Government Policies and Promotion for Enhancing Bioenergy Adoption in Korea and USA

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Abstract

Bioenergy can be obtained from various forms of biomass such as agricultural, food processing, and municipal wastes. Recently, its importance is recognized more seriously because of its positive impacts on economic and stable energy supply and environmental sustainability.

Despite its advantages, bioenergy has not been used as much as it was expected, nor has it been developed to the level of attractive commercialization in energy market. The main reasons for the sluggish progress have been analyzed by comparing the bioenergy policies in Korea and U.S.A.

Both Korea and U.S. governments have recognized the importance of bioenergy and put in various efforts to promote the use of bioenergy. Both governments have legislated alternative energy promotion plans that support R&D, tax reduction, rewards, and low interest loans.

However, it is suggested that the bioenergy policy and plan juxtapose the financial supports (R&D, tax exemption, low interest loan, education, etc.) with strong mandates and obligations. Although imposing strong mandates prerequisites the economically attractive and feasible technologies, it can motivate and speed up more effective technology development, in turn.

In addition, the bioenergy R&D support must include studies on commercialization and marketing as well as process development. R&D on the socioeconomic effects of bioenergy should also be supported. Lastly, decision making processes for the bioenergy policy, and for alternative energy overall, must include environmental agencies for taking advantage of environmental benefits of bioenergy.

Keywords : Bioenergy, Alternative, Energy, Government policies.

Ⅰ. Introduction

Bioenergy is a gas or liquid fuel made from biodegradable materials (biomass or organic matter such as plants). Biomass encompasses a broad range which includes wood waste, wood liquors, peat, wood sludge, agricultural waste, straw, fish oils, sludge waste, municipal solid waste, landfill gases, and food processing wastes.

Globally, bioenergy is getting more attention recently as the crude oil supply from Middle East is unstable and the environmental concern increases. Bioenergy technologies use renewable biomass resources to produce an array of energy related products including electricity, liquid, solid, and gaseous fuels, heat, chemicals, and other materials. Bioenergy ranks second (to hydropower) in renewable U.S. primary energy production and accounts for three percent of the primary energy production in the United States (DOE, 2003). In Korea the proportion of bioenergy is only 0.04% of total energy supply (MCIE, 2001).

As one of renewable energy forms, bioenergy provides significant environmental and sustainability benefits compared to conventional energy. Bioenergy is a clean source energy that has a much lower environmental impact than conventional energy technologies. Also as the term, renewable energy, implies, it is replenishable unlike other sources of energy that are finite and will someday be depleted or become too expensive to use.

Another environmental advantage of bioenergy comes from the possible use of various types of wastes. Municipal, food processing, agricultural wastes, for example, can be used for bioenergy generation, and as a result, the reduction of waste and cost reduction in waste treatment are the benefits to environmental sustainability.

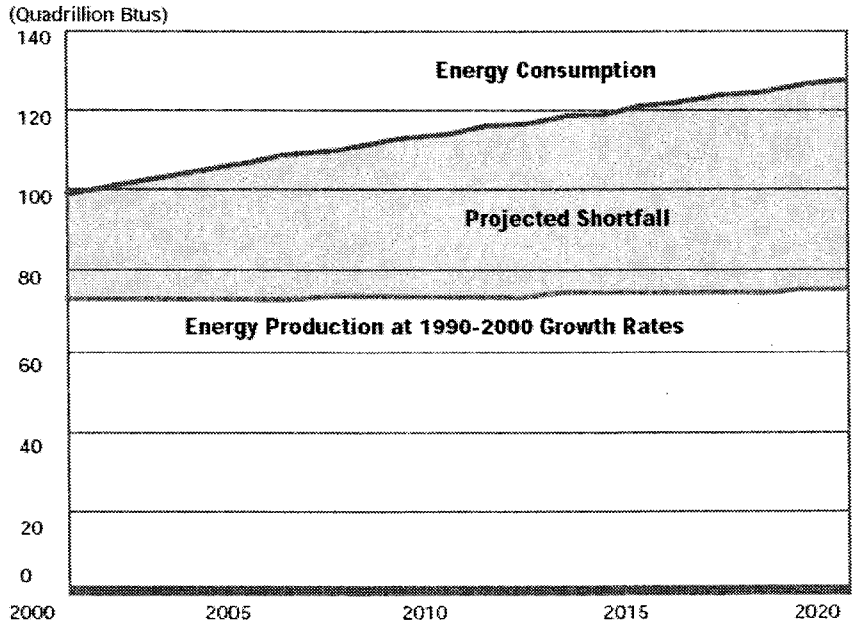
In addition, bioenergy provides excellent economic benefits. Unlike investments on costly imports, bioenergy is usually made within a country, or often in the town as the users of energy. The result is that energy dollars stay home to create jobs and fuel local economies rather than going overseas. Major characteristics of bioenergy are summarized in <Table 1> (KIER, 2004).

<Table 1> Pros and cons of bioenergy (KIER, 2004)

	Pros	Cons
Characteristics of Bioenergy	○ Contribution to reduction of green house effects. ○ Conversion of methane to CO_2. ○ High potential alternative energy reducing the dependence on foreign oils	○ Depletion of forest resources. ○ Complex biological processes of biomass.

Both Korea and U.S.A. heavily rely on imported fossil fuel, so that the economy and homeland security can be substantially affected by the stability of the foreign supplies. America in the year 2001, for example, faced the most serious energy shortage since the oil embargoes of the 1970s, which did not get better until year 2003. For U.S.A., this imbalance between the energy consumption and supply is expected to increase if the foreign oil production stays the same <Figure 1>.

<Figure 1> Growth in U.S. energy consumption is outpacing production. Over the next twenty years, growth in U.S. energy consumption will increasingly outpace U.S. energy production if production grows only at the rate of the last 10 years (National Energy Policy, 2004)



In his State of the Union speech to Congress in January 2003, President George Bush suggested a strong move toward hydrogen energy for the US economy and environment. On May 15, 2001, the U.S. Energy Independence Act (HR 1830) was introduced to ensure the energy self-sufficiency of the United States by 2011. The Act includes measures to establish a Federal Government Fuel Cell Pilot Program, Bioenergy Program, and the other alternative energy programs. According to this ambitious energy plan, 140 million dollars are to be made available for this program for the period 2002 to 2004.

Upon the introduction of the Energy Independence Bill and a couple of sects of this bill, Hydrogen and Fuel Cell Act and Bioenergy Act, which have passed recently, it is expected

that there will be more emphasis on and supports for the research and development of alternative energy forms. U.S. government is taking an enthusiastic initiative to promote the bioenergy use through various routes, whereas the efforts of Korean Government appear to have been less aggressive and narrow. In this paper, the U.S. government's efforts to enhance bioenergy as one of the alternative energy choices is reviewed from the legislative standpoint, and compared with those of Korea Government's. The paper focuses on the government regulations, acts, and mandates that have been introduced and activated for bioenergy promotion.

Ⅱ. Bioenergy Policy and Environmental Sustainability in U.S.

1. Federal & State Policies

The U.S. vision on bioenergy is clearly summarized in the report prepared by the Biomass Technical Advisory Committee established by the Biomass R&D Act of 2000 (DOE, 2003). The Advisory Committee is a group of 26 individuals from industry, academia, non-profits, and the agricultural and forestry sectors who are experts in their fields. The Committee believes that the Vision goals are technically feasible given future advances in research and development and an appropriate mix of market incentives and public policies. The benefits are summarized as follows:

- ○ National Security: Domestic bioenergy sources could help U.S. to substantially reduce dependence on petroleum.
- ○ Environmental Protection: By offsetting fossil fuel use and related emissions of nitrogen oxides, sulfur dioxides, and other pollutants, bioenergy and bio-based products will contribute to cleaner air and water. Furthermore, increased cultivation of carbon-fixing plants will help mitigate greenhouse gas emissions that contribute to global climate change. It will also provide a productive avenue for using agricultural, industrial, commercial, municipal, and forestry wastes.
- ○ Rural Economic Growth: Growth in bio-based products and bioenergy will stimulate rural development efforts in farming, forestry, and associated service industries.

Since the 1992 Energy Policy Act (EPACT92, P.S. 102-486), the first legislative attempt to curb U.S. dependence on foreign oil imports, the United States has tried, at least legislatively, to enhance all aspects of energy and fuel usage, including greenhouse gas reductions and global climate change. To date, however, the expected trends from implementing EPACT92 have not appeared. On the contrary, crude oil imports have steadily increased from an average of 6.1 million bbl/day in 1992 to an average 9.0 million bbl/day in 2002. This corresponds to 25 percent of the world's petroleum consumed by only 2 percent of the world's population.

In retrospect of the last decade's trend, it is not clear how substantial an impact the alternative energy will make within a foreseeable future. However, it is absolutely obvious that the efforts at the legislative level must be maintained in order to persistently push the government, industry, and academia forward to the development of more feasible systems. Therefore, the reintroduction of the Energy Bill as EPACT03 (H.R. 6) has a significant importance in reinforcing the incentives for renewable and other energy resources. For biomass energy and fuels, among the provisions are the elimination of the oxygenate requirements for modern gasolines, phasing out MTBE usage in motor fuels (National Energy Policy, 2004), establishment of goals for biomass-based ethanol and biodiesel consumption in motor fuels, and broadening the fuel qualifications for power generation systems fueled with biomass.

In an effort to encourage the use of bioenergy, U.S. government provides the tax incentives over 10-year period. The tax revenue of $17.1 billion was initially agreed, but the Senate amendment increased the tax revenue to $23.5 billion. The final version of EPACT03 is expected in 2004, and if enacted, the reduction of U.S. dependence on foreign energy sources is expected from 56% to 45% by 2012. The increase of bioenergy also means cleaner emissions.

The efforts have not been limited to the Congress bills and tax cuts on bioenergy. Federal agents such as the Department of Energy and state governments have initiated various acts, mandates, and supports for enhancing the bioenergy use and research and development. <Table 2> summarizes some of these efforts since 2000. Regarding the state government, Ohio was selected as a model because both the governor and senators have vehemently pursued increased use of bioenergy recently (ODOD, 2004).

<Table 2> A few examples of bioenergy related procurements in Federal and Ohio governments

Federal Efforts		
Activity	Detailed content	Related information
Biofuels Energy Independence Act (H.R. 130), 2003	Congresswoman Marcy Kaptur of Ohio has introduced a new bill that affiliates to the Energy Independence Bill.	Bill
Biomass Research and Development Act of 2000	Congress passed the bill to form advisory committee that supports the biomass research and development.	Bill
Farm Security and Rural Investment Act of 2002	The Bill allocated $75 million to USDA over six years to fund research, development, and demonstration projects under the Biomass Research and Development Act of 2000.	Research Grant
Joint Biomass Research and Development Initiative	Energy and Agriculture Departments jointly award $23 million of grant to universities, federal and state research agencies, private and non-profit organizations.	As a part of the 2002 Farm Bill.
Renewable Energy Systems and Energy Efficiency Improvements (2002 Farm Bill)	Grants to agricultural producers and rural small business. USDA $21 million.	The eligible project is: • Purchase and installation of equipment, construction or improvements. • Energy audits, permit fees, business plans, professional service fees. • Feasibility studies, or retrofitting. Grants may be used to pay up to 25% of the eligible project costs.
Executive Order 13134	Presidential order to establish a council to review and enforce the bioenergy-related policies and R7D investment.1999	• The Interagency Council on Biobased Products and Bioenergy (the "Council"). The Council shall be composed of the Secretaries of Agriculture, Commerce, Energy, and the Interior, the Administrator of the Environmental Protection Agency, the Director of the Office of Management and Budget, the Assistant to the President for Science and Technology, the Director of the National Science Foundation, the Federal Environmental Executive, and the heads of other relevant agencies as may be determined by the Co-Chairs of the Council. • The Secretary of Agriculture and the Secretary of Energy shall serve as Co-Chairs of the Council. http://www.bioproducts-bioenergy.gov/about/eo13134.asp
Ohio		
Conversion facilities tax exemption	Corporate Exemption Property Tax Exemption Sales Tax Exemption	The State of Ohio provides the tax exemption to the companies for using bioenergy.
Ethanol Investment Tax Credit	Corporate Tax Credit Personal Tax Credit	The amount of the credit equals to 50% of the amount the taxpayer invests but not to exceed $5,000 per taxpayer per plant.
Ohio Water Pollution Control Loan Fund	Direct Loans	Assistance for livestock waste disposal and reuse and assistance for biomass reuse activities.
Ohio Biomass Energy Program	Grant Funding to Commercial, Industrial, Agricultural, Utility, Government	Grant funding through the Great Lakes Regional Biomass Energy Program administered by the Coucil of Great Lakes Governors and funded by the U.S. Department of Energy, Office of Biomass Program, Biomass Energy Resources and Funding Information, Public Outreach, Statewide Collaboration.
Ohio Third Frontier Project	Ohio Department of Development. $1.1 billion grant for loans, innovation, and R&D.	Much part of the grant is used for bioenergy and fuel cell development.

2. Legislative mandates

Overall, the effort to encourage bioenergy can be divided into 5 categories:

1. Tax exemption
2. R&D grants
3. Award
4. Loans
5. Mandates

It is observed that the Federal efforts are more on establishing policies and guidelines and providing grants for R&D, whereas the state governments provide tax exemption and loans.

Although a legislative mandate for bioenergy generation seems to be a more effective way for accelerating bioenergy uses, many people are afraid of high cost of equipment and operation overburdened by the implementation of the mandates. More intensive research and development programs are still necessary to ensure the feasibility of bioenergy. Be that as it may, many states have adopted policies and mandates such as renewable energy utilization requirements or regulations that enforce the development and installation of internal renewable programs. Iowa, Illinois, Wisconsin, Pennsylvania, and Maine all offer specific mandatory programs and obligations that create an economic environment for renewable energy to grow and flourish. Fourteen states have defined renewable energy programs that mandate that utilities offer renewable energy to their entire customer base <Figure 2>.

A few examples of the mandates enacted in the local state governments are:

- ○ Iowa: Investor-owned utilities **should** purchase a combined total of 105 MW of their generation from bioenergy resources.
- ○ Iowa: All electric utilities operating in Iowa **should** offer green power options to their customers.
- ○ Illinois: The state government **should** provide rebates to owners of vehicles operating on bioethanol (E-85) or biodiesel at lest half of the year.
- ○ Illinois: Alternative Fuels Rebate Program **should** provide rebates for those who

convert an existing conventional vehicle to a bio-fuel vehicle. The rebate is 80% of the cost of converting a conventional vehicle to operate using ethanol or biodiesel.

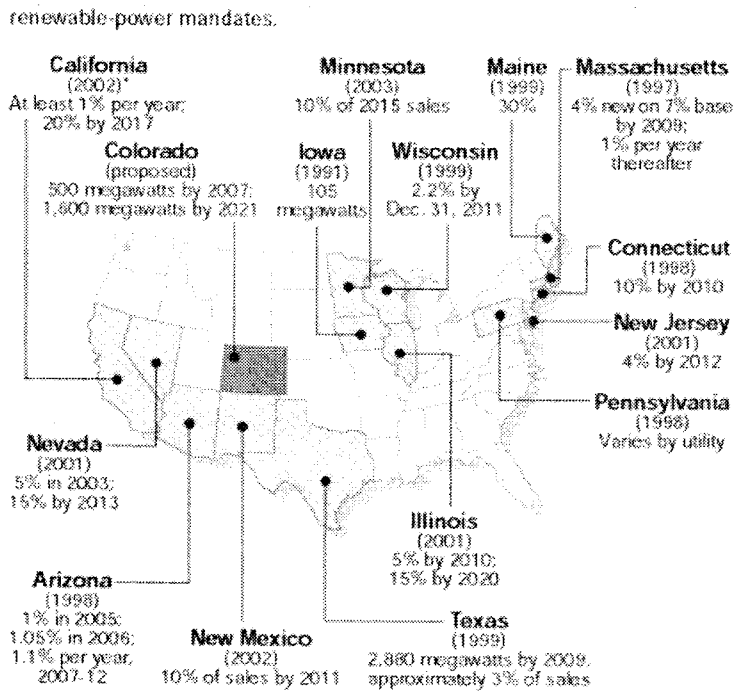
○ Illinois: The state **must** purchase bio-power for at least 5% (15% by 2020) of the electricity used by the buildings owned or operated by the government.

○ Ohio: Regulated electric distribution utilities **must** disclose yearly investments in renewable energy development.

○ Ohio: All diesel fuel purchased for state vehicles **must** show that efforts are made to purchase and use biodiesel.

○ Ohio: The state **should** operate state owned non-flexible fuel vehicles with a 10% bioenthanol blend fuel (Ohio).

<Figure 2> Renewable power mandates in 14 states: A bill requiring Renewable power generation is in the Colorado legislature. Fourteen States have passed renewable-power mandates. *Year mandates was adopted (The Denver Post, 2004)



3. Future of bioenergy policy

The total consumption of bioenergy in the United States was approximately a little above

three percent (3.34 quadrillion, 10^{15}, Btu, quads) of total U.S. energy consumption. Between 1990 and 2001, bioenergy consumption increased 25 percent - an average annual rate of 2.1 percent. Through increased encouragement and mandates from the Federal and state governments, the bioenergy consumption is projected to increase at an average annual rate of 1.8 percent over the 2000 to 2020 time period - from the current 3.3 quads to 4.7 quads in 2020. In 2020, bioenergy will meet about 3.6 percent of U.S. energy demand - a slightly higher share than the current three percent (DOE, 2002).

As shown in <Table 3>, the Energy Information Administration (EIA) projects that bioenergy will continue to account for a significant share of energy consumption in the industrial sector, reaching 8.2 percent of total industrial energy consumption in 2020. Bioenergy will play a relatively small role in electric utility generators and in transportation accounting for 0.4 percent and 0.7 percent of energy demand in those sectors respectively.

<Table 3> EIA projections for Transportation, Industrial, and Electric Generator Energy Consumption (Quadrillion Btu per year)

	2010			2020		
	Total Energy Consumption	Bioenergy Consumption	Bioenergy % of Total	Total Energy Consumption	Bioenergy Consumption	Bioenergy % of Total
- Industrial	35.5	2.7	7.6%	38.9	3.2	8.2%
- Electric Generators	42.7	0.2	0.5%	48.3	0.2	0.4%
Subtotal Power	78.2	2.9	3.7%	87.2	3.4	3.9%
Transportation	33.6	0.24	0.7%	39.5	0.28	0.7%

(Source : DOE/EIA, 2002)

III. Korea : Needs for Stronger Government Mandates

1. Current status : Sluggish growth of bioenergy market

Korea has kept up high energy consumption, and therefore, the energy policy has been set up to reduce the dependence on the primary energy. According to the Korea Institute of Energy Research survey, the supply portion of alternative energy in Korea was 1.03 % of total energy consumption in 1998 (bioenergy: 0.04 %). Although this percentage actually

had increased at the rate of 20.7% from the previous year, it is still lower than other countries pursuing more aggressive alternative energy policies. The energy supply status of 1998 in Korea is summarized in <Table 4>.

<Table 4> Korea energy supply status of 1998 (ETIS, 2003)

Total Energy		Alternative Energy		Supply proportion (%)
Usage (10^3 TOE)	Change rate from the previous year (%)	Usage (10^3 TOE)	Change rate from previous year (%)	
167,370	7.4 decrease	1.715	20.7 increase	1.03

Note that the utilization of alternative energy was slow due to the inactive investment in R&D compared to USA (74 times), Japan (27 times), England (9 times). However, in 2002, the Ministry of Commerce, Industry and Energy established a plan for rationalization of energy use. The plan set out a strategy for 1) maximizing the turnout of alternative energy development and securing reliable technology, 2) promoting alternative energy markets and support for enhancing feasibility, and 3) developing alternative energies suitable to local environment. Also planned was funding to support the cost of alternative energy use and enforce the installation of alternative energy equipment.

It is encouraging that many policies have been installed and being practiced. A few detailed examples of bioenergy promotion policies that are being practice are (MCIE, 2004, 2003);

○ Exemption on the Road traffic tax for biodiesel 20 promotion (since 2002).

○ Subsidies for Promotion of LFG Electric Power.

○ Low interest rate loan for using bioenergy (rate of 3.5%/year).

○ Increased R&D support.

2. Problems and suggestions

However, as of 1999, the alternative energy supply was 1.05% (1.901 10^3 TOE) of the total energy consumption, which is low compared to USA (4.0%), Japan (1.2%), France (4.3%), and Denmark (6.9%). The reasons for the low supply are 1) lack of interest from

industry, 2) insufficient effort to create demands, and 3) lack of competitiveness due to overestimated initial investment.

The alternative energy policy and its problems are summarized in <Table 5> based on the Alternative Energy Promotion Strategies legislated and activated in 1987. According to the plan, alternative energy will take 2% of the total energy supply in the 4th stage (2002-2006) and the total $439 million (527 billion Won) will be invested. It is encouraging to see that the bioenergy R&D is strongly supported.

<Table 5> Alternative Energy Development Plan and Pertinent Problems

	Goal	Support (proportion of alternative energy)	R&D	Problems
1st stage (1988-1991)	Establishing research infrastructure	Financial support (0.5%)	$30 million	○ Ironically the financial support to alternative energy made its marketability questionable. ○ Technology transfer into commercialization seemed to have limitation due to lack of technical evidence and low expectation over commercialization. ○ Well-secured supply on fossil fuel made alternative energy less attractive.
2nd stage (1992-1996)	Foundation for practical use	Developing demands and supplying demo units (0.6%)	$71 million	○ Commercialization turned out to be a premature request due to lack of technical background. ○ Technique for development and distribution was insufficient. ○ Pricing of alternative energy was less competitive than fossil energy.
3rd stage (1997-2001)	Developing expertise	Create markets (1.3%)	$203 million	○ The re-set goal, 1.3%, was achievable, but it was criticized of a lame approach.
4th stage (2002-2006)	Commercial-ization	Expanding the usage and supply	$323 million	○ Practical future direction - In order to strengthen the competitive price, systematic provisions are necessary for implement potential benefits. - Restructuring of energy market is necessary to enable alternative energy purchasing.

However, in order to achieve the goals set forth by the government for promoting the use of bioenergy, more aggressive and encouraging policies appear to be desirable. Mandatory rules and regulations may overburden the industry and public organizations, but

the extra cost for installing and operating bioenergy-driven power systems can be compensated by the strong financial supports such as tax exemption, rebate, etc., which are already enacted and practiced. Moreover, the mandates can spur the bioenergy R&D and the bioenergy market in more effective way to reduce the cost and increase the feasibility.

The proportion of bioenergy in the total alternative energy was a distant second to the waste energy in Korea <Table 6>. Considering the fact that major alternative energy forms in advanced industrial countries are wastes, bioenergy, and wind, the bioenergy supply in Korea is very low. It is welcomed that the Ministry of Commerce, Industry, and Energy proposed in the 2003 alternative energy development and supply policy that aimed to increase the bioenergy supply to 197 × 10^3 TOE in 2003 and 1,050 × 10^3 TOE in 2011 (MCIE, 2003).

<Table 6> Alternative energy proportions of Korea in 2002 (MCIE, 2003)

Category	Waste	Bioenergy	Solar heat	Hydro, tidal	Solar cell	Wind	Total
Proportion (%)	93.5	4.0	1.2	1.0	0.2	0.1	100

Although the available domestic biomass is estimated at 2,300,000 TOE, the actual conversion to bioenergy is no greater than 3.7% only. So far, bioethanol and biodiesel from rice hulls (no production since 2002 due to low quality problems) and methane from organic wastes have been major bioenergy forms (MCIE, 2002). Because the most important factor in bioenergy promotion is technology, and a technology is directly related to price competitiveness, techniques for effective conversion from biomass and storage will be one of the most urgent factors for bioenergy promotion. The recent technology progress has enabled an expansion of bioenergy sources to food wastes and municipal wastes. More efforts are required to bridge these techniques to commercialization and formation of market for bioenergy.

Ⅳ. Conclusions

It is without a doubt that renewable energy is a promising alternative energy for political, economical, and environmental benefits. Bioenergy is especially attractive compared to other renewable energy forms such as solar, wind, hydropower, and geothermal energies,

because of its significant potential impacts on waste reduction and environmental sustainability in general.

It is encouraging that both the Korea and U.S. governments recognize the importance of bioenergy. Currently, there are just a few differences in the status of polices and rules between the two countries, and even these differences seem getting narrowed. The major differences observed in this study are summarized in <Table 7>.

<Table 7> Major differences in bioenergy policies between Korea and U.S. governments

Approach to Bioenergy Innovation	Korea	USA
Major government decision-making processes	Ministry of Commerce, Industry, and Energy, Korea Institute of Energy Research	Congress, Department of Energy, US Department of Agriculture, NSF, US Environmental Protection Agency (EPA)
Local government activities	Not much.	Very active (See Table 1 and Figure 2) both in R&D and mandates.
Government acts and mandates	Initial stage of Acts and Mandates	Strong acts and mandates

Korea has recognized the importance of bioenergy, and has invested more than $300 million dollars mostly into R&D since 1988. However, as of 2003, it appears that the bioenergy supply is sluggish achieving low supplies of bioenergy than planned. In order to boost the bioenergy market, the government must be more selective in supporting the bioenergy research. Promising bioenergy research must start out from more practical resources such as food processing wastes and municipal wastes. Also, the research project must include a detailed and practical method for commercializing the research results. Research projects that propose innovative strategies to bridge the research lab and industry must be encouraged. In addition, evaluation of research projects must consider the socioeconomic effects of the bioenergy technology transfer on the society and economy overall as well as the feasibility of the project.

Also, more importantly, the government must take an initiative in legislating the laws and mandates that enforce the use and installation of bioenergy equipment, and actively engage in bioenergy sales and purchasing to form active bioenergy markets. Tax reduction and loans may as well expand to a level that both the industry and distributors become more eager to participate in the market. Strong mandates must be juxtaposed with feasible

technologies. It is also recommended that both Ministry of Education and the local governments adopt the legislature for public outreach and K-12 education programs to promote the recognition of bioenergy.

The United State has initiated an ambitious plan for enhancing the use of bioenergy. Both the Federal and State governments have been active in supporting research and development, and providing free grants and low-interest loans for installation and improvement of bioenergy processes. Most of all, the both governments are busy working side by side to make regulations, guidelines, and mandates to encourage and enforce the local government and industries to use more bioenergy. For Korea, the level of interaction between the central and local governments on the bioenergy promotion policy is not intensely investigated in this study, but it is obvious that closer collaboration is necessary to optimize the result of the bioenergy promotion policy.

All of these efforts will not bear fruit within a foreseeable future unless more reliable and economically feasible bioenergy processes are developed. Therefore, strong support of R&D appears to be the most urgent approach to a successful bioenergy revolution. In this regard, it is encouraging to see that the Korean Government is putting considerable efforts in the alternative energy R & D (MCIE, 2002). It is reported that Korea is still catching up rapidly with the advanced bioenergy technology with a 3-10 year gap, and is 1-2 levels below from commercialization compared to the cutting edge countries. More financial benefits and carefully selected mandates may help accelerate the bioenergy R&D and uses.

In addition, it must be noted that there are significant opportunities for bioenergy to contribute to a future hydrogen economy. Government programs involved in bioenergy research should coordinate closely with hydrogen research programs to identify and develop opportunities for using bioenergy to produce hydrogen. Likewise, environmental policies and regulations must be simultaneously considered when government mandates on bioenergy are introduced and activated. Therefore, it is encouraging that, in U.S.A., U.S. EPA is playing an important role in introducing and enforcing the bioenergy mandates.

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