean technologies in order to reduce the carbon footprints per capita. The focus is on diversifying energy sources and relying more on renewable energy in addition to designing and implementing sustainable energy systems based on effective energy efficiency measures. At the same time, a wide range of technological possibilities is available for the GCC countries including DAC[14].

The attitude of the GCC countries has dramatically changed in recent years on the issue of climate change and energy policy[15]. Many plans have been put forward in an attempt to reshape and reform energy policies in response to climate change challenges. Qatar for example was the first GCC country to join the World Bank's Global Gas Flaring Reduction project in order to show its commitment to reduce carbon dioxide emissions via controlling gas flaring. The Al-Shaheen project was the first of its kind in the region as a CDM project[16]. The Al-Shaheen oilfield has flared the associated gas since the oilfield began operations in 1994. The project activity will reduce GHG emissions by approximately 2.5 million tCO_2 per year and approximately 17 million tCO_2 during the initial seven-year crediting period. Further than this sample project, at the R&D level, many Gulf States have created research centres focusing on developing new technologies for reducing CO_2 emissions. In Saudi Arabia, the King Abdulaziz City for Science and Technology (KACST) was established as a hub for coordinating the efforts of the Saudi government and research institutes including the Technology Innovation Center on Carbon Capture and Sequestration[17]. In Qatar, the Carbonate and Carbon Storage Research Center (QCCSRC) was instituted[18]. Bahrain's Gulf Petrochemical Industries Company (GPIC) launched the first carbon dioxide recovery plant to reduce carbon dioxide emissions[19]. These efforts by the Gulf States among others indicate that the GCC countries have the determination to leverage new technologies and innovations into reducing the GHG emissions.

International carbon market, DAC and fair burden sharing may alleviate stranded asset risks in GCC countries and Qatar in particular

Using the extended CGEM derived from GEMINI-E3, one can obtain an evaluation of the possible welfare cost for GCC countries if a worldwide carbon tax were implemented, in the absence of emissions trading and without deployment of CDR technologies. Qatar welfare cost is estimated to be 12.8% of discounted cumulative GDP (dcGDP), when compared to a Business as Usual scenario. This provides a proxy for estimating the stranded asset risk, since most of the cost is due to losses in the terms of trade, i.e., the collapse of the fossil fuel prices generated by a drastic reduction of fossil fuel use in all world regions. Qatar, exporting important volume of LNG and being the least cost producer is a little bit less exposed in the short term, but will be strongly impacted in a global ZNE regime. Natural gas is such an environment is a bridge fuel. The pace of energy transition is then determinant as gas producing countries may need to develop hedging strategies against a long-term downside risk for natural gas to optimize welfare.

One way to compensate energy exporting countries from loss of exporting revenue following deep decarbonization policy is to give allocations of CO_2 permits within an international emissions trading market[20]. The numerical simulations support such findings. We have simulated scenarios where an international emission trading system is implemented, DAC and CCS are available, and with an allocation of quotas of CO_2 emissions in such a way as to obtain equalization of welfare losses, expressed in percentage of dcGDP, across 15 coalitions of nations. In these simulations, it can be observed that a repartition of the emission rights corresponding to the remaining part of the SCEB among different groups or coalitions of countries, and letting these coalitions compete in supply on an international market of emission permits, could yield a fair burden sharing and alleviate the imbalance of welfare costs associated with a global climate policy.

The two types of CDR activities that one considers are BECCS and DAC with CCS. BECCS is not available in GCC countries, however DAC with CCS has an important development potential in these countries with important CO_2 storage capacities. All nations could compete in the introduction and exploitation of CDR technologies, but GCC countries could have a competitive advantage with DAC.

A scenario where CDR technologies are introduced leads to a substantial reduction of the global welfare loss, which is evaluated at 1.5% of dcGDP when no short selling of quotas is permitted and 1.3% of dcGDP when short selling is permitted. Short selling of quotas triggers an overshooting effect, where more emissions are permitted in the short-term, to be compensated by negative net emissions at the end of the planning period. In this scenario, the welfare loss is equalized among the 15 coalitions and represents 1.5% or 1.3% of dcGDP. To achieve that, GCC countries receive 8% or 6% of the SCEB and Qatar in particular receives 1.2% or 1.1%. The main gain for Qatar comes from quotas selling which contributes 9.4% or 10.1% of dcGDP to this decrease. Of course this requires significant CO_2 quotas that are equal to approximately 0.9% of the SCEB, while the Qatari inhabitants represent up to now less than 0.04% of the world population and 0.2% of global CO_2 emissions. Table-1 summarizes the simulations results, in terms of welfare losses, for the different scenarios studied.

In these scenarios, a factor plays an important role in reducing the stranded asset risks for GCC countries and Qatar in particular. It is the possibility to harness DAC with CCS. The DAC technology is a natural gas driven process[21], with a levelized cost of USD 300 t-1CO_2. Qatar as other GCC countries has an important potential for storage of captured CO_2. DAC activities generate negative emissions that increase the endowment in emission rights to supply on the carbon market. DAC technologies, coupled with solar driven hydrogen production could also be used to produce clean fossil fuels, with ZNEs. The simulations made with GEMINI-E3 indicate a carbon price (around USD 500t-1CO_2 in 2070 and 1100 t-1CO_2 in 2100) that would make these technologies highly competitive. In the long-term, Qatar could continue to exploit its natural gas endowment in two sustainable ways, producing clean fossil fuels that could be exported and, even more efficiently, generating new emission rights that will be exported via the carbon market, with a minimum logistical cost. The key role of DAC is confirmed by the results of the simulation with an international trading market without CDR that leads to a loss of 3.7% of dcGDP for all coalitions. In that simulation, the carbon price jumps to USD 4000 t-1CO_2 in 2100. It shows that DAC should be viewed as the backstop technology as indicated in the ICEF report[22].

		Cost decomposition		
Scenario	Welfare cost in % of dcGDP	Abatement cost in % of dcGDP	Loss in terms of trade in % of dcGDP	Selling of Quotas in % of dcGDP
Uniform tax No CDR activities No carbon market	Qatar: 12.8% GCC: 12.7% World: 3.7%	Qatar: 4.2% GCC: 6.2% World: 3.7%	Qatar: 8.7% GCC: 6.4% World: -	--
Uniform tax with CDR activities No carbon market	Qatar: 11.3% GCC: 11.3% World: 1.4%	Qatar: 5.4% GCC: 6.9% World: 1.4%	Qatar: 5.9% GCC: 4.4% World: -	--
International emissions trading No CDR activities No short selling	Qatar: 3.7% GCC: 3.7% World: 3.7%	Qatar: 4.2% GCC: 6.2% World: 3.7%	Qatar: 8.7% GCC: 6.4% World: -	Qatar: 9.1% GCC: 9.0% World: -
International emissions trading with CDR activities No short selling	Qatar: 1.5% GCC: 1.5% World: 1.5%	Qatar: 5.0% GCC: 5.9% World: 1.5%	Qatar: 6.0% GCC: 4.5% World: -	Qatar: 9.4% GCC: 8.8% World: -
International emissions trading with CDR activities With short selling	Qatar: 1.3% GCC: 1.3% World: 1.3%	Qatar: 5.9% GCC: 7% World: 1.3%	Qatar: 5.4% GCC: 4.1% World: -	Qatar: 10.9% GCC: 9.7% World: -

Table 1: Welfare costs of 2°C global warming pathway

Conclusion and policy implications

Indeed the simulation results reported in this forum are still preliminary. Considerable uncertainty remains in the projections of key parameters in the CGEM and in the evaluation of potentials for CDR development and storage capacities. In these simulations, however it has been demonstrated that combining DAC, CCS and emission trading, coupled with generous allocations, one may expect a reduction of the welfare cost for GCC countries by limiting the cost of stranded assets. All other countries benefit also of this substantial cost reduction of the global climate policy. The policy implications are the following:

1 GCC countries should develop important R&D programs for DAC with CCS and clean fossil fuel production.
2 GCC countries should be proactive in the establishment of a global emissions-trading system.
3. GCC countries should negotiate a fair share of the remaining SCEB to compensate for the stranded asset risks.
4 The development of an important CDR activity in GCC countries could be a new source of industrial development and valorization of resources.
5 As DAC implementation reduces welfare cost for every country in the world, the cost of proof of

concept at scale close to storage capacities like GCC countries could be shared within an international financing mechanism.

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A First Estimation of Fossil-Fuel Stranded Assets in Venezuela Due to Climate Change Mitigation

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Introduction

Due to the increased interest of policy-makers in mitigating and adapting to Climate Change, the concept of the carbon budget has come about. The 2018 IPCC report suggests a remaining carbon budget for limiting warming to 1.5°C with a two-thirds chance of about 550 $GtCO_2$, and of about 750 $GtCO_2$ for an even chance. McGlade and Ekins (2015) report that fossil-fuel resources contain 11,000 $GtCO_2$, and according to their assessments one third of oil reserves, half of gas reserves and over four fifths of coal reserves must stay underground. The Carbon Tracker Initiative (Leaton et al., 2013) estimates that 60–80% of coal and oil and gas reserves of publicly listed companies would have to be abandoned. If the Paris agreement climate mitigation policies are put in place, or an energy transition follows, investors may be overestimating fossil fuels stocks value creating a 'carbon bubble' (Leaton, 2011; Leaton et al., 2017; Krause et al., 1989).

While this debate has mainly taken place in the world's financial hubs, over half of the world's least developed countries have plans to expand their fossil fuel production as a lever for their economic development (Bradle y et al., 2018). National Oil Companies control approximately 90% of the world's oil reserves and 75% of production (Tordo et al., 2011). Whilst most of these reserves can't be accessed without International Oil Companies technology and finance, this 'stranded nations' (Manley et al.,2017), have the largest proportion of assets exposed to stranding and the largest burden to avoid depleting the carbon budget (Heede and Oreskes, 2016).

Furthermore, many fossil-fuel rich states are characterized by lower long-term economic growth, high inequality, macroeconomic volatility and an uncompetitive manufacturing sector (Egert and Leonard, 2008). If fossil-rich countries governments decide to increase their production, anticipating their market is shrinking, they will be accelerating global warming, increasing their dependency and exposure and contributing to the sustained lower oil prices (van der Ploeg, 2016). However, they could decide to produce less, or not at all, proactively committing some assets to stranding. Ecuador attempted to strand a billion barrels of crude oil beneath the most diverse nature reserve on the planet. The Yasuni-ITT initiative asked the international community if they were willing to pay for stranding oil but failed. The proposal would have subverted the way oil is valued, from something that ought to be explored and extracted to something worth sequestering (Sovacool and Scarpaci, 2016).

To be able to find low-carbon development paths and leapfrog to a less carbon intense and diversified economy, the implications of stranded assets for developing countries needs to be further studied. Previous case-studies on stranded-assets include: South Africa (Leaton et al., 2012), Australia (Sussams et al., 2013), Brazil (Pimentel et al., 2013), Russia (Malova and van der Ploeg, 2017), China's Jilin province (Yuan et al., 2019). According to the Inter-American Development Bank (Caldecott et al., 2016) there is opportunity for pioneering work in this field in Latin America. This work is a first approximation to calculating stranded assets for Venezuela, the country with 18% of the world's oil reserves.

Venezuela´s oil sector decline

Venezuela's oil is state-owned. The development of the resources is in the hands of the national oil company, Petróleos de Venezuela (PDVSA). In 1998 PDVSA produced around 3.4 mbpd (OPEC, 2018), but in the last 20 years the company has steadily lost autonomy and talent (Monaldi, 2015). Production has declined by 50% between January 2016 and January 2019, reaching 1.1 mbpd. Also, from 1999 PDVSA decided to invest in heavy crude through the development of the Orinoco Oil basin, making Venezuela's oil mix increasingly heavy, with a higher production breakeven cost. In 2017, Venezuela was the second global producer of heavy crude with 1.45 mbpd. Although oil was nationalized in the 70's, the policies have been pendular in terms of foreign participation in the oil sector. After 2007, a system of joint ventures was set in place where PDVSA has the majority ownership; foreign partners were sought particularly in the heavy oil which required more investment (Monaldi, 2015).

Venezuela's fossil-fuel assets at risk of stranding

Venezuela owns about 189,663 million USD in oil and gas related assets. The largest amount (33%) as property of oil wells and production facilities (Table 1).

In terms of reserves, the Orinoco Oil Belt has 1,457,912 million barrels of heavy crude with a 20% recovery rate. Venezuela is the country with the largest world reserves. However, excluding gas which is mainly produced as by-product to oil, 86% of the oil reserves are of extra heavy crude and only 4.2% of all reserves have been developed (Table 2).

Assets	Million USD
Total	189,663
Properties, plants and equipment's	127,564
Oil wells and production facilities	62,259
Refineries	23,513
Storage and transport facilities	11,090

Table 1. PDVSA financial assets in 2016
Source: PDVSA 2016 audited Financial Statement

	Condensates, light, medium and heavy crudes	Extra Heavy crude	Natural Gas	Total
Developed proven reserves	8,913	4,031	6,783	19,727
Undeveloped proven reserves	32,085	257,222	28,165	317,472
Total proven reserves	**40,998**	**261,253**	**34,948**	**337,199**

Table 2. Venezuela's oil and gas reserves by type (million barrels or million barrels of oil equivalent).
Source. PDVSA 2016 audited Financial Statement.

Venezuelan assets in a global Energy Carbon budget and transition scenarios

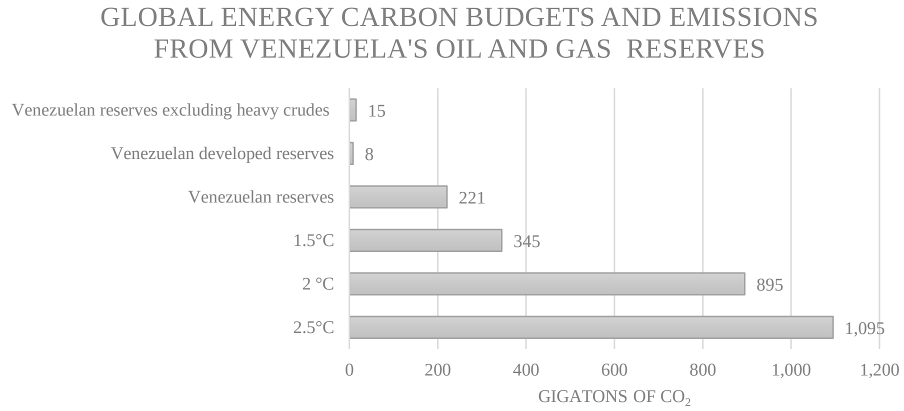
I chose to assess Venezuela's assets against a global carbon budget and energy transition scenarios.

Graph 1 shows global energy carbon budgets between 2019-2050 with a 50% probability of not exceeding the target temperature increase. I used the carbon budgets published by the Carbon Tracker Initiative (Leaton et al., 2013) and subtracted the emissions already committed (2013-2018) according to observations. The graph compares, the global energy carbon budgets with the emissions that would occur if Venezuela's reserves were burned. Emissions from Venezuela's total proven reserves would burn 64% of the 1.5 carbon budget and 24% of the 2 degrees. Whilst Venezuela's developed reserves, those that are already committed in ongoing projects represent 2.4% of the 1.5 carbon budget and 0.9% of the 2 degrees.

Table 3 shows my estimations of $GtCO_2$ for each type of Venezuela's reserves. I used Heede and Oreskes (2016) combustion emission factors 371 kg CO_2/bbl for the PDVSA crude typified as 'Condensates, light, medium and heavy crudes' and 53.4 kg CO_2/kcf for natural gas. For Venezuela's extra heavy oil reserves I used Gordon et al. (2015) global oil-climate index, which analyses thoroughly how different types of oil have different emission profiles. It evaluated Venezuela Hamaca Oil from the Orinoco basin as one of their initial 30 oil studied, and ranked it 4th in terms of overall emissions, producing 750 $kgCO_2$eq per barrel. The emission factor for extra heavy oil I have used is almost double the standard used by Heede and Oreskes (2016) who estimated PDVSA's remaining reserves emissions at 120 $GtCO_2$eq. My estimation is of 221 $GtCO_2$eq.

	Condensates, light, medium and heavy crudes	Extra Heavy crude	Natural Gas	Total
Developed reserves	3.3	3	2.1	8.4
Undeveloped reserves	11.9	192.9	8.7	213.5
Total proven reserves	15.2	195.3	10.82	221.32

Table 3. Venezuela's oil reserves in Gigatons of CO_2
Source. PDVSA 2016 audited Financial Statement and author's calculations.



Graph 1. Global Energy carbon budgets (2019-2050) in Gigatons of CO_2 with a 50% probability of not exceeding temperature increases of 1.5, 2 and 2.5 degrees Celsius, alongside emissions resulting from burning all Venezuelan reserves, the already developed reserves and reserves excluding Extra Heavy crudes. Source. Author's calculations based on CTI, IPCC, PDVSA.

My estimation places more burden in the emission factor of Extra Heavy and may be more similar in methodology to the McGlade and Etkins (2015) study. These authors estimated cumulative production of 3 billion barrels of Venezuelan extra-heavy oil and that 95% of the extra heavy reserves and 99% of the resources are unburnable, even with Carbon Capture and Storage deployed.

To also add a dimension of temporality and understand how much of Venezuelan oil might become stranded, I compared Venezuela's rate of production with global scenarios of energy transition. Under current levels of annual production, it would take Venezuela about 300 years to liquidate its reserves (Manley et al., 2017). Venezuela's market share between 2008-2014, was stable at around 7% of,OPEC production or 2.5% of World production. Considering that Venezuela recovers this market share and that in 2050 there will still be 50.59 mbpd of market for oil in IPCC scenarios for 1.5°C, my estimations are that Venezuela would be able to produce cumulatively by 2050 about 20,050 million barrels, which represents only 5.9% of the country's total reserves. Potentially, this would come from production of all currently developed reserves and only 7,000 million barrels of new undeveloped reserves, probably from the lighter crudes. This leaves untouched by 2050, 94.1% of the country's reserves.

Assessing potential stranding of PDVSA's refining capacity

With reduced global demand of crude oil, there will also be reduced demand for its products. Refineries margin of income could fall by over 50% by 2035 (Grant, 2017). Both national and international refineries owned by PDVSA have a life span of more than 60 years. Those in Venezuela are operating at below 30% capacity in 2017 and would require significant investments to regain full operativity. International refineries owned by PDVSA, particularly those in the U.S. help guarantee market for Venezuelan oil. With new regulations such as the reduced content of sulphur for marine shipping by 2020 (International Maritime Organization, 2019), Venezuelan extra heavy crude, typically high in sulphur may need further treatments in refineries, which may justify investments in foreign refineries. PDVSA refinery assets are worth 23,513 million USD in 2016. Given the nation's debt and the unpromising outlook of the refining industry it may be a good strategy to sell some refineries before they lose market value due to reduced energy demand.

Venezuela's breakeven production prices in stranded assets

Carbon Tracker Initiative's carbon supply cost curves report (Leaton, 2014) applied the carbon budget logic to the oil price and project breakeven cost. It estimated that a 360 $GtCO_2$ budget of cumulative emissions for oil, intersected with the supply cost curve at around the USD 60 breakeven price. The projects that fell in the 60-80 USD breakeven price were considered marginal barrels of oil, outside the carbon budget; projects with breakeven above 80 were clearly uneconomical. Under this procedure to evaluate oil projects, according to WoodMackenzie's breakeven estimates for ongoing Venezuelan oil projects four projects are above the 80 USD and the other three above 60 USD breakeven price, but only because of tax. Only Petroindependencia Heavy oil project has a pre-tax breakeven of 67 USD (Hernandez and Monaldi, 2016). This perspective of stranding CAPEX and projects by breakeven price, has practical limitations because the general global trend of reduction of production costs, due to technological improvement and regulation. PDVSA itself reports reducing costs of production between 2014 and 2016 by 57%. Venezuela Heavy Oil from Anzoategui ranked 11th in CTI 2014 study on CAPEX at risk of stranding with 20 bn USD exposed. This is most likely linked to new projects of extral upgraders which are unlikely to materialize. The current production and new lighter crude projects are viable under this tool for reviewing stranding. Futhermore, there is significant policy room to lower production costs by reducing taxes, as these represent 37.9% of the cost of producing a barrel (The Wall Street Journal, 2016).

Conclusions and policy recommendations

1. Venezuela may have become a failed state due to the natural resource curse and a stranded nation, with large amounts of wealth unworthy of extraction. My estimation is that 94.1% of reserves will not be used by 2050, when the world gets closer to carbon-neutrality.
2. Venezuela needs to reshape the national development discourse by:
   a. Prioritizing non-carbon intensive economic diversification, eliminating fossil-fuel subsidies, expanding electricity supply and a grid based on renewables and ensuring food security.
   b. Making the fossil fuel sector competitive, selling-out riskier assets such as old refineries, and quickly extracting initially to rapidly regain market-share but negotiating closely with OPEC and other producers to avoid rapacious depletion and sell-out scenarios, which leave Venezuela's heavier production out of the market (Mercure et al., 2018).
3. Future Venezuelans may ask how past generations of their citizens where able to deplete the income of PDVSA producing 1.1% of world's cumulative emissions, whilst not investing or creating any wealth and alternative pathways of development.

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Energy Macroeconomics

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In the recent modern industrial age, there are three interesting historic periods that give some indication about what can happen to the world's macro economy if a peak in world oil production were to occur: First, there is the era of the fall of the Soviet Empire which occurred after Soviet peak-oil in 1988. Second, there is the stagflationary era during the 1970s, when the U.S. reached its peak in conventional oil production in 1970 and how that affected the "West" including the U.S., Western Europe and Japan. And third, there is the era after the plateau of the world's conventional oil production that occurred starting in 2005 and which affected the entire world.

Note that since 2009, the world has relied on U.S. shale-oil at the margin for its liquid petroleum needs, and where U.S. shale-oil is about three times the real, inflation-adjusted price that conventional oil was during much of the 20th century, even at today's roughly $50 per barrel petroleum price. Non-U.S. shale-oil, though, may encounter higher costs to produce than U.S. shale-oil considering how easy it is in the U.S. to deal with the shale-gas compliments to shale-oil. That means that once U.S. shale-oil reaches its peak, then there will be a fourth peak-oil situation with a substantial increase in oil prices and a new macro-economic convulsion, upon which an appropriate speculation can be made.

Therefore, along the lines of Hamilton (1983, 2009, 2013) where oil prices are shown to cause macroeconomic events, maybe it is possible to take one step back in causation and look for oil supply levels, i.e., peaks in supply, to see if there are macroeconomic parallels or not.

Churrency Changes and Bankruptcies

Two observed macro-economic effects of a peak-oil event are currency changes and banking problems. First, consider the Soviet collapse. The way the macro-shock started at that time was with the sudden rubble shock-devaluation, where the Soviet rubble jolted down by an order of magnitude on October of 1989 one year after Soviet peak–oil. After the rubble shock, there was a continual rapid inflationary period, and eventually Russia, Ukraine, Kazakhstan and the other Soviet republics all created national currencies, and where the currencies continued to inflate.

Luckily, the new countries and their banks could still rely on having a reserve currency to use, such as the dollar, to help stabilize things. In the post-Soviet days, then, the banks kept two accounts: one for dollar loans and transactions and one for local currency loans and transactions. While this is not unusual in many banks around the world, it was more obvious in those days, but even then most common people kept their money in cash, i.e., dollars, rather than with the banks. Still, even with dollar reserves available to banks, and with government oversight, one could never tell when a bank might go bankrupt which happened from time to time during the post-Soviet transition.

In the West in the 1970s, a remarkably equivalent parallel to the Soviets occurred, where such an improbable parallel suggests that the macro-economies of East and West were more similar to each other than not. The Western shock started on August of 1971, only one year after the U.S. oil peaked in 1970, when U.S. President Richard M. Nixon took the dollar off of the Breton Woods gold standard system. That was the so called "Nixon-shock," which included a short lived wage and price freeze, but where the dollar and other currencies began floating. Troubles with the banks and the banking system took longer to mature, but came about with problems in the U.S. condominium markets, debt crises of several emerging market countries and the U.S.'s own Savings and Loan problems. And there was, in a similar manner as the post-Soviet situation, high inflation rates in the 1970s and into the early 1980s throughout the Western World.

The world's 21st century "Global Free-Trade Empire" had a little more subtle currency change after the 2005 conventional oil plateau. The post-2005 oil-plateau currency change started when the worlds' central banks carried out Quantitative Easing. And while most economists see the financial crisis as the cause of the Quantitative Easing, nevertheless, the increasing price of oil from 2005 onward had to have played a role in these macroeconomic events. After all, the high price of oil degraded economic vibrancy pushing people to lean on housing ever more forcefully as a way to continue spending.

The signal that the world's currencies had changed after 2005 came about in 2008 when many of the central banks started Quantitative Easing on a massive scale which included buying poorly rated mortgage backed bonds and other securities. The monetary base of the U.S., as measured by the Federal Reserve's assets, doubled in 2008 and doubled again in around 2014 such that it is now six times higher than it was in 2005. The ECB's assets also started increasing rapidly after 2008 and are now about 5 times higher than they were in 2005 and similarly with Japan. The world's currencies have different characteristics because the backing of the currencies has changed, and indeed the price of gold tripled. Another indication of the post-2005 currency change could be the invention of

Bit-Coin itself, as the idea behind crypto-currencies is the lack of trust in the central banks. Again, this third currency change somewhat parallels the Nixon-Shock and the Rubble-Shock.

The more obvious change after 2005 was the too-big to fail bankruptcies and potential bankruptcies of the world's largest banks that required all the quantitative easing in the first place. Then there were the banking stress-tests, the mortgage inversions and the housing abandonments that occurred. The inflation in the post-2005 plateau period was also more subtle in that housing and other asset prices rose substantially including that of stock prices, which have attained the highest price to earnings ratios since the late 1920s or the Dotcom Bubble. Thus all three modern "Empires" changed their base currency value, endured at least some inflation and had banking problems.

If we were to speculate on what may happen when peak U.S. shale-oil occurs, which may become the world's ultimate peak oil event, we can project similar circumstances. Probably currencies will become unstable. There may be a shock in gold prices and countries will be forced to devalue their money. It is also possible that European countries will separate each into their own national currencies similarly to how the Soviet Union's rubble broke up and national currencies were issued.

However, without a strong reserve currency, it will be hard to have banking. Therefore gold-backed banks may emerge to take care of banking needs and, like the Middle Ages, each bank will issue gold valued checks, or what might be called a bank issued currency, in order to help the economy work properly. It is also possible that gold and silver coin kiosks will be ubiquitous throughout the world, where people will have to trade in their currencies for gold, or something that is a hard asset, in order to hedge against their inflating currencies. One can only speculate on the relevance of crypto-currencies in such an environment.

So, the banks will transition to these new circumstances but one will never be able to tell which banks may go bankrupt or which ones will stay solvent. And without a single strong reserve currency, or a strong central bank, banks will have to revert to having one side of the bank for gold loans and transactions and one side of the bank used for local currency loans and transactions. But one may not know the gold reserves of any given bank and any bank could suddenly go bankrupt.

Then, countries, such as the U.S. with its gold reserves at Fort Knox, may try to resurrect a stable gold based currency, similar to Ancient Rome's famous Diocletian currency reform. But, it will be difficult not to be tempted to start printing and devaluing that new currency just to pay for government services. In the end, there may be less trust of the banks and less banking and that in turn will cause less economic activity in general. More people will save money under their mattresses than at banks, further reducing lending and economic activity. Fin-techs such as internet peer-to-peer lending will still have the same "trust" issues as conventional banking.

Deregulation and Breakdowns

In new institutional economics, such as Banerjee (2002) and shown in Gleaser and Shleifer (2002) and Umbeck (1977), institutions are as much caused by the macroeconomy as cause changes to it. During the post-Soviet economic change, for example, there was rapid de-regulation of the economy after Soviet peak-oil such as the relaxing of Soviet planned prices and people being allowed to sell things on street corners. The post-Soviet electric utilities were relatively stable, but as more people didn't pay bills and as people learned how to steal electricity from power lines, and because utilities were government owned and not allowed to raise prices severely, utilities often had brown-outs to survive. People would have available a certain time of day for power like for example a 2 hour window from 10 pm to midnight (22:00 to 24:00) and if that was your time, you had to use every electrical thing you needed at that time such as using the clothes washer or baking cookies.

Many post-Soviet stores, usually large ones, went out of business even as smaller mobile retail outlets and bazaars became more popular. There was a lot of trade in food with farmers' markets and trade in other items such as automotive parts, bicycles, chain saws and anything useful usually done on street corners or at bazaars. The mail services, the phone services and other services became inefficient and intermittent, and while you could ascribe that to the fact that they had always been relatively inefficient, nevertheless they had no ability to rapidly improve.

During the 1970's Western post conventional peak-oil, there was also an environment of de-regulation including the de-regulation of natural gas pipelines, airlines and trucking. One of the more interesting break-downs in the U.S. was with regulated gasoline (petrol) prices that created long gasoline lines (queues) with multiple cars waiting for a turn to fill-up with petrol. Other regulations such as the price of "new" oil and "old" oil created black markets of sorts for certifications of oil fields, which in turn reduced the ability to initiate enhanced oil recovery (EOR). Also there were some large retailers that had to re-structure in the 1970s such as Montgomery-Wards, which was sold to Mobile Oil Company, although Exxon was not allowed to purchase Sears. In both the Western and the Soviet situations, there were suddenly unemployed workers in all types of fields even in such fields as accounting, engineering and technical work as suddenly some types of work were less valuable while other types of work became more valuable. In the Post-Soviet States, there were even workers standing on street corners waiting for employers to hire them for the day.

In the 1970s in the West, utilities had to scramble to change away from oil generated power for peaking demands and in some cases could not change to natural gas since natural gas supplies to many locations were constrained by pipeline and shipping capacities. This induced a backing of nuclear power generation as an alternative form of power production and indeed after 2005 there was also a renewed backing of nuclear power that only slowed down and went into reverse after the 2011 Fukushima disaster.

In the post-2005 economy, de-regulations were more subtle. They included how Uber and Lyft among others created de-facto de-regulated taxi services around the world, and how Airbnb deregulated hotels around the world. Electronic information and shopping also changed and forced such retail outlets as Sears into decline. Alternatively, as in Post-Soviet days and in the 1970s West, there have also been counter-deregulations, examples of which include airline, retail store and banking mergers, ostensibly allowed to make businesses stronger in the face of economic volatility. In the U.S. due to the Supreme Court, labor unions have been de-facto de-regulated.

Another interesting parallel between eras is migration. In the post-Soviet world a number of people migrated often to ethnically centered homelands: Russians migrated to Russia, Uzbeks migrated to Uzbekistan and a number of ethnic Germans migrated to Germany. After the 1970s oil price shocks, many in the U.S. who had been living on the outskirts of cities tried to move closer to city centers even as interest in mass-transit accelerated. Job related migrations also occurred. The migrations of the post-2005 era have been more obvious than other eras in that they included the refugee crises around the world not just from Syria, but much of Northern Africa, Latin America and Myanmar among others and often as a result of lower worldwide economic activity.

Similar to the breakdown of utilities in the post-Soviet days, the long petrol queues in the 1970s' U.S. and the banking institutional problems in the post-2005 time frame, it is possible when the next peak in oil production hits to expect that regional utilities may have problems. For example, the current idealized deregulated utilities force regional grids to deal with multiple entities including buyers and generators, and where the grid operators have to mesh the power system differences together to smooth out the lumpiness of power loads and line frequency variances. Once economies and businesses break down, many of these grid entities may pull at each other and at least some of the regional electrical grids may fail, not to mention the possible break downs of water, internet and other utilities, and breakdowns of liquid natural gas (LNG) shipment logistics. Micro-grids might have to be instituted with high cost power and using storable fuels. Indeed, with oil, LNG and nuclear power constrained, as they could be, coal could re-emerge as a powerful energy back-up.

If internet, cell phones and national mail services break down, then private small carriers may become more important. Deregulation or counter-deregulation (consolidations) may happen in medicine, in regional zoning, in inner-city travel, in education, in fin-techs and in other areas. There may also be migrations within countries, between countries and across regions.

Conclusion

According to Reinhart and Roghoff (2009), each financial crisis is both different and the same, or as Tolstoy said, "Happy families are all alike; every unhappy family is unhappy in its own way." And so, too, would a careful analysis of peak-oil situations reveal parallels and differences, kind of along the lines of Diamond (2005), or Tainter and Patzek (2012). The parallels and differences considered here may look to be merely anecdotal. The point is not to prove the parallels, but to simply try to understand what could happen during severe energy circumstances forced on a modern industrial society. After all, global climate scientists consider a single planet's trend, rather than a thousand plants' trends, in order to discern potential futures. Past climate change events are also considered. Here, past macro-economic events are considered. These three past peak-oil situations in the modern industrial era may at least provide an impression of what could happen in the future.

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CONFERENCE OVERVIEW

The 43rd IAEE International Conference takes place in Paris, France, at the Palais des Congrès 21 – 24 June 2020, with the main theme **« Energy and Climate, Working hand in hand »**.

An ideal climate and energy policy regime should simultaneously address possibly conflicting objectives: ensuring energy security, promoting universal access to affordable energy services, and fostering greener and sustainable energy systems.

These policies notoriously have heterogeneous impacts on states, consumers, factor prices, energy technologies and existing assets like fossil reserves and carbon-intensive capital stock. Building credible and effective policies is a difficult task and needs to take into account geopolitical, economic and environmental realities to make them acceptable.

Against this background, the pressing quest for credible and sustainable solutions imposes to rapidly develop deep and broad analyses of policy instruments and institutions. It requires a broad mobilization of the concepts and notions used in economics, natural sciences, humanities or other social sciences to inform the numerous public policy debates affecting international energy trade, environmental regulation, markets vs. government intervention, energy infrastructure and technology choices.

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Stranded Assets and the Low-carbon Revolution: Myth or Reality?

BY ANNA CRETI AND CHRISTIAN DE PERTHUIS

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See footnotes at end of text.

Stranded assets trigger concerns in policy making, finance and investors' circles. Although they are defined differently (see Caldecott (2017) for an insightful survey), here we consider stranded assets as "fossil fuel supply and generation resources which, at some time prior to the end of their economic life (as assumed at the investment decision point), are no longer able to earn an economic return (i.e. meet the company's internal rate of return), as a result of changes associated with the transition to a low-carbon economy" (Carbon Tracker, 2017). In this broad perspective, stranded assets include not only oil, gas and coal remaining in the ground in a world that has decided it cannot bear the environmental cost of burning fossil fuels, but also those who have invested in the extractive industry and companies who use fossil fuels, and even consumers.

Are those stranded assets a myth or reality? For the avoidance of doubts, if we want to achieve the Paris Agreement targets, a reality, for sure. Even worse, a revolution. If we follow the actual trends of energy investments, a myth. Let us explain this contradiction.

According to the latest figures, after three years of decline, global energy investments in 2018 have stabilized at around 1.8 trillion dollars. This is what the International Energy Agency (IEA) reports in its World Energy Investment (2019).

Despite the decreasing renewable costs, especially in some regions, the investment activity in low-carbon projects is stagnating. In fact, there is a drop in electricity generation investment (–1%) and renewable energy (–1%), while that in fossil sources (+ 1%) and in particular coal (+ 2%) grows. On the other hand, the capital allocated to energy efficiency measures is unchanged. Bloomberg NEF's figures for clean energy investment in the first half of 2019 show mixed fortunes for the world's major markets. The "big three", i.e., China, the U.S. and Europe, all showed falls,[1] but with the U.S. down 6% at $23.6 billion and Europe down 4% at $22.2 billion compared to 2018, far less than China's 39% setback. Other countries perform better. Japan attracted $8.7 billion of investment, up 3% on 2018, and India $5.9 billion, up 10%, as it continued its drive toward its ambitious target for 175GW of renewable energy by 2022. Brazil saw investment of $1.4 billion, up 19%.

Looking at the future, in the IEA Sustainable Development scenario, low-carbon investments should cover a share of 65% as of 2030, against the current 30%. These trends are not in line either with future energy demand, or, above all, with the decarbonisation path and the sustainability objectives of the Paris Agreement. The same concern is expressed by Alexander Pfeiffer et al. (2018), who consider committed emissions from existing and planned power plants together with asset stranding.

Transportation networks are also an important component of energy assets. Transporting oil and gas is expensive: more than $9 billion to just double the Trans Montain line connecting Canadian deposits from Alberta to the Pacific; in the $50 billion for a complete LNG supply line from Australia to Japan. A large part of these assets may also fail if we do not act with anticipation. The example of gas infrastructure is instructive. In Europe, the network of pipelines is designed to bring imported fossil gas to the centers of consumption. If tomorrow we do not want more fossil gas, we will have to give up pipelines, unless we convert them to biogas transportation. But this choice requires substantial investment and regulatory changes.

Households are not left out because they also hold assets related to the use of fossil energy which they will have to get rid of. For example, in an increasing number of cities, municipalities now impose low emission zones that prohibit the use of thermal vehicles. These zones prefigure more global regulations that will prohibit the access of thermal vehicles to urban centers. Households living in the peripheric areas will still be dependent on thermal vehicles and have to pay the cost of implementing these regulations. Moreover, in the heating sector, many are also dependent on oil-fired boilers, which will also have to be abandoned.

Given the pervasiveness of the stranded capital, its total value is difficult to estimate. The flow of investment in fossil fuels is better known. In total, the IEA calculates that about $1,200 billion will be invested each year to develop the infrastructure to produce and sell fossils. It is probably necessary to add a comparable amount for downstream investments in equipment to use them. On the basis of these assessments, the Agency calculates the financing needs required to accelerate progress towards carbon neutrality by adding investments for the deployment of renewables and energy efficiency and subtracting those that can be saved on fossil fuels. In France, the I4CE (2018) institute uses a similar method to assess the financing needs of the energy transition. With this method, I4CE reaches the conclusion that "to meet the trajectory of the national objectives in terms of climate, 10 to 30 billion Euros of annual investments are still missing".

The limit of this type of calculation is that it only concerns investment flows and neglects the cost of stranded assets, which increases exponentially as the carbon budget contracts.

Nevertheless, something is changing. The European Investment Bank (EIB) has announced in July that it wants to align the granting of its loans with the objectives of the Paris Agreement. For this, in its new energy strategy published on July 26, the EIB declares its intention to stop all fossil fuel financing by the end of 2020. An announcement that is part of the European climate commitment with the sustainable finance plan from March 2018, the climate strategy at the beginning of 2019, and the publication of a classification of activities favorable to the ecological transition last June.

The decision is the result of a consultation process with EIB stakeholders (NGOs, citizens, companies, etc.) set up since January. They are the ones who brought up the need to better take into account global warming in its activity.

The coal phase-out in Germany is also another important example, based on a huge public financial commitment. The rating is so high that it can cast doubt on the financial capacity of the State (and the Länder) German, yet one of the richest in the world. This is why the economist Ottmar Edenhofer and Christoph Schimdt (2018) recommend using “an effective price of CO_2 to secure the exit of coal”. Using this method would reduce the cost of removing coal and reshuffling it differently between stakeholders: in the face of rising CO_2 prices, the issuing companies would have to quickly convert their production tool. With the proceeds of the carbon tax, the State would recover additional resources to support the transition and engage social redistribution policies. The degree of success of the German program will serve as an example beyond its borders. The other coal-producing countries will have to reconvert much younger electric generation units and capacities. The cost of these conversions continues to grow as new thermal capacities are added to the existing ones.

In France, the Loi Energie under discussion will establish an emission cap applicable from 1 January 2022, for fossil fuel-based electricity production facilities located in continental metropolitan France and emitting more than 0.550 tonnes CO_2eq / MWh.[2]

In the future, limiting the piling up of stranded assets tomorrow requires CCS systems likely to prolong the use of fossil fuels without emitting more CO_2. Investment in more efficient transportation and distribution networks, as well as electricity storage, are also useful to limit emissions. Moreover, emerging countries need to be attentive in deciding which resources to develop to avoid carbon lock-in and whether phasing-in renewables could avoid creating stranded assets in the first place.

We believe that investments in fossil fuels are still alive as climate and energy policies do not tackle the issue with consistent decisions. In the absence of sufficient economic or regulatory incentives, the low-carbon revolution could take too long and even become impossible.

Recent research identifies the crucial role of climate policy in avoiding stranded assets. Rozenberg et al. (2019) point out that irrespective of which type of instrument is used, the marginal cost of the climate change policy decomposes as a technical cost— the cost of using clean instead of polluting capital — and a temporary legacy cost that quantifies society’s regret for excessive past irreversible investment in polluting capital. However, a trade-off exists between political feasibility and cost-effectiveness of environmental policies. In a Ramsey model with clean and polluting capital, irreversible investment and a climate constraint, the authors analyze alternative climate policy instruments. They imply different transitions to the same balanced growth path. The optimal carbon price minimizes the discounted social cost of the transition to clean capital, but imposes immediate private costs that disproportionately affect the current owners of polluting capital, in particular in the form of stranded assets. Carbon price avoids stranded assets but, compared to the first best, it still results in a drop of income for the owners of polluting capital when it is implemented. Second-best standards or feebates on clean investment lead to higher total costs but avoid stranded assets, preserve the revenues of vested interests, and smooth abatement costs over individuals and time.

Another dynamic of stranded is shown by Baldwin et al. (2019). In a model of irreversible investments and a carbon tax increasing at a sufficiently high rate, owners of polluting capital cannot divest above the natural depreciation rate and profits become negative at some point of time due to excessive capacity. Irreversibility in investment implies an earlier shift to investment into the clean sector, to avoid later stranding of assets in the dirty energy sector. It therefore reduces emissions in the short term. Irreversibility effects on the demand side ease the impact of a carbon tax in the short-term. In the long-term, returns on this investment will fall, and thus the current investments are only attractive when short-term additional gains are sufficiently high to compensate for future losses

But choosing these regulatory instruments requires strong political commitment. Kalkuhl et al. (2019), in a model incorporating political-economy constraints, show that under rational expectations, a time-consistent policy outcome exists with either a zero carbon tax or a prohibitive carbon tax that leads to zero fossil investments – an “all-or-nothing” policy. Which of the two outcomes (all or nothing) prevails depends on the lobbying power of owners of fixed factors (land and fossil resources) but not on fiscal revenue considerations or on the lobbying power of renewable or fossil energy firms.

Due to multiple renouncements under the pressure of political feasibility, not only because of lobbying by energy firms, but also by citizens affected by regressive policies, our societies are still accumulating capital that will have to be massively divested. Therefore stranded assets are still a myth. The first cost of the energy transition is divestment, which will have multiple economic, social and cultural facets before becoming a reality. When given the right economic incentives, our companies know how to finance additional investments. They know much less well to disinvest. Leaving the logic of "always more" is the true revolution that our society has to make. To reach this ambitious target, a radical change in the orientation of carbon pricing, financing solutions, technology and household behavior is urgently needed.

Footnotes

[1] Within Europe, the situation is heterogeneous. In Europe, Spain was the star performer at $3.7 billion, up 235% on the same period a year earlier, while the Netherlands was 41% lower at $2.2 billion, Germany down 42% at $2.1 billion, the U.K. up 35% at $2.5 billion and France down 75% at $567 million. Sweden saw investment jump 212% to $2.5 billion, and the Ukraine 60% to $1.7 billion.

[2] However, the draft measure leaves open the possibility of continuing to produce electricity from coal after 2022, "for a small number hours".

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The Interplay Between Expectations and Climate Policy: Compensation for Stranded Assets

BY ACHIM HAGEN, NIKO JAAKKOLA AND ANGELIKA VOGT

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See footnote at end of text.

Assets that unforeseeably become devalued or turn into a liability are referred to as stranded assets (Caldecott, Howarth and Mcsharry, 2013). In the environmental context, asset stranding results from climate-related physical changes and from measures to prevent such changes, i.e., climate policies. Both causes may lead to asset stranding on enormous scale: Stern estimates the costs of climate change to be as large as 5% of global GDP per year (Stern, 2007). Regarding policies, McGlade and Ekins assess that 80% of all coal reserves have to become stranded to reach the 2°C Paris goal (McGlade and Ekins, 2015). Asset stranding, however, does not solely affect the owners of fossil fuel companies or the carbon-intensive firms using those resources as inputs. If large amounts of fossil resources have to remain unburned, the assets of those companies may be heavily overvalued, creating a "carbon bubble" (Carbon Tracker Initiative, 2011). Therefore, any investor holding stocks or bonds of these companies is exposed to the risk of financial instability. Financial assets worth $2.5 trillion are estimated to be at risk of stranding, sufficient to cause systemic shocks on stock markets (Dietz et al., 2016). Regardless of whether or not climate policies are implemented to prevent climate change, assets will become stranded. The costs of climate change without any policy intervention, however, surmount the value of stranded assets resulting from a guided policy-driven fossil-fuel phase-out (Stern, 2007).

In this article, we discuss how climate policies lead to asset stranding and why this phenomenon might prevent the successful implementation of policies. One potential option to achieve a broad consensus over climate policies is to compensate those who lose out due to policy interventions. Taking recent German climate policy-making processes as an example, we argue that policy making and the socio-political environment may lead those losers to expect compensation. Once these expectations are in place, costly compensation may become necessary to avoid larger economic shocks.

Assets become stranded either directly or indirectly depending on the design of a climate policy. Compensation schemes are easier to implement with policies that strand the fossil fuel assets directly. Demand-side policies devalue assets indirectly. For example, implementing energy taxes or raising emission standards reduces the demand for fossil fuels. Likewise, a cap-and-trade mechanism limits the total level of emissions, thereby cutting down on fossil resource extraction. R&D subsidies or energy efficiency programs aim at boosting renewable energy-based technologies and reducing fossil fuel usage. Thus, they too strand fossil resources indirectly.

Regarding supply-side policies, the mechanisms of asset stranding are more diverse. Production bans or revoking production licenses strand fossil fuel reserves directly. Supply-sides taxes, such as production taxes, export taxes or taxes on fossil fuel capital lead to asset stranding indirectly. Implementing a cap-and-trade system for production rights limits fossil resource extraction but it does not specify directly which assets would become devalued. Trading fossil reserves on deposit markets stands as an efficient policy option (Harstad, 2012). On such deposit markets, economic agents trade the rights to exploit fossil resources, leaving both the total amount and the location of the assets to be stranded unspecified.

In addition to questions of economic efficiency, asset stranding will also have implications on the distribution of economic resources. Clearly, any downward revaluation of fossil fuel-related assets due to climate policy will not be distributed evenly across society. The impacts will be concentrated among those who own fossil fuel resources, or capital assets complementary to fossil fuels or cheap energy (including human capital).

While these effects are of interest in their own right, the distributional effects of climate policies and associated asset stranding may also hinder or prevent the implementation of the policies in the first place. Naturally, those sections of society, which expect to lose out from a policy change, will resist the implementation of such change – even if the policy improves overall efficiency.

In principle, policies could be designed to address such distributional effects, perhaps by coupling them with compensatory transfers. However, as climate change is a very long-run problem, the benefits – and thus the surplus out of which these transfers come from – from policies to tackle climate change arise only in the future, while the costs are incurred at the time of implementation. This delay, together with the inability of governments to commit to future policies to compensate any losers, means efficient policies may not be implemented (Besley and Coate, 1998). Furthermore, ambitious climate policies could well lead to large changes in economic structure. This changes the composition of vested interests, and thus may change the composition of political coalitions, or the political preferences of these coalitions. As a result, future policymakers find it not in their interest to carry through with promised compensation. If interest groups today foresee this, they will not take promises of future benefits at face value. In other words, aggregate gains may be left on the table because of political resistance arising due to distributional concerns.

Policies to tackle climate change can also be persistent, sustaining themselves. This happens because economic agents – consumers, firms – will respond to policies, and these responses may strengthen their preference for the policy, creating policy lock-in (Coate and Morris, 1999). For example, the expectation of tighter climate policies can lead to the creation of vested interests in favor of such policies. A low-carbon industry can thus rise under the expectation of tight future policies; and once it exists, its political influence can sustain the implementation of these policies (Grey, 2018).

However, this persistence can also work in the opposite direction, in the case of policies intended to tackle the issue of stranded assets. As an analogy from trade policy, policies to protect declining industries from tightening international competition will also protect the political influence of these industries, so that costly protection is maintained for much longer than would be socially desirable (Brainard and Verdier, 1994). The lesson is that compensatory policies which seek to sustain the fossil sector's existence, rather than allowing it to contract but alleviating the economic pain of those affected by the transition, may lead to persistent political opposition.

All of the above mechanisms can prevent the implementation of policies to tackle climate change. The implication is that policy instruments should be designed to circumvent current political opposition, and to work dynamically to reduce opposition in the future (Acemoglu and Robinson, 2013). Next, we consider the case of the German coal phase out where the German government has sought to ameliorate concerns over distributional impacts of climate policies.

The German coal phase out is an interesting recent example of a regulatory climate policy (in the making) that leads to direct asset stranding. Anticipating the politico-economic difficulties of phasing out coal to reach its climate targets, the German government has set up a "Commission on Growth, Structural Change and Employment" to facilitate a broad societal consensus for the energy transition away from coal. The commission included representatives from different economic, environmental and social interest groups, such as representatives from mining regions, business, industry, environmental associations, trade unions, federal parliament and administration as well as scientists. After several months of intensive discussions, the commission published its final report in January 2019, recommending an end to coal-based power generation in Germany by 2038 (Federal Ministry for Economic Affairs and Energy (BMWi), 2019). Although only advisory, the report is expected to provide close guidance for the political decision-making process of the German government (Egenter and Wehrmann, 2019).

An important aspect of the report is that compensation payments for operators of plants and for employees are recommended to be settled in mutual agreement and the compensation funds should be provided through the federal budget. Support payments worth up to €40 billion are planned to strengthen the coal regions' infrastructure and to create jobs and investments in these regions. As a climate policy with very direct stranding of assets, the planned coal exit law, which is expected to contain a timetable for shutting down coal-fired power plants (Wehrmann and Wettengel, 2019), will likely be accompanied with compensation transfers (although the German parliament's research service concluded that the German state is not liable to compensate plant operators (Marschall, 2019). Through the early involvement of many relevant stakeholders in the commission, the economic risks of climate policies for companies and regions were part of the negotiations from the beginning. It is questionable if such strong commitments for compensation transfers for potentially stranded assets would have also been agreed on with less direct climate policies such as carbon pricing. For climate policies that cause asset stranding through indirect channels such as R&D subsidies for renewable energy, this would have been unlikely.

Although still in progress, the policy-making process in the case of the German coal phase out is an example where investors can expect at least partial compensation for stranded assets. The strong commitment to compensation in this case, however, has to be seen in context of the importance of the lignite industries in Eastern Germany, in regions that receive special political attention due to persistent economic weakness. This aspect significantly contributed to raising the political willingness to compensate for the directly regulated stranding of coal assets and may therefore be specific to this case.

Generally, in this example many parties are involved to find a broad consensus over how to achieve a fair transition. This process gives reasons for investors to form beliefs about potential compensation for asset stranding, and it raises the question of what investors expect regarding the stranded asset risk and compensation mechanisms.

In a recent paper, Sen and von Schickfus exploit the gradual development of a climate policy proposal in Germany, and infer investors' prior expectations by observing their stock market reactions to the amendments of the proposal (Sen and Schickfus, 2017). The proposal was first publicized in March 2015 as the "climate levy" (Klimabeitrag), which suggests charging power plants over 20 years old a fee on their CO_2 emissions.[1] The fee would be applied to emissions exceeding a certain threshold level, which was mainly binding for lignite plants. Hence, the policy would have stranded considerable lignite capacity.

This “uncompensated policy” faced strong opposition. At the end of May 2015, the trade union for mining, chemicals, and energy (IG BCE) presented an alternative proposal. The IG BCE proposed a capacity reserve plan for old lignite units. The affected units would operate only in the case of supply shortages. In June, the federal coalition opted for the security reserve proposal with compensation for affected firms. This “compensated policy” would move 2.7 Gigawatts of lignite capacity into a security reserve, and pay €1.61 billion of compensation. However, there was a “challenge to the compensation”. On August 14, Spiegel Online reported that the security reserve plans might fail based on an official report stating that the security reserve plan violates EU state aid rules. About one month later, the European Commission announced a state aid procedure, looking at such a potential violation.

Sen and von Schickfus investigate how the stock market reacted to the three stages of the proposal by focusing on the stocks of utility companies owning lignite assets, namely RWE and E.ON (Sen and Schickfus, 2017). Investors did not react to the announcement of the initial uncompensated policy, despite the fact that the climate levy would lead to substantial extra costs to these firms. The compensated policy did not lead to any reaction either. However, upon the announcement that the compensation might violate EU regulations, investors reacted sharply leading to over 20% loss in the value of RWE and E.ON. The evidence suggests that investors are aware of the stranded asset risk. However, as they did not react to the initial announcements of an ambitious climate policy, they seem to expect the affected firms to receive compensation.

Such expectations could result in carbon bubbles, if the expectations turn out to be incorrect. If expectations are not in line with the stranded asset risk, a sudden change in the stringency of climate policies can lead to abrupt changes in the value of fossil fuel assets. Energy companies are large and tightly linked to the rest of the economy. Hence, the stranding of assets can be a macro level risk. This situation can form beliefs that compensation payments are inevitable. This is a self-fulfilling prophecy: once expected, transfers may become necessary to avoid a bursting of the bubble. Early and credible commitment to climate policies, and clear signals on the principles by which compensation transfers are determined, are crucial to avoid such choices between systemic instability and costly compensation policies.

Footnote

[1] For more details see: Oei, P.-Y., Gerbaulet, C., Kemfert, C., Kunz, F., Reitz, F., and von Hirschhausen, C. (2015).“Effektive CO_2-Minderung im Stromsektor: Klima-, Preis- und Beschäftigungseffekte des Klimabeitrags und alternativer Instrumente.” DIW Berlin: Politikberatung kompakt, 98.

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Ahmad Al Khowaiter, Chief Technology Officer, Saudi Aramco

Alan Nelson, Chief Technology Officer, ADNOC

Amena Bakr, Senior Energy Correspondent, Energy Intelligence Group

Bassam Fattouh, Director, Oxford Institute for Energy Studies; Professor, the School of Oriental and African Studies, University of London

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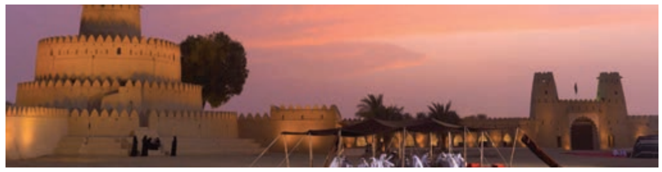

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Report of the 16th IAEE European Conference, Ljubljana, Slovenia

The 16th IAEE European Conference was organized by the School of Economics and Business, University of Ljubljana (SEB LU), and the Slovenian affiliate of the IAEE – SAEE. The central topic of the conference was Energy Challenges for the Next Decade. The conference took place on 25-28 August 2019 at the premises of SEB LU, and was followed by a Post-Conference seminar on 29 August 2019. The SEB LU was proud to host 301 conference participants from 41 countries. The conference started with the PhD day and continued with presentations and discussions in eight plenary sessions and 49 concurrent sessions.

Remarks by Professor Nevenka Hrovatin

At the Conference Opening professor Nevenka Hrovatin, General Conference Chair, Vice-President of SAEE, welcomed all participants and distinguished guests. She expressed her sincere thanks to the general conference sponsor, the Energy Industry Chamber of Slovenia, associating several Slovenian energy companies, three golden sponsors (Petrol, Gen-I and ELES), patrons and all other sponsors, who made the event possible. She highlighted the commitment of the conference organizer SEB LU to the energy efficiency and sustainability, reflected in the comprehensive energy efficiency retrofit project at the School, the solar power plant on the SEB LU roof and in the activities to promote the energy efficient behaviour of the SEB LU employees. Professor Hrovatin was also honoured and proud that the IAEE entrusted this event to the co-organizer, the Slovenian national affiliate SAEE, a young affiliate established in 2015, and to the one of the smallest countries in the EU, Slovenia, with only 2,000,000 inhabitants, but with the robust energy system witnessed in its position in the WEC Energy Trilemma Index.

For her personally, this event also marked her long-standing commitment to the IAEE starting in 1996 with her first participation in the IAEE conference in Budapest. Professor Hrovatin invited all participants to enjoy the conference program with distinguished speakers and chairs in the energy field and all social events. Amongst these was the opportunity to experience driving in Tesla electric cars, provided by the golden sponsor GEN-I.

In her speech at the Gala dinner in Cankar Hall professor Hrovatin thanked the International Program Committee, reviewers and the conference team (Jelena Zorić – Chair of the Organizing Committee, Sarah Jezernik – Chair of the Sponsorship Committee, Matej Švigelj – Chair of the Local Organizing Committee, two young researchers and doctorate students for the PhD day and other conference support Janez Dolšak and Ivana Jovović, Jana Pucelj – general conference secretary and other team members) for dedicating their time and skills in the last two years to the successful organization of the conference. She also addressed special thanks to the participants' serious work and positive energy seen during the conference: the latest being just the right one in the energy mix – renewable energy.

Conference Opening and Welcome Address

The official conference opening took place on Monday, 26 August. Conference participants were greeted by Professor Nevenka Hrovatin, General Conference Chair, Professor Metka Tekavčič, Dean of SEB LU, Christophe Bonnery, President of IAEE and FAEE and Marjan Eberlinc, President of the Energy Industry Chamber of Slovenia and CEO of Plinovodi d.o.o. A special recognition of the Republic of Slovenia to the conference was acknowledged by the welcoming speech by Alenka Bratušek, Minister of Infrastructure of the Republic of Slovenia:

Dear fellow guest speakers, distinguished participants, ladies and gentlemen,

I am pleased to welcome you here in Ljubljana at the sixteenth European Conference of the International Association for Energy Economics. On behalf of the Government of Slovenia I'd like to thank the Faculty of Economics, the Association and all others who made this event possible. It is now more than 40 years that the Association and its partners have been organizing such conferences – and this platform that you have established throughout the years is now more important than ever.

We live in exceptional, yet challenging times. On one hand, we are witnessing the complete digitalisation of our lives and constant technological innovation. On the other, we have the threat of climate change. The energy sector is somewhere in between. Because of this, we, the professionals working in the field of energy, have a crucial role. We have to be on track with innovations in energy and other sectors. And we should also envision the use of these innovations in the transition to carbon-neutrality. In order to achieve this, conferences such as this one are a must.

We have to exchange our knowledge, discuss our research and opinions, and base our decisions on *well-funded arguments. The task we have to deal with is complex, and we'll all have to share our best practices to avoid unnecessary mistakes. As you surely know, Slovenia is sixth in the World Energy Council's Energy Trilemma Index, and it is our plan to keep our energy system one of the best in the World. In our legislative actions, we consider and build on the five megatrends in energetics, that is decarbonisation, democratisation, digitalisation, decentralisation and deregulation.*

We believe that in the near future, the energy consumers-turned-producers will have an active role in energy supply and security. We are aware of the possibilities that smart-grids will bring in the distribution of electrical power. And we also focus our efforts in developing a sound e-mobility and public transportation policy and make the buildings and industry in Slovenia more energy efficient so to achieve our goals in regards to energy environmental sustainability.

Some of these measures come free of charge, but in most part, the transition to carbon neutrality will demand high expenses. I believe this question, the question of financing the decarbonisation process, is one that will occupy you the most during your debates here in Ljubljana and when you are back home. And it is one that is constantly on the mind of everyone involved in this great project of the human race.

Here, I'd like to point out that for me and my colleagues at the Ministry, energy is not only a commodity, but also a common good. With affordable energy we have a better functioning and more inclusive society, and solid ground for a competitive economy. Therefore, in our common transition to carbon-neutral energy sources, we should not only seek to maintain our energy systems robust. We must also focus on making energy stay at least as affordable as it is today.

Dear ladies and gentlemen, we are at a historical turning point for our species and our planet. Talking about likable visions of the future is easy, yet the questions that we have to find answers to are very, very hard. Nevertheless, I believe in our success. I believe we can propose realistic measures to achieve our goal and to finally make a strong step towards a zero-emissions society.

I wish you a nice stay in Ljubljana and a great learning experience here at the conference.

Hvala in lep pozdrav.«

Conference Social Programme

The official conference programme was accompanied by a social programme, giving participants a chance to network and continue the lively debates about the topics discussed during the official conference programme.

The Welcome reception was held at the SEB LU on 25 August 2019, immediately after the PhD day and the Special Seminar. The participants exchanged impressions about interesting lectures they attended and got to know each other.

The Cocktail dinner was held at the Ljubljana castle on 26 August 2019. The Ljubljana Castle, standing on a hill above the city for about 900 years, is the main attraction of Ljubljana. The castle's Outlook Tower and ramparts offer some of the most beautiful views of the city, while the castle houses a museum exhibition on Slovenian history, a puppet museum, and a number of historical rooms such as the Chapel of St George, the Prison, and a video presentation room called Virtual Castle.

The Gala dinner was held in the Grand Hall of Cankar Hall Centre (Hall) on 27 August 2019. The Cankar Hall is a multipurpose centre. Designed by Edo Ravnikar, the student of the notable master of architecture Jože Plečnik, Cankarjev dom is an architectural gem, whose splendour has not diminished with time.

Participants were entertained by the zither music (Blaž Kladnik) and the Award Ceremony (Best Student Paper Award: first place Marco Horvath; second place shared between: Maja Žarković and Filip Mandys; third place Steffen Lewerenz; Best Poster Award: Niklas Wulff and 2019 Journalism Award: Amena Bakr).

During the conference the participants also had the opportunity to experience driving with Tesla electric cars (sponsored by GEN-I) to the vicinity of Ljubljana (Gin Distillery, Bakery and the Lake Zbilje). For accompanying persons sightseeing of Ljubljana and tours to the Postojna Cave and Piran and to the Lake Bled were offered.

Conference Programme

PHD Day – Sunday 25 August

Students and young professionals were encouraged to take part in two PhD day seminars: Seminar 1 How to Write Papers for Publication in Scientific Journals given by Adonis Yatchew (Editor in Chief, Energy Journal; Professor at the University of Toronto) and David Broadstock (Deputy Director and Assistant Professor, Center of Economic Sustainability and Entrepreneurial Finance, Hong Kong Polytechnic University), and Seminar 2 How to Present Research Work in Scientific Conferences given by Markus Graebig (Project Director, WindNODE Consortium). The PhD day concluded with a Special Seminar opened to all conference participants Teaching Energy – Where Does One Begin? by Adonis Yatchew.

Opening Plenary Session Monday 26 August

Energy Landscape of 2030: Challenges and Opportunities

Summarised by Ivana Jovović, PhD student and young researcher at SEB LU

The opening plenary session of the 16th IAEE European Conference was chaired by Christophe Bonnery, President of the IAEE. The plenary speakers were Laurent Schmitt, Secretary General of ENTSO-E, Edward C. Chow, Senior Associate in the Energy and National Security Program at the Center for Strategic and International Studies (CSIS), USA and Alberto Pototschnig, Director Ad Interim, European Agency for the Cooperation of Energy Regulators (ACER).

Laurent Schmitt in his presentation E*nergy Transition - Three Ds: Decarbonisation, Decentralisation and Digitalization* remarked how we are at the centre of a significant transformation. In fact '4Ds' transforming the energy market (decarbonisation, decentralisation, digitalisation, deregulation) may very well become '5ds' as we also have democratisation when we put the end users in the equation. The last EU energy package, according to Laurent Schmitt, has set very ambitious targets for 2030 and 2050. However, there remains a fundamental question whether this is enough. It is up to grid operators to find the best pathways to the long-term targets, and to design scenarios how these targets could be realized. Laurent Schmitt reminds that we have now prosumers, energy communities, smart cities and micro grids appearing at the pan-European level. While the power system evolves, the governance must also change. It is fundamental to enable new transparency in our power system, and align data integration between TSOs and DSOs, especially so when it comes to the congestion management. In concluding remarks Laurent Schmitt emphasized ENTSO-E would continue to support engineering network codes, try to anticipate innovations and project and what is going to happen to the European power system.

Edward C. Chow in his lecture *European Energy State-of-the-Art: An Outside View* noted that when looking at the next ten years it is forecasted that the USA would increasingly be an exporter of oil. It is also forecasted that gas trading in the USA is going to look increasingly as oil trading in the last couple of decades. Europe is import dependent – more dependent on gas, and less import dependent on oil. It is forecasted that the net oil and gas import dependency in the EU will increase by 2035. Edward Chow concluded that in fact, it is not the USA's energy dominance; it is the USA's energy divergence from the rest of the global markets that we should consider in its relations not only to the peer competitors, but also to the closest allies and trading partners of the USA, including Europe.

Alberto Pototschnig began his presentation on the *Clean Energy Package and the Future Challenges for the Energy Sector* by noting that regulation should keep up the pace with the change in technology, and that regulatory framework must adapt without creating uncertainty. The Clean Energy Package is the last item in the sequence of packages that started in mid to late 90s which would enable the EU to deliver on Paris Agreement commitments. Decarbonisation, while being an obvious way of saving the planet, is a challenge when it comes to the energy system. Alberto Pototschnig concluded that with the increased sector coupling, gas resources could provide flexibility to the electricity system.

Dual Plenary Sesson 1
Prospects for Future Electricity Markets

Summarized by Elijah Sriroshan Sritharan, PhD student

Dual Plenary Session 1 was chaired by Hans Auer, Associate Professor at the Vienna University of Technology. The plenary speakers were Richard Green, Professor of Sustainable Energy Business at the Imperial College Business School, Reinhard Haas, Professor at the Vienna University of Technology, and Markus Graebig, Project Director of the WindNODE Consortium.

Richard Green began his presentation A Tale of Two Markets: Contracts for Renewable and Conventional Generators with explaining how in recent years learning curves for wind and solar PVs have come down drastically and as a result the cost of electricity generated from these technologies have plunged sharply. Lower generating costs of wind and solar PVs have created a huge problem for electricity utilities, which either buy or produce electricity from coal-powered or gas-powered (conventional) generators in the electricity market. Richard Green continued by making a remark that tumbling prices for solar and wind energy technologies and rapidly increasing expansion in these sectors do not mean that the renewable energy industry will be able to out-manoeuvre the fossil fuel industry overnight. The challenge the renewable energy sector faces is the energy storage. Richard Green's concluding remarks were that energy storage reduces generation costs during periods of peak demand and enables the grid controllers to manage unexpected variations in the demand or sudden losses in the electricity production capacity until alternative generating sources can be brought into action.

Reihnard Haas gave the lecture titled Heading Towards Sustainable and Democratic Electricity Markets. He noted that solar and wind have shown very rapid growth in recent times and the outlook for them is promising. The cost of the new-built wind and solar power generators have fallen below the cost of running the conventional ones. However, it is not possible to force "variable renewables" into the system. Nevertheless, there is a strong desire of some customers to participate in the electricity supply. For the supply to become predominantly renewable, the grids need to become more flexible and adaptable than they are today. Reinhard Haas concluded that the abundance of digital communication (smart grid) between the electricity consumer and electricity provider has opened up the possibility of a two-way communication. Integrating large amounts of wind and solar PVs requires new ways of operating the grids that will involve smart grids and more back-up supplies.

Markus Graebig's presentation gave an insight into the Sector Coupling, Flexibility and Outlook on the 2nd Phase of Energy Transition – Experiences from the WindNODE Project. WindNODE project includes over 70 partners working in 50 subprojects to provide a detailed view in various aspects of the intelligent energy system of the future. All partners are working together within four focus areas to enable a broad view of the intelligent energy system of the future: identifying flexibility, activating flexibility, digitalising the energy system, and developing a reality lab. As Markus Graebig explains, the first focus area refers to where and how potentials for technical load shifting as well as sector coupling can be found in north-eastern Germany. Digitalising the energy system means integrating large quantities of renewable energy into the energy system in a smart and efficient way. Finally, WindNODE is successfully making use of the new "reality lab" R&D format in north-eastern Germany for the first time. This serves to test out new operating and business models without incurring economic losses.

Dual Plenary Sesson 2
Prospects for Future Natural Gas and Oil Markets

Summarized by Janez Dolšak, PhD student and young researcher at SEB LU

Dual Plenary Session 2 was chaired by Kostas Andriosopoulos, Executive Director of the Research Centre for Energy Management and Professor at the ESCP Europe Business School, Chairman of HAEE. The plenary speakers were Karolina Čegir, Gas Expert at the Energy Community Secretariat, Lucie Roux, ESCP Europe Business School Alumna, and Tatiana Mitrova, Director at the Energy Center of the SKOLKOVO Business School.

Karolina Čegir in her presentation Gas Markets and Infrastructure: Focus on Europe noted that Europe in general has good gas infrastructure to have a developed gas market. There is a clear interaction between the infrastructure and markets as the gas sourcing cost decreased generally in Europe by the development of gas infrastructure. It is expected that the demand for gas in Europe in the next two decades will be stable. A lower production will be replaced by imports, especially by LNG. Gas is also the only fossil fuel whose share in the total energy demand will grow until 2035. The natural gas in the EU has been declining the least of all fossil fuels keeping more or less its current share of 25% through 2030 and loosing just one percentage point up to 2050. Hydrogen and methane have the brightest future among gases. When focusing on the Central-Eastern and the South-Eastern Europe we can observe lower levels of development of gas infrastructure in comparison to the rest of Europe. Local and regional markets influence the development more than long term contracts. Only few sources of supply are available. Plans to develop national networks exist, however their implementation is often delayed. This region faces a necessity for a new gas infrastructure.

Lucie Roux began her presentation Europe Cementing a Key Role in LNG: Global Balancer, Price Anchor and Demand Centre in its Own Right by explaining the Europe's aim is to become the global balancer, the price anchor and the demand centre for LNG. LNG trade flows have gradually shifted from a demand pull into Asia to a supply push into Europe since the fourth quarter of 2018. Surging the supply and weaker Asian prices accentuated this shift in 2019. This is because reloads from Europe to Asia have narrowed. In addition, Russian and USA LNG flows to Europe have increased strongly since the fourth quarter of 2018. Russia is steadily rising in the ranks of European LNG suppliers: a trend likely to persist with the coming new capacity. Regasification capacity utilization is up to 70% in North-Western Europe. Europe is the key LNG balancing market, the price anchor and the demand hub. Liquidity has surged, especially at the Title Transfer Facility (helped by LNG imports growth). The influence of Dutch gas hub in LNG pricing is growing. A weak demand in Asia could be short-term: Japan Korea Marker/ Title Transfer Facility spread could widen. However, Groningen production in Europe is set for a rapid decline, so more gas/LNG imports will be needed. The decline of the European domestic production and the coal phase out from the energy mix will support LNG imports. New import LNG terminal projects in Europe are in preparation. The EU has provided the initial support for four other LNG projects (Ireland, Greece, Sweden, and Poland). Lucie Roux concluded that LNG is as a fuel mostly present in medium and small scales. There is a growing consensus that LNG is the best solution as no equivalent alternatives that can match LNG's emissions profile and scalability are available (IMO 2020). The European small scale LNG market is expected to grow, which is also supported by the International Maritime Organization 2020.

Tatiana Mitrova shared her expertise in the Geopolitics of the European Gas. She stated that today's major four European gas suppliers are Russia, Norway, Algeria and Qatar, while for LNG, the major four suppliers are Qatar, Australia, Russia and the USA. According to the current trend, until 2030 this list will slightly change as the USA will continue increasing its imports and will become the second most important supplier for Europe. Russia, Norway, Algeria, Qatar and the USA are key gas suppliers of all gases for Europe. However, these markets are not equally stable suppliers for Europe. Qatar, for example, is known to be more profit seeking market and adjust their export between Europe and Asia according to the prices at each market. The global energy landscape and energy flows are changing and niches in the buyers' market are shrinking. There is a huge energy interdependency between the EU and Russia. Political issues between parties are associated with the geopolitics. Transactions costs in pipeline gas trade define institutional structures of the gas markets. The European gas market consists of two segments: the LTCS and the SPOT market, where the Russian company GAZPROM secured impressive portfolio of the former. Russia has also the largest contract portfolio, which guarantees at least 120 billion cubic meters per annum. The Russian gas pipelines are well placed in Europe to allow Russian gas to compete on the SPOT market with the LNG. It is expected that global oil prices and the Asian gas demand will define the European gas market situation.

Joint concluding remarks from this dual plenary session were that in the power sector we can expect a weak electricity demand growth, a fast expansion of RES, and still a strong coal presence (due to the low price of coal). Further, global oil prices and the Asian gas demand will define the European gas market situation.

Dual Plenary Sesson 3, Tuesday 27 August
Energy In The Digital World: The Shifting Fundamentals Of The Energy Business.

Summarised by Ivana Jovović, PhD student and young researcher at SEB LU

Dual Plenary Session 3 was chaired by Christian von Hirschhausen, Professor of Economic and Infrastructure Policy at the Berlin University of Technology, and Research Director at DIW Berlin. The plenary speakers were Gašper Artač, Head of the Energy Management Centre at Petrol d.d., Christoph Burger, Senior Lecturer at the ESMT Berlin and Hans Auer, Associate Professor at the Vienna University of Technology.

Gašper Artač talked about Making the Energy Transition Happen – Smart Technologies and New Business Models. As Gašper Artač highlighted, Petrol's vision for 2022 is a commitment to integrate energy, trade, mobility and advanced services into an excellent user experience offered by the important regional provider of comprehensive and sustainable solutions. He presented major energy industry trends and strategies, including RES generation, the efficient energy storage, electric vehicles, micro grids and the establishment of energy communities, and gave insights into major trends from the industry point of view. As Gašper Artač emphasized, Petrol implements projects related to e-mobility, RES generation, and integrated energy solutions (Compile and X-FLEX) in order to respond to the changes in energy technologies and consumers' demands.

Christoph Burger covered in his presentation Digitalization in the Energy World: the Role of Big Data, Artificial Intelligence, Blockchain and Cyber Security. He noted that digitalization investments aim to enable better performance, new networks and services in the light of a new energy world. Further, the artificial intelligence is creating opportunities for new service models with providers still controlling it by humans. Blockchain is seen as a game changer or, with further dissemination, likely providing the process and platform solutions with no hurdles for implementation. Christoph Burger concluded that the cyber security is getting more important while the smart meter infrastructure is specifically vulnerable at the edge.

Hans Auer talked about Competitiveness of Different Renewable Energy Community Concepts in a Smart Energy Future. He highlighted that robust business models on the local energy community level will emerge if 'old fashioned' policy making, legislation and regulations do not prevent cooperation and innovation. Energy community concepts will benefit from digitalization and will increasingly become self-sufficient. Further, he noted that grid tariff design is expected to head increasingly towards fixed charges in a RES world. In the end, Hans Auer emphasised that the resource adequacy questions safeguarding robust and smooth electricity market operation will become even more essential than today.

Dual Plenary Sesson 4
Challenges in the Final Energy Use: Innovation, Technology, Efficiency, Conservation

Summarized by Matej Švigelj, Associate Professor at SEB LU

Dual plenary session 4 was chaired by Reinhard Haas, Professor and Head of the Energy Economics Group, Institute of Energy Systems and Electric Drives, Vienna University of Technology. The plenary speakers were Amela Ajanović, Associate Professor at the Vienna University of Technology, Georg Erdmann, retired Professor from the Berlin University of Technology and Michaela Valentová, Researcher at the Czech Technical University in Prague.

Amela Ajanović presented E*lectrification in Transport: Economics and Environmental Aspects*. Since transport accounts for more than 20% of GHG emissions in the EU, effective policies and measures are needed. She stressed that full environmental benefits of electric vehicles (EV) will be achieved only if EVs are powered by electricity generated from RES. Finally, she noted that everything cannot be solved using EVs, but a new mobility behaviour is needed as well.

Georg Erdmann discussed the issues related to M*arkets for New Energy Storage Technologies*. He emphasized that it is rather challenging to develop promising business cases for electric storage systems due to high investment costs and cannibalization effects. Further, capacity markets are not a sustainable solution, while financing storage systems through monopolistic companies (grid operators) could be a feasible solution.

Michaela Valentová gave an overview of the Energy Efficiency Policy in (Central) Europe - Targets, Instruments, And Investment. She noted that there is a gap between the investment needs and the current scale of investments. Therefore one of the main challenges is to foster the investments. Further, systematic monitoring and evaluation of outcomes should be implemented. In addition, she also suggested the implementation of a broader set of financial (and other) instruments.

Dual Plenary Sesson 5
Energy and Climate: International Governance of Energy Transition

Summarized by Elijah Sriroshan Sritharan, PhD student

Dual Plenary Session 5 was chaired by Andreas Löschel, Professor and Chair for Energy and Resource Economics at the University of Münster. The plenary speakers were Frank Jotzo, Professor and Director of the Centre for Climate Economics and Policy at the Australian National University's Crawford School of Public Policy, Georg Zachmann, Senior Fellow at Bruegel and Maria Sicilia, Chief Strategy Officer and a member of the Executive Management Board at ENAGAS, the owner and transmission system operator of the Spanish gas network and a leading global gas infrastructure company.

Frank Jotzo delivered a presentation on the topic What does the Paris Agreement Imply for the Governance of Long-Term Low Emissions Development Strategies? He started with a question what was needed for decarbonisation with regard to the governance of national level low-emissions development strategies. Policymakers should understand "scenarios", for example, possible low-emissions strategies and conduct multi-scenarios on wide-range of areas, such as the future technology, economy, etc. First must understand "pathways", for example emissions, policy and governance pathways and finally they must understand "options and choices" in new energy industries and also beyond the energy sector. Second, policymakers should go beyond their ministries and cooperate with institutions such as the German Coal Commission and the UK's Committee on Climate Change. Frank Jotzo recalled that frameworks exist that can facilitate the transition. Public investments in policies with clear objectives are paramount, and so is regulation. He concluded that low-emissions development strategies should be regularly and critically assessed and monitored in terms of their direction, speed and the nature of transition.

Georg Zachmann began his presentation Current Discussions on Energy and Climate Targets by stating that the EU has emerged as one of the leading advocates for reducing emissions and has adopted ambitious carbon emission reduction targets. Member States in the EU report which polices they have and what impact these policies have on (1) non-Emission Trading Scheme emissions (2) renewable energy sources and (3) energy consumption. The RES ambition is overall in line with the 2030 targets, but individual member states under-perform. Member states also have national targets for the greenhouse gas emissions, share of renewables, energy efficiency, etc. Paris Agreement sets global targets, regarding the allowed temperature increase and the carbon neutrality.

Maria Sicilia began her presentation What is the Investment Framework Needed to Perform the Energy Transition? by noting that a critical task for governments is to ensure timely investments in green technologies which should be implemented on the appropriate scale. Currently, the private return on green investments lies significantly below the social return. The private sector responds to market incentives and price signals, but also to the policy uncertainty. A robust and gradually rising long-term carbon price is essential. RES have to go beyond the power sector. The innovation is needed for a seasonal storage and carbon capture, storage and use.

Dual Plenary Sesson 6
Future Role of Consumers, Prosumers and Prosumagers

Summarised by Ivana Jovović, PhD student and young researcher at SEB LU

Dual Plenary Session 6 was chaired by Jelena Zorić, Associate Professor at the School of Economics and Business, University of Ljubljana (SEB LU) and Chair of the Organising Committee. The speakers were Massimo Filippini, Director of the Centre for Energy Policy and Economics (CEPE) at ETH Zürich, Reinhard Madlener, Professor at RWTH Aachen University and Director of the Institute for Future Energy Consumer Needs and Behaviour (FCN) and Dejan Paravan, Chief Innovation Officer for the GEN-I Group.

Massimo Filippini gave a presentation on the topic Understanding Consumer Behaviour: Energy Efficiency Gap, Bounded Rationality and the Role of Energy Related Financial Literature. He noted that consumers are boundedly rational when it comes to making energy efficient choices about their consumption. The level of energy financial literacy and financial literacy impact the decision making process of consumers. He further suggested that in order to improve the level of energy efficiency we could: 1) oblige the producers of electrical appliances to provide monetary information for the yearly energy consumption on the energy label, 2) promote educational training on energy and investment related topics, 3) provide decision support tools such as online or mobile phone calculator tools or calculators at the point of sale and 4) promote energy audits at homes. In the near future the set of digital and information technologies, home automation, new algorithms of artificial intelligence and "machine learning" will play an important role in helping consumers to make more sustainable development oriented choices.

Reinhard Madlener gave insights to Energy Prosumage, Energy Poverty, and Energy Justice. He observed that the scientific and political interest in the topics of prosumage, energy poverty and energy justice has strongly increased in recent years. The origin of the energy justice debate comes from the environmental justice literature and the relatively long history of the fuel poverty debate in the UK in times of rising energy prices. A consideration of energy poverty and energy justice is also relevant for guiding any sustainable energy transition , not least for bearing the cost burden of the (existing, new and replaced) energy infrastructure and for maintaining the social cohesion. Reinhard Madlener concluded that the energy transition implies the shift towards new business models, different lifestyles, new policies, etc.

Dejan Paravan shared his experience of his company on How Should Business Models Change in Consumer Driven Energy Markets? He explained that the core business for the company GEN-I was traditionally trade and supply, but with the new developments of energy technologies and in response to the demands of consumers, a third area of core business comprises the development of energy services. In GEN-I digitalization has led to the new ways of customer interaction and communication and to the development of digital products and services accompanied by the emergence of new business models. Another trend is electrification, which should be addressed together with the energy storage, e-mobility, demand response and heating. In relation to decarbonisation targets, GEN-I responds with projects related to the self-consumption for the industry, energy communities, and individuals/households.

Closing Plenary Session Wednesday 28 August

Europe's Energy Sector in the Global Energy Industry: State-of-Affairs and the Future

Summarised by Ivana Jovović, PhD student and young researcher at SEB LU

Closing Plenary Session was chaired by Yukari Niwa Yamashita, IAEE President-Elect 2019, Board Member for the Institute of Energy Economics Japan (IEEJ) and Director in Charge of the Energy Data and Modelling Center, and the plenary speakers were Christian von Hirschhausen, Professor of Economic and Infrastructure Policy at the Berlin University of Technology, and Research Director at DIW Berlin, Michael Pollitt, Professor at the Cambridge Judge Business School and Joint Academic Director at the CERRE(Centre on Regulation in Europe), and Atanas Georgiev, Associate Professor and Vice Dean at the Sophia University St. Kliment Ohridski.

Christian von Hirschhausen presented Energy Scenarios, Projections, and Modelling ("Academic approach"): Case of the "Clean European Energy Package". Main findings of his presentation are that climate and energy scenarios are almost always a controversial topic. The discussion on these issues currently focuses on the "technology-supply-side", but we must also consider demand side mitigation. The fact that demand-side measures have not been systematically represented in scenarios has also been addressed by other researchers. Regarding the energy mix he commented that the nuclear power is not economically viable compared to other electricity sources and is more likely to be enforced in less democratic (totalitarian societies). In his view the increasing energy efficiency is good, but it is not enough. We have to start thinking of considering behavioural changes and societal transformations. Quoting Beck and Mahony (2018), Christian von Hirschhausen finds that we need to engage in "messy business of socioeconomic scenario building". He emphasises the importance of transparency and open-data-open-code. In this respect, he concludes that there is still a lot of work ahead of us

Michael Pollitt in his speech gave the policy advices: What Next for European Energy Policy? Suggestions for the New Commission. His findings are that carbon and heat markets need to be aligned with electricity and gas markets. The reliance on significantly more renewables requires much higher levels of institutional and market alignments. In a low demand growth environment, the fixed network costs and how to pay for them require substantially higher attention. The energy and climate policy should also pay more attention to distributional issues. The biggest relative gains from the EU policy remain in the European periphery and this must be a key focus.

Atanas Georgiev gave a regional perspective on South East European Energy Challenges and Opportunities Regional Energy Balances & a Case Study for Prosumers and RES. Investments in large RES projects in this region practically stopped after 2012 (with the exception of some biomass plants). The development of small RES plants, close to consumption, has not taken off and without proper incentives could not be improved. One of the legal challenges is that the laws do not distinguish between small and large RES producers, thus giving advantage to multimillion investments in utility scale RES capacities. Therefore, key policy recommendations for the region would be ensuring the inclusion of all RES in transparent, non-discriminatory national electricity markets, development of special programs for the subsidised construction of small scale RES as well as reconsidering large scale, government sponsored energy projects in terms of their final consumers' costs compared to the costs of electricity generated in small RES plants.

Post Confeence Seminar Thursday 29 August

Summarised by Ivana Jovović, PhD student and young researcher at SEB LU

The Post-Conference Seminar Energy Transition and Power Markets was delivered by Professor Richard Green, Imperial College Business School. The aim of the seminar was to give participants an overview of key economic and policy issues surrounding the transition to low-carbon electricity in market-based systems. Professor Green first covered the topic of Fundamentals of Electricity, concentrating on how economic costs can be minimized subject to the technical constraints imposed by the need to meet demand at all times without overloading the grid. He continued with the Electricity Markets, explaining

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16th IAEE
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IAEE International Association for Energy Economics
www.iaee.org

University of Ljubljana SEB School of Economics and Business

SAEE Slovensko Združenje za Energetsko Ekonomiko

Energy Challenges for the Next Decade

School of Economics and Business, University of Ljubljana, Slovenia

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optimal prices for power, how to pay for capacity, and different ways of pricing transmission constraints, discussing the difference between the USA and the European market designs, and how the operating constraints faced by power stations could affect electricity prices. Further, he focused on Renewables and Storage, examining how the intermittent nature of their output affects their value to the power system. Finally, he discussed Emissions Savings, setting out the economic theory underlying these issues with a "tutorial" approach, and presenting a number of recent research papers exploring these issues.

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Factoring Greenhouse Gas Emissions in Upstream Portfolio Decisions

BY FLORENT ROUSSET AND FERNANDO ROLLA

Introduction

The reduction of greenhouse gas (GHG) emissions has increasingly become a priority for the business community, including companies active in the oil and gas supply chain. According to the IEA, 15% of global energy sector GHG emissions are associated with oil and gas supply, about 5200 million tonnes (Mt). In Exploration and Production (E&P) activities, the majority of emissions are associated with the venting, flaring and fugitive emissions of natural gas, associated with the production of oil, which releases significant amounts of carbon dioxide (CO_2) and methane (CH_4) emitted into the atmosphere. While CO_2 and CH_4 have significantly different GHG impacts, their combined effects can be aggregated as a single unit measured in tonnes of CO_2 equivalent (tCO_2e).

According to the World Bank, 20% of global emissions are currently subject to carbon pricing regulation, ranging from $1 to $139/$tCO_2e$ with an average of $7/$tCO_2e$. Even in jurisdictions where no such carbon tax is currently in effect, E&P companies are increasingly applying a cost to their future CO2e emissions, in order to factor into project economics a hypothetical cost associated with GHG emissions.

The purpose of the illustrative case study that follows is to demonstrate that factoring in the economics of GHG emissions from the initial decision points of new projects can yield significant value.

The first scenario presented here is intended to highlight the potential for the economic attractiveness of early stage investments to be materially impacted by the cost of GHG emissions. This in turn could result in increased effectiveness of investments, by deployed capital to other resource development. The second scenario is designed to highlight how the assessment of GHG emissions in development concepts can materially improve project economics and mitigate the lifecycle economic risks of such assets.

For the purpose of this illustration, a single economic metric used for exploration decision making has been utilized. Indeed, while there are of course many factors that are assessed in this context, the Expected Monetary Value (EMV) is one of the most commonly used metrics for evaluating exploration opportunities.

Methodology

In this study, an illustrative exploratory offshore oil prospect was designed to assess the impact of applying a carbon price to emissions on the EMV. Two scenarios were considered, one where the development concept, should a discovery be made, would entail flaring all of the associated gas and the other where all of the associated gas would be reinjected in the reservoir. The only difference between these two scenarios from an economics perspective is cost, as the second scenario requires additional capital expenditure (CAPEX) and operating expenditure (OPEX) related to gas reinjection operations. It is worth noting that while both scenarios were assumed to yield the same volume of oil, a case could be evaluated where the reinjected gas contributes to an increase in oil production – however this has not been performed as part of this evaluation.

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The Carbon Intensity (CI), the volume of carbon emitted per unit of energy produced, for each of the two scenarios evaluated was estimated using an open-source engineering-based analysis tool developed at Stanford University called Oil Production Greenhouse gas Emissions Estimator (OPGEE). The OPGEE model takes a set of up to 50 inputs representing the field's properties and productivity averaged over its life in order to calculate the average CI. For this case study, the OPGEE model was modified in order to generate an annual profile for the tCO_2e emissions associated with the production of a hypothetical oil discovery.

The cost associated with these emissions was factored in the economic model by incorporating a range of carbon prices in $/$tCO_2e$ as a "carbon price". A number of sensitivities on the carbon price were run in order to identify the $/$tCO_2e$ threshold above which the second scenario, which has higher CAPEX and OPEX than the first scenario, becomes more attractive due to its lower CO_2 and CH_4 emissions and therefore $/$tCO_2e$ cost.

The EMV is calculated as the probability weighted average of two potential exploration outcomes: a discovery is made and developed thereby generating a positive Net Present Value (NPV) or to the contrary, the exploration and appraisal investments do not yield a commercial project and generate a negative NPV.

Profiles

The exploration and appraisal phase is assumed to be identical in all scenarios, with 3D seismic acquired, two exploratory wells and two appraisal wells being drilled. This is intended as a simplification, as in practice the initial outcome of the first exploration well may not justify the drilling of the two subsequent appraisal wells assumed here, which is nevertheless adequate for illustrative purposes.

The development of this illustrative offshore oil resource assumes the drilling of 18 production wells for both scenarios, yielding a short plateau of 60,000 barrels per day (bbl/d) resulting in a profile recovering 300 million barrels of oil (MMbbl) over 20 years. The production of associated gas is estimated on the basis of a constant gas to oil ratio of 300 standard cubic feet per barrel of oil (scf/bbl).

The chart below displays the oil production profile, identical in both scenarios for the purpose of this case

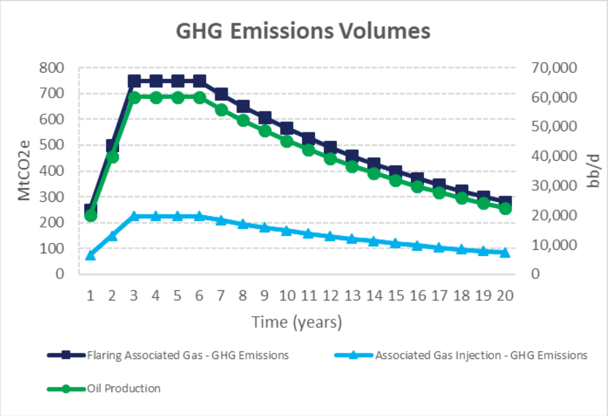

Figure 1: Profiles of oil production and GHG emissions volumes for the illustrative scenarios

study, and the GHG emissions profiles, in thousands of tCO_2e ($MtCO_2e$) per annum. The GHG emissions in the first scenario, where gas is flared, significantly exceed the emissions in the second scenario, where gas is reinjected into the reservoir.

These profiles are then incorporated for economic modelling, described in the following section.

Economic Assessments

The main assumptions used in order to estimate the NPV and then EMV of the various cases were:

- Discount Rate: 10%
- Oil price: flat $60/bbl
- Royalty: 12.5%
- No corporate income tax
- Geological Chance of Success (GCoS): 20%

The formula for the EMV is as follows:

EMV = GCoS ∗ NPV Successful Project + (1 - GCoS) ∗ NPV Exploration Failure

When the NPV of a successful project (discovery made and developed) multiplied by the probability associated with this outcome exceeds the NPV of an exploration failure multiplied by the associated probability, the EMV is positive. The more the EMV of an exploration opportunity is positive, the more attractive it would be considered. Likewise, when a project EMV is negative, or in other words proceeding with this investment is expected to destroy value, this project is unlikely to go ahead, no exploration wells are drilled and the potential hydrocarbons present become stranded.

The following tables summarizes the component parts of the EMV for the two scenarios described above across a range of carbon price sensitivities to illustrate the impacts of accounting for GHG emissions on exploration economics.

Project Indicators	**Unit**	**Flaring Associated Gas Scenario**	**Associated Gas Injection Scenario**
CGoS	%	20%	20%
NPV Exploration Sunk Costs	MM$	-155	-155
NPV Development	MM$	781	717
Expected Monetary Value	MM$	32	19
Estimated Ultimate Recovery (EUR) Oil	MMbbl	302	302
GHG Emissions Development Phase	tCO_2e	10455	3136

Table 1 Project Indicators assuming no carbon price

Project Indicators	**Unit**	**Flaring Associated Gas Scenario**	**Associated Gas Injection Scenario**
CGoS	%	20%	20%
NPV Exploration Sunk Costs	MM$	-155	-155
NPV Development	MM$	634	675
Expected Monetary Value	MM$	3	11
Estimated Ultimate Recovery (EUR) Oil	MMbbl	302	302
GHG Emissions Development Phase	tCO_2e	10455	3136

Table 2: Project Indicators assuming $50/$tCO_2e$

Project Indicators	**Unit**	**Flaring Associated Gas Scenario**	**Associated Gas Injection Scenario**
CGoS	%	20%	20%
NPV Exploration Sunk Costs	MM$	-155	-155
NPV Development	MM$	486	629
Expected Monetary Value	MM$	-27	2
Estimated Ultimate Recovery (EUR) Oil	MMbbl	302	302
GHG Emissions Development Phase	tCO_2e	10455	3136

Table 3: Project Indicators assuming $100/$tCO_2e$

The tables above illustrate how the scenario which assumes gas being flared yields a higher EMV than the gas reinjection scenario when there is no tax paid on carbon emissions, due to the higher costs required to reinject the gas. However, the attractiveness of these two scenarios reverses as a carbon price is incorporated in project economics, with the gas reinjection scenario becoming increasingly more attractive relative to the gas flaring scenario as the carbon price increases.

The EMV of both scenarios is reduced by a carbon price, as in both cases, even where gas is reinjected instead of flared, there are GHG emissions that trigger additional costs. However, it is noteworthy that the scenario with the lowest CI, the one without flaring, yields much more resilient economics, its EMV being significantly less impacted by a carbon price than the other scenario.

Multiple cash flow runs were considered for assessing the impact of different carbon prices on project economics for both scenarios:

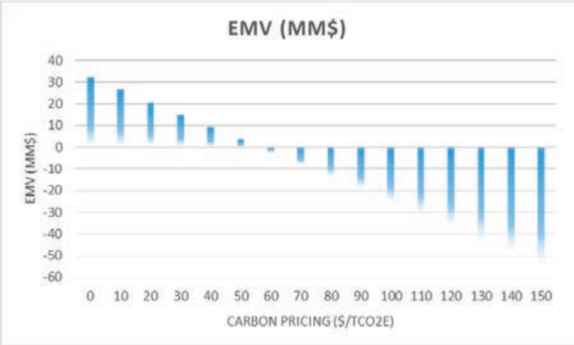

Figure 2: EMV Flaring Scenario across a range of carbon prices

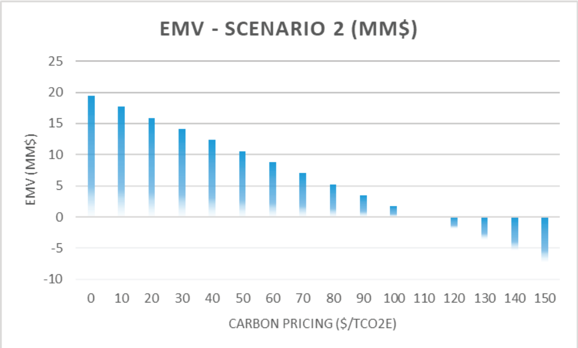

Figure 3: EMV gas reinjection scenario across a range of carbon prices

These figures confirm the earlier observation made that projects with reduced CI may yield lower EMVs due to their higher costs, but remain nevertheless attractive across a broader range of carbon prices. In the examples above, the gas flaring scenario would not justify any exploration investment if a carbon price in excess of \$50/tCO_2e is assumed, whereas the gas reinjection scenario would remain attractive up to a carbon price of \$100/tCO_2e.

Conclusions

Since an exploratory prospect would only be attractive if Expected Monetary Value (EMV) > 0, oil & gas companies should consider the potential impact of a "Carbon Price" when they run economics, even during the exploration phase, and take this into account when screening development concepts.

This is expected to generate a greater emphasis on reducing a project's CI from very early stages of evaluation, when an operator has the greatest ability to influence the development concept that will ultimately be adopted.

A prudent consideration of the potential impacts of GHG emissions on upstream project economics is essential, starting with an estimation of CO_2e emissions profiles and relying on a broad range of sensitivities to carbon prices.

Such an approach is increasingly warranted to preserve upstream value, rank exploration prospects and mitigate the risks of having stranded assets in a company's portfolio.

Conference Theme and Objectives

The development of energy as we know it, from production to conversion to end-use, whether from fossil-fuels, renewable power or other sources, results from an ongoing dynamic interaction between market needs and preferences, progress in technologies and public policy initiatives. Cutting across this to make sense of the ever-changing landscape is the analysis and language of energy economics: the essential ingredient that brings a common understanding of the forces and drivers in play.

The 38th annual USAEE/IAEE Conference provides a forum for informed and collegial discussion of how energy economics is contributing to the current and future thinking of businesses, consumers, technology developers and public policy institutions in North America and around the world as they drive towards the future world of energy.

In 2020, our conference takes place in Austin, Texas. Texas is a state rich in the history of energy as well as a vibrant proving ground for major changes in energy markets. In oil and gas, Texas was the home of the historic Spindletop discovery early in the 20th century; was at the heart of the US oil and gas developments for its first 70 years; and where the Texas Railroad Commission became a globally important regulatory authority. More recently, Texas has seen the birth of the US unconventional oil and gas business with the Barnett Shale in north Texas and the prolific Permian basin. Downstream, Texas is home to major refining and petrochemical plants as well as hosting new LNG export facilities. In electric power, Texas was a pioneer in opening up the market to retail competition and remains one of the few jurisdictions in the US where this remains the norm. And Texas has seen a huge build-out of low-carbon power generation, particularly wind energy, making the state a leader in this field. And last, but not least, Texas institutions like The University of Texas, Rice University, and an engineering school on the mid-Brazos, have been at the forefront of thinking and research about energy science and economics. There is indeed much to discuss and study just in relation to Texas energy markets and we expect conference delegates to benefit from this context.

As in previous years, the conference will highlight forward-looking energy themes at the intersection of economics, technology and public policy, including those affecting energy infrastructure, environmental regulation, markets, the role of governments, and international energy trade. Participation from industry, government, non-profit, and academic energy economists will enrich a set of robust, diverse and insightful discussions.

Topics to be addressed include:

The general topics below are indicative of the types of subject matter which may be considered at the conference. In practice, any topic relating to energy economics, markets, energy policy and regulation, energy trade, energy pricing, drivers of energy demand, adoption of new energy technologies etc. will be considered.

* Global impacts of growing US energy exports
* How are energy markets responding to the shift of U.S. energy policy?
* Pathways to decarbonization of energy and the economy
* Oil prices, the role of OPEC and OPEC/non-OPEC cooperation
* Energy implications of environmental regulations: future and impact
* The role and impact of distributed energy resources in developed and developing countries
* How are digital technologies, including blockchain and artificial intelligence and the Internet of Things impacting energy supply and demand
* What next for electricity storage technologies?
* Drivers and challenges for accelerated electric and autonomous vehicle adoption
* Effective policies to support growth in low-carbon energy
* The role of natural gas in the energy transition to a low-carbon world
* Other topics of interest including shifts in market structures and fundamentals, including those induced by policy and technological forces.
* Drivers and challenges for accelerated electric and autonomous vehicle adoption
* Role of natural gas in the energy transition to a low-carbon world
* Role and impact of distributed energy resources in developed and developing countries
* Evolution of electricity storage technologies
* Financing conventional and renewable energy
* Who is financing what and why it matters?

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Central Texas Association for Energy Economics

Advance call for Concurrent Session Presentation Proposals

We are pleased to announce an advance call for Concurrent Session presentation proposals for the 38th USAEE/IAEE North American Conference, Energy Economics: Bringing Markets, Policy and Technology Together, to be held November 1-4, 2020 at the Sheraton Austin Hotel in Austin, Texas, USA. The deadline for receipt of proposals is May 31, 2020.

Concurrent Sessions

The concurrent sessions at the USAEE/IAEE conference offer opportunities for students, academic staff, as well as energy economists and practitioners in the business, government and research communities to present current analysis, research or case-studies on topics related to energy economics and energy markets. Presentations may be based on academic papers, but this is not a pre-requisite requirement. We stipulate that presentation proposals submitted for inclusion in the concurrent sessions should not have been previously presented at or published by USAEE/IAEE or elsewhere. Presentations are intended to facilitate the sharing of both academic and professional experiences and lessons learned. Those interested in organizing a concurrent session should propose a topic and possible speakers to David Williams, Executive Director, USAEE (usaee@usaee.org). Please note that all speakers in organized concurrent sessions must pay speaker registration fees and submit abstracts.

Concurrent Session Presentation Proposal Format

Authors wishing to make concurrent session presentations must submit a proposal that briefly describes the topic, research or case study to be presented.

The proposal must be no more than two pages in length and should include the following sections:

a. Overview or summary of the topic including its background and potential significance
b. Description of the context, data used, or illustrative example of the topic
c. Summary of key insights, results or further questions
d. Conclusions: Lessons learned, business or market implications, recommendations for further work

Please visit www.usaee.org/USAEE2020/PresentationProposalTemplate.doc to download a proposal template. All proposals should conform to the format structure outlined in the template. Proposals should be submitted online by visiting www.usaee.org/USAEE2020/submissions.aspx Proposals submitted by e-mail or in hard copy will not be processed.

Presenter attendance at the conference

At least one presenter of an accepted concurrent session presentation proposal must pay the registration fees and attend the conference to make the presentation in person. The person submitting the proposal must provide complete contact details—mailing address, phone, e-mail, etc. Presenters will be notified by July 13, 2020 whether their proposal has been accepted. Presenters whose proposal are accepted will have until August 24, 2020 to submit their final papers for publication in the online conference proceedings. While multiple submissions by individuals or groups are welcome, the proposal selection process will seek to ensure as broad participation as possible: any person may present only one topic at the conference. No person should submit more than one proposal as its single author. If multiple submissions are accepted, then a different presenter will be required to pay the registration fee and present each paper.

Students

In addition to the other opportunities, students may submit a paper for consideration in the Dennis J. O'Brien USAEE/IAEE Best Student Paper Award Competition (cash prizes plus waiver of conference registration fees). The paper submission has different requirements and a different deadline. The deadline for submitting a paper for the Student Paper Awards is June 29, 2020. Visit www.usaee.org/usaee2020/bestpapers.html for full details.

Students may also inquire about scholarships covering conference registration fees. Please visit http://www.usaee.org/usaee2020/scholarships.html for full details.

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Clash of Visions – Coal in Southeast Asia

BY WEN-YU WENG

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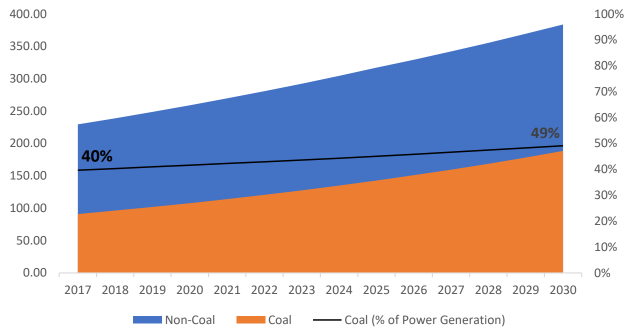
Southeast Asia, a region with immense renewables potential, diverse and rapidly growing economies, and an increasingly educated and technical workforce, has largely presented a mixed picture when it comes to its decarbonization efforts. Despite record-low costs and growing market shares of renewables, coal remain a formidable incumbent in this region. By the IEA's account, power demand in the region is set to soar approximately 70% between 2017 and 2030 under the Current Policies Scenario, with much of the generation expected to be met by coal, which is likely to remain the fastest growing energy source through to 2040.

With rising economic prowess and political significance, Southeast Asia is at a critical junction. Its policy and investment choices will profoundly affect its path of development and the advancement of the global climate agenda. Below, we review some of the main developments and highlight examples that depict the complex narratives around coal within Southeast Asian economies.

Regulatory conservatism



Contribution of Coal to Growth of Power Generation in ASEAN
Source: WEO 2018

There have been many laudable signs of changes in the energy sector. Last year, while residents in an upscale Bangkok neighbourhood began experimenting with futuristic peer-to-peer renewable energy trading on a blockchain platform, renewable energy and environmental advocates in Indonesia were celebrating a small win in the form of a Presidential announcement to wean Indonesia slowly off coal. Not long after, emerging from years of revision, the Thai government revealed its latest Power Development Plan in January 2019, which saw the downward revision of coal in its future power mix and the introduction of a new target for floating solar – a nascent but promising technology. The same technology also became eligible to receive a 20-year Feed-in Tariff (FiT) in the same year under a decision issued by the Vietnamese government.

The steady progress in embracing clean energy generation and related enabling technologies, however, have often been derailed by bureaucratic instincts and institutional inertia. To implement any lasting change in Indonesia, for example, President Widodo will face the Sisyphean task of reforming the convoluted state power procurement plan ("RUPTL") as designed and administered by the state utility, PLN. In recent years, Indonesia's tariff schemes for renewables had become even more unpredictable, threatening to shut out renewables from areas with significant renewable resource potential. In Thailand, the government regulator, Energy Regulatory Commission, raced to demand producers using blockchain technology to pay an additional fee for the "destabilizing effects" of the technology, thwarting public and economic interest in the promising, decentralized approach.

Regulatory changes often protect existing stakeholders and their interests. This is further compounded by the strong ties that often exist between fossil fuel industries, state distribution utilities, and ministries and regulatory bodies in Southeast Asian nations.

Economic forces at play

According to Argus Media, as cited in the *Financial Times*, the price of thermal coal has generally declined since the third quarter of 2018. Prices around the world have fallen to record multi-year lows in the second quarter of 2019, before the markets saw a slight reprieve. The price drops may only reinforce coal's attractiveness to emerging economies.

	2018	2019
Supply		
Indonesia	428.8	389.5
Australia	208.1	200.4
Russia	147.5	139.6
Colombia	77.9	83.9
South Africa	73.5	76.6
US	49.6	38.6
Demand		
Northeast Asia	298.4	300.2
China	207.8	191.4
India	175.9	153.3
EU/Turkey	147.9	151.0
Southeast Asia	104.0	92.7

Global seaborne thermal coal trade for select regions and countries 2017-2018 (mn t)
Source: Argus Media

In 2018, Southeast Asia imported 11.3 million tons more thermal coal than in 2018, offsetting any import declines seen in Northeast Asia, the EU, and Turkey. It is no wonder that the region has been perceived as the frontier for coal power, and a battlefront of an emerging "geopolitical rivalry" between China and Japan as they race to offer willing countries coal power financing and cleaner, more efficient coal technology. This booming market is furthered supported by Indonesia's vast reserves and high production. Today, Indonesia is one of the top coal exporters in the world, and its cheap coal dominates the supply mix in Southeast Asia.

In the meantime, historically low costs of solar and wind projects are driving multi-gigawatt pipelines even in less mature renewables markets. Mapping tools and analysis developed by researchers at the U.S. Agency for International Development and the U.S. National Renewable Energy Laboratory have also found significant potential for utility-scale renewable generation across the region.

Nonetheless, technological and cost factors alone will not be sufficient to drive a renewables build out if investors remain averse to the regulatory risks and market inefficiencies in the economies. When coupled with strong incentives, the private sector has proven keen to play – the solar sector in Vietnam being a particularly noteworthy case study.

Investment pressures

The nudge to renewables relies on push-pull factors working in consortium. While renewable technology LCOEs have dropped, international investors have also begun to embrace the ESG agenda, making coal financing increasingly difficult. Research by the Institute for Energy Economics and Financial Analysis (IEEFA) shows that over 100 globally significant financial institutions have imposed restrictions on lending to, or investment in, coal projects.

This is not an exclusively European nor North American phenomenon. In March, the State Development & Investment Corporation (SDIC) became the first Chinese financial institution to declare its plan of withdrawing from the coal Industry. In May, the United Overseas Bank – the third-largest finance group in Southeast Asia – moved to join its fellow Singaporean Banks, OCBC and DBS, in announcing its intention to stop financing coal. Shortly after, Japan's Mitsubishi UFJ Financial Group revised its environmental and social policy framework to write out future coal financing, albeit with some exceptions begrudgingly factored in.

As private equity and development financing from multilateral institutions exit the doors, coal projects face strong headwinds and a race against time. In addition, mounting regulatory pressures and price competition from renewables threatens to render permitting and attractive financing impossible. Analysis by the Carbon Tracker posited that as much as $60 billion of coal power assets may become stranded over the next decade in key growth economies in Southeast Asia, such as Vietnam, Indonesia and the Philippines.

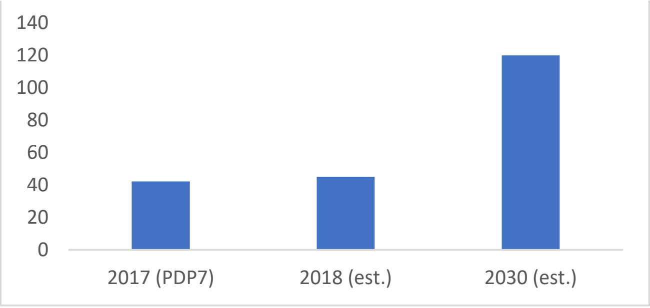
A battle over policy priorities

The concept of stranded assets is no longer as unfamiliar to policymakers as it once was. Policymakers often understand that delaying action could exacerbate the difficulty in course-correction in the future and potentially affect the creditworthiness of governments as well. But course-correction is easier said than done, particularly when institutional priorities and policy motivations are at odds with divesting from coal.

It is unlikely that the momentum of coal power will be halted in the region, as many nations are eager to extend energy access, support economic and population growth, sustain rapid urbanization, and ensure cheap baseload power for its industrial manufacturing base. Members of ASEAN are delivering some of the highest economic growth rates in the world and their governments will seek every means to – literally – power this growth. Future stranding, inefficient or underperforming technologies, and early retirement of coal plants may be economically wasteful, but nations will seek every opportunity to keep the lights on at homes and the machinery churning in productive factories.

Constraints on renewables are multiplied by binding socio-economic mandates. For example, according to the World Bank, as much as 30% of Myanmar are currently under-electrified or lack access to electricity entirely. While micro-grids and mini-grids powered by renewables remain a possibility, the government is keen to extend the fossil- and hydro-fuelled main grid wherever possible. And although renewables off-grid solutions hold great promise, private sector involvement in many countries have faced scaling problems, and legal and economic barriers. Improving access to modern energy services (particularly to "last mile" communities) is also a key policy objective in Indonesia, the Philippines, Cambodia and Laos, and all governments still present fossil fuels as playing an inevitable role in a larger grid.

Sustaining remarkable economic growth also underpins the policy priority of governments in the region. Although Vietnam has been a glowing growth story for renewables in the last few years, in order to support the projected economic and population



Power Generation Capacity Growth
Source: Power Development Plan VII, FTI analysis

growth, we conclude that Vietnam's required power generation capacity will have to at least double by 2030 compared to 2018. The government would not be keen to write off coal projects any time soon.

While every member nation of ASEAN has adopted individual national renewable energy targets, the most significant regulatory contribution requires a co-ordinated approach. The clean energy transition requires a consistent and comprehensive framework that supports the end-to-end needs of a clean energy industry – from early research, to conducive industrial policies, to permitting and licensing, to project finance and creating bankable conditions, to supporting renewable developers find lasting and predictable routes to markets. As a whole, ASEAN has also set itself a goal of generating 23% of energy from renewables by 2025. While the goal is theoretically achievable, our analysis depicts that drastic policy measures must be instituted early and swiftly, and sustainable and steady investment incentives introduced, to cultivate the pipeline necessary to meet the capacity built-out required to meet the regional target.

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7th IAEE Asia-Oceania Conference 2020
Auckland, New Zealand | 12-15 February

Energy in Transition

Nau mai, piki mai, toia mai, haere mai.
Welcome, bring your energy, ascend the heights, welcome.

Plenary Sessions

Planning for IAEE Asia-Oceania 2020 is well underway, including our line-up of plenary sessions. We can announce the following speakers:

Energy Lanscape of 2030: Challenges and Opportunities
Alison Andrew, Yakuri Niwa Yamashita, ZhongXiang Zhang

Fossil Fuels
Ron Ripple, Adonis Yatchew

Energy Transition in Transport
David Levinson, Amela Ajanovic

Electricity Markets
Derek Bunn, Richard Green

Energy Efficiency
David Stern, Janet Stephenson, Tooraj Jamasb

Smart Cities and Grids
Duncan Callaway, Dennice Gayme

Low Carbon Economy
Yukari Niwa Yamashita

Policies and Regulations
Christophe Bonnery, Franz Jotzo, Ying Fan

Pre-Conference Workshop (12 February)

Ten Big Ideas in Energy - What Everyone Needs to Know
Adonis Yatchew

Earlybird Registration (NZD. Valid til 1 Dec):	
Speakers/Chairs (Member)	$955
Speakers/Chairs (Non-Member)	$1155
Full Registration (Member)	$1125
Full Registration (Non-Member)	$1325
Student/Young Professional (Member)	$400
Student/Young Professional (Non-Member)	$500
Spouse/Accompanying Person	$550

Technical and Social Tours

A guided tour of Rotorua and Taupo is planned on the 10 - 11 February for those interested in seeing a unique part of New Zealand.

Tour highlights will include:

- Waiotapu Thermal Wonderland
- Wairakei and Huntly Power Stations
- Huka Prawn Farm

Alternatively, join us for a half-day tour on Saturday 15 February to Auckland's beautiful Waiheke Island, known for its wineries, olive groves and stunning beaches.

Registration for tours will be opening soon.

Abstract Submission Extension

We will now be receiving submissions until ***18 October***

For more information visit our website www.iaee2020.nz
He waka eke noa tātou. We embark on a journey together.

SYMPOSIUM PROGRAM

9.30 – 10:00 Registration & Coffee

10: 00 – 10:30 Opening

Prof. Dr. Nazife Baykal, Chairperson of the Board and President of the Campus @ Middle East Technical University Northern Cyprus Campus

Prof Dr. Gürkan Kumbaroğlu, President @ Turkish Association for Energy Economics

Ersin Tatar, Prime Minister@Turkish Republic Northern Cyprus (tbc)

10:30 – 11:30 Keynote

Yukari Yamashita, President-Elect @ The International Association for Energy Economics IAEE & Board Member, Director @ The Institute of Energy Economics IEEJ, Japan

11.30 – 13:00 Session 1- Geopolitical Framework within Eastern Mediterranean

Dr. Hayriye Kahveci Özgür, Professor @ Middle East Technical University Northern Cyprus Campus

Dr. Amit Mor, CEO @ Eco Energy, Israel

Dr. Isabella Ruble, Senior Research Fellow @ Department of Energy, United States

13:00-14:00 Lunch Break

14:00 - 15:30 Session 2: Hydrocarbon Explorations, Production and Logistics

Dr. Charles Ellinas, CEO @ ECP Cyprus Natural Hydrocarbons Company Ltd

Gina Cohen, Lecturer @ Technion University Israel

Magsud Mammadov, External Relations Director @ TANAP, Turkey

Dr. Sohbet Karbuz, Director of Hydrocarbons @ Mediterranean Observatory for Energy, France

15:30-16:00 Coffee Break

16:00 - 17:30 Session 3: Electricity Supply and Demand in the Eastern Mediterranean

Dr. Murat Fahrioğlu, Professor @ Middle East Technical University Northern Cyprus Campus

Dr. Mounir Rached, President @ Lebanese Economic Association, Lebanon

Markus Graebig, Project Director @ WINDNODE, Germany

18:00 Gala Dinner

Organized by

the **Turkish Association for Energy Economics** in Collaboration with the **Middle East Technical University Northern Cyprus**

Registration is now Open!

Register Online at **registration.ccevent.org/metu2019/payment**

TYPE	REGISTRATION FEE
*Standard**	US $200
*TRAEE members**	US $140
*Locals***	free
* 18% VAT is not included	
** attendees from Turkish Republic of Northern Cyprus	

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Calendar

15-18 October 2019, Power Purchase Agreement (PPA) from Commercial Perspective - Kuala Lumpur at Kuala Lumpur, Malaysia. Contact: Email: vincs@infocusinternational.com, URL: http://www.infocusinternational.com/ppacommercial/index.html

16-17 October 2019, 10th World Energy Congress at Singapore. Contact: Phone: +6531080483, Email: energycongress@insightsummits.com, URL: https://www.meetingsint.com/conferences/smartenergy

16-17 October 2019, Energy Congress 2019 at Singapore. Contact: Phone: +6531080483, Fax: energycongress@insightsummits.com, Email: energycongress@insightsummits.com, URL: https://www.meetingsint.com/conferences/smartenergy

16-17 October 2019, SPE Workshop: Delivering Value Through Automation at Gulf Hotel Bahrain, Building 11 Road No 3801, Manama, Bahrain. Contact: Email: mramathany@spe.org, URL: http://go.evvnt.com/482153-0?pid=204

17-19 October 2019, 4th IAEE Eurasian Conference, Uncapping Central Asia's Potential: How Central Asia Can Contribute to Global Energy Security? at Astana or Almaty, Kazakhstan. Contact: Email: waliyev@gmail.com, URL: TBA

20-24 October 2019, Public Private Partnership (PPP): Financing, Projects & Contracts - Dubai at Dubai, UAE. Contact: Email: vincs@infocusinternational.com, URL: http://www.infocusinternational.com/ppp/index.html

20-21 October 2019, The International Oil Spill Response and Environmental Protection Congress at Gulf Hotel Bahrain, Building 11, Rd No 3801, Manama, Bahrain. Contact: Phone: +971 4 361 9616, Email: basma.t@maarefahmanagement.org, URL: http://go.evvnt.com/473997-0?pid=204

21-24 October 2019, Power Purchase Agreement (PPA) for Renewable Energy - Dubai at Dubai, UAE. Contact: Email: vincs@infocusinternational.com, URL: http://www.infocusinternational.com/pparenewable/index.html

22-24 October 2019, SPE Russian Petroleum Technology Conference at Holiday Inn Sokolniki, 24 Rusakovskaya St., Moscow, 107014, Russia. Contact: Phone: 74952680454, Email: russianoilandgas@spe.org, URL: http://go.evvnt.com/347787-3?pid=204

29-31 October 2019, Argus Biomass Nordics and Baltics, 29-31 October 2019, Copenhagen, Denmark at Copenhagen Marriott Hotel, 5 Kalvebod Brygge, København, 1560, Denmark. Contact: Phone: 442077804304, Email: anita.agyeman@argusmedia.com, URL: https://go.evvnt.com/505863-0?pid=204

29-29 October 2019, SPE Upstream Finance and Investments Conference at London, UK. Contact: Email: ldoyle@spe.org, URL: https://go.evvnt.com/449904-2?pid=204

03-06 November 2019, 37th USAEE/IAEE North American Conference, Energy Transitions in the 21st Century at Denver, CO USA. Contact: Phone: 216-464-2785, Email: usaee@usaee.org, URL: www.usaee.org

04-07 November 2019, European Refining Technology Conference 2019, Warsaw, Poland at Hilton Warsaw, 63 Grzybowska, Warszawa, 00-844, Poland. Contact: Phone: 02073847807, URL: http://go.evvnt.com/364582-2?pid=204

04-04 November 2019, Argus Asia MTBE Conference at Hotel Jen Tanglin Singapore by Shangri-La, 1A Cuscaden Road, Singapore, 249716, Singapore. Contact: Phone: 0566980954, Email: prithika.manivel@argusmedia.com, URL: http://go.evvnt.com/511531-0?pid=204

04-07 November 2019, European Refining Technology Conference 2019, Warsaw, Poland at Hilton Warsaw, 63 Grzybowska, Warszawa, 00-844, Poland. Contact: Email: kelly.tea@wraconferences.com, URL: http://go.evvnt.com/364582-2?pid=204

04-05 November 2019, Bioenergy Conferences at United Arab Emirates. Contact: Phone: 2033182512, Fax: biofuels@engineeringeuroscicon.com, Email: biofuels@engineeringeuroscicon.com, URL: https://bioenergy.euroscicon.com

05-09 November 2019, Power Purchase Agreement (PPA) from Legal Perspective - Singapore at Singapore. Contact: Email: vincs@infocusinternational.com, URL: http://www.infocusinternational.com/ppalegal/index.html

05-06 November 2019, SPE Workshop: Production Optimisation in Gas and Oil Assets at The Hague, Netherlands. Contact: Email: ldoyle@spe.org, URL: http://go.evvnt.com/432984-2?pid=204

06-07 November 2019, 5th Solar PV Operations USA 2019 at Hilton San Diego Mission Valley, 901 Camino del Rio South, 92108, San Diego, United States. Contact: Phone: +4402073757512, Email: luke@newenergyupdate.com, URL: http://go.evvnt.com/417987-0?pid=204

November 07 - December 07 2019, 21st International Conference on Advanced Energy Materials and Research at Zurich, Switzerland. Contact: Phone: 7025085200, Fax: advancedenergymaterials@gmail.com, Email: advancedenergymaterials@gmail.com, URL: https://energymaterials.materialsconferences.com

07-08 November 2019, SPE Liquids-Rich Basins Conference-North America at Odessa Marriott Hotel & Conference Center, 305 East 5th Street, Odessa 79761, United States. Contact: Email: maubuchon@spe.org, URL: https://go.evvnt.com/452466-2?pid=204

11-12 November 2019, Offshore And Floating Wind Europe 2019 (11-12 Nov) with Tidal Summit (ITES) at Hilton London Canary Wharf, Marsh Wall South Quay Square, London, E14 9SH, United Kingdom. Contact: Phone: +44(0)2073757510, Email: dominic@newenergyupdate.com, URL: https://go.evvnt.com/430497-2?pid=204

11-12 November 2019, Offshore and Floating Wind Europe 2019 (11-12 Nov) co-located with ITES at Hilton London Canary Wharf, Marsh Wall South Quay Square, London, E14 9SH, United Kingdom. Contact: Phone: +44 (0) 207 375 7510, Email: dominic@newenergyupdate.com, URL: http://go.evvnt.com/430497-2?pid=204

12-13 November 2019, Energy Capital Leaders at Paris Expo Porte de Versailles, 1 Place de la Porte de Versailles, Paris, 75015, France. Contact: Phone: 27210013891, Email: ryan.barry@oilcouncil.com, URL: http://go.evvnt.com/371624-0?pid=204

13-14 November 2019, Renewable Energy & Emerging Technologies at Jakarta, Indonesia . Contact: URL: http://icreet.com/

13-13 November 2019, Energy Capital Leaders at Paris Expo Porte de Versailles, 1 Place de la Porte de Versailles, Paris, 75015, France. Contact: Phone: +27210013891, Email: ryan.barry@oilcouncil.com, URL: https://go.evvnt.com/371624-0?pid=204

18-21 November 2019, Mastering Renewable & Alternative Energies - Singapore at Singapore. Contact: Email: vincs@infocusinternational.com, URL: http://www.infocusinternational.com/renewable/index.html

19-20 November 2019, CSP Madrid International Solar Conference & Exhibition 2019 at Hotel NH Madrid Ventas, 2 Calle Biarritz, 28028 Madrid, Spain. Contact: Phone: 4402073757177, Email: rwatt@newenergyupdate.com, URL: https://go.evvnt.com/456208-0?pid=204

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