表: 総合政策研究

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The Harnessing of Innovation toward a Sustainable Rural Energy Delivering System

Yukinori Nakano

This paper presents some ideas to accelerate the introduction of new energies in rural areas, where there is not enough additional capital, skilled labor and advanced technology. I point out the analogies between information industries and new self sufficient energy services emerging in some developed countries and that the globalisation and the rapid growth of an information society could be a driving force of new businesses in these two sectors. In both cases, end-user’s position is greater than before because of the development of communication and information processing technology in general. To create a sustainable renewable energy supply system in rural areas, frequent policy dialog via new media between end-users and future service providers under the supervision of local authorities is required.

Key Words: isolated rural areas, electrification, new energy, innovation, technology transfer

1. Introduction

I’ve studied European research and technology development policy mainly in machinery and the information technology industry and found some analogies between the information industry and the new sustainable types of energy service. The new energy service does not exist yet in Japan but it is growing steadily in some countries. These two sectors are now facing big changes, and challenges, which could be observed in the re-definition of the words; “universal service” and “convivial service”.

“Universal service” means here “a service in which whoever, wherever they live, can enjoy the service with reasonable cost” This slogan had its origins at AT&T in 1910s; “One policy, one system, universal service, That the American public requires a telephone service that is universal is becoming plainer everyday.”

To become a member of Bell Telephone Company meant that he got an admission to a precious private (or exclusive) club’s membership. The word “universal service” is not used in the same meaning nowadays. Now, universal means openness for the public.

“convivial service” means “a cheerful and sociable service or a service which provides full of shared pleasure and friendliness”. In other words; frequent communication or information exchange between a customer and a dealer. Personalised service and private service are the synonyms of convivial service. For example, in convenience stores, a customer’s information is transferred to data processing centre simultaneously and the daily goods which are bought by him will be delivered for replacement in short time.

These innovations in service were affected by new information technology leading to a widely distributed system, making smaller-sized units of business possible.

These common phenomena are changing the position of customers. We can call this change “The rise of the end-user’s power in market”.

Electrification of rural areas is a difficult target in policy studies because of the general lack of additional capital, skilled workers and the latest state-of-the-art technology. But, when we study the more efficient technology transfer policies and innovation policies for stimulating the electrification of rural areas, the future is promising because the end-users are helping to evolve
the social system toward a more convivial society.

2. Dynamic change of final net energy demand

2.1. Globalisation and the Information Society

One of the relevant characteristics of globalisation is to reduce trade costs and to create more opportunities for new emerging business. Consequently, end-users would be able to choose any service at any time and any place in a global open market.

New digital information technologies provide abundant diffusion of product information and reciprocal communication between customers and providers around the new services. In the future, the information society will be able to provide exclusive service for some adventurous customers and globalisation will push this precious service into universal market.

For example, when an entrepreneur finds a new promising emerging market, he can invest his money in R&D and technology transfer activities with firm confidence. It depends on a desirable expectation for the future. In any society, an expenditure for R&D should be compensated by sales of commodities or services later. I believe that the new energy market can afford to do this kind of good thing.

In the Energy Working Group of APEC, we have the “Energy Efficiency and Conservation” activity group in addition to this R&D and T.T. group. They proposed a Demand-Side-Management (DSM) approach for reaching better efficiency of existing power facilities with the consultation of end-users’ opinions. This is a typical example of the importance of dialog between end-users and power suppliers. In such a way, we tend to know the dynamic changes of final net energy consumption to make the target of new energy and/or renewable energy clearer in future.

Growth of the information society requires huge amounts of electricity in the beginning, but the technologies of micro-electronics are changing the needs for electricity. More efficient information processing appliances like portable P.C.s., portable phone etc., will require less electricity, because a discrete flow of an electron or a photon is enough to carry net information. If so, portable electric power providing systems, such as normal batteries, solar (photovoltaic) cells and wind-mill power supply systems are suitable to fulfill the net energy demand of information society. We already have an emerging market of wrist watches and calculators driven by photo cells. Why can’t the future radio set or mobile telephone set be driven by sunshine?

2.2. Increasing net energy demand in service, residential and transportation

Returning to the subject of discussion, I would like to point out that final net energy demand has drastically shifted from the industrial sector to commerce, the public service sector, the residential sector and the transportation sector, which was observed in OECD countries even under the period of higher oil prices between 1980-85. This means that the industrial sector moved rapidly toward a less energy dependent structure but not the non-industrial sector.

Of course, in such non-industrial sectors, people have waited for a long time for other kinetic energy resources to use instead of a labor force of livestock for household work and daily transportation. And, when the price of energy jumped up, their lifestyle was not affected. I think that little meaningful and economic energy substitution occurred in these areas other than electrification, because it is not totally related to oil consumption.

In houses, conventional oil heating or gas heating equipment was substituted by heat-pump, which is incorporated in air-conditioning and heating equipment, and wash-machines have taken part of household work from labor to electricity. However, no substitution of driving power was observed. The gasoline engine is another leading part of energy consumption in modern society, and it is kinetic energy that end-users require for individual transportation.

Another example of unexpected policy changes which came from the goals of policy makers was an increase in the energy efficiency of cars. The original goal of decreasing fossil fuel air pollution resulted in more energy efficient cars. The topic of car manufactures developing the new engines to conform to environmental regulation of local authorities is detailed in the discussion “Environmental Policy and Industrial Innovation” written by David Wallace at R.I.I.A. He pointed out the importance of political independence and the quality of dialog between industry and regulator. Good regulation, which is introduced through intensive positive dialog between makers and local governments, lets car makers invest a lot of resources in innovation for future markets. Clean engines consume less fuel and show better energy efficiency. A pollution free engine will improve the energy efficiency at the macro level. Man power will be assisted by electric power more frequently in future transportation. Escalators, lifts and hybrid-bicycles are assisted by electric motor.
3. Experience of Industrial Policy


Forecasting of economic activity is not easy work. In 1981, we published "The Industrial Structure of Japan in the 1980s - Future Outlook and Tasks -". This contains the final net energy consumption analysis for 1978 and an energy flow chart forecast for 1990 (see Fig.1). This was achieved by Industrial Policy Bureau assisted by all of other bureaus and the Natural Resources and Energy Agency of MITI.

The method of this work was not only re-creation of supply-side data but re-construction of the net energy demand flow chart based on the national Input-Output tables. As you know, when final demand structure in GDP is changing, the input flow of energy for each industry will also be changing because of structural linkage of inter-industries. The data was checked from the right hand side to the left; this is to say, from demand side to supply side. Supply side data was only an accumulated table and did not correspond well to the changes of final economic demand structure, namely the industrial structure. Only the Input-Output table method was reliable for making a long term forecast of energy flow from demand side to supply.

During the second oil shock, we thought that the oil dependence ratio of Japanese economy should be reduced. This was the target of industrial policy.

We had had a good experience of policy dialog between MITI and industrialists in the case of environmental issues in late 1970s, especially concerning the feasibility of newer driving technology. Once we were able to display clear social needs and end-user market needs to industrialists, they proceeded with in-house R&D and competed with others to put new technologies in the market.

This type of cooperation toward a new industrial policy dialog reduced our oil dependence and introduced new energy resources. We displayed the flow chart of energy for a 10 years period and the list of end-users facilities which would be modernized to reduce the oil consumption and augment the energy efficiency at the macro level. Industrialists were persuaded and made the massive investment toward new production facilities to reduce oil expenditure, more energy efficient facilities, and switching from oil to natural gas and imported coal. Unchanged high oil prices for the following 5 years gave legitimacy to the decision of private investment. MITI's guidelines toward the less oil dependent industrial structure was appreciated as a successful policy mix in those days.

3.2. Difficulties of forecasting final energy demand

But in reality, we committed three mistakes with our demand side forecasting, which were observed later in comparison with the actual energy consumption in the household and transport sectors.

The first mistake was underestimating the importance of market forces. After 10 years of good performance toward a non-oil dependent society, international oil prices fell and stabilized. The collapse of the former Soviet Union influenced industrialists and end-users sensitivity about the oil dependent economy. This was a good sign for economic expansion in general terms but industrialists lost their enthusiasm for energy efficient investment. Market forces are decisive for industrial sector decisions.

The second mistake was that offices and households required much more energy than expected, especially electricity demand for air-conditioning. Besides the increase in total volume of electricity consumption, demand at peak times abruptly increased. The efficiency of the central power station network was reduced because of heavy investment in response to the peak demand. An increased use of computers in business also pushed up the consumption of electricity at the office.

Our final mistake was about transport sector. The biggest difference between our prediction and reality was about national transportation needs. We predicted that energy consumption for transportation in 1990 would remain at the 1978 level of 15% but in reality it reached 23%.

Communication demand was one reason for this unexpected increase in transport of goods and passengers. The new wave of advanced information society reduced the cost of telecommunication and information processing. POS: point of sales systems increased the net dialog between customers and suppliers of daily goods, and traffic of small size trucks in urban area became more frequent. Another reason was that after oil prices went down, the size of particular cars got bigger and bigger. Domestic oil consumption for inland transportation increased at double the speed of the predicted pace.

4. Technology Transfer

4.1. Different way of technology transfer

We know that there are many ways to obtain state-of-the-art technology.

First of all, technology is sometimes incorporated in manuals, texts and industrial products, such as design books, cars, some household electronic appliances etc.
A patent or intellectual property right also includes a lot of advanced technology packages. We can buy these products or property rights on the global market.

The second way is to be trained or to learn a technique or a technology from someone. This concerns the personal characteristics of technology. The Japanese government offers a lot of opportunities to welcome foreign trainees in Japanese manufacturers. A lot of good knowledge is shared in this way, but some problems occur when they return home. For example, trainees from foreign countries visit Japanese companies and learn about the new production or managing technology, but often don’t learn how to apply that knowledge in their home country. After returning home these resources get fragmented and dispersed geographically, which often makes it difficult for people to put the puzzle of this new knowledge together for the benefit of their community. The Japanese government is encouraging foreign partners to create on-site centres of excellence for sharing the new technological progress gained in developed countries. The researchers who gather will need to overcome regional cultural differences and understand the various needs of local inhabitants, even though, we had better create some R&D project on-site.

The third way is more complex. Promoting R&D activities is another way of technology transfer. Japanese manufacturers sometimes send senior engineers to American partners to co-develop new products. Private companies’ cooperation is not regulated so much. However, inter-governmental R&D cooperation on a regional scale is a rather a difficult matter. For example, the European Union’s R&D policy is characterized by a complementary principle. This means EU Frame-Work R&D programs can only touch the R&D field allowed by member countries and EU Parliament.; such as Joint Research Centre in Euratom, Esprit project, Brite project etc.

Another more flexible scheme of R&D cooperation on a regional scale is “Eureka”. Several companies, from two countries at least, take an initiative to create a voluntary joint R&D program under Eureka scheme and the secretariat of Eureka recognizes this program in case of that the formalities are fulfilled.

Considering these three ways of technology transfer, I think that an initiative to develop new energy delivering system should occur locally and the place of research should be selected locally.

4.2. The asymmetric effect on end-users of introducing a new technology

When we want to get technology from the market, we have to distinguish usefulness and utility; meaning the degree of services or goods deemed necessary to satisfy the subjective needs of consumers. There is an asymmetric or inefficient distribution of goods and services, for end-users because they don’t know what the substance of new technology is, unlike safety goods, environment products, daily foods and so on, where consumers are protected by regulations and national standards which compensate the asymmetric effect of information at the market.

With regard to energy service, individuals don’t have any knowledge and experience as owners of power generators in our modern history of electrification. An individual person could not have a power center in his house normally.

It seems end-users could be continuously informed by APEC Energy Working Group networks and by a NEDO information centre about what is important to create a sustainable rural energy system. There are a lot of admirable web-sites on the Internet. Local governments, entities for public interest and non-profit organisations, such as research institutes and universities, could diffuse or transfer the information so end-users could select the most suitable energy delivering service for their local life style. These groups could try to achieve the point of excellence to support the technology development and accumulate the know-how and experience on-site about the new local delivering system of energy.

4.3. Balance of payment in future information society

Of course, rural areas will need a lot of money to develop and run their new energy equipment.

In the industrial revolution era, rural areas benefited from the use of their natural resources. They started to implement a series of technologies to dig mineral resources and transfer them to horse power. Today local areas can benefit from use of their information resources. To face the challenges of the new information society, we should start to implement a series of new technologies to utilize natural resources from the environment and transfer them to information power which uses smaller amount of electricity. I don’t want to enter into details of the future information society but it is clear that rural areas can provide urban inhabitants with huge amounts of cultural and environmental information through digital multimedia technology via satellite or the Internet. The balance of payment is favorable to rural areas in an information society even if they have to pay the royalties for introducing patents or for Intellectual Property.
5. Considerations of R&D on future rural power delivering system

5.1. Starting from Bricolage

An advanced technology is diffused in various way. A consumer can invent unpredicted ways of manipulation of new products and if they have deeper knowledge about new appliances, they can put together and invent new applications or system technologies which were never imagined by the original inventor. This is a way of “bricolage”; the application of ready-made implements to different tasks.

For example, the generator in the engine of a car could be easily re-oriented to a wind-power electric generation system. This is one of the way to be inventive and demonstrate bricolage. We are always looking forward to finding new “Venture Businesses” but they are in our daily work.

In developed countries, the new venture business market is always expanding and there is fierce competition to get a good share of the market. Other examples of bricolage include, electronics producers who, intending differentiation of products, put photovoltaic cells on portable calculators and wrist watches. Also, the automatic power assisted bicycle was commercialized in Japan more than 5 years ago and the basic idea of this product has been newly applied in other equipment, such as pushcarts to be used at construction sites.

Additionally, the mono-cylinder fuel engine was originally invented for cars but it has been used in various agricultural machines and can be found in farmers’ yard around the world. Like these examples, the seeds for using new, renewable energy technology in diverse ways are in the minds of local users; farmers, fisherman, homemakers. By promoting local bricolage, the diffusion of new energy driven machines in agriculture or renewable energy driven fishing boats will be a symbol of economic development in rural area.

5.2. Universal service versus exclusive service

The definition of universal service is changing because of pressures from the end-users’ side. For instance, access to on-line service was started in the R&D field and was only made available to businesses and entertainment as a precious private or exclusive service. But, it became essential for those without those privileges and it is starting to be considered as an universal service.

For a long time, electrification has been considered to be a networked universal services, however we didn’t have any cost effective or competitive technology for fulfilling the isolated island demand or mountainous rural demand for electrification. In isolated environments, portability or autonomy of power delivering systems is required (see Fig.2).

As telecommunication service is changing, electric power service will be also changing.

The more ubiquitous service is required. Electric cells are available everywhere in the world. This is also one of the universal services, not a deluxe private service for a few sight-seeing tourists.

In the telecommunication field, wire-less technology has been revived by the introduction of a short range mobile phone system linked up to a long distance connection. It is realized by “hybridising” of the optical fiber network and the short range digital wireless system. The hybridisation or cooperation between major points of each system, which were competitors for a long time, is a key issue of innovation. Why not encourage cooperation between an electric power grid and geographic distributed small size power stations in rural areas?

I propose here a hybrid, packaged kinetic-electric unit like a hybrid engine system commercialised recently by Toyota Motor Company and like a seamless energy conversion system driven by the micro level power electronics technologies. Another idea, currently not available is wire-less power supplying systems using micro-wave technologies.

5.3. Self-sufficient systems versus networked systems

As you know very well, stand alone type of renewable energy delivering system such as photovoltaic cells or a wind power system is not able to fulfill the total end-users needs for energy. There are problems of stability and conviviality. Mineral based fuel systems, such as steam engines and conventional reciprocal engines are used everywhere because they use a storable supply of energy and can continue to work day and night. They are one of the driving forces of modern industrial society.

If we could connect the self-sufficient (stand alone type) renewable energy utilities, such as solar panels, wind mill etc., to some conventional fuel power generators, so that a reliable source of energy is maintained, we would achieve a highly sophisticated network system, because energy stability and the satisfactions of end users’ needs will be improved. So, I want to emphasize key-words, such as “networking”,
"cooperation" and "hybridization" of conventional systems and new systems (or technology) for advancing power delivery systems in rural areas.

6. Conclusion

The tide of globalisation and the growth of the information society favours electrification of rural areas. The rural area can be connected to others via various information networks and this asks innovative things of the electricity market. Each system requires the development of the technologies of the other, and state-of-the-art technology will become common knowledge, because of broad information diffusion and private investment seeking rapid profit making opportunities. They are tandem systems.

A sustainable electrification policy for rural areas should be discussed at the local government level to consider the end-users' needs in more detail and to bring the most cost effective private R&D activity and investment there.

There are a lot of potential energy resources in rural areas. End-users who are living in rural areas could get the best-mixed solution of new energy, transforming potential energy sources like wind and solar energy into useful, stable and convivial energy source instead of relying on energy transported from far away central power stations. This social challenge has been mainly implemented in OECD countries since early 1990s and the distance between OECD countries and developing countries is not so great.

Encouraging a cycle of communication and cooperation between producers, governments, universities and end-users (consumers) is essential to the success of introducing new energy systems in rural areas. No one knows the driving force of the new information society, but part of this driving force allows end-users the opportunity to input their desires into the information cycle, from the exclusive networking service, the private self sufficient service, the small scale universal service and to the large scale universal service.

We can enjoy a world class individual life if we apply global solutions for local problems.

"Think globally and act locally" is the motto of the School of Policy Studies, Kwansei Gakuin University.

![Fig. 1 Projected Energy Flow for 1990](image)

**Key words:**

1. Energy for electric power generation
2. Power loss in electric conversion and transmission
3. Energy loss
4. Coal-based fuel
5. Transportation sector
6. City gas and other energies
7. Household-commercial sector
8. Energy used as power
9. Industrial sector
10. Energy used as heat
11. Forms of energy used as production material
12. Industrial sector (excluding the energy sector and forms of energy used as production material)
13. Energy for producing oil products

Fig. 2 Chart of positioning various services

Exclusive service

Individual passenger car
Video tape or CDs
**Power generation for domestic use**
Personal computers
*(ordinary personal industrial goods)*

Self sufficient service

Heat service for building
Local area information service
Unscheduled chartered bus
*(new energy supply system)*
small scale public services

Universal service

Networked service

Pay TV, Video on demand
Value added network service
Internet service
*(Value added energy delivering service?)*
Large scale customer

Train, omnibus, metro-rail
Conventional energy supply service
Telephone system, fax service
*(ordinary public service domain)*
large scale social services
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