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Taiwan's Road to Success in Using Bioenergy: An RD&D Oriented Thinking Approach to the Future

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Biomass energy or bioenergy, in 2015, was the fourth largest source of the total primary energy supply (TPES) in the world[1]. According to *Renewable Energy Development Act* in Taiwan, the biomass energy (*Article 3.2*) is defined as "energy produced by utilizing or processing the agricultural and forest plants, biogas, and domestic organic waste, etc."[2] The utilization of the domestic general waste and general industrial waste (listed in *Article 3.1*) should also be catalogued into biomass energy.

In Taiwan, the installed capacity of biomass energy was the third largest amount of the total installed capacity of renewable energy after the conventional hydro power and the solar photovoltaic energy in 2016[3]. Because of its higher capacity factor[4] biomass power generation was the second largest in terms of fuels of total renewable energy power generation after the conventional hydro power.[5] . However, compared to the solar PV and wind power, the increase rate of the biomass energy installed capacity is very slow since 1998. Currently, it can be found that around 86.58% [6] of the biomass energy installed capacity was catalogued into waste-to-energy from 25 incinerators at a stable level. Therefore, the promotion of biomass energy through the utilization of agricultural and forestry waste in Taiwan should be accelerated.

To promote biomass energy comprehensively, supply, quality, and cost are the three important pillars[7] to provide support toward success on using bioenergy (see Fig. 1[8]). The first pillar is supply which means an abundant supply of biomass feedstock. To produce bioenergy, there is a need to convert the biomass feedstock into energy through thermochemical reactions or biochemical reactions. Only sufficient feedstock can keep the

[1] IEA (2017) Key World Energy Statistics 2017, IEA, Paris.
[2] Renewable Energy Development Act, Taiwan (2009).
[3] Bureau of Energy (2017) Energy Statistics Handbook 2016, Bureau of Energy, MOEA, Taipei, Taiwan.
[4] Strauss, W. (2017) Wood Pellets: How a Simple Solid Fuel is an Important Component of a Pathway to a More Decarbonized Future, APEC Workshop on Bio-pellet Production, Handling and Energy Utilization, Tokyo.
[5] *Supra note 3.*
[6] *Supra note* 2.
[7] Wu, K.-T. (2008) Understand the Biomass Energy, Physics Bimonthly, 30(4), 377-388. (*in Chinese*)
[8] Wu, K.-T. (2005) Personal handouts for renewable energy and biomass energy lectures.

sustainable generation of bioenergy. According to statistics in 2011, except for municipal wastes and general industrial wastes, the bioenergy potential in Taiwan was estimated about 15,042 TJ/year.[9] This was done through the employment of agricultural and forest solid residues. In addition, the bioenergy potential for utilizing livestock and poultry manure for biogas production was estimated to be about 6,905.5 TJ/year[10]. The amount of the biomass feedstock should be enough to generate biopower increasingly for utilization in Taiwan.

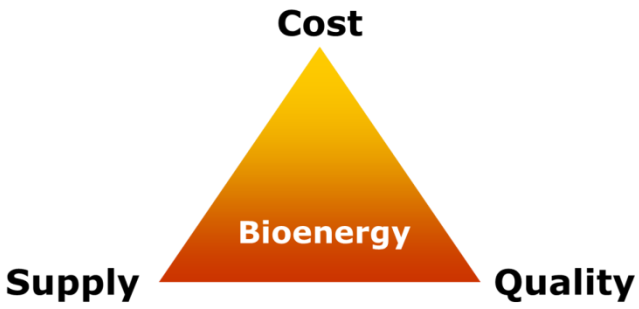

Fig. 1. Three pillars toward success on using bioenergy.[8]

The second pillar is quality which means producing the high quality bioenergy to meet the criteria for utilization. The bioenergy quality is the quality characteristics of bioenergy that is acceptable to users. For example, some sewage sludge with higher ash contents is difficult to be used in producing higher caloric bioenergy, e.g., solid fuel, liquid oil, etc.

The third pillar is cost. Because costs of the most renewable energy remain high, proposed incentives are unavoidable. The cost for producing biomass energy is not only for conversion facilities, but also for the feedstock. Most people always figure that the biomass feedstock is free. Unfortunately, it is not. Moreover, the cost of the collection and transportation of the scatter biomass feedstock to the utilization site is much expensive. Therefore, in Taiwan, although the feed-in tariff (FIT) for electricity generated from the solid biomass/waste has been set as NT$ 3.8945/kWh in 2018[11], currently it is difficult to construct a biomass power plant in Taiwan to operate for 20 years due to the low FIT. Without FIT or converted into energy, solid biomass/waste still needs to be disposed of. The cost for solid biomass/waste treatment including collection and transportation is the external cost. It is suggested that the external cost should be added into the FIT. Nevertheless, the public utilities, e.g., incinerators, which have received the subsidies for facilities should not apply to the revised FIT.

It is also found that the policies, measures, and instruments would affect the FIT establishment, even bioenergy promotion. Consequently, the policies, measures, and instruments should be the core within three pillars, like the cement filled in between three columns (pillars). Afterwards, the foundation of bioenergy application will be much strong for supporting bioenergy promotion.

As mentioned above, the capacity factor of biomass energy is quite high, up to 79%, compared to the solar PV (16%) and wind power (28%)[12]. Thus, promotion of bioenergy in Taiwan should be an important task to increase the utilization of renewable energy.

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[9] Chyang, C. S. (2011) Evaluation of Bioresource Information for Decentralized Bioenergy and Establishment of Pretreatment, Environmental Protection Administration, Taipei, Taiwan. (*in Chinese*)

[10] *Ibid*.

[11] Bureau of Energy (2018) Feed-in Tariff for Electricity Generated from Renewable Energy and Its Calculation Formula in 2018, Taipei, Taiwan.

[12] *Supra note* 5.

In conclusion, constructing three pillars, supply, quality, and cost with the policies, measures, and instruments as the core is an approach for thinking about the future using RD&D orientations for promoting biomass energy in Taiwan.

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