designated size in 2019 saw their revenue expand 4.5 percent year on year, MIIT data showed. Profits in the sector went up 3.1 percent while the operating costs rose 4.2 percent compared with the same period a year ago.[1383]

Xinhua News Item dated **April 27, 2020** titled **"China's electronic information engineering sector faces 16 key tasks"** reported that **s**ensing, cyber security, new generation infrastructure are among a total of 16 fields that have been listed as key tech-challenges to China's electronic information engineering sector, said in the report released by China Academy of Engineering (CAE). The 16 fields are micro-electronics and optoelectronics, optical engineering, sensing, measurement and instrument, electromagnetic space, network and communication, cyber security, hydro-acoustic engineering, electromagnetic field and electromagnetic environment effects, control, cognition, computer system and software, computer application, industrial software system, significant emergency response and new generation infrastructure.

The corona virus pandemic is profoundly shifting the global political economy and social structure. The information technology sector should move faster as the strategic, foundational and leading industry which concerns a country's economy and people's livelihoods, said Chen Zuoning, academician and deputy director with the CAE.[1384]

8.7.6 Energy

China's Information Office of the State Council issued two White Papers on Energy in 2007 and 2012; the relevant texts have been highlighted under the sub-heading Energy 8.7.6 to understand the China's Energy policies and initiatives. Further, **China Energy Storage Alliance (CNESA)** report on **"Energy Storage Industry White Paper 2019: Summary Version"** gives out highlights the China's energy prospects.

8.7.6.1 *White Paper on China's Energy Conditions and Policies, 2007*

*China's Information Office of the State Council issued the country's first ever white paper entitled **"China's Energy Conditions and Policies"** in December 26, **2007**.* The document, composed of eight chapters, points out that China, as an irreplaceable component of the world energy market, plays an increasingly important role in maintaining global energy security. The excerpts of the white paper are given below:

Preface

I. **Current Situation of Energy Development**
II. **Strategy and Goals of Energy Development**
III. **All-round Promotion of Energy Conservation**
IV. **Improving the Energy Supply Capacity**
V. **Accelerating the Progress of Energy Technologies**
VI. **Coordinating Energy and Environment Development**
VII. **Deepening Energy System Reform**
VIII. **Strengthening International Cooperation in the Field of Energy**

[1383] Excerpts from Xinhua Net News updated on February 15 2020 titled "China's electronic information manufacturing expands in 2019", available online at URL: http://www.xinhuanet.com/english/2020-02/15/c_138786358.htm

[1384] Excerpts from Xinhua News Item dated April 27, 2020 titled "China's electronic information engineering sector faces 16 key tasks" edited by Huaxia , available online at URL: http://www.xinhuanet.com/english/2020-04/27/c_139012387.htm

Conclusion

I. Current Situation of Energy Development

China boasts fairly rich fossil energy resources, dominated by coal. By 2006, the reserves of coal stood at 1,034.5 billion tons, and the remaining verified reserves exploitable accounted for 13 percent of the world total, ranking China third in the world. In 2006, the theoretical reserves of hydropower resources were equal to 6,190 billion kwh, and the economically exploitable annual power output was 1,760 billion kwh, equivalent to 12 percent of global hydropower resources, ranking the country first in the world. The per-capita average of both coal and hydropower resources is 50 percent of the world's average, while the per-capita average of both oil and natural gas resources is only about one-fifteenth of the world's average. The per-capita average of arable land is less than 30 percent of the world's average, which has hindered the development of biomass energy. China has built a group of extra-large coalmines each with an annual output of over ten million tons. In 2006, the output of primary energy equaled 2.21 billion tons of standard coal, ranking second in the world. Of this, raw coal accounted for 2.37 billion tons, ranking first in the world. Daqing, Shengli, Liaohe, Tarim and other large oilfields have been successively built as oil production bases, and the output of crude oil has increased steadily, ranking China the world's fifth-largest oil producer in 2006, with 185 million tons in that year. The output of natural gas ballooned from 14.3 billion cu m in 1980 to 58.6 billion cu m in 2006. The proportion of commercial renewable energy in the structure of primary energy keeps rising. The electricity sector also reported speedy growth in 2006. The installed capacity reached 622 million kw, and the amount of power generated was 2,870 billion kwh, both ranking second in the world. A comprehensive energy transportation system has been developed quickly, with the transport capacity notably improved. Special railways transporting coal from the west to the east and relevant coal ports, and pipelines transporting oil from the north to the south and conveying natural gas from the west to the east have all been built. Now, the power generated in the west can be carried to the east, and the regional power grids have all been connected up.

During the period 1980-2006, China's energy consumption increased by 5.6 percent annually, boosting the 9.8-percent annual growth of the national economy. Calculated at 2005 constant prices, the energy consumption for every 10,000 yuan of GDP dropped from 3.39 tons of standard coal in 1980 to 1.21 tons in 2006, making the annual energy-saving rate 3.9 percent, putting an end to the rising trend of per-unit GDP energy consumption. The comprehensive utilization efficiency in the processing, conversion, storage and end-use of energy was 33 percent in 2006, up eight percentage points over 1980. Per-unit product energy consumption has dropped noticeably, and the gaps between the overall energy consumption, the net energy consumption rate of electricity generation for steel and cement production as well as synthetic ammonia produced by plants with an annual output of 300,000 tons or more and the international levels are narrowing. China is the world's second-largest energy consumer. In 2006, its total consumption of primary energy was 2.46 billion tons of standard coal. China pays great attention to improving its energy consumption structure. The proportion of coal in primary energy consumption decreased from 72.2 percent in 1980 to 69.4 percent in 2006, and that of other forms of energy rose from 27.8 percent to 30.6 percent, with that of renewable energy and nuclear power rising from 4.0 percent to 7.2 percent. The shares of oil and gas have increased. The end-use energy consumption structure is noticeably optimized, and the proportion of coal converted into power increased from 20.7 percent to 49.6 percent. More commercial energy and clean energy are being used in people's daily life. The scientific and technological level has been rapidly enhanced. Models of À500 kv DC and 750 kv AC electricity transmission projects have been completed and put into operation, and pilot À800 kv DC and 1,000 kv AC extra-high-voltage electricity transmission projects are under way.

After the 1992 UN Conference on the Environment and Development, China worked out its "21st Century Agenda," and has reinforced environmental protection in an all-round way through legislative and economic means, making positive progress in this regard. China's energy policies give priority to the reduction and rehabilitation of environmental damage and pollution resulting from energy development and utilization. In 2006, coal-fueled generating units reported a nearly 100-percent installation rate of dust-cleaning facilities and a nearly 100-percent discharge of waste water up to relevant standards. The amount of smoke and dust discharged in 2006 was almost the same as that in 1980, and the dust emission per-unit electricity had decreased by 90 percent. The installation capacity of thermal power units with FGD built and put into operation in 2006 totaled 104 million kw, exceeding the combined total of the previous 10 years. Such thermal power units accounted for only 2 percent of all thermal power units in 2000, but the proportion had risen to 30 percent by 2006.

II. Strategy and Goals of Energy Development

The 17th National Congress of the Communist Party of China, held in October 2007, set the goals of quickening the transformation of the development pattern and quadrupling the per-capita GDP of the year 2000 by 2020 through optimizing the economic structure and improving economic returns while reducing the consumption of energy resources and protecting the environment. The Outline of the 11th Five-Year Plan for National Economic and Social Development of the People's Republic of China projects that the per-unit GDP energy consumption by 2010 will have decreased by 20 percent compared to 2005, and the total amount of major pollutants discharged will have been reduced by 10 percent.

To realize the country's economic and social development goals, the energy industry has set the following targets in the 11th Five-Year Plan (2006-2010): By 2010 the energy supply will basically meet the demands of national economic and social development; and obvious progress will have been made in energy conservation; energy efficiency will have been noticeably enhanced and the energy structure optimized; technological progress, economic benefits and market competitiveness will have been greatly increased; and energy-related macro-control, market regulation, legislation and emergency pre-warning system and mechanism compatible with the socialist market economy will all have been improved. The result will be that the coordinated development will have been achieved between energy production, the economy, the society and the environment.

III. All-round Promotion of Energy Conservation

China started energy conservation work in a planned and organized way in the early 1980s, and achieved the goal of quadrupling economic growth while doubling energy consumption by the late 1990s by implementing the policy of "stressing both development and saving, with priority given to saving." To further promote energy conservation, the Chinese government made conservation of resources a basic state policy, and issued the Decision of the State Council on Strengthening Energy-conservation Work. It promulgated and implemented the Medium- and Long-term Special Plan for Energy Conservation, setting the goal for energy consumption reduction during the 11th Five-Year Plan period (2006-2010) and sharing out the tasks and responsibilities to the various provinces, autonomous regions and municipalities directly under the central government, as well as key enterprises. China is perfecting the index system of energy consumption per-unit GDP.

To promote all-round energy conservation, China will take the following measures: The Chinese government has launched an energy-conservation drive among 1,000 enterprises, with the focus on tightening control over those consuming 10,000 tons of standard coal or more each year.

IV. Improving the Energy Supply Capacity

Coal resources already verified only account for 13 percent of the total deposits, and recoverable reserves account for 40 percent of the discovered resources. Only 20 percent of the country's hydropower resources have been utilized so far. Verified oil reserves are 33 percent of the total deposits, and China has begun to enter the middle phase of oil prospecting, still seeing a big potential. Proven reserves of natural gas account for 14 percent, showing that China is in the early stage of exploration and indicating bright prospects in this sphere. To increase its energy supply capacity, China will take the following measures:

China has promulgated the Renewable Energy Law and priority policies for renewable energy electricity, entailing priority to be connected to grids, acquisition in full and preferential price, and public sharing of costs. It has earmarked special funds for renewable energy development to support resource survey, R&D of relevant technologies, building of pilot and demonstration projects, as well as exploration and utilization of renewable energy in rural China. It has released the Medium- and Long-term Program for Renewable Energy Development, putting forward the goal of increasing renewable energy consumption to 10 percent of the total energy consumption by 2010 and 15 percent by 2020.

V. Accelerating the Progress of Energy Technologies

Science and technology is the primary productive force and the main motive force of energy development. The Chinese government promulgated the Outline of the National Plan for Medium- and Long-term Scientific and Technological Development (2006-2010) in 2005, which gives top priority to the development of energy technologies, and, in line with the principle of making independent innovations and leapfrogging development in key fields, shoring up the economy and keeping in step with leading trends, stresses accelerating progress of energy technologies and strives to provide technological support for the sustainable energy development. It vigorously promotes R&D and the application of advanced energy technologies, guides enterprises to expedite technological progress and enhance energy utilization efficiency through the market mechanism.

Popularizing energy-saving technologies: China gives priority to the development of energy-saving technologies, with focus on key technologies in the high energy-consumption sectors, to enhance the utilization efficiency of primary and end-use energy resources; implements the policy outline on energy-saving technologies and guides social investment into the application of energy-saving technologies; places emphasis on R&D of energy-saving technologies and equipment for industry, transport and construction, and the application of technologies connected with integrated renewable energy systems and energy-saving construction materials; strengthens energy measurement, control, supervision and management; and actively fosters an energy-saving technological service system.

Spurring innovation in key technologies: China encourages the development of clean coal technology, reinforces R&D of advanced technologies, such as coal gasification, processing and conversion, popularizes advanced power generation technologies, including integrated gasification combined cycle (IGCC), supercritical and ultra-supercritical power generation, and large-scale circulating fluidized bed (CFB), and develops coal gasification-based poly-generation technology. China attaches particular importance to mastering the third-generation pressurized-water reactor (PWR) nuclear power generation and high temperature gas-cooled reactors (HTGR) for industrial experimental technologies. It actively develops technologies in connection with prospecting for and exploitation of petroleum and gas resources under complicated geographical conditions, and highly efficient exploitation of low-grade petroleum and gas resources; encourages the development of technology for substitutes of energy resources, gives priority to the development of technologies for large-scale utilization of renewable energy; and steadily improves the technology of power transmission at voltages of À 800 kv DC and 1,000 kv AC and power grid safety technology.

It encourages the development of oil and natural gas prospecting and drilling equipment and support equipment for large offshore oil projects, crude oil carriers with a capacity of 300,000 dwt, liquefied natural gas carriers and high-power diesel engines.

VI. Coordinating Energy and Environment Development

From 1950 to 2002, the aggregate amount of China's fossil fuel carbon dioxide emissions accounted for only 9.3 percent of the world's total in the same period. The amount of China's per-capita carbon dioxide emissions ranked 92nd in the world, and the elasticity coefficient of carbon dioxide emissions per-unit GDP was very small.

China aims to achieve the goal of basically curbing the trend of ecological deterioration, reducing total emissions of major pollutants by 10 percent, and gain visible results in the control of greenhouse gas emissions during its 11th Five-Year Plan period (2006-2010). Meanwhile, the country is actively adjusting its economic and energy structures, comprehensively advancing energy saving, emphatically preventing and controlling the pressing problems of environmental pollution, and effectively controlling emissions of pollutants to facilitate coordinated development between energy and the environment.

VII. Deepening Energy System Reform

In 1998, strategic reorganization was accomplished among petroleum enterprises, featuring the establishment of new vertically integrated management system of oil industry. In 2002, China's power industry realized the separation of government functions from those of enterprises, as well as the separation of power plants from grid operation in line with the power system reform plan. In 2005, after the market-oriented reform of the coal industry, China's coal industry saw deepened reform and further development pursuant to the Opinions on Promoting the Healthy Development of the Coal Industry issued by the State Council.

Strengthening energy legislation: It is an imperative requirement for energy development in China to improve the energy-related legal system to provide a legal guarantee for increasing the energy supply, standardizing the energy market, optimizing the energy structure and maintaining energy security. China sets great store by and actively advances the construction of the energy legal system. China has enacted and put in force the Clean Production Promotion Law and Renewable Energy Law, and has issued a series of supporting policies and measures. The amended Energy Conservation Law has been promulgated. The Energy Law, Circular Economy Law, Law on the Protection of Oil and Natural Gas Pipelines and Regulations on Energy Conservation of Buildings are being formulated. The Mineral Resources Law, Coal Industry Law, and Electric Power Law are being revised. Meanwhile, active efforts have been made in research into energy legislation concerning oil and natural gas, the crude oil market and atomic energy.

VIII. Strengthening International Cooperation in the Field of Energy

China has made active efforts to improve laws and policies related to its opening-up, promulgating in succession the Law on Sino-foreign Equity Joint Ventures, Law on Sino-foreign Cooperative Joint Ventures and Law on Foreign Capital Enterprises to create a fair and open environment for foreign investment. In 2002, China formulated the Regulations for the Guidance of Foreign Investment Orientation, and revised the Catalogue of Industrial Guidance for Foreign Investment and the Catalogue of Advantageous Industries for Foreign Investment in the Central and Western Regions in 2004, in order to encourage foreign investment in the energy sector, including energy and energy-related exploitation, production, supply, transportation and energy equipment production, as well as in the energy sector of the central and western regions. In 2001, China promulgated the revised Rules on External Cooperation for Ocean Oil Exploitation as well as Rules on External Cooperation for Onshore Oil Exploitation.

China encourages foreign investment in the production and supply of electric power and gas, as well as in the construction and operation of thermal power plants with a single-generator capacity of 600,000-kw and above, power stations burning clean coal, power stations featuring heat and power cogeneration, hydropower stations mainly for electricity production, nuclear power stations in which the Chinese side holds the dominant share, as well as power stations with renewable energy or new energy resources.[1385]

8.7.6.2 *White Paper on* China's Energy Policy, 2012

China Information Office of the State Council White Paper issued in **October 2012** entitled **"China's Energy Policy 2012"**. The document composed of nine chapters. The excerpts of the white paper is given below:

I. Current Energy Development
II. Policies and Goals of Energy Development
III. All-round Promotion of Energy Conservation
IV. Vigorously Developing New and Renewable Energy
V. Promoting Clean Development of Fossil Energy
VI. Improving Universal Energy Service
VII. Accelerating Progress of Energy Technology
VIII. Strengthening International Cooperation in Energy

I. Current Energy Development

In 2011, the output of primary energy equaled 3.18 billion tons of standard coal, ranking first in the world. Of this, raw coal reached 3.52 billion tons; crude oil, 200 million tons; and refined oil products, 270 million tons. The output of natural gas ballooned to 103.1 billion cu m. The installed electricity generating capacity reached 1.06 billion kw, and the annual output of electricity was 4.7 trillion kwh. A comprehensive energy transportation system has developed rapidly. The length of oil pipelines totaled more than 70,000 km, and the natural gas trunk lines exceeded 40,000 km. Electric power grids were linked up throughout the country, and electricity transmission lines of 330 kv or more totalled 179,000 km. The first phase of the national petroleum reserve project was completed, and the country's emergency energy-supply capability keeps improving.

During the 1981-2011 period, China's energy consumption increased by 5.82 percent annually, underpinning the 10 percent annual growth of the national economy. From 2006 to 2011, the energy consumption for every 10,000 yuan of GDP dropped by 20.7 percent, saving energy equivalent to 710 million tons of standard coal. The country has eliminated small thermal power units with a total generating capacity of 80 million kw, saving more than 60 million tons of raw coal annually. In 2011, coal consumption of thermal power supply per kwh was 37 grams of standard coal lower than in 2006, a decrease of 10 percent. China has made energetic efforts in developing new and renewable energy resources. In 2011, the installed generating capacity of hydropower reached 230 million kw, ranking first in the world. Fifteen nuclear power generating units were put into operation, with a total installed capacity of 12.54 million kw. Another 26 units, still under construction, were designed with a total installed capacity of 29.24

[1385] *Information Office of the State Council White Paper* entitled *"China's Energy Conditions and Policies" issued in December 26, 2007, available online a URL:* https://www.chinadaily.com.cn/china/2007-12/26/content_6349803.htm million kw, leading the world. The installed generating capacity of wind power connected with the country's power grids reached 47 million kw, ranking top in the world. Photovoltaic power generation also reported speedy growth, with a total installed capacity of 3 million kw. Solar water heating covered a total area of 200 million sq. m.

The designing and manufacturing of 700,000-kw hydraulic turbine generators have reached the world's advanced level. China is now able to independently design and build one-million-kw pressurized water reactor nuclear power plants, and has made outstanding breakthroughs in the R&D of high-temperature gas-cooled reactors and fast reactors. Also, 3,000-kw wind power generators have been mass-produced and 6,000 kw wind power generators have come off the production line. The solar photovoltaic industry has formed a sound manufacturing chain, with an annual output of solar panels accounting for more than 40 percent of the world's total. China leads the world in extra-high-voltage DC/AC power transmission technology and manufacturing.

The state actively promotes civil energy projects and works to enhance the overall level of energy service. Compared with 2006, the per-capita primary energy consumption in 2011 equaled 2.6 tons of standard coal, a 31 percent increase; the per-capita natural gas consumption reached 89.6 cu m, an increase of 110 percent; and the per-capita electricity consumption was 3,493 kw, a 60 percent increase. The first and second west-east gas pipelines have been completed, and more than 180 million people across the country have access to natural gas. The government has invested more than 550 billion Yuan in power grid upgrading projects for rural areas, fundamentally improving access to electricity for rural residents. The Qinghai-Tibet electricity network project has been completed, connecting the power grid of the Tibetan plateau with those of the other parts of China. The state is accelerating the construction of electric power facilities in areas that as yet do not have electricity, and has so far ensured that more than 30 million people have access to electricity. Combined heat and power projects with a total installed capacity of 70 million kw have been built in high-altitude and frigid areas in northern China that provide more than 40 million urban residents access to heating.

In 2011, the coal washing rate reached 52 percent and the land reclamation rate, 40 percent. Existing power plants have speeded up their desulfurization and denitration upgrading, and coal-fueled generating units with flue gas desulphurization facilities accounted for 90 percent of the national total. Coal-fueled generating units reported a 100-percent installation of dust-cleaning facilities and a 100-percent discharge of waste water up to the relevant standards. The state is intensifying efforts for the development and utilization of coal bed methane (CBM), extracting 11.4 billion sq m of CBM in 2011. China became the first country to adopt a national standard for CBM emissions. Its energy consumption per unit of GDP has dropped over the past five years, eliminating 1.46 billion tons of CO_2 discharge.

China's per-capita average of energy resources is low by world standards. China's per-capita shares of coal, petroleum and natural gas account for 67 percent, 5.4 percent, and 7.5 percent of the world's averages, respectively.

The energy consumption of four major energy-intensive industries - steel, non-ferrous metals, chemicals, and building materials - accounts for 40 percent of the national total. Low energy efficiency results in high energy consumption for every unit of GDP.

Increasing environmental pressure: Extensive development of fossil energy, particularly coal, has had a serious impact on the eco-environment. Large areas of arable land are taken up for other uses or even spoiled, water resources are seriously polluted, the discharge of carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NO_x) and toxic heavy metals remains high, and emissions of ozone and particles smaller than 2.5 micrometres (PM2.5) are increasing.

The country's dependence on foreign energy sources has been increasing in recent years. In particular, the percentage of imported petroleum in the total petroleum consumption has risen from 32 percent at the beginning of the 21st century to the present 57 percent. **Marine transportation of petroleum and cross-border pipeline transmission of oil and gas face ever-greater security risks. Price fluctuations in the international energy market make it more difficult to guarantee domestic energy supply. It will not be easy for China to maintain its energy security since its energy reserves is small and its emergency response capability is weak.**

II. Policies and Goals of Energy Development

It is stipulated in the Outline of the 12th Five-Year Plan (2011-2015) for National Economic and Social Development that by 2015 non-fossil energy will rise to 11.4 percent in the national total primary energy consumption, energy consumption per unit of GDP will drop by 16 percent from 2010, and CO_2 emission per unit of GDP will decrease by 17 percent from 2010.

The Chinese government has made the commitment that by 2020 non-fossil energy will account for 15 percent of its total primary energy consumption, and CO_2 emission per unit of GDP will be 40-45 percent lower than in 2005. As a responsible nation, China will make every effort to fulfill its commitment.

III. All-round Promotion of Energy Conservation

The Chinese government launched an energy conservation drive among 1,000 enterprises, resulting in a sharp decline in the comprehensive energy consumption index of key industries, and saving energy equivalent to 150 million tons of standard coal. China's energy consumption per unit of GDP dropped 19.1 percent during its 11th Five-Year Plan period (2006-2010).

IV. Vigorously Developing New and Renewable Energy

China endeavours to increase the shares of non-fossil fuels in primary energy consumption and installed generating capacity to 11.4 percent and 30 percent, respectively, by the end of the 12th Five-Year Plan.

The country's installed hydropower generating capacity is expected to reach 290 million kw by 2015.

At present, nuclear power only accounts for 1.8 percent of China's total power output, far below the world average, which is 14 percent. Nuclear safety is essential for nuclear power development. Since the Fukushima Daiichi nuclear disaster in 2011, China has launched comprehensive safety inspections at all nuclear power plants. The inspection results show that nuclear security is guaranteed in China. Over the past 20 years, Chinese nuclear power units in operation have never had accidents at and above Level 2, with major operating parameters being better than the world's average and some indices even reaching the leading or advanced world level.

China will invest more in nuclear power technological innovations, promote application of advanced technology, improve the equipment level, and attach great importance to personnel training. China's installed capacity of nuclear power is expected to reach 40 million kw by 2015.

During the 12th Five-Year Plan period, China will stress both intensive and distributed exploitation, and optimize the development layout of wind power. China aims to improve its power grids' wind-power integration ability. The installed generating capacity of wind power is expected to reach 100 million kw by the end of 2015, with 500 kw of generating capacity coming from offshore wind farms.

Actively making use of solar energy: China is rich in solar energy, which boasts immense room for development and has a promising future. During the 12th Five-Year Plan period, China will promote diverse patterns of solar-power development by integrating intensive exploitation with distributed utilization. It will construct large on-grid photovoltaic power stations and solar power generation projects in Qinghai and Gansu provinces, and the Xinjiang Uygur and Inner Mongolia autonomous regions, which boast abundant solar energy and scattered plots of unutilized land, for the purpose of increasing local supplies of electricity. It will encourage the central and eastern regions to construct distributed photovoltaic power generation systems linked to local buildings. Intensified efforts will be made to popularize solar water heaters, and promote the development of solar central hot-water supply, solar heating and cooling, and medium- and high-temperature industrial applications of solar energy. It will spread solar water heaters, solar cookers and solar houses in the countryside, border areas, and small cities and towns. China's installed generating capacity of solar energy is expected to exceed 21 million kw by 2015, with a total solar heat collection area of 400 million sq m.

During the 12th Five-Year Plan period, China will construct about 1,000 projects of natural gas DES, and ten distributed energy demonstration areas with various typical characteristics.

V. Promoting Clean Development of Fossil Energy

China sticks to the guideline of "scientific overall arrangement, intensive development, safe production, efficient utilization and environmental protection" in the development of the coal industry. Following the principle of "enforcing control in the eastern regions, maintaining stability in the central regions, and promoting development in the western regions," it will push ahead with the building of 14 large coal-mining bases, including the Shaanbei, Huanglong and Shendong coalfields.

China actively promotes green thermal power generation. It has imposed strict restrictions on the construction of new coal-fired power generating sets in the Bohai Rim, Yangtze River Delta and Pearl River Delta areas, except those built for the purpose of "constructing large units and restricting small ones" and co-generation.

China will continue to implement the policy of "simultaneous development of oil and gas," with the target of stabilization in the east, acceleration in the west, development in the south and exploitation in the offshore areas. The country will steadily increase crude oil output and reserves by means of stepping up efforts in prospecting for and exploiting oil in major oil-production areas, including those in the Tarim and Ordos basins, and improving renovation for stable yields and increasing the recovery ratio in old oilfields.

It will optimize the distribution of the refining industry, construct some large refining and chemical bases, and establish three major refining cluster areas in the Bohai Rim, Yangtze River Delta and Pearl River Delta, so as to realize upstream and downstream integration, refining and chemicals integration, and refining-reserve integrated management.

China's efforts to expedite the development of non-conventional oil and gas resources are an important way to enhance its security of energy supply. China aims to increase its annual output of shale gas to 6.5 billion cu m by 2015, and lay a solid foundation for the future rapid development of shale gas.

VI. Improving Universal Energy Service

Providing universal access to electric power: In order to provide the people who have no access to electricity yet in the Tibet, Xinjiang Uygur and Inner Mongolia autonomous regions, as well as Qinghai, Yunnan and Sichuan provinces with electric power, the Chinese government increases investment to expand the coverage of the power grids and develop distributed renewable energy sources. By 2015, most of the people who at present don't have electricity in China will gain access to it.

By 2015, a total of 200 green-energy counties and 1,000 villages using solar energy will be set up as examples.

The Chinese government will appropriate financial funds to improve energy infrastructure and build energy projects that have a direct bearing on the people's livelihood in the border regions, especially in Tibet and Xinjiang, to support leapfrogging development there. It will accelerate the electrical grid construction in Tibet and Xinjiang as well as the Tibetan-inhabited areas in Qinghai, Sichuan, Yunnan and Gansu provinces, enlarge the coverage of the distribution grid, and strengthen the reliability of power supply. The government will draw up and implement the "Tibet Energy Development Program," and provide extra funding to Tibet for its electric power development - the direct investment during **the 12th Five-Year Plan** period to exceed 900 million Yuan. The energy projects to improve the people's livelihood, such as the "Electrification of Southern Xinjiang" and "Electrification of Northern Xinjiang," will be sped up. The state will press on with the project to connect Xinjiang power grid to the northwest China grid so as to form an energy channel as soon as possible to get Xinjiang's redundant electric power transmitted to other parts of China to generate more funds for the development of Xinjiang. The government will build a group of solar power and solar-wind hybrid power plants in the farming and herding areas far from towns to improve the quality of life of the farmers and herdsmen there.

VII. Accelerating Progress of Energy Technology

The National Energy Technology Program During the 12th Five-Year Plan Period, issued in 2011 as China's first scheme to improve its energy technology, has outlined the four key aspects of China's energy technology, namely, exploration and exploitation; processing and conversion; power generation, transmission and distribution; and new energy.

Reinforcing energy technology R&D: China will launch a series of strategic and advanced research projects on frontier technologies in basic sciences like geology, materials, environmental studies, power and energy, and information and control, with the aim of making breakthroughs in basic energy sciences. China will press on with the two national high-tech programs -- "large oil-gas fields and coal-bed gas development," and "large and advanced pressurized-water reactor and high temperature gas-cooled reactor nuclear power stations" -- to facilitate key technological innovations, and enhance the innovation abilities, including "original innovation," "integrated innovation" and "secondary innovation" in the energy sector.

Promoting progress of energy equipment technology: Based on major technological equipment projects, China strives to make technological breakthroughs, improve supporting facilities, set up and enforce technical standards for energy equipment, establish a complete testing and certification system, and raise its ability for energy equipment design, manufacturing and system integration. China will further enhance the supporting policy system, boost the technological advance of key equipment, such as high-capacity, high-parameter and ultra-supercritical generating units, gas turbines, third-generation nuclear power, renewable energy generating units, exploration and development of unconventional oil and gas resources, and spreading the application of state-of-the-art equipment. The government will also strengthen planning and guidance for the energy equipment manufacturing industry to prevent redundant construction.

Launching major technological demonstration projects: Centering on the transformation of energy development mode and upgrading of the energy industry, the Chinese government will give more support in funding, technology and policy to launch major demonstration projects in such fields as large pressurized-water reactors, high-temperature gas-cooled reactors, development and utilization of coal-bed gas, exploration and development of shale gas, and deep processing of coal, energy storage and smart power grids, thus promoting the application of technological and scientific research achievements in production.

Improving the innovation system of energy technology: The Chinese government will continue to support large enterprises, R&D institutes, colleges and universities to set up national innovation platforms that can conduct independent R&D and make breakthroughs in core technologies, especially technologies for coal exploration, development and utilization of coal-bed gas, exploration and development of shale gas, marine engineering equipment, high-capacity high-efficiency and low-pollution power generating equipment, smart grids and advanced nuclear reactors. It will improve the policy system supporting technological innovation platforms. The government will give full play to the role of enterprises in innovation, and encourage them to spread and apply innovative technologies. It will guide R&D institutes and institutions of higher learning to serve enterprises in the field of innovation, and better integrate the efforts of enterprises with that of the research institutes and institutions of higher learning. The state will set up an evaluation and reward mechanism for technological development, and establish and improve a training system and an incentive mechanism for innovations.

VIII. Strengthening International Cooperation in Energy

China is also a member of or important participant in many multilateral organizations and mechanisms, including the energy working group of the Asia-Pacific Economic Cooperation Organization, Group of 20, Shanghai Cooperation Organization, World Energy Council and International Energy Forum. It is an observer of the Energy Charter, and maintains close relations with such international organizations as the World Energy Agency and the Organization of Petroleum-Exporting Countries.

China upholds a policy of opening to the rest of the world in the field of energy. To provide a favourable environment for foreign investment and protect the legitimate rights and interests of investors, it has promulgated a series of laws and regulations in succession, like the Law on Sino-foreign Equity Joint Ventures, Law on Sino-foreign Cooperative Joint Ventures and Law on Foreign Investment Enterprises, and framed such policy documents as the Catalogue of Industries for Guiding Foreign Investment and the Catalogue of Advantageous Industries for Foreign Investment in the Central and Western Regions. The Chinese government encourages foreign investment to engage in the exploration and development of oil, natural gas and unconventional oil and gas resources, such as shale gas and coal-bed gas, by way of cooperation; invites foreign investment in the building of new-energy power stations, hydroelectric power stations, clean-combustion power stations, and nuclear power stations as long as the Chinese partners have control; and supports multinational energy corporations to set up R&D centres in China.[1386]

8.7.6.3 China's White Papers relating to Nuclear Energy

China's first white Paper **"Nuclear Emergency Preparedness**" published by the State Council Information Office of the People's Republic of China in **January 2016** has contents Current Situation of Nuclear Energy Development and Nuclear Emergency Preparedness, Guidelines and Policies for Nuclear Emergency Preparedness, All-round Promotion of Nuclear Emergency Preparedness, Building and Maintenance of Nuclear Emergency Capabilities, Main Measures to Cope with Nuclear Accidents, Nuclear Emergency Preparedness Exercises, Drills, Training and Public Communication, Scientific and Technological Innovations in Nuclear Emergency Preparedness and International Cooperation and Exchanges in the Field of Nuclear Emergency Preparedness'.[1387]

[1386] China Information Office of the State Council White Paper issued in October 2012 titled "China's Energy Policy 2012", available online at URL: http://www.china.org.cn/government/whitepaper/node_7170375.htm
[1387] Excerpts from The State Council Information Office White Paper, the People's Republic of China issued on January 2016, First Edition 2016 titled "China's Nuclear Emergency Preparedness", available online at URL: http://english.www.gov.cn/archive/white_paper/2016/01/27/content_281475279484672.htm

In a **news item "China issues first white paper on nuclear emergency preparedness" published by Xinhua on January 27, 2016**, it is mentioned that the Chinese government published its first nuclear white paper on January 27, 2016, detailing policies and measures to boost nuclear emergency preparedness and highlighting "a rational, coordinated and balanced" nuclear security approach. "China has consistently given top priority to nuclear safety in its peaceful use of nuclear energy," said the white paper, China's Nuclear Emergency Preparedness, published by the State Council Information Office. The white paper attributed the sound record to efforts to improve nuclear safety techniques, enforce rigorous nuclear safety supervision, and strengthen nuclear emergency management in the past six decades or so. China has adopted "the most advanced technology and most stringent standards" to ensure safe and efficient development of nuclear power, which is an important component of China's nuclear energy sector, it said. As of the end of October 2015, the Chinese mainland had 27 nuclear power generating units in operation, with a total installed capacity of 25.5 giga watts (GW), while another 25 units with a total installed capacity of 27.51 GW had been under construction. China plans to raise its installed nuclear power capacity to 58 GW with an additional 30 GW under construction by 2020 and build itself into a strong nuclear power country by 2030. "Nuclear accidents know no national boundaries, and everything related to nuclear emergency management is too important to be taken lightly," the white paper said. Drawing on the lessons learned from the Three Mile Island, Chernobyl and Fukushima nuclear accidents, China has progressed in a full range of nuclear emergency-related activities, such as the enactment of laws and standards, the establishment of institutional and regulatory regimes, the building-up of basic capabilities, and international cooperation and exchanges. The country's nuclear emergency rescue network is "of a proper scale, well-coordinated and of a rational layout", the report said, adding that there is also a plan to establish a new top-level national nuclear emergency rescue team of about 300 members to respond to serious nuclear accidents and international rescue operations. China will also speed up drafting the nuclear safety law and atomic energy law, according to the report. The government vowed to upgrade its nuclear emergency work to "a new level" in order to provide a robust bulwark in support of the safe, efficient, sustainable and healthy development of the nuclear energy sector.[1388]

The State Council Information Office of the PRC **White Paper "Nuclear Safety in China"** was published in **September 3, 2019.** The main body of the white paper was divided into six sections: following a rational, coordinated and balanced nuclear safety strategy, building a policy and legal framework on nuclear safety, ensuring effective regulation of nuclear safety, maintaining high-level safety, co-building and sharing nuclear safety and building a community of shared future for nuclear safety. It mentioned that the discovery of the atom and the subsequent development and utilization of nuclear energy have given a new impetus to the progress of humanity and greatly enhanced our ability to understand and shape the world. Yet nuclear energy has associated risks and challenges. To better utilize nuclear energy and achieve greater progress, we must properly respond to the challenges it poses and ensure nuclear safety. It pointed out that since the 18th National Congress of the Communist Party of China, China's nuclear industry has entered a new period of safe and efficient development. President Xi Jinping proposed a rational,

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[1388] Excerpts from News item "China issues first white paper on nuclear emergency preparedness" published by Xinhua on January 27, 2016, available online at URL: http://www.china.org.cn/china/2016-01/27/content_37674132.htm coordinated and balanced nuclear safety strategy, placing equal emphasis on development and safety, and advocating building a community of shared future for global nuclear safety, he has pointed out the direction for China's nuclear safety for a new era, and provided the Chinese approach to international cooperation in the development and utilization of nuclear energy, and to lasting global nuclear safety. It pointed out that on March 24, 2014, at the third Nuclear Security Summit in The Hague, the Netherlands, President Xi Jinping proposed a rational, coordinated and balanced nuclear safety strategy. China's nuclear safety strategy is the embodiment of Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era in the nuclear field, an important element of China's overall national security framework, and a major innovation in the theory of nuclear safety governance.[1389]

Highlights of White Paper "Nuclear Safety in China" sourced from China Military Online mentioned that Liu Hua, vice minister of Ecology and Environment and director of the National Nuclear Safety Administration, attended the press conference, interpreting the main contents of the "Nuclear Safety in China", published in September 3, 2019 and responding to public concerns about related issues:

China's operation of nuclear facilities maintains good safety record: China has always regarded nuclear safety as an important national responsibility, and has developed nuclear energy and nuclear technology while ensuring safety, said Liu Hua. According to him, by the end of last June, there are 47 operating nuclear power facilities, 19 in-service civil research reactors and critical devices, 18 nuclear fuel cycle facilities, and two low- and intermediate-level waste disposal sites on the Chinese mainland. The operation of these facilities has maintained a good safety record, especially for nuclear power plants, where there have been no an incidents or accidents at or above level II of the International Nuclear and Radiological Event Scale (INES). China's nuclear safety level has remained at the forefront of the world, added Liu.

Nuclear energy cooperation is mutually beneficial: Liu stated that China firmly opposes the harming of the interests of all countries including China through the US' unilateralism and protectionist policies. He hopes that the US will stop the wrong practices and solve problems through equal consultation. China-US nuclear energy cooperation is mutually beneficial. Both China and the US are nuclear powers and have established a complete nuclear industry system. Four AP1000 nuclear power units have been successfully built, commissioned and operated through substantial nuclear energy cooperation in China, which benefited companies of both countries. Liu mentioned that the cooperation between China and the US in nuclear safety has achieved positive results in the past 35 years. Two countries have promoted the improvement of the nuclear safety level through mutually beneficial cooperation. In addition to that, China also carried out fruitful nuclear energy cooperation with France and Russia, among which some major projects including nuclear power plants and spent fuel reprocessing plants have achieved substantial progress. Liu introduced that China has constantly improved the national nuclear safety system, actively promoted international nuclear safety cooperation and established an international nuclear safety cooperation system. China has successively acceded to all the international conventions on nuclear safety of the International Atomic

[1389] Excerpts from The State Council Information Office of the PRC White Paper "Nuclear Safety in China" was published in September 3, 2019, available online at URL: http://english.www.gov.cn/archive/whitepaper/201909/03/content_WS5d6de122c6d0c6695ff7fb3d.html

Energy Agency (IAEA) and the United Nations (UN), and fulfilled its obligations under such international conventions. At the same time, China supports the work of IAEA and gives full play to the role of IAEA under the multilateral system. China is also actively involved in exchanges and cooperation. China has established close ties with the US, France, Russia, Japan, South Korea, Canada and emerging nuclear power countries of the Belt and Road Initiative, signed more than 50 nuclear safety cooperation agreements with these countries and strengthened expert exchanges, technical cooperation, and high-level visits. Relying on the National Technical R&D Base for Nuclear and Radiation Safety Supervision and the State Nuclear Security Technology Center, China provides a platform for developing countries to carry out nuclear safety-related training and exchange activities, helps them to improve national security and safety capabilities, and shares with them China's safety experience.[1390]

China Energy Storage Alliance (CNESA) report on **"Energy Storage Industry White Paper 2019: Summary Version",** which highlighted the following China's Energy and its prospects:

China in 2018, accumulated operational capacity exceeded 1 GW, while grid-side energy storage became the hot topic in China's energy storage market. Jiangsu and Henan provinces each successively put into operation 100 MW scale grid-side energy storage projects, giving a significant boost to the total scale of China's energy storage capacity. Meanwhile, Hunan, Qinghai, Guangdong, Gansu, and Zhejiang also successively released plans for grid-side energy storage projects at a total capacity of more than 1.4 GWh.

1. Scale of the Energy Storage Market in China

According to statistics from the CNESA Global Energy Storage Project Database, by the end of 2018, operational energy storage project capacity in China totaled 31.3 GW accounting for 17.3% of global capacity. Pumped hydro energy storage accounted for the largest proportion of China's capacity at 29.99 GW, followed by electrochemical energy storage at 1072.7 MW. Among the variety of electrochemical energy storage technologies, lithium ion batteries made up the largest installed capacity at 758.8 MW.

2. China Energy Storage Market Manufacturer Rankings

Using data from the Global Energy Storage Project Database, publicly available project information, as well as data submitted voluntarily by companies, the CNESA research department ranked energy storage technology providers, energy storage inverter providers, and energy storage system integrators according to newly operational project capacity in the Chinese market in 2018.

- Energy Storage Technology Providers Ranking
  In 2018, among the new electrochemical energy storage projects put into operation in China, the top ten energy storage technology providers in terms of installed capacity were Narada, CATL, ZTT, eTrust Power, Shuangdeng Group, Hyper strong, CLOU Electronics, Xinyi Power Source, Sacred Sun, and CALB.
- Energy Storage Inverter Providers Ranking

[1390] Excerpts from the China military Online, available online at URL: http://eng.chinamil.com.cn/view/2019-09/04/content_9611439.ht

In 2018, among the new electrochemical energy storage projects put into operation in China, the top ten energy storage inverter providers in terms of installed capacity were Kelong, XJ Group, KLNE, CLOU Electronics, Sungrow, Sinexcel, ZTT, Soaring, Action power, and Nari-Relays.

- Energy Storage System Integrators Ranking
  In 2018, among the new electrochemical energy storage projects put into operation in China, the top ten energy storage system integrators in terms of scale of power were Narada, CLOU Electronics, ZTT, Hyperstrong, Sungrow, Ray Power, Sacred Sun, Sunwoda, GMDE, and Cubenergy.

3. Forecasting the Development of the Energy Storage Marketin China

The CNESA research department began forecasting China's energy storage market scale in 2014, tracking future energy storage development over the past five years with support from industry experts and energy storage companies. Below, we provide a forecast for the scale and development trends of the energy storage market in China from 2019 to 2023.

Physical energy storage: pumped hydro energy storage will continue to dominate in installed capacity

13th Five-Year Plan for Hydropower Development issued by the National Energy Administration of the People's Republic of China, the accumulated installed capacity of pumped hydro energy storage in China will reach 40.00 GW by the end of 2020, and 90.00 GW by 2025.

As of the end of 2018, the operational installed capacity of compressed air energy storage in China totaled 11.5 MW. According to CNESA research forecasts, the accumulated installed capacity of compressed air energy storage projects will exceed 2 GW by the end of 2023. Although CNESA research tracks flywheel energy storage projects in China, installed flywheel capacity is not covered in this White Paper as domestic projects are currently limited to small-scale pilots.

Molten salt thermal storage: the first batch of solar thermal power generation demonstration projects will be put into operation

In September 2016, the National Energy Administration of the People's Republic of China announced the first batch of 20 solar thermal power generation demonstration projects in China with a total installed capacity of 1.349 GW. The projects were each equipped with molten salt heat storage devices. By the end of 2018, the operation capacity of these projects had reached 0.2 GW. When additional projects currently under construction are accounted for, it is estimated that 0.35 GW of new capacity will be added in 2019. Operational molten salt heat storage projects will reach a total accumulated capacity of 0.62 GW by 2019 and 1.369 GW by the end of 2020.

Electrochemical energy storage: speedy growth is expected to continue

In 2018, the electrochemical energy storage in China achieved breakthrough development, with an accumulated operational capacity of 1.073 GW, 2.8 times that of 2017. This growth also marked the crossing into the GW era. Driven by both policies and market demands, the use of energy storage in centralized renewable integration, ancillary services, grid-side applications, and behind-the-meter applications significantly increased in 2018. Grid-side applications in particular showed expansive new capacity, reaching an annual growth rate of 2047.5%. According to data on planned projects from the CNESA Global Energy Storage Project Database, rapid growth in grid-side energy storage capacity will continue in 2019.

As forecasted by CNESA research, by the end of 2019, accumulated operational electrochemical energy storage capacity in China will reach 1.92GW, an annual growth rate of 89%. In 2020, the final year of the 13th Five-Year Plan, the annual growth rate will exceed 70%. In this context, electrochemical energy storage capacity will increase to 10 GW by 2022 and 20 GW by 2023.

Combining the forecasts of the above three types of energy storage technologies, by the end of 2020, the energy storage market in China will reach an accumulated operational capacity of 45.16 GW. A variety of energy storage technologies and applications will play a role in this capacity.[1391]

8.7.6.4 The 13th Five Year Plan

Excerpts of "**The 13th Five-Year Plan for Economic and Social Development of the People's Republic of China (2016–2020)"** on the ENERGY:

Part VII Modern Infrastructure Networks, Chapter 30, Build a Modern Energy System

We will make a strong push to advance the energy revolution, giving impetus to a transformation in the way energy is produced and used, improving the energy supply mix, and elevating the efficiency of energy utilization. We will build a modern energy system that is clean, low-carbon, safe, and efficient, and will safeguard the country's energy security.

Section 1 The Energy Mix

We will coordinate the development of hydropower with ecological conservation while giving priority to the latter; and with a focus on building main hydropower plants in key water basins; we will work systematically to develop hydropower resources in the southwest. We will continue to give impetus to the development of wind and photovoltaic power and provide strong support for solar thermal energy. Focusing particularly on the building of a coastal nuclear power plant belt, we will ensure adequate safety measures are taken in developing demonstration initiatives and projects in nuclear power generation. We will accelerate the development of biomass and geothermal energy and actively exploit tidal power in coastal areas. We will improve supportive policies for power generation from wind, solar, and biomass energy. We will optimize the development of national comprehensive energy centers and step up efforts to ensure the cleaner and more efficient use of coal. We will restrict coal resource development in the east of the country, limit it in the central and northeastern regions, and optimize it in the west; make progress in achieving more eco-friendly exploitation and transformations of large coal production centers; and encourage the application of new technologies in the development of coal based power generation. We will strengthen onshore and offshore oil and gas exploration and exploitation, take well-ordered measures to relax control over

[1391] Excerpts from China Energy Storage Alliance (CNESA) report on "Energy Storage Industry White Paper 2019: Summary Version", available online at URL: https://static1.squarespace.com/static/55826ab6e4b0a6d2b0f53e3d/t/5d15c6faa4a909000140d50f/1561708291553/White+Paper+Summary+2019+-+English+Version.pdf mining rights, and actively exploit natural gas, coal seam gas, and shale oil and gas. We will move forward with the transformation and upgrading of the oil refining industry, implement an action plan for improving the quality of refined petroleum products, and develop new clean oils such as bio fuels.

Section 2, Modern Energy Storage and Transportation Networks

We will coordinate the development of multiple forms of transportation for coal, electricity, oil, and gas; step up efforts to build energy storage and peak shaving facilities; and move faster to develop safe and reliable modern energy storage and transportation networks which enable integrated energy development and free-flowing domestic and international energy transportation. We will strengthen efforts to build trans-regional core energy transportation networks; complete construction on the Inner Mongolia-Jiangxi north-to-south coal line; and optimize the construction of main power grids and trans-regional power transmission routes. We will accelerate the construction of strategic land corridors for importing oil and gas. We will make progress in building oil and gas storage facilities and strengthen capacity for oil and gas storage and peak shaving.

Section 3, Smart Energy Systems

We will accelerate smart development across the entire energy sector and all areas of its operation in order to make energy development more sustainable and adaptable. We will adapt to the development of distributed energy and the diversified demands of users, improve demand-side management of electric power, speed up the development of smart power grids, and make power grids and the power generation and demand sides more mutually responsive. We will promote significant integration of new technologies between the energy sector and other sectors such as information technology; coordinate the development of energy infrastructure and communications, transportation, and other infrastructure; and build an energy internet that enables the coordinated development, integration, and complementarity of power generation, transmission, loading, and storage.

Box : Energy Development Projects

1. High-efficiency smart power systems

- Speed up the development of quality peak shaving power sources such as pumped-storage hydroelectric plants, main hydropower plants, and natural gas peaking power plants;
- Give impetus to the development of storage power plant and efficient power plant demonstration projects;
- Strengthen integration and complementarity between different power sources and storage facilities;
- Make power systems more adaptive and efficient.

2. Clean and efficient coal utilization

- Implement the upgrading action plan for energy conservation and emissions reductions in coal based power generation;
- Carry out nationwide upgrades of coal-fired power units to achieve ultra-low emissions and energy efficiency;
- Ensure average coal consumption per kilowatt-hour is kept below 310 grams in existing power plants and below 300 grams in new power plants;

- Encourage the use of backpressure thermal power units for heating and develop combined multi-source heating, cooling, and power systems;
- Increase the proportion of coal used for power generation.

3. Renewable energy
- Begin construction on 60 giga watts of regular hydropower capacity, giving priority to hydropower development in the southwest;
- Coordinate the development of end-use markets and power transmission routes; take ordered steps to optimize the development of wind energy and photovoltaic energy in the northern, northeastern, and northwestern regions and in coastal areas;
- Accelerate the development of dispersed wind power and distributed photovoltaic power in the central, eastern, and southern regions;
- Carry out solar thermal energy demonstration projects;
- Build the national new energy integrated demonstration zone in Ningxia, and actively move forward with the development of demonstration zones for renewable energy such as those in Qinghai and Zhangjiakou.

4. Nuclear power
- Complete the Sanmen and Haiyang AP1000 projects;
- Develop demonstration projects for Hualong-1 nuclear technology in Fuqing, Fujian and in Fangchenggang, Guangxi;
- Begin construction on the CAP1400 demonstration project in Rongcheng, Shandong;
- Begin construction on a number of coastal nuclear power plants and accelerate construction on the third phase of the Tianwan nuclear power plant;
- Actively carry out preliminary work for inland nuclear power plant projects;
- Move more quickly to conduct feasibility studies and drive forward the development of large commercial reprocessing plants;
- Installed capacity of nuclear power plants in operation will reach 58 giga watts, with over 30 giga watts of nuclear-generation capacity under construction;
- Strengthen the development of systems for ensuring nuclear fuel.

5. Unconventional oil and gas
- Build coal seam gas industrial bases in: the Qinshui Basin; the eastern Ordos Basin; Bishuixing, Guizhou.
- Accelerate the exploration and exploitation of shale gas in: the Changning-Weiyuan region, Sichuan; Fuling, Chongqing; Zhaotong, Yunnan; Yan’an, Shaanxi; the Zunyi-Tongren region, Guizhou.
- Give impetus to tight oil, oil sands, and deep-water oil prospecting and exploitation and to the comprehensive development and utilization of oil shale;
- Move forward with the prospecting and commercial pilot production of natural gas hydrate resources.

6. Energy transmission routes
- Build electricity transmission routes for hydropower bases and large coalfired power bases and, while building the 12 power transmission routes included in the action plan for air pollution prevention and control, focus on constructing

power transmission routes from the southwestern, northwestern, northern, and northeastern regions;

- Step up work on the development of strategic land corridors for importing oil and gas and related trunk pipeline networks in the northwestern, northeastern, and southwestern regions;
- Improve the backbone pipeline networks for natural gas transmission, including the west-to-east gas transmission project, the Shaanxi-Beijing gas pipeline, and the project to transport natural gas from Sichuan to the central and eastern regions.

7. Energy storage facilities

- Complete the second phase of the state petroleum reserves project and start preliminary work for the follow-up project;
- Strengthen work on building reserves for refined oil products;
- Build natural gas reserves, increasing the scale of gas storage and emergency response capacity for gas peak shaving;
- Build coal storage and transportation facilities in areas where coal is in short supply and in coal distribution centers, and improve the emergency coal reserve system;
- Increase the scale of natural uranium reserves.

8. Key energy technology and equipment

- Accelerate research and development and the application of technologies for: unmanned coal mining; the prevention and control of deep mine accidents; unconventional oil and gas prospecting and exploitation; deep water and deep conventional oil and gas exploitation; low- and medium-temperature pyrolysis and quality-specific conversion of low-rank coal; 700°C ultra-supercritical coal-fired power generation; 4th generation nuclear energy; offshore wind energy; solar thermal power generation; large-scale energy storage; geothermal energy utilization; smart grids.
- Improve capacity to manufacture equipment including: 3rd generation nuclear power reactors; giga watt hydropower units; energy-efficient boilers and electric motors.
- Make breakthroughs in the manufacturing of and applied technologies for key components and materials such as high-power electric and electronic equipment and high-temperature superconductors.

Part VII Modern Infrastructure Networks
Chapter 43 Promote Economical and Intensive Resource Use

Section 1, Energy Conservation

We will move ahead with the revolution in energy consumption. We will promote society-wide energy conservation, make comprehensive efforts to promote energy conservation in industry, construction, transportation, public institutions, and other areas, and launch projects to upgrade boilers, furnaces, lighting products, and electric motors and recover waste heat for household heating. We will develop and spur the adoption of energy-conserving technologies and products and demonstrate the application of major energy-conserving technologies. We will launch the "100, 1,000, 10,000" energy conservation initiative to put the top 100 energy consuming enterprises in China under national regulation, the top 1,000 energy consuming enterprises under the regulation of their respective provincial- level governments, and other high energy consuming enterprises under the regulation of lower-level governments; encourage enterprises to take voluntary measures to reduce energy consumption; facilitate the development of energy management systems, energy measurement systems, and online energy consumption monitoring systems; and carry out energy reviews and efficiency evaluations. We will work to raise building energy efficiency and initiate eco-friendliness across the entire construction chain. We will promote energy-conserving, low-carbon electric power dispatching. We will move forward with comprehensive cascade utilization of energy. We will ensure China's total energy consumption stays below five billion metric tons of standard coal.

Section 7, Mechanisms for Efficient Use of Resources

We will impose binding limits on the total consumption and the intensity of consumption of energy and water resources as well as on the amount of land designated for construction purposes. To this end, we will strengthen responsibility for meeting targets, ensure that the market plays a better role, and improve standards, performance assessments, and oversight. We will establish a sound initial allocation system for the right to use energy, the right to use water, and the right to emit carbon, develop markets for the trading of these rights, and create new mechanisms in this area for compensated use, budgetary management, investment, and financing. We will improve standards for conserving energy, water, land, materials, and minerals, raise building energy efficiency standards, and ensure that energy conservation standards cover all key industries and equipment. We will strengthen energy conservation evaluation and inspection. We will establish sound mechanisms through which the central government can assess and reward the energy conservation and environmental protection efforts of local governments, and broaden the scope of comprehensive demonstrations of financial policies designed to promote energy conservation and emissions reduction. We will establish a unified and standardized platform for the sale of state-owned natural resource assets. We will organize initiatives to see that pioneering efforts in energy and water efficiency lead conservation efforts.

Box: Economical, Intensive, and Circular Resource Use Initiatives
1. Society-wide energy conservation efforts • Encourage the use of energy-efficient products and services in enterprises and households; • Implement a plan for catching up with and exceeding international energy efficiency standards with a focus on six major energy-intensive industries – the electric power, iron and steel, building materials, chemical, petroleum and petrochemical, and nonferrous metals industries; • Support the demonstration of comprehensive energy efficiency improvement efforts by 500 major energy consumers; • Organize the implementation of projects, such as those to improve energy systems, upgrade the energy-efficient electric motor system, demonstrate the industrial application of energy-saving technologies, reduce coal consumption and replace it with alternative energy sources, and promote eco-lighting.

Part VII Modern Infrastructure Networks
Chapter 48, Develop Green and Environmentally Friendly Industries
We will support the development of green services providers, expand the use of energy efficient and environmentally friendly products, support innovations in technology, equipment, and service models, and improve related policies and mechanisms, so as to facilitate the development of energy efficient and environmentally friendly industries.

Section 1, Environmentally Friendly Goods and Services
We will improve the environmental credentials management system for enterprises and encourage the development of professional services for energy conservation and environmental protection in areas such as technical consultation, systems design, equipment manufacturing, project construction, and operations management. We will promote energy performance contracting, water-saving management contracting, and third party governance of environmental pollution. We will encourage nongovernmental investment in environmental protection infrastructure construction and carry out trials for putting the comprehensive environmental governance of small towns and industrial parks under trusteeship. We will promote the development of large energy conservation and environmental protection enterprises that are able to compete internationally, and encourage advanced, practical energy conserving and environmental protection technologies and products to reach out to the world. We will advance systems for green labeling, green certification, and green government procurement in a coordinated way. We will establish a green finance system, develop green credit and bonds, and launch green development funds. We will improve grid policies for electricity generated from coal gangue, leftover heat and pressure, waste incineration, and methane. We will accelerate the formation of industrial systems for the green supply chain.

Section 2, Environmental Protection Technology and Equipment
We will strengthen China's capabilities with respect to energy-saving and environmentally friendly engineering, technology, and equipment manufacturing, and research, develop, demonstrate, and disseminate a number of advanced, environmentally friendly technologies and equipment. We will accelerate research and development on and the industrial application of new technologies and equipment, such as those for low-grade waste heat power generation, small gas turbines, fine particulate matter control, vehicle exhaust emissions purification, landfill leach ate treatment, sludge recycling, coordinated multi-pollutant treatment, and soil remediation. We will promote the use of mature and applicable technologies, such as those for integrated high efficiency flue gas dust removal and waste heat recovery, high-efficiency heat pumps, semi-conductor illumination, and waste recycling.[1392]

8.7.6.5 The Malacca Dilemma

In 2003, **Hu Jintao in a speech to senior party members at an economic work conference highlighted what he called the "Malacca Dilemma."** According to President Hu, 80% China's trade passes through the 600-mile waterway including its oil

[1392] Excerpts from PART VII MODERNINFRASTRUCTURE NETWORKS of The 13th Five-Year Plan for Economic and Social Development of The People's Republic Of China (2016–2020) on the ENERGY, available online at URL: https://en.ndrc.gov.cn/policyrelease_8233/201612/P020191101482242850325.pdf imports. China is concerned about encroachments and free navigation through the strait. “Malacca Dilemma” has become the focus of Chinese planners as well as those outside watching China's rise. China's oil demand is expected to rise by several million barrels a day by 2015 with no equivalent rise in domestic production. This has left China scrambling for alternative sources and one option that has gained momentum is the Sino Myanmar pipeline, scheduled to be finished September 2013. Unfortunately for China, this pipeline will not solve problems of sea lanes of communication and may, in fact, make them worse.

The Malacca Dilemma is approximately 1000 km long but at several points is narrow as 15 kilometres. At their absolute narrowest, near Singapore, the width of the strait is only 2.8 kilometre. China's fears a hostile power could seize control of the straits and block nearly all of China's energy imports. Both land based artillery and airpower can effectively deny China the use of the strait. Data from World War II proves that the US conducted a similar campaign against Japan, which was also dependent on imports of oil and raw materials. The deduction was that land-based planes were more effective at maritime interdiction than carrier-based planes. This suggests that an adversary without carriers could still seal the strait effectively. This expands the threat of blockade from just the US or perhaps India, Singapore, Indonesia and Malaysia.

Malacca Strait carries 1/3 of the international trade. China’s energy demands make it import 5.62 million barrels of crude oil per day. 80% of this requirement has to come through the strait with rest being shipped from other places or sent through pipelines. A total of 15 million barrels of oil go through every day of which 90% is crude oil. China produces only 3.8 million barrels a day domestically. The loss of the straits and their oil imports would bring the Chinese economy and transportation network to a halt as it would lose almost two thirds of its oil supply.

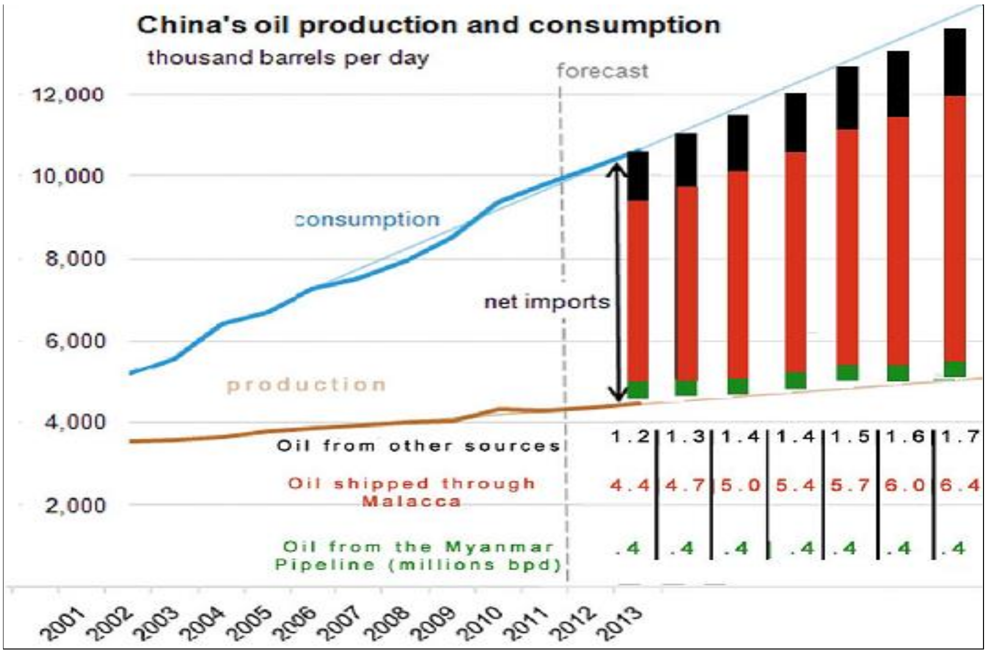
Knowing this, Chinese policy makers have started trying to find alternatives to Malacca. There were four proposals that would help middle-eastern oil get to China faster. The first was a proposal to spend 20 billion dollars to dig a canal across Thailand's Isthmus of Kra. On the face of it, this was a good alternative as it would save a journey of 1500 nautical miles for ships traveling to China. Unfortunately for China, it fell through due to high domestic opposition and a lack of support.. There were speculations that powerful people in Malaysia and Singapore were bribing people in Thailand's parliament to stop the project from going forward as it would reduce the amount of trade through their ports drastically. This may also be a reason why China didn't push the proposal through, as building the canal would probably alienate Singapore entirely after China has spent years in building good relations with it.

Another alternative was a pipeline from Gwadar in Pakistan to Xinjiang. The problem with this proposal was that Pakistan is currently unstable and the geographical landmass that the pipe would have to build would be very difficult. The third alternative was building a pipeline that would start in Iran, go through Pakistan, India and finally on to China. This failed not only because the pipeline was too long (2800 km), but also because of the international cooperation necessary to get it started.

The alternative that did succeed was the Sino-Myanmar pipelines. One will carry 440,000 barrels of crude oil a day while the other will carry natural gas. The pipeline itself extends nearly 800 km from the Shwe gas fields,in Myanmar to Kunming. The project cost China 2.5 billion dollars. Myanmar has welcomed the pipelines, both for the jobs they produce and because it's entitled to draw 40,000 barrels of crude oil a day. It can be said that this pipeline somehow solves China's Malacca dilemma. According to the Economist, "**China sees this project as one of huge importance to its energy security, helping it avoid dependence on shipments coming through the Strait of Malacca.**"

However, there are problems in this project. Firstly, the pipelines are not safer than seaborne shipping. If the Malacca straits were blocked, tankers could always be rerouted. A pipeline has none of these attributes. They are in fixed positions making it easy to attack. It is spread across several miles in a territory where different insurgent groups could cause a multimillion-dollar accident. China does not have control of Myanmar or the pipeline itself except on paper. Myanmar could conceivably halt oil and gas shipments in a dispute with China. The sea route to Myanmar has potential enemies. The US Navy operates out of the small island of Diego Garcia, which is in center of the Indian Ocean and gives them an excellent chance to interdict any shipping heading towards Myanmar. The Indian Navy too has aircraft carriers and the ability to project power over the entire Indian Ocean. The People's Liberation Army Navy is based on building local superiority and cheap forms of area denial. Their strategy is not to build far-flung bases, which they would then have to disperse their forces to defend. While tankers can be re-routed through the Sunda, Lombok, or other passages due to threats, pipelines remain fixed without any other mechanism that can be adopted to prevent damage.

But perhaps these strategic problems would become less important if the pipeline were to genuinely reduce the amount of oil going through Malacca? Unfortunately, Chinese oil imports are growing faster than the pipeline can alleviate. According to the Energy Information Administration, Chinese oil demand in 2010 was 9.4 million barrels per day. In 2011, that rose to 9.8 billion barrels per day. 9.8 – 9.4 equals a yearly increase of .4 million or 400,000 barrels per day demanded. China is only adding 170,000 barrels bpd of new production every year but that is expected to stop once China hits 4.7 billion barrels of indigenous production. The pipeline from Myanmar produces 0.44 billion bpd. Two years of Chinese growth in oil demand and China will be shipping just as much oil through Malacca as they were when it was built.



Source: The Malacca Dilemma: IIT Madras China Studies Centre
URL: https://csc.iitm.ac.in/articles/malacca-dilemma

According to the graph, the red line, which is the shipments through Malacca, is increasing. The pipeline only offers a single one-time reduction. However, that reduction is eaten up in one or two years. The final problem is Myanmar itself. Though initially in China's orbit, it is now showing signs of a democratic transition and attempts to court the West. It is significant to say that Obama's first destination during his second term was Myanmar. Whether the new government is actually trying to be open or playing at being democratic, it has shown willingness to do things that China finds upsetting. The suspension on construction of the Myitsone Dam was unexpected and it indicated that the Burmese government valued public opinion. While the pipeline is not relevant to China as a whole, it will become important for China's Southwest provinces. The pipeline will give Myanmar leverage over China to some degree, but unlike Malacca, it will be completely bilateral. The Malacca straits cannot be harmed, as doing anything would upset the status quo of 10 different countries.

In conclusion, the pipelines have bought China one or two years of slowing on oil shipments through the Malacca Strait. This depends on whether the refinery capacity can start running in Yunnan on time. Finally, they've just given a very serious pressure point to an ally who does not seem as close or as predictable as they did when the project was started. The Myanmar pipeline is going to have no effect on the Malacca dilemma and China will find itself back at square one in a year or two.[1393]

In addition, in an article **"Indian Ocean Shipping: Roles of the Indian Navy and Coast Guard"** by **PK Ghosh**, published in Papers in Australian Maritime Affairs No. 23, Asian Energy Security: Regional Cooperation in the Malacca Strait, it is mentioned that in the

[1393] Excerpts from article titled "The Malacca Dilemma" by **IIT Madras China Studies Centre (CSC) Article #64 dated August 13, 2013, URL:** https://csc.iitm.ac.in/articles/malacca-dilemma case of China 'It is no exaggeration to say that whoever controls the Strait of Malacca will also have a stranglehold on the energy route of China.[1394]

8.7.6.6 "STRING OF PEARLS" Theory

China's 2015 defence white paper **"China's military strategy"** published on May 27, 2015 had pointed out that the PLA Navy move from "offshore waters defence" to "open seas protection" in its chapter IV " Building and Development of China's Armed Forces" mentioning "In line with the strategic requirement of offshore waters defense and open seas protection, the PLA Navy (PLAN) will gradually shift its focus from "offshore waters defense" to the combination of "offshore waters defense" with "open seas protection," and build a combined, multi-functional and efficient marine combat force structure. The PLAN will enhance its capabilities for strategic deterrence and counterattack, maritime maneuvers, joint operations at sea, comprehensive defense and comprehensive support."[1395]

Excerpts of an article "The string of pearls and the Maritime Silk Road" published by China.org.cn, dated February 12, 2014 pointed out that:

The phrase 'String of Pearls' was first used in 2005, in a report entitled "Energy Futures in Asia" provided to U.S. Defense Secretary Donald H Rumsfeld by defense contractor Booz Allen Hamilton. It alleged that China was adopting a "string of pearls" strategy of bases stretching from the Middle East to southern China. These "pearls" were naval bases or electronic eavesdropping posts built by the Chinese in Myanmar, Bangladesh, Pakistani and Sri Lanka. The purpose was to project its power overseas and protect its oil shipments.

Nine years have since elapsed. The phrase, or theory, still sticks in the international media and in some think tank reports.

In fact, the only thing justifiable in the "string of pearls" theory is that it underlines the growing importance, even then, of the Indian Ocean for China's ever-expanding national interests, especially in terms of energy import. Nowadays China is securing its energy needs from all parts of the world, but the Middle East still prevails as the most important source. By the end of 2013, China had become the largest trader and the largest oil importer in the world. The Indian Ocean, and hence the security of SLOCs from Bab-el-Mandeb, Hormuz, to the Malacca Strait, is thus vitally important for China.

Two countries are most important for China's freedom of navigation in the Indian Ocean: the U.S. and India. The U.S. is the only country that has the full capabilities to control the chokepoints in the Indian Ocean and cut off the SLOCs all the way to China, but it is unlikely to exercise such capabilities, unless, perhaps, in an all-out war with China. Even during the Cold War neither the U.S. nor the Soviet Union endeavoured to cut off any SLOCs in the world. Besides, the SLOCs are life-lines for all states. Cutting off China's

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[1394] Excerpts from an article "Indian Ocean Shipping: Roles of the Indian Navy and Coast Guard" by PK Ghosh, published in "Papers in Australian Maritime Affairs" No. 23, Asian Energy Security: Regional Cooperation in the Malacca Strait, Pg 190, available online at URL:
https://www.navy.gov.au/sites/default/files/documents/PIAMA23.pdf

[1395] Excerpts from The State Council Information Office of the PRC White Paper **" China's military strategy"** published on May 27, 2015, available online at URL: http://eng.mod.gov.cn/Database/WhitePapers/

SLOCs will also affect U.S. allies of Japan, ROK and Australia. So long as Sino-American relations remain manageable, such a worst-case scenario is unlikely to occur.[1396]

The occasional paper on **“China's 21 Century Maritime Silk Road Old String with New Pearls?”** written by **Gopal Suri** is one of the four studies that the **Vivekananda International Foundation** has undertaken to examine the ambitious 'One Road, One Belt' initiative of China both by road and sea. Excerpts from the study points out:

The much quoted 'String of Pearls' strategy had its birth in such Chinese concerns. In fact, many strategists look at China's attempts to develop alternative corridors to circumvent the “Malacca Dilemma' as a direct result of these concerns. It would therefore be worthwhile to revisit the supposed “String of Pearls’ strategy of the Chinese so as to gain a better grasp of recent Chinese initiatives in the India Ocean.

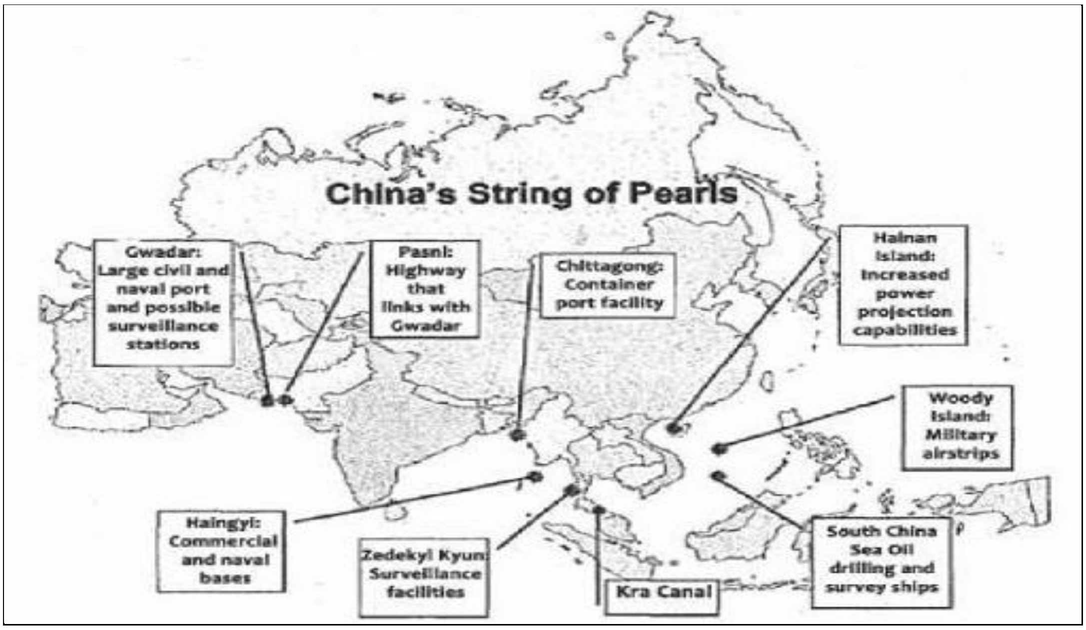
‘**String of Pearls’** Origin: The phrase “String of Pearls' had its origin in a report 'Energy Futures in Asia', prepared by an American think tank, Booze Allen Hamilton, for the US Secretary of Defence in 2004. The report stated that China was adopting a “string of pearls” strategy of bases and diplomatic ties stretching from the Middle East to southern China that included a new naval base under[1397] construction at the Pakistani port of Gwadar. The report further stated that “China is building strategic relationships along the sea lanes from the Middle East to the South China Sea in ways that suggest defensive and offensive positioning to protect China's energy interests, but also to serve broad security objectives”. The 'Pearls', China's interest in securing her energy flow, especially the SLOCs, is a major concern which is reflected in Chinese military strategy as also in various other writings like the defence White Papers. The report stated that China was building up military forces and setting up bases along sea lanes from the Middle East to project its power overseas and protect its[1398] oil shipments. The string of pearls, as mentioned in the report, extended from the coast of mainland China, through the littorals of the South China Sea, the Strait of Malacca and the Indian Ocean, to the littorals of the Arabian Sea and the Persian Gulf. The specific “pearls” in the “string”, as originally articulated, consisted of - Hainan Island, with recently upgraded military facilities; an upgraded airstrip on Woody Island in the Paracel archipelago; the deep water port under construction in Burma; a proposed container shipping facility in Chittagong, Bangladesh; and the naval base under construction in Gwadar, Pakistan (see map below).

[1396] Excerpts of an article “The string of pearls and the Maritime Silk Road” published by China.org.cn, dated February 12, 2014, available online at URL: http://www.china.org.cn/opinion/2014-02/12/content_31445571.htm

[1397] ‘China Builds Up Strategic Sea Lanes’, The Washington Times - Monday, January 17, 2005, http://www.washingtontimes.com/news/2005/jan/17/20050117-115550-1929r/, Accessed on 15 Jan 16, As referred in occasional paper titled “China's 21 Century Maritime Silk Road Old String with New Pearls?” written by Gopal Suri, published by Vivekananda International Foundation (VIF), Pg 11-15, available online at URL: https://www.vifindia.org/sites/default/files/china-s-21st-century-maritime-silk-road-old-string-with-new-pearls.pdf

[1398] ‘China Builds Up Strategic Sea Lanes’, The Washington Times - Monday, January 17, 2005, http://www.washingtontimes.com/news/2005/jan/17/20050117-115550-1929r/, Accessed on 15 Jan 16, As referred in occasional paper titled “China's 21 Century Maritime Silk Road Old String with New Pearls?” written by Gopal Suri, published by Vivekananda International Foundation (VIF), Pg 11-15, available online at URL: https://www.vifindia.org/sites/default/files/china-s-21st-century-maritime-silk-road-old-string-with-new-pearls.pdf

Figure: String of Pearls[1399]



Source: String of Pearls, China's 21 Century Maritime Silk Road Old String with New Pearls?", Pg 12
URL: https://www.vifindia.org/sites/default/files/china-s-21st-century-maritime-silk-road-old-string-with-new-pearls.pdf

'Raison D'etre', China has never professed this strategy nor has it been articulated by Chinese strategists. This was largely an American concept to encapsulate the appreciated Chinese developments which appeared to be designed for undermining American pre-eminence in the region. Chinese initiatives which gave rise to this theory were intended to diversify the routes for transportation of energy so as to reduce China's vulnerability at the Malacca Straits and mitigate the 'Malacca Dilemma'. China was also consolidating its strategic posture in the Indian Ocean by helping Myanmar in augmenting its naval bases as also building new ones. Reports had also surfaced of Chinese investment in the modernization of the Chittagong port but the project has not seen much headway, possibly because of Indian pressure on the Bangladesh government. Chinese investment in the Gwadar Deep Sea Port is another 'pearl' in the strategy. Pakistan has been an all-weather friend for the Chinese and has a deep strategic bond which has underpinned their relationship. Gwadar has helped the Chinese gain a foothold in the Indian Ocean from where they can deploy their navy. In fact, a number of Chinese naval ships, especially those deployed for anti-piracy missions, have frequently called at Karachi, either on their way in or when returning from their deployment. The utility of Gwadar for Chinese strategic requirements therefore cannot be understated. The Chinese also helped Sri Lanka in the construction of a port at Hambantota giving rise to the perception of possible deployment of naval platforms. The perception of China developing bases and relationships around the Indian Ocean stems from the attribution of Mahanian concepts of sea power and the need for overseas bases to secure the SLOCs, to the development of

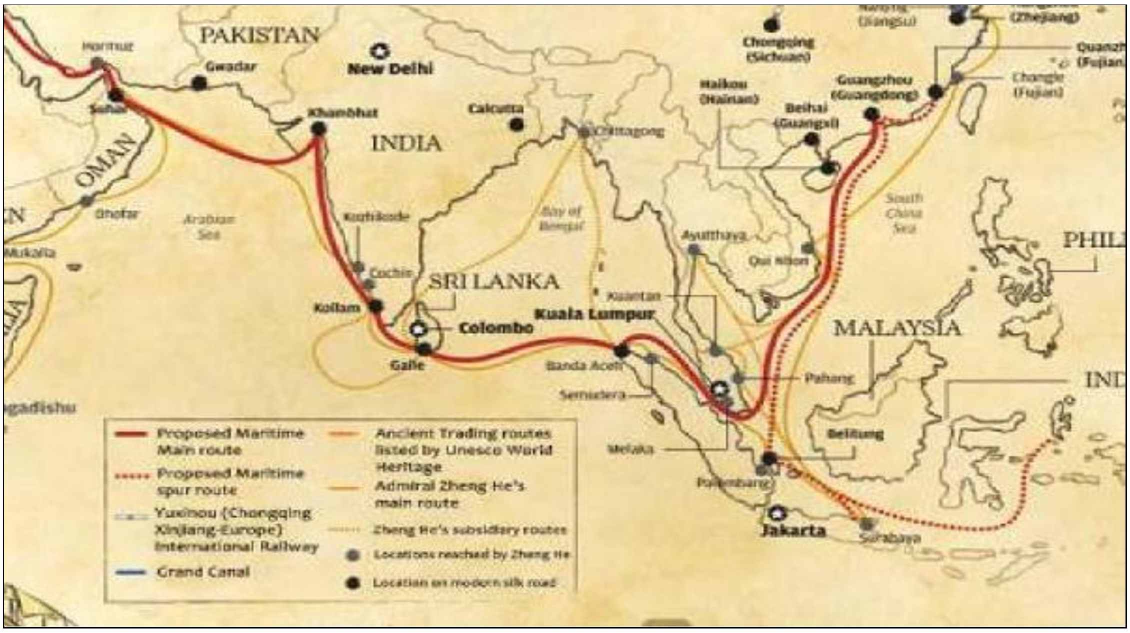
[1399] MacDonald, Donahue, and Danyluk, 'Energy Futures in Asia', 17. Quoted in Thesis, 'Does China Need A "String Of Pearls"? Martin E. Conrad, September 2012. Naval Postgraduate School, Monterey, California, As referred in occasional paper titled "China's 21 Century Maritime Silk Road Old String with New Pearls?" written by Gopal Suri, published by Vivekananda International Foundation (VIF), Pg 11-15, available online at URL: https://www.vifindia.org/sites/default/files/china-s-21st-century-maritime-silk-road-old-string-with-new-pearls.pdf the Chinese navy. However, the same was not clearly apparent in the period following the predictions of 'Energy Futures of Asia'. Meanwhile, Chinese military strategy has undergone a major change with an increased focus on matters maritime leading to a rapid development of its navy in the past decade which has added new dimensions to its war fighting capability. Maritime policy in China has also undergone a paradigm shift with 18th National Congress of the Communist Party of China, in 2012, announcing that the nation would accelerate the development of its ocean resources, resolutely safeguard its maritime rights and interests, and develop into a big maritime power. This also coincided with the second phase of the naval maritime plan, from 2010 to 2020, outlined by the PRC's then Vice Chairman of the Military Commission, Liu Huaqing in 1982 that China would seek to establish control of waters within the second island chain that links the[1400] Ogasawara island chain, Guam and Indonesia. China's intention to step out beyond the First Island Chain and consolidate its maritime interests up till the Second Island Chain is clearly evident in this shift in policy. The announcement of the Maritime Silk Road by the Chinese President is in tune with this new shift in policy which is tailored towards a possible strategic goal of achieving a regional power status in the IOR. This policy also echoes the concept of Three War fares (Psy Ops, Media Ops and Legal Ops) espoused by the Chinese which Cmde Uday Bhaskar (Retd) says could be[1401] used as a Trojan Horse to achieve a desired end.

Fig: The 21 Century Maritime Silk Road[1402]

[1400] 'China's Active Defense Strategy and its Regional Impact', Prepared statement by Stacy A. Pedrozo, Capt, JAGC, USN. U.S. Navy Military Fellow. Council on Foreign Relations. Before the U.S.-China Economic & Security Review Commission, United States House of Representatives, First Session, 112th Congress. http://www.cfr.org/china/chinas-active-defense-strategy-its-regional-impact/p23963, Accessed on 27 Jan 16, ‘China Builds Up Strategic Sea Lanes’, The Washington Times - Monday, January 17, 2005, http://www.washingtontimes.com/news/2005/jan/17/20050117-115550-1929r/, Accessed on 15 Jan 16, As referred in occasional paper titled “China's 21 Century Maritime Silk Road Old String with New Pearls?” written by Gopal Suri, published by Vivekananda International Foundation (VIF), Pg 11-15, available online at URL: https://www.vifindia.org/sites/default/files/china-s-21st-century-maritime-silk-road-old-string-with-new-pearls.pdf

[1401] China's Three Warfares Concept Related to India and the Indian Ocean Region, Commodore UdayBhaskar, IN (ret.), China: The Three Warfares, Report Prepared for Andy Marshall, Director, Office of Net Assessment, Office of the Secretary of Defense, Washington, D.C. Prepared by: Professor Stefan Halper, University Of Cambridge. Pg 486. https://cryptome.org/2014/06/prc-three-wars.pdf, Accessed on 25 Jan 16. School, Monterey, California, 'China's Active Defense Strategy and its Regional Impact', Prepared statement by Stacy A. Pedrozo, Capt, JAGC, USN. U.S. Navy Military Fellow. Council on Foreign Relations. Before the U.S.-China Economic & Security Review Commission, United States House of Representatives, First Session, 112th Congress. http://www.cfr.org/china/chinas-active-defense-strategy-its-regional-impact/p23963, Accessed on 27 Jan 16, ‘China Builds Up Strategic Sea Lanes’, The Washington Times - Monday, January 17, 2005, http://www.washingtontimes.com/news/2005/jan/17/20050117-115550-1929r/, Accessed on 15 Jan 16, As referred in occasional paper titled “China's 21 Century Maritime Silk Road Old String with New Pearls?” written by Gopal Suri, published by Vivekananda International Foundation (VIF), Pg 11-15, available online at URL: https://www.vifindia.org/sites/default/files/china-s-21st-century-maritime-silk-road-old-string-with-new-pearls.pdf

[1402] http://www.china.org.cn/world/node_7219434.htm. Accessed on 27 Jan 16, As referred in occasional paper titled “China's 21 Century Maritime Silk Road Old String with New Pearls?” written by Gopal Suri, published by Vivekananda International Foundation (VIF), Pg 15, available online at URL: https://www.vifindia.org/sites/default/files/china-s-21st-century-maritime-silk-road-old-string-with-new-pearls.pdf



Source: String of Pearls, China's 21 Century Maritime Silk Road Old String with New Pearls?", Pg 15
URL: https://www.vifindia.org/sites/default/files/china-s-21st-century-maritime-silk-road-old-string-with-new-pearls.pdf

The geographical similarity between the supposed 'String of Pearls', as illustrated at Fig 1, and the 21 Century Maritime Silk Road is also hard to miss and it will therefore be worthwhile to delve deeper into Chinese actions to gain a better understanding of their strategic intent in the military maritime realm.[1403]

[1403] Excerpts from occasional paper titled "China's 21 Century Maritime Silk Road Old String with New Pearls?" written by Gopal Suri, published by Vivekananda International Foundation (VIF), Pg 15, available online at URL: https://www.vifindia.org/sites/default/files/china-s-21st-century-maritime-silk-road-old-string-with-new-pearls.pdf

China: Total Production of Energy and Its Composition

Year	Total Energy Production (10 000 tons of SCE)	As Percentage of Total Energy Production (%)			
		Coal	Crude Oil	Natural Gas	Primary Electricity and Other Energy
1978	62770	70.3	23.7	2.9	3.1
1980	63735	69.4	23.8	3.0	3.8
1985	85546	72.8	20.9	2.0	4.3
1990	103922	74.2	19.0	2.0	4.8
1991	104844	74.1	19.2	2.0	4.7
1992	107256	74.3	18.9	2.0	4.8
1993	111059	74.0	18.7	2.0	5.3
1994	118729	74.6	17.6	1.9	5.9
1995	129034	75.3	16.6	1.9	6.2
1996	133032	75.0	16.9	2.0	6.1
1997	133460	74.3	17.2	2.1	6.5
1998	129834	73.3	17.7	2.2	6.8
1999	131935	73.9	17.3	2.5	6.3
2000	138570	72.9	16.8	2.6	7.7
2001	147425	72.6	15.9	2.7	8.8
2002	156277	73.1	15.3	2.8	8.8
2003	178299	75.7	13.6	2.6	8.1
2004	206108	76.7	12.2	2.7	8.4
2005	229037	77.4	11.3	2.9	8.4
2006	244763	77.5	10.8	3.2	8.5
2007	264173	77.8	10.1	3.5	8.6
2008	277419	76.8	9.8	3.9	9.5
2009	286092	76.8	9.4	4.0	9.8
2010	312125	76.2	9.3	4.1	10.4
2011	340178	77.8	8.5	4.1	9.6
2012	351041	76.2	8.5	4.1	11.2
2013	358784	75.4	8.4	4.4	11.8
2014	361866	73.6	8.4	4.7	13.3
2015	361476	72.2	8.5	4.8	14.5
2016	346037	69.8	8.2	5.2	16.8
2017	358500	69.6	7.6	5.4	17.4
2018	377000	69.3	7.2	5.5	18.0

Source: 9-1, Total Production of Energy and Its Composition, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Total Consumption of Energy and Its Composition

Year	Total Energy Consumption (10 000 tons of SCE)	As Percentage of Total Energy Consumption (%)			
		Coal	Petroleum	Natural Gas	Primary Electricity and Other Energy
1978	57144	70.7	22.7	3.2	3.4
1980	60275	72.2	20.7	3.1	4.0
1985	76682	75.8	17.1	2.2	4.9
1990	98703	76.2	16.6	2.1	5.1
1991	103783	76.1	17.1	2.0	4.8
1992	109170	75.7	17.5	1.9	4.9
1993	115993	74.7	18.2	1.9	5.2
1994	122737	75.0	17.4	1.9	5.7
1995	131176	74.6	17.5	1.8	6.1
1996	135192	73.5	18.7	1.8	6.0
1997	135909	71.4	20.4	1.8	6.4
1998	136184	70.9	20.8	1.8	6.5
1999	140569	70.6	21.5	2.0	5.9
2000	146964	68.5	22.0	2.2	7.3
2001	155547	68.0	21.2	2.4	8.4
2002	169577	68.5	21.0	2.3	8.2
2003	197083	70.2	20.1	2.3	7.4
2004	230281	70.2	19.9	2.3	7.6
2005	261369	72.4	17.8	2.4	7.4
2006	286467	72.4	17.5	2.7	7.4
2007	311442	72.5	17.0	3.0	7.5
2008	320611	71.5	16.7	3.4	8.4
2009	336126	71.6	16.4	3.5	8.5
2010	360648	69.2	17.4	4.0	9.4
2011	387043	70.2	16.8	4.6	8.4
2012	402138	68.5	17.0	4.8	9.7
2013	416913	67.4	17.1	5.3	10.2
2014	425806	65.6	17.4	5.7	11.3
2015	429905	63.7	18.3	5.9	12.1
2016	435819	62.0	18.5	6.2	13.3
2017	448529	60.4	18.8	7.0	13.8
2018	464000	59.0	18.9	7.8	14.3

Source: 9-2, Total Consumption of Energy and Its Composition, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Overall Energy Balance Sheet

Item	1990	1995	2000	2005	2010	2015	2016	2017
Total Energy Available for Consumption	**96138**	**129535**	**144234**	**254619**	**365588**	**429960**	**431842**	**446007**
Primary Energy Output	103922	129034	138570	229037	312125	361476	346037	358500
Recovery of Energy		2312	3087	7452	8958			
Imports	1310	5456	14327	26823	57671	77451	89730	99957
Exports (-)	5875	6776	9327	11257	8803	9784	11956	12670
Stock Changes in the Year	-3219	-491	-2424	2564	-4363	817	8031	219
Total Energy Consumption	**98703**	**131176**	**146964**	**261369**	**360648**	**429905**	**435819**	**448529**
Consumption by Sector								
Agriculture, Forestry, Animal Husbandry and Fishery	4852	5505	4233	6860	7266	8232	8544	8931
Industry	67578	96191	103014	187914	261377	292276	290255	294488
Construction	1213	1335	2207	3486	5533	7696	7991	8555
Transport, Storage and Post	4541	5863	11447	19136	27102	38318	39651	42191
Wholesale and Retail Trades, Hotels and Catering Services	1247	2018	3251	5917	7847	11404	12015	12475
Other Sectors	3473	4519	6118	10484	15052	21881	23154	24269
Household Consumption	15799	15745	16695	27573	36470	50099	54209	57620
Consumption by Usage								
End-use Consumption	94289	124252	140476	250877	337469	417494	424278	436953
Industry	63239	89473	96871	177775	238652	280206	279058	283273
Losses During the Process of Energy Conversion	2264	3634	2472	3882	14294	17191	16964	17278
Coking	905		526	855	1595	4099	3887	3721
Petroleum Refining	326		781	1273	1960	2230	2139	2630
Recovery of Energy						14492	15273	15921
Energy Losses	2150	3289	4016	6610	8885	9712	9849	10219
Balance	**-2565**	**-1641**	**-2730**	**-6751**	**4940**	**55**	**-3977**	**-2522**

Source: 9-3, Overall Energy Balance Sheet, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Petroleum Balance Sheet

Item	1990	1995	2000	2005	2010	2015	2016	2017
Total Energy Available for Consumption	**11435**	**16073**	**22631**	**32539**	**44178**	**55188**	**56411**	**58801**
Output	13831	15005	16300	18135	20301	21456	19969	19151
Imports	756	3673	9748	17163	29437	39749	44503	49141
Exports (-)	3110	2455	2172	2888	4079	5128	6383	7027
Stock Changes in the Year	-41	-151	-1245	129	-1481	-888	-1678	-2464
Total Energy Consumption	**11486**	**16065**	**22496**	**32547**	**44101**	**55160**	**56403**	**58745**
Consumption by Sector								
Agriculture, Forestry, Animal Husbandry and Fishery	1034	1203	789	1452	1383	1733	1730	1786
Industry	7322	9349	11249	14030	18555	18908	19093	19546
Construction	327	243	841	1502	2483	3507	3713	4040
Transport, Storage and Post	1683	2864	6399	10928	15079	20550	21032	22029
Wholesale and Retail Trades, Hotels and Catering Services	78	334	247	376	481	616	585	621
Other Sectors	758	1390	1636	1974	2578	3683	3537	3503
Non-production Consumption	285	682	1336	2284	3542	6162	6713	7220
Consumption by Usage								
End-use Consumption	9305	13676	19950	29496	41243	52446	53937	56233
Industry	5180	7096	8860	11108	15858	16230	16650	17043
Intermediate Consumption (Consumed in Conversion)	1630	2230	2353	2896	2663	2627	2424	2465
Power Generation	1234	1359	1178	1306	385	266	285	281
Heating	356	400	427	429	593	493	518	523
Gas Production	40	52	26	14			5	5
Losses in Petroleum Refining	296	420	722	1146	1685	1868	1617	1657
Other Losses	255	159	193	155	194	88	42	47
Balance	**-51**	**8**	**135**	**-8**	**77**	**28**	**8**	**56**

Source: 9-4, Petroleum Balance Sheet, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Coal Balance Sheet

Item	1990	1995	2000	2005	2010	2015	2016	2017
Total Energy Available for Consumption	**102221**	**133462**	**131895**	**235508**	**355578**	**397074**	**378494**	**382094**
Output	107988	136073	138418	236515	342845	374654	341060	352356
Imports	200	164	218	2622	18307	20406	25555	27093
Exports (-)	1729	2862	5506	7173	1911	534	879	809
Stock Changes in the Year	-4239	87	-1235	3545	-3663	2547	12758	3453
Total Energy Consumption	**105523**	**137677**	**135690**	**243375**	**349008**	**397014**	**384560**	**385723**
Consumption by Sector								
Agriculture, Forestry, Animal Husbandry and Fishery	2095	1857	1051	1802	2147	2625	2778	2834
Industry	81091	117571	121807	224766	329728	375650	363175	365480
Construction	438	440	537	604	731	878	805	733
Transport, Storage and Post	2161	1315	882	811	639	492	404	353
Wholesale and Retail Trades, Hotels and Catering Services	1058	977	1461	2627	3192	3864	3826	3461
Other Sectors	1980	1987	1495	2727	3412	4159	4081	3580
Household Consumption	16700	13530	8457	10039	9159	9347	9492	9283
Consumption by Usage								
End-use Consumption	60206	66156	50511	86386	114826	112195	97809	91681
Industry	35774	46050	36628	67776	95546	90831	76423	71438
Intermediate Consumption (Consumed in Conversion)	41258	69488	81987	152208	222948	266481	272512	281405
Power Generation	27204	44440	55811	103663	153742	179318	182666	190025
Heating	2996	5887	8794	13542	17553	24095	26577	28983
Coking	10698	18396	16496	33446	49950	60644	60649	58910
Petroleum Refineries and Coal-to-liquids					213	679	1105	1568
Gas Production	360	764	960	1277	1040	1270	1212	1643
Losses in Coal Washing and Dressing	4059	2033	3191	4782	11235	18338	14240	12637
Balance	**-3302**	**-4215**	**-3795**	**-7868**	**6569**	**60**	**-6066**	**-3629**

Source: 9-5, Coal Balance Sheet, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Electricity Balance Sheet

Item	1990	1995	2000	2005	2010	2015	2016	2017
Total Energy Available for Consumption	**6230**	**10023**	**13473**	**24941**	**41936**	**58021**	**61298**	**64821**
Output	6212	10077	13556	25003	42072	58146	61425	64951
Hydropower	1267	1906	2224	3970	7222	11303	11934	11898
Thermal Power	4945	8043	11142	20473	33319	42842	44371	46627
Nuclear Power		128	167	531	739	1708	2133	2481
Wind Power					446	1858	2371	2950
Imports	19	6	15	50	55	62	62	64
Exports (-)	1	60	99	112	191	187	189	195
Total Energy Consumption	**6230**	**10023**	**13472**	**24940**	**41934**	**58020**	**61297**	**64821**
Consumption by Sector								
Agriculture, Forestry, Animal Husbandry and Fishery	427	582	533	776	976	1040	1092	1175
Industry	4873	7660	10005	18522	30872	41550	43089	44960
Construction	65	160	160	234	483	699	726	789
Transport, Storage and Post	106	182	281	430	735	1126	1251	1418
Wholesale and Retail Trades, Hotels and Catering Services	76	200	419	752	1292	2122	2324	2527
Other Sectors	202	234	623	1341	2452	3919	4395	4881
Household Consumption	481	1006	1452	2885	5125	7565	8421	9072
Consumption by Usage								
End-use Consumption	5796	9279	12536	23234	39366	55032	58234	61625
Industry	4439	6915	9068	16815	28304	38562	40026	41764
Losses in Transmission	435	745	937	1706	2568	2988	3063	3196

Source: 9-6, Electricity Balance Sheet, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Elasticity Ratio of Energy Production

Year	Growth Rate of Energy Production over Preceding Year (%)	Growth Rate of Electricity Production over Preceding Year(%)	Growth Rate of Gross Domestic Product (GDP) over Preceding Year(%)	Elasticity Ratio of Energy Production	Elasticity Ratio of Electricity Production
1985	9.9	8.9	13.4	0.74	0.66
1990	2.2	6.2	3.9	0.56	1.59
1991	0.9	9.1	9.3	0.10	0.98
1992	2.3	11.3	14.2	0.16	0.80
1993	3.6	15.3	13.9	0.26	1.10
1994	6.9	10.7	13.0	0.53	0.82
1995	8.7	8.6	11.0	0.79	0.78
1996	3.1	7.2	9.9	0.31	0.73
1997	0.3	5.1	9.2	0.03	0.55
1998	-2.7	2.7	7.8		0.35
1999	1.6	6.3	7.7	0.21	0.82
2000	5.0	9.4	8.5	0.59	1.11
2001	6.4	9.2	8.3	0.77	1.11
2002	6.0	11.7	9.1	0.66	1.29
2003	14.1	15.5	10.0	1.41	1.55
2004	15.6	15.3	10.1	1.54	1.51
2005	11.1	13.5	11.4	0.98	1.18
2006	6.9	14.6	12.7	0.54	1.15
2007	7.9	14.5	14.2	0.56	1.02
2008	5.0	5.6	9.7	0.52	0.58
2009	3.1	7.1	9.4	0.33	0.76
2010	9.1	13.3	10.6	0.86	1.25
2011	9.0	12.0	9.6	0.94	1.25
2012	3.2	5.8	7.9	0.40	0.73
2013	2.2	8.9	7.8	0.28	1.14
2014	0.9	4.0	7.3	0.12	0.55
2015	0.0	2.9	6.9		0.42
2016	-4.3	5.6	6.7		0.84
2017	3.6	5.7	6.8	0.53	0.84
2018	5.0	7.7	6.6	0.76	1.17

Source: 9-7, Elasticity Ratio of Energy Production, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Elasticity Ratio of Energy Consumption

Year	Growth Rate of Energy Consumption over Preceding Year (%)	Growth Rate of Electricity Consumption over Preceding Year(%)	Growth Rate of Gross Domestic Product (GDP) over Preceding Year(%)	Elasticity Ratio of Energy Consumption	Elasticity Ratio of Electricity Consumption
1985	8.1	9.0	13.4	0.60	0.67
1990	1.8	6.2	3.9	0.46	1.59
1991	5.1	9.2	9.3	0.55	0.99
1992	5.2	11.5	14.2	0.37	0.81
1993	6.3	11.0	13.9	0.45	0.79
1994	5.8	9.9	13.0	0.45	0.76
1995	6.9	8.2	11.0	0.63	0.75
1996	3.1	7.4	9.9	0.31	0.75
1997	0.5	4.8	9.2	0.05	0.52
1998	0.2	2.8	7.8	0.03	0.36
1999	3.2	6.1	7.7	0.42	0.79
2000	4.5	9.5	8.5	0.54	1.12
2001	5.8	9.3	8.3	0.70	1.12
2002	9.0	11.8	9.1	0.99	1.30
2003	16.2	15.6	10.0	1.62	1.56
2004	16.8	15.4	10.1	1.67	1.52
2005	13.5	13.5	11.4	1.18	1.18
2006	9.6	14.6	12.7	0.76	1.15
2007	8.7	14.4	14.2	0.61	1.01
2008	2.9	5.6	9.7	0.30	0.58
2009	4.8	7.2	9.4	0.51	0.77
2010	7.3	13.2	10.6	0.69	1.25
2011	7.3	12.1	9.6	0.76	1.26
2012	3.9	5.9	7.9	0.49	0.75
2013	3.7	8.9	7.8	0.47	1.14
2014	2.1	4.0	7.3	0.29	0.55
2015	1.0	2.9	6.9	0.14	0.42
2016	1.4	5.6	6.7	0.21	0.84
2017	2.9	5.7	6.8	0.43	0.84
2018	3.3	8.5	6.6	0.50	1.29

Source: 9-8, Elasticity Ratio of Energy Comsumption, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Consumption of Energy by Sector (2017)

Sector	Total Energy Consumption (10 000 tons of SCE)	Coal Consumption (10 000 tons)	Coke Consumption (10 000 tons)	Crude Oil Consumption (10 000 tons)	Gasoline Consumption (10 000 tons)	Kerosene Consumption (10 000 tons)	Diesel Oil Consumption (10 000 tons)	Fuel Oil Consumption (10 000 tons)	Natural Gas Consumption (100 million cu.m)	Electricity Consumption (100 million kW·h)
Total Consumption	**448529.14**	**385723.25**	**43743.13**	**58902.17**	**12416.27**	**3326.36**	**16996.54**	**4887.30**	**2393.70**	**64820.97**
Agriculture, Forestry, Animal Husbandry and Fishery	**8931.23**	**2833.93**	**38.45**		**229.64**	**1.52**	**1546.82**	**1.31**	**1.14**	**1175.12**
Industry	**294488.04**	**365480.27**	**43609.05**	**58893.50**	**382.10**	**14.55**	**1459.94**	**3043.74**	**1575.25**	**44959.84**
Mining and Quarrying	**17680.23**	**24451.26**	**202.91**	**739.96**	**29.53**	**1.30**	**438.84**	**31.16**	**164.77**	**2403.62**
Mining and Washing of Coal	9231.73	23211.62	74.92	0.06	7.22	0.81	155.83	0.36	20.15	881.57
Extraction of Petroleum and Natural Gas	3952.10	125.57		713.31	8.90		41.34	28.67	141.42	454.06
Mining and Processing of Ferrous Metal Ores	1531.43	241.23	116.48		2.12	0.02	56.43	0.02		374.11
Mining and Processing of Non-Ferrous Metal Ores	1106.83	106.87	3.49		4.50	0.43	27.65	1.40	0.17	326.11
Mining and Processing of Nonmetal Ores	1190.19	678.27	8.01		2.72	0.03	56.29	0.02	0.39	228.93
Support Activities for Mining	320.41	86.92		26.59	4.03		100.87	0.69	2.64	23.87
Mining of Other Ores	347.54	0.79			0.03		0.42			114.96
Manufacturing	**245139.54**	**161112.70**	**43365.74**	**58153.34**	**324.05**	**13.21**	**958.35**	**3007.76**	**959.04**	**33594.63**
Processing of Food from Agricultural Products	4089.20	2191.65	137.64	0.02	17.55	0.20	36.35	2.24	16.97	716.29
Manufacture of Foods	1995.26	1564.08	2.36		7.91	0.01	13.31	2.48	17.53	263.34
Manufacture of Liquor, Beverages and Refined Tea	1418.03	980.38	0.85		5.04	0.05	8.24	2.15	10.87	156.37
Manufacture of Tobacco	199.77	21.31			0.52		1.32	0.13	1.06	51.96
Manufacture of Textile	7487.00	3272.74	1.39	0.01	13.07	0.05	21.29	6.29	30.76	1684.90
Manufacture of Textile, Wearing Apparel and Accessories	878.54	137.72	0.65	0.01	8.96		9.83	0.62	6.26	215.83
Manufacture of Leather, Fur, Feather and Related Products and Footwear	559.83	90.28			5.18	0.08	4.04	0.37	1.45	147.25
Processing of Timber,Manufacture of Wood,Bamboo,Rattan,Palm, and Straw Products	1075.24	208.56			4.73	0.02	8.73	0.23	2.26	245.28
Manufacture of Furniture	352.61	16.37	0.74		4.62		4.96	0.31	1.73	98.60
Manufacture of Paper and Paper Products	4304.31	4581.20		0.04	4.80	0.02	15.89	13.22	19.55	712.37
Printing and Reproduction of Recording Media	479.45	40.78			6.25	0.03	5.82	0.22	3.42	121.32
Manufacture of Articles for Culture, Education, Arts and Crafts, Sport and Entertainment Activities	433.12	72.47	3.97		6.64	0.04	6.55	0.84	7.18	82.58
Processing of Petroleum, Coking and Processing of Nuclear Fuel	24366.57	44844.68	41.33	54931.90	3.69	0.25	148.78	1725.28	191.46	946.44
Manufacture of Raw Chemical Materials and Chemical Products	49054.85	24697.03	3674.38	3220.70	28.47	2.17	88.84	1033.29	266.18	5122.26
Manufacture of Medicines	2222.42	1153.40	1.52		8.16	0.05	9.64	1.71	9.44	364.77
Manufacture of Chemical Fibers	2174.81	1294.01	16.79		1.13	0.06	2.16	3.09	6.92	425.47
Manufacture of Rubber and Plastics Products	4761.41	658.03	1.22		17.04	0.24	21.18	6.12	11.84	1349.35
Manufacture of Non-metallic Mineral Products	32835.27	27466.13	773.28	0.42	23.92	1.00	280.25	157.46	105.30	3305.08
Smelting and Pressing of Ferrous Metals	60934.21	29440.08	37520.60	0.01	6.61	0.09	60.26	2.13	59.39	5261.49
Smelting and Pressing of Non-ferrous Metals	22157.39	16730.14	517.75		4.94	1.08	38.93	27.97	50.75	6003.30
Manufacture of Metal Products	5152.41	247.86	60.38	0.01	17.29	0.63	22.26	4.51	31.58	1447.58
Manufacture of General Purpose Machinery	3630.43	178.28	444.39	0.01	23.86	2.11	29.58	0.91	15.37	913.95
Manufacture of Special Purpose Machinery	1687.91	137.65	63.87	0.09	20.42	0.93	21.77	1.15	11.20	423.87
Manufacture of Automobiles	3378.13	269.20	69.20	0.06	34.65	0.43	37.80	0.57	22.16	885.42
Manufacture of Railway, Ship, Aerospace and Other Transport Equipments	992.23	182.07	1.19	0.01	5.89	1.82	16.04	4.41	22.81	174.51
Manufacture of Electrical Machinery and Apparatus	2579.77	99.74	5.43	0.02	21.25	0.69	17.07	2.78	10.19	745.59
Manufacture of Computers, Communication and Other Electronic Equipment	3661.76	106.60	13.00		13.86	0.19	11.12	1.00	14.74	1106.77
Manufacture of Measuring Instruments and Machinery	306.85	12.41	0.51	0.01	4.74	0.25	2.67	0.21	1.09	88.69
Other Manufacture	1673.41	366.38	2.03		1.43	0.02	1.56	0.27	5.18	482.13
Utilization of Waste Resources	221.14	48.28	9.92		0.59	0.03	4.63	5.31	3.29	37.15
Repair Service of Metal Products, Machinery and Equipment	76.22	3.19			0.85	0.67	7.47	0.49	1.11	14.71
Electric Power, Gas and Water Production and Supply	**31668.27**	**179916.31**	**40.41**	**0.20**	**28.52**	**0.04**	**62.75**	**4.82**	**451.44**	**8961.59**
Production and Supply of Electric Power and Heat Power	29247.58	179311.44	38.78	0.20	21.88	0.04	58.91	4.61	446.10	8292.15
Production and Supply of Gas	925.36	582.61	1.63		2.87		1.57	0.11	4.93	182.68
Production and Supply of Water	1495.33	22.26			3.77		2.27	0.10	0.41	486.77
Construction	**8554.51**	**732.82**	**12.57**		**472.32**	**9.75**	**596.06**	**43.24**	**1.80**	**789.22**
Transport, Storage and Post	**42190.79**	**352.71**	**6.01**	**8.67**	**5698.53**	**3173.31**	**11253.69**	**1771.34**	**284.71**	**1417.98**
Wholesale, Retail Trade and Hotel ,Restaurants	**12475.43**	**3461.05**	**49.36**		**264.46**	**11.30**	**233.77**	**15.15**	**57.56**	**2526.65**
Others	**24268.83**	**3579.96**	**5.85**		**2075.05**	**88.36**	**1233.30**	**12.51**	**52.95**	**4880.59**
Residential Consumption	**57620.31**	**9282.52**	**21.84**		**3294.17**	**27.58**	**672.96**		**420.30**	**9071.57**

Source: 9-9, Consumption of Energy by Sector (2017), China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Efficiency of Energy Conversion

Year	Total Efficiency	Electricity Generation and Heating by Power Stations	Coking	Petroleum Refining
1983	69.93	36.94	91.18	99.16
1984	69.16	36.95	90.08	99.17
1985	68.29	36.85	90.79	99.10
1986	68.32	36.69	90.63	99.04
1987	67.48	36.75	90.46	98.81
1988	66.54	36.34	90.77	98.76
1989	66.51	36.74	90.30	98.57
1990	66.48	37.34	91.28	90.19
1991	65.90	37.60	89.90	98.10
1992	66.00	37.80	92.70	96.80
1993	67.32	39.90	98.05	98.49
1994	65.20	39.35	89.62	97.48
1995	71.05	37.31	91.99	97.67
1996	70.19	36.63	94.07	97.46
1997	69.76	35.89	94.01	97.37
1998	69.28	37.09	94.97	96.41
1999	69.25	37.04	96.13	97.51
2000	69.38	37.78	96.20	97.32
2001	69.70	38.15	96.47	97.60
2002	68.99	38.67	96.63	96.73
2003	69.38	38.46	96.13	96.38
2004	70.60	38.64	97.10	96.48
2005	71.11	38.97	97.14	96.94
2006	70.87	39.08	97.02	96.90
2007	71.23	39.80	97.54	97.17
2008	71.46	40.47	98.46	96.22
2009	72.41	41.23	98.00	96.74
2010	72.52	41.99	96.38	97.00
2011	72.19	42.13	96.30	97.41
2012	72.68	42.81	95.65	97.11
2013	72.96	43.12	95.60	97.65
2014	73.49	43.55	95.07	97.54
2015	73.72	44.22	92.34	97.55
2016	73.85	44.60	92.76	97.81
2017	73.69	45.07	92.83	97.60

Source: 9-10, Efficiency of Energy Conversion, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Average Daily Energy Consumption by Type of Energy

Type of Energy	1990	1995	2000	2005	2010	2015	2016	2017
Total (10 000 tons of SCE)	**270.4**	**359.4**	**401.5**	**716.1**	**988.1**	**1177.8**	**1190.8**	**1228.8**
Coal (10 000 tons)	289.1	377.2	370.7	666.8	956.2	1087.7	1050.7	1056.8
Coke (10 000 tons)	18.9	29.4	29.6	68.8	106.0	120.7	124.2	119.8
Crude Oil (10 000 tons)	32.2	40.8	58.0	82.4	117.5	148.2	153.1	161.4
Fuel Oil (10 000 tons)	9.2	10.2	10.6	11.6	10.3	12.8	12.7	13.4
Gasoline (10 000 tons)	5.2	8.0	9.6	13.3	19.1	31.1	32.4	34.0
Kerosene (10 000 tons)	1.0	1.4	2.4	3.0	4.8	7.3	8.1	9.1
Diesel Oil (10 000 tons)	7.4	11.8	18.6	30.1	40.3	47.6	46.0	46.6
Natural Gas (100 million cu.m)	0.4	0.5	0.7	1.3	3.0	5.3	5.7	6.6
Electricity (100 million kW·h)	17.1	27.5	36.8	68.3	114.9	159.0	167.5	177.6

Source: 9-11, Average Daily Energy Consumption by Type of Energy, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Average Annual Energy Consumption for Households

Type of Energy	1990	1995	2000	2005	2010	2015	2016	2017
Total (10 000 tons of SCE)	**15799**	**15745**	**16695**	**27573**	**36470**	**50099**	**54209**	**57620**
Coal (10 000 tons)	16700	13530	8457	10039	9159	9347	9492	9283
Kerosene (10 000 tons)	105	64	72	25	21	29	26	28
Liquefied Petroleum Gas (10 000 tons)	159	534	858	1329	1537	2549	2955	3225
Natural Gas (100 million cu.m)	19	19	32	79	227	360	380	420
Coal Gas (100 million cu.m)	29	57	126	145	167	80	63	52
Heat (10 billion kilo-joule)	8972	12637	23234	52044	67410	93841	98623	106330
Electricity (100 million kW·h)	481	1006	1452	2885	5125	7565	8421	9072

Source: 9-12, Average Annual Energy Consumption for Households, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Annual per Capita Energy Consumption of Households

Year	Annual per Capita Consumption for Households (kg of SCE)	Coal (kg)	Electricity (kW·h)	Liquefied Petroleum Gas (kg)	Natural Gas (cu.m)	Coal Gas (cu.m)
1983	106.6	127.7	13.4	0.6	0.1	1.5
1984	113.5	134.9	15.3	0.6	0.4	1.6
1985	126.7	148.7	21.2	0.9	0.4	1.3
1986	127.3	148.3	23.2	1.1	0.6	1.3
1987	132.1	152.1	26.4	1.1	0.7	1.6
1988	141.0	159.1	31.2	1.2	1.4	1.6
1989	139.3	152.4	35.3	1.4	1.5	2.4
1990	139.2	147.1	42.4	1.4	1.6	2.5
1991	139.0	143.0	47.2	1.8	1.6	3.2
1992	134.2	126.9	54.9	2.1	1.8	4.4
1993	133.5	123.2	62.5	2.5	1.5	4.6
1994	129.3	109.5	72.7	3.2	1.7	6.3
1995	130.7	112.3	83.5	4.4	1.6	4.7
1996	120.5	83.0	87.7	5.9	1.7	6.4
1997	119.3	77.2	98.6	6.2	1.7	8.9
1998	119.0	73.1	104.2	6.9	1.9	9.7
1999	121.8	69.9	108.6	6.8	2.1	9.3
2000	132.0	67.0	115.0	6.8	2.6	10.0
2001	136.0	66.1	126.5	6.7	3.3	9.4
2002	146.0	65.7	138.3	7.6	3.6	9.8
2003	166.0	69.9	159.7	8.6	4.0	10.1
2004	191.0	75.4	184.0	10.4	5.2	10.7
2005	211.0	77.0	221.3	10.2	6.1	11.1
2006	230.0	76.6	255.6	11.5	7.8	12.7
2007	250.0	74.1	308.3	12.4	10.9	14.1
2008	254.0	69.1	331.9	11.0	12.8	13.9
2009	264.0	68.5	366.0	11.2	13.3	12.5
2010	273.0	68.5	383.1	10.5	17.0	12.5
2011	294.0	68.5	418.1	12.0	19.7	10.9
2012	313.0	69.0	460.4	12.1	21.3	10.2
2013	335.0	68.0	515.0	13.6	23.8	7.9
2014	346.1	67.8	526.0	15.9	25.1	7.1
2015	365.4	68.2	551.7	18.6	26.2	5.9
2016	393.2	68.8	610.8	21.4	27.5	4.6
2017	415.6	67.0	654.3	23.3	30.3	3.7

Source: 9-13, Annual per Capita Energy Consumption of Households, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Electricity Consumption by Region

Region	1995	2000	2005	2010	2015	2017	2018
Beijing	262	384	571	810	953	1067	1142
Tianjin	179	234	385	646	801	806	861
Hebei	603	809	1502	2692	3176	3442	3666
Shanxi	399	502	946	1460	1737	1991	2161
Inner Mongolia	187	254	668	1537	2543	2892	3353
Liaoning	623	749	1111	1715	1985	2135	2302
Jilin	268	291	378	577	652	703	751
Heilongjiang	409	442	556	748	869	929	974
Shanghai	403	559	922	1296	1406	1527	1567
Jiangsu	685	971	2193	3864	5115	5808	6128
Zhejiang	440	738	1642	2821	3554	4193	4533
Anhui	289	339	582	1078	1640	1921	2135
Fujian	261	402	757	1315	1852	2113	2314
Jiangxi	181	208	392	701	1087	1294	1429
Shandong	741	1001	1912	3298	5117	5430	5917
Henan	571	719	1353	2354	2880	3166	3418
Hubei	415	503	789	1330	1665	1869	2071
Hunan	375	406	674	1172	1448	1582	1745
Guangdong	788	1335	2674	4060	5311	5959	6323
Guangxi	221	314	510	993	1334	1445	1703
Hainan	32	38	82	159	272	305	327
Chongqing		308	348	626	875	997	1114
Sichuan	583	521	943	1549	1992	2205	2459
Guizhou	204	288	487	835	1174	1385	1482
Yunnan	224	274	557	1004	1439	1538	1679
Tibet				20	41	58	69
Shaanxi	240	293	516	859	1222	1495	1594
Gansu	241	295	489	804	1099	1164	1290
Qinghai	69	109	207	465	658	687	738
Ningxia	92	136	303	547	878	978	1065
Xinjiang	120	183	310	662	2160	2543	2138

Source: 9-14, Electricity Consumption by Region, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Installed Capacity of Power Generation

Year	Installed Capacity of Power Generation	Thermal Power	Hydropower	Nuclear Power	Wind Power	Solar Power	Others
2000	31932	23754	7935	210	34		
2001	33849	25301	8301	210	38		
2002	35657	26555	8607	447	47		
2003	39141	28977	9490	619	55		
2004	44239	32948	10524	696	82		
2005	51718	39138	11739	696	106		
2006	62370	48382	13029	696	207		
2007	71822	55607	14823	908	420		
2008	79273	60286	17260	908	839		
2009	87410	65108	19629	908	1760	3	3
2010	96641	70967	21606	1082	2958	26	3
2011	106253	76834	23298	1257	4623	212	19
2012	114676	81968	24947	1257	6142	341	20
2013	125768	87009	28044	1466	7652	1589	8
2014	137887	93232	30486	2008	9657	2486	19
2015	152527	100554	31954	2717	13075	4218	9
2016	165051	106094	33207	3364	14747	7631	7
2017	177708	110495	34359	3582	16325	12942	7
2018	189967	114367	35226	4466	18426	17463	18

Source: 9-15, Installed Capacity of Power Generation**,** China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

China: Energy Intensity by GDP

Year	Total Energy Consumption (tce/10 000 yuan)	Coal (ton/10 000 yuan)	Coke (ton/10 000 yuan)	Petroleum (ton/10 000 yuan)	Crude Oil (ton/10 000 yuan)	Fuel Oil (ton/10 000 yuan)	Electricity (10 000 kW·h/10 000 yuan)
	GDP is calculated at 1980 constant prices						
1980	13.14	13.30	0.94	1.91	2.01	0.67	0.66
1981	12.33	12.56	0.81	1.93	1.81	0.59	0.64
1982	11.81	12.20	0.76	1.56	1.65	0.53	0.62
1983	11.34	11.80	0.71	1.44	1.56	0.49	0.60
1984	10.57	11.18	0.66	1.29	1.37	0.43	0.56
1985	10.08	10.72	0.62	1.21	1.25	0.37	0.54
1986	9.75	10.38	0.63	1.17	1.23	0.36	0.54
1987	9.36	10.03	0.62	1.11	1.15	0.34	0.54
1988	9.03	9.65	0.59	1.08	1.09	0.31	0.53
1989	9.04	9.64	0.59	1.08	1.08	0.32	0.55
1990	8.85	9.47	0.62	1.03	1.06	0.30	0.56
	GDP is calculated at 1990 constant prices						
1990	5.23	5.59	0.37	0.61	0.62	0.18	0.33
1991	5.03	5.36	0.35	0.60	0.60	0.17	0.33
1992	4.63	4.84	0.33	0.57	0.56	0.15	0.32
1993	4.32	4.51	0.33	0.55	0.52	0.14	0.31
1994	4.05	4.24	0.30	0.49	0.46	0.12	0.31
1995	3.90	4.09	0.32	0.48	0.44	0.11	0.30
1996	3.66	3.79	0.32	0.48	0.43	0.10	0.29
1997	3.36	3.41	0.27	0.48	0.43	0.09	0.28
1998	3.13	3.10	0.26	0.45	0.40	0.09	0.27
1999	3.00	2.97	0.23	0.45	0.40	0.08	0.26
2000	2.89	2.67	0.21	0.44	0.42	0.08	0.26
	GDP is calculated at 2000 constant prices						
2000	1.47	1.35	0.11	0.22	0.21	0.04	0.13
2001	1.43	1.32	0.11	0.21	0.20	0.04	0.14
2002	1.43	1.30	0.11	0.21	0.19	0.03	0.14
2003	1.51	1.41	0.12	0.21	0.19	0.03	0.15
2004	1.60	1.48	0.13	0.22	0.20	0.03	0.15
2005	1.63	1.52	0.16	0.20	0.19	0.03	0.16
	GDP is calculated at 2005 constant prices						
2005	1.40	1.30	0.13	0.17	0.16	0.02	0.13
2006	1.36	1.28	0.13	0.17	0.15	0.02	0.14
2007	1.29	1.20	0.13	0.15	0.14	0.02	0.14
2008	1.21	1.14	0.12	0.14	0.13	0.01	0.13
2009	1.16	1.12	0.13	0.13	0.13	0.01	0.13
2010	1.13	1.09	0.12	0.14	0.13	0.01	0.13
	GDP is calculated at 2010 constant prices						
2010	0.88	0.85	0.09	0.11	0.10	0.01	0.10
2011	0.86	0.86	0.09	0.10	0.10	0.01	0.10
2012	0.83	0.85	0.09	0.10	0.10	0.01	0.10
2013	0.79	0.81	0.09	0.10	0.09	0.01	0.10
2014	0.76	0.73	0.08	0.09	0.09	0.01	0.10
2015	0.71	0.66	0.07	0.09	0.09	0.01	0.10
	GDP is calculated at 2015 constant prices						
2015	0.63	0.58	0.06	0.08	0.08	0.01	0.08
2016	0.60	0.53	0.06	0.08	0.08	0.01	0.08
2017	0.57	0.49	0.06	0.08	0.08	0.01	0.08

Source: 9-16, Energy Intensity by GDP, China Statistical Yearbook 2019
URL: http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm

Explanatory Notes on Main Statistical Indicators[1404]

Total Energy Production refers to the total production of primary energy by all energy producing enterprises in the country in a given period of time. It is a comprehensive indicator to show the level, scale, composition and pace of development of energy production of the country. The production of primary energy includes that of coal, crude oil, natural gas, hydro-power and electricity generated by nuclear energy and other means such as wind power and geothermal power. However, it does not include the production of fuels of low calorific value, solar thermal and secondary energy converted from primary energy.

Total Energy Consumption refers to the total consumption of energy of various kinds by the production sectors of the economy and the households in a given period of time. It includes the primary kinds of energy such as coal, crude oil, natural gas, hydro-power, nuclear power, wind power, solar power, geothermal power and bio-energy; the secondary kinds of energy and their products which are transformed from the primary energy such as washed coal, coke, coal gas, electricity, heating, and petroleum products; and other kinds of fossil energy, renewable energy and new energy. The renewable energy, including hydro-power, wind power, solar power, geothermal power and bio-energy, refers to the part attained with some given technical means and used for commercial purposes. Total energy consumption can be divided into three parts: end-use energy consumption; loss during the process of energy conversion; and energy loss.

(1) End-use Energy Consumption: It refers to the total energy consumption by the production sectors and the households in the country (region) in a given period of time. It does not include the consumption during the conversion of primary energy into secondary energy and the loss in the process of energy conversion.

(2) Loss During the Process of Energy Conversion: It refers to the total input of various kinds of energy for conversion, minus the total output of various kinds of energy in the country in a given period of time. It is an indicator to show the loss that occurs during the process of energy conversion.

(3) Energy Loss: It refers to the total of the loss of energy during the course of energy transport, distribution and storage and the loss caused by any objective reason in a given period of time. The loss of various kinds of gas due to gas discharges and stocktaking is not included.

Elasticity Ratio of Energy Production is an indicator to show the relationship between the growth rate of energy production and the growth rate of the national economy. The formula is:

$$\begin{array}{c}\text{Elasticity Ratio of}\\ \text{Energy Production}\end{array} = \frac{\begin{array}{c}\text{Average Annual Growth}\\ \text{Rate of Energy Production}\end{array}}{\begin{array}{c}\text{Average Annual Growth}\\ \text{Rate of National Economy}\end{array}}$$

The average annual growth rate of the national economy can be measured by indicators such as the Gross National Product and the Gross Domestic Product, depending on the

[1404] Explanatory Notes on Main Statistical Indicators, China Statistical Yearbook 2019, available online at **URL:** http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm purposes or needs. The Gross Domestic Product has been used in the calculation of the ratio in this Yearbook.

Elasticity Ratio of Electricity Production is an indicator to show the relationship between the growth rate of electricity production and the growth rate of the national economy. Generally speaking, the growth rate of electricity production should be higher than that of the national economy.
Its formula is:

$$\text{Elasticity Ratio of Electricity Production} = \frac{\text{Average Annual Growth Rate of Electricity Production}}{\text{Average Annual Growth Rate of National Economy}}$$

Elasticity Ratio of Energy Consumption is an indicator to show the relationship between the growth rate of energy consumption and the growth rate of the national economy. The formula is:

$$\text{Elasticity Ratio of Energy Consumption} = \frac{\text{Average Annual Growth Rate of Energy Consumption}}{\text{Average Annual Growth Rate of National Economy}}$$

Elasticity Ratio of Electricity Consumption is an indicator to show the relationship between the growth rate of electricity consumption and the growth rate of the national economy. The formula is:

$$\text{Elasticity Ratio of Electricity Consumption} = \frac{\text{Average Annual Growth Rate of Electricity Consumption}}{\text{Average Annual Growth Rate of National Economy}}$$

Efficiency of Energy Processing and Conversion refers to the ratio of the total output of energy products of various kinds after processing and conversion to the total input of energy of various kinds for processing and conversion in the same reference period. It is an important indicator to show the current conditions of energy processing and conversion equipment, production technique and management. The formula is:

$$\text{Efficiency of Energy Processing \& Conversion} = \frac{\text{Output of Energy After Processing \& Conversion}}{\text{Input of Energy for Processing \& Conversion}} \times 100\%$$

Energy Consumption per Unit of GDP refers to the energy consumption per unit of Gross Domestic Product in a country or the Gross Regional Product in a region in the same reference period. The formula is:

$$\text{Energy Consumption per Unit of GDP} = \frac{\text{Total Energy Consumption}}{\text{Gross Domestic Product}}$$

Electricity Consumption per Unit of GDP refers to the electricity consumption per unit of Gross Domestic Product in a country or the Gross Regional Product in a region in the same reference period. The formula is:

$$\text{Electricity Consumption per Unit of GDP} = \frac{\text{Total Electricity Consumption}}{\text{Gross Domestic Product}}$$