Potential for Renewable Energy's Application for Heating in the Industrial Sector – A Case Study of Selected APEC Economies

By Sichao Kan, Yoshiaki Shibata, Alexey Kabalinskiy, and Cecilia Tam

INTRODUCTION

Industrial sector is a major source of carbon emissions. According to the International Energy Agency (IEA), the industrial cumulative CO_2 emissions from 2015 to 2050 is the highest (compared to power, transport, buildings, agriculture, and other transformation) in its 2°C scenario (global temperature rise below 2°C above pre-industrial levels) (IEA, 2016a). Direct fossil fuel combustion to meet the heating demand from various industrial processes is the largest cause of industrial carbon emissions. Unlike the decarbonisation of power sector, which is well under way in recent years, the mitigation of industrial carbon emissions is a much more difficult task. While, a higher target was set in the Paris Agreement dealing with global climate change, by keeping temperature rise "well below 2°C" compared with the previous "below 2°C". To achieve that goal further actions, including more efforts on carbon reductions from the industry sector, are required.

Sichao Kan and Yoshaike Shibata are researchers at The Institute of Energy Economics, Tokyo, Japan, while Alexey Kabalinskiy and Cecilia Tam are with the Asia Pacific Energy Research Center, Japan. Corresponding author: Sichao Kan (kan.sichao@tky.ieej.or.jp).

In the APEC region, more than 71% of industrial final energy consumption is for non-electricity purpose (IEA, 2016b). Therefore, besides Carbon Capture and Sequestration (CCS), to mitigate the industrial carbon emissions, fossil fuel combustion has to be reduced. This can be achieved by energy efficiency improvements, switching to electricity (and decarbonizing the power system) for meeting heating demand, as well as replacing fossil fuels by renewables.

This paper is looking into the potential of renewable energies' application for heating purposes in the industrial sector in selected APEC economies (Chile, People's Republic of China, Japan, New Zealand, Republic of the Philippines, Russia, Thailand, and the United States). The study in this paper serves as support for the Asia Pacific Energy Research Center (APERC)'s APEC Energy Demand and Supply Outlook 7th Edition.

METHOD

In the industry sector most of the heating demand is for process heating. Applications of process heating are diverse and require different working temperatures. According to IEA's categorization, heating demand below 100°C is referred to as the low temperature (LT) range, heating demand from 100°C to 400°C is in the medium temperature (MT) range, and heating application at the temperature higher than 400°C is categorized as high temperature (HT) heat demand. Solar, geothermal (In this study only Ground Source Heat Pump (GSHP) technology was selected as the representing technology for geothermal. However, it should be noted that not all APEC economies include GSHP in their RE policy), and biomass are the options that can provide industrial process heat. However, renewable technologies that are capable to meet high temperature heat demand are limited. To simplify calculation this study focuses on renewable options that are relevant to most of the APEC economies and industry subsectors that are promising for renewable energy heat. A screening process was taken out to determine the technologies and subsectors. The result is shown in Table 1.

	Geothermal (HP or thermal water)			Solar thermal			Biomass		
	LT	MT	HT	LT	MT	HT	LT	MT	HT
Iron and steel	•			•			•	•	
Chemical and petrochemical	•			•			•	•	•
Non-metallic minerals	•			•			•	•	•
Machinery	•			•			•	•	•
Food and tobacco	•			•			•	•	
Paper, pulp and printing	•			•			•	•	•
Non-specified (industry)	•			•			•	•	•

Table 1 Renewable heat technology and industrial sub-sector matching
Source: Authors

The calculation process is comprised of 3 modules: the heat demand profile module, the renewable resource supply potential module, and the renewable heat potential determination module. In the heat demand profile module, useful heat demand from each temperature range in each industrial sub-sector was estimated for all the selected APEC economies. In the supply potential module, the potential of solar thermal, GSHP, and biomass was assessed by considering the constraints like available area in the factory compound, feedstock potential, and so on. In the renewable heat potential determination module, the potential of renewable en-

ergies' application for heating is determined by the smaller of two: the useful heat demand and the renewable energies' supply potential. However, since GSHP, solar thermal, and biomass are all suitable for providing heat for LT applications priorities were assigned to the options based on their levelised heat supply cost. Actually one of the key components in the renewable heat potential determination module is the calculation of the levelized heat supply cost.

RESULTS AND CONCLUSIONS

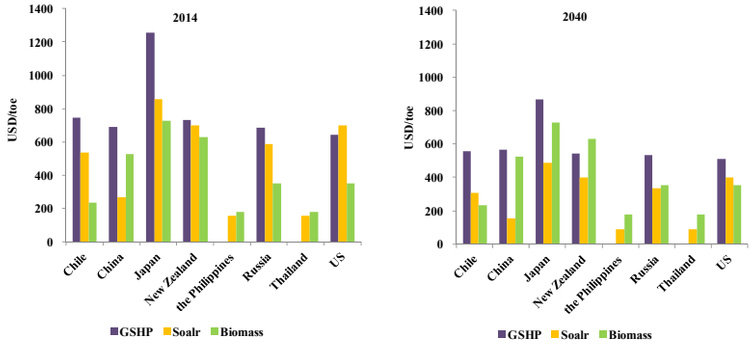

Fig.1 Levelised heat supply cost of the three renewable heat supply options
Source: Authors' estimations

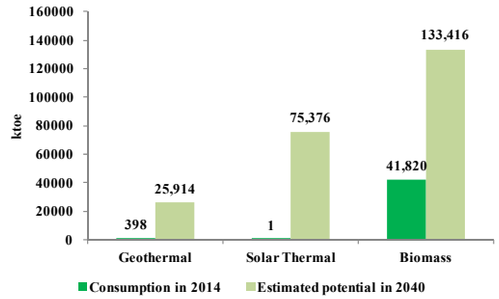

Fig.2 Total renewable energy consumption for heat in all the selected industry subsectors in all the economies in 2014 and potential in 2040 by energy source
Source: IEA, 2016b and author's estimation

In the 8 selected APEC economies, renewable energies are already being utilized for heating in the industry sector. The Food and tobacco subsector, and the Paper, pulp and printing subsector are especially noticeable for renewable heat deployment. And these two subsectors are promising for renewable heat in the future, with potentials estimated to be 42,012ktoe for the Food and tobacco subsector and 49,110ktoe for the Paper, pulp and printing subsector in year 2040. Besides, Chemical and petrochemical subsector is expected be the subsector with the highest potential for renewable energy heat in 2040 given the facts that the subsector is expected to see substantial energy demand growth over the projection period and that low temperature heat demand, which could be supplied by all the renewable options, constitutes more than a third of the subsector's total heat demand.

Among the 8 economies, United States and Thailand have the largest renewable consumption for heat in their industrial sectors. When looking at the renewable heat's share in total final energy demand in the selected subsectors, Chile, Thailand, and the Philippines come as the front runner at the moment. Although the renewable energy consumption for heat in the People's Republic of China is negligible given its huge industrial energy demand, the potential for renewable energies' application for heating, 95,229ktoe in 2040 is estimated to be the largest among the economies. United States has the second largest renewable heat potential for industry use; the potential in 2040 is estimated to be 83,876ktoe, about 3 times of its current industrial renewable consumption for heat.

At present, biomass is the most important renewable option for meeting industrial heat demand and it is expected to remain such over the projection period. In 2040, biomass is supposed to be the renewable energy option with the largest potential for providing heat in the industrial sector. Biomass is suitable for meeting heat demand in different temperature ranges and the utilization of biomass require less change to the industrial facilities. Besides, in economies with abundant biomass supply, like the United States, levelised cost of heat supply of biomass is the lowest among the 3 options. The next promising renewable option for industrial heat is solar thermal despite the fact that its consumption in 2014 in the industry sectors is only 1 ktoe. Although solar thermal is suitable only for low temperature, its cost is expected to decline in the future, making it the most cost competitive renewable option for low temperature industrial heat supply in 2040 in many economies.

Reference

IEA (2016a): "Energy Climate Change and Environment: 2016 Insight".
IEA (2016b): World Energy Statistics 2016.
Asia Pacific Energy Research Center (APERC) (2016): APEC Energy Demand and Supply Outlook 6th Edition.