Project Title: EXHAUST AIR / WIND ENERGY RECOVERY SYSTEM

Project Leader: Engr. Dr. Chong Wen Tong MIET
Contact: Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, MALAYSIA.
E-mail: chong_wentong@um.edu.my
Tel/Fax: +603-7235038/+603-7967531

Co-researcher:
Assoc. Prof. Ir. Dr. Hew Wool Ping
Dr. Ahmad Badarudin Bin Mohamad Badry
Mr. Poh Sin Chew
Mr. Oon Cheen Sean
Mr. Ahmad Fazlizan Bin Abdullah
Mr. Mohammad Sajad Naghavi

Malaysia experiences low wind speed throughout the year (free-stream wind speed, < 4 m/s for more than 90% of total wind hours). Thus, extracting wind energy by using conventional wind turbines in this condition would not be suitable. However, wind energy technology has developed rapidly over the decades; an innovative idea on harnessing wind energy from unnatural wind resources may be one of the answers to generate electricity.

Cooling towers are heat removal devices used to transfer waste heat to the atmosphere; large office buildings, hospitals and schools typically install one or more cooling towers for building ventilation system. Mechatronic draft cooling towers are the most common cooling towers in Malaysia. This type of cooling tower relies on power-driven fans to draw or force the air through the tower. Wind speeds of up to 18 m/s is recorded at a distance of 0.3 meter above the outlet of the cooling tower, which is preferable for generating electricity.

A vertical axis wind turbine (VAWT) with an enclosure is mounted above the outlet of a cooling tower to harness the wind energy for electricity generation. The VAWT is positioned at a specific area and distance at the outlet of the exhaust air source to avoid negative impact on the performance of the exhaust air system whilst capturing more air. The design can be either in the horizontal or vertical direction. To capture the wind exhausted from the bottom (or top), the system can be installed horizontally with supporting structure at both ends of the power-transmission shaft with generator at one side and a bearing at the other side. If the exhaust air is blowing from side or wall, the system can be either horizontal or vertical. The generator can be mounted for vertical installation of the system.

The implementation of the shrouded VAWT on the outlet of cooling towers can recover a portion of the unused exhaust air for electricity generation. The enclosure design is optimized to create a venturi effect and guide the wind-stream to interact with the wind turbine blades. Both the outer plates are arrayed at a specific angle to act as a diffuser. The concern on safety is minimized by mounting the turbine inside an enclosure; a mesh can also be used to cover the enclosure (to avoid bird strike problem and danger caused by blade failure).

From the initial testing done on the small scale model of a cooling tower (5-bladed H-rotor of 0.3 meter in diameter); when the wind turbine is spinning on top of the exhaust air outlet, there are no measurable differences in the air intake speed (1.6 - 1.8 m/s) and current consumption of the power-driven fan (0.39 Ampere). In addition, the enclosure significantly improves the wind turbine rotational speed from 115 rpm to 150 rpm. The electricity generated from this micro wind generation system can be utilized for commercial purposes or fed into the electricity grid. Assuming a 2 meters diameter cooling tower requiring 7.5 kW power for 16 hours operation, 131.4 GWh/year of power consumption will be utilized to operate 3000 similar units of cooling tower. This amount can be reduced by 13% with the proposed exhaust air and wind energy recovery system, which is equivalent to 17.1 GWh/year.