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Policy Framework for Paradigm Shift
Prepared for IEA Joint Seminar on Long-Term R&D Priorities
Catching Up: Priorities for Augmented Renewable Energy R&D

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1. Introduction

The objective of this paper is to present an integrated framework of changing renewable energy policy environment to foresee its future policy implications. After the first oil crisis in 1973, "new" renewable energy technologies such as electric power generation technologies from biomass, wind and solar photovoltaic (PV) have emerged, initially, to decrease the high reliance on oil. Over the past three decades, renewable energy supply increased at higher rate than that of total primary energy supply (TPES) partly helped by the emergences of these new technologies. The share of renewables in the total primary energy supply by signatories of IEA increased from 4.6% in 1970 to 5.6% in 2002. However, the growth rate of renewable energy is getting slower from 3.2% for 1970s and 2.4% for 1980s to 1.2% for 1990s. Especially in the 1990s, the renewables' growth rate is lower than the rate 1.6% of TPES. The result is the shrinking trend in the renewables' share of the past decade in TPES, which rekindles a growing concern to further shrinking of the share in the future.

2. Changes in policy environment

2.1 New factors pushing renewable energies

Despite the fact that the share of the renewables shrank in the past decade, there are several encouraging factors that help the emergence of renewable energies, especially from the beginning of the 21st century.

One of most encouraging factors for renewable energies is the growing expectation of renewables for energy security since 1973. Furthermore, there are four more encouraging factors since the 1990s; i.e., 1) Kyoto protocol, 2) high energy prices, 3) fear against terrorism, and 4) new industries since the 1990s.

In fact, the World Summit on Sustainable Development in 2000 and Bonn Conference in 2004 reflected these expectations internationally. Moreover, IEA itself through Energy Technology Office presented its vision of high expectation to renewables in its alternative policy scenario that renewables will expand its share in global total electric power generation to more than 50% by 2050. Let us consider the last four factors addressed in the above. First, the Kyoto protocol is a

representation of international effort to reduce Green House Gas (GHG) emissions. Concerning global warming, curbing the CO2 emission from fossil fuel burning is the most significant factor in favor of renewable energies. Second, the high prices of energies caused by the recent hike of crude oil prices also favor the renewable energies. The problem of crude oil price is not only the price level itself, but also the fluctuations caused by the political instability in the Middle East. The unstable and high energy prices cause by the crude oil import from the Middle East improve the competitive position of renewable energies against fossil fuel energies. But, it should be reminded that the current price hike of $50/bbl in nominal values is still much lower than the price level of 1979 in real values. The third factor is the fear against international terrorism. The large infrastructure of energy supply rather than small one is an easy target for terrorist attacks, because one attack can damage more heavily on large facilities than on small facilities. The infrastructures, therefore, had better be small-scaled and geographically distributed from security perspectives. Such infrastructures are well characterized by renewable energies. The fourth factor is the emergence of renewable energy industries as a powerful political body to promote itself.

2.2 New factors against renewable energies

There are negative factors against the increase in the share of renewable energies. These are 1) economic growth of developing countries, 2) uncertainty in the technological development, 3) and conventional centralized energy systems.

The growth of the energy demand of developing countries is fast, especially China and India. For example, China and India combined will exceed the total energy demand of OECD countries within several decades. This is a serious concern in terms of both energy security and the environment, as China and India became a net importer in her primary energy supply in 1997 and 1979 respectively. Moreover, if renewable energies will have to increase its share, their growth rates, of necessity, will have to be faster than those of TPES. This is an extremely challenging task for countries like China and India where their first priority is economic development that relies on cheap and domestically available fossil energy such as coal.

Another negative factor arises from the nature of new technologies. The modern renewable energy technologies are relatively new and some are still in the phase of development. Uncertainties about costs, infrastructures, market deployment and technology, therefore, are anticipated as the problem. Intermittency is an example, which has emerged as one of a technological challenge for the expansion of wind power and solar photovoltaic.

Finally, the nature of renewable energies is the distributed availability; therefore, they are more

comfortable with distributed or decentralized system rather than the currently dominant centralized system. It will, however, take additional costs for the adjustment in consideration of such inherent problems of renewable energies like intermittency.

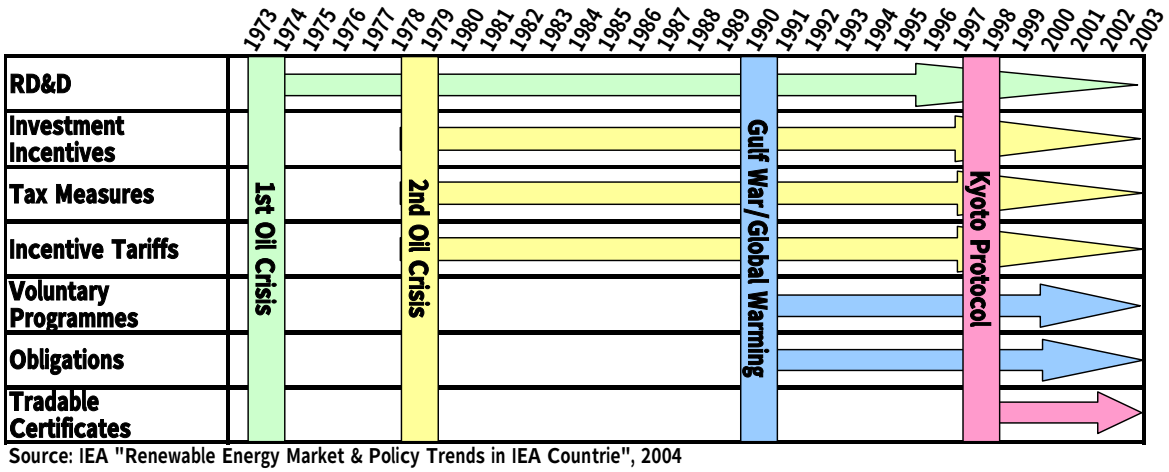
3. Policy responses since 1973

Policy environment has changed partly in favor of and partly against renewables. As far as the renewables' share in energy mix in IEA countries is concerned, the share decreased in the 1990s, although it has slightly increased in recent years.

3.1 Characteristics of Renewable Energy Policies

The changes in policy environment should be reflected in the policies. Figure 1 shows typical policy measures for renewable energies and the timing of their introduction in IEA countries. Since the first oil crisis, the oldest and the longest experienced policy is the subsidies to RD&D. The next group of policy measures includes Investment Incentives, Tax Measures, and Incentive Tariff, which are introduced after the 2nd oil crisis. Voluntary programs and Quota Obligations are introduced since the time of Gulf War. Also, at this time, the issue of global warming was emerged as a serious concern to fossil fuel usage. Finally, the most novel policy measure is Tradable Certificate, which is usually combined with Quota Obligation system to increase economic efficiency.

Figure 1. Policy Measures and their Timing of Introduction



Source: IEA "Renewable Energy Market & Policy Trends in IEA Countrie", 2004

These policy measures have different characteristics. RD&D subsidies are effective for basic research to disseminate the achievements in early stage as in the case of RD&D for renewables. For example, Japan started an RD&D subsidy for solar energy from 1974 and especially for PV from 1980. In the case of the Japanese RD&D subsidy for PV, it seems to be successful in industrial development. Because the PV markets are largely spreading from home appliances to power

supply to grid, the monetary size in the market is large and applications are inter-industrial. However, from the point of power supply or kWh generated, it is still small. In the electric power supply in Japan, wind power is now catching up to PV with smaller RD&D subsidy than PV.

The second regulatory framework emerged in 1978, when the United States federal government implemented Incentive Tariff type "Public Utility Regulatory Policies Act (PURPA)" PURPA in 1978 combined with tax measures (Energy Tax Act of 1978). Denmark, Spain, Germany and other many European countries employed these types of measures through the 1980s and especially in the 1990s. Its advantage is to secure investors and it is very effective for the fast and large number of deployment. Also, it is simple and the cost burden is shifted to consumers and not to government. The disadvantage is that it does not induce direct competitions between suppliers and it can conflict with market-based instruments. For example, this measure may be conflicting for those who want to reduce electric power tariff with market oriented restructuring. The limited competition implies that incentives for cost reduction are low.

If we looked at policy outcomes, they mostly succeeded to increase the share of targeted technologies—including those of the US PURPA, Germany, and Spain. But there are some public opposition and political uncertainty for support especially against the policy cost in terms of increased electric power tariff. In the US, initial contribution of PURPA to the expansion of the renewables is very large in the 1980s in an anticipation of continuing high level of energy prices, but not popular recently because of the relative decrease of the prices of fossil fuels.

In some countries, Quota Obligation is becoming popular in combination with the Tradable Certificate. These are currently employed by some European states such as UK, Italy, and Sweden, as well as Japan, Australia, and many of US states including Texas, Main, New York. In theory, the policy measure of quota obligation has the advantage that it helps renewables to expand the share in competitive environment, which makes costs of implementing the policy lower than the case of Incentive Tariff and it is applicable with Tradable Certificate. Also, it can specify the target with incentive for cost reduction by competitions. The disadvantage of Quota Obligation and Tradable Certificate is that high cost technology/resources cannot compete, because it is designed to lower the policy cost with market-oriented incentives. If it needs to target some specific renewable technologies, it has to select these "renewable" technologies intentionally as qualified. In this case, the advantage of this policy measure might be reduced, because of this targeting.

As for the policy outcomes of quota obligation, it seems still too early to evaluate it except notable success of US Texas, where the wind power cost turned out to be very competitive. In case of

Japan's RPS, the obligatory quota can be much larger than Texas, while the major barrier for wind power is neither economic nor competitive, but intermittency.

3.2 Recent Trends

Until 1990 (i.e., the Gulf War), the policy measures are enhanced by the oil crisis and war in the Middle East. This is a matter of energy security. Renewable energies were, therefore, characterized as oil alternatives until around 1990. With intensive RD&D in the 1970s and the 1980s, some technologies like wind, photovoltaic, biofuel became commercially available. Thereby, the policy focus for these technologies has shifted from RD&D to market deployment.

In addition, the policy objectives of renewable energies, as representatives of clean energy, have gradually emerged since the late 1980s, namely after the issue of global warming emerged as one of global environmental agendas. The environmental issue is, therefore, a forerunner as a driver of the next phase of the renewable energy policies, especially in the phase of market deployment. The major policy appeared at this timing is "Quota Obligation", which has a conceptual similarity with "cap and trade." Quota determines the minimum level of the target, whereas the "cap" determines the maximum level of the target. In fact, the concept of "cap & trade", which was pioneered in the US, has been the primary measure to control hazardous emissions such as NOx and SOx in the 1990s. Then it seems natural that the concept of "Tradable Certificate" appeared in the mid 1990s as a renewable energy version of "Certified Emission Reduction."

As such, the recent emergence of renewable energy policies has the similar characteristics of the GHG emission reduction policies. Conceptually, renewable energies can be treated as external "goods" in the same manner that the GHGs are treated as external "bads." The policies set the targets for "goods" and "bads" and make them tradable to achieve their targets at the most efficient cost allocation.

4. Lessons Learned

4.1 Policy consideration of benefit: diffusion and application of technological benefit to other industries

In the case of Japanese RD&D to PV, generated kWh is as small as kWh generated by wind power, even though the budget of PV has been much larger than that of wind power. However, PV could have found their own niche in not only the energy sector but also other industrial sectors by creating its market values in monetary terms. The previous policy objectives of RD&D in Japan are 1) the capacity building and increases in the energy generated from renewables and 2) the cost reduction for renewables. However, one of the most important policy objectives for creating "benefit" has

not been explicitly clarified, partly because it is obvious but difficult to quantify. As in the case of Japanese RD&D, the renewable energy policy should be considered in terms of both monetary market value ($US) and physical market value (kWh or Joule), especially for its potential use in other industries.

4.2 Policy environment has changed

One of the largest changes in the energy market is the lowered energy price in comparison with the 1970s and the early 1980s, although the prices in the 2000s have been increasing. Although the recent hike in energy prices is giving competitive advantages to renewable energy, the lesson from the US PURPA implementation tells us that we should not assume oil prices to be continuously stayed in a high level. If every prices drop as occurred in the mid 1980s, some of renewable energy will be too costly.

Another change in the energy market is that some of renewable energy industries have gained its power and gradually expanding the market; i.e., wind power. As mentioned earlier, we may encounter inexperienced technological problems with the expansion of renewable energy. One of the problems is “intermittency” primarily caused by wind and solar powers. The issue on intermittency needs to be tackled not as a unique issue of wind and solar powers, but as a potential problem arising from renewable natural resources in general.

4.3 Technological characteristics

Technical characteristics are very important to renewable energy. One typical example is wind power. Wind power is the most successful technology so far under the policy of either incentive tariff or quota obligation. Although the magnitude of the expansion might depend on a specific policy of nations like the case of Germany, the nature of the technology and the resource is one of the key elements of such success. One of the key successful characteristics in wind energy is its availability in three-dimensional space. It can expand not only horizontally (expanding the area of the farm), but also it can expand vertically.

5. Paradigm Shift

5.1 Issue became multifaceted:

Over the last decade, through the changes in the policy environment, the issues of New/Renewable energies have experienced a paradigm shift. The issues became multifaceted including the environment, energy security, distributed systems, sustainable development and communities. Originally, the facet was energy security only. In the 1990s, as the environmental issues caused by energy utilization became serious concerns with not only the environment, but also sustainable

development as demonstrated in WSSD and Bonn conferences. The stakeholders have been expanded from those in the energy sector to those of rural communities in developing countries.

Implications of change in energy systems in the long-term encompass infrastructure for distributed systems enhanced by political support. Ideally, various types of resources and technologies will be integrated into the energy system to promote regional development and advancement of developing countries. However, the parties participated in the energy market are not those from the environment and sustainable development groups. Although new stakeholders can have influence in the policymaking, it is not political voice, but the market equilibrium determined by the choice of energy source through the supply of and the demand for energy. Whatever the strong voices of the environment and developing countries are, if the prices of renewable energy are high and quality is bad, then the prospect of the future expansion of the renewable energies is pessimistic.

The message from here is simple. The policy paradigm has shifted from single to multifaceted but the market has not. Their signals can be traced in the history of IEA RD&D budget.

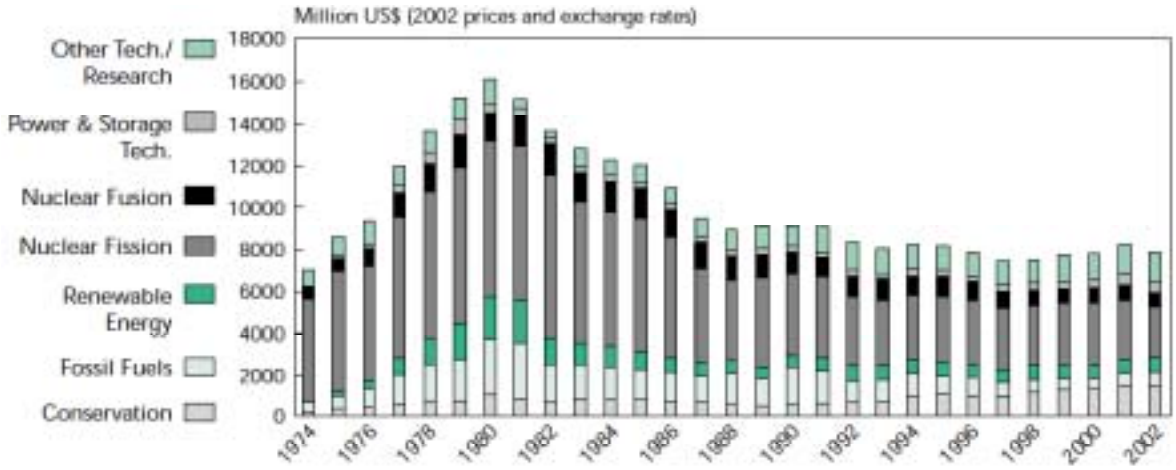
5.2 Policy Implications of RD&D

Figure 2 shows the aggregate energy RD&D budget outlays of IEA countries. It shows that after the first oil crisis, all budgets increased from 1974 until 1980 where the sum of all budgets reaches the peak in 1980, totaling about 160 trillion dollars. After 1980, most of budgets decreased during the late 1980s and the 1990s, except conservation and other technologies, which include hydrogen and fuel cells.

IEA's "Renewable Energy Market & Policy Trends in IEA Countries, 2004" pointed out that the decreasing share of public funding for energy RD&D allocated to renewable energy appears to be inconsistent with presumed political intentions in many IEA countries to increase the share of renewables in TPES. The same can be said under the paradigm shift we discussed in the above. However, if RD&D budget is considered as a response to the energy market, especially the price level, then another explanation becomes possible.

The alternative explanation can be found from a close look at the trend with additional variables of energy prices or energy security. First, the budget for renewables increased much faster than the total energy RD&D budget in the 1980s. This indicates that renewables RD&D are more sensitive than the whole energy RD&D. Secondly, renewables RD&D maintained the budget above zero even after the price level comes back to those of the early 1970s by the mid 1980s and the after.

Figure 2. Government Energy RD&D Budgets

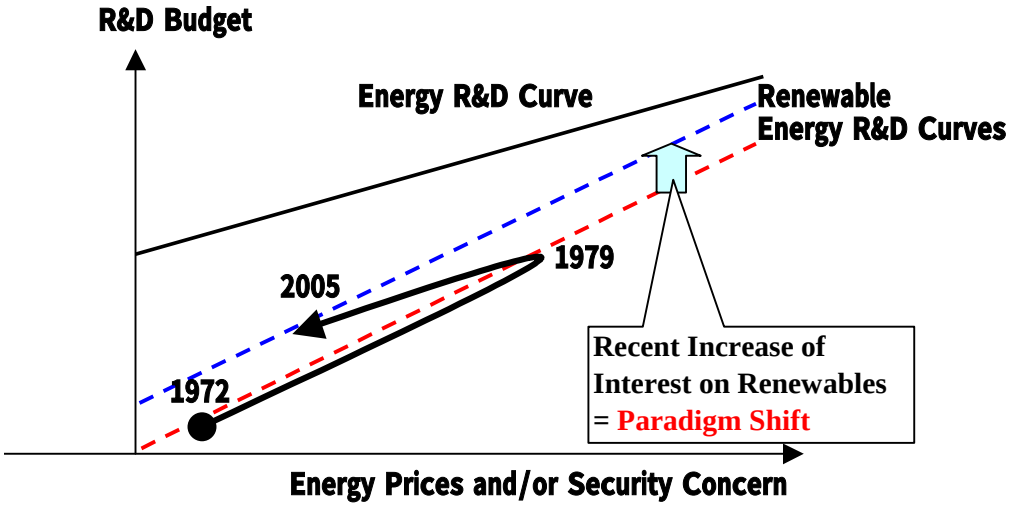


Source: IEA "Renewable Energy Market & Policy Trends in IEA Countries", 2004

Figure 3 simplifies the above points. The figure depicts the relationship between the level of RD&D budget and energy prices, which are assumed to have direct relationship with energy security concern. As energy prices goes up, the energy security concern increases the RD&D budget faster than the total. This implies that the renewables budget curve is steeper than the total energy budget curve. The next observation is simplified in the figure that the renewable energy curve shifts to the upward direction from the curves of the 1970s and the 1980s to the 1990s. In the figure, the budget level moves from the point of 1974 to the peak of 1980 and then goes down to the point of 2005. These two renewables curves are steeper than the Energy RD&D curve, reflecting the faster growth of renewables RD&D budgets.

The three points of 1974, 1980 and 2005 show that renewables RD&D in 2005 is lower than that of 1980. This arises because the price level in 2005 is much lower than that in 1980, therefore, the shrink of RD&D budget is also faster than the total with the steeper curve. Consequently, the share of the renewables RD&D becomes much lower as well. However, the second observation indicates that the renewable energy RD&D curve has shifted upward. This is why governments are still keeping renewables RD&D higher than the level of the early 1970s, when renewables were not in consideration.

Figure 3. Shifts in Government Energy RD&D Budgets



This observation implies that the current level of RD&D budget indicates the magnitude of policy paradigm shifts. But clearly the market force represented by energy prices had much larger impact on the renewables RD&D. As such, the public assistance to renewables has two components. One is the traditional energy security part, which is sensitive to energy market. The other one is the external pressure, which is insensitive to energy market. The part of the external factors becomes more important for renewables as energy market becomes quiet with lower energy prices or lower security concern.

5.3 Paradigm shift; more friends but also more competitors

The recent RD&D indicates that those who are increasing RD&D budget share are not only renewables, but also energy conservation and hydrogen technologies. Energy conservation and hydrogen technologies are the growing importance of the environmental issues in energy policy and thus both items need to be added to energy policy. This indicates that it is not only renewables but also energy in general, which became multifaceted. As a result, the new facets like the environment and sustainable development provided some help to renewables, but they also create new competitors like energy conservation and hydrogen in terms of budget allocation.

Renewable energy has many faces now and each face has its friend and competitors. The face of energy security has to face with the domestic coal utilization in China. The face of CO2 free has to face with nuclear, energy savings and emission “cap and trade” policies. The clean image of renewables has to compete with natural gas and hydrogen technologies.

6. Policy Framework in New Paradigm

In New Paradigm, the public support to renewables from external policy issues like environmental and sustainable development become relatively more important than energy security issues when energy price goes down. Once energy prices go up, the traditional energy security concern will give support to renewables much faster than others will. Therefore, the recent hike in crude oil prices in year 2005 has given significant advantages to renewables from the two-sided effects of both markets and the public support in comparison with the 1990s.

In other words, there are two components in public support—1) internal concern or energy security concern that varies based on energy market and 2) external concern or environmental concern, which has been largely fixed or gradually enlarging depending on the political environment since 1990s. Conceptually, the policies can be differentiated between these two components. The former concern suggests price stability and energy security oriented polices under variable support programs. The latter concern implies that renewables should be supported indifferently in the energy market to support such long-term agendas as the environment and sustainable development. But in practice, the key is clearly how to function the energy market effectively for renewable energy even in a new paradigm for renewables to expand. The policy framework in the new paradigm needs to advance technologies through RD&D but have to be translated into market force for market deployment.

In practice, more important factor in new policy framework can be the nature of renewables; i.e., their global availability and regional variances. A policy framework can be proposed in consideration of the differences of the regional faces of the renewables as well as the regional market forces. The necessities of renewables in Japan are clearly different from those in Ethiopia. As such, the faces of renewable energies depend on the regional necessities, competitors, and political environment, in addition to the most critical element of market force represented by the prices of other alternative energies. As a result, the increased number of faces of renewables provides more opportunities and options of policies in various countries, whereas alternatives to renewables are also gaining their momentum.

The implication to the new framework is that the policy responses of renewables have to be multifaceted in consideration of global and regional characteristics of each renewable source, whether the policy is motivated by the environmental concern or not. The facets of policy framework have to be oriented to the actual energy market and related industries even if the objectives of renewables are oriented to the environment and sustainable development. The followings are examples of such facets of new policy framework.

6.1 Technological development

By its nature, renewable energies are geographically and environmentally dependent and have regional variation in its magnitude of availability. The technological advantage depends on regional characteristics. The existing and required infrastructures are also regionally varied. In this context, the policy formulation should be left for the free hand (autonomy?) of regional authorities and planners. The global communication and exchange of information on the similar technologies and policies will enhance these regional RD&D and policy implementation.

6.2 Market monetary value

The technologies are relatively new, therefore, the inter-industrial potential should be considered for market values. For example, from the point of market monetary values and long-term potentials, photovoltaic will have considerable advantages for its inter-industrial applications, although the contribution to the total power generation has been relatively small due to the high cost. In the case of photovoltaic, given the fact that its efficiency is already higher than Biomass in terms of the utilization of solar radiation by unit area, RD&D for cost reductions for large market deployment in the power sector is more important than that of efficiency improvement.

6.3 Fast deployment of renewables in electric power

For an early expansion of renewables in electric power, wind and its successor will be the most promising renewable, due to learning effects from the success of the wind power technology and the three dimensional scale merit—not only horizontal but also vertical scales. Although offshore wind technology is already developed, candidates from other sources such as tidal current and ocean current have the same characteristics of three-dimensional scale merits in the ocean.

6.4 Global availability

One of the critical advantages of some renewable energy is their global availability, and it can mitigate the gaps between countries of rich energy and poor energy. Cost advantages of biomass in developing countries, for example, seem quite promising for energy supply. Asia is rich in biomass and demand for bio-fuels seems promising in consideration of such huge markets as in China and India. The technological advances of biomass can be applied globally not only in its supply side, but also in the demand side in the form of electric power and bio-fuels. However, to be reminded is that biomass has to compete with other use, especially with food, which is more critical to living than energy for the poor in developing countries.

7. Conclusion

The paradigm shift examined in this paper concludes that the issues of renewable energy are now expanding from the horizons of energy policy to those of environment and sustainable development under the new policy environment. Renewables are partly supported by non-energy market factors. But, in reality, the market force cannot be easily intervened by such external agenda as environment and development. Therefore, the response in the new policy framework is the employment of such elements as environment and developing countries in an energy-market oriented manner. For example, because the technologies and sources of renewables are so varied, global selection of technologies have to be done carefully. The global selection can have advantages for the availability of global applications like the case of biomass, in particular, for the development of developing countries.

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