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The European Centre for Energy and Resource Security (EUCERS) Established in the Department of War Studies at King's College London in October 2010. The research of EUCERS is focused on promoting an understanding of how our use of energy and resources affects International Relations, since energy security is not just a matter of economics, supply and technological change. In an era of globalization energy security is more than ever dependent on political conditions and strategies. Economic competition over energy resources, raw materials and water intensifies and an increasing number of questions and problems have to be solved using holistic approaches and wider national and international political frameworks.

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Foreword *By Peter Hefele and Friedbert Pflüger*

This joint book publication is bringing together contributions by our authors based on their presentations at our KAS/EUCERS workshop series in Singapore, South Korea and Kazakhstan.

In 2015, we started our series in Singapore exploring issues surrounding changing global gas markets. The centre of gravity of the global natural gas market is shifting eastwards, in line with economic growth and increasing energy demand. Indeed, the Asia-Pacific region has surpassed Europe to become the world's largest gas importing region. Demand is projected to continue to surge ahead in the coming years, primarily driven by traditional importers in the region like China, India, Japan and South Korea. On the supply front, the region is anticipating an increase in both piped and LNG gas supplies, not just from traditional suppliers in the Middle East and Africa, but also from major players like Russia and the United States. In addition, regional countries are expected to make a significant contribution to additional gas supplies. Australia, for instance, is poised to become one of the world's biggest LNG exporters by the end of the decade while China is planning to ramp up its own domestic gas output. On the other hand, Europe – the second largest gas-importing region in the world – is following an opposite trend. Consumption is lower than pre-crisis levels and domestic production is in steady decline. Challenges to its gas market are compounded by restrictive and, at times, contradictory energy policies as well as strained relations with major external suppliers like Russia. Moreover, short-term gas diversification options are limited due to political instability in peripheral exporting states as well as relatively unattractive market conditions for major gas exporters. We therefore focused on the geopolitical and geo-economic impacts on the Asia-Pacific region and Europe and its contribution to sustainable energy systems.

We continued our quest to discover the future of energy and climate security in a two-day workshop in Seoul, South Korea, in 2016. The future of coal and chances for clean coal were the central focus in our discussions. Although inexpensive and abundant (proven global coal reserves in 2013 were sufficient to meet 113 years of global production), coal is viewed controversially due to its high CO2 content. However, due to rising global energy demand, coal is still an important player in today's global energy mix. Technologies that allow for carbon capture and storage (CCS) and carbon capture use and storage (CCUS) are key for achieving climate goals while meeting energy demand. Globally, 22 large-scale CCS projects are currently in operation or being constructed – twice as many as a decade ago. What is the future of coal? Will new technologies such as CCS and CCUS make coal a clean energy source? These key issues were discussed during the workshop.

The final workshop in our series took place in Kazakhstan, at the Issyk Kul Lake, in Almaty and Astana, in 2017. Over the four days, speakers and participants discussed the future of energy security, particularly the role of conventional and renewable resources in the aftermath of the Paris Agreement. The workshop focused on three dimensions of energy security, with special attention given to Kazakhstan and Central Asia. The architecture of a future global energy governance, including opportunities of a global energy transition and resource related conflicts. The exchange between speakers and participants from Central Asia and Europe attempted to share knowledge and highlight cooperation opportunities in the field of energy transformation and to encourage the expansion of regional and international expert networks and business partnerships between Kazakhstan and Europe. The final discussion in our series of workshops was organised against the backdrop of the EXPO 2017 in Astana, which offered plenty of impulses.

This publication is a reflection of the workshop series organized by KAS and EUCERS in Singapore, South Korea and Kazakhstan between 2015 – 2017. It picks up the most important points of discussion from our three workshops with contributions by speakers and participants under the general theme of "The future of energy and climate security". Professor Hongyuan Yu of the Shanghai Institute for International Studies (SIIS) introduces the publication with a four-dimension analysis model for energy security. He is followed by Professor Anatole Boute of the Chinese University of Hong Kong who examines energy and water security in Central Asia. After these two contributions with a broader approach, Carlos Fernández Alvarez of the International Energy Agency focuses on coal in the 21st century. Frank Umbach, research director at EUCERS, discusses coal more specifically in the context of China and clean coal. The publication then turns to renewable energy. Birgit Wetzel, a freelance journalist working on energy topics in Eastern Europe, Caucasia and Central Asia, focuses on profitable energy for Central Asia. Also, Arman Kashkinbekov of the Association of Renewable Energy of Kazakhstan outlines the challenges and opportunities of renewable energy for emerging nations such as Kazakhstan. We conclude our excursion into the future of energy and climate security with an outlook by Professor Friedbert Pflüger of EUCERS, who assesses if the Paris climate paradigm will survive the Trump presidency.

We are delighted to present the following book publication as a result of our three workshops in Singapore, South Korea and Kazakhstan and would like to thank our authors for joining us and presenting at our workshop series and for making this publication possible with their contributions.

Dr Peter Hefele is the Director of the Regional Project, Energy security and Climate change Asia-Pacific (RECAP) at the Konrad-Adenauer-Stiftung e.V. Professor Dr Friedbert Pflüger is the Director of the European Centre for Energy and Resource Security at King's College London.

Geo-political, ecological, financial, and passage: Four dimensions analysis model for energy security

By Professor Hongyuan Yu

Energy security is becoming an urgent priority for fast-growing economic powerhouses like China. The international community should work together to build a good environment for the affordability, sustainability and accessibility of energy resources. As China contributes to global economic growth, it simultaneously assumes a role of being one of the largest energy consumers in the world. China plays an important role in the debate of reducing geopolitical accidents, transport line instability, environmental & climate risks. China is a leading member of the developing world, giving it political, economic and diplomatic clout that enables it to contribute to global energy security. China's oil sources of supply mainly include the Middle East, North Africa, West Africa, Asia Pacific, Central and South America and Russia. However, oil imports from Russia are land transported, by rail transport and pipelines, with low potential risks. Nearly 90% of China's oil is shipped by sea, so the main consideration are risks connected with shipping. At present, China imports oil via a single sea route and is highly dependent on the stability in the Strait of Hormuz and the Strait of Malacca. As a whole, its ability to resist risks is poor and the safety factor is low.

Peaceful energy development and global energy cooperation is at the core of the international dimensions of China's energy policy, a win-win cooperation for energy security. China's energy security issues are as follows. First of all, the oil consumption heavily relies on imports and the degree of dependency has reach 59% in 2015. In 2015, the net import of natural gas in China was 35 times of that in 2007, with an average annual growth rate of 59%.[1]

Secondly, the import of oil is largely dependent on the Middle East. Thirdly, the import routes for oil heavily rely on the Strait of Malacca. Fourth, China is compelled to pay extra cost for oil import because of the "Asia Premium[2]". As a rising power on the peaceful development road, China's energy strategy focuses on mutual benefits and on a policy of building a harmonious world. China has taken an active part in energy cooperation with other countries on the basis of mutual benefit to ensure stability of the regional and global energy market. "The core of China's energy strategy is to give a high priority to conservation, rely mainly on domestic supply, develop diverse energy resources, protect the environment, step up international cooperation of mutual benefit and ensure the stable supply of economical and clean energies."[3] China also developed a new energy security concept that calls for mutually beneficial cooperation, diversified forms of development and common energy security through coordination.

Win-win between China and the U.S. for energy-geopolitics

The first suggestion is to strengthen cooperation in the traditional energy area between China and the United States. The U.S. shale gas, oil and natural gas resources sector can be expected to develop more vigorously under Trump. China should strengthen the introduction of and investment in key technologies as well as carrying out joint research and development because the U.S. is searching for more exports as part of its efforts to assist the recovery of the US coal industry. As such the space for cooperation between China and the United States in the field of clean coal is promising. To accelerate China-U.S. technology cooperation, we can gradually increase the volume of coal imports from the United States and promote technology cooperation in the clean coal sector.

Former U.S. Deputy Assistant Secretary Shriver pointed out that the growth of the U.S. and China's oil demand may lead to two very different prospects. One may be a fierce competition for oil supply; another is an increase in mutual cooperation, not only in oil but other issues. The major consumption and importer countries in the energy sector can find a common interest, especially in the oil sector in the Asia-Pacific. China and the United States can avoid deteriorating their political relationship but cooperate in the energy sector, economics and trade to promote the stability and development in the global energy market. The United States have an advantage on natural gas, nuclear energy,

1 BP 2017 World Energy Outlook http://www.bp.com/content/dam/bp-country/zh_cn/Publications/2017SR/Statistical%20Review%20of%20World%20Energy%202017%20CN%20Final%2020150617.pdf

2 The Asian Premium refers to the extra price margin paid by Asian countries for the same quality Middle East crude oil than the rest of the world. This phenomenon has caught attention since early 1990s. Yoshiki Ogawa (Institute of Energy Economics, Japan), Proposals on Measures for Reducing Asian Premium of Crude Oil, November 26, 2002, p.1, downloadable at http://eneken.ieej.or.jp/en/data/pdf/166.pdf, visited on 11 October 2017.

3 President Xi stresses tech advance to accelerate energy revolutionhttp://www.xinhuanet.com/english/2016-12/28/c_135939366.htm visited on 11 December,2017.

coal and renewable energy, and China's reliance on the United States is becoming increasingly larger. Therefore, it is important for China to cooperate with the United States and not to let disputes harm the relationship.

But first of all, the energy relations between China and the United States need to be repositioned. With the global energy production axis shifting to North America, the United States is predicted to become the largest energy production country in the future while China will be the largest consumer.[4] By 2020, the Sino-U.S. energy relationship will change gradually. While in the U.S. energy demand will fall and production will increase, in China energy demand increases and so do import while energy production decreases. Under these circumstances, the dynamics in the Sino-U.S. cooperation in the energy field has changed from being competitors to mutual benefitting partners. As recently, the acquisition of Nixon Company of Canada by China National Off Shore Oil Corporation (CNOOC) won the approval of the Committee on Foreign Investment in the U.S., which means the United States has reduced wariness on China's energy investment and the Sino-U.S. energy relation are pushed towards a benign and complementary direction.

Non-governmental forces for China's energy security

China should pay attention to avoid governmental action and mainly rely on non-governmental organizations and companies to realise China's interests in the Middle East. In the Middle East, China and the United State share common interests which include maintaining security and stability of oil production and transportation, guiding oil prices by cooperation to ensure orderly operation of the international energy market. And also, in regard to energy technology, both China and the United States may conduct cooperation in oil exploration, energy conservation and efficiency as well as energy related environmental protection. The Middle East is a crucial area for Chinese oil imports and since the politics and economy of this area is under the actual control of the United States, China must handle relations with the United States properly in order to expand cooperation with oil-producing countries in the Middle East. Energy issues naturally go beyond national borders. As political entities, nation states cannot fully participate in the whole process of cooperative development of energy including negotiation, contract signing, exploiting and settlement of disputes. The development of cooperation in energy needs the participation of governments, companies, investor etc. The main carrier of China's interests in the Middle East lies between nation states and investors but also between industry players in producing countries and investors. Moreover, energy cooperation involves research and development, information and human know-how, science and technology cooperation. Because the United States have been wary of a potential rise of China for a long time and as the "tap" of global oil, the Gulf area is the fulcrum of geopolitics and also the core of sea power hegemony of the United States, more governmental actions will attract more wariness.

Cooperation between China and Russia for energy-geopolitics

China should evaluate the cooperation with Russia from a strategic standpoint to evade the influence on national energy security posed by the conflict in the Asia-Pacific area. With the comprehensive political, economic, military and cultural tools, China is able to promote peaceful energy cooperation by enriching neighbouring countries. To eliminate Russia's concern that China proved to be the most potential geopolitical threat in the Far-East, and implement the energy cooperation in an all-round way, Russia could be the long-term stable and reliable source of oil and gas for China. Both China and Russia can benefit from the Shanghai Cooperation Organization and the oil and gas network built in Central Asia in the former Soviet Union period. This can enhance the multilateral energy cooperation inside the integrative framework, to learn from each other and promote common development, to build a friendly, cooperative and peaceful zone, and in turn to strengthen the energy security.

Competition for narratives in energy finance

However, fluctuations in the oil market and the price of oil can have more severe impact to China than geopolitics. Now China is not that familiar to global oil market rules. In 2016, China's crude oil imports amounted to U.S. $116660.75 million in 2016, accounting for 0.16% of China's GDP in the same year.[5] If China could control the global oil market, it would be able to stabilize the domestic oil price. Therefore, the competition of energy resources actually means the competition of oil interests. And these are to sell more oil, receive higher profits, but not to contain other countries consumption. It is not necessary to politicalize the energy sector. As China is trying to ensure that there is always enough oil in the international market so that major oil consuming countries will get an adequate supply of oil.[6] Therefore, China, U.S., Europe, Japan and other countries should conduct international energy cooperation to maintain a stable supply of oil.

4 IEA. International Energy Outlook 2016[EB/OL]. www.eia.gov/ieo. visited on 11 December,2017.

5 Chinese National Data, http://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A060702&sj=2016, http://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A060702&sj=2016, visited on 13 January,2018.

6 OPEC. Petroleum will still be the major energy resource in the 21st century[EB/OL]. http://www.opec.org/opec_web/en/902.htm.

Transportation line protection

China's oil import sources include the Middle East, North Africa, West Africa, Asia Pacific, Central and South America and Russia. To ensure safety and freedom in sea navigation, particularly security and safety in the key international waterways, China has conducted cooperation with various countries in countering maritime terrorism and sea piracy.[7] However, the energy exploration and production centre is shifting to North America. The United States will be the biggest energy producer, and China will be the biggest energy consumer. It is obvious that China and the United States are interdependent in energy. One of the topics for the presidential debates between Obama and Romney was energy in 2012. Obama mentioned repeatedly that the United States was becoming resource power and adjusting its energy strategy. Trump made the decision to withdraw from the Iran Nuclear Deal which the Obama administration signed in 2015 and which Trump has claimed was "the worst outcome of negotiations in the history."[8] Trump being president is likely to mean that the United States will withdraw its signature on Iran Nuclear Deal. In a public speech in March, Trump said Iran would be his governing priority, and that he would renegotiate with Iran to extend sanctions against Iran, but at the same time give us companies more opportunities to trade in Iran[9]. That the Trump administration went back on the Obama administration's agreement and continued to impose sanctions on Iran's oil exports means Iran can also restart the nuclear-industry development plans. In this case, Iran will not be the international crude oil supplier, and how the international oil price will fluctuate, how the relevant energy and resources will be in the market and how other countries' roles in the International energy trade will change, will all be out in the open. Trump has adopted a domestic energy industry policy centred on reviving fossil and nuclear energy, a new energy development policy centred on strengthening energy independence and reducing support.

The United States crude oil production has reached the highest level in 14 years[10] but the net imports volumes are the lowest in 20 years. The United States has already been the largest natural gas producer.[11] In 2017, the U.S. shares of global natural gas production were about 21%.[12] The Asia-Pacific region has been the top priority for as a source for Chinese energy imports. For example, China reliance on coal imports has been 14.6% in 2015.[13] Most of the imports come from the Asia-Pacific region: 6.4 million tons from Indonesia, followed by 3.2 million tons from Australia, 2.2 million tons from Vietnam, 2 million tons from Mongolia and 1 million tons each from North Korea and Russia in 2016.[14] China's nickel ore imports from both Indonesia and Philippines are over 2 million tons[15], which is crucial to the electricity sector. Ensuring access to adequate, reliable, affordable and clean energy is a key challenge facing the countries of the Asia-Pacific region, and indeed the whole world. For the Asia-Pacific region, energy security is a key issue because there are large energy users without sufficient domestic reserves and large energy producers with surplus capacity. It is also an issue that has taken on increasing importance because the success of economies in the Asia-Pacific and the rapid development of large parts of the region have brought future energy needs into economic and political focus.

As political allies, member states of the Shanghai Cooperation Organization (SCO) are the main sources of oil imports. China needs to consider developing cooperation relationship with member states of the SCO. China's interest in bringing Iran into the SCO folds pivots on its "string of pearls" policy, which is designed to secure the sea lanes through which its oil is transported. It is pursuing this strategy by establishing naval facilities at key geographical locations in order to ensure that potential choke points, such as the Strait of Hormuz in the Persian Gulf and the Strait of Malacca between Malaysia and Indonesia, remain unobstructed. (Half of China's oil imports today pass through the Strait of Malacca[16]; this proportion is expected to rise to about two-thirds by 2020[17]). China takes American concerns seriously and has worries of its own over its vulnerability to upheavals in global hotspots and to U.S. naval pressure in the Malacca Straits, the narrow Southeast Asian passage through which virtually all Middle Eastern and African oil moves on its way to East Asia. Thus, China has to maintain the security of transportation to protect against the United States' energy strategy as a regional hegemony.

7 China Information Office of the State Council, "China's Energy Policy 2012",http://www.mfa.gov.cn/ce/cese/eng/mtfw/t1139259.htm, visited on 6 October,2016.

8 Reuters. Yeganeh Torbati. Trump election puts Iran nuclear deal on shaky ground. Nov 9, 2016. http://www.reuters.com/article/us-usa-election-trump-iran-idUSKBN13427E, visited on 13 January,2018.

9 Reuters. Yeganeh Torbati. Trump election puts Iran nuclear deal on shaky ground. Nov 9, 2016. visited on 13 January ,2018. http://www.reuters.com/article/us-usa-election-trump-iran-idUSKBN13427E

10 IEA. International Energy Outlook 2016 [EB/OL]. www.eia.gov/ieo. visited on 11 October,2017.

11 IEA. International Energy Outlook 2016 [EB/OL]. www.eia.gov/ieo. visited on 11 October,2017.

12 BP. BP Energy Outlook 2018 [EB/OL]. http://www.bp.com/energyoutlook. visited on 11 October,2017.

13 China Customs Data,http://www.customs.gov.cn/default.aspx?tabid=9368. Visited on 2 November,2017.

14 China Customs Data,http://www.customs.gov.cn/default.aspx?tabid=9368. Visited on 2 November,2017.

15 China Customs Data,http://www.customs.gov.cn/default.aspx?tabid=9368. Visited on 2 November,2017.

16 IEA. The Strait of Malacca, a key oil trade chokepoint, links the Indian and Pacific Oceans[EB/OL]. https://www.eia.gov/todayinenergy/detail.php?id=32452. visited on 11 October,2017.

17 IEA. The Strait of Malacca, a key oil trade chokepoint, links the Indian and Pacific Oceans[EB/OL]. https://www.eia.gov/todayinenergy/detail.php?id=32452. visited on 11 October,2017.

Oversea strategies for China NOCs

There are three kinds of investment for Chinese oil companies' "go out strategy": The first kind is a wholly-owned or sole investment, second is a joint venture participation and the last is a non-equity arrangement. For the wholly owned or sole investment, Chinese NOCs will hold 100% share though buying undeveloped oil & gas fields or the shares of oil companies with reserves. However, the host government may worry about the direct control of reserves by foreign NOCs and impose strict supervisions. Thus, the wholly-owned or sole investment is not the best choice for China NOCs in times when resource nationalism is rising everywhere (e.g., the case of CNOOC purchase Unocal). A joint venture participation includes two types: Shared-cooperation with host national oil companies and cooperation with international oil companies (IOCs). From the four NOC forums in Saudi Arabia, we can see that the host government welcomes the shared cooperation with China NOCs. China NOCs are searching outside their home countries for equity oil and gas and are forming joint ventures and alliances with IOCs. NOCs need IOC technology and oil-field management expertise and are inviting IOCs to serve as contractors for field development-a role formerly filled by service companies. Joint venture participation will reduce the economic, political and social costs and risks for China NOCs' "go-out strategy" and should be given highest priorities. Thirdly, the non-equity arrangement includes a lot complex contracts: Concession, production sharing, oil field service, rent resource; technology aid. China is supposed to combine the energy strategy and diplomatic strategy together, to create a positive external environment through diplomatic channels. The core of energy diplomacy is to ensure a country could get a long-term, stable, sufficient and price-reasonable energy resource, especially the oil, through diplomatic policy and manners.

In conclusion, energy is fundamental to the prosperity and security of nations. Energy is the basis of modern economic and social development. With its special status and role, energy is not just an ordinary commodity – it has increasingly acquired political attributes. Access to energy resources is an important factor for the political and economic development of a country. It not only lays a solid material foundation for the economic development of the country, but also helps to increase its comprehensive national strength, which enables the country to pursue an independent foreign policy and to have extensive influence in international politics. The global energy system is open, which lies in the interdependence among production states, consumption states and transit states. Consequently, it is not only for China but also for other countries to cooperate in energy sector. It is necessary to know clearly that the stability of the whole system is critical to every state. Energy security is the foundation to be a global power. Except for China, every production and consumption state has to realise that only the market and not geopolitics is the way to energy security for the world. As the famous scholar Daniel Yergin said, it is advisable and urgent to make China participate in the global trade and investment system instead of making China like a peddler to bargain with every country, which is helpful to China and the other countries in the energy security system.

But as scientific evidence continues to build, and impacts – from extreme weather to melting Arctic ice – continue to worsen, with costs mounting daily, the impetus to resolve the problem is growing. We're exhausting Earth's finite resources and pushing global ecosystems to tipping points, beyond which addressing pollution and climate issues will become increasingly difficult and costly. The only hindrance to developing a fair, ambitious and legally binding climate plan for the world is lack of political will.

Politicians must be prepared to abandon short-term advantages in favour of a long-term perspective, which would guarantee the future for coming generations through a sustainable low-carbon economy. This means turning away from oil and coal, developing renewable energies, ensuring a high price for carbon and providing adequate finance to protect developing nations from climate change caused by past emissions of the industrialized world.

In addition to the reform of domestic energy policies and markets, Trump's assumption of the presidency will bring about a change in the global energy geopolitical landscape. The Obama administration's energy sanctions against Russia and the nuclear deal with Iran could be overturned in Mr Trump's tenure. After the Crimean crisis, the Obama administration agreed with EU countries to impose sanctions on Russia, focusing on its oil and gas industries, which led to a slump in Russia, a highly energy-dependent economy. In contrast to Mr Obama, Mr Trump has demonstrated goodwill towards Russia and an attempt to repair relations with Russia during the campaign, and the restoration of relations with Russia will have important implications on the energy sector. Trump may withdraw economic sanctions against Russia and resume technology-sharing and banking dealings. Russia's resumption of a favourable environment in the energy sector will have a significant impact on world energy prices and energy patterns.

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Energy and water security in Central Asia: The necessary return to the Soviet cooperation model

By Professor Anatole Boute

Central Asia is an energy and water rich region[18], but paradoxically faces huge energy and water security challenges.[19] The upper riparian (or upstream) countries of Tajikistan and Kyrgyzstan are endowed with large water resources but have limited access to fossil fuel energy.[20] The lower riparian (or downstream) countries of Uzbekistan, Kazakhstan, and Turkmenistan are endowed with considerable fossil fuel reserves but are dependent on water supply from the upper riparian countries.

During Soviet times, water and energy supply in Central Asia was organized in a centralized way to overcome the uneven distribution of resources in the region. Following the collapse of the Soviet Union, in a climate of increasing mutual distrust, the Central Asian states started to prioritize national water and energy independence.[21] National-centred (or state-centred) approaches to the organization of water and energy management generated acute challenges

for water and energy security.[22] Energy and water policy experts generally agree that regional cooperation and integrated management of resources is necessary to ensure the effective use of energy and water resources in Central Asia.[23]

Taking into account the explicit benefits of a regional approach to energy and water security in Central Asia, the region provides a particularly relevant case study to assess obstacles to water-energy cooperation and ways how to overcome them. This paper argues that it is essential to return to the Soviet model of integrated water-energy supply in Central Asia in order to secure the obvious benefits of regional cooperation. The challenge is to create a sufficiently solid institutional structure to avoid free-riding and geopolitical tensions relating to mutual energy-water dependency.

Benefits of energy and water cooperation in Central Asia

The Soviet cooperation model

Transboundary and integrated water and energy management in Central Asia stems from Soviet times. The centralized approach meant that the region's electricity system—the Central Asian Power System—was organized without regard to the borders that now separate the different states in Central Asia.[24] Instead, regional electricity supply was based on the availability of natural resources during the different periods of the year.[25] Hydropower plants were built in what now corresponds to Kyrgyzstan and Tajikistan. Kyrgyzstan and Tajikistan are the upper riparian countries to the Syr Darya and Amu Darya rivers—the two main transboundary watercourses in Central Asia—and thus have a very large potential for hydropower generation. Thermal power plants were built in what is now Uzbekistan, South Kazakhstan, and Turkmenistan as a result of the large fossil fuel reserves that these countries possess (gas in Uzbekistan and Turkmenistan, and coal in Kazakhstan).

18 See, e.g., Onur Cobanli, Central Asian Gas in Eurasian Power Game, 68 Energy Policy 348 (2014); Alexandros Petersen & Katinka Barysch, Russia, China and the Geopolitics of Energy in Central Asia, (Centre for European Reform, 2011), available at http://www.cer.org.uk/publications/archive/report/2011/russia-china-and-geopolitics-energy-central-asia.

19 See, e.g., Bakhtiyor Mukhammadiev, Challenges of Transboundary Water Resources Management in Central Asia, in The Aral Sea: The Devastation and Partial Rehabilitation of a Great Lake 233 (Philip Micklin at al. eds., 2014); Muhammad Mizanur Rahaman, Principles of Transboundary Water Resources Management and Water-related Agreements in Central Asia: An Analysis, 28 International Journal of Water Resources Development 475 (2012); Philip Micklin, Water in the Aral Sea Basin of Central Asia: Cause of Conflict or Cooperation? 43 Eurasian Geogr. & Econ. 505, 522 (2002).

20 Murodbek Laldjebaev, The Water-Energy Puzzle in Central Asia: The Tajikistan Perspective, 26 Water Resources Development 25 (2010).

21 The World Bank, Water Energy Nexus in Central Asia: Improving Regional Cooperation in the Syr Darya Basin 19 (The World Bank 2004).

22 Fichtner GmbH & Co. KG, Central Asia Regional Economic Cooperation: Power Sector Regional Master Plan 2-6 & 2-7 (Asian Development Bank 2012), available at http://www.adb.org/projects/documents/central-asia-regional-economic-cooperation-power-sector-regional-master-plan-tacr.

23 See Makhmud Kh. Khamidov, Characteristic Features of Integrated Water Resources Management in the Syrdarya River Basin, in Implementing Integrated Water Resources Management in Central Asia 29 (Patricia Wouters et al. eds., 2007); Pöyry Energy Ltd., Environmental and Social Impact Assessment for Rogun Hydro Power Plant 321 (Pöyry Energy 2013), available at http://www.worldbank.org/en/country/tajikistan/brief/final-reports-related-to-the-proposed-rogun-hpp; Daene McKinney, Cooperative Management of Transboundary Water Resources in Central Asia, in In the Tracks of Tamerlane-Central Asia's Path into the 21st Century 205 (Dan Burghart & Theresa Sabonis-Helf eds., 2003).

24 Mercados, Load Dispatch and System Operation Study for Central Asian Power System 26 (The World Bank 2010), at 5, available at http://www.carecprogram.org/uploads/events/2010/SOM-Oct/Diagnostic-Study-CAREC-Energy-Strategy-Pillar2-Full-Report.pdf.

25 Vladimir Yasinskiy, Alexander Mironenkov & Tulegen Sarsembekov, Energy Security and Water Resources Management in Transboundary River Basins in Central Asia, 6 EDB Eurasian Integration Yearbook 2013 177 (2013).

Besides energy supply benefits, the centralized approach to electricity supply in Central Asia played an important role in relation to the management of water resources in the Syr Darya and Amu Darya river basins. Large hydro dams and reservoirs, the Toktogul in Kyrgyzstan and Nurek in Tajikistan, were designed during Soviet times primarily for irrigation purposes. The main purpose of this infastructure was to store water during the non-growing period (October–April) and thereby secure water availability during the growing period (April–October).[26]

The centralized management of water and energy resources in Central Asia depended on close cooperation between the upper and lower riparian parts of the Syr Darya and Amu Darya river basins. In order to secure sufficient water levels in the upstream reservoirs for summer irrigation purposes, Kyrgyzstan and Tajikistan had to refrain from producing electricity from hydropower in the winter – when energy is most needed in these cold climates. Following a barter-type arrangement, Uzbekistan, Kazakhstan, and Turkmenistan supplied thermal energy and fossil fuels to Kyrgyzstan and Tajikistan in compensation for not using hydropower in the winter. Refraining from hydropower generation in the winter positively impacted the management of water resources in Central Asia.

Energy independence in the post-Soviet context

The newly-gained independence of the Central Asian countries following the collapse of the Soviet Union represented an important challenge for the continued implementation of this barter scheme. In order to maintain the transboundary and integrated management of energy and water supply in the region, Kazakhstan, Uzbekistan, Turkmenistan, Tajikistan, and Kyrgyzstan concluded regional agreements that formalized the barter-based scheme that existed during Soviet times.[27] According to these arrangements, the lower riparian countries committed to purchasing the hydropower associated with the release of water. Moreover, in exchange for summer water releases, the lower riparian countries agreed to compensate the upper riparian countries with an equivalent amount of exports of thermal power and fossil fuels in the winter.

However, the implementation of the water and energy agreements proved to be problematic. Central Asia gradually moved from a centralized, regional electricity market approach to a national-centered approach, with national energy independence forming a key political objective. Regional energy trade dropped ninety percent since the early 2000s. This has led to inefficiencies (higher energy and thus carbon intensity, resulting in higher cost of supply) and threats to the security and reliability of electricity supply, in particular in the upper riparian countries.[28]

In contrast to the centralized and integrated approach to energy and water supply during Soviet times, the lower and upper riparian countries now struggle to agree on the terms of winter-summer energy exchanges. The absence of cooperation results in the inefficient use of fossil fuels in the lower riparian countries: in the summer, Uzbekistan, Kazakhstan, and Turkmenistan burn natural gas and coal for electricity production – fossil fuels that could be saved through importations of hydropower from Kyrgyzstan and Tajikistan.[29] The absence of cooperation also negatively impacts water use in the region: in order to meet peak winter electricity demand, Kyrgyzstan and Tajikistan increasingly rely on hydropower generation instead of using thermal power or combined heat and power. Maximizing the production of hydroelectricity generation became the priority over securing the availability of water for irrigation. This created tensions in the region due to the crucial importance of agriculture (particularly cotton) for the lower riparian countries (principally Uzbekistan).

Mutual benefits of cooperation

Most studies on water and energy policy in Central Asia agree that it is essential for the Central Asian states to reinitiate transboundary water-energy cooperation in order to ensure the sustainable management of resources in the region.[30]

First, cooperation limits the consumption of fossil fuels – mainly natural gas and coal – in the Central-Asian electricity sector. By importing hydropower during the summer, the lower riparian countries can reduce the production of electricity from thermal sources. In its 2013 analysis of the Uzbek power sector, the World Bank confirmed the benefits of regional cooperation for the Uzbek electricity system by highlighting that "coordinated and optimized seasonal power trade with hydro-rich neighbors could avoid the need for the construction of 500 megawatts of generation capacity in Uzbekistan," generating cost savings of around $700 million.[31]

26 Murodbek Laldjebaev, The Water-Energy Puzzle in Central Asia: The Tajikistan Perspective, 26 Water Res. Development 23, 25 (2010).

27 The regional water agreements are available at http://www.cawater-info.net/library/ca_e.htm. See also, http://www.caee.utexas.edu/prof/mckinney/papers/aral/central_asia_regional_water.htm.

28 See e.g., Daryl Fields et al., Tajikistan's Winter Energy Crisis: Electricity Supply and Demand Alternatives (The World Bank 2013), available at http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:23319658~menuPK:34460~pagePK:34370~piPK:34424~theSitePK:4607,00.html.

29 Artur Kochnakyan et al., Uzbekistan Energy/Power Sector Issues Note 37 (The World Bank 2013).

30 Khamidov, at 29; Pöyry Energy Ltd., at 321; McKinney, at 205; Protocol of the Workshop for the Representatives of Water and Energy Authorities of the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan and the Republic of Uzbekistan Related to Water and Energy Use Issues in the Forthcoming 1998/9 Fall-Winter Season and 1999 Vegetation Period, Aug. 26, 1998, available at http://www.ce.utexas.edu/prof/mckinney/papers/aral/agreements/Annual-Protocol-99.pdf.

31 Kochnakyan et al., at 37.

Second, regional energy and water cooperation can reduce the carbon intensity of the Central-Asian energy sector. By reducing the use of the most inefficient thermal plants in the summer, imports of hydropower have the potential to generate important greenhouse gas emission savings in the lower riparian countries.

Third, cooperation can reduce water spillage (water losses) resulting from winter hydropower generation in the upper riparian countries. This will contribute to improving the availability of water resources in Central Asia, an issue of increasing importance in the context of climate change and its impact on water security. By optimizing the utilization of shared water resources in the two river basins, transboundary electricity management can improve the ability of the Central Asian countries to respond and adapt to the impact of climate change on future water availability.

Obstacles to regional water-energy-climate cooperation

The Central Asian states have repeatedly confirmed their commitment to regional cooperation in the water and energy sectors. However, in practice, the cooperation principles underlying the regional energy and water agreements in Central Asia largely remained dead letters. Disputes about energy and water exchanges have demonstrated the difficulty that Central Asian states have in implementing regional cooperation mechanisms.

Non-implementation of agreements

Regional cooperation in Central Asia suffers due to the lack of trust between the Central Asian countries. This lack of trust results from the states' failure to respect their energy and water supply obligations under regional energy and water agreements.[32] The barter principle according to which winter energy exports compensated for summer hydropower imports created a time gap that proved to be very challenging to manage.[33] Given the quid pro quo nature of the barter scheme, non-implementation by one of the parties of its supply obligations resulted in non-implementation by the other.

The value of fossil energy, electricity, and water

In line with world energy markets, the price of fossil fuels in Central Asia increased considerably towards the end of the 1990s, causing the lower riparian countries to request better prices for the energy exported in exchange for hydropower.[34] Disputes over the cost of fossil fuel energy and thermal power led to reductions and even interruption in the energy supply to Tajikistan and Kyrgyzstan, resulting in the increased use of hydropower to compensate for these energy import deficits.[35] The countries also disagreed upon whether upper riparian states should be compensated for water storage services that support downstream summer irrigation.

National energy independence versus regional cooperation

The drive towards national energy independence in Central Asia is a crucial element in explaining states' reluctance to continue to jointly organize their energy systems, despite the mutual benefits of cooperation for all states concerned. Following the collapse of the Soviet Union, the Central Asian countries aimed to reduce their dependency on neighboring states. Energy independence (energy self-sufficiency or autonomy) is explicitly recognized as a policy priority in the national energy strategies of all Central Asian countries.

Geopolitics of large hydropower generation

To maximize national energy independence and develop their energy export potential, the upper riparian countries aim to build large hydropower plants, including the infamous 3200 megawatt Rogun project in Tajikistan and the 2000 megawatt Kambarata-1 project in Kyrgyzstan.[36] These highly controversial projects exacerbated the concerns of the lower riparian countries, in particular Uzbekistan, regarding access to water, resulting in acute geopolitical tensions in the region.[37] Uzbekistan emphasized the destructive impact that these investments will have on water, food, and environmental safety of the downstream countries.[38] More importantly, Uzbekistan has expressed concerns about the control that these large hydropower dams will give the higher riparian countries over regional water resources. The fear is that Kyrgyzstan and Tajikistan would be in a position to "dictate unilaterally the harsh terms of water discharge to downstream countries, especially during vegetation of agricultural crops."[39]

32 See e.g., Thomas Bernauer & Tobias Siegfried, Compliance and Performance in International Water Agreements: The Case of the Naryn/Syr Darya Basin, 14 Global Gov. 479 (2008).

33 The World Bank, at 11.

34 The World Bank, at iii.

35 Khamidov, at 29; Christine Bichsel, Liquid Challenges: Contested Water in Central Asia, 12 Sustainable Development Law & Policy 25 (2011).

36 Pöyry Energy Ltd.

37 Iskandar Abdullayev et al., Water and Geopolitics in Central Asia, Water, Environmental Security and Sustainable Rural Development: Conflict and cooperation in Central Eurasia 125-143 (Murat Arsel & Max Spoor eds., 2009).

38 Letter of the Government of Uzbekistan to the World Bank Group, July 7, 2014, available at http://www.worldbank.org/content/dam/Worldbank/document/eca/central-asia/140808-gou-wbg-en.pdf.

39 Rustam Azimov, First Deputy Prime-Minister and Minister of Finance of the Republic of Uzbekistan, Statement at the Proceedings of the High-Level Meeting on Regional Riparian Issues in the Context of the "World Bank Note on Key Issues for Consideration on the Proposed Rogun Hydropower Project" 11 (July 18, 2014) available at http://www.worldbank.org/content/dam/Worldbank/document/eca/central-asia/140808-gou-wbg-en.pdf.

This would lead to an "escalation of tensions and of conflict potential in the region of Central Asia."[40]

The necessary return to the Soviet cooperation model

The absence of cooperation in the organization of energy and water supply in Central Asia results in the inefficient use of resources, presenting a threat for energy and water security and possibly for peace in the region.[41] Increasing winter hydropower generation in Kyrgyzstan—because of its energy independence policy and disputes with Uzbekistan on energy supply and transit—exposes the lower riparian countries to the risk of water shortages in the summer and to floods in the winter. In addition to the damage that flooding causes in Uzbekistan and Kazakhstan, winter energy production causes irreversible water losses that affect the Aral Sea.[42] Moreover, by negatively impacting the efficiency of energy supply in the region, energy independence in Central Asia increases the carbon intensity of the region and therefore its overall contribution to global warming.[43]

The economic, social and environmental benefits of regional cooperation far exceed the total gains that the Central Asian countries generate from individual, national-centered actions. Game theory and principles of public goods call for the creation of regional cooperation mechanisms to overcome the incentives that Central Asian states have to free-ride on the water and energy management efforts of their neighbors. The continous involvement of Central Asian countries with each other provides a strong practical reason for these states to work together to achieve the higher benefits of cooperation.

Whatever regional agreements are reached, there must be a strong institutional framework in place to guarantee the implementation of commitments and so avoid free-riding by the parties on their respective efforts. The Central Asian states inherited the regionally integrated energy infrastructure from the Soviet Union, and managed to agree on a relatively sophisticated scheme that reproduced in law the cooperation practice that existed during Soviet times. However, this scheme rapidly collapsed in the absence of a sufficiently robust institutional framework to address the pressure of mutual distrust and free riding.

Following the collapse of the Soviet Union, the Central Asian states started to perceive energy and water dependency on neighboring countries as a threat to their sovereignty, despite the countries' long history of cooperation in this field. The perception of geopolitical risk trumped the mutual economic and environmental benefits that characterize the joint management of resources in the region.

In 2017, the bilateral relations of Uzbekistan with Tajikistan and Kyrgyzstan significantly improved following the passing away of president Karimov. His successor, president Mirziyoyev, started his term by reinitiating diplomatic relations with the upper riparian countries, including in the field of energy-water cooperation. Following years of deadlock in the negotiation of energy-water cooperation arrangements, Uzbekistan made significant compromises regarding the controversial issue of energy pricing and investments in large hydropower plants. Uzbekistan offered to Tajikistan and Kyrgyzstan to export natural gas at a discounted price.[44] Uzbekistan also agreed to authorize the transit of Turkmen electricity to Tajikistan and Kyrgyzstan.[45] Most importantly, Uzbekistan indicated an interest in participating in the construction of the Kambarata hydropower plant, that it previously opposed.[46]

The developments are significant steps towards improved energy-water cooperation in the region. However, past experience indicates that, even if the parties manage to agree on a new cooperation regime, the success of this regime will depend on the extent to which sufficiently strong institutions can be established to ensure mutual trust and so avoid free riding.

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40 Id. at 20.

41 Daene C. McKinney & Ximing Cai, Multiobjective Water Resource Allocation Model for Toktogul Reservoir (USAID/EPT Project, Technical Report, 1997), at 29, available at http://www.caee.utexas.edu/prof/mckinney/papers/aral/Model-Rpt.PDF.

42 Mukhammadiev, at 237; Khamidov, at 26.

43 Fichtner GmbH at 2-6 & 2-7.

44 "Uzbekistan predlozhil Tadzhikistanu pokupat' prirodnyi gaz po tsene nizhe srednemirovoi", Fergananews, 7 November 2017, www.fergananews.com/news/27202.

45 "Uzbekistan and Turkmenistan Reach Agreement on Electricity Transit", Asia-Plus, 22 May 2017, https://www.news.tj/en/news/centralasia/20170522/240069; "Uzbekistan podgotovil svoi LEP dlia raboty s energosistemami Tadzhikistana i Turkmenii", 8 November 2017, Fergananews, http://www.fergananews.com/news/27206.

46 "Mirzieev zainteresovalsia vozmozhnost'iu pokupki aktsii Kambaratinskoi GES-1", Fergananews, 24 November 2017, www.fergananews.com/news/27326; "Uzbekistan khochet voiti v doliu pri stroitel'stve GES v Kirgizii", Fergananews, 23 November 2017, https://regnum.ru/news/2348837.html; "Uzbekhydroenergo to participate in construction of Kambar-Ata HPP-1 in Kyrgyzstan", 9 October 2017, AkiPress, https://akipress.com/news:597533?from=mportal&place=project.

Coal in the 21st century: From outstanding growth to stagnation

By Carlos Fernández Alvarez

From the beginning of the century to 2012, coal demand growth was staggering. At almost 5% per year, coal accounted for roughly half of the additional global primary energy from 2000 to 2011. In other words, in that period coal supplied the same additional primary energy as oil, natural gas, nuclear, and renewables combined. It increased its share in primary energy from 22.5 to over 29%, edging closer to the 32% share that oil had at that time.

But from 2012 global demand growth slowed substantially and in 2015 we witnessed the first decline in the 21st century. In 2016, global coal demand dropped further, resulting in a total fall of 4.2% from 2014 to 2016. This drop was by far the largest decline in absolute terms on record and nearly matches the decline of 1990-1992, which was the largest two-year decline recorded since the IEA was formed in 1974.

What happened? The main driver of coal's fall is the power sector, where lower gas prices and a surge in renewables and energy efficiency improvements have put a major dent on coal consumption across the globe. Substitution for natural gas in industrial and residential sectors has also been a contributor.

However, the first estimates for 2017 suggest that global coal demand has rebounded, at least somewhat. This is consistent with our most recent IEA forecast, in which global coal demand reaches 5 530 Mtce by 2022. This is only marginally higher than current levels, meaning that coal use all but stagnates for around a decade.

Yet although coal-fired power generation increases by 1.2% per year through 2016-22, its share of the power mix falls to just below 36% by 2022, the lowest level on record. Likewise, coal's share in the primary energy declines below 26%. Yet this is still a significant share. Despite relative declines, coal is not going to disappear overnight.

Indeed global trends mask significant differences at the regional level. In Europe as a whole, the decline of coal began some years ago and will continue – most countries in Western Europe have closed or are gradually closing their coal-fired power plants. The list of countries which have committed to phase out coal from their power mix include Sweden (2022), France (2022), United Kingdom (2025), Italy (2025), Austria (2025), Netherlands (2030), Finland (2030), Portugal (2030) and Denmark (exact date to be established). These countries join Belgium, Switzerland and Norway, which currently have zero coal power generation.

The story is different in Eastern Europe and the Balkans, where countries like Bulgaria, Czech Republic, Greece or, particularly, Poland, are dependent on coal, mainly domestic lignite. Given the social and regional problems associated with mine closures and energy security considerations, a coal phase out in those countries is much more unlikely.

A more nuanced case is Germany, where despite political will the phase out of coal generation is extremely challenging: coal still represents around 40% of electricity generation while nuclear, currently accounting for more than 10% of the power mix, will be phased out by 2023. In addition, most coal generation comes from domestic lignite, so any phase out implies the closure of adjacent mines, with significant social and regional effects.

In the United States, the mood of the coal industry brightened considerably since 2017 as measures introduced by the Federal government provided optimism. Some regulations were reviewed and the financial environment for coal mining improved while recent tax reform brings some new life to the sector, in particular the provision to promote CCUS. At the same time, higher domestic gas prices stabilized coal use in the power sector while higher international coal prices boosted exports and revenues for coal companies.

Ultimately the production increase in the US (40 Mt) is the largest since 2001. Acosta mine, the country's first new coal mine since 2011, was opened in May 2017 and other projects were announced. However, the renaissance may be temporary. Sluggish power demand, abundant gas supply and renewables expansion are expected to challenge coal and limit the prospects for any resurgence in construction of new coal power plants.

Chinese coal demand declined in 2014, 2015 and again in 2016 – despite an increase in coal-power generation – and then rebounded in 2017. Whereas coal power generation remains strong, coal substitution in small industries and residential heating, together with higher efficiency in power, steel and cement industries has made a dent in coal demand.

This sets the scene for the years to come. Improving air quality has become a major policy priority, and the shift from coal to gas, combined heat and power and electricity solutions in the residential and industrial sectors (others than steel and cement) will have a significant effect on coal

use. This combined with saturation of growth in the coal intensive heavy industry will drive coal demand down through 2022.

Remarkably, this fall in demand will take place despite growth in coal conversion and in coal-power generation. Coal conversion growth is supported by the projects in the pipeline for coal-to-liquids, coal-to-gas and coal-to-chemicals. In 2017, the power sector saw coal power generation increase by 4.8%, and this despite substantial growth in PV production (75% compared with 2016), wind (26%), nuclear (16%) and gas (8%). But with strong power consumption growth (6.6%) and relatively low hydro output (1.7% increase, far from historic highs of the past) additional coal power generation was needed to fill the gap.

Ultimately, coal power generation in China remains the world's largest coal consuming sector, accounting for almost one quarter of global demand. Given coal is the marginal supplier of electricity in China (the role of gas is minor and the other sources are largely must-run sources), electricity consumption and output of the other power sources in China are key to understand coal demand trends. Growth in hydro, which was outstanding in the past, growing from 200 TWh produced in 1999 up to over 1 100TWh today, will slow significantly in the coming years, as further developments are more challenging. Wind and solar will grow very strongly, but today they barely represent 7% of power generation. Nuclear development will be also significant. Growth in nuclear, wind and solar versus power demand growth is the main equation which will determine coal power generation.

This has given rise to talk of coal generation overcapacity in China, a halt on the construction of new coal generation capacity and how this could impact Chinese and global coal demand. So let's put things into perspective. In 2017, 39 GW of new coal capacity was commissioned in China, more than the coal capacity installed in Czech Republic and Poland combined. The Chinese government will cap coal capacity at 1 100 GW, still significantly higher than the 980 GW installed as of December 2017. Given that the current load factor of coal plants in China is less than 50%, the control of coal power construction is a logical policy move but is at the same time compatible with the increase of coal power generation.

Meanwhile in India, despite rapid growth of renewables, coal use will continue to rise. With a growing fleet of coal power plants running at less than 60% of capacity and robust power demand growth, coal-fired generation is forecast to increase at nearly 4% per year on average in the coming years. Outside of the power sector, growth in thermal coal demand is concentrated in the industrial sector, thanks to robust economic growth, as well as in coking coal, thanks to rising steel consumption, housing, railways and steel-intensive industries like shipbuilding, defense and vehicle manufacturing.

Across South East Asia – and particularly in Indonesia, Vietnam, Malaysia and Philippines – coal demand is set to grow, driven by power generation. Yet significant differences exist between them. Indonesia is the fourth world's largest country by population, with very low per capita electricity consumption and is the largest exporter of thermal coal by far. Coal is an important piece of the strategy to fuel economic growth and higher standards of life for its population. In Vietnam and Philippines, although there are also coal reserves, imported coal will play a big role in growing electrification. Finally in Malaysia, where coal reserves are very scarce, electricity consumption is close to the global average. Here the buildup of coal power generation is more related to diversification from gas in the power mix rather than the need to ramp up power output as fast as possible.

A singular case is Pakistan, a country with 200 million people consuming just over 100 TWh of electricity per year. This is about 500 kWh per year per capita, or sixteen times less than the average in the OECD region. Endowed with vast reserves in its Thar lignite field, Pakistan is betting on domestic and imported coal to expand electricity supply in the coming years. Projects announced using imported coal account for 7 GW, plus more than 3 GW based on domestic lignite.

Many of these projects are moving ahead quickly. Sahiwal coal power plant (1320MW) was commissioned in 2017 and others are under construction. We forecast coal demand to more than quadruple between 2016 and 2022 and Pakistan emerges as a significant international player, with imports accounting for half of its consumption. But construction of coal power plants is only one of the links in the supply chain. Production from the Thar field needs to ramp up and the infrastructure to deliver imports to coal plants wneeds to be developed.

Although moving much slower than Pakistan, Bangladesh is also planning an expanded role for coal with 19 GW of new coal power generation capacity announced. The expectations that Egypt may become a large coal consumer (and importer) cooled significantly in 2017 after the government decided to postpone coal projects until 2022. Whereas construction plans have not been cancelled, there are serious question marks about their future owing to lower than expected power demand growth and the discovery of Zohr, a giant gas field which has changed the Egyptian energy landscape. Meanwhile, Dubai is set to open the first large coal power plant in the Middle East when Hassyan coal power plant (2 400 MW) starts operation.

Clearly, we see a clear geographical shift of coal demand to Asia in the coming years. This trend began some years ago and is set to continue. Back in 2000, Europe and the United States each represented one quarter of global coal demand. Today, they represent less than one quarter combined. In parallel, coal demand in Asia in 2000 represented less

than half of the world's consumption. Today, it is almost three quarters.

Essentially, a geographical breakup of coal is emerging. In IEA's Medium-Term Coal Market Report 2016, we said that "if coal production, demand, trade and all the coal-related technology and finance disappear from the western world while they are increasingly concentrated in Asia, a geographical split will emerge, with emerging difficulties for a balanced coal-related dialog."

Only one year after the publication, the different views on coal are becoming more evident. The Powering Past Coal Alliance, launched by the United Kingdom and Canada and joined by over 20 countries and some States and cities, as well as business and other organisations, targets the end of traditional unabated coal power generation. In parallel, at COP23 the United States announced a Clean Coal Alliance to promote the use of clean coal technologies.

The link between these two apparently conflicting positions is Carbon Capture, Utilisation and Storage (CCUS). CCUS is a family of technologies and techniques that enables the capture of CO2 from fuel combustion or industrial processes, the transport of CO2 via ships or pipelines, and utilization in practical applications or its storage underground. The IEA has called for urgent action to support CCUS. Despite recent progress with the commissioning of a number of projects in different sectors, including Petra Nova (coal power plant), Illinois Industrial (corn-to-ethanol), Quest (oil sand upgrader) and Al Reyadah (steel production), the lack of policy support means that investment in CCUS continues to lag far behind that of other low carbon technologies.

The need for urgent action to boost CCUS technologies was recognized by governments and industry at a high-level Summit hosted by the IEA in November 2017. The Summit was co-chaired by Rick Perry, the US Secretary of Energy and Dr Fatih Birol, the IEA Executive Director, and attendance included Ministers and top government officials from Australia, Canada, Japan, Mexico, Norway, Poland, the Netherlands, the United Kingdom and the European Commission, as well as CEOs and senior executives from major energy companies including ExxonMobil, Royal Dutch Shell, BP, Statoil, Chevron, Total, Suncor Energy, GE Power, Dow Chemical, Mitsubishi Heavy Industries, Port of Rotterdam and Glencore.

The unprecedented level of participation in the Summit demonstrated a growing appreciation that CCUS will be critical to achieving global climate goals while supporting energy security and economic growth objectives. CCUS can reconcile the reality of continued use of coal (and gas) in the power sector and the urgent need for emissions reductions. It is also one of few solutions able to deliver deep emissions reductions in key industrial sectors such as steel, cement and chemicals production.

While the availability of CCUS is expected to play an important role in determining coal's future, CCUS is not only about power generation and it is not only about coal. Deployment of CCUS is a condition sine qua non in order to have a low carbon future.

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China and clean coal

By Dr Frank Umbach

Coal is – after oil – still the second most important energy resource in the worldwide energy consumption. It has longer availability than conventional gas and oil resources, is cost-competitive, widespread, plentiful, scalable, easily storable and geopolitically secure. Hard coal, together with lignite, accounts for not less than about 55% of all fossil energy resources. They are used to make steel, cement, fertilisers, and is a feedstock for the chemical industry.[47] The proved global coal reserves in 2016 are sufficient to meet 153 years of global production, and thus are far more available than the ratio of reserves versus production (R/P) for oil and natural gas – 50.6 and 52.5 years, respectively.[48] Moreover, coal resources are 20 times larger than coal reserves and could be exploited with slightly higher prices and/or future technological innovations.

According to the International Energy Agency (IEA), global coal consumption is expected rather to stagnate (+0.2% annually) through 2040. Around 180 billion tonnes (bn t) are produced over the next 25 years – accounting for just less than a fifth of the worldwide coal reserves. While the coal demand might decline dramatically in Europe by -61% (compared with the U.S. by -11%) and even China (-13%) by 2040, it will be offset by a rising demand in India and South Asia, Southeast Asia, and Africa.[49]

But the share of global energy demand will decline from 29% in 2012 to 24% by 2040, though it will remain the world's second most important energy source just ahead of natural gas as new production and transformation technologies – e.g. liquefaction and gasification of coal – are already underway. China, India, and Australia alone are forecasted to account for over 70% of global coal production by 2040, highlighting Asia's strategic import¬ance and the strategic shift in world coal markets. Hence a world without coal appears unrealistic by at least 2040/50.

In this light, the adoption of 'clean coal technologies'[50] and high-efficient coal-fired generation technologies, as well as of Carbon, Capture and Storage (CCS), will be key factors in containing a further dramatic rise of CO2 emissions, and also to ensure a realistic transition to a low carbon power system. Around 60% of the existing worldwide coal capacity is subcritical – the least efficient class of commercially available coal-fired efficiency technologies.

New strategic trends of China's energy and coal policies

On a global energy level, China matters more than any other country in the world. It extends to all fuels and technologies. It is worldwide the largest producer as well as importer of fossil fuels, including coal. China is also the world's largest investor in renewable energy sources (RES) and all kind of low-carbon technologies as well as the largest producer and exporter of solar equipment.

As the world's largest energy consumer and emitter of Greenhouse gas emissions (GHGE), China's future direction of its energy policies will have an ever-increasing impact on the global energy markets, its geopolitical implications for worldwide peace and stability as well as for global climate mitigation policies and the perspective to decrease the global warming below the internationally agreed <2°C target.

China is using nearly as much coal as the rest of the world combined and its coal production is providing more energy to the world's economy than the whole Middle Eastern oil production. While China's coal share of its primary energy demand will decline from the 62% to around 45% and of its electricity generation from 67% to 39% from 2017 to 2040, China's coal consumption cannot be replaced entirely by gas or RES. Its total coal demand might only decline by -15% from 1,957 million tonnes of oil equivalent (Mtoe) to 1,706 Mtoe by 2040.

In 2015, China has officially promised to reach the peak of its GHGE by 2030 and only afterwards to decrease them. In the Paris Agreement and its NDC, China has promised just to cut its carbon intensity (the amount of CO2-pollution released to create each dollar of economic activity) by 40-45% by 2020 and 60-65% by 2030 compared with its 2005 level. It allows Beijing still to increase its emissions by 2030, though on a slower pace and by promising to reach its GHGE peak earlier.

Since 2015, China has begun to decrease its coal consumption more significantly, albeit its policies have

47 See also F.Umbach, 'The Future Role of Coal: International Market Realities vs. Climate Protection?', EUCERS-Strategy Paper Six, King's College, London, May 2015.

48 See BP, 'Statistical Review of World Energy', June 2017.

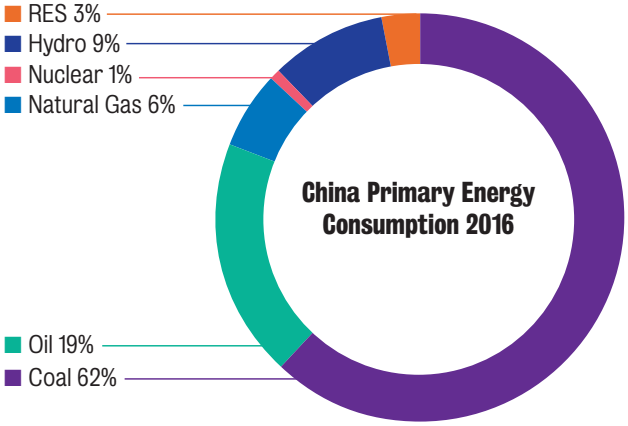
49 See IEA, 'World Energy Outlook 2017' (Paris: OECD/IEA, 2017), pp. 203 ff.

50 'Clean coal technologies' usually describes and involves a collection of technologies being developed to attempt to help lessen the environmental impact of coal energy generation and to mitigate worldwide climate change, including pre-combustion capture, post-combustion capture and oxy-fuel combustion technologies.

remained contradicting and ambivalent. As part of its 13th Five Year Plan for Power Sector Development (2016-2020), China has significantly revised its previous energy plans by decreasing investment and plans in the light of a much lower increase of its energy demand as the result of a lower annually projected GDP growth of 6-7% (declining by some 40%), an overall economic restructuring from a once low-tech factory of the world into a global high-tech power and an impressive decline of energy intensity.

While China's energy mix has become 'greener' and is being welcomed in the light of the global climate change mitigation policies and the U.S. declared withdrawal from the Paris Climate accord of December 2015, its expansion of RES is very much driven by economic-industrial as well as technology policies and its anti-air pollution fight rather than its global climate protection policies. China has also launched its national Emissions Trading System (ETS) at the end of 2017 by setting emissions quotas, but it is limited for companies in the power sector and not the broader economy. Nonetheless, by emitting 3.3 bn t of carbon dioxide annually, its carbon trading scheme is about 1.7 bigger than the EU's carbon market as the hitherto the world's largest one. Together with the EU, it could create the world's largest carbon market. But the motivations and strategic interests are very different in China and the EU.

Figure 1: China's Primary Energy Consumption (PEC) 2016



Source: Dr. F.Umbach based upon BP, 'Statistical Review of World Energy', 66th Edition, June 2017.

China's endured air pollution crisis has stirred a national debate as its GHGE have increased by 40% between 2010 and 2015. Beijing's leader¬ship became increasingly concerned by increasing public debates such as the chemicals warehouse explosions in the port city of Tianjin in August 2015 as well as by the popular and independent criti¬cal documentary 'Under the Dome' over the economic damages of relentless econo¬mic growth exacerbating China's eco¬lo¬gi¬cal problems.

In the spring of 2014, China already declared a 'war on pollution' with plans to improve air quality and reduce CO2 emissions per capita by 40-45% by 2020 from 2005 levels – in 2014, cuts were already equivalent to 33.8% vis-à-vis 2005. In 2014, for the first time, a record of additional renewable capacity surpassed the additional capacities of coal with its lowest increased level since 2004. But China will still remain the largest emitter through 2040 and may produce more than twice the amount of GHGE set to originate in U.S. by 2030. In 2012, China already emitted some 60% more CO2 than the United States. In 2014, for the first time, China was producing more CO2 emissions per capita than the EU (7.2 t vs. 6.8 t respective¬ly). In total, it was even outstripping the combined GHGE of the EU and United States.

In June 2015, China unveiled new pledges on climate change for the medium term. By implementing these pledges, these targets have implied huge investments in new green infrastructure such as smart power grids, high-speed rail networks, and urban recharging systems for electric vehicles. With more than one-quarter of the world's RES capacity (totalling some 564 GW, incl. 305 GW of hydropower), it has become the world leader in investments for RES and production of solar panels as well as batteries for electric mobility. The government envisages some 340 GW hydropower, 110 GW of solar and 210 GW of wind power by 2020. In January 2017, China announced to spend more than US$360 bn on RES and to create more than 13 million new jobs in the RES sector by 2020.

China may also overtake the U.S. in nuclear power by building another 19 reactors to the presently operating 38 ones within the next 10 years as another 'clean energy resource'. In 2015, nuclear power generated just 197 bn kilowatt per hour (kwh) or 3.6% of its total net electricity generation.

However, between 2012 and 2015, a surge of 170 GW of new coal-fired capacity went online. As a result, the average load capacity declined from 62% in 2011 to 45% in 2015. Nonetheless, Beijing still approved some 155 new coal projects in 2015 – the equivalent of 15% of overall Chinese coal-fired power capacity in 2014, or almost 40% of the capacity of operational American coal plants. More than 60% of China's existing coal fleet today (around 570 GW) is less than 10 years old. Given the mid-range technical lifetime of new coal power plants is around 50 years in operation, those coal power plants might be in operation until 2040/50. China is currently still building 50 additional modern coal plants, which may produce an estimated 1.1 bn t of CO2 per year. In 2015, 52 GW of new coal-fired capacity has been added, though a number of advanced coal power plants have been stopped (but not cancelled).

Against this background, almost all projected scenarios for China have concluded that, through 2040, the majority of Chinese energy and electricity generation mix will still

come from fossil fuels – and even at higher volumetric levels. In the end, only a much more radical nationwide deregulation of electricity markets and restructuring of the entire coal sector might decisively reduce reliance coal while boosting RES by a much wider margin.

Over the last 15 years, China has continuously tried to restructure its coal sector and industry, which is beset by about 10,800 small local and often inefficient coal mines with out-dated equipment and insufficient investment in 2015; additionally, they have been beset by dismal safety records – 7,500 of these mines produced 20% of national output yet represented 70% of mine accidents. In 2017, China had officially still more than 4,000 coal mines with a total capacity of 3.41 bn t a year, though other Chinese sources have reported 7,000 mines still existing. China pursued new strategies for rationalizing and stabilizing national coal output projected originally up to 5.1 bn t from 3.6 bn t in 2013. It curbed coal consumption at 4.2 bn t and set a coal share of no more than 58% of the primary energy mix by 2020. Beijing has pushed through major structural reforms in the form of mergers and acquisitions in order to create 10 'super-large' coal companies by the end of 2020, accounting for about 60% of the country's total coal production. But Beijing has faced difficulties and encountered widespread opposition to the closure of small mines.

China also seeks to further enhance the energy efficiency of its coal-fired fleet in order to reduce emissions and by integrating modern scrubbers for decreasing air pollution. China's efficiency levels reached 37% and were thus already higher than the world's average of 33% in 2015. China seeks to close in particular many older 'subcritical' coal power plants and build most of the new ones as much cleaner 'ultra-supercritical' coal power plants with lower emissions and higher efficiency. Between 2006 and 2015, 90 of the 100 top plants are ultra-supercritical - compared with just one in the U.S. But of its total coal power fleet with a combined 920 GW capacity, only 19% are ultra-supercritical, 25% supercritical and 56% subcritical as the world's least efficiency and most dirty coal power plants. Its 'dirty coal' use is expected to decline from 650 mt per year (mtpa) in 2012 to 191 mtpa by 2025 and around 100 mtpa in 2035. But it is not really clear whether Beijing's present coal plan will reduce CO2-emissions in entire China or ultimately shift most of the pollution just from its largest cities to its hinterland and other countries.

In the years ahead, China's coal demand and indigenous production could also grow again because of its programmes for coal conversion to synthetic natural gas (SNG), liquid fuels (CTG) and Coal-Bed Methane (CBM). Although these new coal conversion options can also substantially reduce CO2 emissions and air pollution, Chinese authorities also harbour con-cerns regarding these technologies' intensive use of energy and water, and therefore, the total emissions in a lifecycle balance might be marginal.

Furthermore, a peak in coal does not necessarily and automatically correlate directly with a forthcoming peak in GHGE as long as China's oil and gas demand is rapidly rising. Like the U.S., China seeks also switching from coal to gas (with the aim of a 10% share of natural gas of its primary energy consumption by 2020) for decreasing emissions. But in contrast to the U.S., China has not only to increase its indigenous gas production, but also its imports via pipelines and LNG from foreign suppliers. Chinese researchers have also questioned the overall assumption that the coal-to-gas switch will really improve the air quality as it could contribute to the thick toxic smog with higher concentrations of nitrogen dioxide (NO2) as burning gas creates water vapour, which reacts with airborne pollutants to create smog.

In January 2017, Beijing already stopped more than 100 coal-fired projects. Reportedly only 22 GW of new-coal-fired Power generating capacity was approved for construction compared with 142 GW in 2015. According to the 13th Five-Year Plan (2016-2020), around 150 GW of new coal capacity has been cancelled or postponed until at least 2020. In January 2017, China's coal capacity in the pre-construction planning stage decreased to 570 GW of coal power capacity from 1,090 GW a year before. Beijing plans to cut its coal power capacity by 300 million tons (mt), that will shrink its coal output rise to 3.9 bn t of coal by 2020 (up from 3.75 bn t in 2015), while its coal consumption will grow from 3.96 bn t to 4.1 bn t over the same time. Thereby it will decrease 800 mt of outdated and inefficient coal capacity and add 500 mt of clean coal capacity. However, the decision has not been taken primarily due to decrease air pollution and shrinking emissions, but to curb overcapacities as its coal-fired power plants had an average load factor of just 46%, risking many newly build ones becoming 'stranded assets'.

Despite China's efforts to reduce its coal share in its electricity mix from more than 70% in 2011 to 65% in 2016 (and planned to decline to 47% by 2040), it has relaxed its production controls for mining coal in the second half of 2016. It has allowed 800 mines to operate again up to 330 days instead of 276 days (a target it introduced in April 2016), due to higher prices and bottlenecks of supply after its coal production dropped 11% in the first 10 months of 2016 compared with the same period of 2015. The relaxed production controls have increased the production by 300 mt.

China's rise to the worldwide largest supplier of coal projects and clean coal technologies

China is not only the world's leading investor in RES but also the largest global investor of public financing for foreign coal power plants.[51] Confronted with the combined challenges of overcapacities and dwindling profitability, Chinese coal companies – with the support of the government – are forced to invest and expand abroad of becoming global players as part of Beijing's ambitious industrial, technological and geo-economic policy ('China 2025'). It questioned its coal policies at its home market as it could have favoured a carbon leakage strategy for outsourcing emissions just to other countries. However, the rise of coal imports during the last years might only be temporarily as long as the restructuring and consolidation process of its domestic coal industry and the expansion of RES and natural gas will continue.

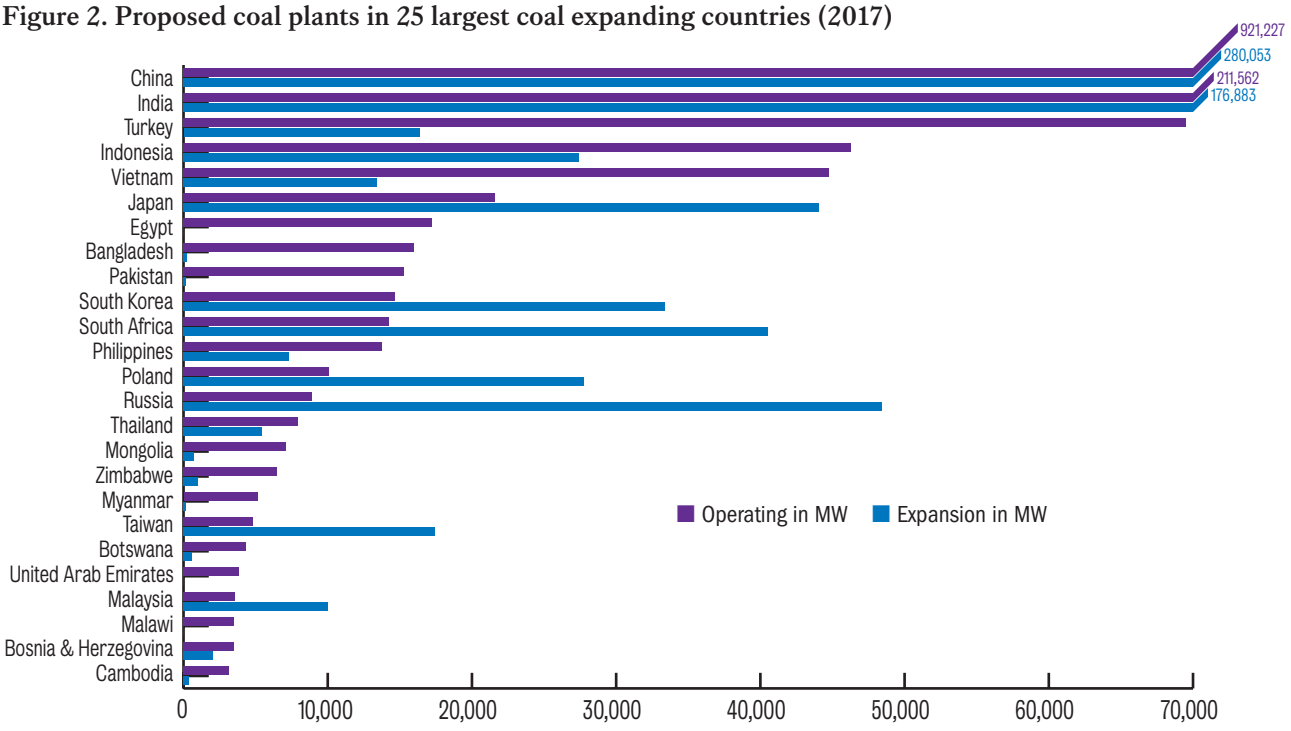
In 2013, China's public financing for coal power plants abroad amounted to not less than 40% of the worldwide one. But those policies for expanding coal production and consumption stand in opposition to global efforts for mitigation climate change below the 2°C target and the policy of the Organization for Economic Cooperation and Development (OECD) and its 34 member states. They have stopped all public funding of foreign coal power plants except when no RES-projects can be implemented in developing countries. Even those 'ultra-supercritical' coal power plants are only being allowed, when they can be equipped with CCS technology.

According to various new data and sources of 2017, Chinese companies are currently building up to 50% (or 700 new coal power plants at home and abroad) out of worldwide 1,600 new coal power plants being constructed or planned in 62 countries to become operational in the next decade.

Despite its signing of the Paris Agreement in December 2015, Chinese state-owned companies have continued their investments into new coal power and coal mining projects worldwide – ranging from Indonesia and Southeast Asia to Pakistan and South Asia to Turkey and the Balkan states in Europe as well as to Africa and Latin America. China has even supported coal power projects in countries (such as in Africa) as part of its 'Belt-and-Road-Initiative (BRI)', which had never burned coal in the past. But despite newly enforced efficiency standards for coal power plants with much lower CO2-emissions and environmental regulations for decreasing air pollutions on its domestic energy market, those new standards and regulations do not apply often for China's exported coal power projects abroad. Those investments also often take place in countries which have low environmental regulations and standards as well as weak laws and to cope with endemic corruption.

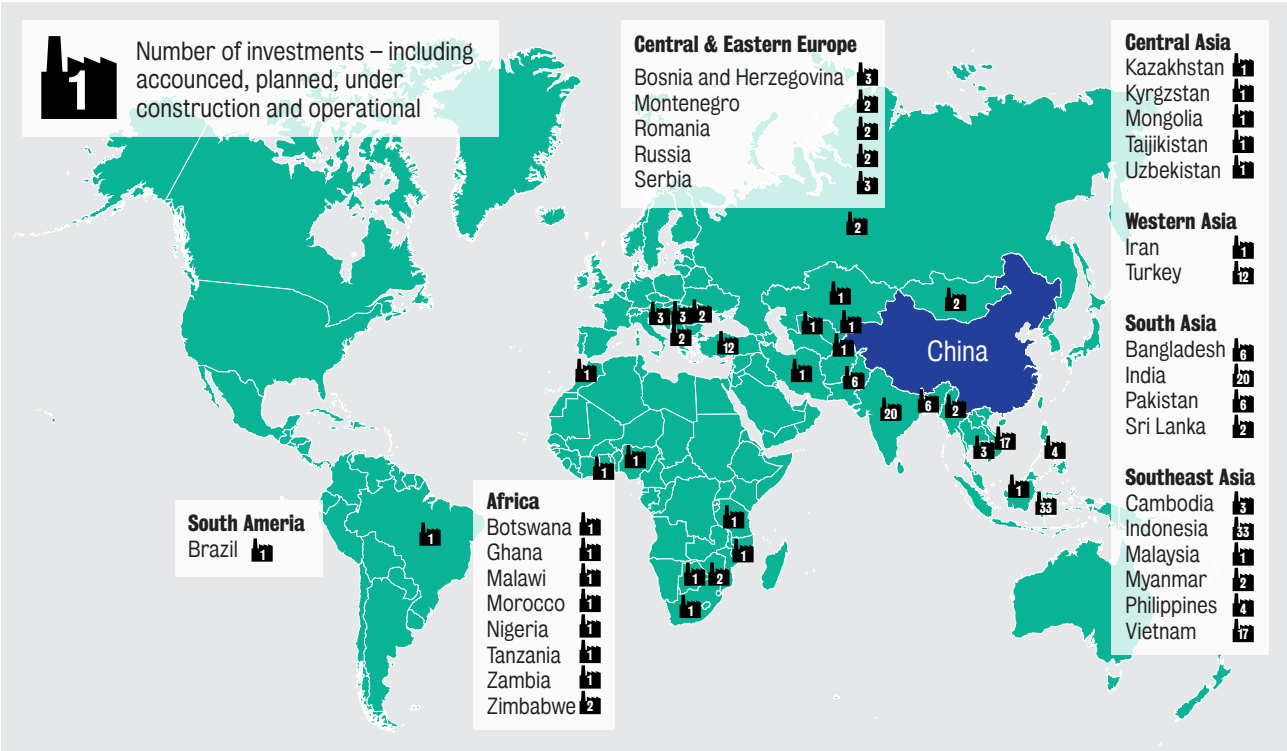
51 See also F.Umbach/Ka-ho Yu, 'China's Expanding Overseas Coal Power Industry – New Strategic Op¬por¬tu¬nities, Commercial Risks and Geopolitical Implications', and F.Umbach, 'China's Overseas Coal Investments Challenge Climate', GIS, 21 March 2016.

Figure 2. Proposed coal plants in 25 largest coal expanding countries (2017)



Source: Urgewald 2017 (https://coalexit.org/)

Figure 3: China's global coal expansion Chinese investments in new coal-fired power plants by country



Source: GIS 2017

Strategic perspectives

Although China's overall coal consumption has decreased between 2013 and 2016 and is expected to fall by 2040, it will remain the world's largest coal consumer by 2040. Up to now, China's coal demand and production peaked in 2013. But Beijing is not phasing out its coal demand and production by 2040/50. It is also struggling with its efforts to decrease its coal consumption. In 2017, China's coal consumption (for the first time since 2013) has increased again by an estimated 0.4-3.3% towards the previous year alongside of its coal imports (even doubling those from the U.S. of its total of 270 mt). In result, China's GHGE have also climbed up by 1-3.5% in 2017 after three years when the emissions were falling primarily due to a slowing economic development. Also, globally Asia's coal demand and prices have risen in the first four months of 2018, which might persist for several years. Furthermore, China's shift from coal to gas also resulted last winter in mounting problems due to insufficient gas supply infrastructure in place. At the end, Beijing had to revive coal power plants and to lift restrictions on coal imports particularly on the countryside as it has no replacement for heat or electricity generation. But China might maintain a cap on coal utilization for electric power generation of 1,100 GW up to 2030. Most international experts expect a final peak of coal consumption in China already before 2030, around 2026.

While Beijing's policy makers have shown some willingness to sacrifice economic growth, it has clearly its limits. According to the IEA's 'New Policy Scenario', China will still account for almost 45% of the worldwide coal demand by 2040. As it has become the world's leader in clean energy technologies, its policies to invest abroad in 'clean energy technologies' is not constrained to RES and defined in 'either-or' categories but includes also the export of clean coal technologies. The increasing competition between China and Japan in Southeast Asia for building more efficient supercritical or ultra-supercritical clean coal power plants, for instance, is fuelled by a rising technological as well as geopolitical rivalry in their bilateral relations.

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Profitable energy for Central Asia

By Birgit Wetzel

Central Asia has a great potential for renewable energy. Also, and maybe therefore, it has a good potential for an independent economic and political development. The question is how to develop its potential. Central Asia is rich with carbohydrate resources, such as coal, oil, and gas. Why should they invest in renewable energy? There are several good reasons for it. And while investing in renewable source, Kazakhstan, Uzbekistan and Turkmenistan can continue to export their fossil fuel resources. This is necessary because fossil fuels offer a rich source of income for the region, if they are exported, and can be a good source of income for the state budget. Instead of using their fossil fuel resources, the states of Central Asia could develop their natural resources to produce energy with sun, wind, and water. The region, geographically and meteorologically, offers great potential for renewable energies, which can fuel dynamic and sustainable economic development.[52] Investments could be made to produce parts, which would bring work to regions with high unemployment rates.[53] In the second phase, after their installation, energy could be produced locally and independent from great infrastructure projects and could attract new industrial investments with their low price for electricity.

Another reason is that the development of this renewable energy potential will lower the conflict potential in the region, situated between the big powers Russia and China. Both big powers consider Central Asia as their back yard, or in case of China, as the region for which they have their long-term strategy, called One Belt One Road. Chinas interests are quite visible, as they are building roads and transport routes across Central Asia, giving Central Asian states long term credits with low interest rates. At first sight this may seem fine, at second view it is clear to see that thereby China ensures its influence in the region and makes the states dependent on China's credits. Several other neighbouring players have their interests in the region, but are not quite as ambitious: Turkey, India, Pakistan and Iran. If economies in Central Asia will develop well, they can become interesting markets. What is most important is to develop an energy strategy that ensures a sustainable development of the region. Without energy, economies cannot grow. It is essential for economic growth. Because of this, energy can be used as a soft weapon. Therefore, energy security and energy independence must be a top priority for emerging economies, especially those who are in the focus area of greater powers.

Energy security means to have a stable, secured and self-reliant energy resources and an infrastructure to provide resources where and when they are needed. Central Asia as a region has a good potential to reach these goals. Kazakhstan's wind potential alone surmounts its prognosed electricity needs for 2030 by ten times[54]. Its endless steppes off great opportunities for wind farms. Tajikistan is among the ten leading states worldwide, with a great hydro potential for producing electricity. Solar power and biomass have great potentials in Uzbekistan[55], which has 300 days of sun annually. The new energy resource for Kyrgyzstan is hydro power from small rivers, and Turkmenistan with its wide deserts has a vast potential for sun generated electricity. In remote mountain areas of Kyrgyzstan and Tajikistan with limited access to public grits, solar collectors can be a useful source of energy to heat water and to reduce the amount of fossil burning. But, although there is a vast/huge potential, renewable energies so far do not play a role in all Central Asia.[56]

Energy landscape today

Central Asia's energy needs are until now largely fed by fossil fuels. In Kyrgyzstan coal produced locally fills the electricity generating power works in the Kyrgyz capitol of Bishkek, heavily polluting the air, especially in the winter time. Heavy smog in February 2018, when temperatures had reached an extreme low of minus 32, even led to a government crisis. Besides coal, gas from Russia fills the large gap between home production and needs. Kyrgyzstan is dependent on gas from Russia. This has been the reason to enter the Eurasian Market Union, where prices are reduced for friends. Hydro power has long been an option. Since the independence from the former Soviet Union, states of Central Asia have been struggling to be independent but have not been successful in gaining energy independence. Kyrgyzstan, to 80% covered by high mountains, has a great potential for hydro power.[57] At the same time, its neighbours are eagerly looking at the water resources which they do not have. They would need water in spring, when harvests start to grow. But exactly that is the time when the mountain states, Kyrgyzstan and Tajikistan, start collecting water coming from the

52 http://www.irena.org

53 http://www.dkau.de/index.php/de/informationen/business-ideen/die-investitionen-auf-den-wind

54 http://www.dkau.de/index.php/de/informationen/business-ideen/die-investitionen-auf-den-wind

55 http://www.sonnenenergie.de/index.php?id=30&no_cache=1&tx_ttnews%5Btt_news%5D=67

56 ZA Analysen, Nr. 89, Juni 2015

57 http://www.laender-analysen.de/zentralasien/pdf/ZentralasienAnalysen94.pdf

mountains in spring, and save it for summer, for electricity generating power hydro stations.

The same can be found in Tajikistan, where high mountains cover even 90 percent of the country. Small river hydros could provide in sum large quantities of electricity. Another solution would be to provide neighbouring Uzbekistan and Kazakhstan with water from the dams in spring and receive gas and oil in return. This could be a win-win solution for the timbering and until investments are made and small scale hydros installed. But lack of trust has until now blocked this trade.

Uzbekistan is rich with fossil energy. The majority of primary energy comes from fossil fuels, with natural gas, coal and oil as the main sources. Numbers slightly vary: Twelve thermal power plants and 31 hydropower plants annually generate up to 58.9 billion kW/h of electrical power and more than 10 million Gcal of thermal power, of which between 88.5% is provided by natural gas-powered thermal plants and 11.5% by hydropower plants, the only significant renewable source in the country, and a remarkable increase in the last five years. Coal has a small share of only 4%. With the gigantic power-generation facilities of the Soviet era and an ample supply of natural gas, Uzbekistan has become the largest electricity producer in Central Asia.[58] Electricity is transmitted and distributed through power transmission lines whose voltage ranges between 0.4 kV and 500 kV, and whose total length currently exceeds 243,000 km. Uzbekistan's electricity capacity is expected to increase thanks to the modernisation of old facilities. Uzbekenergo is currently implementing 28 large-scale investment projects. During the last decade, hydropower energy production has been steadily increasing. It is expected to grow mainly by the development of mini-hydropower plants with a capacity of 420–440 MW and the modernization of existing HPPs, as shrinking water resources are insufficient for a massive hydropower project.

Kazakhstan has rich resources of oil, gas, coal and uranium. Oil is exported in large quantities, earnings are estimated to sum up to 25 % of the BIP. Coal is mostly used domestically. It produces 80 of the country's electricity. As a consequence, and in addition to a rising number of producing industries, Kazakhstan's emissions have dramatically increased since 2006. In 2010 the Government started into a new emission reducing program, to reduce the emissions until 2020 to a level lower than the one in 1992, the beginning to its independence. In 2017 Kazakhstan hosted the EXPO 2017 in its capital Astana. The Mottos was "Green Energy". Kazakhstan uses the term renewable energy also for nuclear energy. Therefore, it uses its great resources of Uranium to promote renewable energy, referring to nuclear energy as a non-polluting and not CO_2 producing source.[59] Their explanation is that nuclear energy does not emit any CO_2. There are no – visible – traced left from using nuclear energy. This explanation for the kind of view may be due to the fact that Kazakhstan is doing good business selling Uranium and it is the top exporter worldwide for providing power plants with material. In its history and until now, Kazakhstan has suffered severely from nuclear tests carried out in Soviet times, on its territory in the 1950-ies. Until now, several thousand people of the region are suffering from radiation from those times, and its consequences, such as a high rate of cancer, and a high rate of disabled and dead new-borns[60].

Natural gas is the greatest source of energy in Turkmenistan[61] in fact, the country has the second, some sources saying the 6th greatest resources worldwide, after Iran, and surely the greatest gas resources in Centre Asia. A great part of the available gas is exported to China via a 5000 km long gas pipeline[62]. 80 % of the country are covered by the Karakum desert, with a very high potential for solar energy, and also for wind power installations. The population of only 5 million people is scattered over a large territory. Since 1993 each Turkmen citizen receives a certain amount of Gas, electricity and water for free. Electricity prices are very low. But citizens are asked to save energy, so more gas can be exported.[63] Until now, Turkmenistan does not produce any renewable energy, and there are no plans known to do so in the near future.

Why are renewable energies important for Central Asia

Renewable energy is highly relevant for Central Asia. There are a number of reasons why. Renewable energy is important to fight climate change, and they produce cheap energy. Once installed, the price for electricity produced will be stable and low. This again will attract industries and foster the economic development, which, as a consequence, will improve the stability and the sustainability of Central Asia.

Renewable energy is an important factor for peace keeping. Fossil fuels are becoming scarce and are therefore leading to conflicts. Relying on fossil fuels as a major source energy would increase the risk for conflict, which in Central Asia can be avoided. They have a choice – which not all

58 https://www.iea.org/statistics/statisticssearch/report/?country=Uzbekistan&product=balances and www.sonnenenergie.de/index.php?id=30&no_cache=1&tx_ttnews%5Btt_news%5D=67

59 http://www.laender-analysen.de/zentralasien/themenindex/wirtschaft_energie_umwelt.php

60 http://www.laender-analysen.de/zentralasien/themenindex/wirtschaft_energie_umwelt.php

61 http://www.laender-analysen.de/zentralasien/pdf/ZentralasienAnalysen05.pdf

62 http://www.laender-analysen.de/zentralasien/pdf/ZentralasienAnalysen90.pdf

63 http://www.laender-analysen.de/zentralasien/pdf/ZentralasienAnalysen89.pdf

countries have. Renewable energies are politically highly relevant. They support independence from other energy resources, and imports of fossil fuels. Even more important, they provide counties with a self-reliant energy resource and support their independence, economically and politically.

What needs to be done

Although there is a great potential for renewable energy in Central Asia, not much has been done[64] [65]. It is the questions if ruling elites will give way for investments for energy for civil society? And will an economic development for the countries be in their interest? If installing renewable energy means that more fossil fuels can be exported, this may be a reason to give way to new energies. For Kyrgyzstan and Tajikistan, it will be attractive to reduce their dependency on gas from their neighbour Russia. Challenges will be investments and electricity grids to be installed. Kazakhstan has already made plans what energy resources should be used in which regions.[66] [67]Uzbekistan, with 32 million people, is home to half of the whole population of Central Asia. It also has plans and it is trying to interest investors.[68] On the political level, an understanding of the potentials and the long-term consequences for the region and its stability should become visible. Investments are needed, respective laws and tax regulations should be introduced to attract industries. Kazakhstan and Uzbekistan alone have already taken some steps. What would be more successful is regional cooperation and energy cooperation, which would offer cross border electricity production and transport, and a great swap potential, as well as great flexibility. The UN conference for security and sustainability for Central Asia, that took place in Samarkand on November 12-13, 2017 in Samarkand, has created hope that regional cooperation is seen as a positive move. A treaty for cooperation was signed by all five countries: Uzbekistan, Kazakhstan, Turkmenistan, Kyrgyzstan and Tajikistan.

Summing up the result: Renewable energy and energy cooperation in Central would mean a great step for peace, stability and sustainability for the whole region. Investing in renewable energy in regional cooperation would mean to make use of a great potential of renewable energy, energy without conflict potential, and to invest in a great potential for economic progress, for independence and a prosperous economic and political future.

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64 http://www.laender-analysen.de/zentralasien/pdf/ZentralasienAnalysen89.pdf

65 http://www.irena.org

66 https://www.dena.de/newsroom/energieeffizienz-in-kasachstan/

67 http://www.laender-analysen.de/zentralasien/pdf/ZentralasienAnalysen89.pdf

68 http://www.laender-analysen.de/zentralasien/pdf/ZentralasienAnalysen89.pdf.

The rise of renewables – challenges and opportunities for emerging nations: Example of Kazakhstan

By Arman Kashkinbekov

Renewable energy in emerging or developing countries has begun only several years ago after tremendous success in the USA, and EU countries. China is leading the growth today in the whole World with clear and already achieved goal of capturing global RE market. From available industry information we observe reaching plateau level in America, and EU, now focusing on regulative and electricity produced stability issues, while developing World is catching up very quickly.

Investments in developing countries exceeding those in developed couple of years ago and continue to grow. On the other hand, RE industry overcame traditional oil, gas and coal by the lumpsum investments. While some countries still argue on attractiveness of new energy to end consumer others are taking the strong lead.

In the US, this work has intensified with the activities of the Obama administration, which developed and implemented the Million Solar Panels program, which had a wide public support among the population. In California, the largest solar power station with a capacity of 500 MW was built and launched. It implies an increasing share of RES in the total amount of electricity produced in the future. New administration in the White House is trying to change these positive trends in favour of coal-based production.

In Germany, the share of renewable energy has already exceeded the threshold of 30% and the country's authorities have seriously considered introducing more stringent administration of the industry by ensuring a constant flow of energy from producing organizations and launching an auction system to further lower the tariff level. Analytical estimates of 130 billion already spent on the industry investments from the state inspire respect and show the whole world the seriousness of the country's plans to switch to alternative energy sources.

Japan, having little available land, decided to build solar stations in the Pacific Ocean. The recent catastrophe at the Fukushima nuclear power plant undoubtedly also significantly influenced the authorities' bid for more efficient and environmentally safe sources of energy in the long term.

Scandinavian countries such as Denmark and Sweden have developed state programs for the significant development of the renewable energy industry in order to achieve a 70-90% threshold in the overall energy balance. Denmark nowadays covers a large domestic demand at the expense of these energy sources and considers its export opportunities to neighbouring countries.

Among the CIS countries, the leader, with a large margin, is Ukraine, which, in a situation of uncertainty with gas supplies, has set a course for rapid and full-scale implementation of RES renewable power throughout the country, which resulted in overcoming a milestone of one gigawatts in total installed capacity in 2016.

The most negative is the experience of Spain, where the government provided too much material support for renewable energy sources at the very start, in the form of high tariffs, which led to a great instability of the Spanish energy networks and chaotic development of the industry.

Kazakhstan has begun its journey in 2013 when the first Law on support of renewable energy was adopted by the Parliament, setting up a system of feed-in tariffs to initiate solar, wind, hydro and biomass projects. Another major step was signing by the President a new Concept of moving the country into green economy, where renewable energy was a primary focus point. Strong promotion for RE industry point was existence of independent Ministry of Ecology which later was included as a part into big Ministry of Energy, covering oil, gas, coal, uranium production.

Clear goals of reaching 3% of renewable energy in the total electricity produced balance as of 2020, 10% by 2030, and 50% by 2050 were set.

As part of the implementation of the Concept, in 2014 the Government approved fixed tariffs for producers: 34.61 tenge / kWh (excluding VAT) for solar stations, 22.68 tenge / kWh for wind farms, 16.71 tenge / kWh for small hydropower plants (hereinafter - HPP) small hydropower plants are meant with a capacity of up to 35 MW, and without dam construction, and 32.23 tenge / kWh for biogas plants.

Given the current tenge exchange rate against the US dollar at the rate of 182 tenge per 1 US Dollar, the introduced tariffs were investment attractive, which led to the launch of the first large and small projects in this area, as well as to a

Figure 4: Map of Kazakhstan

significant increase in interest in the sector from Kazakhstan and foreign investors.

Since then, several large-scale industry projects were developed and put under operations, including 50 MW Burnoe Solar – 1 solar power station in Jambul region (South of the Country), 45 MW Yerementau Wind Farm in Akmolinsk region (North), solar panels assembly plant in the Capital of Astana, and small solar power station in Kapshagai region. All of those came with direct support and involvement of the Government thru national companies' participation. International financial institutions such as EBRD/European Bank for Reconstruction and Development, EADB/Eurasian Development Bank, GEF/ Green Energy Fund supported with financing. Following sustainable measure is in creating investment-attractive regime for private businesses to enter the market and realize projects.

The situation in the renewable energy industry began to change significantly a year later, and continued in the current year, 2016, when, due to a sharp fall in world energy prices, primarily oil and gas, the republic's budget began to experience significant filling difficulties, which, also, influenced the exchange rate of the national currency in relation to other major world currencies, mainly to the US dollar. There was a drop in the rate of tenge from 182 tenge / dollar to 345 tenge / dollar, or more than 40 percent.

Figure 5: Tenge – U.S. Dollar exchange-rate

Source: Bloomberg

This depreciation of the national currency sharply and directly affected the investment attractiveness of the RES industry both for foreign and for Kazakhstan investors, since it did not guarantee high return on investment, primarily due to the need to purchase almost all equipment abroad for a hard currency.

At the end of April 2016, the Head of State signed a law amending some legislative acts on the transition of Kazakhstan to a green economy, which included all the

necessary amendments aimed at restoring interest in the renewable energy industry.

The main was the existence of a relevant important article on the indexation of the existing fixed tariffs from 2014 on the level of the devaluation of the tenge to the dollar, in addition to the previous indexation to the level of the annual change in the consumer price index.

In addition, the new version of the law provided for the development of a single national plan for the development and deployment of new renewable energy capacities in Kazakhstan, by regions, by periods, and by the actual needs of the electric power industry. This document is the most important, expected by all market participants, and also allows interested investors to clearly understand when, where and what new energy-producing facilities are required for the country.

From the idea of mandatory introduction of batteries or storage facilities to stabilize the flow of electricity from renewable energy sources it was decided to abstain for now, considering too little of its share in the total electricity production in the Republic of Kazakhstan, which, according to the results of 2015, was only 0.6%.

The law also envisages the development and implementation by the authorized body - the Ministry of Energy of the Republic of Kazakhstan - of a standard contract for connection to the networks of the national operator KEGOC and clear and understandable rules for including energy producing organizations in the unified ministry list. Earlier, the list was approved by the Government of the Republic of Kazakhstan by a relevant resolution, which should now be replaced by a new list of the Ministry of Energy. The goal here is to get rid of projects “on paper”, and the inclusion of real, economically sound and financially supported projects that have the highest percentage of feasibility in practice.

I must outline here that rumours and fears of traditional energy managers about instability of new RE assets were wrong, with almost no technical or operational issues for the time of exploitation of these stations.

The share of renewable energy achieved 1% as of 2017 and continues to grow. Kazakhstan is strongly coal based electricity generation country, where 75% of production comes from traditional coal power stations mainly build in Soviet Era. About 45% of them already finished their technical lifecycle and are required to be immediately modernized, refurbished or replaced. Kazakhstan has no nuclear power stations as many other countries in the World, which makes on energy example one of the worst on Earth.

At the same time price of electricity produced in one of the lowest in the World, as per information from international energy agencies, our Country has second lowest tariff to end consumers after Ukraine.

The trick here is in indirectly subsidized tariffs for coal feed producers making them investment unattractive meaning no new traditional stations or modernizations to be financed on a large scale except for small repair works.

Kazakhstan possesses huge and still unexplored RE potential measured in terrawatthours which is available for exploration and utilization. The main value of these new energy comes from its capability of providing required mix to overall energy balance to secure energy stability of the Country.

At the same time, level of start-up of 1% allows us to study existing international experience in developing renewable energy and to choose our own, correct way without harming too much traditional energy, crucially important to industry and economic growth.

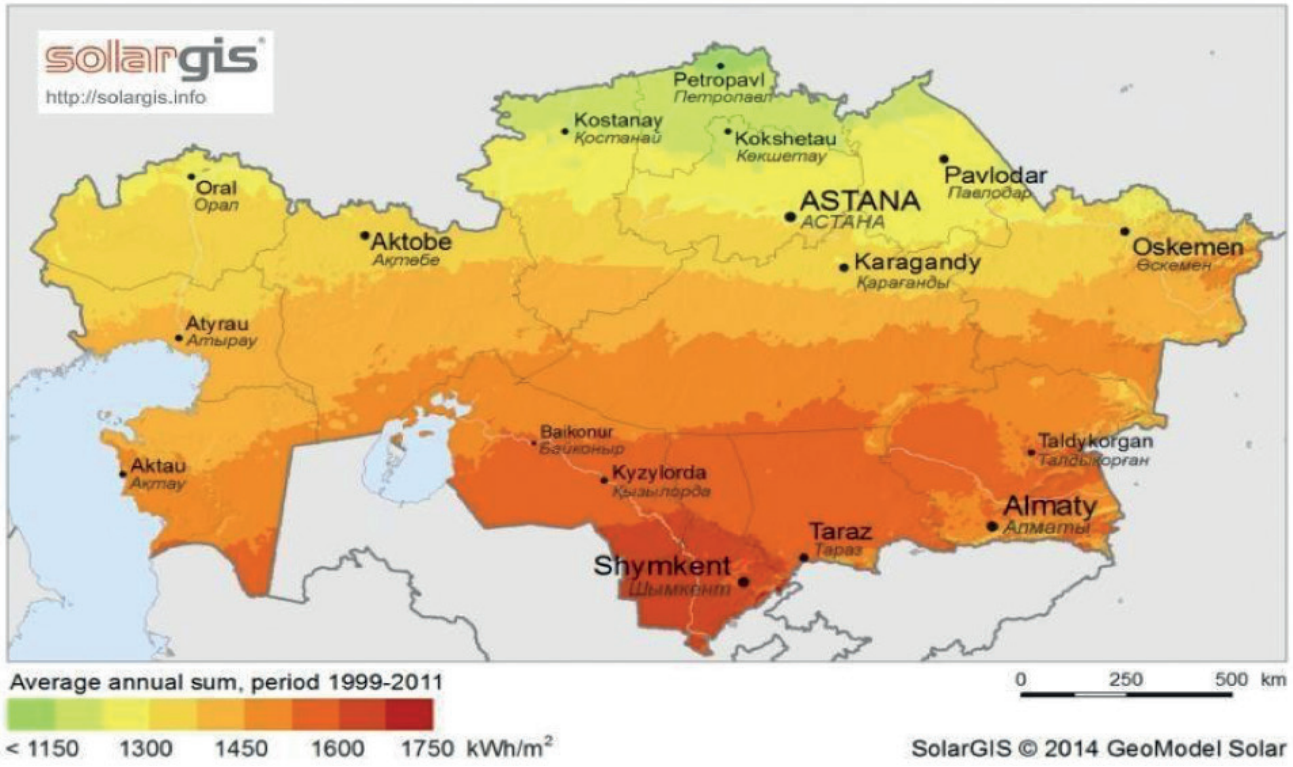
This year of 2018, in the end of May – beginning of June, Ministry of Energy of Kazakhstan, the main authorized body of the Government, will be holding first round of auctions for new projects in renewable energy, with second in Fall. The ideas behind it is to lower existing tariffs as per latest international developments and to attract the most advanced and resource-strong international corporations into the industry. For local developers auctions up to 10 MW will be available.

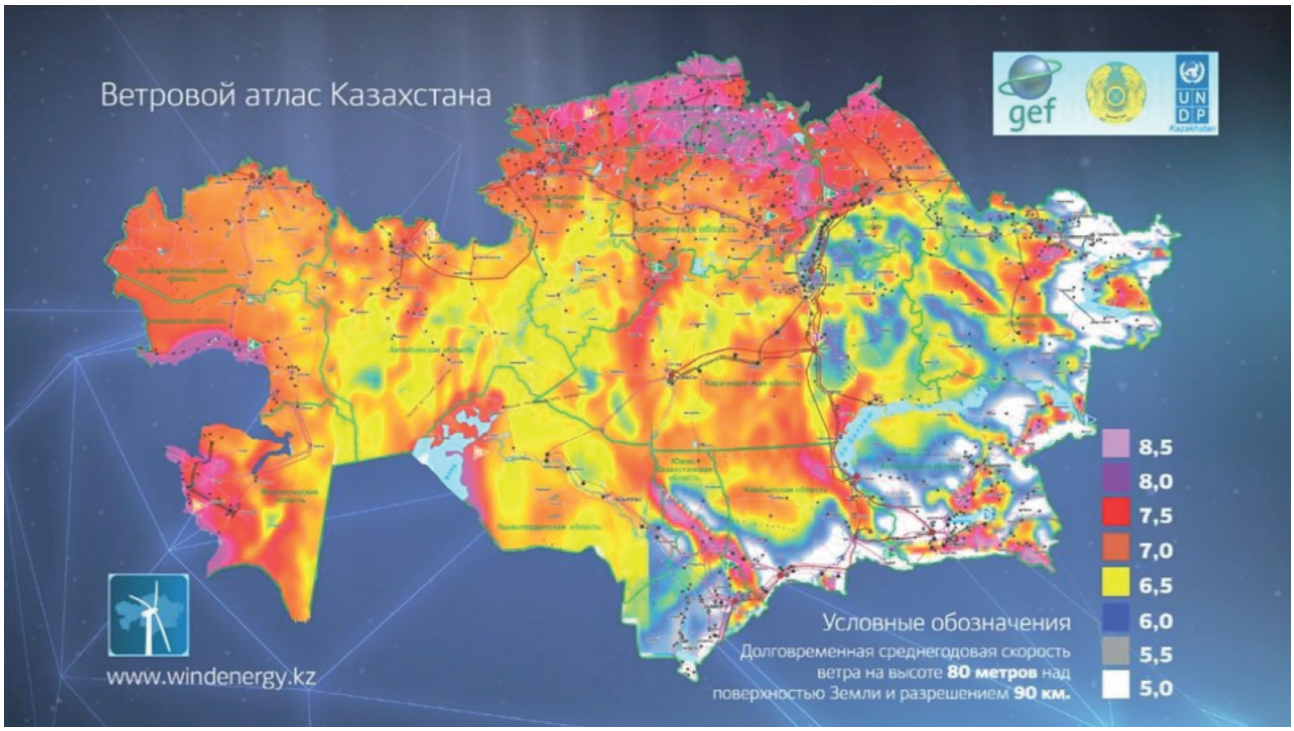
Regardless this move, the main concerns of investors remain, such as stability of national currency and its fluctuations vis-a-visa Dollar, stability of regulating legislative framework, financing issue of limited possibilities of national currency funding inside the Country, mining and metallurgical anti lobby, and required support of local developers and producers.

As of today, more than 90 companies had signed PPA contracts with Financial Settlement Center of Renewable Energy but unfortunately due to mentioned risks the majority of the projects are on sale to foreign investors.

At the same time, starting end of last year, Kazakhstani Energy Ministry is initiating new package of incentive measures such as annual indexation of win tariffs by 70% of annual devaluation rate of national currency tenge, and 30% of annual inflation or CPI rate, which should cover in full possible currency fluctuation risks. Another one is providing semi-State guarantees to special body of financial settlement centre of renewable energy to support its financial stability as an offtake contractor for all existing and upcoming RE projects. Substantial measure is upgrading existing PPA/ Power Purchase Agreement as per international standards which should make it more bankable for international financial institutions and investment funds.

Figure 6: Global horizontal irradiation, Kazakhstan





Source: Windenergy.kz

Following steps will be now required to further improve investment attractiveness of the industry:

1. Developing State Programme to support renewable energy growth, which should incorporate all best practices and recommendations from national and international experiences.

2. Defining newly established Center as the main KZ GOV's arm for investors and businesses, with Ministry of Energy to start focusing on policy making and drafting required laws and regulations.

3. Full implementation of country's obligations under Paris agreement in terms of reduction of CO2 emissions, and introduction of carbon capture technologies.

4. Further developing daily measures required to stimulate small and medium size investors and innovators, with double focus on projects and technologies.

5. Implementing wide support PR and mass media campaign amount widest circles of population in Kazakhstan, to get public support and understanding.

6. Closer cooperation with stakeholders including international organizations such as IRENA, UN/UNDP/ UN Environment, EBRD, ADB, EADB, the World Bank/IFC, and others in order to provide wider range of financial and technical assistance measures to industry developers.

Last year, in 2017, Kazakhstan had successfully held international exhibition "The Future Energy" Astana Expo 2017, which attracted millions of tourists. Important conferences were held including with Nobel Laureates, and Heads of States, as well as RE industry professionals who shared their views and recommendations.

As the main follow up measure, new Governmental International Center for Green Technologies and Investment Projects had evolved, focusing on "single window" approach and development of concrete industry projects and technologies.

The centre will work on 3 levels: national, regional and international, starting from success stories at home and expanding it wider.

Arman Kashkinbekov is the Vice Chairman of the International Center for Green Technologies and Investment Projects and the CEO of the Association of Renewable Energy of Kazakhstan

Figure 7: Current issues in renewable energy industry

Source: Expo 2017 "Future Energy" presentation

The future of energy and climate security

Outlook

Will the Paris climate paradigm survive the Trump presidency?

By Friedbert Pflüger

This publication – thus far – has sought to shed light on the evolvement of various energy forms and the general future of the energy security concept following the Paris Climate Agreement. And, given its insights and conclusions, it is clear that this excursion was indeed warranted, if not even urgently needed, in order to better understand what possible scenarios in the global energy landscape may look like in the coming years.

The Paris Agreement, for its part, has essentially been accepted as a fixed paradigm, a new understanding between the majority of nations in the world that encapsulates a firm recognition that urgent measures need to be undertaken to drastically reduce GHG emissions and curb anthropogenic-induced climate change. But, is this paradigm as solid as it seems? The following essay will take the opposite approach and actually explore whether the Paris Agreement itself is in peril as it is impossible to ignore its tribulations associated with the US election outcome.

In the immediate aftermath of Paris, the energy world witnessed a decisive paradigm shift. The voices seriously doubting climate change and the consequent need for action seemed to have been muted or marginalized. Much of the world – and most significantly both the United States and China – both accepted climate change as a grave challenge and were willing to act. Before Paris, Germany, with its Energiewende, had almost become a lone ranger – after Paris, it was back to being a front-runner on the path to a low-carbon economy.

With Donald Trump's election, however, the Paris Paradigm and the global alliance supporting it is once more facing a decisive challenge. The president of the United States has called climate change a Chinese hoax, supports coal and has withdrawn from the Paris Agreement altogether. Having been ratified in the US solely by an executive decision of President Obama – without the involvement of the legislative and in absence of a strong renewables lobby as in Europe – this proved to be a relatively simple task for him. Congress has no record to embrace climate policies – on the contrary.

Against this backdrop, the questions already faced by the staunch believers in the power of Paris only become more acute: OECD-countries might be able to bear the burden of achieving the necessary emissions reductions – but what about China, India, Indonesia and other emerging countries? The Agreement clearly states that "in the light of different national circumstances...the equitable access to sustainable development and eradication of poverty" and the "fundamental priority of safeguarding food security and ending hunger" have to be clearly recognized. In other words, there will be no firm caps for emerging countries, as the Paris Agreement will fully take into account that economic and social development and poverty eradication are the first and overriding priorities of developing countries.

Therefore, what weight does the Paris Agreement have in light of such attempts to improve living conditions and provide access to energy for hundreds of millions of people currently deprived? Or to consider energy security and the imperatives to exploit indigenous resources first, to create domestic jobs and to achieve the same advantages as OECD countries? We cannot disregard this huge loophole in our shiny new paradigm. If climate change additionally reverts to being a secondary issue for the world's most powerful nation, we should not be surprised that emerging nations are encouraged to maintain the perception of fossil energy as a decisive driver of economic development.

And how credible is this paradigm shift in light of lower oil/gas prices that make fossil fuels even more competitive vis-à-vis renewables? OPEC decided to cut its production for the first time in nearly a decade. However, this is largely a symbolic gesture, as the output reduction is from all-time high production levels and will only do little to place longer-term upward pressure on oil prices.

But not all hope is lost: China is positioning itself as a global climate leader. In October 2017, in his opening remarks at the 19th congress of the Communist Party, China's President Xi Jinping called for China to take the helm in the fight against climate change.[69] Meanwhile, the captain has chartered officers and crews: the EU (of which first and foremost Germany), Canada, California and numerous American metropolises have agreed to take on the climate challenge together with the Kingdom of the Middle. As a direct result of US withdrawal, China has managed within just a few months to perform a fundamental transformation of its image: from coal-intensive scapegoat to visionary champion of global climate policy. However, it would be short-sighted to regard this about-face solely as an expression of skillful PR or clever gambits. China

69 Doshi, Rush. (2017, October 25). "Xi Jinping just made it clear where China's foreign policy is headed." Washington Post. Retrieved from https://www.washingtonpost.com/news/monkey-cage/wp/2017/10/25/xi-jinping-just-made-it-clear-where-chinas-foreign-policy-is-headed/?noredirect=on&utm_term=.85cd4266df4c

is seriously in the process of substantiating its claim to leadership with concrete measures. Two symbolic examples:

- On December 18th, 2017, the country's first solar-panel-paved street was opened to traffic in Jinan: slightly over a kilometer, it covers 5,875 square meters and can generate up to 1 million kilowatt-hours of power annually — enough to power 800 Chinese homes.[70]

- 500 km to the south, in the vicinity of Huainan, the Chinese have built the world's largest floating photovoltaic power station to date: 166,000 solar panels, mounted on plastic pontoons, have a capacity of 40 MW and can supply 15,000 homes with electricity.[71] To add to the forceful symbolism: the floating solar park was built on a former opencast coalmine. In 2018, a further floating solar power plant is scheduled to come online – four times as large!

It is true that coal still dominates China's energy mix – and will continue to do so for the foreseeable future. Large swaths of the country still lack connections to the transmission network, making the use of coal for industrial production the only option available to local politicians. It should be noted that China's power plants burn as much coal as the rest of the world combined. On the other hand: over the past three years, emissions from coal have been continuously declining and the current five-year plan stipulates a two-year moratorium for issuing permits for new coal power plants. What is more, the rapid development of smart networks, a revamped electricity market design including an emissions trading system and the resolute advancement of renewables are clear signs for a real energy transition, if not even an energy revolution, taking place in China. The country is planning on investing EUR 317 billion in renewables over the next three years, furthering their unprecedented expansion: China currently already has close to 200 gigawatt of installed wind capacity, more than twice as much as the first runner-up, the United States. Two thirds of photovoltaic cells sold worldwide and half of newly installed wind turbines come from the People's Republic.

Germany, too, has vowed to fill the gap left by the US' disengagement from within the EU and close ranks with China. Yes, the country is still struggling to reduce its total emissions, which have stagnated for the past few years particularly due to high emissions from coal-fired power plants and the transport sector. On the other hand, the share of renewables in the country's power production is continuing to surge, covering about a third of the country's power needs for the first time in 2017.[72] And on January 1, 2018, Germany crossed a symbolic milestone in its energy transition by briefly covering around 100 percent of electricity use with renewables for the first time ever. One of the more important developments however, is perhaps that operators have offered to build offshore wind farms in the North Sea without relying on taxpayer subsidies for the first time in Germany, thus illustrating that it is possible for subsidized renewables to eventually "stand on their own feet." Ultimately, these investments in renewables, together with natural gas as a complementary fuel, are expected to pay climate-friendly dividends once Germany shuts down its nuclear power plants in 2022 and accelerates its coal phase-out.

Whether these measures are sufficient remains to be seen. Nonetheless, the pressure keeps mounting on the fossil fuel industry (particularly oil and coal). This may suggest that its transformation may not be swift and far-reaching enough: We do not precisely know the extent of our remaining carbon budget. But – under any circumstances – we are depleting it faster than we should. Climate change is becoming increasingly tangible. According to MunichRe, extreme weather occurrences more than tripled over the last 30 years – they are becoming more frequent and more devastating. As constituencies realize this, pressure will mount on governments to act faster. Is a transitional period with fossil and renewable generation side by side – like envisioned by the recent establishment of a renewables investment fund by energy giants BP, Eni, Repsol, Saudi Aramco, Royal Dutch Shell, Statoil and Total – still an option? Or can we expect increasingly stringent regulation aimed at a drastic and immediate change of course?

The European Emissions Trading Scheme (ETS) is not working. This failure drastically increases the chance of national governments taking matters into their own hands and limiting emissions through regulation rather than market forces. We already have high incentives for the purchase of electric vehicles. Norway offers generous tax rebates, while Germany pays a direct subsidy of EUR 4,000. Battery costs have fallen by 35 per cent in 2015, and Bloomberg predicts that electric vehicles will be truly cost-competitive sometime in 2022. As a result, Volkswagen is planning to increase its share of electric vehicles to 25 per cent of its production by 2020. And this development could further accelerate: voices from Norway, the Netherlands, Germany and elsewhere are calling for the ban of internal combustion engines. A similar development away from fossils is being discussed for the German heating sector.

70 Hanley, Steve. (2017, December 30). "China Opens Up 1-Kilometer Long Solar Road." CleanTechica. Retrieved from https://cleantechnica.com/2017/12/30/china-opens-1-kilometer-long-solar-road/

71 Garfield, Leanna. (2018, March 19). "China's latest energy megaproject shows that coal really is on the way out." Business Insider. Retrieved from http://www.businessinsider.de/china-floating-solar-farm-coal-mine-renewable-energy-2018-1?r=US&IR=T

72 Ameland, Sören. (2018, January 5). "Renewables cover about 100% of German power use for the first time ever." Clean Energy Wire. Retrieved from https://www.cleanenergywire.org/news/renewables-cover-about-100-german-power-use-first-time-ever

In addition, there is a global divestment movement away from fossil fuels afoot, which may put a serious damper on the future availability of funds for the industry. So far, some 580 institutions, controlling assets worth about USD 3,4 trillion, have divested from the sector. While the first wave has predominantly targeted coal, it could be the precursor to further divestments from oil and gas.

For the time being, natural gas still that has the highest potential to help mitigate climate change. In the mid-term, gas is set to largely push coal out of the equation, similarly to the dash for gas in the UK or the US shale revolution, which both significantly contributed to CO2 reductions in their own right. Germany, too, would need to swiftly phase out coal in order to prevent an increase in emissions from the upcoming electrification of its heating and transportation sector. Gas is also a fossil fuel, that is true. However, its use leads to much lower greenhouse gas emissions than coal and oil. Looking to increase efficiency in the transportation and heating sector as well as in power generation can bring about fast results in the fight against climate change. Concrete steps with measurable outcomes for 2020 are needed more than lofty visions for a carbon free 2050 – just as it would be more impressive to take concrete measures to end the war in Syria than to celebrate ourselves for declaring global peace by 2050.

Given widely differing national regulatory particularities, the most effective mechanism of incentivizing the necessary transition to gas would be a sustainable reform of the ETS or, should this fail, measures such as enforcing a carbon price floor like in Britain and/or implementing national regulations outright prohibiting coal. The resulting transition from coal to gas – in combination with CCS and technologies to minimizing carbon leakage – is an opportunity for industry and climate protection alike.

The US presidential election has shattered the belief in a predetermined path for climate action. The future remains uncertain, but solutions might come unexpectedly, as they did in the case of the Great Horse Manure Crisis of 1894, when the advent of the automobile dispelled the fear that London would end up covered by a thick layer of dung. For now, the spirit of Paris has to be kept alive and ideologies relinquished even as the world remains open to new technologies – ultimately, not renewables, but decarbonisation is the goal! The right incentives for greenhouse gas emission reductions need to be set. At the same time, micro-management and central economic planning should be shunned while economic and technological competition that will ensure the best possible solution should be embraced.

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