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ROLE PLAYED BY COAL IN THE ENERGY BALANCES OF THE ASIA-PACIFIC COUNTRIES

Abstract: The Asia-Pacific region is a much diversified part of the world. Countries of various sizes, populations, religions, cultures, languages, diverse economic systems and varied levels of economic development are situated here. Moreover, this is the region facing dynamic economic development and aspiring to become the economic centre of the world in the near future. First of all, the rising energy demand is satisfied from the most easily accessible sources, thus, in case of numerous Asian countries, it means exploiting coal resources. Even though in the days of calling for reduction of CO_2 emissions, one may say that such an approach is unpopular, at the very least, the analysis of the energy balances in the selected countries of the region shows that for a long time coal shall play a significant role as an energy source.

Keywords: coal, energy balances, energy diversity.

1. Introduction

The world coal resources as at the end of 2008 are estimated at 826 001 million tonnes,[1] where 31.4% is situated in the countries of the Asia-Pacific region, with particular emphasis on China (13.9% of the world reserves), Australia (9.2%) and India (7.1%). Still, it is Europe that is the richest region in this raw material (with the entire Russia territory), having 33% of the world coal resources. The next one ranks North America, having 29.8% of the world reserves, dominated by the USA share of 28.9% of the world resources.

In 2008, 3324.9 Mtoe[2] of coal was mined in the world, which represented 5.3% increase as compared to 2007. Over 61% of the world coal production is situated in the Asia-Pacific region which is the largest coal producer as compared to other regions of the world. Then, 19.2% comes from North America and 13.7% from Europe (with the entire Russia territory).

[1] All data regarding the world coal reserves, production and consumption are taken from *BP Statistical Review of World Energy 2009*, BP, June 2009.

[2] Mtoe – million tonnes of oil equivalent. A tonne of oil equivalent is the energy obtained after combustion of 1 tonne of crude oil.

Table 1. Coal production and consumption in the world as of 2008 [Mtoe]

Region	Production	Consumption	Balance
North America	638.4	606.9	31.5
Central and South America	55.5	23.3	32.2
Europe and Eurasia	456.4	522.7	−66.3
Middle East	0.5	9.4	−8.9
Africa	143.4	110.3	33.1
Asia-Pacific	2030.7	2031.2	−0.5
World	3324.9	3303.7	21.2

Source: *BP Statistical Review of World Energy*, June 2009.

The largest coal consumer in the world is the Asia-Pacific region, having 61.5% share in the total world consumption in 2008. The following positions are taken by North America (18.4%) and Europe (18.4%).

Table 1 presents the geographical distribution of coal production and consumption in the world as of 2008 in more detail.

2. Energy diversity of the Asia-Pacific countries

There is considerable energy diversity in the countries of the Asia-Pacific region. In each of them coal as the energy resource plays a different role.

Firstly, as regards the energy, the countries of the Asia-Pacific region should be divided into energy net importers and net exporters. Obviously, in each case this may mean an entirely different structure of export (and analogically import) of the energy resources. Australia – the largest energy exporter in the region – most of all sells coal abroad. Whereas, Indonesia exports coal, significant amounts of natural gas and crude oil (however, in the net presentation, the export of this last raw material is small). In Malaysia, the export is dominated by oil and natural gas. Interestingly, majority of the region exporters sell a large share of possessed energy resources. The most blatant example is Brunei exporting 87% of what it is capable of mining and producing. The largest exporters in the region – Australia and Indonesia – sell to other countries 54 and 41%, respectively, of their annual production of energy carriers.[3]

As for the energy importers, particular attention should be paid to Singapore which satisfies 100% of its demand for the energy resources with the foreign sources. Obviously, in cases of the developed economies in the region (excluding Australia), in principle, it is necessary to import large amounts of energy sources. Both in Japan and South Korea, the net import of energy carriers almost four times exceeds the domestic production.

The division of the region into countries economically developed and developing is significant for the region energy profile, also in the aspect of the energy efficiency

[3] Data according to International Energy Agency, http://www.iea.org.

in the individual economies. The data of the International Energy Agency clearly show that the well-developed economies (Australia, New Zealand, Japan and South Korea) are much more efficient in usage of the produced (and imported) energy. There is a large span between Japan, which is an unrivalled model, and China which places second in the region (after Vietnam) among the worst energy utilizers. As compared to Japan, China is nine times less efficient in energy utilization with reference to the generated GDP.

Moreover, the level of development influences the scope of applying the energy technologies, reducing the negative impact on the natural environment. However, one should remember that the most important here is the type of the energy resource which is utilized as the main source for energy acquisition. Therefore, among other things, Australia and China, whose energy industry is based on coal, note higher CO_2 emissions to the atmosphere per a unit of the obtained energy.

The short energy characteristics of the region presented here shows the differences in the energy status of individual countries. It carries some meaning while discussing the role played by coal in the energy balances of selected economies.

2.1. China

The size of the Chinese economy, and following on from this large amount of energy produced and consumed in this country, have decided that at present China is one of the major participants in the world energy system. While actively participating in the international trade of the energy resources, it significantly influences the prices and processes taking place in the natural oil, natural gas or coal markets.

Table 2. Chinese coal energy industry expressed in numbers

First	world coal producer in 2007 (2549 Mt, ca. 40% of the world production)
Sixth	world coal exporter in 2007 (54 Mt)
Sixth	world coal importer in 2007 (48 Mt)
First	coal derived electric power producer in the world in 2006 (2301 TWh)

Source: own study on the basis of *Key World Energy Statistics 2008*, International Energy Agency, 2008.

On the one hand, China is relatively rich in the energy resources. In 2007, China was the largest coal producer in the world, generating ca. 40% of the world production. It also ranked fifth in the list of the largest crude oil producers and tenth – in the ranking of the largest natural gas producers (see Table 2). On the other hand, the violently growing energy needs in 1993 made China the net importer of crude oil and

Table 3. Energy balance of [a] China 2006 [ktoe[b]]

Item	Coal and peat	Crude oil	Petroleum products	Natural gas	Nuclear	Hydro	Geothermal, solar, wind	Combustible renewables and waste	Current	Heat	Total
Production	1 234 447	184 852	0	48 987	14 292	37 478	3 740	225 494	0	0	1 749 290
Import	20 566	145 175	45 059	795	0	0	0		463	0	212 058
Export	–51 025	–6 337	–15 338	–2 425	0	0	0	0	–1055	0	–76 180
TPES	1 206 978	322 579	21 418	47 357	14 292	37 478	3 740	225 494	–592	0	1 878 744
TPES acc. to the source[c]	*64.26%*		*18.32%*	*2.52%*	*0.76%*	*2.00%*	*0.20%*	*12.01%*	–	–	*100.00%*
TFC[d]	**393 421**	**4 316**	**291 611**	**37 461**	**0**	**0**	**3 399**	**224 124**	**199 246**	**48 268**	**1 201 846**
Industry	300 174	2 817	38 530	16 175	0	0	0	0	136 363	32 354	526 413
Transport	3 626	0	120 863	61	0	0	0	0	1 934	0	126 484
Other sectors	65 984	199	64 909	13 993	0	0	3 399	224 124	60 949	15 914	449 472
Non-energy use[e]	23 637	1 300	67 309	7 233	0	0	0	0	0	0	99 478

[a] The positive values in the energy balance mean the amount of energy or energy resources (per the energy units) remaining at an economy disposal in a given year. The negative values mean the utilization, processing, export or losses of a specific amount of energy or energy resources (per the energy units). The presented specifications of energy balances omitted the following items available in the specifications prepared by IEA: marine bunkers, changes of the reserves status, transfers, statistical differences, coal transformation and gas liquefaction systems, consumption division in "other sectors". The omitted values are included in TPES and TFC, therefore, the sum of the presented balance rows may differ from the values of these collective items; [b] Ktoe – thousand tonnes of oil equivalent. A tonne of oil equivalent is the energy obtained after combustion of 1 tonne of crude oil; [c] TPES division according to the sources of origin. Own calculation. This item is not a component of the energy balance prepared by IEA but is calculated in accordance with IEA methodology. Crude oil and petroleum products are taken inclusively, whereas the international current and heat energy trade is omitted; [d] TFC – Total Final Consumption, the amount of energy available for consumption after all processing and transformation processes; [e] TPES division according to the sources of origin. Own calculation. This item is not a component of the energy balance prepared by IEA but is calculated in accordance with IEA methodology. Crude oil and petroleum products are taken inclusively, whereas the international current and heat energy trade is omitted.

Source: International Energy Agency, http://www.iea.org.

in 1998 – the net importer of the energy in general.[4] Until 2006, China was self-sufficient with regard to natural gas (in 2007 this has changed) and at present China is self-sufficient only with regard to coal (at the same time, this has not prevented China to place sixth among the largest importers of this resource). Thus, China is an example of an economy forced to change entirely its principles of energy safety strategy, which is significant to the rest of the world, in so far as it regards the second (after the USA) largest energy consumer in the world.[5]

Coal is the most important resource in the Chinese energy balance (see Table 3) and assures 64% of the energy supply in the entire economy. For the most part, this resource is used for production of the electric power and in the industry. In 2006, China placed second among producers of the electric power in the world, but it dominates with regard to production of current in the coal power plants.

As mentioned above, the Chinese economy is exceptionally energy-consuming and diverges from the world standards in this area. The comparison with Japan – a region leader with regard to energy efficiency – is overwhelming. For example, in 2007 China consumed 50% more of crude oil than Japan.[6] At the same time, less than 19% of the energy supply in China comes from oil, and in Japan – as much as 45% (see Table 10). Any action aimed at improvement of this situation shall be of vital importance for the Chinese economy in the near future. Most of all, it is not possible to maintain the rate of the economic growth in the long-term perspective with the present energy costs of this process. The quickly-growing energy needs of the dynamically developing industry are most of all satisfied by means of coal (the share of this resource in the energy production started to grow rapidly in 2001). Utilization of the low quality coal, usage of outdated technologies and state interference into the resource trade market put together result in non-efficiency of this energy sector. Since the coal sector is the last one in which China is capable of self-sufficiency, it is particularly important to reduce the demand for this resource.

2.2. India

At present, India is the fifth energy consumer in the world.[7] Interestingly, with the population slightly smaller than in China (87% of the inhabitants in China[8]), the Indian energy use corresponds to as much as 24% of the Chinese consumption.

[4] Data according to *China Energy Profile*, Energy Information Administration, U.S. Department of Energy, http://www.eia.doe.gov.

[5] *International Energy Annual 2006*, Energy Information Administration, U.S. Department of Energy, http://www.eia.doe.gov.

[6] Data according to *China Energy Profile* and *Japan Energy Profile*, Energy Information Administration, U.S. Department of Energy, http://www.eia.doe.gov.

[7] *International Energy Annual 2006*; *BP Statistical Review of World Energy 2008*, BP, June 2008.

[8] *The World Factbook*, CIA, https://www.cia.gov/library/publications/the-world-factbook/index.html.

However, this does not prove higher energy efficiency of the Indian economy (both China and India obtained a similar result in this area) but its considerable economic backwardness. This is also confirmed by a large share of combustible renewables and waste in the energy supply (see Table 4), which by no means results from implementation of alternative forms of energy recovery from renewable sources but from popularity of the simplest ways of heat generation: wood, rubbish and animal excrement combustion.

Table 4. Indian coal energy industry expressed in numbers

Third	world coal producer in 2007 (485 Mt)
Fourth	world coal importer in 2007 (54 Mt)
Third	coal derived electric power producer in the world in 2006 (508 TWh)

Source: own study on the basis of *Key World Energy Statistics 2008*.

In the coming years, the energy needs of India may only increase. For instance, this is shown by the gap with regard to energy, existing between India and China. Obviously, the growth rate of demand for the energy resources shall depend on the development level of the Indian economy. The Goldman Sachs Bank forecasts[9] that in the coming years, the GDP *per capita* shall increase in India from the level of USD 817 in 2006 to the level of USD 4360 in 2030. At the same time, the population will exceed 1.5 billion giving India the position of the most populated country in the world.[10] Simultaneously, 45% of the population will live in the urbanized areas (27% in 2005), whereas 200 million cars will be driven on the roads (less than 6 million in 2004).[11] The International Energy Agency forecasts that the economic development of India will translate to the increased demand for energy from the level of 537 Mtoe in 2005 to the level of 1299 Mtoe in 2030 (in case of an alternative scenario providing for implementation of better energy strategies the said number shall be 1082 Mtoe).[12] The forecasts presented above show that in reality India is only about to enter the intense development jump manifested by increased demand for energy.

Coal is a key resource for the energy balance of India. In 2006, almost 40% of energy supply was obtained from this source (see Table 5). This country has large coal resources (6.7% of the world resources in 2007[13]) and ranks third among the largest world producers (see Table 4). However, it turns out that in the case of this country own production is not sufficient and India is forced to import coal in the amounts placing it in the fourth position of the world ranking for coal importers.

[9] *The N-11: More Than an Acronym*, Global Economics Paper No. 153, Goldman Sachs, 2007.
[10] U.S. Census Bureau, *International Data Base*, http://www.census.gov/ipc/www/idb/.
[11] T. Madan, *India*, The Brookings Foreign Policy Studies Energy Security Series, 2006, p. 7.
[12] *World Energy Outlook 2007*, International Energy Agency, 2007, p. 119.
[13] *BP Statistical Review of World Energy 2008*, BP, June 2008.

Table 5. Energy balance of India 2006 [ktoe]

Item	Coal and peat	Crude oil	Petroleum products	Natural gas	Nuclear	Hydro	Geothermal, solar, wind	Combustible renewables and waste	Current	Heat	Total
Production	197 903	39 000	0	23 406	4 849	9 770	796	159 916	0	0	435 640
Import	30 254	113 299	16 793	7 989	0	0	0		274	0	168 609
Export	–761	0	–32 984	0	0	0	0	0	–33	0	–33 778
TPES	**222 772**	**152 298**	**–16 218**	**31 395**	**4 849**	**9 770**	**796**	**159 916**	**242**	**0**	**565 820**
TPES acc. to the source	*39.39%*		*24.06%*	*5.55%*	*0.86%*	*1.73%*	*0.14%*	*28.27%*	–	–	*100.00%*
TFC	44 581	0	114 937	16 574	0	0	107	158 810	43 480	0	378 488
Industry	34 502	0	21 167	6 162	0	0	0	27 596	19 620	0	109 048
Transport	0	0	37 133	898	0	0	0	120	893	0	39 045
Other sectors	10 078	0	27 987	811	0	0	107	131 094	22 967	0	193 043
Non-energy use	0	0	28 650	8 703	0	0	0	0	0	0	37 353

Source: International Energy Agency, http://www.iea.org.

In consideration of the foregoing, the natural direction of changes in the energy security strategy of India is a better usage of the possessed coal resources. The import of this resource is much more expensive than utilization of the local resources and requires additional investments into the port and railway infrastructure. Obviously, increased efficiency of own mining and increased coal production shall also require financial expenditure. However, as is indicated, the greatest problem of the coal industry in India is the monopoly of Coal India Limited – a state enterprise with its eight subsidiaries controlling majority of coal mining in India. This company is considered exceptionally inefficient (the costs of mining are even 50% higher than in other countries), suffering from excessive employment and strong trade unions as well as holding too little funds to be spent on investments into technologies allowing for increased level of mining in more difficult and deeper mines[14]. Moreover, one should remember that the Indian coal resources are not limitless. BP forecasts that with the amount of confirmed resources and the mining level as at the end of 2007, the coal in India shall be sufficient for 118 years (R/P indicator).[15] However, if the annual 5% increase in mining shall be maintained, the said resources would deplete already after 40 years.

2.3. Japan

Japan is an example of economy almost entirely dependent on foreign sources of energy. The net import of energy exceeds over four times the level of the domestic production. It does not have own resources of oil and gas and has only trace quantities of coal,[16] thus Japan is the largest coal importer in the world and the second importer of gas, oil and petroleum products.

Table 6. Japanese energy industry expressed in numbers.

First	world coal importer in 2007 (182 Mt)
Fifth	coal derived electric power producer in the world in 2006 (299 TWh)

Source: own study on the basis of *Key World Energy Statistics 2008*.

The dominating element of the Japanese energy balance (45% share in the energy supply, see Table 7) is crude oil. Passing over the needs of the transport sector, in this country crude oil is utilized to considerable extent to produce the electric power (Japan is the largest world producer of electric power from this source). However, in the general balance, it is only fourth resource from which current is generated. IEA data of 2006 show that the largest amount of electric power in Japan is obtained from

[14] T. Madan, *op. cit.*, p. 51.
[15] *BP Statistical Review of World Energy 2008*.
[16] See *BP Statistical Review of World Energy 2008*.

Table 7. Energy balance of Japan in 2006 [ktoe]

Item	Coal and peat	Crude oil	Petroleum products	Natural gas	Nuclear	Hydro	Geothermal, solar, wind	Combustible renewables and waste	Current	Heat	Total
Production	0	742	0	3 191	79 075	7 375	3 567	7 116	0	0	101 066
Import	113 410	206 322	48 673	74 186	0	0	0		0	0	442 591
Export	–1 382	0	–10 101	0	0	0	0	0	0	0	–11 483
TPES	**112 410**	**207 907**	**32 666**	**77 443**	**79 075**	**7 375**	**3 567**	**7 116**	**0**	**0**	**527 560**
TPES acc. to the source	*21.31%*		*45.60%*	*14.68%*	*14.99%*	*1.40%*	*0.68%*	*1.35%*	–	–	*100%*
TFC	**31 062**	**532**	**200 602**	**31 228**	**0**	**0**	**771**	**2 661**	**84 355**	**577**	**351 787**
Industry	30 025	28	34 399	7 325	0	0	0	2 637	27 572	0	101 987
Transport	0	0	89 494	0	0	0	0	0	1 634	0	91 129
Other sectors	628	0	39 691	23 545	0	0	771	23	55 149	577	120 384
Non-energy use	409	503	37 018	357	0	0	0	0	0	0	38 288

Source: International Energy Agency, http://www.iea.org.

the nuclear power plants (303,426 GWh). The next sources are coal (298,899 GWh) and gas (254,492 GWh).[17] Coal provides Japanese economy with over 21% of energy and in this meaning is the second, after crude oil, most important component of the energy balance.

2.4. Australia

Australia is the only highly-developed economy in the Asia-Pacific region which is not the net energy importer. The IEA data show that ca. 55% of the annual domestic energy production is exported.[18] Sales of the energy resources abroad (most of all coal, liquified gas and uranium) give the Australian economy 35% of all income from export.[19] In practice, Australia is a country almost entirely self-sufficient with regard to energy production. The only components of the energy balance, that Australia is forced to import, are crude oil and petroleum products. At the same time, import covers not more than 40% of this resource demand.[20]

Table 8. Australian coal energy industry in numbers

Fourth	world coal producer in 2007 (395 Mt)
First	world coal exporter in 2007 (244 Mt)
Seventh	coal derived electric power producer in the world in 2006 (199 TWh)

Source: own study on the basis of *Key World Energy Statistics 2008*.

Coal is the most important energy resource in the Australian energy balance. It ensures 43% of the energy supply (see Table 9). With regard to the size, Australia holds fourth-large coal resources in the world (after the USA, Russia and China), which make 9% of the world resources.[21] The second, very important source of energy, is crude oil which in principle is only utilized in the transport industry. The natural gas, placed in the third position, is mainly used in the industry, also for the purposes of electric power production.

Due to the status of the energy balance presented here, Australia is considered to be a very safe country with regard to the energy security. However, the Australian governmental and expert considerations do not omit the issue of the energy security, but it must be said that (in particular in the governmental studies), it is presented rather as an issue to be dealt with in the future.

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[17] *IEA Energy Statistics*, http://www.iea.org/Textbase/stats/.

[18] The other sources show even 66% share of export in the energy production. See *Energy in Australia 2009*, Australian Bureau of Agricultural and Resource Economics, 2009.

[19] *APEC Energy Overview 2008*, Asia Pacific Energy Research Centre, Japan 2009, p. 6.

[20] *Australia Energy Profile*, Energy Information Administration, U.S. Department of Energy, http://www.eia.doe.gov.

[21] *BP Statistical Review of World Energy 2008*.

Table 9. Energy balance of Australia in 2006 [ktoe]

Item	Coal and peat	Crude oil	Petroleum products	Natural gas	Nuclear	Hydro	Geothermal, solar, wind	Combustible renewables and waste	Current	Heat	Total
Production	201 355	23 079	0	36 825	0	1 350	206	4 978	0	0	267 794
Import	31	20 026	11 957	1 209	0	0	0		0	0	33 226
Export	–150 034	–12 550	–1 776	–14 607	0	0	0	0	0	0	–178 968
TPES	**53 749**	**29 726**	**9 034**	**23 426**	**0**	**1 350**	**206**	**4 981**	**0**	**0**	**122 474**
TPES acc. to the source	*43.89%*		*31.65%*	*19.13%*	*0.00%*	*1.10%*	*0.17%*	*4.07%*			*100.00%*
TFC	**3 494**	**0**	**39 041**	**13 250**	**0**	**0**	**58**	**3 855**	**18 029**	**0**	**77 727**
Industry	3 328	0	3 757	8 378	0	0	0	2 572	8 076	0	26 110
Transport	79	0	28 770	379	0	0	0	44	225	0	29 496
Other sectors	87	0	3 029	3 836	0	0	58	1 240	9 727	0	17977
Non-energy use	0	0	3 486	657	0	0	0	0	0	0	4 143

Source: International Energy Agency, http://www.iea.org.

A special attention must be paid to the fact that in comparison to other OECD states, Australia maintains a very low level of energy sources diversification (ca. 75% of energy supply comes from coal and crude oil, see Table 9), which makes Australia sensitive to unexpected turbulences on the coal market (over 43% of energy supply) as well as on the oil market (over 31% of energy supply).[22]

The next problem to be tackled by Australia in the future is improvement of the energy efficiency. Due to the fact that so far this country has not experienced serious effects of turbulences in the energy resource market, not much attention was paid to the issue of energy saving as one of the methods to increase the energy security. In this area, the Australian experience diverges significantly from the experiences of Japan or countries of West Europe, therefore, a difference in the indicators of energy efficiency is clearly visible between Australia and other OECD states.[23]

3. Conclusions

The American Energy Information Administration forecasts that until 2030 the world coal consumption shall increase by 49%, as compared to 2006. At the same time, the coal share in the total energy consumption shall increase from 27 to 28%.[24] 90% of the forecasted consumption increase is to be ascribed to the Asian countries, which are non-OECD countries, with indication to their industry and electric power production sector. Even if from the environmental point of view and ambitious plans to reduce emission of the greenhouse gases, coal is considered to be a "dirty" and outdated source of energy, no signs indicate that its role in the energy balances of many countries will decrease in the decades to come.

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[22] P. Kinrade, Toward a sustainable energy future in Australia, *Futures* 2007, No. 39, p. 240.

[23] See *ibid*., p. 242, and *Power plays. Energy and Australia's Security*, Australian Strategic Policy Institute, 2007, p. 29.

[24] *International Energy Outlook 2009*, Energy Information Administration, p. 49.

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ROLA WĘGLA W BILANSACH ENERGETYCZNYCH KRAJÓW REGIONU AZJI I PACYFIKU

Streszczenie: Region Azji i Pacyfiku jest bardzo zróżnicowaną częścią świata. Występują tu państwa o różnej wielkości, liczbie ludności, religiach, kulturach, językach, odmiennych systemach gospodarczych i zróżnicowanych poziomach rozwoju gospodarczego. Jest to także region dynamicznego rozwoju gospodarczego aspirujący do tego, aby w niedalekiej przyszłości być centrum gospodarczym świata. Wzrost gospodarczy oraz zwiększająca się stale populacja pociągają za sobą ogromne zapotrzebowanie na energię. Wzrastający popyt na energię jest w pierwszej kolejności zaspokajany z najłatwiej dostępnych źródeł, co w przypadku wielu azjatyckich państw oznacza sięganie do zasobów węgla. I choć w dobie nawoływania do redukcji emisji CO_2 jest to co najmniej niepopularne, analiza bilansów energetycznych wybranych krajów regionu pokazuje, że jeszcze przez długi czas węgiel będzie pełnił istotną funkcję jako surowiec energetyczny.