Science for Sustainable Societies

Hiroshi Komiyama

Beyond the Limits to Growth

New Ideas for Sustainability from Japan

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Science for Sustainable Societies

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Books published in this series will be solicited from scholars working across academic disciplines to address challenges to sustainable development in all areas of human endeavors.

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Hiroshi Komiyama
Mitsubishi Research Institute, Inc.
Tokyo, Japan

ISSN 2197-7348 ISSN 2197-7356 (electronic)
ISBN 978-4-431-54558-3 ISBN 978-4-431-54559-0 (eBook)
DOI 10.1007/978-4-431-54559-0
Springer Tokyo Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013954961

This book is based on the Japanese Original by TOYO KEIZAI INC., Tokyo, 2011

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface to the English Edition

In 1972 the non-governmental organization Club of Rome published the landmark *Limits to Growth* (Meadows et al. 1972) a scenario-based analysis of 12 possible world futures to the year 2100. Its key messages were that the human ecological footprint cannot continue to grow for more than 100 years from 1972 at the rapid rate seen from 1900 to 1972; it is possible or even likely that this footprint will overshoot Earth's sustainable limits; once sustainable limits are overshot, contraction is unavoidable, but overshoot can be avoided through appropriate global policy.

At this moment in 2013 it would appear that our world has in fact followed the business as usual scenario of *Limits to Growth*, and that we have long since entered the trajectory of overshoot. Therefore, by the reasoning of *Limits to Growth*, a contraction of our collective ecological footprint is inevitable, either in the form of a planned contraction or a collapse.

I however believe that if we act, now and with resolution, to solve the pressing trio of energy, resource, and environment problems confronting us, there is still time to avoid a catastrophic future, while at the same time maintaining the standard of living now enjoyed in advanced nations, and allowing the developing countries of the world to reach that same advanced-nation standard. For this reason I have chosen *Beyond the Limits to Growth* as the title for this English translation of my 2011 book *Nihon Saisouzou* (literally, *The Revitalization of Japan*) (Komiyama 2011). This book is by no means intended as a criticism or rebuttal of the work of the Club of Rome. Rather, I here present my own (admittedly optimistic) view of how we all, in advanced and developing countries alike, can go about achieving a sustainable world whose development is not constrained.

I believe that it is not only imperative, but also very likely, that new technologies will emerge that will allow us to exceed the limits identified by the Club of Rome and to put societies on a trajectory in which wealth is measured in terms of quality rather than mere quantity. As I discuss in this book, these new technologies will be driven by a novel "creative demand" rather than by conventional "diffusive demand" and this, in turn, will contribute to the shift from quantity to quality in terms of goods produced to meet our needs for energy, materials, and health.

Fig. 1 Yokkaichi City in the 1950s (*left*) and the present (*right*). Source: Yokkaichi City. http://www.city.yokkaichi.mie.jp/kankyo/kogai/aramashi01.html

Let me here explain very briefly why I am optimistic about the future by offering just a few examples from Japan's experience which may not be well known to non-Japanese readers.

Japan rose from the ashes of the Second World War in 1945 to become the world's second largest economy in 1968 through a post-war economic miracle that began in the first half of the 1950s and continued through the 1960s. This Japanese miracle mirrored a similar phenomenon (the "Wirtschaftswunder") that also occurred during the same period in post-war West Germany.

Japan's post-war economic miracle, however, did not happen without very serious negative consequences, the environmental aspects of which are represented by three of the so-called "Big Four Pollution Diseases of Japan." These three are (1) Minamata disease, a neurological affliction caused by severe mercury poisoning, which was first identified in 1956 in Minamata City in Kumamoto Prefecture and was caused by methylmercury in wastewater discharges from a chemical factory; (2) a second outbreak of Minamata disease in Niigata Prefecture discovered in 1965; and (3) Yokkaichi asthma, a collection of pulmonary diseases (COPD, bronchitis, emphysema, asthma) caused by sulfur dioxide pollution from petrochemical facilities and refineries in and around the city of Yokkaichi in Mie Prefecture from 1960 to 1972 (Fig. 1) (The fourth of these Big Four is Itai–itai disease, severe bone degeneration caused by cadmium poisoning that resulted from mining operations in Toyama Prefecture beginning around 1912.) (Ministry of Environmental Japan Web-Site 2013).

The extent of the environmental damage suffered as a consequence of Japan's rapid economic expansion from the 1950s to the 1970s is by no means limited to only the three epidemics mentioned above. The environmental contamination of the skies and of major bodies of water, such as—among many others—Suruga Bay on the Pacific coast of Honshu near Mount Fuji, the Sumida River running through Tokyo (Fig. 2), Dokai Bay in Kitakyushu City (Fig. 3), and Lake Kasumigaura northeast of Tokyo, was absolutely dreadful, as can be seen in the nearby pictures. Indeed it would be no exaggeration to say that the pollution of that era extended throughout the entire country.

Fig. 2 The Sumida River in 1967 (*left*) and now (*right*). Source of *left*: Ministry of the Environment, Summary of Annual Report on the Environment in Japan 1983 (JPY only). http://www.env.go.jp/policy/hakusyo/zu/eav11/eav110000000000.html#2_1. Source of *right*: Tokyo Houseboat Guide (JPY only). http://www.t-yakata.com/tyh_dkship.htm

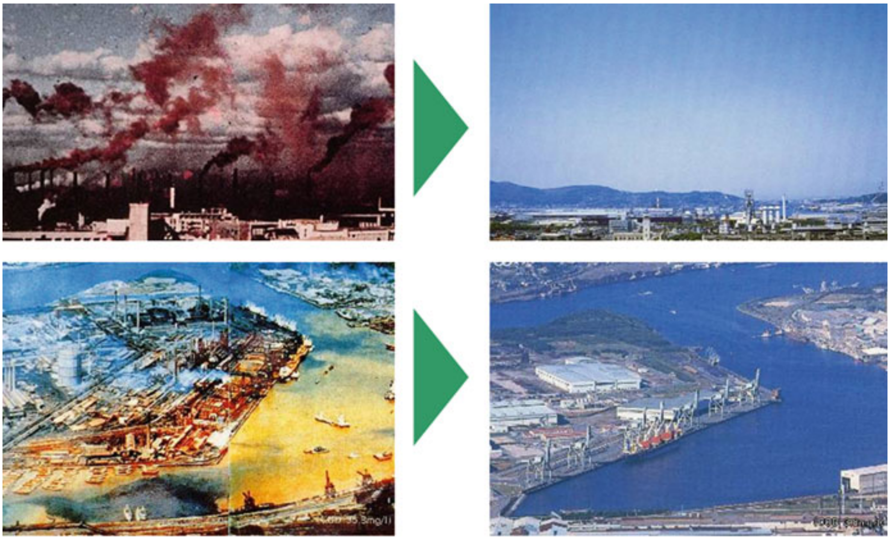

Fig. 3 Kitakyushu in 1960 (*left*) and now (*right*). Source: Kitakyushu City. http://www.city.kitakyushu.lg.jp/kankyou/file_0269.html

Faced with these environmental problems, Japanese industry developed the technologies to remove harmful substances from the emissions of industrial facilities and eventually overcame the severe problem of environmental pollution. In Japan, because it came to a situation where people were being directly harmed, the pollution problem had to be solved; the central government imposed emissions regulations on noxious substances, then municipalities topped these with their own strong emissions regulations, and the manufacturing industries complied with these regulations. Today, Japan is not only one of the leading industrialized nations, but it is also a country of clean urban centers and pristine rural landscapes, as the many foreign visitors to Japan each year can attest.

Just as it overcame grave environmental problems, so too has Japan surmounted equally serious energy supply crises. Japan is a country markedly poor in the hydrocarbon energy resources of oil, natural gas, and coal. With proven oil reserves amounting to a mere 44 million barrels, Japan's reserves would only meet its consumption needs for roughly ten days. As a consequence, Japan imports virtually 100 % of its petroleum. Similarly, Japan produces domestically less than 5 % of the natural gas it consumes, and about one-half of one percent of the coal it consumes.

In fact, Japan has long been heavily reliant on overseas sources for its fossil fuel needs. In 1973 the First Oil Shock occurred, followed in 1979 by the Second Oil Shock, causing the price of crude oil to skyrocket. Responding to this experience, Japan developed energy-saving technologies that raised energy efficiency and was able to admirably overcome the crisis. In the manufacturing sector, for instance, highly energy-efficient production methods for materials such as cement and steel were born. In processing and assembly industries, the automobile industry developed high fuel-efficiency small cars, building the foundations to later increase international competitiveness.

To take the cement industry as an example, Fig. 4 shows the amount of energy consumed in producing one ton of cement from 1960 to the present in Japan, the United States, and several European countries. Cement is made using limestone, clay, silica, etc. as raw materials, but because it involves an endothermic reaction, energy is always required. In the production of cement, Japan's energy efficiency is overwhelmingly better than that of other countries.

Japanese cement companies, by frantically improving the production process from wet process to dry process to suspension pre-heater (SP) and then to the new suspension pre-heater (NSP) process, have up until now reduced energy consumption. At present, all of the cement plants operating in Japan have adopted the newest NSP process. As a result, energy efficiency has already come down to 1.6 times the theoretical limiting value, to the point where further reductions are difficult.

But globally speaking, there is still room for improvement. If we look at the entire world, there are many countries where energy consumption for cement production can be reduced. As can be seen in the Fig. 4, for instance in the U.S. producing one ton of cement uses 1.6 times the amount of energy used in Japan. The reason is that the U.S. has adopted a policy of holding energy prices down to a cheap level. Likewise, China, which produces more than half the world's cement, uses 1.6–1.7 times as much energy as Japan.

The very same kinds of cutting-edge solutions have been applied not only to cement-making, but also to many of Japan's manufacturing industries. Why was this so? It is because Japan had to deal with high energy prices, and in the attempt to surmount this challenge, technological improvement has been relentlessly pursued.

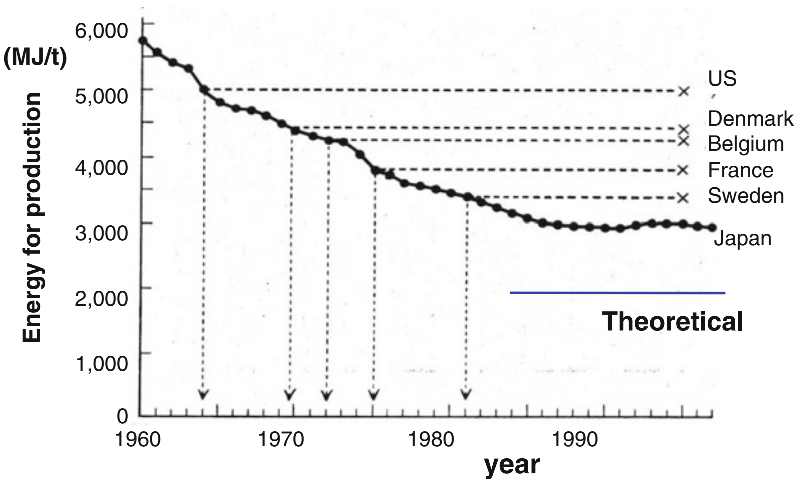

Fig. 4 Energy consumption for cement production. Source: Japan Cement Association

Just as Japan was able to solve the past environmental and energy problems that accompanied its post-war economic growth, I am confident that Japan has what it takes to solve the new problems it now confronts: a graying and shrinking population; the need to create new demand in the face of saturation in demand for existing products; the imperative to reduce carbon dioxide emissions by increasing energy efficiency still further and developing renewable energy sources; the establishment of a material-cycling society to cope with the mineral resource limitations of our finite Earth.

These solutions will benefit Japan directly, but moreover they can provide a model for the rest of the world, since Japan is in fact coming up against these many problems in advance of other nations; in other words, Japan is not merely an advanced nation saddled with problems, but a nation saddled with problems in advance. In thinking about this background and Japan's past achievements, I am optimistic that Japan will not remain a "problem-saddled advanced nation," but rather will use its power to leap forward as a "problem-solving advanced nation"—that is, a forerunner in addressing emerging problems in the world.

Key Features of Our World in the Twenty-First Century

In approaching the many problems discussed in this book, it is important to bear in mind four essential trends that characterize our world as it enters the twenty-first century. Let me offer a brief sketch of these four defining features here.

The first feature is the remarkable explosion of wealth that occurred first in what are now the developed nations and that is presently occurring in the developing world. As can be seen in Fig. 5, which plots Gross Domestic Product (GDP) per

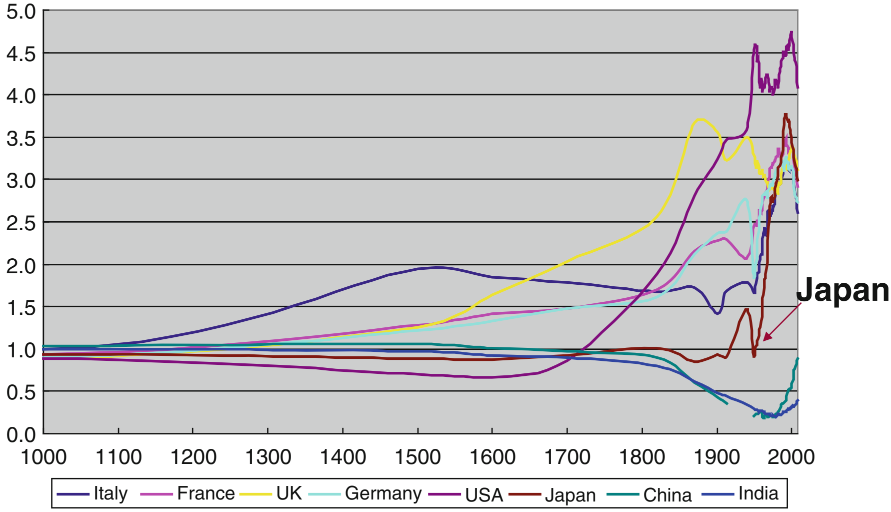

Fig. 5 Per capita GDP of select nations, normalized to that of the entire world. (Data from Angus Maddison: The Conference Board Total Economy Database (http://www.conference-board.org/data/economydatabase/))

person (normalized to that of the entire world) from A.D. 1000 to 2008 for the major industrialized nations as well as India and China, there is a familiar pattern to this wealth explosion.

For century after century through the Middle Ages per capita GDP was stagnant, but with the advent of the Industrial Revolution, first the United Kingdom, followed in succession by the United States, then France and Germany, Italy, and finally Japan, enjoyed almost exponential growth in per capita wealth. Of course these trajectories saw some sharp drops from the effects of depressions and wars, but the pattern is clear. Also striking is the fact that economic growth in the industrialized world has flattened out in recent years.

As still-developing nations, China and India stand in contrast to the other nations shown in the graph. Since they did not experience the Industrial Revolution in the nineteenth and early twentieth centuries, their per capita GDPs relative to that of the entire world actually began a slow decline after approximately 1800. However, it is clear from the shape of their growth curves from the late twentieth century that India and China too are embarking on the same trajectory that the world's industrialized nations followed decades earlier. We may expect that in time China and India too will reach the status of industrialized nations just as Europe, the United States, and Japan did previously. In the conditions of developed countries, normal citizens have access to food, clothing, shelter, mobility, and information. Once these basic material needs are met, what people desire is satisfaction. I believe that this desire will create new demand for growth.

The second key feature of our modern world is longevity, a natural consequence of the wealth explosion. Figure 6 shows the change in life expectancy for several countries over time. The huge leaps upward in life expectancy are most pronounced in the industrialized world. For instance, Japan's life expectancy in 1950 was 61 years,

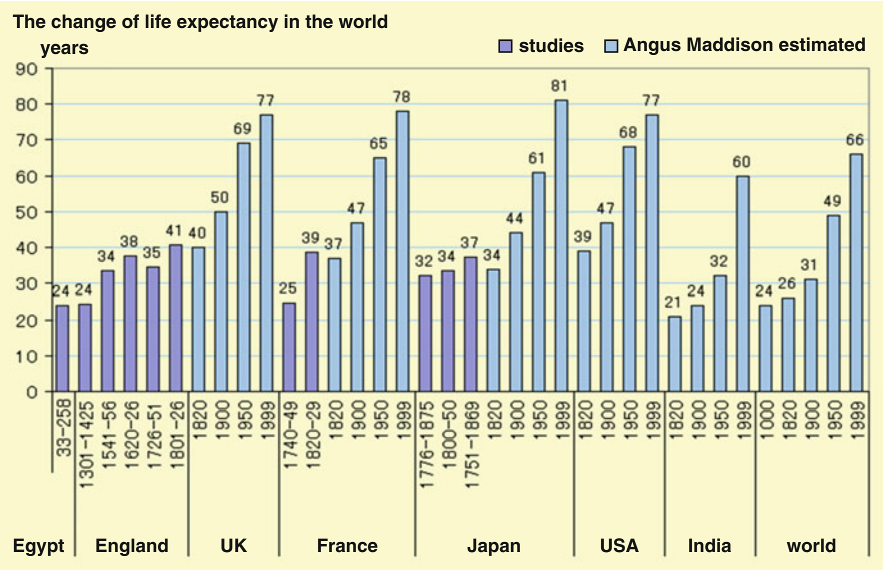

Fig. 6 Change in life expectancy. Source: http://www2.ttcn.ne.jp/honkawa/1615.html

the shortest among industrialized countries, but by 1999—in the span of just two generations—it had jumped to 81 years, at that time the longest in the world.

Although the gains in longevity are largest in the industrialized world, industrializing nations like India are also enjoying the lengthening of life spans. Just as China, India, and other developing countries are now tracing the upward trajectory in wealth that was experienced earlier in advanced nations, so too will they follow the same course of expanding longevity. Long life in itself is an undeniably good thing. The challenge, as I discuss in this book, will be in re-ordering our societies in such a way that the growing numbers of elderly citizens can find satisfaction in their lives and continue to contribute to community life.

The third feature is the saturation of man-made objects that inevitably occurs in developed countries. Whether the man-made object (i.e., the product) is a television, an automobile, housing, or a building material such as cement, when the product is first introduced no one yet possesses it, but it begins to diffuse throughout society and rather quickly reaches the state of saturation, wherein new demand for it can no longer grow. An example of this phenomenon is shown in Fig. 7, which plots cement production per person over time in Japan, the U.S., France, and China.

Cement production in the U.S., Japan, and France shows a similar pattern of growing from near zero but then eventually reaching a plateau, which corresponds to the demand arising from the need to replace old, existing concrete structures. Clearly China is still in a phase of expansion, but someday soon it too will reach saturation. The key issue for the world in the twenty-first century related to this saturation phenomenon will be how to cope with the corresponding demand ceiling. In this book I propose a way out through "creative demand" for new products that will be invented to deal with the needs of the future.

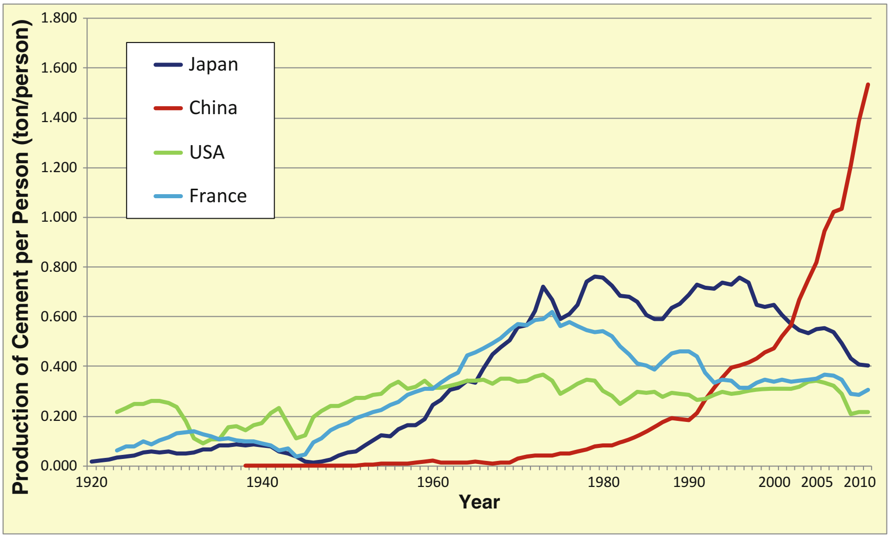

Fig. 7 Production of cement per person. (Data of Cement production volume: United Nations Statistical Yearbook. Data of Population: UNSD Demographic statistics, United Nations Statistical Yearbook)

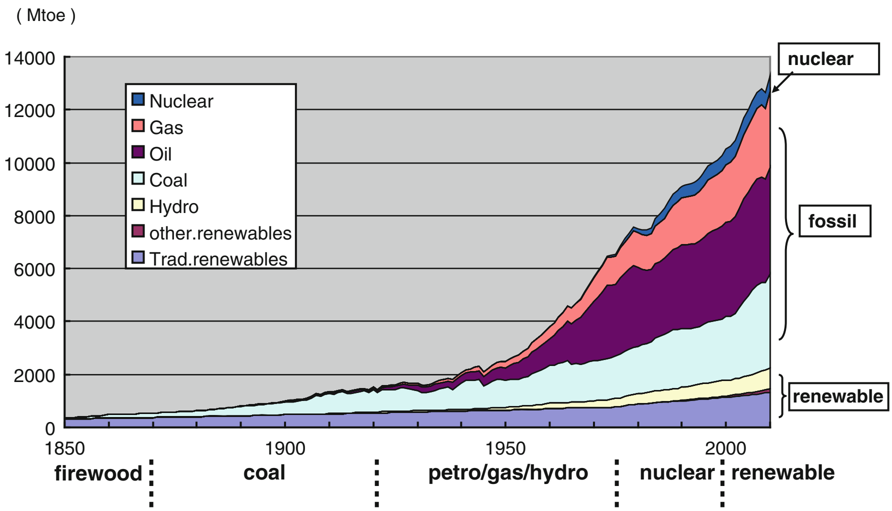

Fig. 8 World primary energy consumption, 1850–2010. (Data from Arnulf Grubler, 1998 BP Statistical Review of World Energy, 2008 and others)

The fourth and final main feature of the twenty-first century world is the ongoing progression in energy sources that humanity uses to meet its needs. For millennia humankind used biomass in the form of wood. Then with the Industrial Revolution began the widespread use of coal, which is still very much with us today as a fuel for base load electricity production. For other purposes, such as rail and sea transportation, coal steadily gave way to petroleum beginning in the early twentieth century. Recent years have seen the increased use of natural gas as a fossil fuel source. Starting in the 1950s nuclear power was introduced as a civilian energy source, and now accounts for just over 5 % of the world's total supply of primary energy. These trends can be seen in Fig. 8.

It seems quite likely to me that the world will undergo a shift from fossil-based fuel sources to renewable fuel sources in the twenty-first century. This will happen as a result both of the slow depletion of non-renewable and low-cost fossil sources, and also of humankind's efforts to reduce carbon dioxide emissions. How this fundamental shift in the world's energy supply can be brought about is a central topic of this book.

Overview of This Book

In Chap. 1 I begin by explaining the true nature of the demand shortage in advanced nations. Introducing the concepts of "diffusive demand" and "creative demand"—namely, demand for things that already exist and demand for things that have not yet taken shape, respectively—I explain that diffusive demand will necessarily saturate as a given man-made object, such as an automobile, a house, or a television, reaches every part of the population in sufficient quantity. When a man-made object reaches saturation, new demand, which arises when people who do not possess something acquire it for the first time, vanishes, leaving only replacement demand, which comes from replacing or renewing something acquired previously. Concrete examples of the saturation process for housing, automobiles, and televisions in Japan and other advanced nations are given. I argue that the fundamental shift in the nature of demand to replacement or renewal demand, caused by the saturation of population and of man-made objects, lies at the heart of the demand shortage that plagues advanced economies.

Moreover, many advanced nations such as Japan are now seeking relief from the demand shortages they are experiencing in their saturated domestic markets by expanding into developing countries such as China and India. However, by looking in detail at examples such as cement and automobiles, I show that developing nations like China are themselves following the same trajectory toward saturation that Japan once traced. Therefore, sooner or later China and other developing nations will likewise reach a condition of saturation.

Furthermore, because the quantity of demand is necessarily higher before the saturation condition is reached as compared to after it is reached, an overcapacity of production is bound to be introduced in the pre-saturation phase that will saddle the economy in the post-saturation phase. As an example, Japan's automobile industry has been able to cope thus far with the saturation of the domestic market (and accompanying domestic production overcapacity) by using the excess capacity for exports first to the United States, and now to China, and to India in the future.

But because the global market will saturate one day, likely sooner than is generally thought, this is not a sustainable strategy for all time.

Having described the above situation, I suggest at the close of the first chapter that a solution for Japan lies in stimulating "creative demand" for products that have not yet come into existence. In fact, because problem-saddled developed country Japan is preceding the rest of the world in running into problems of a graying society, and energy and resource scarcity, and the environment, it is in an optimal position to generate new "creative demand" by working out solutions to these burdensome issues. Indeed, it is this very demand that will become the foundation on which Japan can break loose from the past decades of economic stagnation and once again prosper.

In Chap. 2 the discussion continues with the identification of what I believe the new paradigms of the twenty-first century will be: exploding knowledge, limited Earth, and aging society. Chapter 2 considers in detail the first of these paradigms, that of exploding knowledge. Although the explosive growth in human knowledge has been undeniably beneficial, it has brought with it a negative legacy as well: the problem that an increase in knowledge has made it extremely difficult to grasp the whole picture.

Furthermore, by discussing the past Nobel Prize-winning achievements of the discovery of penicillin, the invention of the transistor, and the meson theory of nuclear interactions, as compared to the more recent neutrino experiments, I argue that as science has developed and become compartmentalized into numerous specialized areas, the distance between human values and science has gradually increased.

Since it is unlikely that we will ever get rid of compartmentalization, what is important is whether we can integrate a vast body of compartmentalized knowledge in accordance with our objectives and create the whole picture as a solution for achieving our objectives. Humanity must work seriously on creating a method that makes this possible; I call this method of integrating compartmentalized knowledge "knowledge structuring." Humanity will be able to solve many of the problems it confronts today if knowledge is structured, if Information Technologies (IT)—which is particularly good at accumulating and searching for information—is used successfully, and if meaningful discussions are carried out that can bring a flash of insight, neither deductive nor inductive, from a small number of clues at hand.

Since the end of the twentieth century, the speed of information transmission has exceeded the speed at which Adam Smith's "invisible hand" operates—the mechanism by which the free market achieves an optimal distribution of resources through intermediaries of the price, regardless of individual wills. In consequence, as was revealed by the financial crisis in 2008, a mechanism has been established whereby the informationally strong obtain information instantly by taking advantage of an information divide (informal gap) and use it to exploit the informationally weak. As a result, the market, far from coming into equilibrium, has often run away and become more uncertain. The consequences of this acceleration of information speed on the energy situation are also discussed.

In concluding Chap. 2, I show how information technology has the potential to solve many problems in society by presenting the Japanese example of Tōno City in

Iwate Prefecture, which has managed to cope with a shortage of doctors using the Internet. In a similar way, information technology may be able to provide fundamental means for solving problems in many areas besides medical care, including education, transportation, and agriculture.

Chapter 3 takes up the second of the big paradigms, that of the limited Earth, and introduces “Vision 2050” as a proposed solution to the three interrelated problems of energy, resources, and global warming. “Vision 2050” is a comprehensive model for achieving sustainable societies, which was originally proposed in 1999 (Komiyama 1999). This model has been disseminated not only as the Japanese-version original book, but also in an English version as well as a Chinese version (Komiyama and Kraines 2008) (Komiyama 2001). Under assumptions of growth in developing nations and maintenance of living standards in developed nations, the model envisions attaining sustainability by 2050 by meeting three main challenges: (1) triple energy efficiency, (2) build a system for material cycling, and (3) double the use of non-fossil fuels.

By examining in detail the case of automobiles as an example of energy consumption during product use, we show that in the future, even if the number of vehicles in the world grows to triple the current number, because the amount of gasoline consumed by each is expected to be one tenth the level now, the total energy used will be about one third. Similarly, taking cement as an example of energy used to produce something, it is seen that there is still great room for reducing energy consumption in manufacturing through the adoption of advanced technology. The improvement of the entire world’s energy efficiency can be brought about by the development of state-of-the-art technology and the transfer of established technology.

The construction of a “material cycle system,” i.e. a recycling society, is next explained. Considering the costs of manufacture vs. recycling for steel and aluminum, the two metals used in greatest quantity, we show that recycling vastly reduces energy consumption—by a theoretical factor of 27 for steel and a practical factor of 30 for aluminum. In this chapter, I explain how “urban mines” are no urban myth, as discarded industrial objects contain a much higher concentration of precious materials like gold and lithium than mineral ores do. Three requirements are necessary to successfully re-circulate resources: a societal system for recovering resources, product design that allows for easy separation of resources, and the technology for separation.

Turning to the third goal of doubling the use of non-fossil energy, we note that in around 2050 roughly three times more energy than now will be used on Earth, but consistent with the first “Vision 2050” aim of tripling energy efficiency, the total amount of energy consumed in 2050 will be no different from the present. Given this, the proposal of “Vision 2050” is to reduce the share of fossil fuels from the current 80 to 60 %, and to raise the share of non-fossil fuels from 20 to 40 %. Nuclear fission will likely be necessary as a transitional energy source until the twenty-second century. I further argue that there are only four types of renewable energy that during the twenty-first century can grow to the scale of at least one percent of total energy supply: hydro, solar, wind, and biomass. Regarding biomass, I explain why using food crops for fuel is not an option; instead I propose that for the large-scale introduction of biomass, using seawater to grow algae in the desert is full of promise.

It is shown that carrying out “Vision 2050” will lead to a 25 % reduction in worldwide carbon dioxide emissions by 2050, leading to a carbon dioxide concentration of 460 ppm. This stands in sharp contrast to a business-as-usual scenario (really a breakdown scenario) in which emissions more than triple and the carbon dioxide concentration reaches 600 ppm. I argue that this is a vision on which advanced and developing nations can agree, as energy consumption in advanced nations will be reduced by two thirds and their carbon dioxide emissions will be cut by 80 %. At the same time, in keeping with the due right of developing nations to continue growing in order to become advanced nations, the two-thirds reduction of energy consumption in the developed world will be allotted to developing nations to support their economic growth.

The topic of fostering “creative demand” in the areas of environment and resources is explored in Chap. 4. I propose to break down energy consumption from the perspective of making things and daily life, and I discuss how the relative size of these two broadly defined end-uses differ in China, the U.S., and Japan. Considering the world situation and the differences among countries, it is concluded that the strategy Japan should adopt is to lead the world in energy saving in making things and to reduce greenhouse gas emissions in daily life.

The structure of energy consumption in households and in office space is discussed. Since air-conditioning accounts for 30 % in both cases, the theoretical limit of an air-conditioner’s performance is explained, showing there is still great room for improving energy efficiency.

Next the Porter Hypothesis is introduced, which says that environmental regulation of domestic companies leads to their enhanced international competitiveness (Porter 1991). In support of this hypothesis, the cases of automobile exhaust gas regulations by Japan’s Clean Air Act and of environmental regulations for cultivating Dutch tulips are raised.

Returning to air conditioning in Japan, it is shown that because insulation is poor for historical reasons and there is easily room to increase energy efficiency threefold by improving insulation, and because the efficiency of the air-conditioning unit itself can be raised fourfold, it is quite possible to reduce energy consumption for air conditioning to one-twelfth the present level.

The discussion of the first segment of Chap. 4 is summarized in three conclusions: (1) room for innovation lies in the difference between the theoretical limit and the current reality of a product; (2) a rational technological prediction is important in imposing environmental regulations; and (3) the technological prediction is also important in making a policy in light of the economic impact of environmental regulations.

As a case study of a past failure of Japanese industry in “diffusive demand,” the history of DRAM (dynamic random access memory) manufacturers is introduced. Next the Galapagos syndrome is discussed, referring to the fact that Japanese products, in spite of their high performance, have not become the global standard as they have evolved endemically in an island and are highly priced. One key cause of the high price is the large number of Japanese manufacturers of a given product, leading to small production volumes for a given unit and therefore a higher unit cost. This problem could possibly be solved by bringing about a consolidation of manufacturers in an industry into perhaps two companies. Related to this issue of the need for company consolidation, the recent declining state of the Japanese solar panel industry is also discussed.

Chapter 4 concludes with a treatment of Japan's world-class energy saving devices in the important household water-heating domain, namely Eco-Cute (an electric heat pump for water heating) and ENE-FARM (a residential fuel cell), and what should be done for such energy-saving equipment to capture the world market without repeating the earlier failures of dynamic random-access memory (DRAM) and solar cells. It is absolutely vital to think thoroughly about how to forestall the low-cost imitation of these products by overseas makers and seize the global market, on the assumption that ENE-FARM and Eco-Cute will be copied. Specifically, an attempt should be made to reduce costs through their introduction to the Japanese market through citizens' action and governmental support.

Chapter 5 addresses the fact that Japan has a society that is aging at a rate unprecedented in any country. Scientific research results indicate that people can age in good health if five conditions are met: (1) nutrition, (2) exercise, (3) communication with others, (4) openness to new concepts, and (5) positive thinking. These conditions can be called the "five conditions for happy aging."

It is suggested that senior citizens may be able to contribute to education in a broad sense by taking advantage of their wisdom developed as a social resource. Since school teachers today are stretched by their duties, participation in school education by people having sufficient social experience would produce significant synergies in coordination with teachers. Moreover, in recent years educational venues have been losing diversity both on the teachers' side and on the students' side; people with more diverse experiences, such as senior citizens, might help to correct this situation.

It is advisable to send about three sufficiently experienced working people, for instance, to each elementary school or junior high school as instructors to give lessons at least three times a week. In the new educational system, once chosen as teachers, experienced working people would of course take charge of fewer class sessions than regular school teachers, but should be prepared to stand on the lecture platform even for a single class session throughout the year. Their annual income might be $10,000 to $20,000 at most: many senior citizens have generous financial resources, including annuities, and thus want to contribute something to society rather than expect monetary rewards. The point is that the involvement of committed senior citizens in education would contribute significantly to bringing diversity to educational venues, as well as making their lives worth living.

Agriculture, forestry, and fisheries are also industries that can make efficient use of the abilities of senior citizens. As various proposals are considered for increasing the productivity of agriculture, such as facilitating the entry of private businesses into the market or introducing efficient large-scale agricultural systems, and for restoring the forestry industry, such as establishing a Forest Stewardship Council

(FSC)[1] certification system, senior citizens should be given opportunities to participate in these new agricultural and forestry initiatives. They might work as either regular employees or volunteers. If the work is physically too demanding, they should not be required to work every day or on a full-time basis. They may engage in growing high value-added safe and delicious farm products that require special care and close attention to cultivate.

The chapter concludes with a plea not to fear globalization. There is an opinion that globalization will damage Japan's agricultural industry as much cheaper farm products would be imported; however, Japanese consumers would not choose products based only on price, as products can also compete in terms of security, safety, and delicacy. Not all products need to be evaluated globally on the basis of price alone. In discussions over globalization, we tend only to fear that price competition would prevail in the market, eliminating less competitive businesses. I believe that markets will be divided into two groups in the future—one that is standardized globally and is composed of globally competitive markets and the other which consists of localized markets.

The final chapter introduces the "Platinum Society Plan," a vision for simultaneously solving the serious problems arising from the new paradigms of the twenty-first century—"exploding knowledge," "limited Earth," and "aging society." These problems include a declining population, a rapidly aging society, deteriorating urban infrastructures, sagging dynamism of local cities, dilapidated farmlands, expanding budget deficits, and growing global environment problems.

To generate creative demand, I propose the idea of the "Platinum Society," which pursues the construction of a comfortable life in each region. The word "platinum" implies an exceptionally high-quality comfortable society realized by organic combination of three innovations: "green innovation," pursuing an ecological low-carbon society; "silver innovation," intending to achieve a dynamic aging society in which all people participate; and "golden innovation," designed to build a society where people keep developing themselves by effectively using IT.

The purpose of the Platinum Society Plan is to improve the lives of citizens at their initiative through coordination with industry, government, and academia. However, their activities would not bear fruit if they are carried out separately in individual regions, because the amount of data and information owned by each region is so limited that sufficient demand would not be generated to create new industries or raise a voice strong enough to reform the legal and social systems. Thus the Platinum Society Network was established in 2010 to facilitate the solution of common issues facing various regions through exchange of information and ideas. The accumulated efforts of all regions to improve daily lives would stimulate enormous demand to develop new industries.

A brief overview is given of how the Platinum Society Network seeks to meet its objectives through such activities as the Platinum Vision Working Group, the Platinum Vision Handbook, and the Platinum Vision School.

[1] The Forest Stewardship Council is an international NPO headquartered in Bonn, Germany, that was established in 1993 to further the sustainable management of the world's forests. One of its main activities is the certification and labeling of sustainable forest products.

Just as the key to revitalizing and strengthening Japan lies in the courage to create the society we Japanese ourselves want and the power to make from scratch the things to support that society, so too must other advanced countries themselves determine their own future. I sincerely hope the people of other nations feel drawn toward our concept of a Platinum Society. Because Japan's problems are ultimately the world's problems, I believe the concept may be more widely accepted by the world.

Acknowledgments I thank Mr. Yutaka Nakahara, Dr. Daniel Walter, and Mr. Toru Hashi of Mitsubishi Research Institute, Inc., Mr. Ryuji Konishi, Chairperson of Japan Family Business Research Institute and the Secretariat of Platinum Society Network, for their help in preparing this English book.

Tokyo, Japan Hiroshi Komiyama

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Introduction to the Japanese Edition

From Problem-Saddled Developed Country to Problem-Solving Developed Country

For some time now I have been calling Japan a "problem-saddled developed country." This is an indisputable fact. Japan is not endowed with natural resources, and damage from environmental pollution is easily incurred. The dual phenomena of low birthrate and aging population are also rapidly growing more serious. The overcrowding of the cities and the depopulation of the countryside alike are grave. The food self-sufficiency rate is low.

However, in the near future, the rest of the world will be confronted with the same problems that Japan now faces. In this sense Japan is taking on the world's problems ahead of the others. In other words, Japan is not merely an advanced nation saddled with problems, but a nation saddled with problems in advance.

Japan Possesses the Untapped Power to Solve Its Problems

I believe that Japan does have the capacity to solve these problems.

For instance, let us consider the pollution issue. Japan is an advanced industrial country where land is limited and many people dwell. Because a large number of people reside near factories, pollution problems readily occur. Even in such countries as the United States, Russia, or China that have vast land area, many harmful substances like sulfur oxides are discharged. However, even if the forests die out, because not many people live close to industrial areas, the direct harm inflicted on people is limited. In Japan's case, during the period of high economic growth from the 1950s to the 1970s, such diseases as Minamata disease, Itai–itai disease, and Yokkaichi Asthma were caused by pollution, and the environmental contamination of Suruga Bay, Dokai Bay, Sumida River, and Lake Kasumigaura, among other bodies of water, was dreadful. It is no exaggeration to say that the pollution of that era extended to the entire country.

Faced with this problem, industry developed the technologies to remove harmful substances and overcame environmental pollution. In Japan, because it came to a situation where people were being directly harmed, the pollution problem had to be solved; the central government imposed emission regulations on harmful substances, then municipalities topped these with their own strong emission regulations, and the manufacturing industries complied with these regulations.

The same may be said regarding energy, as well. Japan imports nearly 100 % of its petroleum. In 1973 the First Oil Shock, and then in 1979 the Second Oil Shock, occurred, causing the price of crude oil to skyrocket. Responding to this experience, Japan developed energy-saving technologies that raised energy efficiency and admirably overcame the crisis. In the manufacturing sector, for instance, highly energy-efficient production methods for materials such as cement and steel were born. In processing and assembly industries, the automobile industry developed high fuel-efficiency small cars, building the foundations to later increase international competitiveness.

To take the steel industry as an example, the technology for blast furnaces originally used to make steel was essentially introduced from overseas, but the production methods that increased energy efficiency were researched and developed in Japan. In the steel-making of former times, when a thin sheet was being made, after the iron from the blast furnace was first cooled, its temperature was then raised and the metal worked in a process that was repeated again and again. But once the continuous casting method was developed, it became possible to work the steel into a finished product in one stroke without, to the extent possible, cooling the steel. This continuous casting method (also called “strand casting” in English) contributed the most greatly to the improvement of energy efficiency in steel-making.

Furthermore, the technology known as blast furnace top-pressure recovery turbine (TRT) generation was developed, further raising energy efficiency. In this top-pressure electricity generation, the blast furnaces of a steel mill are used as a source of power. The gas from a blast furnace generated in the process of making steel has a high pressure; at this pressure the gas is used to turn a turbine generator and make electricity.

Moreover, the coke necessary for making steel is produced by placing the raw material—finely grained coal powder—into a furnace and baking it. In that process the coke emerges from the furnace red-hot, and it is cooled by blowing argon gas over it. Because the argon gas blown over the coke contains heat, this heat too is put to use. Since every possible means, such as these, to raise the energy efficiency have been devised, Japan has been able to realize the world’s highest energy-efficient plants.

The very same kinds of means have been applied not only to steel-making, but to many of Japan’s manufacturing industries. Why did this become so? It is because Japan had to deal with high energy prices, and in the attempt to surmount this challenge, technological development has been incessantly carried out.

Japan possesses the experience of having solved the environmental pollution and energy problems, and so now it is able to sell these technologies overseas.

The size of Japan’s economy reached the rank of No. 2 in the world in 1968. At that time Japan, already a problem-saddled advanced nation, was not crushed by these problems, but rather recorded a splendid history of fostering competitiveness by solving these problems.

In the background that made this possible are a diligent national character and the strength of public consensus to undertake technological development in order to solve problems. Although there are a number of problems in Japan's educational system, viewed internationally the Japanese level of education is generally high. In this sense, in Japan there does exist fundamental human talent.

In thinking about this background and these achievements, I am confident that Japan will not remain a "problem-saddled advanced nation," but rather will use its power to leap forward as a "problem-solving advanced nation"—that is, a forerunner in addressing emerging problems in the world.

The Good Fortune of Being Located in Asia, the Core of Economic Growth

In addition, what is favorable for Japan is that the problems Japan now has on its hands will be the problems that the future world will confront.

If the world continues on its current path, the population increase of developing nations and rising incomes will probably combine to cause the environment of the entire world to worsen, resources to run short, society's graying to grow more serious—the entire world will fall into the same condition that Japan now finds itself in.

Taking for instance the problem of an aging population due to a low birth rate, Japan's total fertility rate is 1.41 children per woman. For China, which adopted its one-child policy, the rate is 1.58 and for South Korea, which has become an advanced country, it is 1.30, falling short by a wide margin of the 2.08 necessary to sustain a population. (The data for Japan is as of 2012; for China, as of 2011; for South Korea, as of 2012.) South Korea is forecast to enter the era of the graying population around 2020, and China around 2030.

Generally the graying of society exerts a negative influence on economic activity. The burdens of pensions, health care, and nursing grow larger. But it goes without saying that longevity itself is a delightful thing. For elderly citizens and for society alike, can a workable aging society be realized or not? Therein lies the question. There is absolutely no doubt that this realization of a good aging society is a challenge that, mobilizing all its heretofore cultivated wisdom, humanity must take up.

Hence, it is necessary for humankind as well that Japan solve the problems now confronting it. Examples of such solutions include high energy-efficiency production technologies and product development, the spread of energy-economizing homes, new tailor-made medical treatments, transportation and medical systems that can deal with both depopulated and overcrowded areas, as well as the creation of new manufacturing industries and social systems that can support an aging society.

For Japan the point more advantageous than any other is that it lies in Asia, the engine of global economic growth for the time being. This surely is a blessing of fortune for Japan.

Let us for instance consider medical care. In general, it is believed that if one's cholesterol level is high, the probability of a cerebral hemorrhage occurring is elevated, but this conclusion was derived based on data pertaining to Westerners. So long as the investigation is restricted to Westerners, indeed a connection can be inferred between high cholesterol levels and the incidence of the disease.

On the other hand, what is the situation for the case of the Japanese? Compared to Westerners, cholesterol levels overall are low, and there is not much correlation with incidence of cerebral hemorrhage. For Japanese, it is said that what is important is not whether the cholesterol level is high or low, but changes in the level. If levels begin to rise, caution is warranted.

As can be understood from this example, in Japan the development of medical treatment based on data not only for Westerners, but for Japanese, is necessary.

In the field of gene therapy, it is becoming clear from recent research that the gene arrangement of Japanese is closer to Chinese and Koreans than to Westerners.

In this way, there is a context for data analyzed in Japan or for treatments developed in Japan to be readily accepted in the Asian region.

The same may be said not only for medical treatment but for housing as well. If one is to attempt to reduce carbon dioxide emissions from households, it is necessary to build homes with high energy efficiency. In doing so, if we consider the climate in which the homes are located, compared to cool, dry Europe and North America, Japan—with its hot, humid summers and dry winters—is fundamentally more similar to other Asian regions.

In particular, because Japan stretches in a long north–south arc from Hokkaido to Okinawa and moreover mountain ranges run through the center of the archipelago, although at the same longitude Japan's area encompasses diverse climates. For just about anywhere in Asia, there is a place in Japan with a similar climate. Thus, if housing construction and town planning in each of Japan's regions is carried out in a manner befitting the local climate, the knowledge and technology created in the process can easily be introduced into other Asian countries.

For these and similar reasons, Japan's being located in Asia may be said to be a stroke of good luck.

Many Countries Harbor Warm Sentiments Toward Japan

In thinking about overseas development, there is something of which almost no Japanese are aware. Namely, the fact that foreigners' feelings toward Japan are extremely favorable. This too works to Japan's advantage.

Recently, when I visited Brunei, the feelings toward Japan were excellent. Whether visiting Thailand, Vietnam, or other Southeast Asian nations, or India, or Saudi Arabia, Qatar, and other Arab nations, the feelings toward Japan are extremely good. A great many Japanese do no evil, and are gentle by temperament. They like cleanliness, and act reliably when working together in a group.

But many Japanese believe that foreign feelings toward Japan are poor. This is because anti-Japanese sentiments of Korea and China are exaggerated and widely reported. And indeed, anti-Japanese sentiment in general in both Korea and China cannot be denied. However, even in the case of Korea, since around the time of the joint sponsorship of the soccer World Cup in 2002, the situation has been considerably changing. I think that going forward this will largely change in China too. From manga and anime to video games and the novels of Haruki Murakami, and even to safe and delicious food, longings for Japanese culture in a broad sense are growing stronger among the Chinese people.

In a 2010 survey conducted by the British Broadcasting Corporation (BBC) on which countries have a beneficial effect on the world, Germany came out on top, followed by the European Union and Japan in second place, and Canada in third. As far as which countries were disliked, Japan did rank higher than Germany, the European Union, and Canada, but this is because many Chinese and Korean name Japan as a country they do not like. All the same, generally speaking the world estimates highly Japan's having accomplished its modernization after the Meiji Restoration and leaping even into the global top class as a non-Western nation.

The Japanese need to recognize this fact. If Japan can transition from "problem-saddled advanced nation" to "problem-solving advanced nation" and if it spreads these societal and technological solutions to the rest of the world, this will bring a truly favorable wind to our situation. For this very reason, for the sake of the entire world as well, we must now boldly take up the challenge of solving the problems we now face. This challenge will bring us new opportunities for growth.

Tokyo, Japan Hiroshi Komiyama

Contents

Chapter 1
"Diffusive Demand" and "Creative Demand—Overcoming Product Saturation with Demand for Innovation"

The True Character of the Demand Shortage in Advanced Nations

At the present time, in the search for growth opportunities many Japanese companies are making forays into developing markets, with China being the prime example. In looking at developments since the Lehman Shock of 2008, while the progress of economic recovery in advanced countries has been feeble, the recovery in developing countries has been strong (Kwan 2010). For this reason, it is easy to understand why companies are with one accord heading into these enormous markets. But, considering that the world will sooner or later be saddled with the same problems as Japan, it is necessary to think about how long the rapid growth of the developing world will continue.

Let us analyze the maturation of advanced countries and the rapid growth of developing countries with the concepts of what I call "diffusive demand" and "creative demand." By diffusive demand I mean, broadly speaking, demand for all products that are now on the market. Durable consumer goods such as automobiles and televisions, cement (as an indicator for buildings,) et all fall into this category. Existing large-scale technologies and systems such as *shinkansen* trains, thermal power plants, and nuclear power plants also fit this category. On the other hand, what I mean by creative demand is, in fact, latent demand for things that have not yet taken shape i

Because there is evidence that "diffusive demand" will saturate in the not-too-distant future, Japan must find a way out of its predicament using "creative demand."

H. Komiyama, *Beyond the Limits to Growth: New Ideas for Sustainability from Japan*, Science for Sustainable Societies, DOI 10.1007/978-4-431-54559-0_1,

Demand for Man-Made Artifacts Will Necessarily Saturate

In coming to terms with the problem of demand, I have for some time now been advocating that the concept of "saturated demand for man-made objects" is important. A major reason for demand deficiency in advanced countries in my view is f the saturation of man-made objects in the market. Simply put, the basic and consumer needs of the vast majority of people in these countries have been quantitatively met.

Housing and automobiles typify man-made objects and provide good examples of what I mean by saturation. In their lifetime people spend the largest amount of their personal income on housing (MIC Web-Site 2013). Automobiles are second. In consumer importance (MIC Web-Site 2013) Of course, significant expenses also accompany such events as weddings and funerals, but these are services, not artifacts Here I would like to consider the demand for goods.

The saturation of a man-made object is the condition whereby a given artifact reaches every part of the population in sufficient quantity. This saturation has a definite effect on the demand structure. Two types of demand drive diffusion of products or technologies in the market place. The first is "new demand" for acquiring an object, artifact, or technology for the first time,. The second is demand for replacement or renewal (upgrading, to a larger television or a faster computer, for example) of something acquired previously. When a man-made object saturates, (i.e. when everyone who needs it has it) the "new demand" vanishes, leaving only replacement demand. In developing countries, generally new demand plays a central role, but in advanced countries the nucleus of demand shifts to replacement demand.

Let us consider housing. The population of Japan in the twenty-first century has been essentially flat at a level around 127 million, peaking at 128,084,000 in 2008 and then shifting to a slight decline (MIC Web-Site 2013). However, owing to the change from extended families to nuclear families, the number of households continued to rise in this century and now has almost reached saturation at roughly 50 million. In comparison to this, the total number of dwellings is around 60 million and already exceeds the number of households by about 10 million (MIC Web-Site 2013).

Many people can probably grasp these figures as something they experience personally. Of course, there are cases where some own summer houses or other second homes, but many of the dwellings in excess of the number of households are vacant homes where no one lives. The truth is, there are many cases where we have built homes in the Tokyo metropolitan area and left unoccupied the homes in the countryside where our parents, who have already passed away, used to live.

In Japan each household already has shelter, one primary home, and thus housing, which is a man-made object, has saturated. When the saturation condition of this man-made object is reached, the demand for housing shifts from new demand to demand for replacement or re-building of old homes. If we take 50 years to be the average lifetime of a dwelling (its service life), then the annual demand, equal to the total number of owned homes divided by the average lifetime, is 1–1.2 million homes. In fact, if we look at new home construction starts over the past 20 years or so, disregarding the post-Lehman Shock years of 2009 and 2010, this is roughly the level we see (MLIT Web-Site 2013).

Next, consider automobiles. At present, the number of four-wheeled passenger cars owned in Japan is approximately 58 million, roughly one vehicle for every two people (Japan Automobile Manufacture Association, Inc. 2013). In just about every advanced nation, such as the United States, the United Kingdom, France, or Germany, there is roughly one car for every two people. In contrast to this, in China there are roughly two cars for every 100 people, and in India only about one car for every 100 people.

In China, which has only two cars for every 100 people, until American or Japanese levels of 50 cars for every 100 people are reached, automobile sales will boom. The stock of automobiles will continue to rise. In other words, new demand will cause the market to expand explosively, and this situation is the same in India or anywhere else in the developing world (Japan Automobile Manufacture Association, Inc. 2013).

On the other hand, what will be the situation when automobiles saturate as in Japan? Just because they have saturated, it is not the case that automobiles will completely stop selling. Assuming an average lifespan of 12 years before they are scrapped, each year the number of cars sold will be equal to the number scrapped. That is to say, replacement demand will form the core of demand. In Japan there is a stock of a bit less than 60 million passenger vehicles, and taking 12 years as the lifetime, 60 million divided by 12 years means 5 million vehicles will be newly sold each year. In reality, over the past 10 years the number of passenger vehicles sold domestically in Japan has fluctuated between approximately 4 million and less than 5 million (Japan Automobile Dealers Association 2013).

Figure 1.1 shows at what speed demand for consumer durable goods has saturated in Japan. We can see that, depending on the product, the speed of increase in the household diffusion rate is slow for some items and fast for others. What is really conspicuous is the speed of diffusion of color televisions.

It seems that the driving forces behind the speed of diffusion are human beings' strong desire to view images—that is, to obtain information through the sense of sight—and a reasonable price in comparison to automobiles. From their first appearance until reaching a diffusion rate of 90 %, it took color televisions only about 8 years. Recently, the mainstream flat-panel televisions too have been spreading amazingly quickly.

Just as cathode-ray tube color televisions gave way to flat-panel technologies such as liquid crystal displays, so too will two-dimensional televisions 1 day become three-dimensional TVs. When this happens, a new demand will certainly be born for an already existing man-made object (televisions). But it is important to keep in mind how this new situation will be different from the time when televisions first appeared on the scene. The cathode-ray tube televisions that were born at a time when there were no televisions at all were acquired as new demand by nearly all households that had a respectable level of income. The next-generation color televisions probably did have the effect of speeding up the timing of replacement TV

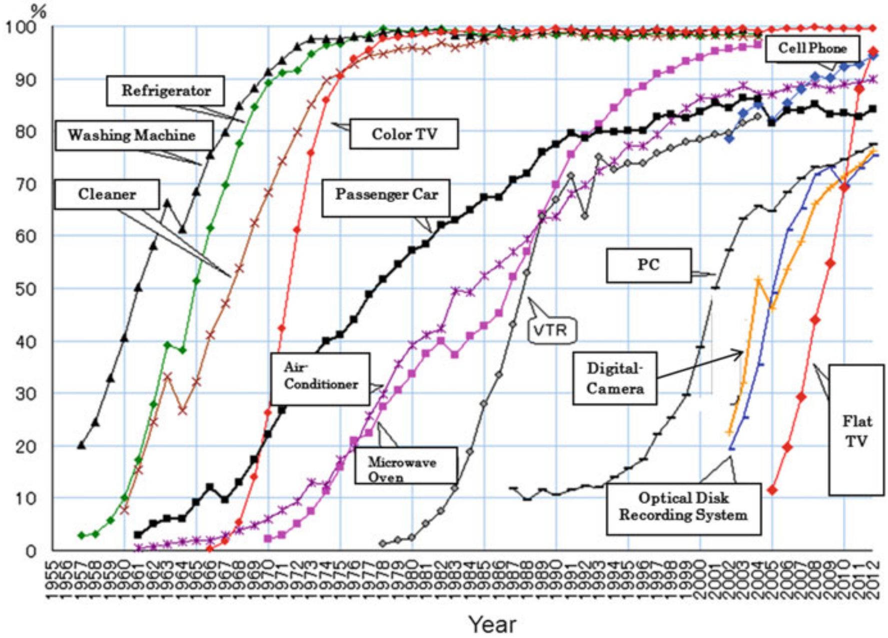

Fig. 1.1 Trend for diffusion rate of consumer durable goods per household in Japan. Source: http://www2.ttcn.ne.jp/honkawa/2280.html

purchases, but it was still, after all, replacement demand and differed from new demand. In the future, when 3D TVs appear, more than a few people will likely not buy them. It is the same for housing. In this manner the saturation of man-made objects has a decisive effect on the demand structure.

In nearly all advanced countries the population has stopped growing. The fundamental shift in the nature of demand to replacement or renewal demand caused by the saturation of population and of man-made objects lies at the heart of the demand shortage that plagues advanced economies.

How Long Will China's High Growth Last?

Right now, China is the driving force behind world demand (Morrison 2013). Do we have any idea how long China, by virtue of its voracious demand, will continue to be the engine of the global economy? Let us consider the sustainability of China's economic growth from the standpoint of the saturation of man-made objects.

If you are an optimist, you are likely to say something to the effect that, "Because China, at any rate, has a population of 1.3 billion, it will be all right, at least for a while." But if we compare it to past examples, things are not as simple as that.

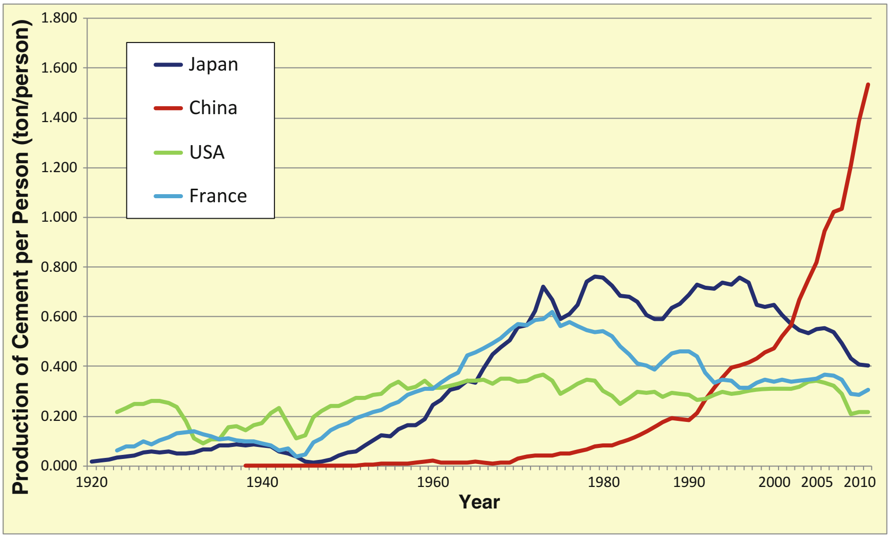

Fig. 1.2 Production of Cement per person. (Data of Cement production volume: United Nations Statistical Yearbook. Data of Population: UNSD Demographic statistics, United Nations Statistical Yearbook)

It is difficult to decide for which products we should look at the saturation rate. Here we will take up the examples of passenger cars and, as a representative index of social infrastructure, cement.

Steel also provides a good index of social infrastructure, but scrap—one of the sources of raw material for steel making—is imported and exported in large quantities, as is the steel produced in blast furnaces. Consequently, when we look at the degree of investment domestically, we must adjust the import and export figures to account for these different sources, and cannot simply use the production figures for crude steel.

In contrast, cement is heavy and inexpensive. For this reason it is almost entirely locally produced for local consumption. If we look at how much cement is produced, we have an index from which to infer how close to saturation social infrastructure such as roads, ports, dams, and bridges are coming.

Figure 1.2 shows the changes over time in per capita cement production (i.e., the amount of cement produced annually divided by the present population) for Japan, China, the United States, and France. As can be seen, the speed at which cement production in China has increased in recent years is amazing. Considering this speed, because China's population is so large, one is forced to ask whether the market might not saturate.

Just how far will the saturation of China's cement market progress? To answer this, we must look at stock production totals—how much cement has been used until the present. In calculating this, it is proper to perform the mathematical integral to find the area under each of the curves in the figure. If we do this, we find roughly 16 tons per person for the U.S. Among advanced nations the U.S. is in fact a special case. The ratio of immigrants who arrive from overseas is high. As a result, the U.S. is the sole advanced country whose population is increasing even now. Compared to Japan or France, its cumulative cement use is small, but taking into consideration its population increase it is generally difficult to say the U.S. is typical of the advanced countries.

Other countries like France show a typical pattern for advanced nations. From around the time of the end of the Second World War in 1945, cement production increased significantly, reaching a peak in the mid-1970s. From that time production began to fall, and in recent years has been virtually flat. It would be best to interpret this as France having entered the period where production is only responding to replacement demand. Even if the construction of infrastructure has practically stopped, after 50 years of use buildings, roads, and other constructions begin to degrade and must be repaired or rebuilt, thereby giving rise to a certain amount of demand. Including this as well, France's total investment in cement comes to 22 tons per person.

In Japan too, from the 1960s to the first half of the 1970s cement production rose dramatically. This period corresponds to the period of Japan's post-war economic miracle, when an annual economic growth rate near 10 % continued for several years. After that time there were repeated fluctuations at a high production level, but from the late 1990s production began to fall and presently appears to be asymptotically approaching an equilibrium state. Cumulative production in Japan is 29 tons per person.

In China, as shown in Figure 1.2, until 2011 the per capita total stock of production was already close to 15 tons per person. Total world cement production in 2011 was approximately 3.6 billion tons; of this, China actually produced 2.1 billion tons, corresponding to 58 % of the world total. Converting this to a per capita annual production rate, it is roughly 1.5 tons, so assuming that this pace continued, the cumulative stock in China likely caught up to the U.S. in 2012, will catch up to France in 2016, and to Japan shortly after 2020.

The land area of China and the U.S. are almost the same, and China's population is 4.5 times that of the U.S. The fact that by 2012, the per capita cumulative production of cement will be the same in the two countries means that on China's territory cement will have been poured 4.5 times more densely than in the U.S. It is the case that the gross "investment" in infrastructure such as highways, airports, and buildings will be 4.5 times larger in China than in the U.S.

Thus, supposing China continues for the time being its high annual growth of 10 % per year, if infrastructure (roads, ports, buildings, etc.) is constructed faster than projected, then in as little as 2 years—and in any case in no longer than 10 years—China is certain to reach a condition of saturation. Even in terms of actual experience, already if one looks out from elevated ground over a city like Beijing, the density of highways, buildings, and the like is no different from Tokyo. Shanghai and the coastal areas are the same. It is hard to imagine that there is much room left to pour large quantities of concrete. Even in Ürümqi, the capital of the inland Xinjiang Uyghur Autonomous Region, large buildings line the streets.

Automobiles Will Also Reach Saturation in the Next 7–10 Years

Next, we consider automobiles, which occupy an important segment of economic activity.

First let's contemplate how many automobiles can be sold once these man-made objects reach saturation and enter an equilibrium state. As already stated, in advanced countries for every 100 people there are 50 automobiles. Assuming cars on average are scrapped after 12 years, 50 divided by 12 gives about 4.2 vehicles. That is to say, each 100 people own 50 automobiles and, supposing they replace these every 12 years, among these 100 people each year four people purchase a replacement car. This is the demand in the state of equilibrium.

In fact, domestic automobile sales in advanced countries per 100 members of the population are 5 in the U.S., 4 in Japan and France, and 3.5 in South Korea, where the saturation state has practically been reached. In Japan's experience, in 1963 one vehicle per 100 people was reached, and 6 years later three vehicles per 100 people was achieved. South Korea, about 25 years behind Japan, followed the same growth pattern from 1987 to 1992. In other words, it only took 5–6 years to reach the saturation value of three to four vehicle sales per year per 100 people (Fig. 1.3). This period overlaps with the period of rapid cement production growth in Japan and in Korea, and took place in each country during the economic boom years.

If we think in terms of these kinds of historical circumstances, we can see that China has entered the same growth trajectory 50 years after Japan and 25 years after Korea. China reached about 13 million automobile sales in 2009 and about

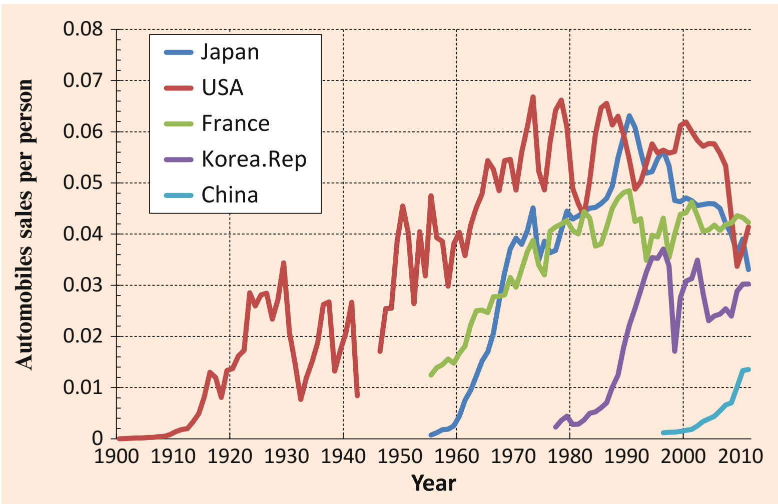

Fig. 1.3 Automobiles in China will saturate within 5–10 years. (Data of Automobile sales: Automobile industry handbook (Japanese). Data of Population: UNSD Demographic Statistics)

18 million in 2010. If we convert these figures to vehicles per 100 people, they correspond to 1 and 1.4 vehicles, respectively. Accordingly, within the next 5–6 years, per 100 people there will be three to four vehicles sales annually in China; to put it another way, the market will likely reach the level of 40–50 million vehicles per year. But this market too will before long saturate, and growth in the number of sales is forecast to hit its ceiling.

In this way, if we forecast the future of cement, an indicator of the status of infrastructure provision, and of automobiles, an indicator of the status of durable good diffusion, it will not be very long before China reaches the state of "saturation of man-made objects." We may see that China's economic growth can be the engine of the global economy only for another t 5–10 years or so.

Accompanying Overproduction, Keen Competition Will Intensify

The potential for product saturation suggests a huge problem looms on the economic horizon. Namely, economies will be encumbered by production overcapacity.

In the growth phase, beginning from the state where the stock of automobiles is small until entering the saturation stage where 50 automobiles are owned per 100 people, demand for new products exists and is expanding. Of course, demand fluctuates somewhat, but depending on the year there will be some years when more than four cars per 100 people can be sold.

For example, in the process leading up to 50 cars being owned per 100 people, it is the case that there will be years in which six or seven vehicles can be sold per 100 people. If we look at the example of Japan, this corresponds to the decades from the 1970s to the 1990s. During that period, up to six vehicles per 100 people were sold. In China's case, the annual number of cars sold would be equal to 13 million (i.e., the total number sold at the time when one car is sold per 100 people) multiplied by 6, or about 80 million cars. In other words, the number of cars sold will overshoot the number sold in equilibrium. Even though manufacturers know that this is overreaching, in response to the sudden rise in sales volume they will struggle fiercely to increase their production capacity in an attempt to quickly secure market share. In consequence, they will become saddled with an excess of production capacity.

During the era when Japan's automobile industry was growing, the U.S. market was still continuing to expand. Then it was possible to make use of the production capacity in excess of domestic demand for U.S.-bound exports. However, the American market is now for the most part not expected to expand. Other advanced nations, just like the United States, are also in a state of saturation. What can be done once the number of cars sold in China stops growing and the production overcapacity becomes apparent, as a result of the number of owned cars accumulating, the market saturating, and the number of cars sold per 100 people reaching three or four? We can only count on India as the next market, but India too is chasing hard on the heels of China. The speed at which man-made objects are saturating is high.

Of course, owing to the diffusion of hybrid vehicles and electric vehicles, replacement demand will to some extent be promoted. But, in the end, in advanced countries because this is not new demand, the number of vehicles sold per 100 people will not rise dramatically. The market will reach saturation

The new wave of hybrid vehicles and electric vehicles will also hit developing countries at the same time. Thus it is difficult to imagine a transition scenario like the one that advanced countries experienced, where the diffusion of gasoline vehicles is next followed by the shift to hybrid and electric vehicles.

Companies are pursuing a strategy of focusing on China as it is for the time being the driving force of global demand. However, it is necessary to plan business development while fully keeping in mind that sooner or later the era will arrive of cut-throat competition caused by production overcapacity. That period will come far sooner than is generally thought.

The “Clouds Above the Hill” Are No Longer There or “Lost in the Fog”

If we suppose that, even when viewed globally, the saturation of man-made objects is coming in the not-too-distant future, it is clear that the problems confronting Japan cannot be solved by pursuing diffusive demand and forging ahead into developing countries.

First, rapid growth in developing nations’ means that man-made objects will saturate in those countries unexpectedly quickly, and sooner than is generally thought to be the case. As a result, in the course of time overproduction is going to be accompanied by increasing competition for shrinking markets.

Second, there is the employment problem. If Japanese companies launch into developing countries, the domestic market will become hollowed out. On the other hand, in the sense that Japanese can work overseas, new employment will be created. In addition, we can expect an effect whereby demand from developing countries revitalizes domestic industries. But, in the aggregate, it cannot be said that this will be a benefit for Japan’s total domestic employment.

Third, the Japan of today is faced with two particularly burdensome problems. The first of these is how to ensure the provision of materials such as energy, resources, and food. As for resources like crude oil and iron ore, growth of demand in developing nations coupled with limited and dwindling means that prices will continue to rise overall, even taking into account volatile spikes and plunges in the market. By around 2050 the prices of all resources will surely be high. For food also, due to population growth and the increase in the rate of meat consumption, it is projected that supply and demand will be strained. Regulations regarding deforestation too are being strengthened. Even taking account of nuclear energy as a self-sufficient energy source, Japan imports some 80 % of its energy in the form of crude oil and other fossil fuels (OECD 2011). Japan also relies nearly 100 % on imports for almost all of its mineral resources (JOGMEC Web-Site). Imports make up 75 % of timber and pulp raw materials, and on a calorie basis 60 % of food (MAFF 2011; Forestry Agency 2011).

In the future, will Japan really be able to go on with this system of reliance on imports for these kinds of mainstay material resources? We must come up with an answer to this problem.

The second burdensome problem is connected to the social system: the depopulation of the countryside, the overcrowding of cities, medical care, pensions, transportation, logistics, education, national finances, declining birthrates and an aging population, among other issues. In particular, let us focus on the graying population issue. The graying society is a problem that humanity will not be able to avoid in the twenty-first century, and moreover it is an issue that problem-saddled advanced nation Japan will experience ahead of other nations. I would like to discuss other problems in relation to the graying population issue.

The aging population is a result of longevity. As a consequence it is something we should rejoice in, and is without a doubt a good thing. I hope that we want to create a society that can sing the praises of longevity without anxiety.

History teaches us that where there is demand, new industries are born. Thus it stands to reason that we must create new industries by making clear the latent needs that are generated along with the advent of the aging society. As Japan becomes a graying society, the working-age population between 15 and 65 will fall, and the country will find itself in a pinch. But in fact this situation itself can be parlayed into an opportunity.

Even in China, which on the whole is thought to have a young population, the working-age population will begin to decline in 2015 (BTMU 2010). The aging of society is not a problem of Japan only. It is not only a problem of all advanced nations, but an issue for all humanity that will soon involve developing nations as well.

The reasons are clear. First, because ordinary people have come to receive sufficient nourishment and have access to clean water, and also enjoy the benefits of advanced medical care, the lengthening of human life span has progressed. The average life span during Classical Greek and Roman times was 24–25 years, and even in the year 1900 it was a short 31 years. During those eras of short life spans, access to good nutrition, clean water, and medical treatment did not extend beyond a limited ruling class. Many of the individuals who have left their mark on history belonged to this ruling class and had relatively long lives. It is said that Socrates lived into his early seventies, and Plato lived to around eighty. Additionally, especially because of the diffusion of education to women, the condition of having several, or in the most extreme cases more than ten, children has decreased. These are the causes of the aging of society. In other words, the graying society can be said to be the inevitable result of the advance of civilization.

Consequently, we will move forward by inventing supply to cope with the aging of society and awaken demand for this supply. Or, by making the new needs apparent as demand and inventing supply, we should be able to create new industries. The industries born by doing this will surely become universal for all humanity.

The industries based on “diffusive demand” still have advantages in developing countries, where new demand is vigorous and wages are low. Therefore, it is necessary for a developed nation itself to dig up the “creative demand,” whose shape is still not clear, and through these new industries expand the economy of its own country. This is the shape of the reality for parlaying crisis into opportunity.

The years in Japan after the collapse of the Bubble in 1991 are called the “Lost Decade” or the “Lost Two Decades.” But in fact since Japan became an economic superpower with the second largest GDP in 1968, for the next 40 years its growth as a developed country has stopped (MIAC 2012). Diffusive demand expanded and the GDP grew, but Japan has not been able to bring forth the “creative demand” that is the foundation for further development. In this sense we should have called this period the “Lost Four Decades.”

However, problem-saddled developed country Japan is in an optimal position to generate “creative demand” as it is preceding the rest of the world in addressing the problems of energy and resources, the environment, the graying society, etc. Indeed it is this very demand that will become the foundation on which Japan will break loose from the “Lost Four Decades” and once again prosper.

Attaching importance to the “creative demand” discussed in this chapter does not contradict the international development of industries related to “diffusive demand.” On the contrary, a synergistic effect is called for. New industries will likely be able to unfold internationally in a period sooner than could be imagined in the past. Likewise, for instance, core components that Japanese corporations manufacture domestically will be exported to assembly plants launched overseas, and conversely parts produced overseas will be turned into products in domestic factories and re-exported. In this way the demand of developing countries will revitalize the domestic economy, and the resultant reserve strength can be applied to a new industrialization geared toward creative demand. In this manner we must endeavor to act in concert as the two wheels of a single axle.

In a manner of speaking, the international development of diffusive demand was the growth struggle of the twentieth century, while the new industrialization for creative demand is the modern battle of the twenty-first century. I believe that prosecuting both of these battles simultaneously and synergistically is the strategy that Japan must pursue.

Since the Meiji Era, Japan has aimed for the “clouds above the hill.” Japan pushed forward with the developed nations of the West as its goal. But we ourselves have become a developed nation and now, standing amidst the clouds, though we look up to the sky we find nothing to set our sights on. There is nothing for us to do but ourselves decide our target and push forward. This is precisely the fate of a developed nation.

In the next chapter I consider the methods for stimulating “creative demand.”

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Chapter 2
The Twenty-First Century Paradigm and the Role of Information Technology

In Chap. 1, we considered demand by roughly classifying it into two types: "diffusive demand" and "creative demand."

The "paradigm of the twentieth century and before" was characterized by diffusive demand. The paradigm was constituted by a material desire to satisfy needs for food, clothing, and shelter, as well as transportation, and social mobility. Many of the industries that came into being in the nineteenth and twentieth centuries were intended to satisfy such desires. I describe those material desires as diffusive demand leading to a "saturation of man-made objects."

It follows that new demand in the twenty-first century will be generated by a new paradigm. Thus, in this chapter first describes what the paradigms of the twenty-first century are and then reflects on the role played by the knowledge explosion, one of those paradigms, and the role played by information technology, which looks as if it came into being to solve problems created by the knowledge explosion.

Exploding Knowledge, Limited Earth, and Aging Society

What are the paradigms of the twenty-first century? I believe there are three, which I classify as "exploding knowledge," "limited earth," and "aging society" (Fig. 2.1).

These three paradigms do not represent anything that is either good or bad for humanity. Each constitutes a basic framework containing both light and shadow.

For instance, there has been an explosive increase in knowledge. It may not be a gross exaggeration to say that almost everything humanity desires can be achieved if the correct knowledge can be employed at the correct place and in the correct manner. Even the problem of reducing carbon dioxide emissions, which the world now faces, can be easily solved if the best knowledge human beings have can be diffused to all six billion humans on Earth.

H. Komiyama, *Beyond the Limits to Growth: New Ideas for Sustainability from Japan*, Science for Sustainable Societies, DOI 10.1007/978-4-431-54559-0_2,

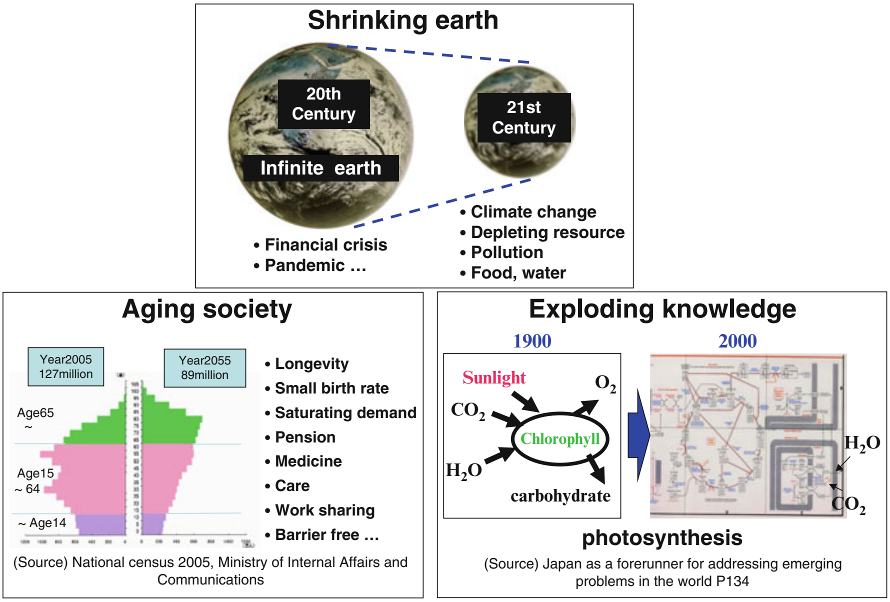

Fig. 2.1 Paradigm in the twenty-first century

In this sense, it is good that knowledge has increased explosively. That, however, has made it difficult, at the same time, to grasp the whole picture, which is composed of individual pieces of knowledge. It is now difficult for people who need the correct knowledge to acquire and use it at the correct time and place.

The second paradigm, a "limited earth," refers to the fact that the basis for sustaining humanity, which hitherto could be regarded as infinite, has come to be clearly recognized as being limited due to the expansion of human activities. Japan is a global front-runner in many areas responding to this issue. Japan's technologies and social system are at the top level in the world in a wide range of areas including high energy efficiency, high resource-use efficiency, integration of environmentally non-destructive technologies, and highly efficient water supply systems.

Regarding the third paradigm—the "aging society"—only its critical consequences for Japan, which is aging most rapidly among the countries of the world, have been highlighted. The entire world, however, will become an aging society before long.

When I talk with Americans about the aging society, they say, "Japan is in a serious situation. We will have no shortage of workers because we have adopted a policy of allowing immigration." This understanding, however, is wrong. When China becomes an aging country, the United States will also become an aging country at roughly the same time. At that time, the availability of young Chinese immigrants will decrease.

In fact, according to publications (2012) of India's Registrar General and Ministry of Health and Family Welfare, the fraction of India's total population accounted for by the elderly over the age of 60 reached 7.5 % in 2010. Moreover, they showed a projection that this fraction would reach 12 % in 2025. If it continues to grow at this pace, as India's Education Minister has said, the elderly fraction will surpass 20 % in 2040 and the likelihood is high that India will become a genuine aging society. In India, along with the rise in the fraction of elderly people, the health problems associated with this generation are also growing more severe. For instance, the prevalence of diabetes has reached 3 % in rural areas and 9 % in urban areas, and thus in India too the problems and issues of the aging society that need to be resolved are becoming obvious. The problem of the aging society is no longer a problem only for Japan and China, but is becoming a problem of global scale.

If the present trend continues, within the first half of the twenty-first century, coupled with an increase in economic and productive activities in emerging countries due to increases in population and incomes, the entire global environment will deteriorate and a shortage of resources will accompany the aging of society (WWF et al 2012). The entire world will fall into the same situation Japan experienced and responded to successfully, and will face the same difficulties Japan faces now.

Most people already have some understanding of the "limited Earth." Everyone also intuitively understands the "explosion of knowledge" if it is explained. It is not so well understood that the "aging society" is understood as an issue common to all humanity. Conversely, for this reason, it is significant for Japan to take the global initiative to create solutions for the challenges of an aging society.

Negative Legacy of Intellectual Activities

Among these three paradigms, let us first in this chapter what I mean by the paradigm of "exploding knowledge" Environmental and resource problems have been called the negative legacy of the twentieth century: these were brought about by material human activities (WCED 1987). On the other hand, there is a negative legacy of intellectual human activities: the problem is that an increase in vast amounts of specific and often fragmented knowledge has made it extremely difficult to grasp the whole picture.

A typical example is the year 2000 or the Y2K problem with computers, which is still relatively fresh in our memories. People had computers store years using their last two digits of the four-digit year; for example, the year 1990 was stored as "90." A great fuss was made when it was thought that a variety of things, ranging from strategic missiles and automobiles to electricity and gas infrastructure and home appliances, might fail when the year turned to 2000 in the Western calendar because computers would not be able to distinguish between the year 1900 and the year 2000.

Everyone concerned was aware of each problem in his or her field. For instance, gas companies confirmed that no problem would occur by inspecting and examining processes from manufacturing gas to supplying it to households. They did not know, however, how the memory chips of microcomputers embedded in gas water heaters of baths in households would react because these were out of their jurisdiction.

No big problems occurred as a result. What is important, however, is the fact that no one in the world was able to foresee what impact the simple problem of representing a year in the Western calendar by its last two digits would have on the entire Earth.

On March 11, 2011, a large earthquake and tsunami hit 201 districts in the Tohoku and Kanto regions, and people were horrified by the resulting Fukushima Dai-ichi nuclear power plant accident. The response of society also revealed the fact, similar to that revealed by the year 2000 problem with computers, that no one in the world could grasp the whole picture. Press reporting was extremely confused, and demagoguery was rampant. What underlay this were experts who were knowledgeable in their own areas of specialization, but who could not grasp its relation to the whole problem coupled with the incompetence of intellectuals and decision-makers who could not integrate the views of technical experts, and the knowledge explosion that brought about this situation.

In the twentieth century, knowledge expanded explosively. Take a look at Fig. 2.1 again. Photosynthesis by plants is a process in chlorophyll through which carbohydrates and oxygen are generated from carbon dioxide and water by solar energy. This was all the knowledge on photosynthesis that was available in 1900.

It has now been found, however, that photosynthesis is a chemical reaction, and we know which catalysts cause which chemical reactions in great detail. The structure of ion channels through which carbon dioxide moves from leaves to cells had been known at the molecular level. New knowledge is being created even now, and if the amount of knowledge in 2000 is compared with that in 1900, the former must be not less than 1,000 times the latter. As far as the outline of the structure of photosynthesis is concerned, it is not that the knowledge available in 1900 was wrong; rather, it is just that the details of its structure did not become known until the twenty-first century.

Is there any person, then, who has humanity's total knowledge of the mechanism of photosynthesis? There is probably no such person. In short, even though knowledge has increased at a tremendous rate, the whole picture can no longer be viewed due to compartmentalization.

The Relation Between Knowledge and Value Is Difficult to Understand

The twentieth century is called the "age of war," the "age of population explosion," and the "golden age of science." What is a "golden age of science?" I think this refers to the fact that advanced inventions and discoveries led directly to the creation of new human values.

Take the example of the Nobel Prize. In the early twentieth century, it became possible to synthesize ammonium from nitrogen and hydrogen, for which Fritz

Haber and Carl Bosch received Nobel Prizes. Because it became possible to synthesize ammonia using an iron catalyst, the creative power of catalysts to drive chemical reactions was born.

Until that time, production of nitrogen fertilizers had relied on human and animal excreta and other sources. Thanks to the synthesis of ammonia, it became possible to synthesize nitrogen fertilizer, which created the public value of a leap in agricultural production. It also created economic value in the sense that the chemical industry emerged to produce ammonia and yielded huge profits. The synthesis of ammonia was linked to intellectual, public, and economic values in a simple manner.

In 1928, Alexander Fleming discovered penicillin from *Penicillium notatum* (Fleming 1945). It was put to practical use through the "rediscovery of penicillin" by Howard Florey and E.B. Chain, and radically changed the clinical treatment of infectious diseases. For this result, those three—Fleming, Florey, and Chain—were awarded Nobel Prizes. The discovery of penicillin created the intellectual value of antibiotics, the public value of saving humanity from suppuration, and the economic value of the development of the pharmaceutical industry.

Similarly, the synthesis of nylon by Wallace Carothers at Dupont in the U.S., the invention of the three-terminal transistor by William Shockley, John Bardeen, and Walter Brattain at AT&T's Bell Laboratories, and the invention of the integrated circuit (IC) by Jack Kilby at Texas Instruments (TI) created new values in a simple and clear manner.

As science developed and became compartmentalized into numerous specialized areas, the distance between human values and science gradually increased. This is easier to understand if you compare two Nobel Prize winners: Hideki Yukawa and Masatoshi Koshiba.

Hideki Yukawa clarified the mechanism of the nuclear force (Yukawa 1949). An atomic nucleus, which is at the center of an atom, consists of protons, which have a positive electric charge, and neutrons, which possess no charge. It was a mystery why many protons can remain bound. This was Yukawa's question. Because they have the same positive charge, they should repel each other and scatter, yet they are bound as a nucleus.

Yukawa predicted by using a mathematical model that, if there are entities called "mesons," positively charged protons can stay bound through these intermediaries. This was subsequently proved by an experiment, and he received the Nobel Prize. Yukawa can even be said to have created a pattern of research for elementary particle theory, and his work ranks at the highest level among those of Nobel Prize winners.

On the other hand, Masatoshi Koshiba received the Nobel Prize for his work on neutrinos (Koshiba 2002). Studies of neutrinos have recently been at the center of physics, and I think his work is also at the highest level. It is not as easy to understand why neutrino research has become a central area in physics as it is to understand the story of the nuclear force. I suspect that most people cannot understand the former. Although both Nobel Prize-winning works were similarly at the highest level, they were very different in terms of their distance from everyday human intuition. The creation of penicillin made it possible to cure many infectious diseases with medicines. Alternatively, a three-terminal transistor was created and replaced a vacuum tube, making a radio that had been as large as a contemporary microwave oven as small as the palm of a hand. Compared to such easy-to-understand examples, the connections between knowledge and values are characteristically difficult to understand nowadays.

Importance of "Knowledge Structuring"

Today, a variety of technologies are required to solve problems in energy, medicine, and education, and to cope with the aging of society. Such technologies are obtained as a huge set of partial pictures. Knowledge that contributes or has the potential to contribute to them is found here and there, and is "compartmentalized knowledge" that is created from unexpected sources. It is unreasonable, however, to ignore compartmentalization and demand useful research, research that solves energy problems, etc. It is unlikely that we will ever eliminate compartmentalization altogether. What is important is whether we can integrate a vast body of compartmentalized knowledge in accordance with our objectives and create the whole picture as a solution for achieving our objectives. Humanity must work seriously on creating a method that makes this possible.

I call the method of integrating compartmentalized knowledge "knowledge structuring." We need to create a vision or a model for re-inventing the future. For this purpose, knowledge must be integrated. Knowledge structuring is required to make integration and vision "better and easier to understand."

Many elements are related in a complex manner in many of the problems we confront, including energy, environmental, and aging problems. Structuring problems and knowledge will be the key to respond to them. To make a large-scale system, it is necessary to combine the results of research and experience in many areas. Therefore, this is essentially the age of networks. Humanity, however, has not acquired the knowledge needed to operate networks well.

How should we manage and operate networks well in order to integrate knowledge? What is fundamentally required is "to structure knowledge," "to create and share the whole picture," and, furthermore, for each individual "to be able to recognize what role he or she plays." In addition, the existence of such people that have determined that "it is their mission to make this network function" is also indispensable.

Discussion is important to successfully construct an excellent vision in the context of a knowledge explosion. Discussion, however, must not be carried out in the wrong way. There is no point to it unless it is done in a logical and structured manner. Otherwise, it will just end up at cross-purposes. Alternatively, things could move in an irrational manner with people being led by the person talking in the loudest voice because no one understands the whole picture.

In addition, it is also necessary to try to apply a method of thinking like the great detective Sherlock Holmes. Neither deductive nor inductive methods alone are sufficient to create a vision out of 100 million fragmented pieces of a jigsaw puzzle. You have to create a vision with a flash of insight from the small number of clues that are found.

A true discussion brings a flash of insight similar to that of Holmes to ordinary people like us. An unexpected idea might occur to someone when people with a sufficient accumulation of knowledge keep discussing an issue seriously. This leads to a leap to a new model. We Japanese are not good at having such a discussion. What we have to acquire is such a cultural climate for discussion.

The role played by universities is important for structuring knowledge. When the student newspaper of the University of Tokyo planned to run a story titled "The University of Tokyo 2050," I wrote the following two things. One is that there will be a major change in the composition of students. Unlike today, one third will be students who come primarily from senior high schools. Another third will be students who return to school after having been in the workforce. Still another third will be students from abroad. Students will diversify to this extent, and faculty members will similarly diversify.

The second thing I wrote is that people who conduct research deeply just as it is done today will account for half of researchers, with the remaining half represented by people who specialize in relating different parts of the whole of cutting-edge knowledge held by humanity. That is, we need more people to study structuring and integrating knowledge.

It is important to "structure knowledge" and use information technology (IT) effectively, in order to integrate knowledge and to create a holistic vision. IT is good at accumulating and searching information, to begin with, and this is now being networked over the Internet. Therefore, humanity will be able to solve many of the problems it confronts today if knowledge is structured, if IT is used successfully, if discussions are carried out, and if the correct knowledge is employed at the correct place at the correct time. It is precisely for this reason that "structuring knowledge" is essentially important.

Sustainability Science

In the previous section I have explored the important role that information technologies (IT) will play in structuring knowledge to address the complex issues humanity faces in the twenty-first century. As noted above, many future researchers will specialize in analyzing and integrating many varied knowledge components in order to develop robust understanding of the problems and their potential solutions. This constitutes a radical departure from the way academic research is traditionally carried out and is necessary to ensure that tomorrow's problem solvers are not bounded by conventional methods that prevent them from seeing potential alternative pathways or innovative solutions to contemporary problems.

In addition to developing capacity in our students to study and advance means to structure and integrate knowledge, we must also cultivate future leaders who think holistically and creatively with a view to understanding the underlying causes of our most intransigent and persistent problems that stem from our "limited Earth" and "aging societies." As we explore these issues more fully in subsequent chapters, it will become increasingly clear that researchers and thought leaders of the future will have to be trained with the skills they need to be able to move beyond analysis and understanding in their research to action.

The concept of linking knowledge to action for sustainability has slowly been gaining traction in academic circles since the concept of a new integrative science was introduced by the National Research Council (NRC) over a decade ago and further developed by Robert Kates in a presentation to the World Academies Conference in Tokyo in 2000 (NRC 1999; Kates 2000; Kates 2011). Today, with the introduction of sustainability science in an increasing number of research universities worldwide, more scholars are being trained to recognize and deal with problems that are not only complex, but are inter-connected, and to do so with the specific aim of identifying solutions to those problems (See, e.g., Sustainability Science, special issue, 2009).

While specific programs may vary, sustainability science is characterized by three basic assumptions: that it is interdisciplinary, provides integrative analysis, and is aimed at action that contributes to solving complex global problems such as climate change, species depletion, entrenched poverty. At the first International Conference on Sustainability Science held in Tokyo in 2009, scientists also agreed that because it is action oriented, sustainability science should incorporate knowledge of local conditions. In practice, it takes account of its relationship to traditional scientific research, ensures coherent integration of knowledge generated across disciplines, and incorporates means by which robust collaborations across disciplinary, geographical, and social boundaries can occur (Kauffman 2009).

The concept of integration of knowledge in sustainability science has also been present since its inception. In developing this science at The University of Tokyo we approached the problem of sustainability at three levels of "system"—global, social, and human. In our view the current crisis of sustainability can be analyzed in terms of the breakdown of these systems and the linkages among them (Komiyama and Takeuchi 2006). Global warming would be the type of problem for example that emerges from the interactive relationship among these three systems. As argued in these pages, its solution demands development of a low-carbon society that embraces systemic and technological reforms leading to significantly reduced emissions of the gases that contribute to global warming. In order to address this type of problem and move forward with development of technological and other solutions or actions, sustainability scientists must adopt a comprehensive holistic approach, one that can integrate knowledge about all three systems. Structuring knowledge as discussed in the preceding section can help them to do that. Assembling a platform of knowledge that provides an overview of the entire web of issues involved in the problem at hand will enable scientists ultimately to replace the current piecemeal approach with one that can develop and apply comprehensive solutions to these problems, stimulate "creative demand" from the public and existing disciplines, and in turn point the way to the development of new inventions for a better future.

Speed Has Surpassed the “Invisible Hand”

In the previous sections I have considered the role that information technologies (IT) have played in both the generation of the knowledge explosion of our time and in structuring that knowledge so that it can be channeled quickly to effective action. Sustainability science as discussed above will help future scientists and decision-makers develop and apply the new integrated knowledge that is necessary for sustainability. IT will play an important role in generating integrated knowledge and in sharing it.

Another characteristic of this age of new knowledge is speed. Today, not only can information be transmitted and shared globally in an instant, physical speed has also never been greater. People and goods can be moved around the world faster than ever before. And because of the application of new technologies for the movement of information, people and goods, productivity is also at an all time high. Our world is one in which productivity, information transmission, and physical distribution are breathtaking in both their speed and scope. And the implications of this are not insignificant.

Let us consider the impact on humanity of changes in the speed and range of information transmission. Information was and is valuable. Royalty, ruling classes and successful merchants throughout history have won wars against foreign countries, ruled people and yielded huge profits for themselves by obtaining information faster than others through a variety of methods including the use of horse-drawn carriages and carrier pigeons. Throughout the middle ages in Europe and from the Heian through the Muromachi periods in Japan, lives changed little. History progressed at a slow pace. But in post-medieval times in Asia as well as in Europe, societal change occurred not only in the wake of natural shifts as well as war and pestilence—that is as a reaction to forces beyond peoples' control—but, rather, as deliberate attempts to improve human well-being. As a result, progress in many areas of human endeavor increased rapidly—in science and technology, medicine, transportation, culture, governance and law.

In the modern period, Adam Smith, who is considered to be the father of economics, wrote *An Inquiry into the Nature and Causes of the Wealth of Nations* in the latter half of the eighteenth century, and expounded the utility of the so-called “invisible hand” that individuals' pursuit of personal interests promotes the interests of society as a whole. In contemporary words, if left to the free market, an optimal distribution of resources will be achieved through intermediaries of the price, regardless of individual wills (Arrow 1951).

That, however, held good at most until the latter part of the twentieth century, presumably because the speed of information transmission has become faster than the speed at which the “invisible hand of God” operates.

At present, no one knows precisely whether this is good or bad for humanity. Who should decide how resources are distributed other than the market? It is also a fact that there is no method other than the market mechanism that can rationally decide it.

A perfect market is a prerequisite for achieving an optimal distribution of resources. A perfect market assumes that each economic agent is a rational economic person who always compares costs and benefits to make an optimal choice. It is required that many buyers and sellers exist so that no one person can influence market prices, which is accepted as a given. Market participants are required to have the same perfect information about products, and entry into and exit from the market must be free (Arrow 1951).

In the real world, however, such conditions do not hold in most markets. Furthermore, human beings do not necessarily behave as rational economic persons. While the global economy as a whole is moving toward liberalization, as was revealed by the financial crisis in 2008, a mechanism has been established whereby the informationally strong obtain information instantly by taking advantage of an information divide (informal gap) and use it to exploit the informationally weak.

Information moves around faster than the "invisible hand of God." This is an important point for humanity. As a result of the increase in human power, the market, far from coming into equilibrium, has often run away and become more uncertain. I think this was symbolized by the global financial crisis caused by the Lehman Bros. crash. Since the dysfunction of the "invisible hand" has become clear, it may be the time to enforce, for instance, the "Tobin tax," a low-rate tax on all international currency transactions, in order to inhibit speculative transactions and maintain market stability (Tobin 1978). To begin with, the assertion that a free market achieves global optimization itself is losing credibility at present.

For instance, the discipline called thermodynamics has the concept of "equilibrium." It deals with conditions under which two coexisting different things stabilize if left as they are infinitely. For instance, the most stable state for water in a container is to accumulate at the bottom.

The economy is similar to this. It may be called "quasi-static." If everyone, whether he or she is in Japan or in the global environment, including the United States, Europe, and Africa, or whether he or she works in a manufacturing industry, in agriculture, or for an investment company, if he or she obtains similar knowledge and behaves slowly, the market balance will not change significantly and unstably, and the economy may head in the wisest direction.

Take for example the problem of depleting energy resources. Because humanity is likely to reach a turning point around 2050, we may want to cooperate with each other to use energy more efficiently than we do today since there would be risks in continuing to consume energy as we are now. Because various pieces of information on warming, information on markets and prices of crude oil and other mineral resources, and information on moves by companies and governments trying to acquire resources are transmitted instantly, however, a variety of agents may behave in various ways before a balance of energy supply and demand anticipating needs in 2050 is achieved, thus making the market unstable, and leading to the destruction of the global environment before reaching stability.

This seems to be symbolized by the oil spill that occurred in the Gulf of Mexico off the coast of Louisiana in April 2010. Crude oil used to be mined by drilling into a prospective oil field on land. If the correct place was drilled, crude oil gushed out.

Oil prices were low. But, as oil consumption increased, prices rose from $1 per barrel in the days when I was a student to $20 per barrel, then to $40 per barrel. In 2008, before the Lehman crash, oil prices exceeded $100 per barrel, partly due to inflows of speculative money. Although prices declined temporarily due to a simultaneous global recession, it has been floating in the range of $70–$90 per barrel against the backdrop of the growth of emerging countries such as China.

It is said that the range of oil fields that can be developed profitably expands when the oil price reaches $70. Consequently, oil fields were developed at locations such as the oil field off the Louisiana coast, which is 1,500 m below sea level and highly costly and technically difficult to develop. Even if the risk is known to be high, the will to drill outweighs the risk in light of the trend of crude oil prices. Nothing can be done about it as long as a market economy and freedom of information are guaranteed. The accident in question can be said to be the consequence.

It is said that tar sands in Canada can be used economically if the crude oil price is $40 a barrel or greater. Tar sands are something like sand mixed with coal tar, and they can be sources of oil. Crude oil constituents are dissolved out using water vapor, and, when it cools to condense, water and oil can be separated. A problem with tar sands is that various contaminants dissolve into the separated water, in addition to the fact that large amounts of heat and water are required. It still remains unresolved how to dispose of such water, and a major environmental problem may arise out of this in the future.

If the gigantic Hurricane Katrina, which hit the southeastern United States and caused great damage in 2005, can be considered to be one of the warnings of global warming, I think the oil spill accident in Louisiana is an incident that symbolizes the prediction that fossil resources will become depleted in the future.

We have to recognize the fact that humanity's acquisition of enormous technological power and informational power that surpasses the "invisible hand of God" is increasing the instability of markets and increasing uncertainty, which could result in an unexpected situation.

Information Technology Is a Common Foundation for Innovation

On the other hand, information technology has the potential to solve many problems in society.

For instance, Tōno City in Iwate Prefecture has managed to cope with a shortage of doctors using the Internet. Tōno City had difficulty securing obstetricians and gynecologists. Eventually, the city lost all of its obstetricians and gynecologists. It takes about 40 min under normal road conditions to get to a hospital in the nearest city of Kamaishi. No one can rest assured when giving birth to a child under these circumstances. The city of Tōno, which had come to the end of its resources, devised a new system using information technology (Tono City Web-Site 2013). It concluded contracts for medical examinations over the Internet with obstetricians and gynecologists in various places and hired midwives. This made it possible for a doctor to examine a patient via the Internet during pregnancy, thus enabling the whole process of giving birth to a child from initial medical examination to delivery.

The system constructed by Tōno City is not limited to the problem of obstetricians and gynecologists. Many areas in Japan suffer from a shortage of doctors. It is no exaggeration to say that most under populated areas have shortages. Probably, it is effective to construct a total system consisting of a doctor's examination over the Internet; nurses, midwives, and a variety of medical technicians called co-medical staff including X-ray technicians and laboratory technicians who work with patients; diagnostic chips, drugs, and equipment that are convenient for practical use; and a medevac helicopter for transporting patients and doctors in emergencies.

Achieving such a system should create a totally new medical industry and employment involving the development of elemental technology and products, training of co-medical personnel, and helicopter systems. At the same time, it would be an indispensable solution for a problem in Japan and a measure for creating a new industry.

The knowledge explosion and disciplinary compartmentalization not only occur in medical care, but can also be said to have become problematic to a more prominent extent than in other areas.

If you have a backache and go to a hospital, you undergo many examinations. The results of an ultrasound examination may be fairly good, with no impairment being found with an MRI examination. There may be no problems with X-rays of your gastrointestinal tract, and your blood pressure may not be abnormal. No sugar may be detected in your urine. Each specialty doctor may say there is no problem in particular, so why then does my back ache? There is no answer.

This is a real story. Many of you may have had similar experiences. This is a typical example of "pieces of a jigsaw puzzle being increased by the knowledge explosion but no one can see the whole picture." Medical care is intended to target the health of an individual, but knowledge is compartmentalized into specialized areas. Neither examinations nor doctors are to blame. A support scheme is required that can correctly extract the whole picture. Presumably, this is precisely the role information technology should play, including "knowledge structuring."

Information technology may be able to provide fundamental means for solving problems in many areas besides medical care, including education, transportation, and agriculture. On the other hand, although Japan is comparable to other countries in terms of the level of information technology, it has problems in its application within society. In reality, it cannot possibly be called an advanced country in this regard. Applying cutting-edge information technology in society is one of the keys for Japan to grow from a problem-saddled advanced country into a problem-solving advanced country.

As is clear from the example of Tōno City's medical system, information technology is not used alone, unlike cell phones. By linking doctors, co-medical staff, diagnostic technologies, and medevac helicopters using information technology, a totally new and efficient medical system can be constructed that can solve difficult problems related to under population and a shortage of doctors.

Such a system as a whole creates international competitiveness. Suppose developing countries have medical care problems. What they want, however, is neither medical equipment nor emergency helicopters—nor even doctors. They want a comprehensive medical care system that solves medicare problems. Japan tends to pay attention to individual or elemental technologies. Elements, however, work properly only in a total system.

Using excellent elemental technologies to innovate Japanese society and to create new industries can solve Japan's problems and eliminate the sense of impasse existing in Japan.

That is precisely why total systems born in Japan should create an industry that exports those systems to the rest of the world. Because the shortage of doctors in Japan today is a problem that will affect the rest of the world in the near future, Japan is a country advancing into problems.

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Chapter 3
"Vision 2050" to the Rescue of a "Limited Earth"

Next let us consider the second paradigm—"The Limited Earth." The problems caused by the fact that the Earth is limited are far-reaching. These include not only energy, resources, global warming, air pollution, water pollution, ground pollution, food, and water, but also—if we think broadly—such problems as the widescale spread of infectious diseases of people and livestock. The reason is that the probability of virus mutation and transmission increases along with the probability that wild animals come into contact with livestock, livestock with other livestock, humans with livestock, and so on. And in turn, the probability of contact on the limited surface of the Earth increases in proportion to the square of the population density.

"Vision 2050" has been proposed as a solution to three of these issues, namely energy, resources, and global warming. These three problems are deeply interrelated, with each problem and response coupled to the others. Therefore these three issues must be solved at the same time. That solution is "Vision 2050," a model that the world should aim for in order to solve these problems confronting humanity.

Of course, "Vision 2050" does not include other problems facing our world, such as terrorism, political conflict, or eradication of poverty. While it does narrow down the focus to the material foundations of the overarching picture, in order to solve these three problems, it is a vision that gives structure to and integrates fragmented and scattered knowledge, thereby providing a whole picture of these issues.

Vision 2050

As a world model, "Vision 2050" is a comprehensive model that, under the assumptions of growth of developing nations and maintenance of living standards in developed nations, aims to solve the problems of energy, resources, and environmental conservation. That is, (1) tripling energy efficiency, (2) building a system for material cycling, and (3) doubling the use of non-fossil fuels.

H. Komiyama, *Beyond the Limits to Growth: New Ideas for Sustainability from Japan*, Science for Sustainable Societies, DOI 10.1007/978-4-431-54559-0_3,

If in the future all the countries of the world, including developing countries, are to enjoy the living standards of the present developed world, then it is clear that colossal amounts of energy will be necessary. It is projected that the world's population in the year 2050 will be slightly more than 9 billion, but if that is indeed so, then energy consumption will likely rise to three times the present level (Komiyama 1999a; Komiyama and Kraines 2008). If we simply let things take their own course, the world will rely on fossil fuels such as coal and oil just as in present-day China, and it will be unavoidable that the concentration of greenhouse gases, beginning with carbon dioxide, will rise even further.

On the other hand, if income levels rise, it is highly probable that around 2050 the population increase centered on developing countries will also halt, and the global population will peak at approximately 9.1–9.6 billion and thenceforth slowly decline. Thus, from now until 2050, if we hold in check the increase of the burdens on our Earth by planning for thoroughgoing energy conservation, recycling of resources, and the use of green energy, then the Earth will likely continue to provide a sustainable foundation for humankind.

The grave issue is the fact that the rate of the Earth's response is slow. For instance, even if at some point the concentration of greenhouse gases reaches a fixed level, the sea-level rise from global warming will continue for a 1,000 years after that point (IPCC 2007). This is because the water temperature of the deep oceans will lag behind and continue to rise. The bottom line is that we are reaching a state where we will no longer be able to stop global warming. For this reason alone we must take action without a moment's delay.

Just as it is from the standpoint of population projections, I believe that the year 2050 will be a major crossroads for the Earth and for humanity. However, the reality is that achievement of even the modest goals of the Kyoto Protocol is in a difficult situation. Therefore, taking into consideration the speed at which people's agreement can be molded and the rapidity of technological progress, it is most logical to exert ourselves with the year 2050 fixed as our goal. And so it is "Vision 2050."

Even If the Number of Automobiles Quadruples, Energy Consumption Can Still Be Reduced

Let us test from a theoretical and technical standpoint whether "Vision 2050" is possible. Regarding the appropriateness of the first goal of tripling energy efficiency, I have arrived at the conclusion that this is indeed possible by investigating all of the principal categories of energy consumption. I have comprehensively investigated not only my own field of specialty, petrochemistry, but also the so-called raw materials industries which, even in the manufacturing domain, consume energy on a massive scale, such as the steel industry, paper and pulp, and glass. (My works *Chikyuu Jizoku no Gijutsu* [Iwanami Shoten] and *Chikyuu Ondanka Mondai ni Kotaeru* [UP Sensho] contain more on these topics (Komiyama 1995, 1999a, b). Please consult them for further information.)

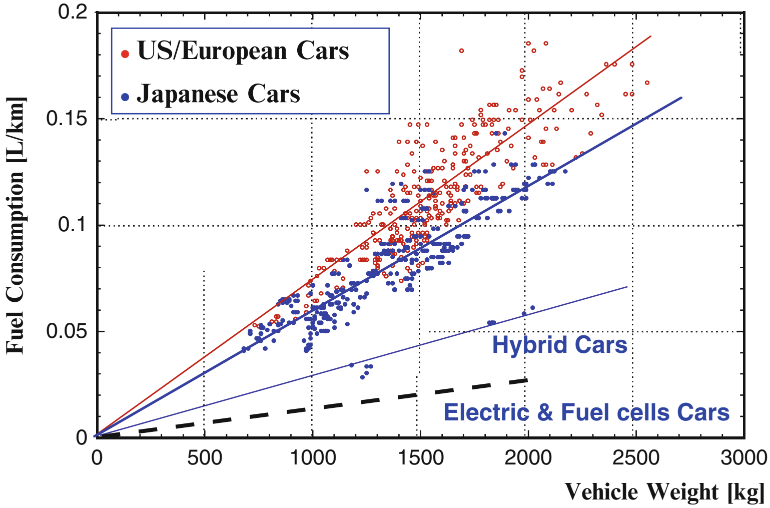

Fig. 3.1 Automobile energy consumption to 1/10 at 2050. (Data from Yahoo! Jidosha)

When we consider energy consumption, it is wise to divide the consumption into energy that is consumed in order to make things and energy that is consumed when these produced items are used.

First, as an example of the latter, let us look at automobiles. Automobiles consume 15 % of all energy used, and the effort to save energy in this area is one of the most important issues on the consumption side (Agency for Natural Resources and Energy 2012).

When cars run, energy is dissipated in the friction between the tires and the ground. To be more precise, when the speed exceeds 100 km/h (kilometers per hour), the effect of air resistance also comes into play, but up to speeds of 70 or 80 km/h at which a car travels on ordinary roads, the issue is almost entirely the drag arising from tire on road. If there were no frictional drag, after a certain speed is reached then the car would continue to move without using any energy. The theoretical limit of energy required for lateral transport is zero.

In fact, these days "energy-saving car races," in which entrants compete over how far they can travel using one liter of gasoline, are taking place all over the world. In an international race in 2009, the winning team from Switzerland amazingly ran over 5,000 km. How many liters of gasoline did they use to travel 1 km? If you calculate one liter divided by 5,000 km, it is extremely close to zero. The Swiss team's car weighed 25 kg, and the woman who drove it weighed 45 kg, for a total of 70 kg, so compared to an ordinary car the weight was almost zero. In short, this proves experimentally that if the weight of the car is close to zero then it can run a long distance while using hardly any energy.

Accordingly, let's plot a graph (Fig. 3.1) with the number of liters used to travel 1 km on the vertical axis and the car's weight on the horizontal axis. If the technology used is the same, then the points fall on a straight line with a positive slope passing through the origin (i.e., the heavier the car, the more gas consumed).

Please have a look at Fig. 3.1. The line on top is for U.S. and European carmakers such as GM and Volkswagen, and the one beneath it is for Japanese manufacturers. As you can see from this graph, if you compare Japanese cars to Western cars of the same weight, the fuel economy of Japanese cars is about 20 % better. The fact that the energy efficiency is 20 % higher for a car of the same weight means that this is not a case of better fuel economy because the car is lighter, but rather that the energy efficiency is high because the technology is good. Furthermore, if we move to hybrid cars, than at the same weight the car runs the same distance on half the fuel. If we then move to electric vehicles or fuel-cell vehicles, this is cut in half once again. Incidentally, the data point for the Swiss team mentioned above is practically on the origin of the graph.

In the future, if the automobile weight reductions continue and the weight is cut by about half, and electric cars or fuel cells come into wide use, the energy consumed by cars will fall to 1/2 (from the weight reduction of the car frame) times 1/5 ($= 4/5 \times 1/2 \times 1/2$), or 1/10 of the present value. This shows the possibility that in the future, even if the number of vehicles in the world grows to triple the current number, because the amount of gasoline consumed by each will be one tenth the level now, the total energy used will be about one third.

Electric vehicles and fuel cell vehicles run on a motor without using a combustion engine. Compared to the case where such an engine is used, the number of parts that reach a high temperature is small, and so the necessity to use steel as material for the vehicle's parts is reduced. Because lighter materials can be used, it is possible to reduce the vehicle's weight.

However, the reduction of carbon dioxide emissions by a large margin from the high energy efficiency of electric vehicles is limited to countries like Japan which have a high efficiency of electricity generation. For example, compared to a coal-fired electricity generation efficiency of approximately 38 % for Japan, in China on average it is on the order of 28 %, and in the United States it is 30 % or so. As a result, in countries such as these, even if, owing to the spread of electric vehicles, carbon dioxide emissions during vehicle operation are reduced, the emissions from electric power plants will rise. Moreover, because nearly all of China's thermal power plants do not desulfurize emissions, air pollution assumes serious proportions. In these countries, it is necessary to come to grips with these problems in a comprehensive way, by among other things strengthening energy conservation and instituting pollution countermeasures.

It is projected that the world's population will reach about 9 billion in the year 2050 (United Nations, New York 2011). At that time, supposing that most countries of the world reach the same level of development as the present-day developed nations and own automobiles at a proportion of just under one vehicle per two people, the number of vehicles in the world will be more than 4 billion. As there are now about 1 billion vehicles in the world, the number owned will quadruple.

In general, a great many people make an argument along the lines of the following: "If the Chinese all come to own a household vehicle, and if this trend spreads to India as well, then nothing can be done to save the global environment." But that kind of argument does not take into account the advance of technology.

The reason that arguments about the energy consumption of vehicles time and again become vague is that they are not based on an orderly theory. And so they do not reach a clear conclusion regarding the extent to which the energy efficiency of automobiles can be improved. For instance, in the graphs of fuel economy used in automobile catalogs, because it is often the case that engine displacement is shown on the horizontal axis and fuel consumption on the vertical axis, it is not possible to comprehend how far energy efficiency can be improved through technological progress.

If, as in Fig. 3.1, on the vertical axis we plot the number of liters of gasoline used to run 1 km and on the horizontal axis the weight of the vehicle, from the very beginning we may come to see the future. In short, for the energy consumption required to propel a vehicle, zero is the theoretical limiting value. In the example of the Swiss team mentioned previously, the fuel efficiency was close to this limit and falls near the origin of this graph. Through the development of energy conversion technology and lightweight material technology, how close to this origin we can come is in fact the goal.

Thinking in this way, even if the number of cars cruising through the world quadruples from the present number, if the energy efficiency is five or even ten times the current level, then the energy consumed to power these vehicles will decrease. That this is possible has been shown by theory; the forecast for technology provides the view of how it is possible to approach this theoretical limiting value. To sum up, in the case of automobiles, realizing the technology to approach the theoretical limiting value is the answer to the problem of a "Limited Earth."

Not only for automobiles, but also for such devices as air conditioners and water heaters which use a great deal of energy, the gap between the theoretical limit and the present state is large, and there is ample room for improving energy efficiency. This fact is one of the grounds for the possibility that technology can contribute to the future.

Energy Conservation Can Be Realized Economically

Automobiles provide an example of something humans make that consume energy when they are used. Let us consider cement as an example of using energy to make something.

Figure 3.2 shows the amount of energy consumed in producing 1 ton of cement. Cement is made using limestone, clay, silica, etc. as raw materials, but because it involves an endothermic reaction energy is always required. In the production of cement, Japan's energy efficiency is overwhelmingly better than that of other countries.

Japanese cement companies, by significantly improving the production process from wet process to dry process to suspension pre-heater (SP) and then to the new suspension pre-heater (NSP) process, have up until now reduced energy

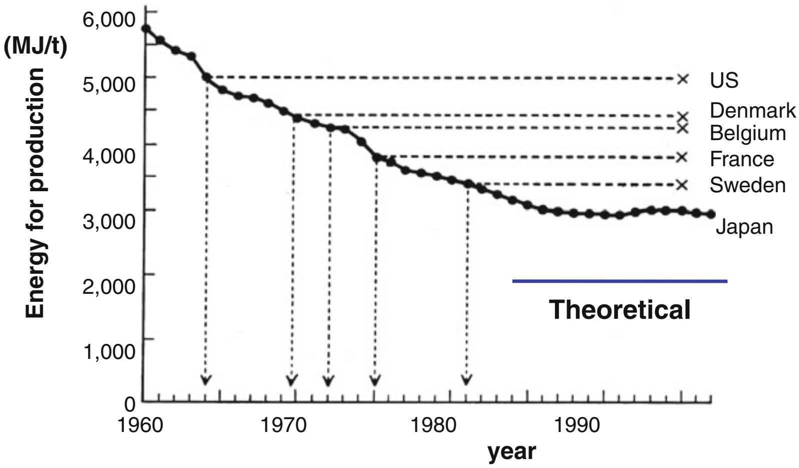

Fig. 3.2 Energy Consumption for Cement Production. Source: Japan Cement Association

consumption. At present, all of the cement plants operating in Japan have adopted the newest NSP process. Through this technological progress, for cement production the energy efficiency has already come down to 1.6 times the theoretical limiting value, having fallen to the point where further reductions are difficult.

However, if we look at the entire world, there are still many countries where energy consumption can still be reduced. As can be seen in the figure, for instance in the U.S. producing 1 ton of cement uses 1.6 times the amount of energy used in Japan. The reason is that the U.S. has adopted a policy of holding energy prices at a cheap level. Likewise, China, which produces more than half the world's cement, uses 1.6–1.7 times as much energy as Japan.

These facts offer the following two important insights. One is technology transfer. For countries like Japan possessing the most advanced production processes, further reducing energy consumption is difficult. However, if China introduces Japanese technology, the energy consumed to make the same 1 ton of cement can be significantly reduced.

Energy consumption falling from 1.7 to 1 means a 40 % reduction. Because the energy consumption of one country which produces half the world's cement is reduced by 40 %, the effect of controlling energy use and carbon dioxide emissions is extremely large.

China too is embracing the idea of a "Green China," and awareness is increasing of the need to reduce the burden that economic growth imposes on the environment. However, considering the scale of the economy, energy consumption is excessively high. Introducing established technology with high energy efficiency is surely China's responsibility as a great power of the world.

This is where the energy-conserving technology that Japan has amassed comes in. As we have seen in the case of cement, in the world's energy efficiency, there is a gap between respective countries or factories. If superior technology diffuses throughout the world, that alone would bring about a drastic reduction in energy consumption. And this will also provide an excellent business chance for Japan's industrial sector.

The improvement of the entire world's energy efficiency will be brought about by the development of state-of-the-art technology and the transfer of established technology. We must realize that Japan is in an advantageous position both in "technology development" fields where there is still room for improving energy efficiency (such as automobiles, air conditioners, etc.) and also in "technology transfer" fields where the improvement of energy efficiency is already nearing its limits.

One more important insight is that the improvement of Japanese energy efficiency took place in a free market. In short, Japanese cement companies were able to raise their energy efficiency because this was realized in an economical way. To build a new plant, capital investment is necessary. In other words, it is the case that these investments were undertaken because, through the increase in energy efficiency and reduction in energy costs, the investments could be recovered.

Similarly, it is not true that the improvements in energy efficiency of Japan's coal-fired thermal power plants were pursued with the Earth's environment in mind. Because by implementing these improvements energy costs could be lowered and the investments recovered, the capital investments were made and the efficiency of coal-fired power plants was raised. Actually, in the case of Japan's coal-fired power plants, the energy efficiency with which coal is burned and converted into electricity reaches as high as about 40 %, but in China on average it is on the order of 28 %, and in America 30 % or so (Ecofys Netherlands 2010).

In today's world, there is an excess of capital but it lacks a place to go. As a result, too much investment has flowed into securitized financial instruments intended to produce money from money, and this brought on the financial crisis.

In contrast, investments in energy-conserving technologies, by actually lowering energy costs, produce value and have a high chance of being able to recover the capital. Of course, energy conservation technology investments are not the types of thing that yield the huge annual returns of 20 or 30 % that Wall Street shoots for. But, if investments are made in areas and promising technologies able to conquer the problems of a "Limited Earth," owing to the reduction in energy costs, annual returns of 3–5 % can be expected. If capital can be directed into such fields, it will be possible to solve the problem of global warming.

The Reason Why Recycling Is More Energy-Efficient

Next let us turn to an explanation regarding the construction of a "material cycle system." A material-cycle type system is, simply speaking, a recycling society. What is important for humanity is that recycling reduces energy consumption.

Let's consider steel and aluminum as examples. Producing steel from iron ore is a process of turning iron oxide into iron. Since iron ore is an oxide, oxygen is removed from it using a blast furnace and thereby iron is produced. This reaction that removes oxygen is called reduction. For it to occur reduction energy is necessary. In contrast, when new iron is produced from scrap that is used iron waste, energy is required to melt the iron. This is called the heat of fusion.

If we compare the reduction energy to the heat of fusion for iron, we find that the reduction energy is 27 times larger. In other words, producing the same amount of steel from iron ore requires 27 times more energy than producing it from scrap.

This is the reason why even now scrap is being commercialized. As of 2009, of the world's steel production of approximately 1.4 billion tons, 1.0 tons is produced from iron ore and 0.4 tons from scrap. Already 30 % of the iron raw material is being recycled.

After steel, aluminum is the metal used in greatest quantity; the bauxite from which it is made is, like iron ore, an oxide. As opposed to this, aluminum scrap is just metallic aluminum. Producing aluminum from bauxite uses 83 times more energy than producing new aluminum from aluminum scrap.

The ratio of theoretical values is 27 times for iron to 83 times for aluminum.

For the case of aluminum—which is different from that of steel—whether it is produced from bauxite or from scrap via electrolysis, in either case electricity is used. Therefore it is easy to compare the energy efficiencies. Compared to the theoretical ratio of 83 to 1, in an actual factory the ratio of energy consumption is on the order of 30 to 1. Even so, from the standpoint of energy consumption, scrap aluminum is far and away a better resource than the natural ore. As we can see from this, the recycling of metals allows us to reduce energy consumption.

Here too the year 2050 is a critical juncture. By 2050 it is projected that most countries, including China and India, will approach the state of "saturation of man-made objects." Take automobiles, for instance: Humankind as a whole is expected to own more than 4 billion of them by 2050. In that state saturation will be reached and the number of vehicles owned will hit a ceiling, after which it is anticipated that there will be no great changes.

Under those conditions, assuming the average service life of an automobile to be 10 years, each year four hundred million vehicles will be sold and four hundred million will be disposed of as scrap. It must be noted that at that time, all of the material resources needed for new vehicles will be contained in the scrapped ones. When this becomes so, it will be possible to make four hundred million new vehicles from the scrap of four hundred million vehicles. Naturally, this represents the extreme case, but if a societal system can be created in which recycling is carried out successfully, then in 2050 new mine resources will become unnecessary. What is more, in principle recycling results in less energy being consumed than making new products from mineral resources dug out of the ground.

Now, of course it is not possible that new resources will become absolutely unnecessary. The main reason is that impurities are mixed into scrap.

For example, the steel cans used for beer and other drinks and formed into a can shape at one go by applying pressure to flat metal sheets. But for this purpose the steel must be of high quality, lest cracks appear. In fact, in high-purity steel, small amounts of other materials are intentionally admixed in, but it is difficult to make such high-quality steel from scrap.

For this reason, it is not the case that everything can necessarily be made from scrap; about one tenth of all steel used will contain new steel, and the one tenth of the used steel that has truly become impure will be discarded. In other words, I believe that in the actual shape of things to come, nine tenths of used items will be recycled.

Up until the present humanity has dug iron ore from the earth, and reduced it with coke to produce steel, thereby accumulating it as a man-made object. Before long these man-made objects will saturate and society will evolve so as recycle the steel already in existence in the world. This is what I have called the “material circulating society,” and I expect its arrival by roughly the year 2050.

“Urban Mines” Are Not an Urban Myth

Not only steel and aluminum, but other metal resources such as copper can be recycled in the same manner. Take gold for instance. The gold ore dug from mines is said to contain per ton 5–10 g of gold, and at this level it is high grade. In contrast, a 1 ton collection of cell phones contains 250 g of gold, and can be said to be a much higher grade of gold ore than that from mines. This is the reason they are called “urban mines.”

In thinking about the future, the lithium used as a raw material in batteries is also critical. In producing rechargeable lithium batteries, from the very start recycling is considered to be a premise. At the present time, since the diffusion rate of lithium batteries is still low and the saturation state of “man-made objects” has not yet been reached, it is necessary to manufacture the batteries by mining lithium resources. Naturally, because of this it is a precondition that Japan not lose out in the competition for resource acquisition.

However, if we set out to create a recycling system for lithium batteries from the outset, after 20 or 30 years we will possess a sufficient amount of lithium battery capacity for the needs of society and anything above this will be unnecessary. At that time, if a lithium battery recycling system has been set up, there will be no need to mine and import lithium resources.

This is an optimal arrangement for Japan, which is lacking in resources. It is also a model that humanity should aim for.

Three Points for Building a “Material Circulating Society”

If a “material circulating society” can be created in this way, humanity will be liberated from the resource depletion problem, one of the triad of problems of energy, resources, and environment. The problem is how we go about constructing this re-circulating society. Necessary to successfully re-circulate resources are the following three things: a societal system for recovering resources, product design that allows for easy separation of resources, and the technology for separation. The direction of the future is to construct a material circulating society via these three avenues.

Regarding the societal system, the cooperation of citizens will probably also be necessary. It may well be good to consider a system where money is paid and resources are collected. Formerly, the disposable camera (the so-called "QuickSnap") was a case of building up a system for resource re-circulation. As long as the resources come to be naturally collected, because in principle using recycled resources consumes less energy at a lower cost, the resources will come to be re-circulated smoothly.

It is certain that the material circulating society will be a more complicated society than the old one. Steel was made by digging up iron ore from the earth and removing oxygen from the iron ore in a blast furnace. Producing it in mass quantities, using it in mass quantities, and discarding it in mass quantities: this was the way of the world through the twentieth century.

In the re-circulating society, once something is used it will be collected and re-used. It is a fact that constructing a system in which resources are not dug out of the earth will be a difficult business, but a re-circulating society is a more advanced society and humanity has no choice but to make such a society its goal. The reason is that we are already being confronted by the global warming problem, and moreover, in the not-too-distant future our resources will be exhausted.

At Present 80 % of Our Energy Relies on Fossil Fuels

We have explained that if we can raise energy efficiency we can greatly reduce energy consumption, and that if we can realize a recycling society we can greatly reduce mineral resource consumption. Next let us consider whether we can double our use of non-fossil energy in order to lower the fraction of our energy that relies on fossil fuels.

At the present time, broadly speaking about 80 % of the world's primary energy supply relies on oil, coal, and natural gas, which are fossil fuel resources. Of this 80 %, the ratio is about one third for each of these three sources. The two big problems with fossil fuels are that they release large amounts of carbon dioxide when burned, causing global warming, and that sooner or later they will be depleted.

The remaining 20 % is made up of non-fossil fuels, of which nuclear power and hydropower each contribute 5 %, and biomass derived from plants contributes 10 %. Present-day biomass is, simply stated, "firewood," and mainly in developing countries it provides much of the energy used for cooking.

Assuming that the world's population continues to increase as it has and the growth of emerging countries like China, India, and Russia continues and they reach the level of today's advanced nations, in around 2050 roughly three times more energy than now will be used. Because "Vision 2050" aims for triple the energy efficiency (i.e. one third the primary energy consumption), supposing that this can be realized, the total amount of energy consumed in 2050 will be no different from the present. Presupposing these conditions, the proposal of "Vision 2050" is to reduce the share of fossil fuels from the current 80 to 60 %, and to raise the share of non-fossil fuels from 20 to 40 %. It is thought that nuclear, hydro, solar, wind, biomass, and geothermal are realistic components of this 40 % (Komiyama and Kraines 2008).

Nuclear Power as a Transitional Energy Source

If we say we are going to reduce our use of fossil resources, as alternate sources we have only nuclear energy, solar energy (including biomass, wind, and hydro, all of which are ultimately derived from the sun's energy), and geothermal energy.

For nuclear energy there are the two options of nuclear fission and nuclear fusion. Whether nuclear fusion can be put to practical use and largely relied on or not is unclear at this time. Even if it does become possible, like large-scale geothermal, it probably won't be until the twenty-second century. In light of this, until that time we can only count on the nuclear fission path of what is now called nuclear power generation.

But still, can humanity rely entirely on nuclear energy in the future? That too would no doubt be difficult. If nuclear power were to substitute for all of today's energy, the world would need about 10,000 large 1-GWe-sized nuclear power plants.

If we think of the diverse regional conflicts taking place throughout the world, we would have to consider whether humanity could properly control a situation in which as many as 10,000 nuclear reactors existed, from which plutonium and uranium—the raw materials for nuclear weapons—could be extracted.

Moreover, we have experienced the major accidents at Three Mile Island and Chernobyl, and now even in Japan, which is said to possess superior safety technology, the Fukushima Daiichi accident has occurred. Furthermore, in the future nuclear reactors will one after another reach the end of their service lives. As an engineer, I find it impossible to imagine the difficulties of undertaking the colossal construction of 10,000 reactors and then maintaining them all.

In reality, there are also countries such as France, which relies on nuclear power for about 80 % of its electricity generation. Prior to the accident at Fukushima Dai-Ichi, Japan's level of reliance on nuclear energy was about 30 %. In the wake of the accident, at this writing in August 2013, only two of Japan's 50 reactors are operating, while the remaining 48 are out of service for necessary safety upgrades and inspections. As an alternative to make up for the lost nuclear generation, many thermal power plants that had been dormant have been brought back on line.

In the case of a country like France, it is difficult to make a transition to renewable energy in a short time period. However, in the case of Japan, along with taking the opportunity following the nuclear accident to further advance energy conservation methods, it is necessary to accelerate the transition to renewable energy. We should proceed with the understanding that nuclear energy ultimately is an energy source to be used in this transition period.

From the twenty-second century onward, a world centered on solar energy will likely be realized. However, it takes time and money to introduce a new energy system on a large scale. It is necessary to consider the twenty-first century a transitional period until that time, and to make the debate over nuclear power a constructive one.

Producing Biomass in the Desert

Ultimately, energy sources reliant on fossil fuels and nuclear power will have to be replaced by renewable energy. This renewable energy, also known as natural energy, comes in various forms. However, I believe that there are only five types of renewable energy that during the twenty-first century can grow to the scale of at least 1 % of total energy supply: hydro, geothermal, solar, wind, and biomass. There are various other methods, such as ocean thermal energy conversion and wave power, which can be introduced on a small scale, but energy sources that can supply more than 1 % of our energy are limited.

For instance, even now hydropower accounts for 8 % of Japan’s electricity and about 3 % of its total energy (International Energy Agency web-site 2013a, b, c). There is probably still room for expanding the application of small- and medium-sized hydro resources. There is also a great deal of room to develop wind technology and biomass technology, to say nothing of solar cell technology. Geothermal also offers possibilities for expansion. According to some estimates, Japan possesses the world’s third largest potential for geothermal energy production. The development of technology to utilize geothermal sources deep within the Earth’s crust offers considerable promise. These technology improvements and their mass production will ultimately lower costs and accelerate the introduction of renewable energy.

In Chap. 4 I will provide a detailed explanation of solar cells, and so here I would like to discuss biomass. The biomass I am talking about here is not the firewood cut from trees. Likewise, making ethanol from corn and using it to power automobiles has lately been in the news, but using food crops for energy is not appropriate.

Let’s look at the reason. Using the oxygen they take in through breathing, humans burn the nourishment obtained from food, and with the energy thereby generated they carry on the activities of life. Food after all is something that humans internally convert into energy. Incidentally, that energy is on average one hundred watts per person.

The energy from food, when compared to society’s total energy supply, is small, corresponding to about 10 % of the total energy consumed. Using 10 % of all food, even if we could make ethanol without any loss at all, we could only produce enough for 1 % of our total energy needs. Using corn as biomass—that is, trying to use food as energy—has an effect that is trivial.

Moreover, conversely if we were to use 10 % of all food supplies for energy purposes, food shortages would become grave. Actually, in 2007 as a result of corn harvests being directed toward ethanol production, the price of corn skyrocketed and became a major problem in some countries, such as Mexico (Wise 2012). Additionally, the price of feed for cows and other animals soared, and livestock farmers in Japan too were extremely hard hit (Inaguma 2009). These events are self-explanatory if we compare the relative quantities of food and energy resources.

By the year 2050 the world’s population will likely rise to about 9 billion. Besides this, along with the increase in economic wealth, the ratio of meat consumption will increase. For example, chickens require an amount of grain that corresponds to three times the amount of energy in the chicken meat they produce. In turn, to produce the same amount of meat, cows require twice as much grain as chickens. Considering the increase in population and the changes in eating habits, I am afraid that food shortages will be historically inevitable. In consequence, using food products as biomass is not an option, and all land that can be used as farmland will likely be put to use for food production.

In thinking about the future of biomass, the most important questions are what will be used as the raw materials and where will it be raised. For the large-scale introduction of biomass, broad swaths of land and efficient sunlight are necessary—in other words, a high speed of plant growth.

I believe that using seawater to grow algae in the desert is full of promise. There is sunlight in abundance, but because the cost of using fresh water is high, sea water will be drawn in and used. Many deserts in the world are located close to seashores.

Now, the phytoplankton that grow in sea water, such as for instance chlorella, spirulina, or euglena, have a high efficiency for photosynthesis and are single-celled. Among these, some contain a ratio as high as 30 % of constituents that are extremely similar to oil. If these kinds of phytoplankton are raised and pressed, oil substances can be obtained. The oil substances can be used for such things as jet fuel, and the gases obtained from pressing can be burned in place of coal to generate electricity. If these gases are compressed and solidified into briquettes, they can also be easily transported.

In the future, through the medium of biomass, there will be ample potential for the efficient use of solar energy.

Reducing the World's Carbon Dioxide Emissions by 25 %

Let us look at "Vision 2050" from the standpoint of carbon dioxide emissions. Figure 3.3 shows world energy scenarios and the concentration of carbon dioxide in the year 2050 under each scenario.

At the present time, owing to the use of fossil fuels, about 6 billion tons of carbon dioxide are generated per year. (Note that here and in the following, the mass is given in terms of the carbon content of the CO_2. Because of the addition of oxygen to the carbon, the total mass of CO_2 is 3.7 times the mass of the carbon.) The white portion corresponding to 1.5 billion tons is the amount covered by the non-fossil sources: nuclear, biomass, hydropower. If this energy were obtained by burning fossil fuels instead, an additional 1.5 billion tons of carbon dioxide would be generated. Currently, the 6 billion human beings living on the planet use this much energy (Komiyama 1999b).

Figure 3.3b shows a projection of what will happen in 2050 assuming that the world population grows to 9 billion, almost all countries become advanced nations, and present patterns of energy consumption continued unchanged. Here it is assumed that all nations will reach a level of energy consumption equivalent to today's advanced countries (excluding the U.S.). Because this is the business-as-usual scenario, the use of renewable energy does not rise much, and the increase in

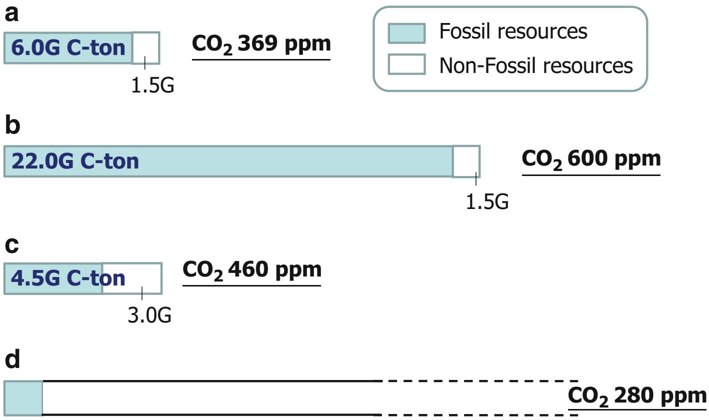

Fig. 3.3 Energy scenario and CO_2 concentrations: (**a**) 1990, (**b**) 2050 BAU case, (**c**) vision 2050, and (**d**) after twenty-second century. Source: Komiyama H and Kraines (2008)

energy consumption is almost entirely covered by fossil fuels. As a result, energy consumption triples, and carbon dioxide emissions in fact grow to 22 billion tons per year, much more than triple the current level.

This is the "breakdown" scenario. It is the scenario in which the carbon dioxide concentration in 2050 will reach approximately 600 ppm, and the Earth's temperature compared to the pre-industrial revolution era will likely rise about three degrees.

If this happens, even looking from an energy resource perspective, even for coal (which is generally thought to have the largest reserves), depletion will start to become a reality. Therefore, the business-as-usual scenario is the same as a breakdown scenario, and in this sense the problem is that present-day humanity is headed for a breakdown.

A Vision on Which Advanced Countries and Developing Countries Can Agree

I believe that "Vision 2050" is a vision on which advanced countries and developing countries can agree.

In advanced countries man-made objects are already reaching saturation. If material living standards and the quantity of services are maintained at about the same level, tripling energy efficiency means that energy consumption will decrease to one third its current amount. If non-fossil energy sources, which now account for roughly 20 % of energy consumption, are doubled, reliance on fossil fuels will fall to 60 %. Should this happen, compared to the present the amount of fossil fuels used in 2050 will be 1/3 (from the reduction in energy consumption) times 6/10 (from the decrease in fossil fuel reliance), or 1/5. Emissions of greenhouse gases such as carbon dioxide will automatically fall by four fifths, or 80 %.

At COP-15 (the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change) held in Denmark in December 2009, leaders of the United States, European Union, Japan, and other advanced industrial nations agreed in recognizing the need to reduce greenhouse gas emissions by 80 % by the year 2050 (UNFCC 2010). The principles for achieving this are just what we have described.

On the other hand, it is also the due right of developing nations to continue growing in order to become advanced nations. Total world-wide energy consumption will be maintained at its current level, but advanced nations will reduce their consumption to one third, with the remaining two thirds allotted to developing nations to support their economic growth. However, they must use the most advanced, highly energy efficient technologies. For automobiles, for instance, just as in developed nations, they will use vehicles with high fuel economy. Or, as we showed in the case of cement, they will use highly energy-efficient production technologies.

In so doing, the merits for developing countries can be explained this way: "Investing in energy conservation results in energy cost savings and is economically beneficial; and what is more, we want to make good use of the excess capital in the world." Now, the bargain that emerging economies must make is that production is their right, but efficiency is their duty. This is the key to success for "Vision 2050."

It is certain that the achievement of "Vision 2050" will not be a simple matter for either the developed world or the developing world. Developed countries will cut carbon dioxide emissions by 80 % while maintaining their standards of living; developing countries will grow while restraining their emissions. For both parties, this is surely the best vision on which they can agree.

Here let us briefly summarize the gist of "Vision 2050." By raising energy efficiency, energy consumption will be reduced. By creating a material circulating society, virtually all resources will be reused, and at the same time energy consumption will be cut. Through the decrease in energy consumption and the expansion of non-fossil energy use, reliance on fossil-fuel sources will be reduced and emissions of greenhouse gases will be significantly slashed.

In concrete terms, energy efficiency will be tripled and, in addition to this, non-fossil energy sources (nuclear, hydro, solar, wind, biomass) will be doubled from the present. If this is done, then "Vision 2050" assumes a form in which world emissions of carbon dioxide decrease by 25 % from roughly 6 to 4.5 gigatons per year. Through these means, the three problems of energy, resources, and global warming will be simultaneously solved.

The important point is that if by 2050 we can meet the goals of "Vision 2050," our prospects heading into the twenty-second century will be bright.

What does it mean to meet the goals of "Vision 2050"? It is a presupposition that for renewable energies, inexpensive and highly energy-efficient technology will be obtainable; moreover, if nuclear power that has overcome the safety issues is added to the mix, the realization of this vision will be all the more easy.

From then on, it will suffice to maintain the flow and continue moving forward. By the twenty-second century, we will have established a material circulating society, so there will be no need to dig resources from the earth. With regard to energy, we will have acquired technologies for the efficient use of clean, renewable energy sources, so fossil-based energy will be practically unnecessary. Solar energy may be thought of as inexhaustible, as it showers down upon the Earth at a rate 10,000 times greater than we use all our energy. Hence, the year 2050 is an important milestone on the way to the twenty-second century.

For a vision, I feel that a kind of forward-looking image that integrates knowledge is essential. If it is merely a pessimistic outlook in which the future is stagnant, it cannot generate vitality among people. If it can be attained, "Vision 2050" provides an image wherein a world can be created in which the burdens of material and energy are light from the twenty-second century onward.

Japan as a Resource Self-Sustaining Nation

The times are vastly changing owing to the growth of developing nations. The era in which primary resources could be bought cheaply is already ending. In the future, although prices will rise and fall because of changing economic conditions and other factors, over the long term the price of primary resources will no doubt continue to rise. Looking back at the past, crude oil prices have continued to rise from the 1960s, the era when it was a dollar per barrel. Even iron ore, with its large reserves, has lately jumped in price.

Not only price increases, but also indications can be seen that resources are being depleted. For example, take the large-scale crude oil discharge accident that occurred in April 2010 in the Gulf of Mexico off the coast of Louisiana (BP web-site 2013). This showed us the following realities: Of the reserve-rich and easily exploited oil fields on land, almost none now remain, and exploiting oil fields beneath the deep ocean brings with it great risks and high costs.

It is not only a matter of energy resources such as crude oil, but as we head toward 2050 the world's population will increase, and the problem of food shortages will grow more severe. Accompanying the enriching of economies, eating habits will shift from being centered on grain consumption and meat consumption will increase. Because eating meat is less energy efficient than consuming grain directly, greater grain production will be necessary.

The depletion of timber resources is also a serious problem. In times past, many civilizations consumed great quantities of timber as an energy resource and building material, and as a result of using up the forests, they collapsed. We must learn from this history.

In light of this situation, what actions must Japan take with respect to "Vision 2050"? In Japan's case, the share of the total energy supply accounted for by non-fossil sources is 16 % (Agency for Natural Resources and Energy 2010). In Japan, with its limited land surface, installing solar panels on all roofs and idle land would be able to cover about 8 % of present energy consumption. Wind, biomass, hydropower, and geothermal will also be used. If nuclear power too is employed and the share of non-fossil energy sources is doubled, then they will make up 32 % of the total current energy consumption.

Self-Sufficiency in Japan at 2050	
Komiyama's Proposal	
ENERGY	70%
MINERAL	70%
FOOD	70%
WOOD	100%
WATER	100%
Japanese goal as well as 21st model of humanity	

Fig. 3.4 Self-sufficiency in Japan at 2050

At the same time, there is no need to reduce energy consumption to one third its present level. Assuming that the current volume of goods and services remains fixed, if we further suppose that energy consumption is cut by just over half to 45 % of its present level, on a scale where current energy consumption is 100, this consumption will be 45. Because the non-fossil energy share of this will be 32, the share of non-fossil sources will be 32/45 of total energy consumption. In other words, more than 70 % of all energy consumption can be covered by renewables and nuclear, which emit no carbon dioxide and are inexhaustible.

If this situation is realized, compared to the present the quantity of fossil fuels used will be 45/100 (from the reduction in energy consumption) times (45 – 32)/45 (the new level of reliance on fossil fuels) = 0.13, or about one tenth the present quantity. That is to say, it is possible for Japan and other developed nations to reduce carbon dioxide emissions by 90 %.

Accordingly, if developed countries cut their energy consumption to one third and even if the introduction of renewable energy occurs at a rate about one half that of the above calculation, it is possible to reduce carbon dioxide emissions to roughly one fifth of their current levels. This is the picture of the future "Vision 2050" paints for Japan and the developed world.

The realization of "Vision 2050" will consolidate Japan's material foundations. To summarize this chapter, I would like to propose making Japan's self-sufficiency rate in 2050 for energy, mineral resources, and food 70 %, and for timber resources, 100 % (see Fig. 3.4).

Regarding energy, as we have already stated, by reducing energy consumption to 45 % of its present level and by raising non-fossil energy use to 32 % (double its present level), over 70 % of energy consumption will be covered by inexhaustible renewable energy and nuclear energy. In other words, 70 % of energy will be provided self-sufficiently.

At the present time Japan relies on imports not only for energy sources, but also for nearly all its mineral resources. However, considering materials like steel and aluminum, these are in fact recycled to a considerable extent. As noted previously, worldwide about 30 % of steel materials are already recycled products. In the future, as man-made objects approach the point of saturation, this ratio will rise further, and in approximately 2050 a situation is projected in which quantitatively scrap alone will suffice. Japan must anticipate this trend.

In this way, through the construction of a material circulating society, the recycling rate will rise and the self-sufficiency rate for mineral resources will be increased to 70 %.

Regarding food, presently the self-sufficiency rate on a calorie basis is about 40 %. However, of foodstuffs as a whole, actually on the order of 30 % are estimated to be discarded. Therefore, first the amount of waste will be reduced. Furthermore, roughly 30 % of crops are lost in the fields due to damage caused by diseases and harmful insects, but this will be reduced through the improvement of technologies to control these factors. Additionally, the following countermeasures will be thoroughly implemented: land on which cultivation has been abandoned, which currently makes up a considerable area, will be used; high-yield rice varieties will be created; and these will be used to make rice flour and feed for livestock. Through these efforts, the food self-sufficiency rate will increase to 70 %.

Although timber resources are used for construction and pulp production, the current self-sufficiency rate is less than 30 %. This is a result of the cheap supply of timber from overseas and of the decline of the domestic forest industry, but in the future, owing to environmental conservation and increasing demand from developing countries, the price of overseas timber will likely continue to rise. On the other hand, there is no fundamental reason why a forest industry cannot be realized in Japan, which is humid and warm and covered 70 % by forests. By overcoming the societal issues and developing the technology, Japan must create a sustainable, highly productive forest industry. By doing so, it will be possible to attain a 100 % self-sufficiency rate for timber resources, and this is indispensable for ecosystem maintenance as well.

Water, food, timber, minerals, and energy form the physical foundations of our lives. Fortunately, Japan is rich in water resources Moreover, the high efficiency of its waterworks systems is among the best in the world. For example, losses from leakage in Tokyo's water system are only about 3 %. Worldwide, the average water leakage rate is as high as 30 %, and even in metropolises of developed countries, losses of 30 % are quite common. In the future water will become a critical strategic resource. On this point, the water business is liable to open paths into the many countries that worry about water scarcity.

In conclusion, if these self-sufficiency rates (except for water) can be achieved, Japan's material foundations will be secure. If a self-sufficiency rate is 70 %, then in a time of crisis it is relatively easy to make reductions of about 30 %. For energy, for instance, as happened during the time of the First Oil Shock, by taking such countermeasures as dimming the neon city lights at night and suspending broadcasts in the middle of the night, it is possible to pull through.

At the risk of repeating myself, considering the population increase and economic growth of developing countries, sooner or later the entire world will have no choice but to head in this same direction. If a country like Japan—with limited land area, a large population, and scant underground resources—can achieve self-sufficiency in energy, mineral resources, timber, and food, then this will become a model the entire world should follow.

By moving forward and strengthening its material foundations, Japan will in fact be taking the lead in working toward solutions to problems that the whole world will sooner or later face. This is the basis for calling Japan, as I have been, a "problem-saddled developed country" that can become a "problem-solving developed country."

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Chapter 4
Finding a Way Out Through Creative Demand, I

Currently, many Japanese companies are looking for growth opportunities in developing countries. If a saturation of man-made objects is to occur globally in the not-too-distant future, as we discussed in Chap. 1, how should Japan act?

If we call demand that leads to a saturation of man-made objects diffusive demand, and call demand that has not yet emerged creative demand, as defined previously, Japan should stimulate creative demand, create new industries, and seek markets globally by solving the problems it faces.

In light of "Vision 2050" presented under the second paradigm, "Limited Earth," it is necessary that one of the areas in which such things are possible is that of energy and resources. Automobiles, air-conditioners, water heaters, refrigerators, lighting, solar cells, storage batteries, and fuel cells are all reservoirs of innovation.

Another important area is one that responds to the aging society, and an enormous range of new industries may be found there. Products that will emerge include safe automobiles, on-demand transportation, robot suits, housework assistance robots, self-help care supporting houses, and regenerative technology for eyes and teeth. The social system that mobilizes them will bring about innovation and create new industries.

In this chapter, let us consider the direction Japan should take in the area of environment and resources.

Monozukuri (Making Things)[1] and Daily Life

First, let us take a look at the present state of energy consumption in Japan, which is assumed when we think about the area of the environment and resources. When energy consumption is analyzed, it is often broken down in accordance with the

[1] *Monozukuri*, which literally means making things or goods, refers to a unique style of Japanese manufacturing and is sometimes defined as "the duplication of design data into a material" or the "art, science, and craft of making things."

H. Komiyama, *Beyond the Limits to Growth: New Ideas for Sustainability from Japan*, Science for Sustainable Societies, DOI 10.1007/978-4-431-54559-0_4,

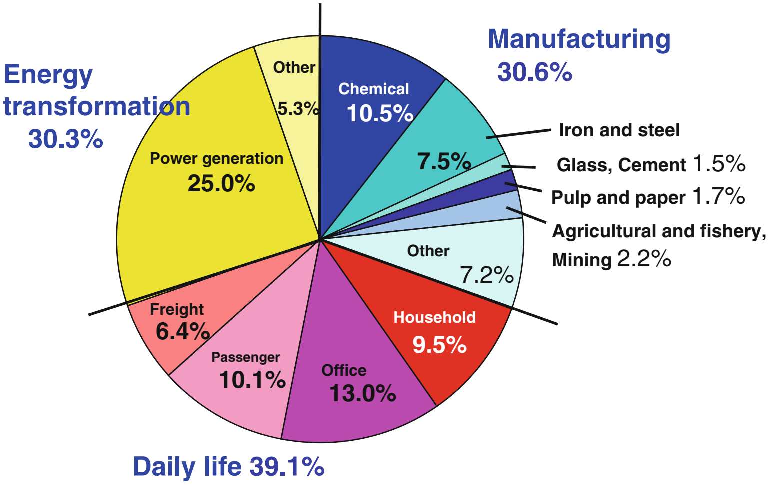

Fig. 4.1 Distribution of energy consumption in Japan. (Data from Sogo Enerugi Tokei 2007 (Data: 2005), Japan Agency for National Resources and Energy). Note: Energy consumption at energy transformation sector indicates the energy is not converted to electricity as well as self consumption at power generations

basic distinction between industrial and consumer sectors. This idea is akin to the dichotomy of capitalists vs. workers, which was popularized in a previous age and is thus inappropriate.

I propose to break down energy consumption from the perspective of *monozukuri* (making things) and daily life. Refer to the pie chart in Fig. 4.1. *Monozukuri* includes producing food in agriculture in addition to manufacturing plastic in the chemical industry and iron in the steel industry.

Most energy conversion takes place in power generation plants, which themselves consume energy to produce electricity.

Daily life covers households and offices that consume the goods thus produced. Although energy use in offices is typically classified as industrial sector use, we classify it as energy use in daily life because offices are also places where people spend their time working. Energy use for passenger and cargo transport is also included in energy use in daily life. Energy use for passenger transport is mostly accounted for by energy consumption that results from operating transport equipment such as automobiles. Energy is, after all, consumed for cargo transport by people driving vehicles such as cars.

Such a broad classification from the two perspectives is intended to make it easier to discuss which activities emit carbon dioxide and what are reasonable ways to reduce carbon dioxide emissions. For these purposes, it is more logical—and makes it easier to think of responses—to adopt the standard that classifies energy consumption by whether energy is consumed in making or using things, instead of the standard based on the dichotomy in which capitalists or workers are using energy.

Electricity generated by power plants is consumed for *monozukuri*, or making things, and for daily life. If, in this way, energy consumption is divided into

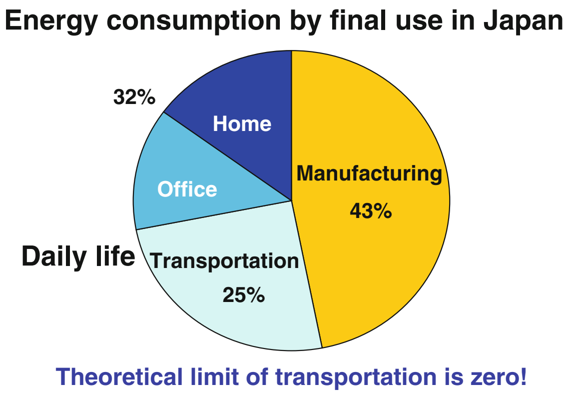

Fig. 4.2 Energy consumption by final use in Japan

consumption for *monozukuri* and daily life, in the case of Japan, a little less than half of total energy consumption is for making things and a little more than half for our daily lives, as can be seen in the pie chart in Fig. 4.2.

In China, 70–80 % of total energy consumption is presumably for making things. The reasons for China's low energy efficiency are the low energy efficiency of high energy consuming industries such as metal and chemical industries, coupled with the high proportion of such industries, as well as energy prices that are kept low by governmental guidance (Nan Zhou et al. 2007). Conversely, 70–80 % of the total energy consumption in the United States is considered to take place in daily life. The United States also has a social structure that is unlikely to motivate energy saving because energy prices are low.

The tendency of energy consumption to shift gradually from consumption for making things to that for daily life corresponds to the process of transforming from developing countries to emerging economies and further into advanced countries, and the industrial structural process of shifting from primary industries to the secondary and tertiary industries. Also, developed countries may differ in terms of which kinds of activity use more energy depending on whether industries for making things remain to a considerable extent, as in Japan, or to a small extent, as in the United States. In addition, when it comes to the question of which type of activity in daily life is energy used for, 28 % of total energy consumption is used for transport in the United States (U.S. Energy Information Administration 2011).

Let me add that an index measuring primary energy supply per GDP is often used in international comparison of energy efficiency. This index means how much energy is consumed to generate a unit of GDP. This index only gives one perspective. The argument once made that Japan had been surpassed by other developed countries in terms of energy efficiency was too simplistic.

For example, like Iceland before the Lehman collapse, a rapid increase in the percentage of GDP accounted for by the financial industry makes it appear that the energy efficiency per GDP unit has increased. Since an increase in the percentage of service industries such as the financial industry which do not use much energy makes GDP (the denominator of the primary energy supply-to-GDP ratio) increase more than primary energy supply (the numerator of the ratio), it necessarily results in a decrease in the supply (consumption) per unit.

Therefore, in discussing energy efficiency, it is meaningless unless the energy efficiency in an individual sector such as the cement or auto sector is discussed. If energy efficiency is compared from this perspective, Japan boasts the highest energy efficiency in the world. This is an important point.

In any case, the energy consumption structure varies from country to country. The approach for reducing greenhouse gases represented by carbon dioxide differs by country.

In the case of Japan, the strategy that should be taken is clear.

Forty-three percent of Japan's energy consumption is related to "making things." As the energy-saving technology in this area is advanced, it is difficult to reduce emissions further in industries such as the cement or steel industries.

The remaining 57 %, however, is consumed in "daily life." The total of household and office consumption accounts for 32 %, and the remaining 25 % is consumed by transport including commercial transport. In addition, if we take a look at energy consumption in Tokyo, about 90 % is accounted for by "daily life." This gives an important hint for predicting the change in the structure of energy consumption in the future. Japan, which has such a structure of energy consumption, is advanced in energy conservation in making things but has enough room for energy saving in "daily life."

If you look at the world, on the other hand, large room for improvement is left in energy saving in "making things" in most countries, and they have the potential for energy saving in "daily life" as much as, or more than, Japan does.

In light of this situation, it may presumably be concluded that the strategy that Japan should adopt is to lead the world in energy saving in "*monozukuri* (making things)" and to reduce greenhouse gas emissions in "daily life." Assembly industries such as automotive and consumer electronics industries should continue to develop excellent energy-saving products and sell them in Japan and abroad. The materials industries should also lead the world in energy-saving technology and transfer technology to other countries to contribute to reducing carbon dioxide on a global scale. On the other hand, carbon dioxide emissions should be reduced in "daily life" in Japan.

Structure of Energy Consumption in Households

Now, what is energy consumption in the household like? Figure 4.3 shows the breakdown of household energy consumption by use.

In the energy consumption breakdown by use, water heating represents the largest share, followed by air-conditioning, each accounting for 30 %. With lighting and refrigeration (motor and other primary components) included, these uses account

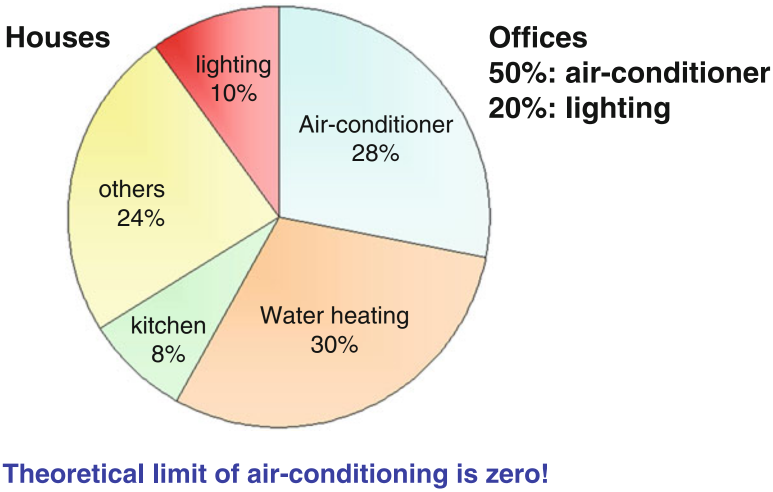

Fig. 4.3 Energy consumption in houses and offices. (Data from Handbook of Energy & Economics Statistics in Japan 2009, The Energy Conservation Center, Japan)

for nearly 80 % of home energy consumption. Air-conditioning accounts for 30 % and lighting 40 % of office energy consumption. Therefore, as you may see, to what extent energy consumption can be reduced in these areas with large energy consumption is the key at home and office.

Let us take an air-conditioner as an example. The mechanism of an air-conditioner is completely different from that of an electric stove or *kotatsu*. An air-conditioner works by a machine called a heat pump, which pumps out indoor heat and pumps in outdoor heat. It discharges heat from the indoor to the outdoor space when cooling and transfers heat from the outdoor to the indoor space when heating.

The energy efficiency of an air-conditioner is represented by the coefficient of performance. The upper table in Fig. 4.4 shows this. The coefficient of performance, 3, in the leftmost cell of the upper table means that 1 kW of electricity enables 3 kW of heating or cooling.

The theoretical limit of the coefficient of performance is calculated as "indoor temperature divided by outdoor-indoor temperature difference." Note that the indoor temperature is represented in absolute temperature, obtained by adding 273 to the actual temperature in Celsius. If the current indoor air temperature is 28° and if the outdoor air temperature is 35°, the coefficient of performance is $(273+28)/(35-28)=43$. In other words, it is possible to pump out of the indoor space heat which is 43 times as much as the electric energy consumed. This value, 43, is a theoretical value, and it was actually only 3 around 1990. Conversely, how much difference there is between the theoretical and the actual value constitutes the potential room for innovation.

Just like an air-conditioner, an automobile, which I mentioned in Chap. 1, has large room for innovation. In contrast, cement has small room for innovation. In thinking about in which areas it is effective to reduce carbon dioxide emissions and in

Vision: Heating energy consumption to 1/12

Air Conditioner

Before 1990	1997	2004	2006	2010	Vision 2050	Theory
3	4	5	6	7	12	43

House Insulation

Bonfire	A ruinous house	Temple's main hall	House	Eco-house	Ideal
0	1	5	30	100	∞

1 / 3 x 1 / 4 = 1 / 12

Fig. 4.4 Heating energy consumption to 1/12 at 2050

which areas it is effective to promote energy-saving technology, it is important to see first what degree of difference there is between the theory and the reality. If there is a divergence between them, then the next procedure is to find out where the cause of the divergence is from the technological perspective and search for a path to innovation.

Appropriate Regulation Encourages Innovation

In general, environmental regulation is still believed to increase costs for businesses and weaken their competitiveness. During the 1990s, however, Michael Porter, a researcher famous for his theory of management strategy, presented the so-called "Porter Hypothesis," which says that environmental regulation of domestic companies leads to their enhanced international competitiveness (Porter and van der Linde 1995).

The Porter Hypothesis goes as follows. As companies work to reduce pollution following the institution of environmental regulations, technical innovation progresses to bring about savings in raw materials and an increase in energy productivity. As a result of this, some companies realize an improvement in earnings that exceed the cost of the environmental measures. Therefore, appropriately-designed environmental regulations bring about technological innovations and make companies more competitive.

For instance, the following cases can be cited. Corporate productivity rose in Japan and Germany, which introduced stringent environmental regulations in the 1970s. The introduction of stringent exhaust gas regulations by the Japanese version of the Clean Air Act (or "Muskie Act," automotive exhaust gas regulations which prescribed emission reductions of nitrogen oxide and other substances from gasoline-powered passenger cars to one tenth of the level at that time) led to strengthening the competitiveness of Japanese cars in the U.S. market (Ueda 2001).

Another example is the Dutch tulip. The Netherlands is famous in the world for tulip bulb cultivation. As tulip cultivation aggravated oil and water pollution, environmental regulations became more stringent. The shift to hydroponics in response to the strengthened regulations is said to have solved environmental problems and to have also improved the international competitiveness of the Dutch tulip.

There are many objections to the Porter Hypothesis, however. There are cases where strengthening environmental regulations doesn't work. As a matter of fact, it is natural that there are both successful and unsuccessful cases.

In short, it depends on whether there is room for innovation. Strengthening the regulation of an area where innovation is technically possible yields good results, as seen for example in the automobile and cement industries. The problem here is that there is insufficient deliberation among the policymakers, economic bureaucrats, and engineers in creating environmental regulations and that they fail to see how much room there is for innovation in imposing regulations.

A technological point of view cannot be said to be fully reflected in discussions on the economic impact that environmental regulations may have. This is a weakness of the economic policy.

Air conditioners provide a good example in this regard, as well. The discussion of the technology prediction for air-conditioners shown in Fig. 4.4 was actually one that my research group at Tokyo University made in 1990. We had excellent engineers participate in the discussion to predict the future evolution of air-conditioners. The conclusion obtained was that the coefficient of performance would increase from 3 to 12 by 2050. It was considered hardly possible at the time because we predicted that an air conditioner of the same performance would work with a quarter of the power consumption.

In making the prediction, we went into extreme details. For example, we even estimated how much the magnet used in the motor of an air conditioner's compressor would be improved. The magnet technology is relevant to the efficiency of an air conditioner. One of the causes of the large gap between the actual coefficient of performance and its theoretical value for an air conditioner is the fact that its compressor consumes about twice the amount of electricity as the theoretical value. It can be improved by using a more efficient magnet for the motor. We predicted that a permanent magnet called a neodymium-iron-boron magnet would become available to raise the efficiency of the motor. Energy consumption would be reduced as a result. We made this prediction by considering various elemental technologies contributing to increasing the efficiency of an air conditioner, including not only magnet technology but also fluid dynamics technology or lubricating oil technology.

The prediction that the coefficient of performance would increase fourfold by 2050 was completely ignored by a committee of the Ministry of International Trade and Industries (MITI, currently the Ministry of Economy, Trade and Industry). However, the speed of reality was beyond even our prediction. The coefficient of performance reached 5 in 2004 and 7 in 2010. It more than doubled compared with 1990. At this rate, it may exceed 12 in 2050.

In fact, when Japan’s Energy Conservation Law was revised in 1998, a formula was adopted for introducing regulatory standards that take into consideration the technology improvement potential of products. In concrete terms, conservation standards are determined according to a formula (called the “top-runner method”) that takes into account such factors as the performance of the item among products currently commercialized that has the best energy efficiency (i.e., the top-runner), and future projections of technological development. If a company continues to sell a product that does not meet the standards without sufficient reason, the company’s name may be published and fines may be levied. Goods made subject to these regulations were mainly home electrical appliances and automobiles; the energy efficiency of these items has since seen great progress. For example, the energy reduction of air conditioners was noted above. Because the achievement of higher regulatory standards increases the competitive power of products, these policies are evaluated highly for having created strong incentives for energy conservation.

In the 2013 revision to the Energy Conservation Law, building materials with enhanced insulation properties were also included in the top-runner system. Also, in 2012 the Japanese Government decided on a policy making it mandatory for all newly constructed buildings (homes, office buildings, etc.) to comply with energy conservation standards by the year 2020. In the future, the rapid realization of these insulation mandates will lead to innovations that serve to boost the competitiveness of the construction industry.

In this way, a rational technological prediction contrasting theory and technology is indispensable for examining regulations and their economic impact.

Air-Conditioning Energy Consumption Can Be Reduced to One Twelfth

Although Japan is a country of high energy efficiency, one of its few weaknesses is in building insulation.

This is related to its history and climate. As Kenko Hoshi wrote in the *Tsurezuregusa*—“A house should be built with the summer in view”—Japanese houses were built for the purpose of enduring the mugginess of summer (Porter 1914). It is uncomfortable in the summer in Japan because of the high humidity and temperature. For this reason, the roof tiles of a Japanese house are thick, and it has enough space underneath for good ventilation. On the other hand, it is not suitable to spend winter in. Japanese people used to endure the winter by being thickly clad and warming themselves over a *hibachi* or Japanese charcoal brazier.

Then, after World War II, air-conditioning was introduced from Western countries, which resulted in incoherence. Japanese started to use walls instead of shoji screens between pillars for partitioning and to heat and cool their houses. Thus, due to the low adiabatic efficiency of a Japanese house, in summer it has to be cooled by using a large amount of energy. It also results in a violent outflow of hot air from air conditioners that can make things unpleasant.

Due to poor insulation, there is a different problem in winter: the warm air in the room comes in direct contact with a windowpane cooled down to a low temperature by the outside air, causing condensation. Condensation causes mold and mites. On the other hand, a large difference in temperature tends to occur between different locations in the house, and such problems have occurred as elderly people collapsing in a toilet or bathroom because it is cold in these areas. Japanese used to build a well-ventilated house appropriate to the Asian monsoon zone. Incoherence arose because the Western housing model was introduced without any modification.

Therefore, we should build highly insulated houses suitable to the Japanese climate. Double-glazed windows and vacuum insulation materials are in particular expected to have an insulation effect. Turning single-glazed windows into double-glazed windows increases the insulation effect and can also prevent condensation.

I also think that vacuum insulation materials should be utilized in Japanese houses. Vacuum insulation materials are thin and have better insulation because of a vacuum layer between thin panels. They have already started to be used in refrigerators made in Japan. A refrigerator using vacuum insulation materials has a vacuum-flask-like structure. Its power consumption is small, and it has a large capacity. If vacuum insulation materials are mass produced, their cost can be reduced to the level that enables them to be used as building materials.

As for the thickness of housing insulating materials, in the case of Germany, for example, the standard value has recently been raised from 10 to 20 cm, but, given the housing situation in Japan, 20 cm is not realistic as it results in narrower houses. Vacuum insulation materials are the most appropriate. The situation in many Asian mega-cities is closer to Tokyo than to Germany. Consequently, Japanese technology can contribute to Asia, and, for Japan, technology developed for itself directly provides a breakthrough for advancing into other parts of Asia.

Improving the insulation effect leads to reducing the energy consumption. If the efficiency of an air conditioner increases four times to reduce its energy consumption to a quarter and if the housing insulation effect increases three times, it is possible to reduce the amount of energy consumption for home air conditioning to one twelfth, since $1/3 \times 1/4 = 1/12$.

Room for Innovation Lies in the Difference Between "Theory" and "Reality"

Three conclusions can be obtained from the above discussion.

The first conclusion is that room for innovation lies in the difference between "theory" and "reality." Taking the examples of cement and automobiles discussed in Chap. 1, energy saving in the cement industry has progressed to the point close to the theoretical value, and so there is little room for innovation there. On the other hand, there is large room for innovation in the automobile industry.

The second conclusion is that a rational technological prediction is important in imposing environmental regulations. A technological prediction must be made on the basis of an accurate understanding of the difference between the theory and the reality.

For example, even with an air conditioner, its coefficient of performance had been close to 3 and had not improved much before 1990. However, once the goal of energy saving was clearly presented, an innovation occurred, and the coefficient of performance started to increase. If you follow an air conditioner which was awarded the Energy Conservation Grand Prize, you will find that it evolved as expected according to the technological prediction we made. In other words, imposing strict regulations in an area which has a large room for innovation facilitates technological innovation.

The third conclusion is that a technological prediction is also important in making a policy in light of the economic impact of environmental regulations. Currently, it is hard to say that technological prediction is fully reflected in developing environmental regulations. Consequently, the process winds up in exchanges of unwarranted assertions among the industry, policy makers, and environmentalists.

As far as technological prediction is concerned, no reliable answers can be obtained from companies if you ask them about it. Scholars and engineers have to assemble and logically thrash it out. Such patient and solid discussions have hardly been made. It is thus an important point how to reflect a technological prediction in environmental policymaking and economic forecasting.

Why Did Japan Fail in Diffusive Demand?

As we have seen in the discussion of Vision 2050, improving energy efficiency is a central issue that humanity must address. The diffusion of Japan's exemplary high-efficiency devices will be extremely effective for the world's energy conservation efforts. To achieve these contributions to world-wide energy-saving goals, Japan must perform well in the economic competition for such products.

Energy and resource conservation technologies in the area of the environment are still what Japan is good at, and Japan maintains its global superiority in them. Japan is globally superior in individual technologies, including those for flat screen TVs of the energy-saving type, LEDs (light-emitting diodes) attracting attention as new light bulbs, solar cells, and high-efficiency water heaters, such as "Eco-Cute," "ENE-FARM" and "Eco-jaws." Therefore it is important whether Japan will really be able to keep winning in these areas.

I am strongly concerned about *monozukuri* (making things) in these areas, however. For instance, solar cell manufacturers may repeat the failure of DRAM (dynamic random access memory) manufacturers. To be frank, the major cause is poor management.

Monozukuri can be roughly classified into two kinds in accordance with the stage of its development. The first kind of *monozukuri* creates a product that has not existed before, such as the LED. The second kind of *monozukuri* concerns making products which we already know how to make, such as commodity plastics. These two kinds of *monozukuri* are completely different in terms of the source of competitiveness and competence required.

For instance, one could go as far as to say that the source of competitiveness of a commodity chemical product is found in how much share it has. Shin-Etsu Chemical has the supremacy, even from a global perspective, in the market of vinyl chloride, which is one of the commodity chemicals. It is strong because it has the largest share in the world as a single company and has price leadership. Although this is not limited to vinyl chloride and applies to polyethylene, polyolefin, polystyrene, etc., Japanese companies lack a substantial presence except in the vinyl chloride market. In other words, even though the capability for *monozukuri* is required for such generic products, what determines competitiveness is scale.

Now what about mobile phones? For instance, can mobile phones made by Nokia of Finland, which has the largest share in the global mobile phone market, be said to be the outcome of *monozukuri* based on the Japanese sense of *monozukuri*? Nokia's mobile phones are, after all, made by importing most of the necessary components from Japan and assembling them in foundries in Taiwan. They sell phones thus made all over the world.

Their strength lies not in how they make mobile phones but in their business model. Products such as mobile phones that have become common are called commoditized products. How to earn profit from commoditized products depends more on the matter of management than that of technology and manufacturing—in other words, it depends on the business model.

There is a wall between *monozukuri* which creates something that does not yet exist and *monozukuri* which competes through a business model. There are several points of juncture in the process of the transition from one to the other.

A good example is DRAM a kind of IC (integrated circuit), whose global market Japan had once conquered.

ICs are said to have started with the invention that came to be well known as the "Kilby Patent" by Jack Kilby, who later won the Nobel Prize (Kilby 2000). Then, an energy-saving and general-purpose memory came out which was known as DRAM. Its history is said to have started when Intel Corporation commercialized a 1-kilobit DRAM for the first time in the world in 1971. Thereafter, the storage capacity increased fourfold almost every 3 years as the generation changed—4 kb, 16 kb, 64 kb, 256 kb, 1 Mb, and 4 Mb.

From the period of 4 kb DRAMs to that of 4 Mb DRAMs, Japanese DRAM manufacturers had held the largest share. As a result, in the middle of the 1980s, Japanese manufacturers' share in the global DRAM market reached as high as 80 %. Korean manufacturers such as Samsung emerged subsequently, however, and Japanese manufacturers were surpassed by them in 1998.

There are several fatal reasons causing the decline of Japanese manufacturers including a shift in the mainstream of computers, for which DRAMs were mainly used, from mainframe computers, which Japanese manufacturers were strong in, to personal computers.

Another one of the reasons was the fact that production increased as DRAM density increased. As the amount of plant investment became large, a division of labor began in DRAM production to replace the system of doing everything in-house. The development and manufacture of DRAM manufacturing equipment were relegated to manufacturers of semiconductor manufacturing and inspection equipment such as Tokyo Electron, Nikon, and Advantest. This caused a considerable part of manufacturing know-how to be transferred to semiconductor manufacturers. Such a tendency had already started when 1 Mb DRAMs were produced.

One could go as far as to say that all you have to do to make DRAM is to buy manufacturing equipment. Of course, you can't make DRAM just by buying manufacturing equipment. In this case, you can start manufacturing DRAM if you hire engineers away from Japanese companies.

When the manufacturing know-how was thus revealed, Korean manufacturers made a huge investment at one fell swoop to surpass Japanese manufacturers instantly. After all, this also boils down to what business model was adopted.

The same thing can be said of polymers, a representative chemical product. Similarly with generic resins such as polyethylene and polyolefins, which are a kind of polymer, Japanese manufacturers spent all their time on domestic competition and were late in advancing into the global market. Japanese manufacturers only thrashed out minute technical problems and were weak in thinking of a business model. Consequently they ended up losing in the global market.

What should a company do to win in the market of commoditized products? At the stage where a product newly born is gradually commoditized—in other words, where everyone becomes capable of producing the product—a decision is necessary to make a huge investment aimed at gaining a huge share in view of the global market. I think the major cause of the fact that Japanese companies have been losing in a conspicuous number of markets, including the mobile phone market, is their failure in both the timing and scale of investment. The "Platinum Society Network" (see Chap. 6 for details), which I am now working on, has it in view to solve such a problem of scale from the demand side.

Two-Manufacturer System for Major Appliances

Another important point for Japanese products to survive in the environment area concerns the problem of the "Galápagos syndrome."

The Galápagos syndrome refers to the fact that Japanese products, in spite of their high performance, have not become the global standard as they have evolved endemically in an island and are highly priced. At present, the energy efficiency of Japanese air-conditioners is overwhelmingly high from a global perspective, as represented by the coefficient of performance of 7. Japanese refrigerators are also overwhelmingly energy efficient. These products, however, are expensive anyway compared with those of other countries. In Japan, if you want to buy the latest air-conditioner, it costs you about ¥200,000, but the mainstream price range for air-conditioners in the United States is from ¥70,000 to ¥80,000.

The same goes for refrigerators. Whereas the mainstream price range of refrigerators in the United States is from ¥80,000 to ¥130,000, a refrigerator of the latest model costs about ¥200,000 in Japan. In the United States, people would be surprised to see such a refrigerator: "What is this? God, it's a fridge!" That's it. If, however, its price can be reduced to ¥100,000, with its electricity cost being one third of that of comparable products, it will sell like hotcakes.

A washing machine with a highly efficient dryer can sell better if its price can be reduced. For example, in the United States, a lawsuit may be filed over whether or not to hang out the laundry. Whereas ecofriendly people insist that "you should hang out your laundry," other people argue against them by saying, "Hanging out the laundry causes a decline in the asset value of my apartment house," or "There is no practice such as hanging out the laundry in the American culture."

If you use an energy-saving type dryer made by Japanese manufacturers, you use much less electricity in drying your laundry. Japanese dryers are of the heat-pump type and can reduce energy consumption by about 80 % compared with dryers of other types. In this sense, there is a potential demand for Japanese dryers.

The reasons why such high-performance home appliances are high-priced are that there are too many companies making them and that there are too many models of those products. For instance, there are at least seven manufacturers of refrigerators in Japan. In addition, as you can see if you take a look at air conditioners and refrigerators at a large home appliance retailer, even a single manufacturer offers a line of many models. What is the result of this? Japanese manufacturers' production volumes per model are roughly a few percent of those of a major overseas company. In other words, overseas manufacturers' sales volumes per model are a factor of several tens larger than those of Japanese manufacturers. The production per model of a Japanese manufacturer is on the order of a hundred thousand, whereas that of a major overseas manufacturer is on the order of several millions.

For instance, let us compare a refrigerator manufacturer which produces 100,000 refrigerators per year with one which produces 1,000,000 refrigerators. Since the fixed cost per unit is given by the total fixed cost/number of units produced, the fixed cost per unit for the manufacturer producing 1,000,000 refrigerators is nearly zero. This is one of the major causes of the current difference in price between overseas and Japanese manufacturers.

What should be done to realize mass production then? Manufacturers producing refrigerators should relinquish their refrigerator operations, which are to be consolidated into, for instance, an "East Japan Refrigerator Company" and a "West Japan Refrigerator Company." Air-conditioner operations should similarly be concentrated into an "East Japan Air-conditioning System" and a "West Japan Air-conditioning System." In this way, it is necessary to consolidate manufacturers into about two companies.

The Ministry of Economy, Trade and Industry does realize that there are an excessive number of companies, but, unlike the heydays of industrial policy, it can do nothing about it. In earlier days, the Ministry of Economy, Trade and Industry (which was then the Ministry of International Trade and Industry) has led the consolidation of manufacturers. For instance, in the chemical industry, manufacturers producing methanol, a kind of alcohol, were integrated into East Japan Methanol (led by Sumitomo Chemical) and West Japan Methanol (led by Mitsui Toatsu) during the 1970s. There are numerous such cases in the chemical industry.

If the central government cannot make a move, what approach is available? The following idea is conceived under the “Platinum Society Network.”

That is, a motivated local government should place a large-volume order for highly efficient energy-saving products. For instance, if multiple local governments place an order for 1 million units of a particular product, the manufacturer of the product cannot produce that amount of product at once. The idea is to create incentives for integration on the demand side, if it is difficult for manufacturers to merge and integrate voluntarily, in order to change the state of too many companies in Japan. The total population of those municipalities which have already decided to participate in the Platinum Society Network has reached approximately 80 million. Since this is a considerable population, I hope such an attempt can start here.

Of course, I do realize that it is a considerably far-fetched opinion, but is there any good alternative? We should not forget the fact that Japanese DRAM manufacturers who once boasted their prosperity were cornered and eventually reduced to one company, Elpida Memory.

The Anxious Future of Solar Cells

In this regard, I am also anxious about the future of the Japanese solar cell industry which had led the world until several years ago. Japan had so far led the world in solar cells because the three pillars of “technological progress,” “financial assistance,” and “scheme construction” had functioned effectively.

In terms of technology, the “Sunshine Project” and the “New Sunshine Project” were created to provide financial assistance to technology development. Governmental subsidies were also provided to users. When solar cells were commercialized, it initially cost about ¥6 million to install solar cells on the roof of a single house. As the electricity charge for an ordinary household ranged from about ¥100,000 to about ¥500,000, only those who were so rich or curious were able to afford installing solar cells (PVTEC web-site 2013). Therefore, the Japanese government subsidized solar cells installation by ¥3 million (PVTEC web-site 2013). As the price for solar cells declined, the subsidy was gradually reduced. Although there are a variety of subsidy programs at present, given the difficult fiscal situation, it is unpredictable what will become of these programs after 2013.

Furthermore, the relevant schemes have been reformed. Given the provision of the Electricity Business Act that restricts the direct sales of electricity to power plants, one has to become a power plant in order to possess solar cells. This provision was appropriately amended. Incidentally, I have solar cells installed in my house. A scheme was created that enabled me to become the “Komiyama Power Plant” just by signing and affixing a seal to several documents.

This scheme enabled solar cell users to have excess electricity resulting from the full operation of solar cells during daytime purchased by an electric power company, and to purchase electricity from the power company when they are short of electricity, for instance, at night. Japan fostered the solar cell industry by leading in technology, reforming the relevant systems, and providing governmental financial assistance. There is no room for controversy that Japan was an advanced country in the world in terms of solar cells.

In fact, Japanese solar cell production in 2006 accounted for 37 % of global production, pulling significantly ahead of Germany in second place, which had a share of 20 % (IEA 2011). Subsequently, however, Japan was overtaken by Germany and then by China. In 2008, China had the largest share in global production with 26 %, followed by Germany in second place (19 %), and Japan dropped to third place with a share of 18 % (IEA 2011). Even Sharp, which had the largest share in the world in 2006, retreated to fourth place. In these days with the fast speed of information transmission and fierce global competition, you will be overtaken instantly if you relax your guard.

As to the number of companies currently producing solar cells in Japan, there are four if you only count major manufacturers (Sharp, Sanyo, Kyocera, and Mitsubishi Electric), and as many as 18 companies if you count those which are members of the Japan Photovoltaic Energy Association. Without consolidating these companies and reducing costs by mass production, Japanese solar cell manufacturers will not be able to survive in the global market.

Speaking of solar cells, as far as organic solar cells, which are in the development stage, are concerned, companies may compete with each other in development as much as they like. That will lead to the birth of world-leading products. Crystalline silicon solar cells, which are currently the mainstream, however, have now been completely commoditized, as can be seen from the fact that China has captured the largest share. A business model appropriate to such products is making a large-scale investment at one fell swoop for mass production to win a large share in the global market and reducing costs further by economies of scale to seize price leadership.

Although the fierce nature of global competition is constantly taken up by the media, Japanese corporate management in reality never fails to seem to lack in a global perspective.

As a matter of fact, we performed virtual design for the future prediction of solar cells 15 or 16 years ago. What we did was called life cycle assessment, which designs and assesses an integrated system from resources to products. In so doing, we also conducted a simulation of the production process. As far as the scale of production of solar cell plants was concerned, 1 MW was the mainstream capacity at the time. We thus made a design by assuming three different scales of production: 10 MW, 1 GW, and 100 GW. Then we found a large difference in production cost. In particular, a large advantage from economies of scale was predicted between the scales of production of 10 MW and 1 GW.

One gigawatt is equal to 1,000 MW. As we assumed a production scale of 100 GW at a time when the scale of the production process was 1 MW, not a few people seemed to feel, “Aren’t these solar cell researchers being foolish?” However, the discussion of economies of scale is important, and we were confident, in the light of the market, that such a large scale of production would be realized before long. In fact, Sharp has already constructed a plant whose scale of production is 1 GW. The scale of production of 1 GW is now a common sense of the world.

This virtual design was made primarily by the University of Tokyo in collaboration with industry. We presented it at an academic conference but did not draw so much attention. Massachusetts Institute of Technology (MIT) in the United States published a report on solar cells more than 10 years later. Based on the design of the life cycle of solar cells, the report indicated that their energy pay-back time (the period of operation of energy generating equipment required to recover the energy put into manufacturing the equipment) would be 3 years if they were used in Boston. More than 10 years earlier, we had reported that the pay back time was 2 years if solar cells were installed in Tokyo. The simulation model we used is archived by the Society of Chemical Engineers and is open to the public. Anyone can use the program for calculation (NEDO 2012).

Japan is weak in the ability to conceive what technological analysis is required to foresee the future, and Japanese make more of the results published by researchers in the United States and Europe than these latter really deserve.

Japan, which is a problem-saddled advanced country, is still a developing country in the sense that, for all its technological sophistication, Japan is still naïve when it comes to international marketing of the fruits of that sophistication.

World-Leading "Eco-Cute" and "ENE-FARM"

What consumes energy most in a household is water heating. Japan is the most advanced in the world in energy-saving equipment in this area. "Eco-Cute" and "ENE-FARM" are typical of such equipment. Both are excellent devices, and only Japan is mass producing them (Figs. 4.5, 4.6, and 4.7). What should be done for such energy-saving equipment to acquire the world market without repeating the failures of DRAM and solar cells?

ENE-FARM is a home fuel cell which generates electricity by extracting hydrogen from city gas, LP gas, and kerosene and reacting it with oxygen.

About 37 % of the energy from gas and oil which is input to generate electricity is converted into electricity. ENE-FARM uses 50 % of the thermal energy emitted in this process to make hot water. Thus 87 % of the total energy input is utilized; heat loss is only 13 % (Tokyo Gas Web-Site 2013).

Currently, the generating efficiency of a thermal power plant is 42 % on average. Since a loss of about 5 %, including transmission loss, occurs in transmitting electricity from a thermal power plant to homes, electricity used at home is about 37 % of the energy input at a power plant.

In other words, as the amount of electricity available for home fuel cells has reached the level of centralized thermal power generation, home fuel cells use what corresponds to the waste heat discarded at a centralized power plant.

If home fuel cells of solid oxide type (SOFC) are put into widespread practical use in the future in addition to polymer type fuel cells (PEFC), which are now the mainstream, they may achieve an efficiency comparable to the maximum efficiency of a centralized thermal power generation plant. In fact, in the fall of 2011, an

Fig. 4.5 Eco-cute. Photo by: Heat Pump & Thermal Storage Technology Center of Japan

Fig. 4.6 Eco-cute with solar thermal energy. Photo by: Heat Pump & Thermal Storage Technology Center of Japan

Fig. 4.7 ENE-FARM. Photo by: JX Nippon Oil & Energy

SOFC-type fuel cell was placed on the market in Japan. It achieved an impressive power generation efficiency of 45 %, and an overall efficiency of almost 90 % (since 42 % of the thermal energy emitted is used to produce hot water) (JX Nippon Oil & Energy Web-Site 2013).

On the other hand, Eco-Cute is an electric water heater that uses the same heat pump technology as used by air conditioners to boil water by capturing heat in the air. It boils water by using 10 % out of the 37 % of input energy at a power plant that reaches home in the form of electricity. It can then obtain four to five times as much energy. About 80 % is utilized in this case as well: $(37-10\ \%)+(10\ \%\times 5)$. The efficiency of the heat pump will continue to rise in the future.

Eco-Cute is a product which Japanese companies created from scratch. It was the result of technology development for using carbon dioxide as a refrigerant to produce hot water at 80 °C. A refrigerant is a substance that plays an important role in heat transfer. Substances such as CFCs that destroy the ozone layer had been used as a refrigerant and caused problems. Eco-Cute solved those problems.

ENE-FARM was technically more difficult to produce. It requires technology to extract hydrogen from LP gas and other materials. Furthermore, ceramics technology, which plays an important role in batteries, can be said to be Japan's forte, and Japan has undisputed dominance in the world in this area. A product whose generating efficiency may rise to 45 % before long is expected to be launched in Japan. If such a product comes out, technology for these kinds of products will gain greater importance.

These products have a hot water tank with high performance. The insulation performance of American products of the same type is low. As hot water produced by them cools down quickly, their eventual energy efficiency is lower. Eco-Cute and ENE-FARM, which have to keep water heated in a tank, have a tank with high thermal insulation. Japan has an advantage in such comprehensive technology. Both of them realize a high energy efficiency.

ENE-FARM produces hot water by using energy left after generating electricity, and Eco-Cute pumps up heat from the air. In any event, using ENE-FARM and Eco-Cute can greatly reduce energy currently consumed for heating water.

Water heating accounts for 30 % of household energy consumption in Japan, and the demand for hot water for showers and baths is extremely large in the entire world as well (Nakagami et al. 2008). The reduction of energy consumption for this end use makes a major contribution to improving energy efficiency and reducing the amount of carbon dioxide generated. It is only in Japan that such home fuel cells and heat-pump type electric water heaters are under mass production. A large advantage lies here.

Eco-Cute and ENE-FARM Will Create a 30 Trillion Yen Market

How large then is the size of the market for Eco-Cute and ENE-FARM?

Let's estimate it by referring to the automobile market. At present, about 70 million cars are sold in the world in 1 year. Nearly half of them constitute an increase in stock and are newly purchased by people who do not own a car. The remaining half are accounted for by demand replacement.

Now taking these numbers of car sales as reference, let us think about the Eco-Cute and ENE-FARM market. In developed countries, there is probably no one who does not take a shower or bath, even if there may be those who do not have a car. On the global scale, it may be safe to think that there is a potential market with a scale of about 100 million units.

The key to the diffusion of ENE-FARM and Eco-Cute is, above all, price. An index price in Japan is approximately ¥500,000, and a low price may be required in the United States, where the energy price is low.

The actual selling price of Eco-Cute is already below ¥500,000. It can be reduced further. ENE-FARM is power generation equipment with a capacity of approximately 1 KW and, at the same time, hot water producing equipment. Then its reference price may be ¥500,000, for it also costs to make a power plant. For example, it costs about ¥200,000 per kilowatt to build a thermal power plant. Therefore, the price of about ¥500,000 is thought to be reasonable if you consider that you have to pay ¥300,000 extra for a water heater.

If the price of Eco-Cute and ENE-FARM as water heaters is assumed to be ¥300,000, the size of the market is ¥300,000 times 100 million. That is, a huge market of 30 trillion yen per year will emerge.

Refrigerator and air conditioner markets are those which already exist. I have already stated the strategy for Japan, which has energy-efficient products in existing markets, to beat countries which compete with it by producing less efficient but inexpensive products. Since the market for home fuel cells and heat-pump type water heaters is a new market, it is necessary to consider a strategy for Japan from the perspective of how to cultivate this huge potential market.

In light of the current trend of informatization, these new technologies and products are expected to be commoditized at a faster speed. In order not to repeat the failures of DRAM and solar cells, it will be necessary to take steps promptly for building a business model in view of commoditization.

Reducing Costs by Taking Advantage of the Huge Domestic Market

What I am most concerned about now is the fact that manufacturers are more interested in the domestic market and have a weak awareness of the need to expand their operations into the global market. They should target the wealthy class abroad. Specifically, they should develop strategies to focus on selling to the wealthy class in North America, Europe, and China.

"It's the era of global competition. We have to respond to globalization." We have heard such comments from management. If you look at the reality, however, you notice the lack of an international mindset and the vulnerability of the international strategy on the part of Japanese companies. In light of the past history, I am concerned that Japan may lose out on a chance to win the international market again.

What happens if developing business abroad is not taken into account from the beginning? If things are left as they are, ENE-FARM and Eco-Cute will be disassembled and copied, and they will start making the same things in China and other emerging countries. Even if the original Japanese products are advertised as having higher energy efficiency, what happens if their versions are sold at half the price? The results are easily imaginable.

It will probably be impossible to prevent imitation. Japan did the same thing after World War II, when it was at the developing stage. Consequently, what is important is to think thoroughly about how to forestall this and seize the global market, on the assumption that ENE-FARM and Eco-Cute will be copied. Specifically, an attempt should be made to reduce costs through their introduction to the Japanese market through citizens' action and governmental support.

There is clear compartmentalization between heat-pump type electric water heaters and fuel-cell type power-generating hot water heaters. Heat pumps are suitable for warm areas, and fuel cells are suitable for cold areas. The reason is that, whereas the efficiency of a heat pump declines at low temperature as it captures heat from the outdoor air, that of a fuel cell does not decline even at low temperatures. In other words, these two products mean that Japan has acquired truly powerful products responding to global warming.

I believe Eco-Cute and ENE-FARM are comparable to the "Model T Ford" at the beginning of the twentieth century. The Model T Ford created something that came to be known as the automotive market, which had virtually not existed before. Henry Ford worked out the mass production system for something that only a small number of rich people had been able to own, and under the slogan of "the price affordable to our employees," dramatically lowered the cost and created the market itself. Similarly, now that Japan has created such breakthrough new products as Eco-Cute and ENE-FARM, it has to be prepared to create the market itself, as the Model T Ford did.

For this purpose, it is advisable for the government to consider supporting the purchase of ENE-FARM and Eco-Cute to make it easy for many people in Japan to buy them. Even though Japan is now in the population decline phase, it still remains a gigantic market with the world's seventh largest population with high average income. Create a large market in Japan to enable mass production and a reduction in the cost of production, then lower the price and concurrently develop overseas operations. Such a strategy should be taken.

Of course, it is possible to argue against this by saying that it should be left to the market principle whether a new product is accepted in the market. There are two reasons, however, for me to think that some public support is needed.

First, information is disseminated rapidly. Unlike earlier days, information leaks out instantly on the Internet and spreads to the world. Even if a breakthrough new product is created, the time needed to copy it is too short. It will be too late unless the market is created at a pace incomparably faster than in the age of the Model T Ford.

Secondly, although the global free market is said to be spreading, in reality, there are many countries, such as China and Russia, which participate in competition under "state capitalism," in which the government owns 100 % of the capital. Although South Korea is generally said to fall outside that category, it is one of the countries where industry consolidation led by the government has been in progress since the currency crisis in the latter half of the 1990s. As symbolized by Samsung and Hyundai, companies in major industries have been almost concentrated into a single company. South Korea has acquired powerful capital strength and competitiveness by "one-company capitalism," so to speak.

The speed of information transmission is really fast. In the free market, a company has no choice but to change itself to keep up with the speed of information which affects changes in supply and demand. In addition, Japanese companies have to compete with such state capitalistic companies. We now find ourselves in such a competitive environment.

Japan, of course, has the history and pride of having developed on the premise of the free market. It can not engage in state capitalism. In view of the changes in competitive conditions, however, it may be a good idea for the government and private companies to share a vision and for the government to implement measures to support private companies in creating a new market.

In implementing such measures, Japan, which is based on the free market principle, may open itself to foreign capital as needed. It will be fine so long as foreign capital invests in environment-related industries in Japan, manufactures goods in Japan, is based in Japan to carry out activity in Japan and the world, and pays corporate tax and creates employment in Japan. It is problematic as a mature developed country to insist on nationalism even with regard to capital.

What is important is to strengthen the domestic industrial infrastructure and to create employment. If we think about Japan's future, it is not sufficient if Japanese companies merely develop overseas operations, construct plants abroad, and survive as capital. If we think this way, in order to create products meeting creative demand, we may take into account the possibility that foreign capital in Japan realizes it in Japan.

In reality, huge international companies such as General Electric (GE) of the United States, Siemens of Germany, and Nestle of Switzerland actually show a greater reaction to talk of the potential and vision of Japan's environmental technology than Japanese companies and government do.

Japan's Strength Lies Precisely in "*Monozukuri* from Scratch"

Now, there is "*monozukuri* (making things) from scratch," which stands in contrast to "creating a business model for *monozukuri*." I suspect that Japan's strength lies precisely there.

In order to bring the strength of Japan to fruition in real economic activity, its weakness must first be overcome. Japanese companies' weakness in *monozukuri* has been that they did not determine by themselves what to make. In short, it was *monozukuri* of the developing country type. For example, in the area of cathode-ray tube TVs, Japanese companies even developed a flat screen cathode-ray tube TV to triumph all over the world, even though the TV market itself had already existed.

In the automotive industry, Toyota's originality shines. It is not Toyota alone. In the second half of the 1990s, the Clean Air Act, which was said to be the most stringent air pollution prevention law in the world at that time, was instituted in the United States. Famous manufacturers of the world, including the Big Three of the United States, thought that it was impossible to make a car that clears the standards of the Clean Air Act.

Then, Honda, which was a latecomer to the passenger car market, developed a new engine named CVCC. Honda launched the "Civic," a fuel-efficient and low-pollution car that cleared the standards of the Clean Air Act, to startle the world. Hybrid vehicles, which Toyota and Honda later developed, can also be said to be revolutionary. Certainly, in such examples, the creativity of Japanese companies is outstanding. Nonetheless, in both cases, the automotive market had already existed. The model of Japanese *monozukuri* was to improve products in the existing market and to win competition by putting a better product on the market.

Creativity is required in catching up, too. I have no intention at all to deny the creativity of Japanese companies and people. Qualitatively different types of creativity, however, are required for creating new industries and for catching up with competitors in an existing industry.

We have been using electricity as if it were like the air we breathe. However, in a society which has never used electricity, no ordinary way of thinking yields the idea of constructing a power plant, laying out transmission lines, and sending electricity to factories and homes to earn a profit.

When it comes to automobiles, there were no gas stations and roads were not paved in those days. Under such a situation, a practical automobile loaded with a gasoline engine was developed for the first time in Germany in the latter half of the nineteenth century. Subsequently, Henry Ford of the United States developed the "Model T Ford" and revolutionarily lowered its price to create a market. In contrast, Japanese *monozukuri* has been dealing with something for which a model to be aimed at had already existed and has not necessarily created new industries from scratch.

Japanese companies should not wait for their opportunities to elicit "creative demand" and create new industries. They would then be forestalled by companies from other countries. Japan has an advantage in this regard as well. It lies in the fact that Japan is a problem-saddled advanced country—a country advanced into various problems ahead of others. It suffices for us to solve our own problems by ourselves. All we need to do is to engage in *monozukuri* of the advanced country type, in other words, to create by ourselves what we need. Moving from the "age of catching up" to the "age of an advanced country" specifically means creating a model from scratch on our own in response to our challenges.

Japan has diligent people, technological capacity, and the foundation for building a social system. What is lacking in Japan is the mindset to create something new from scratch. There are no longer clouds over the hill.

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Chapter 5
Finding a Way Out Through Creative Demand, II

Japan is faced with a society that is aging at a rate that is unprecedented in any country. In 2006, people aged 65 and over represented about 21 % of Japan's population, while they are expected to account for 30 % in 2025 and 40 % in 2050 (Cabinet Office Japan 2010). The populations of China and India are expected to reach their peaks in the mid-2030s and by the end of 2050, respectively. That is, all countries will face aging societies by 2050.

Japan has never experienced an aging society in its history. The country has yet to identify all the problems it could face. Any unexpected event is conceivable. In this respect, Japan has just started responding to an aging society from scratch, without knowing what will happen in the future. Taking this opportunity, I would like to present some of the challenging problems related to Japan's aging society.

Japan—A Country with Challenges and the Power for Manufacturing from Scratch

Japan has a number of difficult problems with respect to its social systems, including the depopulation of local communities, congestion of cities, education, public finances, medical care, pension systems, transport, and distribution. Aging-related problems are at the root of these issues. In general, aging is considered to adversely affect the economy because it causes a decrease in demand and increases the costs of the medical care and pension systems.

One effect of the aging society is a sharp increase in social welfare costs paid out from the government's general expenditures. General expenditures refer to the national government's general accounts less government debt expenses and transfers to local governments. This budget can be used for implementing government policy. Social welfare costs are incurred in such systems as pension, medical care, and nursing care. In 1965, in the midst of a period of rapid economic growth, the ratio of social welfare costs to general expenditures was 17.7 %. The ratio then

H. Komiyama, *Beyond the Limits to Growth: New Ideas for Sustainability from Japan*, Science for Sustainable Societies, DOI 10.1007/978-4-431-54559-0_5,

increased sharply to 34.9 % in 2000 and to 53.1 % in 2011 (Terasawa 2011). The majority of the budget applied to government policies is used for social welfare. Now, it is impossible to strategically allocate the budget. It goes without saying that the aging issue lies behind surging social welfare costs.

Aging is an issue faced by all human beings in the twenty-first century, and is closely related to many problems.

At the same time, however, we must remember that aging is a benefit obtained from longer lives. We want to build a society in which we can enjoy longer lives while feeling secure. To achieve such a society, it is essential to develop new industries by creating demand for aging-related products and services and by converting needs into real demand to encourage supply. Here is a great opportunity for Japan to take advantage of its capability of "making things from scratch." Although Europe is poised for aging societies in the near future, few countries have the manufacturing strength of Japan.

Sweden, Finland, and other advanced countries in northern Europe have a business model based on purchasing raw materials and having manufacturers in Taiwan manufacture products, but they find it difficult to manufacture products themselves. This can be explained by the fact that these countries lack industrial clusters—infrastructure to develop new industries. American venture businesses are likely capable of creating new industries that involve manufacturing from scratch, but they do not acutely feel this need: The United States has yet to face an aging society thanks to its immigration policy, and so its population is not aware of the need to take action against the global issue of aging.

Japan should take advantage of the current situation as a country that has the manufacturing strength and simultaneously faces the problem of an aging society.

Five Conditions for Happy Aging

In response to an aging society, different approaches should be applied to healthy people and those who require nursing care.

First, we must discuss how to enable healthy senior citizens to participate in society. "Senior people" suggests "the weak" or "people requiring nursing care." However, the fact is that 70–80 % of senior citizens aged 70–80 are healthy. These senior citizens have various abilities.

Based on data collected over 20 years on 6,000 senior citizens, Professor Hiroko Akiyama of the University of Tokyo's Institute of Gerontology has pointed out the following trends among senior citizens.

Senior citizens were interviewed to see how they lose physical and mental independence in their daily lives—inability to take a bath, make a phone call, or do other things without the help of others. The results of an analysis of these interviews clarified the following three trends.

With respect to males, 70 % begin to slowly lose their daily-life independence in their 1970s and completely lose it when they are about 90 years old. On the other

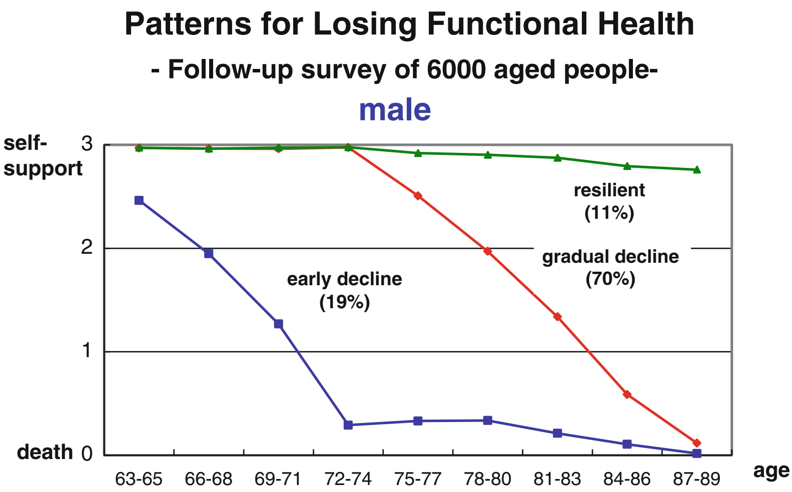

Fig. 5.1 Patterns for losing functional health. Source: Akiyama Hiroko (2010)

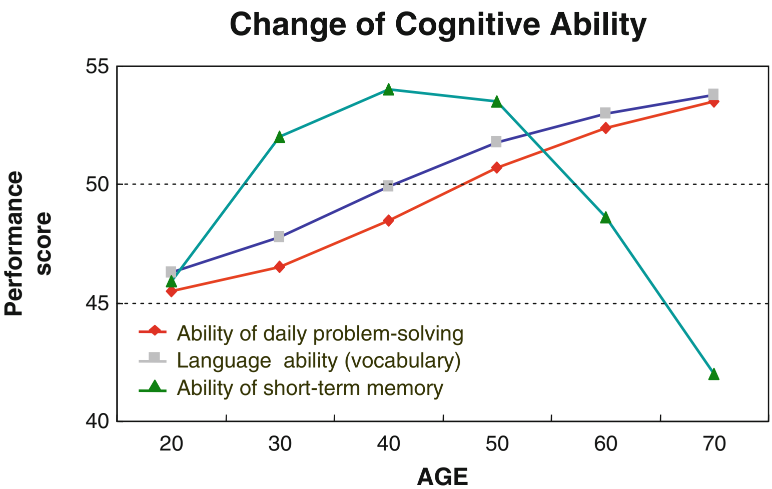

Fig. 5.2 Change of cognitive ability. Source: Cornelius and Caspi (1987, p. 150)

hand, 11 % of males stay healthy even at the age of 90. However, nearly 20 % of males lose their independence in their mid-1960s and require long-term nursing care from the age of about 72 until they die (Figs. 5.1 and 5.2) (Akiyama 2010).

Conversely, one might say that 70–80 % of people can stay healthy even when they are in their 1980s. Humans can maintain their verbal skills and problem-solving abilities until about 2 years prior to death. Namely, their wisdom, as exemplified by their verbal skills and problem-solving abilities, improves with age. Despite their decreasing physical strength, senior citizens are an important human resource of wisdom for society.

The conditions for “happy aging” are known scientifically. The physical and scientific mechanisms of aging and health are being elucidated by the life and cognitive sciences. Related research results indicate that people can age in good health if five conditions are met: (1) nutrition, (2) exercise, (3) communication with others, (4) openness to new concepts, and (5) positive thinking. These conditions can be called the “five conditions for happy aging.” “Happiness” is a personal issue. The principal purpose of national policies for an aging society should be to build a social environment where individuals can satisfy such personal issues.

The majority of senior citizens need only marginal support to participate in society. For instance, people who are hard of hearing need support from hearing aids, while those with weakening knee muscles would want a robot to help them walk. We must consider how to assist healthy senior citizens to participate in society. Such assistance, by satisfying the five conditions for “happy aging,” is the best solution to the issue of protecting healthy people from becoming unhealthy.

The other pillar of policies for healthy senior citizens is preventive medicine. The first basic policy for a vigorous aging society is to improve the five conditions for “happy aging” and reinforce preventive medicine.

The second basic policy for an aging society, it need not be said, is to support those who require nursing care. Nursing care is an area where Japan can make the best use of its technologies. Technologies for reducing or eliminating inconveniences caused to recipients of nursing care would not only improve the quality of life (QOL) of such people, but also reduce burdens on caregivers.

Involve Senior Citizens and Working People in School Education

To achieve the participation of senior citizens in society, we must consider two aspects—technology and social system. To supplement decreasing physical strength, people may need advanced technologies and new services. However, healthy senior citizens can achieve participation easily without the help of such technologies or services, simply by changing the social system.

Senior citizens may be able to contribute to education in a broad sense by taking advantage of their wisdom developed as a social resource. They may play a direct part in school education. Today, school teachers are stretched by their duties. Participation in school education by people having sufficient social experience would produce significant synergies in coordination with teachers. This is a useful example of the efficient use of human resources based on the wisdom and experience of senior citizens.

A questionnaire survey was conducted some years ago covering (about 200 each) school teachers, PTA members, and businesspeople, asking whether they favor the idea of working people participating in school classes. Amazingly, almost all respondents agreed to the idea.

Prior to the survey, we expected PTA members and the majority of businesspeople to be supportive of the idea, while school teachers would likely object. The ratios of proponents among each group was in the order we had expected, but over 90 % of school teachers also supported participation.

Before participating in education, working people must be given basic training. The education system under which classes are conducted by working people together with teachers would produce highly beneficial effects on education. Senior citizens participating in such educational venues as working people would not incur significant expenses.

School Education Is Losing Diversity

One current problem facing school education is that the presence of isolated students is tolerated less as society matures. The teaching certificate system is also becoming excessively complex over time. When I was a college student, educational psychology and other pedagogical subjects were available to students whenever they decided to obtain, even belatedly, a teaching certificate. Some prospective applicants did not even take such subjects. At that time, however, necessary credits were sometimes given to students when they took a 1.8-liter bottle of sake (called an *isshobin*) to the professor in charge to ask for a credit. There was something easygoing about those days.

Today, such a practice as bribery with an *isshobin* would not be tolerated, of course. Instead, the fact is that students are now obliged to decide whether they want a teaching certificate as early as their high-school days and take the required teacher training program in college. Only those students are qualified to teach. Thus, educational venues are losing diversity of human resources.

Diversity has also been lost in the lives of students. No parents want their children to become delinquents. It is a pity that today we have few people, including parents, who can give advice to would-be delinquents from their own experience by saying that they were once delinquents but they now live like this, or by giving them examples from overseas. To build such an environment, we need people who have diverse experiences. The loss of diversity among school teachers may be a significant factor in current educational problems.

To improve the educational system, it is advisable to send about three sufficiently experienced working people, for instance, to each elementary school or junior high school as instructors to give lessons at least three times a week. Currently, there are a few cases in which well-known TV celebrities or media personalities give lessons at their old schools. Such activities are not part of education in the true sense of the word. The basis of school education lies in giving 45-minute classes for several hours a week, throughout the year.

In the new educational system, once chosen as teachers, experienced working people should be prepared to stand on the lecture platform even for a single class session throughout the year. They would of course take charge of fewer class sessions than regular school teachers. Their annual income might be one to two million yen at most because their work is part of their social contribution. But, the involvement of committed senior citizens in education would contribute significantly to bringing diversity to educational venues, as well as making their lives worth living.

Half jokingly, I often suggest that each school employ three experienced working people. The first teacher would take charge of science classes, which are subject to rapid scientific changes and developments, because many elementary school teachers do not possess good knowledge of science. The participation of engineers and other scientifically experienced working people would contribute much to science education.

The second person should be an English teacher, who should have experience living abroad. Such experience would enable the teacher to convey to students foreign cultures, lifestyles in foreign countries, differences in ways of thinking, and other new knowledge.

The third senior citizen should be a person having a "fierce expression." In the past, such people were often seen in the general affairs departments of large companies, and were in charge of dealing with *sokaiya*[1] corporate racketeer groups. These days this type of person can be found among people who handle unreasonable demands from customers. Currently, schools are seriously bothered by "monster parents," who accuse their school over trifles (Funamizu 2009). Schools need people who are courageous enough to roar at such "monster parents." To deal with "monster parents," such people should have good judgment to assert that a parent's demands are unreasonable or that the school is to blame for such and such reasons. Difficult problems may be brought to the courts. Schools should be encouraged to participate aggressively in the construction of such a society. The presence of these competent human resources would enable school teachers to focus more time on education.

The entry into the educational community of people having various social experiences would produce more educational diversity, while at the same time widening points of contact between children and society. It would also help school teachers broaden their way of looking at things. Many senior citizens have generous financial resources, including annuities, and thus want to contribute something to society rather than expect monetary rewards. A new educational system should be formulated to give senior citizens opportunities to involve themselves as regular teachers in school education. They would be satisfied to take charge of even only one class session a day.

The participation of healthy senior citizens in society may not be limited to school education. For instance, they might be able to support child-rearing, which is now a serious issue.

[1] A *sokaiya* is a racketeer who extorts money from a company by threatening to cause trouble at the general stockholders meeting.

Today, the Internet serves as an easy means for senior citizens to find various opportunities to work for private businesses. They should find more opportunities to take advantage of their wisdom by monitoring needs and developments in society, and dealing with them flexibly. Society would benefit from the participation of senior citizens having sufficient wisdom and physical strength as the economy is revitalized and new jobs are created as a result.

As the trend toward the nuclear family has progressed to its limits, Japan is now faced with a growing number of senior citizens living alone. Such people tend to be isolated. They generally stay indoors, lose points of contact with society, and ruin their health. They eventually need nursing care.

When outside their homes, senior citizens have more opportunities to communicate with others and spend money. Many senior citizens can participate in society by changing their working style or by receiving a little support. Such people can satisfy the "five conditions for happy aging."

In summary, our discussion so far suggests that the abilities of senior citizens can be most effectively used in school education. It should be emphasized that their participation is indispensable for the reconstruction of Japan's educational system. Some experts insist that children are more important for the future than senior citizens. Their justification is understandable, but this is not a matter of choice. The two will combine to produce a synergy.

In fact, we realize that the social participation of senior citizens would lead to solving many present problems. For instance, remember the medical care system of Tōno City as discussed in Chap. 2. Tōno City's system, which is designed to connect sparsely populated regions with physicians via the Internet, is extremely helpful to senior citizens. This system was originally started to solve a shortage of obstetrics and gynecology specialists. Medical care should be given to all people.

If a medical care system is composed of physicians, co-medicals, medical devices, diagnostic chips, emergency helicopters, and patients, in addition to the Internet connecting them, then such a system can serve as one for an aging society, and at the same time as a medical care system needed for the future.

Agriculture Competing by Safety and Taste

Agriculture, forestry, and fishery are industries that can make efficient use of the abilities of senior citizens. Currently, a spirited debate is underway in Japan over whether or not the country should sign the Trans-Pacific Partnership (TPP) free trade agreement. In the near future, Japan will be forced to open and liberalize its markets. Japan should open its markets to its advantage.

The key to Japan's success after its participation in the TPP lies in how we should enhance the productivity of agriculture. One alternative is to facilitate the entry of private businesses into the market and also to introduce efficient large-scale agricultural systems. Under such new systems, agriculture would be developed on a large scale by a small group of people. This may result in a number of job cuts.

Meanwhile, Japanese farm products are attracting keen attention for their delicate taste and safety. Because they are safe and delicious, they sell at high prices in China and some other countries.

Cherries produced in Yamagata Prefecture, for instance, are so delicious that they look as if they are objects of art compared to the dark purple cherries imported from the United States. The same can be said of strawberries and mandarin oranges. Many visitors to Japan are surprised by the taste of Japanese fruits and buy them as souvenirs. In China, Japanese apples and rice are very popular among wealthy people. That is, by buying farm products, consumers overseas have confidence in their safety and delicacy, as well as their prices. Thus, we have another alternative for producing high value-added, sophisticated farm products under a labor-intensive system.

Either a large-scale system to cut costs and improve profitability or a labor-intensive system to make superior products may apply to industries other than agriculture to enhance productivity measured in value.

For instance, to restore the forestry industry in the Tenryu region, the city of Hamamatsu established the "Hamamatsu City Vision on Forests and Forestry" to obtain an FSC certificate. FSC certification is a global scheme for certifying forests in accordance with established criteria with respect to appropriate forest management. Once a certificate is granted, businesses cutting or processing wood taken from the forest are permitted to attach logos to such products proving that they have been manufactured from wood grown in an appropriately managed forest. FSC certification is a global certification system.

When FSC-certified, forests increase their value. Lumber taken from the forest is tagged and managed throughout the supply chain. It is noteworthy that trees cut down from a forest and left unprocessed carry no collateral value, while standing trees have collateral value as lumber when tagged. Businesses can borrow money from banks against such tagged trees. This is one example of an initiative to reconstruct the forestry business to ensure its productivity.

Senior citizens should be given opportunities to participate in these new agricultural and forestry initiatives. They may work as either regular employees or volunteers. If the work is physically too demanding, they should not be required to work every day or on a full-time basis. They may engage in growing high value-added safe and delicious farm products that require special care and close attention to cultivate. This is another example of an effort to rebuild agriculture and forestry.

Specialists called tree surgeons provide expertise as an occupation concerning the resuscitation of weakening or old trees. Recently, the new occupation of agricultural doctor has been proposed. Wisdom characterizes senior citizens. Using this wisdom would lead to fulfilling the "five conditions for happy aging."

In addition, technology is capable of making up for age-related declines in muscle strength. In Japan, many forests are said to be becoming wastelands partly due to a shortage of hands. It is not so difficult for Japan with its technology to develop a tractor capable of climbing mountain slopes and thinning trees and cutting underbrush. In its development phase, however, there is no knowing whether we can actually develop tractors that can perform the required functions, for example, climbing slopes and doing tree-thinning work, or whether they would sell in the market. In this sense, no new industry would emerge unless there are people willing to assume potential risks.

For such tractors to create a business, the new tractor market has to reach critical mass (a stage at which the sale of a product starts to explode). If only one unit of a tractor is sold, it may have to be priced at millions of yen or even one hundred million yen, considering research and development expenses. As R&D expenses are almost fixed, they would be reduced by a factor of one thousand per unit if 1,000 units were sold, to practically zero. Then one unit might sell for 2 million yen, for example. Thus, policies should be established to lower prices through volume efficiency.

A big issue for advanced countries is who should implement initiatives for developing new industries. Developing countries can simply adopt successful cases from advanced countries, at low risk. In contrast, in order to create new products that do not currently exist on the market, the cost is initially high. For this reason, many small venture companies are forced to withdraw from the market before critical mass is reached. In order to create new industries for an aging society, we need a special system such as the Platinum Society Network discussed in the following chapter.

Don’t Be Frightened by the Threat of Globalization

We should not overly fear the threat of globalization.

As often pointed out in the past, taxi fares do not need international standardization. On the other hand, liquid crystal televisions, LEDs, and other electrical products are subject to global market competition, and need to be designed from a global point of view. In agriculture, products can compete in terms of security, safety, and delicacy. They may also compete in terms of how they protect the natural environment, such as in the case of *satoyama*.[2]

In Japan, many consumers prefer farm products that are not only safe and delicious but are also effective for protecting *satoyama*, even if they are more highly priced. What does this mean? There is an opinion that globalization will damage Japan’s agricultural industry as much cheaper farm products would be imported. We should note, however, that Japanese consumers would not choose products based only on price. Features of products other than price can be elements of market competition. Not all products need to be evaluated globally on the basis of price alone.

While many markets are being consolidated globally, some in Japan are still, and should be, managed on the basis of Japanese values. For instance, many consumers value farm products grown in a beautiful landscape such as the *satoyama* or a similar natural environment. They evaluate farm products not only by price but by other features as well. We should not care if American agriculture experts do not understand our values.

[2] Satoyama, referring to the border zones between arable flat land (sato) and mountain foothills (yama) found throughout Japan, also connote a valuable natural landscape and resource that were traditionally managed by local communities.

In discussions over globalization, we tend to fear only that price competition would prevail in the market, eliminating less competitive businesses. I believe that markets will be divided into two groups in the future—one that is standardized globally and is composed of globally competitive markets and the other which consists of localized markets.

The sustainability of humans would not be maintained if the world becomes uniform with no diversity of nature and culture. The efforts of each country to maintain diversity in nature and culture would enable us to enjoy foreign travel, grow disease-resistant farm products, develop new drugs, and so forth, to assure the sustainability of human beings.

The importance of diversity applies to Japanese society as well as the global community. To be resistant to a broad range of external changes, society would need to be diverse by accepting the participation of a large variety of people ranging from males and females to young and old citizens, to foreigners, and from healthy to physically handicapped people.

An Aging Society Is a Golden Opportunity for Japan to Take Advantage of Its Technical Capabilities

With respect to the issue of supporting people requiring nursing care, we should use our capabilities to "make things from scratch," in addition to implementing nonstructural measures.

A robotic suit is an example of such capabilities. A Japanese venture company linked to Tsukuba University has developed and launched a robotic suit. This product is very useful not only for senior citizens losing muscle strength and those under rehabilitation, but also for those providing nursing care. In nursing care, nursing caregivers sometimes injure their backs while taking care of patients on a bed or in a bath. Expectations are high for this new suit as it could replace some tasks done by nursing caregivers.

Currently only Japanese technology is capable of making endoscopes three millimeters in diameter. Japan has already developed a technology for restoring hearing by directly conveying vibration to the inner ear. Techniques to reproduce corneas and teeth are beginning to be used in regenerative medicine. There are strong needs to develop a wheelchair that enables patients to discharge waste without the help of others, as part of an industry we might call "the human dignity industry." Developing technologies like this to aid a sensory organ or help bodily mobility is certain to improve the quality of life of senior citizens.

In the near future, a tremendous diversity of new products may appear in industrial segments associated with the aging society. Japan has accumulated advanced elemental technologies, including soft and strong materials suitable for robotic suits, materials that can endure an unlimited number of movements, sensors for detecting weak electric currents with a high degree of accuracy, and actuators (devices that convert input energy into physical motion).

Fig. 5.3 HAYABUSA. Photo by: Japan Aerospace Exploration Agency

For instance, robots need a large number of efficient motors of various shapes. Such motors require sophisticated magnets. Such magnets, called neodymium-boron magnets, have been discovered in Japan. Neodymium-boron magnets need a coating because they are apt to corrode. Japan is probably the only country that is capable of making the magnets, coating them, and producing them in various shapes.

We need system technologies to manufacture advanced actuators by integrating sensors and motors, in addition to raw materials and components. Japan holds an unchallenged position in its capacity to organize and combine elemental technologies.

The planet probe Hayabusa, which returned to Earth in June 2010 from its journey into space, was the crystallization of the latest technologies. A large number of Japanese people watched Hayabusa on television as it was burning out after undocking its sampling capsule before reentering the atmosphere, and many people were surely impressed by this (Fig. 5.3).

Launched in May 2003, the Hayabusa probe was tasked to land on the asteroid Itokawa three hundred million kilometers away, collect material samples, and return to Earth. Every element of the probe can be said to be the fruit of Japan's advanced technologies. One typical example is the autonomous navigation mechanism used for Hayabusa to land on Itokawa. The probe assessed its own status before landing because the asteroid was so distant from Earth that communication with Japan was insufficient to take full control of the probe.

To allow Hayabusa to take care of itself, the sensors on it had to accurately measure distances and monitor its status, while the actuator controlled the probe's movements and attitude. Moreover, this highly complex system was manufactured within a very small budget, compared to the U.S. budget for space development. Japan excels in making sophisticated systems under such limitations.

Japan can succeed in many industrial fields if it takes the approach used in the Hayabusa project. In agriculture, for example, a variety of sensors may be used to collect soil information, make the best mixture of nitrogen, phosphoric acid, and potassium fertilizers to increase productivity, and supply the mixture to farmers. Further, precision farming has recently been started on an experimental basis. Under the new agricultural system, using GPS data, the minimum optimal amounts of fertilizers and water are sprinkled over each section of a field.

Devices and equipment intended for an aging society must be manufactured with extreme care because many of them are used in direct contact with the human body. They should not cause pain or friction, and they must not be too heavy to use. Japan is probably the only country with a full range of technologies for developing raw materials into finished products.

When we talk about countries where policies on aging are established, we always refer to Sweden and other Nordic countries. It is true that, in Nordic countries, non-structural social systems are in place to solve issues of aging. However, Japan is one step ahead in manufacturing. There has recently been a series of symposia in Japan to discuss aging societies and related problems with participation from European countries such as Sweden, Germany, and Switzerland. Meanwhile, there have been some discussions on starting joint projects. These countries are turning their expectations toward Japan's manufacturing strength.

Of course, there is much to learn from Nordic countries. They have the courage to reform their societies. For instance, the meal assistance robot "Bestic" produced by Robot Dalen—which is a Swedish robotics initiative enabling commercial success of new ideas and research within robotics and automation—plays the roles of arms and fingers when taking meals for those having difficulty moving their arms by detecting subtle movements. Sweden is promoting "Bestic" using such means as a poster portraying an elderly couple having a meal in a restaurant using "Bestic". This scene signifies one ideal picture of an aging society.

Japan is the most rapidly aging country in the world, and is seeing growing needs for aging-related products. Many of them, which I have repeatedly mentioned in terms of "creative demand," are still to appear on the market. For this very reason, Japan should not wait, as it has in the past, for other advanced countries to develop new products to meet such needs. Now that global competition is a matter of course, we are sure to be overtaken by others and miss opportunities if we just keep waiting.

In industrial sectors aiming to develop and offer new products needed by an aging society, I believe Japan is capable of fostering manufacturing industries that can maintain their technical advantages over an extended period.

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Chapter 6
Toward the Realization of a "Platinum Society"

In the preceding chapters, I have discussed problems arising from new paradigms of the twenty-first century—"exploding knowledge," "limited Earth," and "aging society"—and how to cope with them. Japan is, a problem-saddled advanced country, already faced with a wide range of problems arising in connection with these paradigms. Japan is in the vanguard of what other advanced industrialized countries can soon expect to face.

Japan has already begun to struggle with these issues including a declining population, a rapidly aging society, deteriorating urban infrastructures, local cities losing dynamism, dilapidated farmlands, expanding budget deficits, and growing global environment problems. To simultaneously solve these problems, we must establish a vision for a new nation that can meet the challenges of the twenty-first century. It is a nation that will replace the preceding visions of the administration of Prime Minister Hayato Ikeda (1960–1964) in its income-doubling plan and the administration of Prime Minister Kakuei Tanaka (1972–1974) in its plan for remodeling the Japanese Archipelago. This vision should be the "Platinum Society Plan" as presented in this chapter.

Shooting Through the "Clouds Above the Hill"

Our new vision must be based on the acknowledgement that the age of the "Clouds above the Hill" is now over.

The era known in Japanese history as the Meiji Period from the mid-nineteenth century to the beginning of the twentieth century was the period in which the leaders of Japan, who would succeed in making Japan a full-fledged modern state after the Meiji Restoration, in order to secure the security and independence of the nation and its people, chose the route of imitating the U.S. and European nations in their civilization and enlightenment, wealth-creating industry promotion, national prosperity and military strength, and quickly rearranged the Tokugawa Shogunate into a

H. Komiyama, *Beyond the Limits to Growth: New Ideas for Sustainability from Japan*, Science for Sustainable Societies, DOI 10.1007/978-4-431-54559-0_6,

Western-style constitutional state. “Clouds above the Hill” is the historical novel sketching the coming of age of a group of young men who bore the burdens of modernizing Japan in that period. The novel is centered on the brothers Yoshifuru and Saneyuki Akiyama, two of the military men who led Japan to victory in the Russo-Japanese War, the moment when a small nation of the Far East leapt in one bound to the status of a world power, and on the haiku poet Shiki Masaoka, who left an indelible mark on Japan’s literary world. It is a work that focuses on how these and other diverse characters who lived in the Meiji Period and contributed to Japan’s modernization supported the nation’s leaders with an earnest spirit, and also how they thought and acted as individuals. For this reason, it is not only highly regarded as a historical novel, but it has also won many fans in Japan among executives and businessmen, who feel a sense of kinship with the way the novel’s characters lived their own lives.

Regarding the title of his book, the author Ryotaro Shiba wrote the following in the Afterword: “This long tale is the story of happy optimists unparalleled in Japanese history. By and by, they completely lose themselves in the extraordinary undertaking of the Russo-Japanese War… These optimists, with the characteristics of the men of that era, move forward with their eyes fixed solely on what lies ahead. If perchance one wisp of white cloud were hanging in the blue sky above the slope they are climbing, then surely they would gaze only at it as they made their way up.”

Indeed, that very wisp of cloud is the image of Japan as a modernized country sought after by that group of young men coming into their own in the Meiji Period.

Looking back at the history of Japan, Japan appears to have been maintaining great military strength even on a global basis at the time when Toyotomi Hideyoshi dispatched troops to Korea in the sixteenth century to fight with the Korean kingdom and its major supporter, Ming China. Its military strength was evidenced by its persistent belligerence against Ming China. For good or ill, the results of war substantially depend on the industrial technology and the economic strength of the country. In the period of Hideyoshi, Japan was among the world leaders in gun and shipbuilding technologies.

Early in the seventeenth century, after unifying the country and starting the Edo period, Tokugawa Ieyasu closed its doors to foreign countries to check the entry and spread of Christianity. The national isolation resulted in the emergence of such first-rate intellectuals as Matsuo Basho and Kobayashi Issa and the development and prosperity of culture, including *ukiyoe* (colored woodblock printing), the tea ceremony, and *wasan* (Japanese mathematics).

With respect to social systems, the express messenger system was developed nationwide. In education, various types of systems were instituted, ranging from temple schools[1] to higher educational institutions managed by the feudal domains. Other

[1] Temple schools, called *terakoya* in Japanese, were private educational facilities during the Edo period that taught reading, writing, and practical technical skills for occupations to the children of ordinary people. The number of temple schools during the Edo period rivals the number of elementary schools in Japan today.

systems were also introduced to simultaneously enhance productive capacity in the primary industries and to preserve the environment, including paddy fields, a public water system, a common land system, forest development, plantations, and a forestry and flood control system. It is true that the seclusion policy during the Edo period produced benefits, such as the development of domestic cultures and social systems.

On the negative side of the seclusion policy, it left Japan out of international competition in industrial technology. Japan realized for the first time how it had been lagging in industrial technology for 250 years when the Black Ships arrived at Uraga in 1853, carrying cannons, near the end of the Edo period.

Upon the arrival of the Black Ships and amid demands of the United States and other foreign countries to open the country up to the world, the Tokugawa regime was overthrown and the Meiji government rose on the ruins. Then Japan started a desperate effort to catch up with Europe and America in the new period.

Japan is really a strange country. It was understandable that once the decision-making body of the nation had changed hands, the national system would undergo substantial change. Still it was interesting that the new regime abolished almost all systems firmly established before and during the Edo period and replaced them with Western counterparts.

The parliamentary system was introduced from Britain. For the security and law enforcement system, Japan adopted the French police system to replace its conventional enforcement system composed of such duties as *yoriki*, *doshin*, and *okappiki*.[2] The university system was modeled on the German system. After a visit to Britain, Maejima Hisoka introduced the British postal system although the express messenger system had long been established in Japan. Thus Japan replaced nearly all social systems during the Meiji period.

Pursuing a policy of encouraging new industries, the Meiji government introduced from Western countries technologies necessary to modernize or develop the fiber industry, the fertilizer industry, and the steel industry, as well as the medical system, during the age of the "Clouds Over the Hill" as portrayed by novelist Ryotaro Shiba (Shiba 1979). The clouds over the hill represented Western societies and Western industries. During the Meiji period, Japan sought to reach the clouds.

In those days, Japan pursued the growth model of a developing country, under which the national government took the initiative in introducing industrial technologies and encouraged new industries, thereby increasing GDP and improving people's living standards. Over the hill were the clouds they must aim for—the models of advanced countries that had to be introduced.

Decades later, Japan was defeated in World War II. The people had almost nothing when they restarted. And again they worked hard to reach "the clouds above the hill" (Dower 1999). Toward the end of the 1960s, Japan became the world's second

[2]Yoriki, meaning "helper" or "assistant", were members of the samurai class who performed administrative tasks for the feudal lords, including policing functions. The doshin were a lower grade of police officer below the yoriki. Working below the doshin were the okappiki, who sought out and apprehended criminals.

largest economy in GDP. The "clouds over the hill" should have disappeared at that point. Then Japan should have shifted from the growth model of a developing country to that of an advanced country. Nevertheless, the country failed to make the shift. That failure still lies behind today's problems.

When Japan was a developing country, the central government took the initiative in developing industries, which resulted in improved living standards of the people. Now Japan is one of the most advanced economies in the world, and the Japanese society is fully matured. Japan is now a "problem-saddled advanced country." We still do not see what Japan should become in the future nor which industries might help revitalize the economy and best position the country for a promising future. Today, advanced countries like Japan must proceed and plan for the future without a model example.

We have no other choice than to clarify the issues, establish goals to solve them, and build an advanced society worthy of being called a role model for the world. This should be the right way for Japan to reconstruct itself. I believe that Japan has sufficient cutting-edge technology and cultural imagination to enable it to achieve its goals. New demand and a new economy will be created through seeking solutions to the complex problems that all advanced nations face in the twenty-first century. In this context, I believe Japan's regeneration will be a new model for solving global issues, one that can serve as a universal ideal for the world.

Pursuing the "Platinum Society" Through Three Innovations

You do not need to take "universal ideals" too seriously. Paradoxically, you may start with what you have on your plate. The growth model for advanced countries is designed to improve day-to-day lives. Looking back at history, advanced countries worked hard to solve their own problems. They left their mark on history when their activities were accepted widely by the world.

Looking at the present status of Japan, we should stubbornly endeavor to solve our own problems. When we mention this in relation to the demands as discussed so far, we should not only rely on "diffusive demand" but also generate "creative demand."

To generate creative demand, I propose the idea of the "Platinum Society," which pursues the construction of a comfortable life in each region. The word "platinum" implies an exceptionally high-quality comfortable society realized by organic combination of three innovations: "green innovation," pursuing an ecological low-carbon society; "silver innovation," intending to achieve a dynamic aging society in which all people participate; and "golden innovation," designed to build a society where people keep developing themselves by effectively using IT.

The Platinum Society aims to improve the lives of people through innovation, not at the initiative of the government. The environment for green innovation varies from region to region. It is different, for example, between Hokkaido and Okinawa. Thus, it is impossible for the government to take across-the-board uniform measures. It is the citizens who should take the initiative in each local community.

The purpose of the Platinum Society Plan is to improve the lives of citizens at their initiative through coordination with industry, government, and academia. However, their activities would not bear fruit if they are carried out separately in individual regions, because the amount of data and information owned by each region is so limited that sufficient demand would not be generated to create new industries or raise a voice strong enough to reform the legal and social systems.

Then, what is important is a network of regions facing common issues. Such a network would facilitate the solution of these issues through exchange of information and ideas. The accumulated efforts of all regions to improve daily lives would stimulate enormous demand to develop new industries. The Platinum Society Network was established for this purpose in 2010. In part, this network vision evolved from the tenets of sustainability science as noted in Chap. 2 and was developed in collaboration with scientists and multiple stakeholders in communities, business and government with a view to developing new integrated knowledge that is aimed at action. However, to ensure that knowledge for action does affect decision-making and lead to sustainable development, it must be linked to the simultaneous development of new business models.

The goal we seek is a comfortable society in which all people, including senior citizens, can participate and develop themselves throughout their lives. It is a society in which employment is guaranteed to all workers through "green innovation," "silver innovation," and "golden innovation." The Platinum Society Network is a national movement to encourage such a society and village revitalization. In this chapter, we explore the structure of this network, examples of progress that are already underway to achieve the goal of this network, and mean to promote it throughout Japan.

In reforming society, it is rare that the whole society starts acting simultaneously with a word from one person. Usually, a leader steps forward toward the frontline first. Then, companions gradually join the frontline in larger numbers. Once their activities reach critical mass, the whole society starts moving. This is the process which we should seek to promote the Platinum Society. Japan consists of 47 prefectures, which include about 1,750 local governments. What is important is that one or two local governments in each prefecture start moving.

As mentioned in Chap. 2, we have yet to acquire the wisdom to effectively control the networks amid the twenty-first century knowledge explosion. For this reason, many networks are unable to carry out activities appropriate to their ultimate-goals and commensurate with their abundant resources. As noted in Chap. 2, the emerging sustainability science can help to overcome this weakness by developing means for integrating large quantities of complex knowledge, developing new knowledge that is aimed at solving specific problems, and framing such knowledge in a way that it can be applied to action. To operate effectively, networks must meet certain requirements, including the structuring of objectives and activities, the sharing of structured knowledge, the presence of a network of people who share structured knowledge, and the presence of people who are committed to ensuring that the network will function as it is intended (Fig. 6.1).

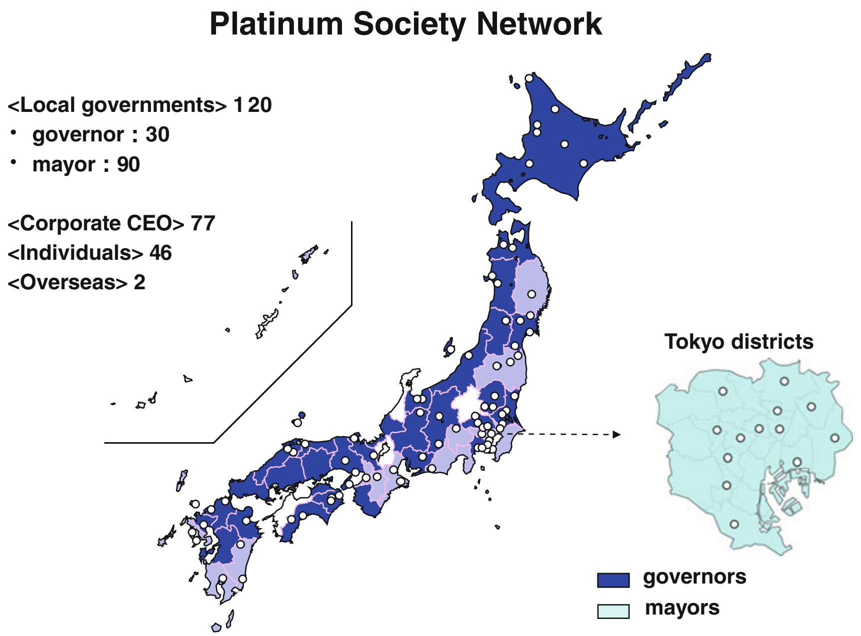

Fig. 6.1 Platinum Society Network

The Platinum Society Network seeks to meet these requirements through such activities as the Platinum Vision Working Group, the Platinum Vision Handbook, and the Platinum Vision School, described below.

Those who “have firmly resolved” to undertake activities that are necessary to meet the “platinum vision” should be invited to become members of the network. Indeed, there are encouraging signs in Japan today that the movement we hope to create through the Platinum Society Network is already underway. As of July 2013, 120 local governments were registered as members and a number of local governments have begun moving in the desired sustainable direction. We consider some of those examples in the following section.

Local Governments Have Begun Moving

The Japanese archipelago stretches in a north to south direction, with mountain ranges running along the center. This geographical feature causes diversity in climate, culture, and lifestyle. Just as the landscape of Japan is characterized by diversity, so are the problems the country faces today. Such terms as “global warming,” “renewable energy,” and “aging population” mean different things in different regions. One model of a sustainable city will therefore not be suitable for each and every region. Each region must foster and develop communities that are appropriate to that region. Different regions may carry out completely different activities. Some regions may install a smart grid as part of its green innovation, while others may build an information system, including an on-demand transport system and a medical care system. Nevertheless, these regions share the objective of building a network of towns that interact, stimulate one another, share knowledge, and evolve in a synergistic manner.

Consider, for example, an on-demand transport system as one way to deal with an aging society. Today, many local transport services are on the verge of financial crisis due to an increasing number of automobiles and depopulation. Once local public transport has disappeared, senior citizens can find no other means of transport and are likely to lose many points of contact with society. This, in turn, can easily lead to their loss of the five conditions for "happy aging," leading to greater social burdens such as an increased need for nursing care. In order for society to promote the five conditions for "happy aging," and thus avoid increasing social burdens, it is indispensable they tap in to and apply the best science and technology available. This again suggests the need for the networks among academia, communities and the public and private sectors at all levels in developing means to address and solve the problems we face today. Solving the problem of transportation for an aging population provides insights to the ways in which such challenges can be met.

Local route buses nationwide in Japan are sustained by subsidies of more than 40 billion yen from national and local governments. In many regions, buses have been losing users, causing a serious financial problem. To prevent further losses, bus lines are lowering service levels to cut costs, which in turn decrease the number of users.

Under an on-demand transport system, as compared with conventional bus lines, passengers could use buses by appointment whenever they want. Under this system, more bus stops could be made available than in route bus services, providing more convenience for passengers. An on-demand transport system was developed by the University of Tokyo Graduate School of Frontier Sciences and was tested in 2009 in 13 local governments nationwide, including Kashiwa, Chiba Prefecture, and Hokuto, Yamanashi Prefecture.

This system has the advantage of being able to self-learn by accumulating and analyzing data used every time the system is operated. By doing this, the system can identify a "golden route," or a frequently used route, and thus it can ensure efficient bus operation and enhanced convenience for users. On-demand transport systems are not designed for senior citizens alone. They are systems comfortable to all citizens in the suburbs or in depopulated areas. Just as with Tōno City's medical care system, in which concerned parties are connected with one another via the Internet, many social systems targeted to meet the needs of senior citizens can simultaneously solve other problems.

The mention of a "town suitable for an aging society" reminds us of the concept of the "Compact City." This concept is embodied in a policy to construct an efficient and convenient town by concentrating social functions in the center of the city as part of the reconstruction of a depopulated region. In addition to providing services that enable people to live and work within the area, the policy also is aimed at providing greater convenience for senior citizens by providing access to shops and services within a walking distance. This approach is based on the belief that living together within a single region would permit more efficient services.

There is, however, an alternative belief. In a "compact city," residences and facilities are concentrated around a key station. By contrast, an on-demand transport system could permit the town to expand around the station in a concentric fashion, providing convenience to the suburban areas as well as to the urban center. Then more people can live in larger residences some distance away from the urban center. Or, senior citizens already living in the suburbs would not need to move to the central part of the city. They would be able to live on a larger piece of land in the suburbs than in the urban center and enjoy gardening, for example, as well as retain friendships and familiarity with the environment. In this case, when people age, they could increasingly use on-demand transport. No inconvenience would be caused in moving around the city as a bus comes to pick them up in ten minutes or so. The environment would become further enhanced if electric buses were introduced for this purpose.

Some senior citizens might consider living in a "compact city," in which they could live in collective housing in the urban center, such as condominiums, for convenience. Others may prefer to live in the suburbs by relying on an on-demand transport. That is, citizens have more alternatives for the type of society they want to live in.

Currently, many local on-demand transport systems are based on taxis subsidized by local governments. This is not practicable in the long-run. To ensure the sustainability of the system and to create new innovative industries and new business models, it is important, first, to make the most of advanced scientific technology and, second, to make them financially workable.

Other approaches are being tried in many regions. For example, Aomori Prefecture will start an eco-town construction plan under which 200 eco-houses will be built, surrounding residences will be renovated, and a smart grid will cover the whole town to make efficient use of energy. Fukui Prefecture has started a program jointly with the Institute of Gerontology of the University of Tokyo to integrate health diagnosis data, medical practitioners' billing statements (statements of prescription, medication, treatment, examination, and other matters issued by practitioners for health insurance claims), and nursing-care data, all of which were managed separately, in a unified procedure. The combination of the initiatives by the two cities would enable us to analyze the relationship between eco-houses and health or disease.

The city of Kitakyushu declared itself an environmental city and started activities to promote a low-carbon society across Asia. The city of Yokohama has opened Yokohama Eco-School (YES) with the aim of mitigating climate change in the city, while the city of Kyoto will initiate eco-activities under the motto "DO YOU KYOTO?" These initiatives also include programs implemented by smaller towns, like "My Family Energy-Saving Contest" in Taikichō, Hokkaido, and the forestry reconstruction program in Shimokawamachi to construct a low-carbon model society for coexistence with northern forests.

The activities of Kamikatsucho, Tokushima Prefecture, are particularly interesting. There are 26 local governments in Tokushima Prefecture, and each senior citizen living in the prefecture pays 600,000 to some 900,000 yen per year for medical care. Among the senior citizens, those living in Kamikatsucho pay least for medical bills. This fact is considered to be associated with the high degree of participation of senior citizens in society through work.

Kamikatsucho is a small town located southeast from the center of Tokushima Prefecture. The town has a population of slightly less than 2,000, of which far more than 40 % are seniors, significantly exceeding the national average. Kamikatsucho has been endeavoring to develop itself under the catch phrase, "*Kamikatsu—Ikkyu to Irodori no Sato* (*which means village*)," with residents contemplating the issues of the village like the Zen priest Ikkyu and using their wisdom to further the town's revitalization.

Irodori or "color combination" refers to the so-called "foliage business," which is now well-known nationwide. The color combination signifies garnishes such as autumnal leaves, persimmon or heavenly bamboo leaves, and cherry and plum blossoms. These leaves and blossoms are commercially sold and created a new successful business in which senior citizens and women who have been out of the workforce for a long time can participate without making heavy capital investments. The foliage business was started on a trial basis in 1986 with initial annual shipments on the order of 1 million yen, and has expanded to about 200 million yen now.

In the foliage business, Kamikatsucho constructed an information system to distribute order and market information. An input device has been developed for frequent training, and other support is given to senior citizens so that they can operate personal computers and take pride in participating in this business.

In Kamikatsucho, senior citizens are leading vigorous lives, the regional economy is being revitalized, and medical costs are decreasing, probably because they are fulfilling the five conditions for "happy aging." This town is a model of an aging society that Japan should pursue on a much larger scale.

Local governments are not alone in undergoing reform. I have the feeling that a cluster of "platinum societies" is going to emerge in the areas along the Tama River. Having Tokyo, Kawasaki, Yokohama, and other large cities along it, the Tama River is probably the clearest urban river in the world. Once polluted, this river has now been rejuvenated so that sweetfish swim upriver every year. On its mouth is Haneda Airport's fourth runway to provide international access. On the other side of the river from the runway, the city of Kawasaki is planning to build an internationally competitive Asian research base called King Sky Front (Kawasaki Innovation Gateway of Science, Yokohama) for life science and health care (Fig. 6.2).

In the Tamagawa area, a little up the river and located a 12-minute train ride from Shibuya, the Creative City Consortium is reinforcing its activities by taking advantage of its location near Seijogakuen, Kaminoge, Denenchofu, Sangenjaya, and other modern urban districts. On the strength of unusual human resources and sophisticated cultures in these towns, the consortium will review and distribute a grand design of a Creative City, study, experiment, and verify infrastructures needed to build a Creative City, and perform activities toward the achievement and sustainable development of such a city (Fig. 6.3).

Japan has policy incentives in place for promoting the development of "creative cities"—such as rankings for environmental achievement under the Comprehensive Assessment System for Built Environment Efficiency" (CASBEE). The first

Fig. 6.2 KING SKYFRONT (Kawasaki City). Photo by:Kawasaki City

Fig. 6.3 Futako Tamagawa Rise. Illustration by: Futako Tamagawa Rise

commercial building in Japan to receive the top award under this system is the Kashiwa-no-ha shopping center that was designed explicitly to promote a comfortable, environmentally friendly and socially invigorating living space. Located in Chiba Prefecture, which has actively promoted the development of a model "Smart City" in Kashiwa, the effort began with the International Campus Town Initiative. Building on to the success of that campus, k proponents are extending the problem-solving approach to urban development based on sustainability science for development of the smart city. This model city will be built on three thematic pillars that reflect the Platinum Vision model, that is, a sustainable urban model that is: environmentally friendly; a city of health and longevity; and a city of new industry creation (Mitsui Fudosan Co., Ltd 2012).

Platinum Vision Handbook for Structuring and Sharing Knowledge

The membership of the Platinum Society Network is composed of local governments (head of local governments), businesses (current and previous corporate executives), special members (those who are admitted by the Board of Directors), and outside experts. (What does "foreign entities" mean? This doesn't seem like a good term. Do you mean outside experts? E.g. academics etc.)

Among the members, working groups (WGs) will be set up in four fields. The first WG will focus on the achievement of an "ecological society." This group will focus on smart grids, next-generation transport systems, technical aspects of biomass, zero-emissions policy for housing and school buildings, corporate CSR activities, support policy for citizens' activities, promotion of energy-efficient equipment, and efficient management of agriculture and forestry. The second WG will address the achievement of "vigorous lives of senior citizens." Its subjects will include the application of IT to medical and nursing care, development of a town friendly to senior citizens, and formulation of a scheme to support life motivation and longer lives. The third WG will study the achievement of IT-based vigorous lives. Its work will focus on the use of IT for other purposes than for ecology and aging society, such as the communication of traditional local arts and cultures and "cyber communities." The fourth WG will deliberate on the development of human resources and management of local governments. The subjects will include the development of senior citizens and working people as school teachers and the evaluation and visualization of local governments.

The purpose of the working groups is not to go into detail about individual problems but to find out keys to earlier development and achievement of approaches taken in each region. Thus, slow-moving working groups should be scrapped and rebuilt to keep them active at all times.

Their activities also include the compilation of the Platinum Vision Handbook and the establishment of the Platinum Vision School aimed at developing cognitive skill and problem-solving ability with respect to related issues in those managing local governments.

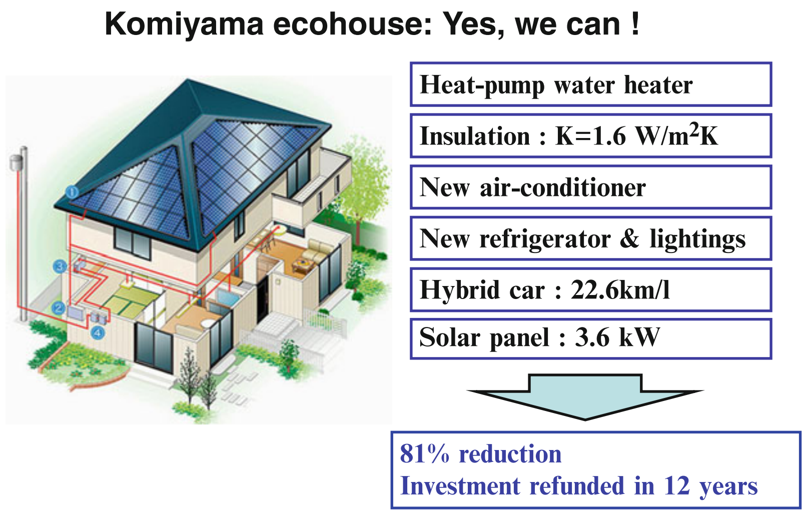

Fig. 6.4 Komiyama Eco-House: yes, we can!

The Platinum Vision Handbook is an IT-based, constantly evolving structured handbook. In the Platinum Society Network, on the other hand, individual regions will try a wide variety of cases. The role of the Platinum Vision Handbook is to turn such individual cases into “reusable knowledge” (Platinum Vision Committee 2013).

We plan to compile and incorporate these cases in the Platinum Vision Handbook so that social experiments and experiences are shared to produce synergetic effects. The maximum possible amount of knowledge will be collected from the effort of each region to build a “platinum society” and structured and integrated in the handbook. An enormous amount of such information will be accumulated, classified, and accessed on the basis of an IT system.

The Platinum Vision Handbook is an open system accessible to any person in the world. This system follows the same editorial policy as Wikipedia, which accepts data entry by any people worldwide. Selected editors manage the system to ensure data quality. Platinum Society Network members are responsible for entering data. Thus, the Platinum Vision Handbook evolves in both quality and quantity in line with progress of the Platinum Vision.

What is important here is “knowledge structuring.” To integrate approaches followed by individual regions in an efficient fashion, we need to build a freely accessible information environment by decomposing the experimental results from regions into elements and pooling such elements, instead of merely mimicking the town development process of other regions.

For instance, I own an eco-house, called Komiyama House, on an experimental basis (Fig. 6.4). The windows are double-glazed to enhance the heat-insulating properties. A heat pump called EcoCute is used to make warm water. A solar cell is installed on the roof. Other new ideas, including ENE-FARM and LED, are also being experimented on the eco-house.

However, Komiyama House cannot be moved as it is, because different regions have different climates. To solve this problem, the house unit must be divided into elements, such as a solar cell, a heat insulation system, and an EcoCute unit. Through such decomposition, we can create constructive information for other regions.

Using such information, one might be able to conclude, for example, that Komiyama-san uses this heat-insulation system, and that such a type would be better in Okinawa. Another might say that Komiyama-san's solar cell could be used also in that region.

Komiyama House is only one of many cases. There may be few cases where Komiyama House can apply directly. It is then important to "factorize" each case into individual elements and abstract common elements to create a universal solution.

The paper-medium Platinum Handbook has a similar structure. It is not a collection of examples of experiments themselves, but it is structured, with the table of contents giving shape to the structure. The Platinum Handbook, based on IT, permits users to make a table of contents freely from their own perspective. The Platinum Society Network expects local university students to play an important role in not only participating in the establishment of a platinum society in coordination with their local government, but also in taking the initiative in the evolution of the Platinum Vision Handbook.

The Platinum Vision Handbook serves as a platform for realizing "structuring objectives and activities" and "sharing structured knowledge," which are requirements for networks.

Platinum Vision Awards and the Dissemination of the Platinum Society Model

Since the Platinum Society is a society that has not yet been realized, there are of course many debates on what it should look like. But this image of the society will not crystallize into a single clear image solely by means of a thorough debate. The reason is that the common space that forms the scene of our actual daily lives possesses a great variety of distinctive features, be they geographic, social/cultural, etc. Accordingly, in order to pursue the conditions leading up to the realization of the Platinum Society, it is vitally important to gather examples of the trials and errors made by citizens and regions as they feel their way about, and structure and disseminate the "knowledge" thereby obtained. It should be the case that an approach suggesting a model for the future Platinum Society will be included among the trial and error cases.

As discussed earlier, the Platinum Vision Handbook collects advanced examples from throughout the country and provides the contents on the Web, so that many people may share in it. In addition to this, a new activity called the "Platinum Vision Awards" has also begun, which singles out and recognizes, from among the many examples collected from each region, efforts that are thought to be leading the way toward the Platinum Society.

The Platinum Vision Awards were established with the goal of showing examples of the Platinum Society. These "awards" advance efforts from all over Japan that embody the form taken by a society that has the Platinum Society as its aim or that strive to achieve it. For instance, objects of commendation include the creation

Fig. 6.5 Amachō, an Attractive Educational Island. Photo by: Douzen-High School Renovation Project

of new industries through innovation and endeavors that are solving regional problems via schemes brimming with new ideas. By widely disseminating such models to society in general, we are striving for the understanding and spreading of visions toward the realization of the Platinum Society, as well as of concrete actions.

For the first Platinum Vision Awards, which were given in 2013, there were more than 120 submissions from among the municipalities and other members of the Platinum Society Network. The winner of the Grand Prize was Amachō, a small island town in the Sea of Japan. Owing to the outflow of young people, the area's vitality had declined, to the point that even the region's single high school came to face an existential crisis. On this island from which so many young had fled, the situation was such that the only labor available to work the area's abundant natural resources and tend to the primary industries were the elderly. However, to overcome this crisis Amachō developed a structure to turn this situation to its advantage. Namely, using the high school as a basis, the entire island branded itself as an attractive field for education. The key to this "attractive education" was the practical use of the natural resources and the experienced elderly population. By these efforts, Amachō has become known throughout Japan as an educational island where "on-the-job" type training can be obtained in a natural environment. Furthermore, not only has the outflow of young people been checked, but residents of child-rearing age from all over the country have increased, and even study-abroad students have come from overseas (Fig. 6.5).

Platinum Vision School and a Network of Networks

Another key to attainment of the Platinum Society Vision is the Platinum Vision School.

The Platinum Vision School is a school for developing local government leaders in building a platinum society appropriate to each region by freely utilizing the Platinum Vision Handbook. Its goal is to realize a network of people sharing structured knowledge, which is a network requirement.

In the Platinum Vision School, students receive six-month lessons by top instructors for two days and one night once a month. At the end of the course, the students submit their graduation thesis titled “Platinum Project of My Town.” The course will be composed of two semesters. For the first semester this year, 28 local government personnel have applied for the course.

These students, although very few, will take a step forward. The school would be successful if real leaders are developed. The impacts of this growing educated network may not be felt immediately, but vigorous local governments are sure to stimulate their neighboring regions just as a pebble thrown in a pond starts ripples.

The Platinum Vision School organizes alumni reunions to build human networks. Graduates of the Platinum Vision School are required to return to their respective local governments and start efforts to achieve the “Platinum Project of My Town.” They would improve performance with the local government in a synergistic manner through the network and review their results.

In addition to the Platinum Vision School, a number of school activities are being established nationwide for the purpose of developing human resources. The Platinum Network operates in coordination with these networks—“a network of networks” as I have advocated. In a few years, these activities will give birth to a grand nationwide ring of people in line with the proliferation of the platinum society.

Further, the Platinum Society Network aims to build a global network of sister cities to convey the idea of developing comfortable towns. The Platinum Project is a grand vision with a major focus on the year 2050. The vision is composed of three levels of networks—an urban network, a network of universities and research institutions, and a network of overseas sister cities (Fig. 6.6).

Many cities and businesses have applied to participate in the Platinum Society Network. The number of members was still increasing as of April 2011. Also a number of individuals and embassy staff are willing to participate.

Today, many Japanese share a sense of danger. They feel that they must start to change their society before it is too late. These sentiments are not unique to Japan. We find many references to increasing social malaise and dissatisfaction throughout the advanced industrialized world. Each country must determine its own future. But if we are successful in Japan to create platinum societies, we will contribute to solving some of the world’s most complex and intransigent problems. Japan has great manufacturing strength that is second to none in the world. Its only weakness has been its failure to determine at its own discretion what to create and for what purpose. Now is the time to put that strength to achieving a sustainable future.

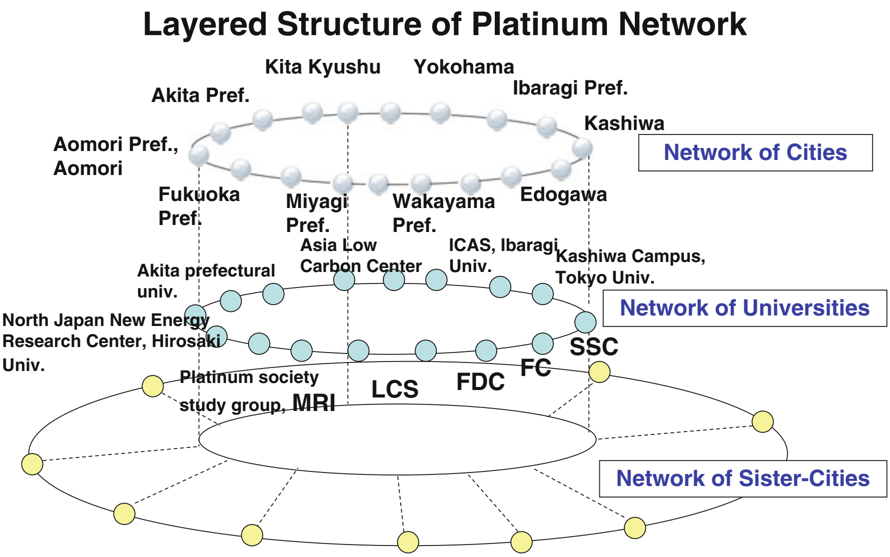

Fig. 6.6 Layered structure of Platinum Society Network

The key to revitalizing and strengthening Japan lies in the courage to create the society we ourselves want and the power to make from scratch the things to support that society. As long as foreign peoples feel drawn toward our concept of a Platinum Society, I believe that the concept is sure to be more widely accepted by the world—because Japan's problems are ultimately the world's problems.

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