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OTEC: The promising renewable energy in Sabah, Malaysia

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***Abstract*— Fossil fuels are the major energy source for electricity in Malaysia. Considering the issues related to energy security and the severity of climate change it is imperative to explore alternative and sustainable energy sources. One such alternative that can be explored as a solution is Ocean Thermal Energy Conversion (OTEC). OTEC is a renewable energy source that generates electricity from the thermal gradient between the surface and the deep seawater. The optimal condition for implementing OTEC technology is a temperature difference of at least 20°C between the surface and the deep seawater in the tropical and sub-tropic regions. Malaysia as a tropical country possess the ideal condition for OTEC. Aside from generating a base energy supply, an OTEC operating plant can be diversified to produce fresh water and integrate deep seawater technologies such as marine cultures, agriculture, and air-conditioning. Hence, OTEC technology can contribute to the UN's Sustainable Development Goals (SDGs) by addressing global problems, including clean energy, freshwater production, and food security. This paper discusses the overview of OTEC technology and the present status of OTEC development in Malaysia. The authors hope that this review will provide useful insights on the ongoing projects and aspiration of materializing OTEC in Malaysia in the near future.**

Keywords—OTEC, clean energy, sustainability, Sabah, UTM-OTEC

I. INTRODUCTION

Fossil fuels are the major energy source for electricity in Malaysia. The ramifications of this source especially its carbon footprint which contributes to global warming have been of great concern. In response to worsening global warming and the aspiration of achieving carbon neutrality by 2050 for sustainable development, Malaysia is committed to energy transition by implementing renewable energy (RE) technologies. The government aims to achieve a 20% renewable energy capacity mix by 2025 [1]. Renewable energy is generated from natural resources that are constantly replenished. For example, solar energy, wind energy, ocean energy, hydropower, and bioenergy. Ocean Thermal Energy Conversion (OTEC) is a RE source that generates electricity from the thermal gradient between the surface and the deep seawater. Oceans are the world's largest solar energy collectors, as they cover two-thirds of the Earth's surface. The surface of the ocean is the warmest with most of the thermal energy absorbed from the sun being stored. These surface layers of the oceans do not mix easily with the deeper waters; thus, the temperature progressively drops as depth increases. The temperature differential in ocean water can be harnessed to power a thermal device, generating work that is subsequently converted into electricity [2]. For OTEC to work effectively, a minimum temperature difference of 20°C is required, which exists in the tropical and sub-tropical areas [3].

Malaysia is a tropical country located near to equator, and thus is exposed to high temperatures with solar radiation. The largest ocean around Malaysia is the South China Sea, where the potential of OTEC can be harnessed from the warm surface water and the deep cold water at a depth of about 700 m, off the Sabah Trough [4]. A marine survey conducted from 2006 to 2008 showed Malaysia has high OTEC potential with warm surface water (27°C) and deep cold-water troughs (4°C), beyond 1200 m water in the Sabah and Sarawak regions [4]. Due to the characteristics of the high specific heat of water, ocean surface temperature does not change during the night. Unlike solar and wind energy plants that are dependent on weather, an OTEC plant can generate electricity at any given time. Hence, an OTEC plant can provide stable and continuous energy 24/7 with the capacity factor of about 95% [5]. The potential of OTEC in the world is estimated to be 8-10 terawatts (TW) [6,7]. In Malaysia, the total OTEC potential is postulated to be at least 26, 000 MW [8]. This huge OTEC capacity in Malaysia is comparable with other tropical and subtropical countries such as Fiji, the Philippines, and Nauru Island [9]. Interest in OTEC development in Malaysia started after oceanographic surveys of Malaysian waters showed high OTEC potential with very deep cold-water troughs and warm surface water. Since then, the activities relating to OTEC policy, advancement, and promotions have been accelerated [4]. In addition, several research studies have been conducted to evaluate ocean profiles [9-10], performance analysis for OTEC plant deployment [4,10-12], and biofouling assessment [13]. This paper presents an overview of OTEC technology, based on its principle and current development around the world, economy evaluation and the potential environmental effect. The remainder of the paper focuses on the current OTEC projects in Malaysia. The authors hope that this paper will provide insights of OTEC potential development in Malaysia for those intended to explore and invest OTEC projects in Malaysia.

II. PRINCIPAL OF OTEC

The OTEC can be categorised into three different systems: closed-cycle, open-cycle, and hybrid-cycle.

A. *Closed-Cycle*

Closed-systems use low boiling point working fluids such as ammonia and freon (R717 or R22) [14]. Due to the lower boiling point, these fluids are preferred as working fluid for efficiently utilizing the modest temperature differences available in ocean waters. Closed-cycle operates based on heating and vaporising a working liquid (in the heat exchanger) using warm water as shown in Figure 1. Additionally, pressure builds up in this working fluid, forcing it to evaporate and the expanding vapour passes through a heat engine, such as a generator or turbine generating electricity. In another heat exchanger, the steam would cool down upon interacting with cold water that is pumped from the deep-sea water and condensed back into a liquid and the cycle is repeated [15]. The efficiency of a closed-cycle depends on the difference between the warm surface seawater and cold deep water.

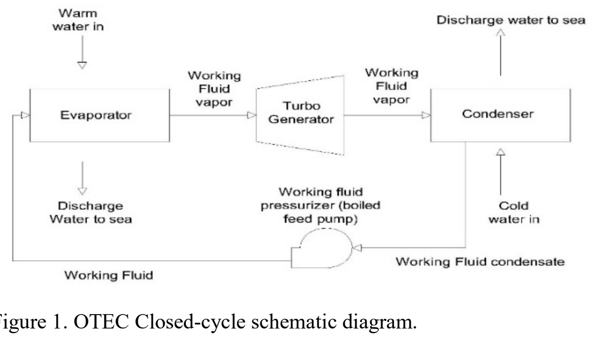

Figure 1. OTEC Closed-cycle schematic diagram.

B. *Open Cycle*

The temperature difference between warm surface seawater and cold deep seawater can produce not only electricity but desalinated water by using an open-cycle in OTEC system. The important operations in an open-cycle system are vacuum and pump. Figure 2 shows the warm surface seawater is pumped first into a low-pressure vacuum chamber. The reduced pressure in this chamber operates between 1 and 3% of the atmospheric pressure which allows the warm seawater to be at lower temperature than normal, thus turning it into vapour [16]. The vapour passes through a low-pressure turbine which is connected to a generator and produce electricity. It is worth noting that, vapour is free of salt and other impurities because only freshwater vaporizes and salt will be left behind. After passing a turbine, vapours are channelled into a condenser, where the condensation of vapour into liquid take place after getting into contact with the cold deep seawater, producing desalinated water. Open-cycle system is environment friendly as it produces clean energy without carbon emission however the system's efficiency is generally lower compared to close-cycle due to the small temperature gradients.

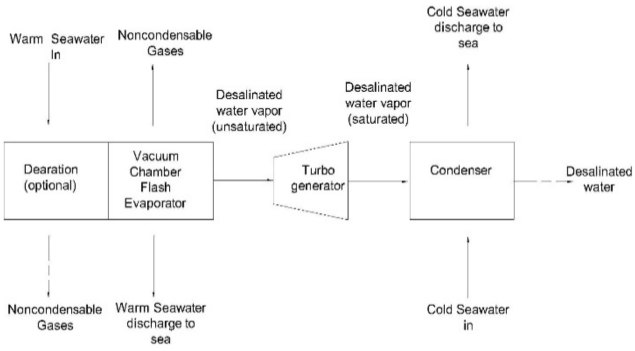

Figure 2. OTEC Open-cycle schematic diagram.

C. *Hybrid-Cycle*

A hybrid cycle combines elements of both closed- and open-cycle systems to maximize energy efficiency and resource utilization. The hybrid system is designed to maximize the use of heat exchangers and minimize energy loss. Same as open system, in the vacuum chamber, warm seawater is evaporated and the water steams heat the working fluid causing it to vaporize. The working fluid is then vaporized and passes through the turbine to generate electricity, and the resulting steam from the warm seawater is condensed for desalinated freshwater production [15]. The strength of a hybrid system is it can generate both electricity and produce desalinated water as shown in Figure 3.

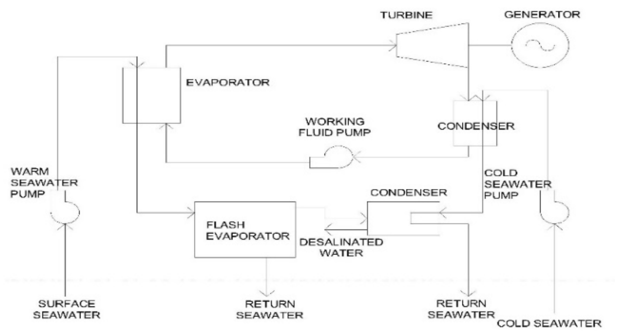

Figure 3. OTEC Hybrid-cycle schematic diagram.

III. Type of OTEC Plants And OTEC Projects around the World

A. On-Land OTEC

These onshore systems move warm and cold seawater from the ocean to the facility via pipelines. Benefits include a simpler connection with current infrastructure and maintenance. The development of pipelines presents logistical and environmental challenges.

B. Floating of Offshore OTEC

The equipment is placed on platforms that float in the ocean. They are placed farther out from the coast in regions with the best temperature differentials. Access to colder, deeper water is one benefit that can increase effectiveness. Due to their remote location, challenges include increased construction and maintenance expenses.

C. OTEC Based on Shelves

Located on the continental shelf, these systems balance having access to deep, cold water and being close to the coast. They provide a cost-effective middle ground between offshore and land-based designs. Complex engineering and environmental effects can result from building atop the shelf.

D. OTEC Projects around the world

Historically, Jacques D' Arsonval, a French scientist was the first who developed the idea of OTEC to produce electricity based on Rankine Cycle in the 1880s. In past, it was once thought that its application was impracticable. However, the idea has been challenged and proved wrong with advancement of technology. Over a century past, research activities of OTEC have been developed and has been explored in various part of the world (Table I). In Japan, the study of OTEC begin in 1974 where the purpose of the project is to study and establish OTEC. The researchers investigated methods to increase the efficiency of OTEC plant. The Saga University first constructed a 1kW plant in 1977 followed by 50kW offshore plant in 1980. In 1994, the researchers at Ocean Energy Institute of Saga University successfully built a 4.5kW in 1994. Then, in 2013, a 100kW of OTEC was installed in Kumejima Island, Okinawa, Japan. Hawaii is another location where OTEC technology is feasible. This is due to the warm surface of the sea and the deep depths that can be reached quite near the coast, with temperature as low as 5^0 C. A pilot OTEC plant was set up in Hawaii in 2011 with the purpose of designing and testing heat exchangers. Subsequently, a 105kW closed-loop OTEC prototype plant connected to the US power grid was constructed in Kona, Hawaii in 2015.

TABLE I. Example of OTEC development around the world

Type of Platform	Location	Output energy
Landbase	Saga, Japan	30 kW
	Kumejima, Japan	100 kW
	Big Island, Hawaii	105 kW
	La Reunion, France	15 kW
	Gosung, Korea	20 kW
	Port Dickson, Malaysia	3 kW
Offshore	Kiribati	1 MW

IV. Economy evaluation of OTEC

Like other technologies, OTEC's costs consist of investment, or Capital Expenses (CAPEX), Operational Expenses (OPEX), and financing costs. The CAPEX comprises all costs related to the implementation of an OTEC plant, including its conceptualisation, planning, components, and installation. The OPEX comprises all the costs for operating and maintaining the OTEC plant after it has been installed, including maintenance, reparation, component replacement, as well as on-site personnel costs. The LCOE reflects the costs of generating one unit of electricity considering all the costs and electricity generation accrued over the OTEC plant's lifetime. In this section, OTEC's economics based on CAPEX, OPEX, and LCOE is discussed. In 2020, Langer et al. reviewed OTEC's economics in academic and industrial literature [17]. Since then, 29 new scientific articles[1] with economic analyses on OTEC were detected. From this sample, four overarching research trends can be discerned. First, many papers (9 out 29 papers) assess the economic feasibility of multi-use OTEC concepts that combine power production with freshwater production [14-20], cooling [14,15,17, 20- 22], food production [22-23]and power-to-gas [21]. Second, OTEC is often (9 out of 29 papers) combined with other renewable energy technologies, especially with solar thermal heating units [15,16], [20, 21], [24- 28], to increase the temperature of the warm surface seawater and thus enhance the OTEC plant's efficiency. Third, many studies (9 out of 29) [15,19, 27, 29- 34] consider the fluctuations of OTEC power production (seasonal) and electricity demand (intraday) for their designs. Fourth, recent studies (8 of 29) consider OTEC's economics for resource potential assessments of larger geographical areas [18,19, 29-30,33-36]. Besides these four trends, we also observe

OTEC's role in future power systems and interplay with other renewable energies being investigated via energy system modelling [23], [41].

[1]Based on literature search on Scopus for original articles in English on OTEC economics since 2020. Search query: TITLE-ABS-KEY ((otec OR "ocean thermal energy") AND economic*) AND PUBYEAR > 2019 AND PUBYEAR < 2025 AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")). Total sample as of August 2024: 52 papers. Final sample comprises 29 papers after filtering out irrelevant studies (e.g., no economic analysis).

Notwithstanding the growing number of economic analyses on OTEC, the original findings of Langer et al.'s [42] still apply, namely that (1) OTEC's costs are highly uncertain due to lack of practical experience and data, and that (2) OTEC's costs might be higher compared to other renewable energy technologies under current assumptions. However, two mechanisms might render OTEC economically viable in the future, namely economies of scale and technological learning. Economies of scale describe the phenomenon of decreasing specific costs (costs per unit of product) with increasing size. For example, if the costs for permits are the same for a 5 MWnet and 10 MWnet plant, the specific permit costs in US$/MWnet of the 10 MWnet plant would be half of those of the 5 MWnet plant. A technical report by IEA-OES 2024, have reported that OTEC is expected to have strong economies of scale with a CAPEX of roughly 35,000 US$(2021)/kWnet for a 5 MWnet system and 12,500 US$(2021)/kWnet for a 100 MWnet [43]. Consequently, there is a strong incentive to scale OTEC up from the current kW-scale to a commercially viable MW-scale. Depending on the local power generation costs, OTEC could already be economically viable at roughly 5 MWnet, for example in small island development states like Tonga [34]. The other cost-reducing mechanism is technological learning. According to available literature, the OPEX of OTEC is estimated to be relatively small and ranges between 1.4–8.8% of CAPEX [42].

For Malaysia, it is estimated that minimum and median LCOE as 143 and 166 US$(2021)/MWh for a closed-cycle, floating 100 MWnet OTEC, which is considerably higher than the global weighted average LCOEs of competing renewable energy technologies in 2022, like the 49 US$(2022)/kWp for utility-scale, ground-mounted solar PV and 33 US$(2022)/kW for onshore wind [34]. However, OTEC's LCOE might be lower if accounting for technological learning, which encompasses the cost reducing effects of growing experience, standardisation of OTEC components and processes, and the emergence of global and local supply chains, amongst others. For instance, in Indonesia, the OTEC's LCOE could be as low as 62 US$/MWh once the technology is fully scaled up and matured [39]. Then, medium- to large-scale OTEC would be cost-competitive in terms of OTEC against other power generation technologies such as wind, biomass, utility-scale solar PV, geothermal, and coal. It is important to note that, despite OTEC's higher LCOE, it may still be a cost-effective solution in power systems with high shares of renewables. In the context of solar PV and wind power, that have lower LCOE, their power production depends on the weather and time of day and can thus change within seconds, requiring energy storage and other grid management measures to ensure the reliable and safe supply of consumers. In contrast, OTEC's power production, only fluctuates seasonally and thus makes it a cost-effective option to avoid large shares of variable generation and storage overcapacity [34].

Initial installation of the OTEC plant incurs high capital costs. Notwithstanding, profit generated from the byproducts from OTEC plants can offset its expenses. The estimated freshwater that can be produced from 1 MW of a H-OTEC plant is approximately 2 million of litres per day, which can be commercialised as drinking water and potable water [44]. In addition, H-OTEC can produce more desalinated water than open-cycled OTEC at lower capital cost [45]. The electricity generated from OTEC can be utilized for hydrogen production through electrolysis via proton exchange membrane electrolyser (PEME) [46]. Furthermore, utilization of DSW offers a lucrative market. The total annual revenue generated from these DSW related industries was reported to be about 2 billion yen, contributing to social and economic benefits to the island communities [49].

V. ENVIRONMENTAL IMPACT OF OTEC

One of the major concerns for environmental effects is the large intake and discharge of seawater. A large amount of seawater is required for OTEC operation, which is brought in through intake pipes and released back into the ocean after condensation. The intake of water may cause organisms' entrainment and entrapment, which requires a proper monitoring to avoid it. Notably, operational plants in Okinawa and Hawaii have not face such issue, indicating that it is rare event [50]. Nutrient upwelling by deep-sea water brought to the surface containing high levels of nitrates and phosphates. Depending on the site and seasonal variations, excessive nutrient may cause eutrophication of harmful algal blooms and oxygen depletion in the water. However, it can be beneficial when increased growth of marine bio-species like planktons contribute to the sequestering of CO_2, thus reducing the impact of climate change [51]. Besides, that the release of cold water near to surface water could thermally shock marine life and even lead to slower rates in marine species. Therefore, it is crucial to disperse at intermediate depth to minimize those potential effects. This can be done through numerical modelling which will take into consideration meta-oceanic conditions and assist in dispersal strategies to minimize environmental impacts [52]. Alternatively, cold post-OTEC water can also be collected into containers or enclosed areas for the use of mariculture or other DSW-related industries, instead of returning to the seawater.

Concerns for the use and handling of hazardous chemicals such as ammonia in OTEC plant can be managed by stringent inspection and by complying to waste management as for other industrial developments [50]. Notably, the environmental impact assessment conducted by the National Oceanic and Atmospheric Administration (NOAA) have concluded that potential environmental risk by OTEC is acceptable. Nonetheless, further assessments are necessary to monitor, manage, and avoid significant environmental risk to marine ecosystem prior to OTEC deployment depending on the sites identified. It is also worth mentioning that, OTEC systems emits very low CO_2. Based on a 100 MW H-OTEC hypothetical study, it is estimated to have more than 97% CO_2 savings compared to a coal power plant [53]. More, OTEC platforms can offset approximately 5106 tonnes of carbon dioxide from the environment for 1 GW of electricity generated per year [54]. Hence, OTEC is one of the promising green technologies that can reduce carbon print.

VI. CURRENT PROJECT BY UTM-SASTREPS

Founded in January 2013, UTM-OTEC is the sole OTEC centre in Southeast Asia. Since then, several domestic and international OTEC projects have been accomplished. These projects have mostly involved civil and structural work, site validation (Sabah and Sarawak), business model development, creation of regulatory frameworks, and the design of innovative OTEC systems for lower enthalpy. Recently, the UTM-OTEC and the Institute of Ocean Energy at Saga University (Japan) have partnered on a research project to develop an advanced hybrid OTEC system (H-OTEC) and establish Malaysia's first H-OTEC trial plant. With its combination of deep seawater (DSW) multi-utilization and H-OTEC system research and development, it will be the world's first and most advanced H-OTEC test facility. Under the Science and Technology Research Partnership for Sustainable Development (SATREPS), the Malaysian Ministry of Higher Education and the Japanese Science & Technology Agency have financed around RM6 million for this project. The project is divided into ten sub-projects that are led by researchers from UTM and other local universities such as Universiti Putra Malaysia (UPM), Universiti Kebangsaan Malaysia (UKM), and Universiti Malaya (UM). The aim of this project is to address problems associated with traditional systems like heat exchanger costs and requirement for anti-fouling precautions and generation of spin-off products. A new 3-kW turbine design is also among the ongoing research and development projects. Other ideas include the use of inexpensive stainless-steel heat exchangers rather than expensive titanium, the introduction of nano-working fluids to replace ammonia as the traditional working fluid, and the exploration of the flash distillation method, which exchanges heat by injecting warm water vapour rather than warm seawater directly [4]. Through these innovative strategies, it is expected to reduce the required temperature differential from 20°C to as low as 10°C, as such the heat from the Sun stored in waters shallower than 800 m could be harnessed [55]. As part of exploring the spin-off industries, the researchers aim to improve research output in cold deep-sea water utilization to enhance growth of seaweeds and abalones, and to analyse the water quality of OTEC desalination water. Through its expansion and strengthening of the field of OTEC research, results from this study will have a major positive impact on the environment and energy sustainability. In the aspect of OTEC deployment, the possibility of developing both land-based and floating OTEC platform designs can be explored with the help of technological and knowledge advancement in the offshore oil and gas industry. In that regard, UTM-OTEC researchers have recently partnered with SHELL-Marine Renewable Energy to study the technical feasibility, economic understanding, and environmental implications of both conventional OTEC and hybrid-OTEC systems for an offshore plant in Pulau Kalumpang, Sabah (Figure 4).

Figure 4. The map of Sabah that shows the location of Kalumpang island, situated in between the district of Tawau and Semporna.

VII. OTEC POTENTIAL IN SABAH

Sabah also famously known as the Land Below the Wind, is the second largest state in Malaysia, located in northern Borneo, in the region of East Malaysia. Sabah is blessed with rich biodiversity and renewable energy potential. Despite the richness of natural resources, Sabah has the highest poverty rate [56]. Eradication of poverty in Sabah has been challenging due to geographical and demographic reasons, whereby many are still living in rural areas and islands with poor infrastructure. In the context of the Sabah energy landscape, the Sabah Energy Roadmap and Masterplan 2040 have reported that the energy mix comprised mainly of natural gas (86%), diesel (6.7%) and renewable energy; biomass, hydro & solar (7.3%). Harnessing the thermal difference of ocean, OTEC technology offers a unique option compared to other conventional renewable energy technologies such as solar, wind, biomass, and hydropower. The comparison of OTEC between other renewable energy technologies in the context of Malaysia is summarized as in Table II. There is great opportunity to develop OTEC projects in Sabah. The oceanographic surveys in Sabah waters found very deep waters, which is suitable conditions for OTEC to work. The authors previous work has identified a total of nine OTEC potential sites within the Malaysian Exclusive Economic Zone (EEZ), with a total usable area of 9.2301 × 10^{10} m^2 [9]. The theoretical estimation of renewable energy production by an OTEC plant within the Malaysian EEZ is 3.99 x 10^6 kW to 1.188 x 10^7 kW, which like and four times greater than the current government target for RE power generation by 2025 [9]. Recognizing the huge potential of OTEC in Sabah, the Sabah state has recently approved the Ocean Thermal Energy Conversion (OTEC) Enactment 2024 and Energy Commission of Sabah Enactment (Amendment N0.2) 2024. This enables the Energy Commission of Sabah to have power on matters related to OTEC activities. For instance, regulate the exploration, construction, and operation of OTEC facilities in Sabah. This enactment will pave the way for incorporating OTEC as a renewable energy source in the energy mix and be part of the initiatives of the blue economy.

TABLE II. COMPARATIVE OVERVIEW OF RENEWABLE ENERGY

Parameter	OTEC	Solar	Wind	Biomass	Hydropower
Resource Availability	Abundant in tropical coastal areas	High solar irradiance across Malaysia	Limited due to low wind speeds	Abundant agricultural waste (palm, oil, timber)	Abundant in river-rich areas
Reliability	Continuous 24/7 operation	Intermittent (weather/daylight-dependant)	Intermittent (low wind speeds in Malaysia)	Continuous if supply is sustained	Reliable base-load power
Cost	High initial investment	Low to moderate upfront costs	Moderate to high (depends on location)	Moderate costs, with local availability of resources	High initial investment (dams)
Technological Maturity	Emerging technology (still developing)	Mature technology, well-established	Mature, but limited feasibility in Malaysia	Mature, with ongoing advancements	Well-established in Malaysia
Environmental Impact	Low emissions, potential deep-sea impact	Low emissions, land-use concern	Low emissions, but noise and land impact	Moderate, depends on sustainable practices	High impact (deforestation displacement)
Fresh water Production	Yes (open and hybrid system)	No	No	No	No

Socioeconomic benefits must be thoroughly analysed for OTEC to be meaningful to its stakeholders. The success of the "Kumejima model" can be replicated in the "Malaysia Model" particularly, in Sabah, the state that is blessed with OTEC potential. In Sabah, the mariculture industry is one of the commodities that contribute to Sabah's economy. It is well-known for its tiger prawns, pearl oysters, giant clams, seaweeds, and various fish [56]. Thus, the potential of DSW integrated industry from the OTEC plant can contribute towards accelerating the socioeconomic transformation of the state and the people of Sabah. In addition, the public needs to have positive attitudes and knowledge towards renewable energy for successful implementation. Adopting the research conducted by Ooi et al., 2015, that investigated the social response to OTEC implementation in Sabah in comparison to fossil fuel power stations [57], UTM-OTEC researchers recently conducted surveys during their engagement with residents and experts in Sabah (unpublished results). As part of their ongoing project with Shell-MRE, the researchers designed questions within the qualitative questionnaires to evaluate the acceptance level of OTEC in Sabah. The respondents were experts from different entities in Kota Kinabalu, villagers of Kampung Mas Mas, Tawau and students from SMK Balung, Tawau. For each different group of respondents, the questionnaires were given out after a presentation about OTEC technology was given. The group of experts consist of the energy field, environment field, researchers, and community advocates. A total of 17 respondents participated in the survey. From the survey, the researchers found that most of the experts (76.5%) accepted and agreed with the implementation of OTEC in Sabah. At the community level, 33 respondents from the age of 32 to 75 years old participated. The survey results showed that 29 of 33 respondents from Kampung Mas Mas were strongly supportive of the implementation of OTEC. At the school engagement, a total of 28 respondents aged between 16 to 17 years old participated. The authors found that only 57% agreed with OTEC implementation. This could probably be due to a lack of awareness or interest on OTEC. Hence, it is important to motivate students to participate in active learning to increase awareness about OTEC. The findings from the surveys align with the previously published results that showed high social acceptance for OTEC implementation among people living in Sabah [57]. The technical, economy, and environmental evaluation for OTEC implementation in Sabah is currently on-going and will be discussed in future work.

VIII. Conclusion And Future Direction

Malaysia is committed to energy transition and working towards decarbonization through clean renewable energies. For sustainable future in Malaysia, OTEC must be combined with other mature technologies like solar, biomass, and hydropower to reduce national CO_2 emissions, helping the country achieve its target of reducing carbon intensity by 45% by 2030. As part of the government's priorities and initiatives towards the energy transition and energy mix, OTEC technology and UTM are highlighted as stakeholders in the National Energy Policy (NEP 2022-2040) and Hydrogen Economy, and Technology Roadmap (HETR). Therefore, the authors aspire that OTEC be implemented and incorporated in the national energy mix working towards energy transition soon. In line with that, an OTEC feasibility study is crucial for commercially viable OTEC plants to developed in Malaysia. In addition, the results obtained from the technical performance analysis of 3kW (H-OTEC in I-AQUAS, Port Dickson) for 1 MW pilot H-OTEC can help with the development of a 10 MW commercial plant for clean energy and water production, concomitantly working towards reducing carbon footprint. Hence, having an OTEC plant, the SGDs goals can, directly and indirectly, be achieved for the betterment of human and planet lives. The authors hope that the government will assist and provide incentives to attract investors for materializing OTEC plants in Sabah.

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