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Eastern countries in the context of world perspective energy trends

The swift transfer of material production to the East — a cause of its fast economic progress — is in the public eye. Particular interest is aroused by the energy sector. The rapid industrial development of the region combined with the world's largest population growth here will give rise to crucial change in energy sectors on the national and international scale.

The world's energy consumption increased by 45% in 1990–2010; it will probably grow by 43% in 2010–2030 and by 32% in 2030–2050. The average annual growth of 1.5% in 2010–2030 will slow down after 2020, and constitute 0.9% in 2030–2050[1].

The greatest rise in energy consumption is expected in developing Asian countries, while in North America, Western Europe, CIS and developed Asian countries the increase will be very low or practically nil. It will cease altogether in industrialized countries after 2020 when the population growth stops. Greater energy efficiency will compensate for the growing per capita energy consumption with China, India and the Middle East consuming 60% of the world's total[2].

Table 1

Primary power consumption dynamics in world regions

Region	Consumption of primary energy (M.T.O.E.)						
	1990	2000	2010	2020	2030	2040	2050
North America	2167	2178	2089	1994	1931	1869	1756
Europe	1131	1096	1089	993	985	924	859
Developed Asian count.	634	645	627	610	591	524	472
CIS	834	754	923	976	895	828	768
EA, SEA, SA, CA and Transcaucasus	753	3976	6573	7462	8321	1047	11 024
Middle East	611	985	1067	1143	1210	1618	1984
Africa	546	723	896	1012	1248	1692	2127
South America	710	979	1055	1123	1187	1578	1865
Australia and Oceania	186	208	223	218	197	189	178

Source: Прогноз развития энергетики мира и России до 2040 года . ИНЭИ РАН, 2012. С. 18; based on figures: Energy balances of Non-OECD countries. P., 2012. P. 14–87.

Combined approaches to power consumption forecasts — demographic (population growth and per capita power consumption) and economic (GDP increase and power intensity) will prompt the conclusion that primary energy growth rates will be three times lower than the average GDP growth rates in 2010–2050, a noticeable decrease since 1990–2010.

The power balance throughout the world and in every particular region will be changing slowly due to the long-life cycle of production funds. The market shares of three main fuels will be levelled out at 25 or 26% and the basic non-mineral power resources will account for 7 or 8% of the market share each[3].

Table 2

Percentage of primary energy sources in the world power consumption

Energy source	Share of energy consumption, %				
	1970	1990	2010	2030	2050
Oil	42	36	29	26	25
Natural gas	17	20	24	25	28
Coal	30	25	26	25	24
Hydropower	9	10	10	10	7
Nuclear energy	1	8	9	9	8
Renewable energy	1	1	3	5	8

Source: BP energy outlook 2030. L., 2011. P. 18, Shell energy scenarios to 2050 Y., 2009. P. 28. Calculated on figures: Energy balances of Non-OECD countries. P., 2011. P. 18–59.

To meet the demand for primary energy the consumption of all types of fuel has to be increased. The structure of world power consumption will become more diversified and balanced. Intersectoral competition will lead to consumption of equal amounts of oil, gas, coal and non-mineral resources with a small edge of gas. While the percentage of oil will decline in the long-term perspective, the percentage of gas will grow. The share of coal which increased at the turn of the century due to the rapid industrial development of India and China, will be shrinking. Renewable energy (including bio-fuel) will account for 18% of the growing energy carriers supply until 2030 and for 21% after 2030[4].

Eastern regions, particularly the Middle East, rich in hydrocarbons, and East, South and South-East Asia where fossil fuel is not enough for their rapidly developing economies, deviate substantially from the world's trends of changing power consumption structures.

Table 3

Consumption growth of different types of primary energy in Eastern regions (1990–2050)

Region	Source of primary energy(M.T.O.E.)					
	Oil	Gas	Coal	Nuclear	Hydro	Renew.
South Asia	195	98	297	8	5	51
East Asia	406	507	738	286	169	207
South-East Asia	196	187	254	29	16	12
Asian developed countries	-53	112	0	-46	0	62
Middle East	206	216	0	0	0	4
Central Asia and Transcaucasus	27	35	26	0	0	2

Source: Energy Outlook for Asia and the Pacifics. Mandaluong City, Asian development bank, 2013. P. 25;Calculated on figures: Energy balances of Non-OECD countries. P., 2012. P. 142–43.

Coal will retain its leading position in power consumption in East and South Asia although the average growth rates will be 1.7% (total consumption rates being 2.7%) and the percentage of coal in the region's power balance will go down from 46.2% in 2010 to 40.1% in 2050. China's share in the world's consumption, however, will grow from 47% in 2010 to 53% in 2030 due to a decline in the share of coal in the developed nations power balance (the annual rise in the world's coal consumption will be as low as 0.2%)[5]. The decline in China's share in the East will be balanced by India where, contrary to the world trend, coal consumption growth rates will be higher than total primary energy consumption rates. Given restricted possibilities for greater imports of energy carriers in the near future the Indian rapidly developing economy can be supplied with energy only through wider consumption of local coal.

Natural gas will be the fastest growing fuel on the global scale until 2050 but its growth will slow down in comparison with historical trends while the markets will be extended and measures intensified to increase the energy consumption efficiency.

The world's largest consumption growth will be in Asia (without the Middle East). China will account for 54% of the consumption growth in the region. The Middle East will demonstrate the world's second largest consumption level. The region's share in the global consumption will rise from 5% in 1990 and 12% in 2010 to 19% in 2030 and 21% in 2050[6].

Oil will have the lowest consumption growth rates of all mineral energy resources. Nonetheless the global demand for fuel (including bio-fuel) will rise by 14.4% in 2010–2030 and by another 9.8% by 2050. Asian countries will account for over three-fourth of the global demand, and China for over 50% of the global oil

consumption. By 2030 China will be the world's largest oil consumer overtaking the U.S. — the biggest oil producer by 2020. India will be the third largest oil consumer[7].

Sources are also diversified in electric power generation — an area of competition between primary resources. Gas consumption will go up here by 2.9 times in 2010–2050 and will ensure the greatest increase in electric power production.

The growth rates of non-carbon resources will be as fast as ever; they will amount to 36% of the world growth.

A retrospective view has always revealed a strict dependence of the demand for electricity on the population's income. The correlation between power consumption growth and the GDP growth is 0.7 to 0.9 in each particular country and the world as a whole. This balance will remain the same in the next two or three decades. Hence electricity generation growth rates in developing countries will be three times higher than in industrialized countries. The per capita electric power consumption, however, in developing countries will be less than 30% of this indicator in industrialized nations by 2050 (20% in 2010).

The difference between developing and developed countries will persist in the power production structure with the former dominated by a non-carbon trend and the latter by coal and fast growing gas and renewable resources. The percentage of primary energy used for world electric power production will go up from 36% in 2010 to 55% in 2050[8].

It is a stable trend that electric power production growth rates exceed GDP growth rates by 1.1–1.3 times (in different groups of countries).

Table 4

Electricity production in world regions

Region	Generation of electric power (Tw.H)			
	1990	2010	2030	2050
North America	4010	4950	4900	4850
Europe	4900	5000	5150	5200
Developed Asian countries	920	1050	1020	980
Middle East and North Africa	810	1120	1150	1220
SA, SEA, EA, CA and Transcaucasus	950	8010	19750	23 010

Calculated on figures: Energy outlook for Asia and the Pacifics. Mandaluong City, Asian development bank, 2013. P. 81–83, Energy balances of non-OECD countries. P., 2012. P. 18–53.

Coal will continue to dominate in electric power generation in Asian countries (excluding the Middle East) although its percentage will go down (in line with the trend of coal reduction in the total power consumption with almost all coal used in electric power generation) from 60% in 2010 to 55% in 2050 (the corresponding figures for the whole world being 42 and 39%). The percentage of natural gas will

increase; it is the only not-renewable primary energy source the percentage of which will grow in the total energy consumption with exceeding rates of its use in electric power generation (from 13 to 17%) (in the world from 21 to 27%). The share of oil will decline (according to the trend of reduced oil use in total power consumption along with reduced growth rates of fuel oil in electricity production) from 6 to 3% (a similar trend will be observed throughout the world). In the Middle East natural gas will continue to oust oil. Its percentage will boost from 13 to 77% in 2010–2050. The share of hydroenergy will drop due to limited natural conditions for new construction) from 12 to 9% (in the world from 16% to13%), while the percentage of atomic energy will increase (for many countries it is the only way of giving impetus to power production without excessive spending and environmental losses) from 8 to 11% (in the world from 14 to 12%). The percentage of new renewable resources will grow in the East from 1 to 5% (in the world from 2 to 8%)[9]. In Asia in 2035 36% will be produced in China (compare with 11 % in 2010), 27% in Japan (56% in 2010), 16% in India (5% in 2010), 14% in Korea (21% in 2010) and 5% in Taiwan (5% in 2010)[10].

Developing Eastern countries will produce almost the whole of the world consumption increase in atomic power generated energy . With stagnation or decline in demand for this type of energy in industrialized countries, most of which will stop using a greater number of facilities than the number put into operation, world growth rates in the near future will amount to 3.5% a year. The list of countries producing this type of energy — Japan, the Republic of Korea, China, India, Pakistan, Taiwan and Armenia — will be enlarged by Malaysia, Thailand, Vietnam, Turkey and Iran. The use of atomic raw materials will remain the basis of power engineering in the Rep. of Korea (30.1% in 2010 and 29.8% in 2050). Japan is not planning to put new plants into operation and the share of atomic power stations in electricity generation will be gradually ebbing (from 18.9% in 2010 to 13.2% in 2050) as the worn-out equipment is dismantled[11].

According to forecasts, hydroelectric plant generated energy consumption will have lower growth rates than total power consumption — 1.9% a year in 2010–2050 (the world average being 1.8%). China will account for almost the whole growth ; it will double the consumption of this type of energy. In most countries this energy resource has no growth prospects due to the lack of natural conditions. Yet in Tajikistan, Kyrgyzstan, Bhutan, Georgia and Armenia it remains the basis of power generation with a possibly shrinking consumption percentage. New facilities will be put into operation in Myanmar[12].

Renewable energy resources consumption growth will be slower in the East than in the whole world. The use of the latest power production methods will be balanced by ending the use of traditional bio-resources, such as firewood or manure (which make up about a half of power consumption in such underdeveloped countries as Nepal, Bhutan, Cambodia, Laos and Mauritania)[13].

A sectoral structure of consumption of different types of energy carriers in the foreseeable period will practically remain the same and average indicators in

Eastern countries will be close to the world's ones because the fast GNP growth in the East implies harmonic and proportional growth of all economic sectors. In 2010–2050 66% of the oil consumption growth in the East will be «swallowed» by transport (74% in the whole world) , 12% by industry (9% in the world) and 22% by construction industry (17% in the world). 60% of gas consumption growth will be in power engineering (58% in the world), 23% in construction (26% in the world) and 7% in transport (16% in the world). Nearly all coal (94%) will be burnt in electric power plants and boiler facilities in the East and the rest of the world and only 6% consumed in industry.

Asia will account for the lion's share of primary energy consumption in all world economic sectors. Oil consumption growth will be caused by the rapidly growing number of vehicles in China (a ten-fold rise in 2010–2050) and India. Asian electric power generation will absorb almost the whole coal consumption growth, and the construction boom in China will be the reason for the oil and gas consumption growth in the building industry. The continued industrialization will be more localized in Asia and be a major consumer of all types of energy resources.

Growth rates of primary energy consumption in South East Asia, East Asia and South Asia will be faster than growth rates of power production. The growing deficit will be compensated by imports. A comparison of GNP dynamics, primary energy carriers consumption and trade reveals that net-import of mineral energy carriers will double there in 2010–2050. As for the Middle East and North Africa, primary energy production growth rates will exceed growth rates of power consumption by 1.4 times. The situation will vary substantially in Asia.

Table 5

Primary energy export/import in Eastern regions

Region	Export/import (±) of primary energy (M.T.O.E.)		
	2010	2030	2050
South Asia	-205	-525	-810
East Asia	-760	-1195	-1490
South-East Asia	+110	-70	-195
Middle East and North Africa	+355	+430	+535
Central Asia and Transcaucasus	+55	+215	+310

Calculation based on figures: Energy outlook for Asia and the Pacifics. Mandaluong City, Asian development bank, 2013. P. 31.

The East –now a major consumer of primary energ– will remain its major producer. Iraq will make the greatest contribution to the world increase of primary energy carriers production. The existing contracts will boost oil production there to 50% of Saudi Arabia production by 2020 and to 80% in 2050. Iraq is becoming a key oil supplier to rapidly developing Asian markets, particularly China. In the 2030s it will leave Russia behind and become the world's second largest oil exporter[14]. Kazakhstan, Turkmenistan, Myanmar, and Azerbaijan will increase oil and gas deliveries many times over. Saudi Arabia will retain its percentage (12%) of the world market. Within the framework of coordinated policies the Persian Gulf countries will increase oil and gas supplies to meet the growing world demand. Production and export of coal will steeply grow in Mongolia (to China) and in Indonesia. The Eastern region will continue to contain the world's largest exporters and importers of primary energy sources15.

The steep rise in energy production and consumption in the East will require huge investments to produce, transport, generate and distribute energy and to repair and modernize old equipment. Long-term investments in the world power sector average 4% of the GDP. In the industrialized importers of energy with a big per capita GDP this indicator is under 2% of the GDP, in industrializing countries with few energy resources and a low per capita GDP it is 4%, in countries with a well developed energy sector and an average GDP level it is 6%, in developing countries with large but yet untapped energy resources and a still low per capita GDP it can reach 10%.

The percentage of investments in the energy sector of Singapore, Taiwan, Japan, Rep. of Korea and Israel is under 1.5–1.9%; China, India, Malaysia, Indonesia, Turkey, Pakistan, Syria, Morocco — 2.1–4.2%; Iran, Algeria, Saudi Arabia, Kazakhstan, Myanmar, Iraq, Oman and Kuwait 4.2–6.1%; Azerbaijan and Mongolia 8–10%[16].

Cumulative investments in world power sector forecasted on the basis of this trend and some calculations are as high as $56 trl. In 2010–2050[17]. 60% of this sum will be channeled to electric power generation, 19% to oil industry, 19% to the natural gas industry and 2% to the coal sector. 25% of investments will go to North America, 14% to Europe, 15% to China, 7% to the Middle East, 5% to India and 9% to developing Asian countries[18].

Total investments in the Asian power sector (excluding the Middle East) will constitute $11.7 trl in 2010–-2035 (prices of 2010) and another $6.2 trl[19]. In 2035–2050 (the corresponding figures for North Africa being $0.5 trl. and $0.3 trl)[20].

Investment rates in energy sectors of different Eastern regions and their sectoral structures vary greatly.

Table 6

Investments in Energy Sectors in regions of the East

Regions	Region's share in total investments, %	Sectoral investments (bln. $2010)			
		Gas	Oil	Coal	Electric and thermal energy
Middle East and N.Africa	22,3	1200	2200	-	2500
Central Asia and Transcaucasus	2,6	390	210	-	600
South-East Asia	6,9	320	310	300	1120
East Asia	45,7	840	800	910	6530
South Asia	14,2	470	380	580	1890
Developed Asian countries	8,3	630	290	320	1950

Source: Energy outlook for Asia and the Pacifics. Mandaluong City, Asian development bank, 2013. P. 122; *Calculated on base of figures*: Energy invest outlook. P., 2003. P. 6–14.

Investments in the Eastern energy sectors will be channeled in line with present-day international trends. The largest part of all investments (78% in East Asia, 72% in South Asia, 74% in developed Asian countries, 66% in South-East Asia, 59% in Central Asia and Transcaucasus, 46% in Middle East and North Africa) will be made into electric power generation (58% into the construction of new generating facilities and 42% into building electric power lines and distribution grids). The Middle East and North Africa have a high level of investments in the oil and natural gas industries (54% of all investments; $1.74 trl and 1.52 trl accordingly in 2010–2050). Nearly 100% of investments in the oil extracting industry will go into production of conventional oil (which is natural given its abundance), 73% into creation of new and modernization of old facilities, 25% into oil refining and 12% into construction of transportation infrastructure[21].

On the whole, oil production in the Middle East will receive far less investments than in the U.S. and South America due to incomplete loading of facilities and ability to increase production without additional investments.

Investments in the Middle East gas sector are more substantial on the wold scale. 71% of investments will be used to develop new gas fields (exclusively traditional), 7% to build liquefaction factories, 22% to lay gas pipelines and distribution networks[22].

Considerable resources will be channeled into the coal industry in East and South Asia ($0.92trl and $0,45% trl accordingly) where 94% of the sum will be invested in building new mines and updating old ones and 6% in creating transportation infrastructure[23].

The investment structure in the energy sectors of developed Eastern countries is characterized by increasing investments into technological re-equipment of facilities processing primary energy sources and generating and distributing electric power.

In Central Asia and Transcaucasus great emphasis is made on investments into oil and natural gas industry ($0.42 trl in 2010–2050), development of new fields (55% of investments) and construction of pipelines (45% of investments in 2010–2050)[24].

A major source of such massive investments into energy sectors will probably be provided by redistribution of funds from state price subsidies of primary energy consumption to direct capital investments. Subsidies provided to energy consumption in almost all countries are hampering their progress. Spending on subsidies to the world energy sector reached $2.1 trillion in 2010, which is 3,5% of the world GDP, or 8% of total expenditures of all countries of the world. Over 20 countries spend more than 10% of their GDP on subsidies to power sectors (including Iran, Turkmenistan, Uzbekistan, Saudi Arabia, Kuwait, Egypt)[25].

Subsidies are provided both in power production and consumption. They precede the payment of taxes when energy consumers pay a price lower than the delivery price. Such practices are common in poor countries to maintain an acceptable living standard.

In addition to consumer subsidies, subsidies for producers are widely used when energy companies sustain losses not due to low energy prices for consumers but due to low efficiency caused by an archaic economic system or an unfavorable situation (for example the prime cost of production and transportation of hydrocarbons in the Persian Gulf is 20 times lower than in Yamal). To make their energy sector competitive most countries have to resort to various forms of direct or indirect subsidizing.

Subsidies before taxation make up 0.7% of the world GDP or 2% of all tax revenues. These are mostly for electric power and oil products. About a half of such subsidies are in the Middle East and North Africa where they eat up 1/4 of state revenues[26]. Subsidies after taxation are four times higher than subsidies before taxation. They are characteristic of economically developed countries. More than one-fourth of their volume are coal industry subsidies. The percentage of subsidies in the GDP is particularly high in North Africa and developing Asian countries. The three leaders are the U.S. ($502 bln in 2010), China ($279 bln) and Russia ($116 bln)[27]. Major Eastern countries have a high cabsolute value of subsidies — Iran ($80 bln in 2010), Saudi Arabia ($45 bln), India ($24 bln) and Egypt ($21 bln)[28].

The consequences of subsidizing are not only budgetary losses. Low subsidizing prices make investments into power production unattractive for private and state companies. This diminishes power supplies — a key condition for economic growth. In North Africa, for example, the losses sustained by electric power suppliers due to subsidized prices cut their opportunities to invest into new generating facilities. Subsidies oust state expenditures which could stimulate economic growth. Some countries (Turkmenistan, Iran) spend more on power subsidies than on public

education and medical care. Subsidies lead to ineffective distribution of resources in favor of capital- and power-consuming sectors dependent on state subsidies.

Without subsidies resources could be distributed more effectively, economic growth would be faster, the use of non-renewable resources more efficient, development and introduction of energy saving technologies more vigorous. Finally, the lion's share of subsidies does not reach their address since they mostly affect well-to-do people living in houses with air conditioning and heated water and owning cars. 20% of well-off households receive 43% of subsidies while 20% of poor families only 8%[29].

In 2009–2012 given the economic and ecological damage done by price subsidies binding decisions were made at international (G-20 Summit in Baltimore and APEC in Singapore) and national levels on non-interference of the state in price-formation at power markets (in many countries including Indonesia, Thailand, India and Jordan from 2013–2014) and transformation of subsidies into direct money or quasi-money transfers. These measures must boost the demand for energy on the part of the multimillion masses of the poor, which will require additional investments in the power sector.

These forecasted values of investments in the Eastern power sector only refer to obtaining macroeconomic and demographic indicators. Still, 1.3 bln people in the East have no access to electricity and 2.7 bln use traditional biomass for cooking (840 mln in India, 105 mln in Pakistan, 100 mln in Bangladesh, 48 mln in Myanmar and 124 mln in Indonesia)[30].

In 2009 $9.1 bln ($6.9 bln in developing Asian countries) was invested into securing an access to modern forms of energy. According to IEA estimates, an average of $14 bln will be spent to this end in 2010–2030[31]. Calculations show that cumulative investments in this period amount to $300 bln (about 87% in Asian countries). 95% of this sum will be streamed into electrification of rural areas[32]. As a result the number of Asian people having no access to electricity must go down from 675 million in 2009 to 375 million in 2030[33]. In India the percentage of people without an access to electricity will dwindle from 25% in 2009 to 10% in 2030, in underdeveloped Asian countries from 36 to 16%, in Middle East and North Africa from 11 to 8 % and in the whole world from 19 to 12%[34]. Eastern countries will be fully electrified by 2050 with an additional $270 bln[35]. This is the minimum essential for achieving predicted macroeconomic indicators and avoiding disastrous ecological consequences.

In 2010 34% of investments into providing an access to the latest types of energy were made by international consortia (banks of development, foundations, etc.), 22% by private companies (mostly financed by the World Bank), 14% under bilateral assistance programs and 38% by national governments[36]. A similar trend is likely to persist in the next two decades.

The growing pressure of the ecological factor will require additional investments into the energy sector. From 2000 to 2010 carbon dioxide emissions into the air (85% in the energy sector) rose by 5% every year. If this trend persists, the average

annual temperature on the Earth will be 3.5 degrees higher by 2030 which, among other things, will lift the level of the World Ocean by 2 metres flooding vast areas[37]. To prevent a disaster efforts will be made to reduce the emissions strictly in compliance with international documents. These efforts will imply technological re-equipment of power facilities in developing countries (where nearly all emissions occur) and require large investments.

As there is no alternative to burning fossil fuel in the world energy sector today, emissions can be brought down only by introducing low carbon technologies, especially CCS (carbon capture and storage) technologies. The use of already existing technologies would keep carbon dioxide concentration at an acceptable level. However these technologies are expensive and cannot be widely applied in developing Eastern countries. Large-scale investments in this sphere cannot be expected before 2020 when ecological pressure makes them inevitable.

Annual investments in this sphere are estimated at $275 bln[38]. Cumulative investments (as calculations indicate) will be $8.2 trillion in 2020–2050 (36% in China, 20% in India, 9% in other developing Asian countries and 8% in the Middle East and North Africa)[39]. Trade in emission quotas will make investments flexible and international in character.

The steep rise in the Eastern industrial economy boosts a demand for energy sources. This growing demand will be met by the East itself. Both increases will require huge investments in the energy sector. The growing ecological losses will inevitably require additional capital investments. The East's energy sector will eventually become a major sphere of capital investments and a driver of international economic dynamics.

Endnotes

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