IEAGHG Information Paper 2016-IP43: Waste Power CCU Projects in Japan

A project to capture CO_2 from a waste power plant and to sale the captured CO_2 to alga cultivation business was initiated in a Japan's small city Saga in August 2016. The CCU project receives public grant from the Ministry of the Environment (MOE) as the ministry sees waste power plants as a promising potential CO_2 source for CCUS. Around 80% of Japan's municipal solid waste is incinerated and there are more than 300 waste power plants in operation across Japan[1].

This note is to summarize the CCU project and its previous smaller project, based mainly on a presentation made by a Saga municipal official in a GCCSI meeting held in Tokyo on 24 October 2016.

1. Background

Saga City is a small city, located in northern part of Kyushu Island in Japan (Fig.1). The city experienced municipal merger in 2005 and its current population is around 230,000.

The former Saga municipal government built a 4.5 MW waste power plant in Takagise town in 2003. The plant is capable of incinerating municipal solid waste of 300 t per day, 60 to 70% of which are biomass-derived, with CO_2 emissions of 220 t per day. It took seven years after the completion of the municipal merger in 2005 until the plant began to receive waste from outside of the old Saga-City area due to opposition from local people in Takagise town. The new municipal government, therefore, wanted to improve the local perception of the power plant and attempted to stimulate local economy by promoting the use of CO_2 captured at the plant. In 2014, Saga City was designated as "a biomass industry city" jointly by seven ministries, including the cabinet office, MOE and METI.

Fig. 1 Location of Saga City

Fig.2 Waste Power Plant in Takagise Town (Source: Toshiba web site[2])

[1] Japan Environmental Sanitation Center et al. (2014), "The Future of Waste Power Plants" (in Japanese), http://www.jesc.or.jp/Portals/0/images/activity/pdf/gomihatsuden_houkokusyo.pdf

[2] https://www.toshiba.co.jp/thermal-hydro/thermal/products/ccs/biomass.htm (in Japanese)

2. 10 kgpd Demonstration

In 2013, the Saga municipal government, in conjunction with Toshiba, Kyushu Electric Power, and Ebara Environmental Plant, started a two-year demonstration project to capture CO_2 at the waste power plant and to use the captured CO_2 in a plant factory. Toshiba built a 10 kg-CO_2 per day capture plant with an amine-based post-combustion capture technology (Fig. 3). Power and heat for the capture system is supplied from the waste power plant. They examined the performance of the capture plant, the composition of captured CO_2 stream and capture costs.

They used the captured CO_2, concentration of which is more than 99.9%, to maintain CO_2 concentration at a 1,000 ppm level in a newly-built plant factory for the demonstration. In the factory, leaf vegetable was grown by hydroponic culture. The demonstration concluded that leaf vegetable in the environment of 1,000 ppm-CO_2 grew 50% more in weight and that the products didn't contain any hazardous substances. The project was completed with 8,000-hour operation in March 2015.

Fig. 3 10kgpd Capture Plant (Source: Toshiba web site[3])

3. 10 tpd Commercial Project

Building on the 10 kg-CO_2/d demonstration project, the municipal government commissioned Toshiba to build a 10t-CO_2 per day capture plant for the waste power plant (Fig. 4) and started the sales of the captured CO_2 to an entrepreneurial venture for their alga cultivation business in August 2016. The CO_2 is transported in a gaseous phase via a 200 m pipeline to the 2 ha cultivation facility. The alga to be cultivated is Haematococcus, which produces Astaxanthin, raw materials for cosmetics and nutritional supplement. The CO_2 supply is 2 to 3 t-CO_2 per day at present and there is an extension plan of the cultivation

[3] https://www.toshiba.co.jp/thermal-hydro/thermal/products/ccs/biomass.htm (in Japanese)

facility to 28 ha. There are 40 to 50 workers at the facility, 30 out of which are locally hired.

The capex is 1.45 billion Yen (~US$14 million) and the project receives a grant of 500 million Yen (~US$4.8 million) from the Ministry of the Environment. Excluding the grant and power and heat supply from the power plant in a cost calculation, they conclude that the levelized CO_2 supply costs is around half of a market price of 60 Yen (~57 cents) per tonne of CO_2. The municipal government has no intention to generate direct profit through the project but expects new businesses to come to the city, resulting in increase in their tax revenue and job opportunities for the local community.

There are a couple of other plans in CO_2 use: plant factories and cultivation of Euglena, which produces biofuel for aviation. A pre-study for Euglena cultivation includes the use of sewage processed water, which reveals a side benefit – reduction of nitrogen and phosphorus in the treated water.

Fig. 4 10 tpd Capture Plant (Source: Toshiba web site[4])

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[4] http://www.toshiba.co.jp/about/press/2016_08/pr1001.htm?uid=20160810-4479e