Policy Brief

Assessing Energy Security in Asia and Europe: Policy Implications for CAREC Countries

Farhad Taghizadeh-Hesary
Associate Professor of Economics, Tokai University, Japan

Aline Mortha
Graduate School of Economics, Waseda University, Japan

December 2019

Disclaimer

The CAREC Institute policy brief and working paper series is a forum for stimulating discussion and eliciting feedback on ongoing and recently completed research and workshops undertaken by the CAREC Institute staff, consultants, or resource persons. The series deals with the key economic and development issues, particularly those facing the CAREC region, as well as conceptual, analytical, or methodological issues relating to project/program economic analysis, and statistical data and measurement.

This policy brief emerged from a joint workshop organized by the CAREC Institute and the Asian Development Bank Institute (ADBI) on the topic of achieving energy security in Asia during 22-23 October 2019 in Almaty, Kazakhstan where renowned scholars and authors of the book titled "Achieving Energy Security in Asia: Diversification, Integration, and Policy Implications," and the CAREC government officials deliberated on the status of energy consumption, energy supply, import, export, energy cooperation with neighboring countries, strategies for increasing a share of renewable energy, and analyzing the energy security levels in their respective countries.

The views expressed in this paper are the views of the authors and do not necessarily reflect the views or policies of the CAREC Institute, its funding entities, or its Governing Council. CAREC Institute does not guarantee the accuracy of the data included in this paper and accepts no responsibility for any consequences of their use. Terminology used may not necessarily be consistent with the CAREC Institute official terms.

Central Asia Regional Economic Cooperation (CAREC) Institute
No. 376 Nanchang Road, Urumqi, Xinjiang, the PRC
f: +86.991.8891151
LinkedIn
km@carecinstitute.org
www.carecinstitute.org

Table of Contents

1. Executive summary

The growing energy demand in Asia coupled with uneven distribution of energy resources within the region poses variety of challenges for the region's energy security.

This policy brief aims to compare energy security in Europe, a more advanced region in terms of economic integration and energy security, and Asia to provide policy recommendations for the Central Asia Regional Economic Cooperation (CAREC) region which has abundant energy resources but low level of regional integration.

The literature shows that despite weaknesses in availability and accessibility due to low resource endowments, the EU's efforts towards sustainability and price reduction have contributed to increase in overall energy security. Energy security in Asia, however, is on decline due to rapid depletion of resources, steady increase in demand, steady increase in CO_2 emissions, and a renewed vulnerability to price volatility.

This policy brief provides policy recommendations including simultaneous increase in all four dimensions of energy security - availability, applicability, acceptability and affordability – to improve the national energy security in CAREC counties, establishing a unified legal energy framework, and building a common energy market in CAREC region to improve the regional energy security.

The development and utilization of renewable energy and higher share of renewable electricity output, increase in energy efficiency, prevalence of renewable energy technology (solar photovoltaic, wind generators, hydrogen energy, etc.), improved access to electricity through renewable energy (and distributed generation) will improve the level of energy security and will reduce the greenhouse gas emission in CAREC countries.

1. Introduction

Rising concerns over climate change in the recent years have increased the importance of energy for policymakers, and energy security became a central concept in energy policy. Asia and Europe are two regions facing numerous challenges related to energy. The European Union (EU) is the largest economy in the world, as well as the largest trading block, and yet, is relatively poorly endowed when it comes to energy resources. As a consequence, the EU remains quite dependent on its energy imports. On the other hand, Asia is a fast-developing region, with an increasing demand for energy, due to a growing middle class and large population.

The world's total energy consumption grew from 8,761 Mtoe in 1990 to 14,126 Mtoe in 2017 (Table 1). Around 70% of this change was initiated by the energy consumption of the Asia-Pacific region which increased its consumption from 25% (1990) to 41% (2017). This energy consumption dynamic of the Asia-Pacific region contrasts with the energy consumption of Europe which has remained at a stable level during the same period.

Hence, the consumption ratio between Asia-Pacific and Europe rose from 1.2 (1990) to 3.2 (2017). Asia is projected to surpass the OECD before 2030 to become the world's largest energy consuming block. Contrary to the EU, some countries in Asia and Oceania, such as Kazakhstan, Azerbaijan or Australia, are endowed with energy resources while some others, such as Japan or the Republic of Korea are heavily reliant on energy import. In addition, the majority of energy comes from fossil fuels, hence posing environmental and health issues. The uneven distribution of energy resources coupled with the rising demand present variety of challenges at the national, sub-national, and regional levels in terms of the region's energy security and environmental sustainability.

Table 1. Energy Consumption by Region (Mtoe)

	1990	2000	2010	2017	Change (2010-2017)	Change (2010-2017) %
Asia & Pacific	2,213	3,014	4,971	5,909	**2,895**	**70**
Europe	1,786	1,854	1,931	1,857	**3**	**0**
Other	4,762	5,148	5,964	6,360	**1,212**	**29**
World	**8,761**	**10,016**	**12,866**	**14,126**	**4,110**	**100**
Asia – Pacific (%)	25%			41%		
Europe (%)	20%			13%		
Asia-Pacific/ Europe (Consumption Ratio)	1.2			3.2		

Data source: ENERDATA, 2019. Table prepared by the authors.

The energy supply pattern in the CAREC region shows that while some CAREC countries are rich in fossil fuels (oil, gas, coal) and hydro resources, others lack sufficient domestic resources to adequately cover their energy demand, and seasonal variability among countries is also particularly pronounced.

Le et al. (2019) developed a comprehensive index for energy insecurity and examined trends using a sample of 24 selected Asian countries during the 1990–2014 period. Their study covered five CAREC members. The results show a trend of increasing energy insecurity in the PRC, and Pakistan. On the other hand, certain fluctuations but steady improvements in energy security are observed in Mongolia. While, Kazakhstan and Tajikistan demonstrate a trend of fluctuations and increasing energy insecurity.

Drawing on the case of the EU, a global leader in energy cooperation, this policy brief seeks to highlight similarities and differences, as well as obstacles and opportunities to achieve the energy security in EU and Asia to provide recommendations for improving the energy security in CAREC.

2. Definition and assessment of energy security in Europe & Asia

Despite being the subject of many studies in the past decade, the definition of the term "energy security" remains a debated issue among scholars and tends to represent many different notions. Winzer (2012) even stated that "energy security has […] become an umbrella term for many different policy goals" (Winzer, 2012: 36). This section will examine the evolution of the term.

The first occurrence of the term "energy security" dates back to the 1960s and was popularized by the oil crises of the 1970s (Cherp and Jewell, 2014: 415). Yergin (1988) argued that throughout the 1970s and 1980s, energy security implied a stable supply of energy at an affordable price. Later, some authors included the notion of economic equilibrium in their definition. For instance, Bielecki (2002) interpreted the notion of "reasonable price" as "cost-based and determined by the market based on supply/demand balances" (Bielecki, 2002: 237). The concept of energy security was one-dimensional until the early 2000s and was solely related to the economic aspect. The rationale behind this limited definition was based on the large price spikes experienced after the oil shocks of the 1970s.

In an attempt to combine these different approaches, the Asia-Pacific Energy Research Centre (APERC) created the 4As framework in 2007 (APERC, 2007) where energy security is defined through four dimensions, namely through energy resource availability, accessibility barriers, environmental acceptability, and investment cost affordability (APERC, 2007: 2).

2.1. Availability

In most studies, the availability component refers to energy supply or the "geological existence of fossil energy resources" (Tongsopit et al, 2016: 62). Studies examining this issue used the reserve to production (R/P) ratio of various energy sources (Yao and Chang, 2014; Tongsopit et al, 2016) or the degree of reliance on imports and diversity of the energy mix (Chalvatiz and Ioannidis, 2017; Vivoda, 2019).

The EU countries have been heavily relying on energy imports over the years (Table 2). Small countries, such as Luxembourg, Malta, or Cyprus, almost fully rely on imports to meet their energy demand. While few countries endowed with fossil fuels, such as the United Kingdom, the Netherlands, and Poland, which were able to meet their energy demand with their own production in the 1990s, become net importers in recent years. Chalvatiz and Ioannidis (2017) highlight the EU imports more than half of its energy in the form of crude oil and natural gas (Chalvatiz and Ioannidis, 2017: 466). Availability is a serious issue for the EU countries and has been at the top of the EU policy agenda, as it has been proved that almost all oil-importing countries face negative supply shocks in case of high oil prices (Taghizadeh-Hesary et al., 2019a).

Table 2. Energy import as a percentage of energy use in the EU and Southern Europe Energy Community

	1990	2000	2010	2014		1990	2000	2010	2014
Albania	7.97	45.00	23.71	13.8	Latvia	85.71	63.23	56.14	45.16
Austria	67.30	65.75	64.83	62.42	Lithuania	69.28	52.52	78.44	75.04
Belgium	72.66	76.37	74.26	76.26	Luxembourg	99.15	98.1	97.2	96
Bosnia and Herzegovina	34.39	29.23	32.56	22.73	Malta	100	100	99.42	98.38
Bulgaria	65.94	46.84	40.75	36.55	Moldova	99.15	96.83	93.81	90.01
Croatia	39.64	49.17	45.1	45.86	Netherlands	7.82	23.28	16.3	19.77
Cyprus	99.55	97.93	96.35	94.03	North Macedonia	49.26	42.47	43.88	51.77
Czech Republic	17.4	25.25	28.7	28.99	Poland	-0.74	10.74	33.21	28.39
Denmark	41.93	-48.84	-19.86	0.94	Portugal	79.78	84.36	75.31	71.67
Estonia	44.64	32.53	12.31	3.4	Romania	34.41	21.81	21.57	16.78
Finland	57.43	53.92	52.24	46.2	Serbia	30.16	13.5	32.4	28.78
France	50.06	48.13	48.16	43.49	Slovakia	75.22	64.34	65.18	58.83
Germany	46.99	59.82	60.66	60.88	Slovenia	46.26	51.7	48.21	44.5
Greece	57.1	63.13	65.82	61.97	Spain	61.6	74.1	73.05	69.36
Hungary	48.97	53.53	57	55.61	Sweden	37.11	35.82	35	28.27
Ireland	65.02	84.36	87.25	84.26	Ukraine	46.12	42.87	40.41	27.21
Italy	82.73	83.58	81	75	UK	-1.01	-22.21	26.57	39.67

Data source: World Bank, 2019. Table prepared by the authors.

On the other hand, many countries in the Asia-Pacific region are naturally endowed with energy resources, fossil fuels in particular. Australia, Brunei, Indonesia, Malaysia, and Vietnam are net energy exporters. In contrast, advanced economies such as Japan, South Korea, or Singapore rely heavily on imports to meet their energy demand. Using a comprehensive index based on R/P ratios, Tongsopit et al. (2016) evaluated the level of availability in the ASEAN region, finding that its score has been decreasing since 2005. Authors argued that new resource discoveries in the region were not sufficient to "keep pace with growing production of oil and gas" (Tongsopit et al, 2016: 64) and that the rate of increase in renewable energy (RE) is not enough to compensate for fossil fuel resource depletion (Tongsopit et al, 2016: 64). With such findings, it is likely that the high level of energy supply security of the region is only short term.

2.2. Accessibility

The "accessibility" component of energy security is defined by APERC (2007) as "the ability to access available energy resources" (APERC, 2007: 19). Its barriers include economic, political, and technological factors. In contrast, Yao and Chang (2014) defined this second dimension as "applicability," and focused on the technological feasibility and maturity, which will be examined below.

Given the relatively homogenous level of development in the EU, most of the obstacles to accessibility lie in political and geopolitical factors. In addition to the high level of reliance on energy import in the Union, most of the countries tend to rely on a single partner (Chalvatiz and Ioannidis, 2017: 466), namely Russia, which has been providing one third of the EU's energy in the recent years (Aalto and Temel, 2014: 761). The 2014 dispute between Russia and Ukraine, which is a transit country for gas, has provoked gas shortages in some EU countries (Chalvatiz and Ioannidis, 2017: 466). The EU has made attempts to create a diplomatic dialogue with Russia by involving the country in the Energy Charter Treaty, although with little success (Vogler, 2013: 632). Vogler (2013) argued that Russia is unwilling to commit to a unified EU discipline, as it can achieve more advantageous bilateral deals with member states. In addition, Syria and Libya, two of EU's trading partners at the

beginning of the 2000s, have experienced political turmoil, severely affecting their exporting capacities. In comparison, the region of Asia and the Pacific is characterized by its low level of reliance on external imports, with politically stable trade partners (Australia, Indonesia, Malaysia, among others). However, it includes various developing countries, with a low level of infrastructure development.

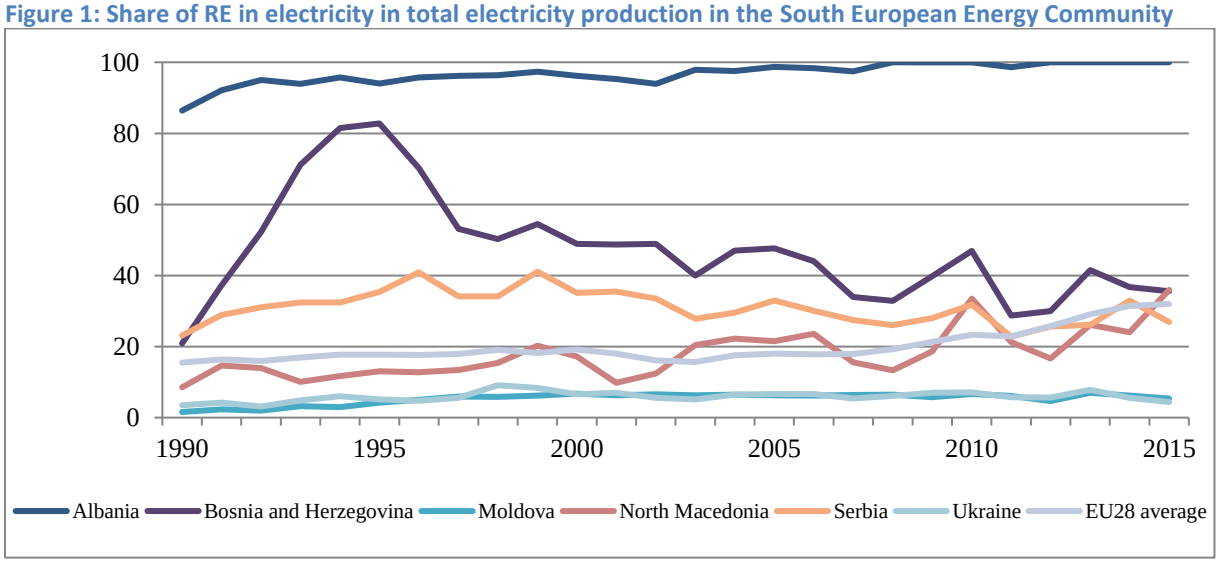
2.3. Acceptability

The third component of energy security is defined under the APERC framework as a measure of environmental sustainability (APERC, 2007: 2).

Environmental sustainability has been one of the three pillars of the EU for the last two decades, led by its 20-20-20 targets, i.e. to reach a 20% share of RE sources, 20% increase in energy efficiency, and 20% lower greenhouse gas (GHG) emissions by 2020 (Aalto and Temel, 2014: 765). Both emissions cut and increase in RE share are on track (Lund, 2012).

In 2015, the average share of RE in the electricity mix was 32%, with extreme disparities among the member states. For instance, while Austria, Croatia, or Denmark produce more than 65% of their electricity from renewable sources, Cyprus and Malta's share is below 10%. When extending this analysis to the rest of the members of the South European Energy Community, which are legally bound by the treaty to "implement reforms in the energy and environmental sectors in accordance with the EU's […] policy" (Mihajlov, 2010: 872), the disparities widen, with countries such as Albania above 90%, and Kosovo, Ukraine, and Moldova barely producing 5% of their electricity from renewable sources. While the EU is on the path for a high environmental acceptability, the other members of the South European Energy Community are behind. Mihajlov (2010) estimated that Kosovo and Bosnia and Herzegovina in particular have made very little progress in implementing the EU legislation in environmental protection.

Figure 1: Share of RE in electricity in total electricity production in the South European Energy Community



Data source: World Bank, 2019. Table prepared by the authors.

The diversity of Asia and the Pacific is also reflected in their levels of acceptability, and environmental sustainability. While ASEAN members share common environmental and energy strategies through the Plan of Action on Energy Cooperation (PAEC) since 1995, the rest of the region is quite heterogeneous. The share of RE in the electricity mix within ASEAN itself is quite variable, with countries endowed with energy resources (Brunei, Malaysia, Indonesia) having a remarkably low share. Tongsopit et al. (2016) also included in their evaluation the per capita CO_2

emissions. The study showed a diminishing score in acceptability, mostly driven by Thailand, Indonesia, and Vietnam (Tongsopit et al., 2016: 67). The authors also highlighted that targets for carbon emission reduction within ASEAN are not legally binding, which could explain the steady increase of emissions. Non-ASEAN members have witnessed a slight increase in their share of electricity produced from RE sources. In addition, Australia, New Zealand, Japan, and South Korea experienced a reduction in their CO_2 emissions in the recent years (World Bank, 2019). Given that the level of development of these countries is quite homogenous, such evolution was expected.

2.4. Affordability

The last dimension of energy security proposed by APERC (2007) is the price affordability and is defined by Tongsopit et al. (2016) as "the ability of an economy or society to access energy resources at a reasonable price" (Tongsopit et al, 2016: 65).

Over the period of 2010-2019 in Europe, citizens of former communist economies, as well as citizens from small states (Malta and Cyprus) have been paying relatively high price for electricity compared with other countries in the continent. In particular, countries from Northern Europe (Denmark, Finland, Sweden) enjoy very low price on electricity. Countries, such as Malta and Hungary, managed to bring down their electricity price despite the growing demand. On the other hand, Belgium, the Czech Republic, Spain, Cyprus, and Romania have witnessed a significant increase in their electricity tariffs, lowering their level of energy security in the affordability dimension. Within the EU, efforts have been made to ensure single market rules, and liberalization of the energy market. The standardization of the market aimed at increasing energy efficiency and reducing costs given the economies of scale and promotion of the overall competitiveness of the economy (Aalto and Temel, 2014: 762).

Taking into account the volatility of gas prices, as well as retail electricity tariffs in ASEAN countries, the study of Tongsopit et al. (2016) provides a good overview of the level of energy security with respect to affordability in ASEAN. The authors showed that the countries that were most affected by price volatility were Singapore, Cambodia, and Laos, due to lack of energy resources and dependence on foreign imports (Tongsopit et al., 2016: 67). Singapore proved to be the country with high and volatile electricity price, while Thailand, Vietnam, Myanmar, Malaysia, Cambodia, and Laos showed stable price trends in the period of analysis (Tongsopit et al., 2016: 67). In addition, Taghizadeh-Hesary et al. (2016) argued that the impact of oil price fluctuations is larger on developing economies, hence making them more vulnerable to price shocks. Overall, the affordability of energy in the region has been steadily decreasing between 2005 and 2010.

2.5. Assessing Energy security status in CAREC region using 4As framework

Chang and Taghizadeh-Hesary (2018) applied the 4As framework for assessment of the energy security status in the CAREC region. The 4As framework requires a good number of indicators for each dimension and corresponding data over a certain period to diagnose the status of energy security in a country or a region to derive policy implications. The application of the 4As framework is presented briefly as follows.

The equal number of indicators for each dimension are collated and the corresponding data are compiled. The data is coded and normalized by ordinal scales. Each indicator contributes equally to each dimension of the 4As, i.e. availability, applicability, acceptability, and affordability. The scale is ranging from 1 to 10, indicating that 1 is the lowest status and 10 the highest. The four dimensions with ordinal values constitute a rhombus where a perfect rhombus indicates the best status of

energy security. The area of the rhombus represents the overall status of energy security in a country or region (Taghizadeh-Hesary et al., 2019b).

Table 3 provides the indicators that were used in the study by Chang and Taghizadeh-Hesary (2018) on CAREC region. Data was taken from the British Petroleum Statistical Review of World Energy, the World Bank, and the World Development Indicators and International Energy Agency (IEA).

Table 3: Energy Security in CAREC Countries: Selected Indicators

Dimension		Indicators
Availability (Endowment)	AV1	Reserve-Production (R/P) ratio of oil (years)
	AV2	Share of renewable electricity output (%)
Applicability (Efficiency)	AP1	CAREC countries' energy intensity (MJ/$2011 PPP GDP)
	AP2	CAREC countries' carbon intensity (t CO_2/toe)
Acceptability (Preference)	AC1	CO_2 emissions per capita (t CO_2/person)
	AC2	Share of renewable energy consumption (%)
Affordability (Capability)	AF1	Energy consumption per capita (toe/person)
	AF2	Access to electricity (%)

Source: Chang and Taghizadeh-Hesary (2018)

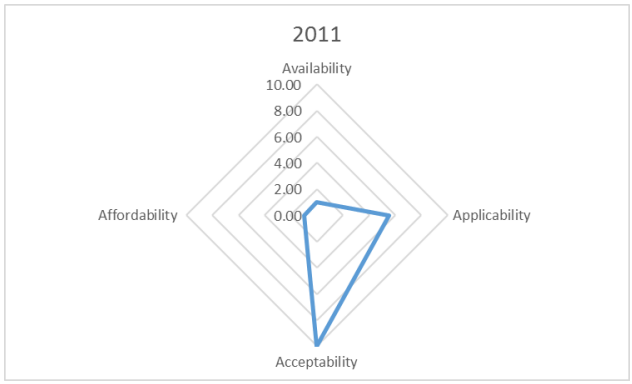
Figure 2 (A-1, A-2, and B) demonstrates the results of the empirical analysis of energy security for the CAREC region. The empirical output is a rhombus which shows the regional energy security status. The blue line inside the rhombus in A-1 indicates the status of energy security in 2011 in CAREC region while the blue line in A-2 indicated the status of energy security in 2015. The total area presents the overall status of energy security over the years in CAREC in 2011 and 2015. The corners show how each dimension of energy security has changed over the years.

Under the 4A framework, between 2011 and 2015, availability and affordability appear to have improved while acceptability appears to shrink considerably, and applicability seems to remain the same. The area of the rhombus on Figure 2-B shows that the overall status of energy security in CAREC countries is improving, though 2015 is slightly worse than 2014.

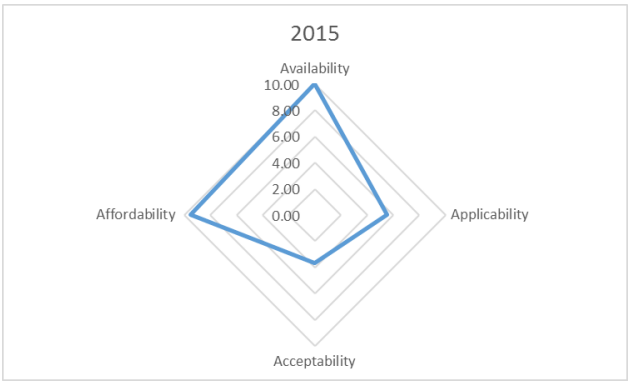
The improvement of availability over the period was due to slight increase in the proven reserves of oil. The affordability showed an increasing trend though it decreased slightly in 2015. The main drivers of the increase are primary energy consumption per capita and access to electricity. The Applicability dropped in 2012 but increased in 2013 and remained the same in 2014, however decreased again in 2015. The main cause of decrease is worsening carbon intensity. The acceptability was the highest in 2011 but it has been decreasing since then. The main cause of decline is increase in CO_2 emissions per capita and the declining share of renewable energy consumption, however it seemed to improve slightly in 2015.

Figure 2. Energy Security Status in CAREC Countries: 2011 vs 2015

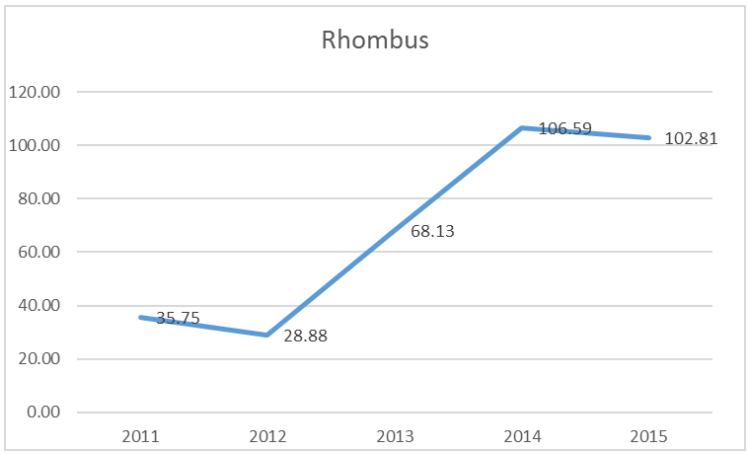
A-1



A-2



B



Source: Chang and Taghizadeh-Hesary (2018)

3. Conclusions and Policy implications for CAREC countries

Given the surge in demand for energy in the recent years, Asia is expected to increase its level of energy security in order to maintain economic development. The policy brief attempted to compare energy security in two regions, Europe and Asia, to provide policy recommendations for the CAREC countries.

Following the definition of APERC (2007), this study chose to analyze energy security using the 4As framework, namely energy resource availability, accessibility barriers (including political and technological), environmental acceptability, and investment cost affordability.

From the perspective of energy supply (availability), Europe and Asia are extremely different. EU countries are very much dependent on import from their neighbors (Norway and Russia) and the Middle East, while many countries in Asia and the Pacific are net exporters of oil, gas, and electricity. Nevertheless, research has shown that for many Asian countries, particularly in ASEAN, the rate of depletion of natural resources in order to meet the rising energy demand is extremely fast, and hence, the relative supply security in Asia should be understood as being short-term.

Regarding the accessibility or applicability of energy, Europe and Asia are yet again facing very different challenges. While accessibility is constrained by diplomatic tensions and political instability

with their import partners in the EU, Asia's applicability is limited by its low level of technological maturity and is yet to improve its energy infrastructure.

With respect to acceptability, the EU's efforts towards environmental soundness and sustainability have certainly been paying off, as the region's emissions have been cut, and the level of electricity coming from RE sources has been increasing. On the other hand, Asia is characterized by its growing trend of GHGs emissions, with the exception of Australia, Japan, New Zealand, and Republic of Korea. Sustainability hence remains a challenge in Asia.

Finally, with its unified energy market, the EU has been showing steady decrease in electricity price in the recent years, while many countries in Asia are extremely vulnerable to energy price volatility, and that the affordability component in the region has been on the decline. The EU's efforts towards sustainability and price reduction have contributed to the increase in overall energy security in the region, while the level of energy security in Asia (especially in ASEAN and the PRC) has been on the decline.

Simultaneous increase of 4As for higher energy security in CAREC countries

In order to achieve higher level of energy security in the CAREC region, all four dimensions of energy security (4As) need to improve simultaneously. The higher share of renewable electricity output will help increase availability and the overall status of energy security in CAREC countries (**availability).** The higher level of renewable energy production will decrease carbon emissions and carbon intensity. More adoption of renewable electricity technology will lower carbon intensity and improve the level of energy security in CAREC countries (**applicability).** The development and utilization of renewable energy will lower carbon emissions per capita and increase the share of renewable energy consumption, which will in turn enhance the level of energy security in CAREC countries (**acceptability)**. Improving access to electricity through renewable electricity (and distributed generation) and establishment of a unified energy market will reduce the energy price and improve the level of energy security in CAREC countries (**affordability).**

Unified legal energy framework and common energy market in the CAREC region

The review of institutional, political, and legal levels of integration in Europe shows that Europe has been constructing a unified legal energy framework and building a common energy market over the years. On the other hand, CAREC and other Asian regions are limited in their level of political and legal integration to the extent that treaties regarding energy and intra-regional organizations do not provide legally binding frameworks. As a result, energy markets in the CAREC region remain national.

Easing the regional energy trade in CAREC member countries will improve the accessibility and availability of energy, hence it will improve the energy security status. According to the CAREC energy strategy 2030, establishment of a large-scale energy infrastructure can achieve economies of scale, instill a collaborative culture, and generate a strong drive towards common energy security through long-term regional relationships (ADB, 2019).

References

Aalto, Pami and Dicle Korkmaz Temel. 2014. "European Energy Security: Natural Gas and the Integration Process." JCMS: *Journal of Common Market Studies* 52 (4): 758-774. http://dx.doi.org/10.1111/jcms.12108

ADB (2019). CAREC Energy Strategy 2030: Common Borders, Common Solutions, Common Energy Future. Manila: Asian Development Bank

APERC Asia Pacific Energy Research Centre. 2007. *A Quest for Energy Security in the 21st Century*. Tokyo: Institute of Energy Economics Japan. https://aperc.ieej.or.jp/file/2010/9/26/APERC_2007_A_Quest_for_Energy_Security.pdf

Bielecki, J. 2002. "Energy Security: Is the Wolf at the Door?" *Quarterly Review of Economics and Finance* 42 (2): 235-250. http://dx.doi.org/10.1016/S1062-9769(02)00137-0

Chalvatzis, Konstantinos J. and Alexis Ioannidis. 2017. "Energy Supply Security in the EU: Benchmarking Diversity and Dependence of Primary Energy." *Applied Energy* 207: 465-476. http://dx.doi.org/10.1016/j.apenergy.2017.07.010

Chang, Y. and Taghizadeh-Hesary, F. (2018).Renewable Energy and Implications on Energy Security: Case of CAREC Countries. Presentation at the Achieving Energy Security in Asia: Role of Renewable Energy Workshop, 12-13 March 2018, Baku, Azerbaijan

Cherp, Aleh, Jessica Jewell, Lund University, The International Institute for Industrial Environmental Economics, Internationella miljöinstitutet, and Lunds universitet. 2014. "The Concept of Energy Security: Beyond the Four as." *Energy Policy* 75 (c): 415-421. http://dx.doi.org/10.1016/j.enpol.2014.09.005

ENERDATA. 2019. "Database" Accessed October 16th, 2019. https://www.enerdata.net

Eurostat. 2019. "Database" Accessed October 16th, 2019. https://ec.europa.eu/eurostat/data/database

IEA International Energy Agency. 2019. "Energy Security" Accessed October 16th, 2019. https://www.iea.org/topics/energysecurity/

Le T.-H, Y. Chang, F. Taghizadeh-Hesary and N. Yoshino (2019). Energy Insecurity in Asia: A multi-dimensional analysis. *Economic Modelling*. 83: 84–95, http://dx.doi.org/j.econmod.2019.09.036

Lund, Peter. 2012. "The European Union Challenge: Integration of Energy, Climate, and Economic Policy." *Wiley Interdisciplinary Reviews: Energy and Environment* 1 (1): 60-68. http://dx.doi.org/10.1002/wene.37

Mihajlov, Andjelka. 2010. "Opportunities and Challenges for a Sustainable Energy Policy in SE Europe: SE European Energy Community Treaty." *Renewable and Sustainable Energy Reviews* 14 (2): 872-875. http://dx.doi.org/10.1016/j.rser.2009.10.026

Taghizadeh-Hesary, Farhad, Naoyuki Yoshino, Ehsan Rasoulinezhad, and Youngho Chang. 2019a. "Trade Linkages and Transmission of Oil Price Fluctuations." *Energy Policy* 133: 110872. https://doi.org/10.1016/j.enpol.2019.07.008

Taghizadeh-Hesary, F., Yoshino, N., Chang, Y. and Rillo, A. 2019b. Introductory Remarks and Preface. In *Achieving Energy Security in Asia: Diversification, integration and policy implications*. Eds. Farhad Taghizadeh-Hesary, Naoyuki Yoshino, Youngho Chang, Aladdin Rillo. Singapore: World Scientific.

Tongsopit, Sopitsuda, Noah Kittner, Youngho Chang, Apinya Aksornkij, and Weerin Wangjiraniran. 2016. "Energy Security in ASEAN: A Quantitative Approach for Sustainable Energy Policy." *Energy Policy* 90: 60-72. http://dx.doi.org/10.1016/j.enpol.2015.11.019

Vivoda, Vlado. 2019. "LNG Import Diversification and Energy Security in Asia." *Energy Policy* 129: 967-974. https://doi.org/10.1016/j.enpol.2019.01.073

Vogler, John. 2013. "Changing Conceptions of Climate and Energy Security in Europe." *Environmental Politics* 22 (4): 627-645. https://doi.org/10.1080/09644016.2013.806634

Winzer, Christian. 2012. "Conceptualizing Energy Security." *Energy Policy* 46: 36-48. http://dx.doi.org/10.1016/j.enpol.2012.02.067

World Bank. 2019. "Indicators." Accessed October 16th, 2019. https://data.worldbank.org/indicator

Yao, Lixia and Youngho Chang. 2014. "Energy Security in China: A Quantitative Analysis and Policy Implications." *Energy Policy* 67: 595-604. http://dx.doi.org/10.1016/j.enpol.2013.12.047

Yergin, Daniel. 1988. "Energy Security in the 1990s." *Foreign Affairs* 67 (1): 110-132. http://dx.doi.org/10.2307/20043677