



# Global Warming Trends and Mitsubishi Technologies

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*Global warming is the most critical global issue of the 21st century, and greenhouse gas emission reduction policies alone may be insufficient to solve the problem. Thus, the development of a social system in which energy security, environmental protection, and sustainable economic growth (3E) are all achieved simultaneously and the expansion of 3E efforts that advance and disseminate energy- and environment-oriented technologies are essential. To further the achievement of a sustainable international society, our company has expanded our solutions businesses to meet high-level social needs through the use of comprehensive techniques integrating the technologies and products that we have cultivated as a vendor of energy- and environment-oriented products and elemental technologies in other products.*

## 1. Background

Modern society is based on fossil fuel energy sources that have accumulated over several hundred million years. Our reliance on fossil fuels has led to global environmental concerns about the depletion of natural resources and energy sources, as well as global warming.

The recent rise in crude oil prices and the surge in resource prices have led to a reconsideration of the importance of a stable energy and resource supply (i.e., energy security) and the environment (i.e., environmental protection), including global warming policies. Sustainable economic growth is a growing concern, and the simultaneous achievement of the 3Es is fast becoming a critical issue in the 21st century.

In this report, we first outline recent trends in energy and environmental issues, before describing the products and technologies of our company that can contribute to achieving the balanced concept of 3E.

## 2. Trends in energy and global warming policies

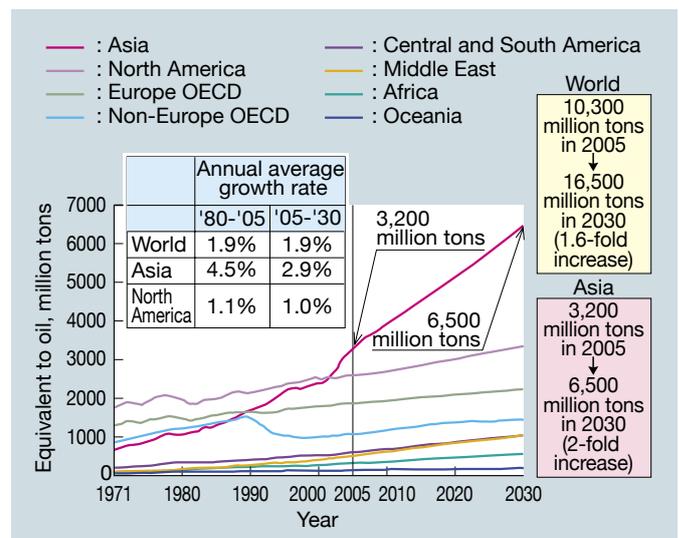
### 2.1 Energy trends

Energy consumption is thought to increase with economic growth and has soared globally with the economic growth of populous countries such as China, which has maintained a high 9.7% average annual economic growth since 1980. Asia/World Energy Outlook 2007,<sup>1</sup> published by the Institute of Energy Economics, Japan, predicts that primary energy supply and demand will increase 60% by 2030, with Asia accounting for about 40% of the global energy supply and demand (Fig. 1).

The supply and demand of natural gas, which emits less CO<sub>2</sub>, is predicted to increase. Natural gas, oil, and coal

will account for 27, 34, and 27%, respectively, of the world's energy, indicating that fossil fuels will remain the world's primary energy source.

The recent rise in oil prices to nearly \$100 a barrel has caused rumblings around the world. This sharp increase may have resulted from a combination of factors, including OPEC production controls, declines in oil refinery operating rates, and the influence of speculative investment. Another factor is the increase in liquid fuel demand in developing countries, stemming from improvements in the standard of living (e.g., motorization). As a result, we must reconsider



**Fig. 1 Regional primary energy consumption worldwide**  
Source: Asia/World Energy Outlook 2007 (Institute of Energy Economics, Japan)

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the importance of energy security.

## 2.2 Global warming policy trends

The Intergovernmental Panel for Climate Change (IPCC) 4th Assessment Report,<sup>2</sup> published in February 2007, predicts that air temperatures will rise 1.1–6.4°C from 1990 to 2100 because of increasing CO<sub>2</sub> concentrations in the atmosphere. Already, increasing temperatures have resulted in rising sea levels and extreme weather events, with serious impacts on ecosystems and people alike. Thus, global warming may have significant effects on the essentials of human survival, such as food, water, and habitable areas (Fig. 2).

Extreme events related to global warming (e.g., floods, heat waves, and El Niño events) have already caused extensive damage around the world. Several indicators of global warming have also been observed in Japan, including reduced ice drifts in the Okhotsk Sea, earlier blooming seasons, and shifts in animal and plant habitats.

In response to global warming, the Kyoto Protocol came into effect in February 2005, providing momentum to several international efforts. However, in Japan, CO<sub>2</sub> emissions in 2005 were 7.8% higher than those in 1990, despite a 6% reduction goal, and emissions in the EU were only 2% lower, despite an 8% reduction goal, indicating the difficulty of achieving Kyoto Protocol targets during the first commitment period (2008–2012).<sup>3,4</sup>

One problem is that not all developed countries are sharing the responsibility for reducing CO<sub>2</sub> emissions. Although Japan is a signatory to the Kyoto Protocol, some major emitters such as the U.S., China, and India are not. Discussions have been held about a future framework for the second commitment period starting in 2013 (post-Kyoto), but there are many complicated energy and economic issues, not only between developed and developing countries but also within the two groups, as each country accelerates the establishment of its own national strategies and policies.

As one of the most successful energy-conserving societies in the world, Japan has agreed to disseminate its energy conservation technologies around the world. Post-Kyoto, Japan will be required to develop and introduce mechanisms and effective frameworks that can maintain industrial competitiveness while transmitting its outstanding energy and environmental technologies and products to developing countries.

## 2.3 Necessity of 3E expansion

The 21st century may be a century of mighty market mechanisms as globalization advances in every sense. It will be increasingly important to consider the effects and limits of market mechanisms, while also taking into account the economic discrepancies that exist between developed and developing countries and that are also proliferating in Japan.

Frameworks that can keep 3E (energy security, environmental protection and sustainable economic growth) in balance are essential in managing energy security and global warming.

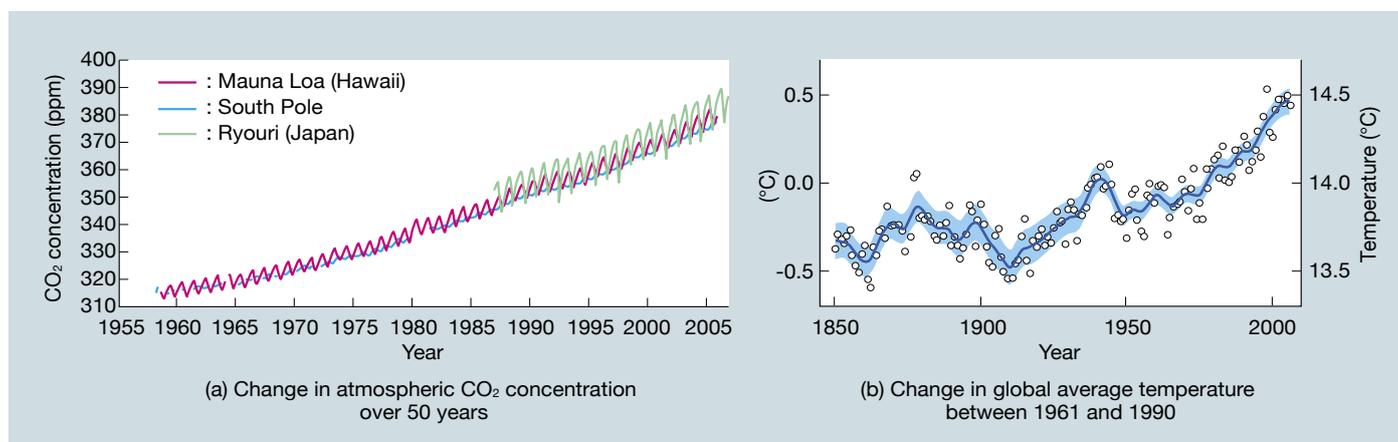
The surge in oil prices suggests that demand may soon exceed supply. If hydrocarbon fuel prices continue to rise, a shift to alternative energy sources that are competitive in price with fossil fuels will occur, causing further changes in supply and demand (Fig. 3).

In terms of 3E, both energy security and environmental protection policies would benefit from energy source diversification such as a shift to environmentally sound natural gas, clean use of abundant coal resources, promotion of nuclear power, and advanced use of natural (renewable) energy sources that are economically rational.

## 3. Our efforts and proposals

### 3.1 Our efforts in energy and environmental fields

The simultaneous achievement of 3E requires the (1) reduction of final energy use (energy conservation and improved efficiency on the user side), (2) improvement of



**Fig. 2 Interannual variations in atmospheric CO<sub>2</sub> concentration and global air temperature**

(a) Interannual variation in atmospheric CO<sub>2</sub> concentration over the past 50 years.

Source: Climate Change Monitoring Report for 2006 (Japan Meteorological Agency)

(b) Interannual variation in global mean air temperature between 1961 and 1990.

Source: IPCC 4th Assessment Report 2007, Japan Center for Climate Change Action (<http://www.jccca.org/>)

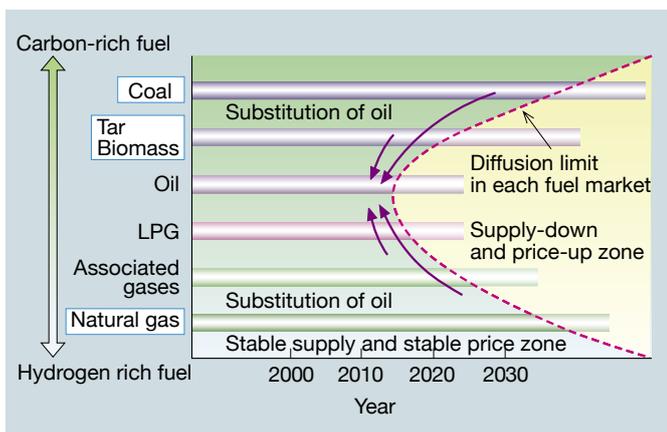


Fig. 3 Rollover point for each fuel

energy production efficiency (reduction of primary energy use), (3) promotion of low-carbon energy use (nuclear power and renewable energy), and (4) recovery, storage, and use of generated CO<sub>2</sub>. Our company possesses a wide variety of products and technologies that help to curb the negative effects of economic growth that lead to increased energy consumption and CO<sub>2</sub> emissions (Fig. 4).

To reduce dependency on fossil fuels, we have sought to achieve high conversion efficiency, to reduce waste materials generated in energy conversion, and to enhance the use of renewable energy such as nuclear, solar, wind, and geothermal. We have also taken steps to further improve the already unsurpassed thermal power generation efficiency of integrated coal gasification combined cycle (IGCC) and gas

turbine combined cycle (GTCC) technologies. In addition, we have promoted the use of CO<sub>2</sub> recovered from exhaust gas and have developed energy recovery systems for sludge and other byproducts.

### 3.2 Proposals for 3E expansion

#### 3.2.1 3E expansion in Japan and the rest of Asia

As outlined above in “Trends in energy and global warming policies,” the energy purchasing power of Japan will inevitably become weaker than that of China and other Asian nations, which continue to significantly increase their energy demand. Thus, as energy security becomes an increasingly critical issue in Japan, the tight supply of and demand for electric power and the associated environmental concerns are becoming critical elsewhere in Asia, as a result of economic growth.

One solution for these problems is to expand 3E, not separately in Japan or the rest of Asia but collectively throughout the entire region, by the following means (Fig. 5):

- (1) Implement energy source diversification and environmental measures in Asia by disseminating the energy- and environment-oriented products and technologies that Japan has built up, including nuclear power generation, renewable energy systems, and coal gasification.
- (2) Produce coal-based liquid fuels and associated chemical products in Asian locations for use on the Asian mainland and export to Japan.
- (3) Introduce and disseminate these technologies and the export and import of liquid fuels and associated chemical products through partnerships between Japan and the

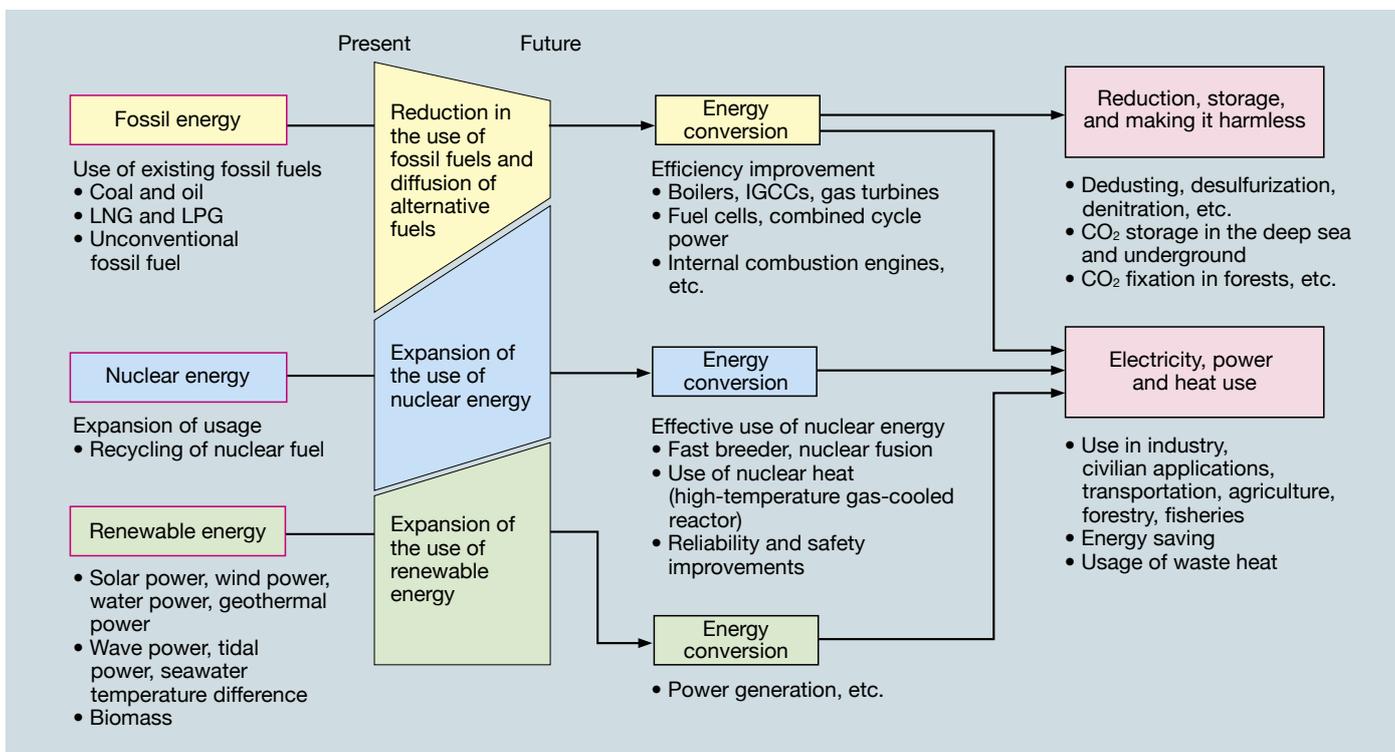
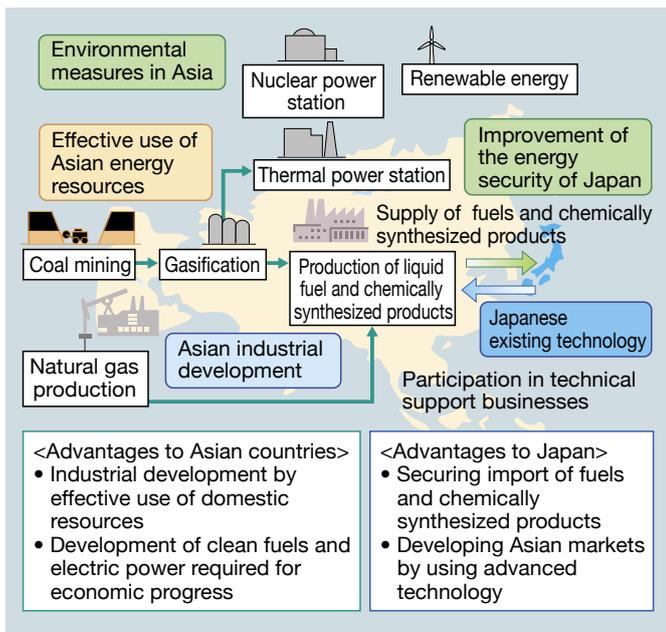


Fig. 4 Energy- and environment-oriented products and technologies of MHI contributing to the simultaneous achievement of 3E



**Fig. 5 Cycle showing the simultaneous achievement of 3E through collaboration between Japan and the Asian mainland**

rest of Asia, at intergovernmental and corporate levels.

Expanding 3E in Japan and the rest of Asia will benefit both parties in the following ways:

(1) Benefits for the Asian mainland

Electric power supply and demand could be mitigated by effectively using abundant local coal resources at low environmental loads and by integrating their use

with nuclear power. This diversification and clean use of energy sources would reduce the use of natural gas and oil, which are valuable foreign currency generators. Thus, energy diversification could lead to economic growth and new industries (fuels and associated chemical products) in Asia that are based on local energy sources.

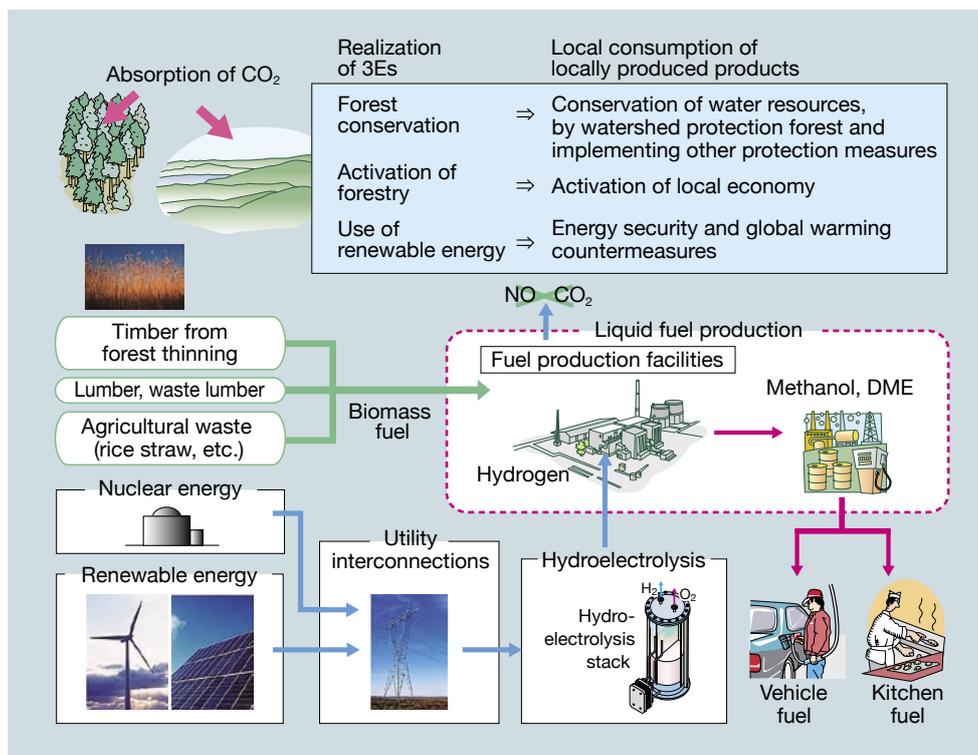
(2) Benefits for Japan

The global energy supply and demand for fossil fuels would be mitigated as both Japan and the rest of Asia turn to the use of liquid fuels and associated chemical products produced in Asia. This, in turn, would lead to an energy source surplus, thus ensuring energy security in Japan. Domestic industries would be able to maintain and enhance industrial competitiveness and technologies by disseminating energy- and environment-oriented products. Although its purchasing power and negotiating presence have gradually weakened, Japan could use 3E expansion as a powerful card in negotiating the acquisition of energy interests and the purchase of energy resources in Asia.

**3.2.2 3E expansion in Japan**

Energy security is also dependent on improving the degree of energy self-sufficiency. The use of biomass resources may prove to be an important tool both to correct growing regional disparities in Japan and to improve energy self-sufficiency and reduce greenhouse gas emissions.

In their global warming initiatives, the United States and Brazil have recently encouraged the use of ethanol from agricultural products as a vehicle fuel. They also view this as an opportunity to improve and revitalize agriculture and rural



**Fig. 6 Cycle showing the simultaneous achievement of 3E using biomass resources in Japan**

communities. Ethanol is an excellent fuel and is integrated into the conventional infrastructure for liquid transportation fuels (i.e., gasoline). However, its use competes with food production and is problematic in effectively reducing CO<sub>2</sub> emissions.

In contrast, our company is developing technologies to produce liquid fuels from cellulose biomass (thinned wood, agricultural waste materials, etc.) that does not compete with food production. For 3E expansion using this technology, we propose a low-carbon liquid fuel production process that uses abundant local resources such as cellulose biomass and solar/wind energy (**Fig. 6**).

This process may help to preserve forests and farmland that serve the public interest (e.g., water source preservation) and may also revitalize agriculture, forestry, and local communities in Japan. It will serve as a stepping stone to improve energy self-sufficiency by promoting renewable energy use.

#### 4. Conclusion

The assurance of stable energy sources, prevention of global warming, and development of sustainability are critical issues facing modern society. The integration of recycling into societal practices offers one solution to these problems. This shift would require scientific and technological innovation to improve energy conversion and utilization efficiency and the promotion of policies regarding environmental protection (air, water, soil, etc.), waste

treatment, and recycling.

While energy security is important for national security in Japan, the mitigation of global warming is becoming an important diplomatic issue. Japan must disseminate the energy- and environment-oriented technologies that it has cultivated to rapidly developing countries such as China, India, and Southeast Asian nations, where energy consumption is increasing. Mitsubishi plans to continue providing products and services that enable 3E expansion and to promote further innovation of our technologies and businesses.

#### References

1. Asia/World Energy Outlook 2007 issued by the Institute of Energy Economics, Japan
2. IPCC 4th Assessment Report 2007, Environmental Data (Japan Meteorological Agency)
3. Progress Report of Action Plan for Meeting Japan's commitment under the Kyoto Protocol (May 29, 2007), The Global Warming Prevention Headquarters (Prime Minister of Japan and His Cabinet)
4. European Environment Agency: Press release, 15 Jun 2007, EU Greenhouse Gas Emissions Decrease in 2005



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