Energy Crisis as Global Problem

NAKAMURA Kenichi

1. The Energy Crisis

・ Floating on a Sea of Oil

At night the Japanese islands sparkle. Japan's cities are very bright at night. Why, and when, did we adopt a lifestyle in which we brighten the night? The answer to this is closely connected to the energy crisis.

First let's define "energy crisis." High school students learn about the "law of conservation of energy," which teaches us that energy can neither be created nor destroyed. In that light, the proposition that "we are running out of energy" is incorrect. Energy does not disappear, it changes form. When energy does work, it changes from more-useful to less-useful forms, and ultimately to the least useful form of all, heat.

The energy crisis derives from one other law, the "second law of thermodynamics," which teaches us that when energy is used, it changes to a less-usable form. Petroleum and coal are "savings" of easy-to-use energy created by the Earth and sun. Humankind's socioeconomic system, however, has developed by depending on oil and coal, these versatile savings that are easily used for a variety of purposes. These savings have been consumed at a ferocious pace whose curve is greater than exponential growth, and changed into heat that is not useful. Here we find the energy crisis.

The metaphor of "blood flow" in the human body is often used to describe the conversion process of energy in society. All human actions consist in consuming energy and changing it into less-useful forms. Energy consumption and conversion are integrated into the practices of social life like the flow of blood, and for that reason people seldom have the perception that we consume energy. With so many people thinking this way, it is seldom recalled that the world as a whole is consuming a colossal amount.

People noticed energy consumption when the price skyrocketed. The first oil crisis of 1973 caused a panic in oil-consuming nations. In Japan people went around buying up detergent and toilet paper, and the rise of land prices and inflation accelerated. In 1974 consumer prices jumped 23%, GDP fell to −1.2%, and the 20 years of rapid postwar growth ended.

The 1979 second oil crisis happened because of political changes in energy-supplying Mideast countries. In 1978 the Iranian revolution temporarily stopped oil production, and that same year the Organization of Petroleum Exporting Countries (OPEC) announced an increase

in the posted price of crude oil. Due to this crude price rise, the expense of crude oil purchases rose to 7.3% of GDP for the world as whole.

The price of crude, which in 2002 was about $20/bbl, subsequently started rising until in February 2008 it blew past $100/bbl, and that July attained $147/bbl. That was the "Third Oil Crisis." It is true that in part a large inflow of speculative funds into the crude oil market helped push up crude prices. The Iraq War and other instability among oil-producing countries was also a factor. But the long-term cause was the rapid increase in demand. US consumption of oil increased, and demand rose in China, India, and other NIEs, which pushed up oil prices. Over the medium and long term, the rate of new oilfield discoveries is failing to keep pace with the rapid rise in oil consumption. "Cheap oil" is already a thing of the past, and it is very likely that oil will remain expensive over the long term. Further, people are starting to share the sense of crisis that the "age of oil" is ending.[1)]

So, how much are we consuming? Table 1 shows oil consumption amounts. World oil consumption in 2007 was 85,220,000 bpd (this includes ethanol and biodiesel).

A barrel is a liquid measure unique to the oil industry, and equal to 158.98 L. Its origin is the large oil barrels used in the US state of Pennsylvania, where the world's first oil well was discovered. In one year each American uses 25 barrels of oil, which comes out to 11 L per day. Americans alone use up about one-fourth of the world's oil. Each Japanese consumes 15 barrels yearly, or 7 L per day (about four one-shou bottles). The consumption rates of other developed countries are at levels similar to Japan and the US. We can describe these countries as "floating on a sea of oil."

The NIEs China, India, and Brazil have in recent years rapidly increased their coal and oil consumption, putting them at about the same level, nationally, as the developed countries. But because their populations are very large, per capita daily consumption is only 0.9 L per Chinese and 0.4 L per Indian, putting them under 1/10th Japan and US consumption. The NIEs, which desire to live as the developed countries do, will have greater and greater demand for oil.

2. Oilfields — Savings Banks of Energy and Carbon

Oilfields are unevenly distributed in just a few regions, which contrasts with the wide distribution of coal throughout the world. Oilfields, which are "savings banks" of energy, are discovered only in specially chosen places. Oilfields require spaces that can trap large amounts of organic liquids underground, which in turn requires movement of strata and surrounding

1) Campbell, Colin and Laherrere, Jean, " The End of Cheap Oil ", Scientific American, March 1998,pp.59-65.

rock with special structures. For the trapped organic material to mature into petroleum, the structure must satisfy appropriate temperature conditions, and must be at depths of 2,300-4,600 m. For these reasons oilfields are found only in places that have all these special conditions.

Countries with large oilfields are limited to a few including the five Persian Gulf states, Venezuela, and Russia. Japan, the US, European countries, and others import much oil from them.

The five oilfields in the world with exceptionally large reserves are shown in Table 2.

World's Five Giant Oilfields

(1) Ghawar Saudi Arabia Discovered 1948 87.5 billion bbl
(2) Burgan Kuwait Discovered 1938 87 billion bbl
(3) Samotlor Russia Discovered 1961 20 billion bbl
(4) Safaniya Saudi Arabia Discovered 1951 20 billion bbl
(5) Lagunillas Venezuela Discovered 1926 14 billion bbl

Source: Association for the Study of Peak Oil and Gas (ASPO) database.[2)]

The world's biggest oilfield is Ghawar, which is under the desert in eastern Saudi Arabia. Until drilling began, it was estimated to hold 87.5 billion bbl of oil. Its vast capacity is matched only by the number two field, Burgan.

Ghawar is an oblong field oriented NNE to SSW, covering 280 km north to south and 50 km east to west at its widest point. It is a stratum of carbonate rock called the "Arab D stratum," which averages 2,000 m in depth and 400–500 m in thickness.

This giant oilfield produced 1.5 million bpd in 1970. This figure itself is giant. Not only that, the field dramatically increased its output to 5.2 million bpd in 1976 and 1977 just after the first oil crisis, and to 5.7 million bpd at the time of the second oil crisis in 1981. The output of this one field during elevated production exceeded Japan's entire consumption in 2007 (5.05 million bpd). These facts bring home the astonishing supply capacity of this one oilfield.

Even more surprising is the colossal volume of world consumption (85.22 million bpd). The world uses up the equivalent of the entire 87.5 billion bbl of Ghawar in only a little over 1,000 days. A giant oilfield of about 500 million bbl will last but a week. The world's thirst for oil, which advances at a fearsome pace while drying up one giant oilfield after another, is a giant

2) APSO database http://www.aspo.org

threat.[4)]

We think of the "energy crisis" as if it is one problem, but instead of being singular, it is two problem groups.

First, oilfields and coal seams are repositories sealing in carbon. They perform the role of "carbon repositories" that enclose, deep in the ground, hundreds of billions of tons of carbon that had previously been suspended in the atmosphere. The continued burning of coal and oil by humans since the modern age began means that we are returning carbon in the ground to the atmosphere as carbon dioxide. The US and China, which are number 1 and 2 in consumption of mineral fuels, are also numbers 1 and 2 in carbon dioxide emissions. This leads to global warming.

Second, oilfields and coal seams are "savings banks of useful energy." The Earth has sealed solar energy underground in forms such as oil and coal. As such, when we extract oil and coal from the ground, we continue to rapidly withdraw past "energy savings" that the Earth saved over a long time. Modern civilization has rapidly built affluence by using coal and oil. The Ghawar and Burgan oilfields were in effect the largest and extremely rare "savings accounts" that the Earth had built up. The world continues to make withdrawals from these deposits, and each time supplies grow tight, we have withdrawn fistfuls of cash from the "savings" of giant oilfields.

We are being attacked from two sides by these two problem groups — global warming from one side, and energy constraints from the other. Solving one could very well aggravate the other. For example, if we are able to discover an energy source to replace oil, it would create the conditions for continued increase in energy consumption, which could accelerate global warming. In other words, there is a trade-off between the goals of solving these problems, and solving one cannot be called a solution. The rest of this chapter will focus on energy constraints, and global warming shall be left to the following chapter.

3. Coal Eliminated the Limitation Imposed by Land Area

Humans appeared on Earth about 2 million years ago. They used fire. Ancient humans knew of oil's existence, but they used it for mortar, a preservative, lamp light, medicine, and cosmetics. For most of human history, fuels were wood and charcoal. Humanity cut down forests and used them as fuel to build premodern civilizations. Forests capture solar energy and produce firewood, while fields produced organic raw materials such as cotton. But forests and fields were limited, and above all there was limited land, which imposed a quantitative

4) Wrigley, E. A., Continuity, Chance and Change: The Character of the Industrial Revolution in England, Cambridge University Press,1988,chp.3.

ceiling on the energy resources and raw materials that can be extracted from the land. There are also limits to the strength of humans and horses, which were also constrained because in total they are supported by the food and feed produced by the land. In sum, the limits of the land effectively held human activities in check. For that reason, land limitations were a constraint on the development of civilizations. Premodern civilizations would either perish or abandon their lands and relocate when they had completely destroyed their forests.

· Breaking Free of Constraints with Coal

Humankind first used coal to break free of this constraint. It was the British who first produced and consumed coal in quantity. Their country was well endowed with coal, and about the year 1600 the British were mining places accessible to open-pit mining and places whose coal could be transported by river, selling the coal and even exporting it. In the 16th and 17th centuries the Netherlands used peat as an energy source, but as economic growth accelerated their peat started depleting and the marginal cost of production rose, which is contrasted with Britain.[6] Because coal provides about twice the heat of wood by weight, it was no longer necessary to cut trees for fuel. The work of growing forests by the land and sun was replaced by people extracting coal, an underground energy savings account. In other words, by withdrawing past energy savings, humankind broke free of land limitations and of constraints on growth.[5]

In 1769 the Englishman James Watt invented the steam engine. Coal mines were overflowing with water, and pumps were needed to remove it. With the invention of the steam engine, the heat of coal combustion boiled water, and the steam pressure was efficiently converted into the kinetic energy for pumps. Coal was the mother of invention for the steam engine, and at the same time its midwife.

People then started making locomotives and other machines that used steam engines. These machines broke free of another constraint on growth by substituting the energy of coal for human and horse power. Although there were constraints on the power delivered by humans and draft animals, coal production was for the time being free of constraints. What's more, steam engines are far more powerful than humans and horses. Heavy labor by humans pulling cargo boats through canals was replaced by steam ships, while the power of horses pulling carriages was replaced by steam locomotives. It was a motive power revolution.

Using coal freed humans from the energy constraints of forests and fields. Extracting and taking advantage of the coal stored underground made it possible to exponentially increase

6) Cipolla, Carlo M., The Economic History of World Population, London, Penguin,1979,p.56.
5) Ibid.pp.89-93

energy use. Humanity was also freed from the limited strength of human, horses, and the like. The steam engine gave humans motive power incomparably greater than that of humans and animals. Additionally, humans and domestic animals such as horses were liberated from hard labor, which is to say that labor-saving was now possible.

The 19th-century British economist William Jevons observed: "Coal in truth stands not beside but entirely above all other commodities. It is the material energy of the country — the universal aid — the factor in everything we do. With coal almost any feat is possible or easy; without it we are thrown back into the laborious poverty of early times." [7)]

Coal brought landmark changes to civilization. Except for food production, many other products came to use mined minerals as their raw materials, and the proportion of organic energy sources and organic materials grown in soil gradually diminished. Even agriculture, which depends on the soil, raised its productivity by means of supplemental mineral energy and the chemical fertilizers, pesticides, and machine power applied. As this shows, coal was the indispensable energy source that underpinned the industrial revolution, a replacement for human and animal power, supplementary power for agriculture, and a force behind the division of labor.

This change triggered the creation of an international shipping route network for steamships, and on land the building of railroad networks used by steam locomotives. This brought together formerly scattered production elements, and the division of labor greatly broadened. The pattern of British-led globalization had been created, and the globalized industrial revolution got underway.

· New Constraints: Labor Unions and Environmental Deterioration

At the same time, new constraints began appearing. Coal mines required much human labor. As all the coal near the surface was mined, it was necessary to dig it out from deep underground. Deep mine shafts were narrow, hot, and full of water, and had frequent cave-ins and explosions. Fine coal dust attacked the miners' lungs. Work in the coal mines was hard, dangerous, and turned the miners black from head to toe. Colliers did not live as long as people who worked above ground. While the Earth does not resist the actions of humans withdrawing its energy savings, as humans dug their way deep into the Earth, their work became dangerous, harsh, and unhealthy.

To somehow mitigate the severity of their work, colliers organized unions with a strong sense of camaraderie and created worker unity. Almost everywhere there were coal mines, the

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7) Thompson, E. P., *The Making of The English Working Class*, Victor Gollancz, 1963, Yergin, Daniel, *Prize*, Simon & Schuster, New York, 1991, p.543.

Union of Mineworkers was organized. While colliers and union leaders were in a position to share coal, which is an achievement of modern civilization, in many cases they were believers in socialism, and generated political issues using combative language. Collective actions such as the colliers' demands for higher wages and improved working conditions served to slow the rate of coal production. This was a source of concern to mine owners, capitalists, and consumers because it drove up the prices of coal and products made with it. The social resistance spawned by this energy source had assumed the form of workers and labor unions.[8)]

Coal extraction worsened the environment. To begin with, digging much earth out of the ground caused subsidence of the area, and the ROM coal extracted from mines left much rock and low-grade coal after washing, which, when accumulated in piles, are known as tailings. These burn readily because they contain sulfurous compounds, and they spewed hazardous substances including hydrogen sulfide and sulfur oxides. When it rained on tailings, hazardous substances leached out, made the water acidic, formed heavy metal ions, and contaminated the water. What is more, as colliers dug mine shafts they would encounter underground water veins, or groundwater would arise in the shafts, thereby creating a great deal of wastewater. This threatened to dry up underground water veins and deplete groundwater sources. Wastewater was expelled with gravel, which contaminated the water, made it acidic, and killed agricultural crops. This depletion of water resources and water contamination were very serious.[9)]

Further, coal combustion caused air pollution. The smoke contained soot and mortar-like ash and residue; soot fell and turned everything black, and cinders filled every cranny. Because coal contains sulfur and many other impurities, it polluted urban air with sulfur oxides, nitrogen oxides, and other hazardous substances, and caused respiratory ailments. Additionally, the carbon in coal was not completely burned, so burning coal emitted carbon monoxide. Even with complete combustion, coal emitted the greenhouse gas carbon dioxide. One could say that when humans withdrew these coal energy savings, the Earth imposed a sanction called environmental degradation.

The working class and environmental degradation became visible warnings about overcoming an energy limitation by means of coal.

4. Discovery of Oil and the Great Game

· Oil Gushers

In August 1859 Edwin L. Drake dug down about 20 m in a low area near Oil Creek in

8) Ophuls, William, *Ecology and the Politics of Scarcity*, Freeman, San Francisco,1973.pp.88-90.
9) Yergin, *Prize*, 7), pp.26-34.

Titusville, Pennsylvania and struck oil. Until then he had spent a year and a half digging one well after another, which people called "Drake's folly." It was believed that oil seeped out of the ground, and no one thought that there were oilfields, which are spaces like underground water veins.

This was the world's first oil well, which earned Drake $600 a day. In time there were countless wildcat oil drillers in the area buying up land and drilling. Instead of a gold rush, Titusville was the scene of an oil rush. Refineries also sprouted like mushrooms. In the second half of the 1860s this spread throughout the US and created a mad "oil bubble." [10)]

In the mid-19th century US society was distinctively different from those of Europe and Asia because no constraints were imposed to limit human desires. For land, there was the limitless frontier lying to the west, and therefore no limitation on land like that faced in Britain and the Netherlands. Further, the mountains of Appalachia had much coal accessible by open-pit mining. Additionally, class consciousness was weak, community controls were very weak, and there was no traditionalism to fetter people's pursuit of their desires. As Alexis de Tocqueville observed, the US was the "republic of happiness," which was a collection of disconnected individuals who believed in material plenty, future growth, and the pragmatic pursuit of happiness.[11)] And along came oil gushers.

Oil is a liquid, and this black liquid issues naturally from the ground while oilfield pressure remains high. When a wildcatter struck oil, it would keep gushing out of the ground. Unlike coal, which is a solid, people do not have to dig deep underground. All people needed to do to be in business was put the oil that emerged into barrels and sell it.

Although there was pollution caused by crude oil runoff into surface water, unlike the coal tailings that were left permanently, much oil waste was left deep underground, and that portion did not cause aboveground pollution. What is more, heavy portions of extracted crude oil were sold as tar. In this and other ways, oil was cleaner than coal. Constraints imposed by pollution were clearly less with oil than with coal.

When people struck oil, they faced not scarcity, but plenty that was even excessive. A problem that "oil king" John D. Rockefeller faced in the 1870s was not a lack of oil, but overproduction. What lacked was not energy resources, but means for storage and transport. But since oil is a liquid, it was easy to transport. The containers called "barrels" were sometimes even more expensive than the oil they held,[13)] but later it became possible to transport large volumes all at once by means of rail, tankers, and pipelines, which lowered

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10) Tocqueville, Alexis de, *De la democratie en Amerique*, Japanese translation by Matsumoto Reiji, Vol.2 No.1 Iwanami Book Publishers、2008, pp.222~244.

11) Yergin, *Prize*, 7) , pp.39-44.

13) Yergin, *Prize*, 7) , p.37.

transport costs.

The excess of oil lacked applications and consumers. [12] At first, oil was used in kerosene lamps, which suddenly brightened nights in the US. Kerosene lamps were said to be the light of the modern age, unrivaled by the dark of night, bright, and the world's cheapest. It brought great change to people's way of living, which had previously drawn a sharp distinction between night and day. [14] Starting in 1870 a spate of new applications appeared, yielding the internal combustion engine, the automobile, aircraft, the heavy and chemical industries, and more. Inventions were created, technologies were developed, and industries established to pioneer applications for this excessive oil. These inventions, technologies, and industries broadened applications and pushed up the price of oil.

The type of human brought forth by oil was "oil men," that is, wildcatters, oil engineers, oil sellers, and oil capitalists. They believed in growth and expansion, looked down on frugality, and felt they had a mission to break free of constraints. This type of human was the exact opposite of coal miners, who worked in the dark and dangerous underground. Oil attracted physically stout young men with passion and ambition who gave their all to making money. "Oil men" were individualistic and libertarian, and the most disconnected from the Christian socialism that taught group unity and sympathy for one's fellow man to the colliers.

In the last three decades of the 19th century in the US, which was an unconstrained society, oil bubbled forth in excess and oil men ruled the day, and for US business this was the age of business in the true sense of the word,[15], i.e., it created a society of unconstrained competition seeking wealth.

· The "Great Game"

John D. Rockefeller (1839–1937) was a giant among the oil men. In 1870 he founded Standard Oil and built an oil refinery. He also created quality standards, and his company name "Standard" meant assuring quality standards. He also negotiated with railroads to lay long-distance pipelines, thereby building a nationwide distribution network and supplying consumers with oil of consistent quality.

Rockefeller proceeded to buy and merge rival companies, and bought oil refineries throughout the US. He set up a cartel to deal with overproduction of oil. Standard Oil had 90% of all US refining capacity in 1879. Starting with oil refining, Rockefeller organized an integrated company which combined everything from oil drilling on the upstream end to sales

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12) Tugendhat, Christopher, and Adrian Hamilton, *Oil : The Biggest Business*, Deborah Rogers, 1975.Yergin, Prize, pp.26-28.

14) Yergin, *Prize*, 7) , p.37-39. Tugendhat, and Hamilton, *Oil,* 12), cpt.1.

15) Yergin, *Prize*, 7) . cpt.2, Tugendhat, and Hamilton, *Oil,* 12), cpt.2.

at the downstream end, with distribution in the middle.

Rockefeller maximized his profit by managing the production of oil wells scattered across the land, worked around laws and regulations, which differ from state to state, and always kept tabs on inter-city price differences and supply-demand gaps. The essence of his business was a management system spanning everything from production to sales through rigorous numerical data. The black liquid bubbling out of the ground was transformed into data minutely recorded in the company's books.

Rockefeller called this the "Great Game," and he became the game's winner. To Rockefeller and the other oil men, the work of withdrawing the "energy savings" that the Earth had accumulated and changing it into money was a business game of merchandizing oil and dominating its price and amount. Oil was supposedly energy savings that the Earth had accumulated, and a public good, but private enterprises controlled it monopolistically or through market competition. That private control went by the name "great game," which Rockefeller gave it.[16)]

5. The Global "Great Game"

· The American Century

The 20th century was "the oil century" and "the American century." In 1901 an oilfield that dwarfed those of Pennsylvania was discovered at Spindletop, Texas. When its production rapidly dwindled, fields were discovered in Louisiana and Oklahoma. Texas spawned the oil companies Gulf and Texaco, which rivaled Standard Oil and later built themselves into the large multinationals called majors. In the first half of the 20th century the US was the world's biggest oil producer, and the biggest oil exporter.

The consumption of oil grew with the development of machinery, the internal combustion engine, automobiles, aircraft, and the like. In 1902 there were just over 20,000 automobiles in the entire US, but that number exceeded 1 million in 1912. As the number of vehicles skyrocketed, America's ravenous demand for gasoline increased. In this decade of the 1900s, boilers and ship engines also started switching their fuel from coal to oil. It was the beginning of the "liquid revolution." Big houses and sprawling cities developed on the assumption of plentiful oil. Houses and urban spaces, which were the vessels for people's day-to-day lives, changed to become energy-intensive. Oil sprang from the ground, virtually free, and gave birth to modes of production and consumption that considered mass consumption a merit.

The cultural value that found a home in the US was to consume a lot, which assumed an

16) Nakamura Ken-ichi "On Energy Crisis (Japanese)", in Ohnishi Hitoshi, Takahashi Susumu & Nakamura Ken-ichi, International Politics (Japanese), Token Shuppan, 1984, p.58.

excess of resources. Daniel Bell wrote that American culture primarily emphasizes satisfying each individual's personal consumption, and that the desirability of economic growth and increasing economic goods for personal consumption gained the status of religious belief.[18] Growth became entrenched thinking, and with that the perversion that oil, which had been in excess, is essential to livelihood was considered natural.

The monetary amount of oil worldwide expanded at an astonishing pace, doubling every 10 years over the century starting in 1870. In the 1950s after the Second World War, western Europe and Japan, which had until then used coal as their main energy source, underwent the "liquid revolution" and switched their energy source to oil. The mass-consumption lifestyle and value perception which held that the more energy one consumes, the more affluent one becomes, also took root in European countries and Japan.[17]

· Globalization of the Great Game

Starting at the end of the 19th century, giant oilfield discoveries were made outside of the US as well, and the global "great game" began. To discover oilfields and secure transport routes, the petroleum men from the US and other countries visited all parts of the globe. Rockefeller and his competitors and successors implemented the global great game in the quest for world oil hegemony and vast profits.

Especially in the 1900s at the peak of imperialism, many oilfields were discovered in the Persian Gulf coastal region. All powers focused on the economic importance of oil, and militarily as well, they saw the importance of oil as a strategic resource to power their navies and other forces. The political situation in the Persian Gulf coastal region was nebulous before the First World War, and no Western power was able to gain hegemony there. As world powers jostled for position in this region according to their intentions, in came the oil men and various other types, who rubbed shoulders with local influential people and tried to gain their trust. They offered a bridge between the locals and the Western companies and engineers who had oil-drilling technology. At times such as when local rulers were in economic straits, oil companies would, on the condition that they would pay fixed amounts as concession fees for certain areas that might well yield oil, obtain exclusive rights to explore for oilfields, drill for oil, refine it, and export it. This is called the concession contract system. Giant oil companies such as Aramco and BP emerged after starting from one concession contract.

At the same time, in some ways the US great game can be applied in the global great game. To the oil men who had played the great game in the US, the vast and diverse expanse of the

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18) Hymer, Stephen H., *The International Operations of National Firms and Other Essays* (Japanese), edited and translated by Miyazaki Yoshikazu, Iwanami Book Publishers, 1979, p.352.

17) Bell,Daniel,The Coming of Post-Industrial Society,Basic Books, 1973, pp.279-282.

US was a scale model of the world. Standard Oil's successors and rivals developed into multinational corporations that linked their production bases sprinkled worldwide with markets around the world, slipped around laws and regulations, which differed from one country to another, and maximized their profits amid inter-country price differentials and the supply-demand gap. Stephen H. Hymer, a pioneering researcher on multinationals, writes that multinational corporations are an American phenomenon,[19] and the oil businesses of these colossal oil companies were truly an enlarged version of this American phenomenon.

But the global great game was in ways different from the US great game. Indeed the people who prospected for oil in the Gulf coast region were private persons, and the oil companies were private enterprises after profits. But those whom they negotiated with for concession contracts were people with political power, such as local governments or local rulers. Oil concessions for oilfields and pipelines were determined through transnational negotiations between private individuals/enterprises and political power. What is more, naked power struggles often erupted among local people in power over oil and pipeline concessions, with only those controlling the concessions surviving. Behind the oil prospectors and oil companies, Western powers were intervening by pulling official and unofficial wires according to their strategic intents.

For that reason, the winners in this game are alliances of private business and public power. As such, the global great game consisted of a superficial business game, behind which the participants engaged in mortal-combat power struggles at the same time. Confederations of private and public actors arose, with the optimum alliances winning. For the global great game to be called a business game, it had a heavy element of power struggle, and further the winners were determined by not only chance and business acumen, but also by power.

Changes in the Oil Majors

Concession contracts accorded in the global great game were maintained under British and American control during both world wars. After the Second World War they were maintained under US hegemony, and supported a stable oil supply to the capitalist countries led by the US. Oil was controlled by the majors, which grew into super-giant multinational corporations using concession contracts. But after the two oil shocks in the 1970s, many oil-producing countries nationalized the oil companies that had been created through concession contracts, or gradually moved into capital participation. As a result, hegemony over oil shifted from the majors to control of crude by the national oil companies (NOCs) of oil-producing countries.[22]

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19) "New Seven Sisters," *Financial Times*, March,11,2007.
22) Ibid.

In the 20th century the biggest multinationals were the oil companies. From the second half of the 19th century to the mid-1970s, giant oil companies controlled at least 70% of crude oil production, oil reserves, and oil distribution. The main seven companies were called "majors" or, owing to the similar way in which they did business, the "Seven Sisters." Those seven companies were, in their 1973 names, Exxon, Mobil, Chevron, Texaco, Gulf (these five are American; the first three were created when Rockefeller's Standard Oil was split up under the Antitrust Act), British Petroleum, and Royal Dutch Shell (British/Dutch). It was also said there were eight majors if France's Total were included. Through repeated competition and collaboration, the majors cooperated in determining oil-related rules. The majors symbolized private rule over oil.

However, after the first oil shock the oil-producing countries which banded together into the Organization of Petroleum-Exporting Countries (OPEC) strengthened their hold over oil. The Seven Sisters adapted to political changes, and especially starting in the 1990s they proceeded to streamline, reduced investment in the risky development of new oil fields, and merged a number of times, consolidating into the four companies of Exxon Mobil, Chevron (name changed from Chevron Texaco in 2005), BP, and Royal Dutch Shell. These four companies still held a superior position in shaping rules on oil and in sales value, but by the end of the 20th century they had less than 10% of world crude production and the share of their reserves declined to 3%. Meanwhile, oil-producing countries' NOCs and other companies, such as Saudi Aramco, Petronas (Malaysia), Petrobras (Brazil), Gazprom (Russia), PetroChina (China), National Iranian Oil Company, and Petroleos de Venezuela came to have about 30% of crude production and reserves. Journalists sometimes call these seven companies the "new oil majors."[20] The result of compromise between resource nationalism by governments of oil-producing countries and rationalism in oil control is expressed by the lineup of the "new oil majors," which were created under national policies.

· The Winner Is Aramco

The hegemon in the global great game appeared in an unlikely place. The biggest hegemon is Aramco, which was founded by an alliance between four US majors and the Saudi royal family. In 1933 King Abpdul Aziz (commonly known as Ibn Saud) of the Kingdom of Saudi Arabia, which was of little interest to anyone, awarded to Standard Oil of California (SoCal, now Chevron), which was one of the US majors, albeit a small one, an exclusive concession to drill for and produce oil across the whole of the country's Eastern Province. The conditions were that Saudi Arabia would receive a £50,000 loan and annual rent of £25,000 from SoCal,

20) Nakamura, "On Energy Crisis", 16), p.58-62.

advance payment of £50,000 if oil were discovered, plus £1/t of oil. Owing to the depression the number of pilgrims visiting Mecca had plummeted, and this deal was made because the Saudi king, who is the protector of Mecca and Medina, was in dire economic straits.[27)]

A number of big oilfields were found in that area, thanks to which the small desert country Saudi Arabia walked the path which led to becoming the world's biggest oil producer. And SoCal, which had obtained the concession, had such colossal prospects for production that it sought joint investors for development. The first to join was Texaco (now Chevron) in 1944, followed by Exxon and Mobil in 1946. These four US majors founded a company which in 1948 became known as the Arabian American Oil Company (Aramco). Oilfields developed by Aramco included two noted in Section 1, the world's largest field, Ghawar, and the fourth-largest, Safaniya. The four US majors that managed these fields jointly owned Aramco until the Saudi government gradually nationalized it over the 15 years from 1973 to 1988.[28)]

In 1988 the Saudi government changed the company's name to Saudi Aramco. This national company, which was under the command of the Supreme Council for Petroleum and Minerals chaired by the king, still has the world's biggest oil reserves. Saudi Arabia has much spare production capacity, and has served as the swing producer because it stabilizes market prices as by increasing production when oil supplies are tight and reducing production at times of oversupply. It has hewed to a moderate line so as not to hurt the interests of the US, which became the world's biggest oil consumer. Aramco, which has the world's largest crude production capacity, has often had standoffs with other OPEC states, and, even if it sacrifices its own profits, has responded to the oil wishes of Americans for a stable supply of oil. Even after becoming Saudi Aramco, the company retained many American employees, and even now the company has Americans carried over from the former Aramco, mainly in its engineering division. This Saudi NOC sustains the international rule of oil.[29)]

6. The End of "American Oil"

· Peak Oil

Since 1970 the reality of oil in the US has been that oil production peaked, after which it would become gradually more difficult to extract oil from existing fields, and the discovery of new fields declined even as consumption increased. Already in 1956 the geologist M. King Hubbert had predicted that US oil production would peak in 1971, that subsequently the quality of extractable oil would decline, costs would rise, and the discovery of new fields

27) Yergin, *Prize*, 7) chp.21.
28) Simmons, *Twilight in the Desert*, 3), cpt.5.
29) Hasegawa Eiichi, The Struggle of Oil among Powers(Japanese), Minerva Shobo, 2009, pp.41-107.

would gradually decrease. He called this "peak oil." [33] US oil production peaked in 1970, one year earlier than Hubbert had predicted.

Hubbert's calculations were very simple. He started with the previous year's US crude oil stock as X, and as a variable that increases X, he added A, the oil reserve amount discovered in the US during the current one-year period. As a variable that decreases X, he subtracted B, the amount of oil produced in the US during the current one-year period. This means that the current year's crude oil stock is X+A−B. Hubbert then aggregated his calculations for every year from 1859 when oil was first discovered, and drew the famous "Hubbert's curve."

Meanwhile, the US pumped more oil out of the ground each year. With 1953 being the reference year, the US oil production rate B/X grew 43% until 1969 in response to healthy demand. In 1970 oil production peaked at 9 million bpd, and then gradually declined.

On the other hand, from 1953 to 1970 the US rate of new oilfield discoveries A/X dropped a substantial 35%. What's more, as the years passed the size of discovered new oilfields diminished. From 1959 these two variables — oil production and the amount of new oil discovered — crossed and became about the same, after which US crude stock leveled off until in 1967 stock began to fall for the first time in US history. The US then started producing more oil than its new discoveries, and its stock declined. It was the autumn of American oil.

Why did the rate of new oilfield discoveries decrease? Hubbert's interpretation was as follows. Oilfields that were large, with good quality oil, easy to drill, and whose oil could be easily transported to consumer areas were already more or less all discovered, and therefore such good oilfields were now hard to find. In other words, Hubbert was saying that the undiscovered or undeveloped oilfields in the US were small, or had heavy low-quality oil, or were hard to drill, or were in remote areas, and therefore many such oilfields would be unprofitable at current oil prices.

In fact, for the 35 years after the first oil shock the US government wanted to raise the oil self-sufficiency rate, so it put effort into new exploration and drilled exploratory wells in offshore oilfields, the Gulf Coast, and northern Alaska. Further, big oil companies rolled out a variety of enhanced oil recovery technologies in a bid to raise the oil recovery rates of already discovered oilfields. But there have been no new discoveries or technological breakthroughs that would significantly change Hubbert's curve. Big oil companies now tend to avoid exploration of risky oilfields.

The US rapidly withdrew its savings of crude oil stocks, and by about 1970 it had used over half its total extractable oil stock, and it has now arguably used three-fourths. To express it

33) Klare, Michael, *Blood and Oil: The Dangers and Consequences of America's Growing Dependency on Imported Petroleum*, Henry Holt and Company, 2004. Fig.1-2.

metaphorically, the US is now transitioning to the "second half of the second half," or to the "winter years." [36)]

· Continued Expansion of US Consumption

The US was formerly an oil power that boasted colossal oil reserves. In just 111 years since the first oilfield discovery in 1859, oil is moving from autumn to winter, and the reason is America's extraordinary consumption, which is one-fourth of the world's oil.

Moreover, the industry, lifestyle, and city types that consume much oil exist not only in the US, because since the second half of the 20th century they have moved also to western Europe and Japan. And since the 1990s China, India, and other emerging nations are attempting the transition to such energy-intensive lifestyles. This increasing world consumption threatens to exceed the point of peak oil.

Oil consumption data [37)] indicate that worldwide consumption in 2007 was 85,220,000 bpd, and in 1997 was 73,600,000 bpd, for an increase of about 27% in 10 years. In that decade consumption growth was only 2% in Eurasia, while in Japan it decreased 12%. Over the three decades since the oil shocks energy conservation for oil resources achieved advances in Japan and Europe, so that they decreased energy consumption even if their economies grew.

However, the US, which was the cradle of oil consumption civilization, continues to increase its oil consumption. In the decade from 1997 North American oil consumption grew 12%. Despite coming up against peak oil in 1970 and facing oil crises three times, the US kept increasing its oil consumption. Of course since the oil crises there were eight presidents, and energy policy changed somewhat with the changes in administrations, but as one can typically see in the "New Energy Plan" report under George W. Bush, the US continued to choose the oil consumption civilization, which necessitates expanding oil consumption.

What's behind this consumption growth? First, from 1975 to 2006 US population increased by a factor of 1.4. This differs from the stagnating populations of Japan and Europe, and is a cause of rising energy use. However, the increase in oil consumption far outstrips the population increase. Second, as an indicator of increasing oil consumption, the total distance driven by the US motor vehicle fleet monotonically increased two-fold over the three decades from 1975 right after the oil crises. In the 1980s per capita gasoline consumption decreased temporarily, but again rose starting in the 1990s, for a 1.6-fold increase over the entire three-decade period. The per capita number of registered vehicles increased from 0.6 to 0.8. Instead of public transportation, Americans used automobiles more than ever. Moreover,

36) Hasegawa, *The Struggle of Oil*, 29), pp.174-205.

37) Ibid. p.175, Fig.3-1, & Fig 3-2. McQuaig, Linda, *It's The Crude, Dude: War, Big Oil and the Fight for the Planet,* Doubleday, 2004. sct.7 at chp.5.

vehicles sold during the 20 years starting in 1987 got 900 pounds heavier, engine displacement nearly doubled, and fuel economy worsened by 8%. Although sport utility vehicles (SUVs) are heavy, get poor mileage, and have a high probability of fatal accidents, they are not subject to the mileage regulatory standards which apply to other automobiles. Not only does the US not try to quit the car, it also does not even try to make automobiles more fuel-efficient.[38] This shows that over the last 30 years Americans have made no serious effort to wean themselves off oil, and in fact chose to continue living in the "sea of oil."

· Dependence for Oil on the Gulf States

Like other oil importing countries, the US has depended mainly on imports from the Persian Gulf. Its main suppliers have been Saudi Arabia, Kuwait, and other Gulf states. The US government has maintained its hold on political leadership in the Gulf region by means of unofficial alliances with the regimes of Iran's Reza Shah, Iraq's Saddam Hussein, and the Saudi royal family. But the Gulf region, which holds two-thirds of the world's oil, saw the Fourth Middle East War in 1973–74, and the Islamic Revolution of 1979 in Iran. There was also the Iran-Iraq war of 1980–88 and the Gulf War of 1990–91, one of whose causes was the oil grab.

On each of these occasions the US exposed its weakness: dependence on oil from the Persian Gulf region. Officially and unofficially the US intervened militarily, and in 2003 it started the Iraq War. Because of the 1979 Islamic Revolution, Iran ceased to be a pillar of US hegemony, as did Iraq because of the Gulf War. Saudi Arabia's royal family was the only main ally remaining after the Gulf War. In Saudi Arabia there are objections to depending on the US for security while supporting the US with oil. The fact that many of the young men in the 9/11 hijackings were Saudi Arabian indicates the intrinsic instability of the unofficial alliance between the US and Saudi Arabia.[39]

7. The Arrival of Peak Oil and Peak Coal

Another focus is China, which achieved blistering economic growth and became "the world's factory." [40] According to the International Energy Agency (IEA), China's total energy consumption (everything including oil, coal, wind, and photovoltaic) surpassed that of the US in 2009 and became the world's largest. Its 2007 oil consumption was second in the world after the US, accounting for 9.3% of total world consumption. China criticized the IEA

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38) Nakamura Ken-ichi, "War Strategy of Saddam Hussein(Japanese)," in *Sekai*, April 1991. Klare, Michael, *Blood and Oil*, 33).
39) Hasegawa, *The Struggle of Oil*, 29), pp.206-299.
40) Ibid. p.265.

estimate claiming that it is inaccurate, but there is no longer any doubt that China's energy consumption is about the same level as that of the US, and that its energy demand continues to grow.

The biggest factor behind increasing consumption is economic growth; over the 30 years from 1978 to 2007, China's GDP grew six-fold and its energy consumption doubled. With the arrival of the 21st century China's energy consumption increased at a faster rate, and oil consumption in particular increased 1.6-fold in six years, from 4,920,000 bpd in 2001 to 7,855,000 bpd in 2007. Especially in 2004 oil consumption rose 17% over the previous year. Around 2004 China surprised the world by conducting a flurry of diplomatic meetings between heads of state around the world, especially in the Former Soviet Union and African countries, to secure long-term contracts to supply oil and mineral resources. China rapidly built giant tankers to import huge quantities of oil, and by the end of 2009 it built as many as 13 large oil storage bases.

· China Faced High Oil Prices on the Road to Development

China's energy situation differs from that of Japan, the US, and other countries. In 2007 China's per capita oil consumption was low, at 0.9 bpd. The "world's factory" is being squeezed between skyrocketing oil prices and environmental constraints just at the stage where its oil consumption is low. Although energy consumption is rising rapidly, the main energy source is coal, and not yet switched to oil. In 2007 oil accounted for only 19.7% (23% if natural gas is included) of China's energy, which is still 70.4% coal.[41] Since 2004 China has been hit by internationally high oil prices, and it is not easy to endure such high prices long even with China's deep pockets.

Gasoline for transportation is the main use of oil. For example, in 2007 China surpassed Japan in the number of new automobiles produced, and in 2009 surpassed the US, but per capita car ownership is 1/20th that of the US, and 1/10th that of other industrialized countries. McKinsey estimated that by 2020 China's fleet will triple, and one can see from this prediction that China is at the stage where automobile and gasoline demand increases explosively. It is predicted that if China's oil consumption keeps increasing at the present rate, in 2025 it will be about twice current consumption, and in 2030 China will depend on imports for 80% of its oil consumption.[42]

China has three large oilfields in its eastern region: Daqing, Shengli, and Liaohe, which make up 70% of domestic consumption. Starting in the 1970s, China increased its oil

41) International Energy Agency, *World Energy Outlook*, 2007.
42) Hasegawa, *The Struggle of Oil*, 29), pp.265-272.

production as an oil-producing country, and until the 1980s it exported to Japan and Singapore. China is the world's fourth- or fifth-largest oil producer, and can produce nearly half of its own oil consumption, which in that respect makes it different from India. Nevertheless, it could not keep up with rising domestic consumption, and in 1993 became an oil importer. In 2008 China was not only a crude oil importer, but also became a net importer of oil products.[43] In 2009 its dependence on oil imports exceeded 50%. Although China's government has hopes for the discovery of new oilfields in Xinjiang and other parts of the western region, even if quite large oilfields were discovered, they would do little to help with spiraling demand.

The IEA predicts that China's oil production will peak in the mid-2010s and then gradually decline. Oil production in the second of the two largest oil-consuming countries will peak when its demand is highest.

· Rapid Rise in Coal Demand

China's engine of growth is energy-intensive industries such as steel, cement, metals, and ammonia. Compared to the proportion of China's GDP in the world as a whole, China's production of steel, cement, and ammonia account for 31%, 47%, and 43% of total world production, respectively, which are very high percentages. Considerable portions of these are exported, with much of the final consumption being in the US, Japan, and Europe. What is more, energy efficiency in these industries is very poor because their energy-saving technologies are outdated.

More than anything else, coal powers the energy-intensive "world's factory." While the shift to oil has been making little headway in comparison with the economic growth rate, in the second half of the 1990s the proportion of coal in energy consumption tended to decline for a time, but from 2000 the proportion of coal again tended to increase, which pushed the proportion of coal in energy sources up to 70.4% in 2007. And in just the subsequent five-year period, coal production doubled.[44] Coal consumption continued growing at an annual rate of 9% in 2008 and 2009, and the amount consumed in the first quarter of 2010 (which would be 3 billion t on a yearly basis) increased an amazing 28.1% over 1Q 2009 ("China's coal bubble... and how it will deflate U.S. efforts to develop 'clean coal,'" Energy Bulletin, 4 May 2010). Under a conservative estimate, China will double its coal consumption in just eight to 10 years.

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43) Zhang Kunmin, "China in a Low-Carbon World; Its Role, Challenges and Strategies," Yoshida Fumikazu and Ikeda Motoyoshi, eds, *Sustainable Low-Carbon Societies*, Hokkaido University, 2010, pp.179-193.

44) Lafargue, Fransois, *Etats-Unis, Chine et Inde: A la Conquete de l'or Noir Guerre Mondiale du Petrole*, Ellipses, 2008.

China has the world's third-largest coal reserves, said by the World Coal Institute to be 110 billion t. This would enable China to maintain its 2010 coal consumption for 37 years, but if Chinese coal consumption grows at an average of 10% yearly, it will use all its coal in just 16 years (Chinese authorities give 187 billion t as China's official reserves, but it is clear that even if that figure is used, the current exponential energy increase will be impossible in the medium-term future). In the near future China will unavoidably face not only peak oil, but also peak coal.

Energy demand grows exponentially and getting coal is difficult. Therefore if China takes a path to rapid growth whose main energy source is coal, and coal consumption exceeds domestic production, China will perforce depend on coal imports,[45] and in fact China became a coal importer in 2007. In 2009 it imported 75 million t, and in 2010 it is on track to double that and import 150 million t, an amount equal to 60% of the total exports of Australia, the world's largest coal exporter. Is it possible to keep getting this much coal from abroad?

It is not, because India and other emerging nations going full speed ahead with development likewise depend on coal. Because India has no domestic oil resources and coal reserves that are only half those of China, its dependence on coal will probably become greater than China's. Both of these exponentially growing emerging countries are depending on coal imports in a bid to overcome the energy constraints of domestic coal, but compared to oil, which is an international commodity, coal accounts for much of domestic consumption, and the total amount traded internationally is small. It is therefore a thin market. Enormous coal imports by these two giants will likely soon push up the price of coal.[46]

China's rapid development and building of energy resources over the last 10 years has worsened environmental problems. On July 16, 2010 a pipeline explosion at Dalian caused a huge oil spill in the Yellow Sea. Chinese authorities say that in the first half of 2010 environmental accidents approximately doubled. As noted in Section 3, heavy consumption of coal worsens the environment much more than does oil. Further, the large number of coal-mining deaths (according to official 2009 statistics, 2,631 people died in coal-mine accidents) is a serious problem in China.

Summary

· Energy Demand

Demand in recent years can be described by the following five statements.

1. Regarding the developed countries, which have consumed much oil, the US consumes

45) Hasegawa, *The Struggle of Oil*, 29), p.273. Zhang Kunmin, "China in a Low-Carbon World," 43).
46) Lovins, Amory B., *Soft Energy Paths: Toward a Durable Peace*, The Friends of the Earth, 1977.

one-fourth of the world's oil and tends to increase its consumption, while Europe has leveled off and Japan's consumption is trending toward decline.

2. China, India, and other emerging nations have smaller per capita consumption than the US, Europe, and Japan, but their oil demand is skyrocketing. This and the emerging nations' oil demand will elevate oil prices.
3. Coal is the main energy source in emerging nations. Their main energy source will not switch from coal to oil, and coal consumption will rapidly increase. Their coal demand will make coal prices rise.
4. Because of the above factors, consumption of both oil and coal will tend to increase, and supply will be unable to keep up.
5. Rising energy consumption is leading to environmental deterioration.

· Energy Supply

1. Production in many existing oilfields has already peaked, extraction is becoming more difficult, oil quality is declining, and the marginal cost of production is rising.
2. Oilfield exploration is no longer able to discover fields which are large, of good quality, easy to drill, and near consuming areas. Many newly discovered fields are small, of poor quality, hard to drill, and far from consuming areas.
3. For both oil and coal, the age of "cheap energy" is over. In the medium to long term, energy prices will rise and fluctuate wildly.
4. Energy resources will transition from a non-zero-sum condition to a zero-sum condition, and there are concerns that confrontations will intensify due to factors such as supply instability and the scramble for resources.
5. Items 1 through 4 do not mean that reserves will physically run out. Considerable amounts of recoverable reserves will remain, but society will become destabilized and panic could readily occur.

· Soft Path

The idea behind the soft path is to hold energy consumption down to a level that can be maintained comfortably. This was called the "soft path" by Amory Lovins, the person who first proposed it.[46] Lovins says the soft path has the following five characteristics.

1. The goal for the medium-term future is to rely on renewable energy sources such as photovoltaic, wind, hydro, and tidal power. Unlike petroleum and other solar energy "savings," these are the flow of energy constantly coming to Earth from the sun,

46) Lovins, Amory B., *Soft Energy Paths: Toward a Durable Peace*, The Friends of the Earth, 1977.

regardless of whether humans use it.

2. Soft energy technologies are diverse. Instead of sending power over long distances from the huge power stations of giant electric utilities, soft energy can work because power is produced near demand and in response to the demand situation.
3. Soft energy sources are used by freely adapting natural energy existing everywhere. This contrasts with oil resources, which have an uneven geographic distribution.
4. With soft energy, the quality of energy ultimately needed is matched to the application, as with electricity for motive force, or for space heating or cooling.
5. Information on soft energy technologies is not monopolized by science and technology experts.

Energy Crisis as Global Problem

NAKAMURA Kenichi

Abstract

・Energy demand and supply in recent years can be summarized by the following ten statements.

1. Regarding the developed countries, which have consumed much oil, the US consumes one-fourth of the world's oil and tends to increase its consumption, while Europe has leveled off and Japan's consumption is trending toward decline.
2. China, India, and other emerging nations have smaller per capita consumption than the US, Europe, and Japan, but their oil demand is skyrocketing. This and the emerging nations' oil demand will elevate oil prices.
3. Coal is the main energy source in emerging nations. Their main energy source will not switch from coal to oil, and coal consumption will rapidly increase. Their coal demand will make coal prices rise.
4. Because of the above factors, consumption of both oil and coal will tend to increase, and supply will be unable to keep up.
5. Rising energy consumption is leading to environmental deterioration.
6. Production in many existing oilfields has already peaked, extraction is becoming more difficult, oil quality is declining, and the marginal cost of production is rising.
7. Oilfield exploration is no longer able to discover fields which are large, of good quality, easy to drill, and near consuming areas. Many newly discovered fields are small, of poor quality, hard to drill, and far from consuming areas.
8. For both oil and coal, the age of "cheap energy" is over. In the medium to long term, energy prices will rise and fluctuate wildly.
9. Energy resources will transition from a non-zero-sum condition to a zero-sum condition, and there are concerns that confrontations will intensify due to factors such as supply instability and the scramble for resources.
10. Items 6 through 9 do not mean that reserves will physically run out. Considerable amounts of recoverable reserves will remain, but society will become destabilized and panic could readily occur.

Keywords

oil, coal, energy consumption, energy supply, USA, emerging nations, oilfield, environmental deterioration.