From Waste to Energy - Applicationof Renewable Energy in Sewage Treatment Facilities

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Our Mission

With the mission of improving drainage services in a cost effective and environmental responsible manner, the Drainage Services Department (DSD) has been promoting energy efficiency via two approaches, namely implementing various energy saving measures, and making use of renewable energy in its sewage treatment works (STWs) and sewage/stormwater pumping stations. In particular, several renewable energy initiatives have been studied and implemented over the past years. For instance, DSD has progressively installed 5 combined heat and power (CHP) and 1 micro-turbine plants in its STWs since 2006 for capturing the energy in biogas which is produced as a by-product in the sewage sludge treatment process. At present, the total installed capacity of renewable energy systems in DSD is around 12 MW and the equivalent energy saved by the systems is over 29 million kWh per annum.

Application of Biogas Generation and Combined Heat and Power Technologies

2. Currently, around 93 percent of the some 7.2 million people in Hong Kong are served by public sewers, resulting in more than 2.8 million cubic meters of waste water being collected and treated to different levels (ranging from primary, chemically enhanced primary, secondary to tertiary treatment) each day. About 900 tons of treated sewage sludge, or biosolids, are produced every day from DSD's STWs. Biosolids have a high calorific value, and typically, one kilogram of dry biosolids contains about 18,000 kilojoules. Its energy content is approximately 40% of that for gasoline. Biosolids are clearly a valuable renewable energy source.

3. DSD has adopted the anaerobic digestion process for treatment of biosolids at its four major regional secondary STWs. With the use of CHP/micro-turbine plants for co-generation, biogas produced from the anaerobic digesters is largely transformed into useful electricity and heat energy. The CHP plants installed in DSD's STWs are all running on reciprocating engines. From an engineering point of view, this kind of engines has the merits of quick starting and good part-load efficiencies.

4. As shown in Figure 1 below, biogas generated in sludge digesters is first transferred to and stored in biogas holders. After desulphurization and moisture removal, the purified biogas is fed at a constant pressure into the CHP plant. The energy stored in the biogas is then converted into thermal energy and mechanical energy which drives a synchronous generator for producing electricity to meet part of the power demand of the STW, whereas the heat recovered from the electricity generation process for maintaining the sludge inside the digester at a temperature of about 35 °C, for maintaining the performance of the digestion process.

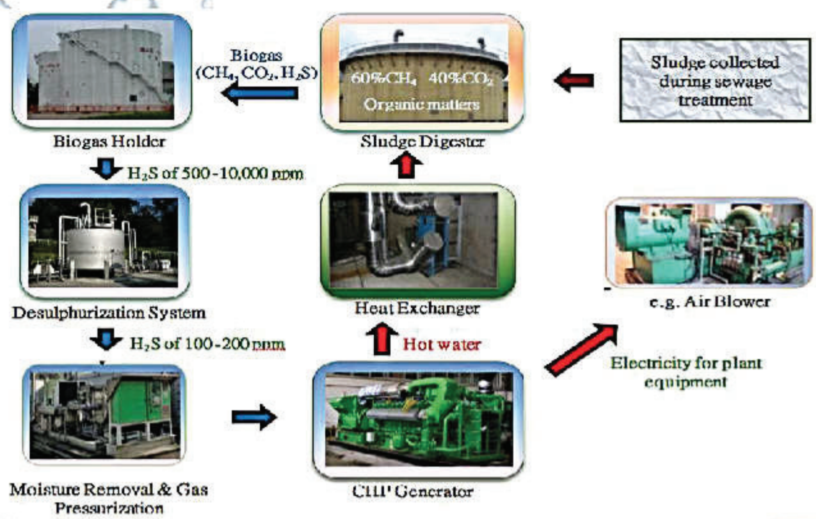

Figure 1: CHP system flow diagram

5. The first CHP generator in DSD was commissioned in 2006. It has a capacity of 330kW. Between 2006 and 2014, four more CHP plants and a micro-turbine generator were installed, bringing the total capacity to 3,650 kW. The graph in Figure 2 presents the associated timeline of installation. All CHP plants in DSD are now operating in on-grid configuration (i.e. connected to operate in parallel with the power supply grid). Notably, the CHP plant in one of DSD's secondary STWs, with a capacity of 1.4 MW, is the largest high-voltage grid-connected generating unit operating in Hong Kong.

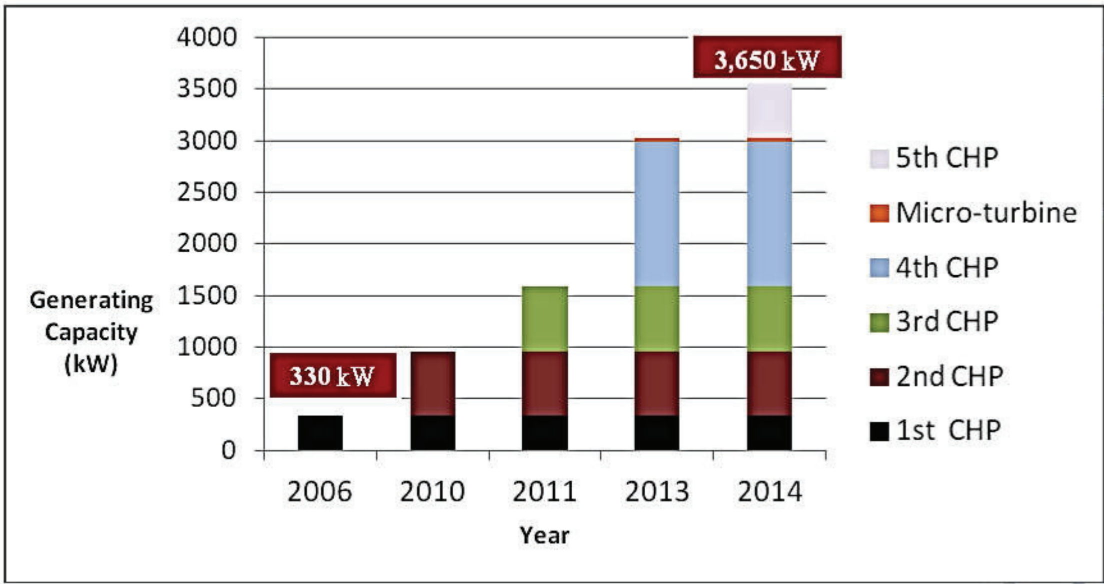

Figure 2: Timeline of installation of CHP plants and micro-turbine generator in DSD

6. In 2014, the equivalent energy recovered from use of biogas in DSD's STWs was more than 28 million kWh, which is equivalent to the annual electricity consumption of some 3,100 four-member families and reduction of emission of almost 20,000 tons of CO_2.

7. DSD's CHP systems did not get implemented without meeting some challenges. For example, if a CHP generator serves to power equipment that constitutes a large portion of electricity load (e.g. effluent pumps), the on-off switching of the equipment sometimes cause nuisance tripping of the generator. This is because the generator is unable to reduce its operating frequency instantaneously and its protective device is thereby triggered. This accordingly causes temporary shutdown of the generator. A large pool of loading can help modulate the impact of switching of a single piece of equipment. As far as heating load is concerned, given that the sludge digesters in STWs require thermal energy for maintaining its optimum digestion temperature of some 35°C, the large amount of heat captured by CHP generators can perfectly be capitalized to heat up the sludge in winter days. However, in summer days, as the digesters do not need such a large amount of thermal energy, the heat generated by the CHP generators may not be able to be fully utilized and better utilization is now being explored, such as the use of tri-generation.

8. To enhance the utilization of the biogas generated, which is on the rise, DSD is planning to install additional CHP generation systems in its STWs.

Looking Ahead

9. DSD will continue to keep abreast of the latest development in energy saving technologies and renewable energy utilization, and to strive to reduce energy consumption as well as greenhouse gas emission in the course of its operation. It is envisaged that new technologies that will emerge in the not too far distant future will help further enhance the performance of the systems that utilize renewable energy, whereby providing even more contributions to sustainable development.

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