UNMANNED WELLHEAD PLATFORM powered by a solar–wind hybrid

Shell Malaysia Exploration and Production (SMEP) is determined to make a significant contribution to Shell's commitment to a sustainable future and ambition to reduce its carbon footprint to net zero. This journey began with the Gorek platform (Figure 1), a minimal facility wellhead platform fully powered by solar energy. Following that success, SMEP is now embarking on a journey to power its Timi wellhead platform development using a hybrid power system utilising solar photovoltaic panels and wind turbines.

FIGURE 1
SMEP's first fully renewable-energy powered offshore platform, Gorek, achieved its first gas in May 2020.

Introduction

SMEP's older, unmanned wellhead platform designs were powered by combustion-based equipment such as microturbine generators. That method of power generation is no longer an ideal solution for more sustainable development due to its carbon dioxide emissions. Additionally, conventional power generation systems are complex to design and have high capital and operating expenditure because of the number of equipment items required and the corresponding wear and tear.

A renewable energy arrangement powered by solar and/or wind energy in combination with batteries and standby diesel engines is fast becoming the system of choice for oil and gas operators to power their offshore wellhead platforms. For example, in the North Sea, Shell operates 13 offshore platforms that use hybrid power systems. Of these, eight monopile platforms, including Caravel, Cutter, L09-FA, L13-FI-1 and Shamrock, use a solar–wind hybrid system.

Such systems do not produce any direct greenhouse gas emissions in normal operation, as the diesel engine is in standby mode. They are also less complex to design, operate and maintain than conventional systems. Moreover, because they require the installation of minimal equipment, the resulting platform designs are lighter and the capital expenditure is lower.

However, the biggest challenge for any operator wanting to develop a platform with a renewable energy system is the reduced power available compared with conventional power generation methods. Even given recent developments in solar-panel technology, the conversion efficiency of the panels is 18–22%. Therefore, an 80-m^2, 14-kWp solar photovoltaic array must be installed to generate the 25 kWh/d required to supply the load and charge the batteries during the day in the worst-case solar insolation conditions.

Installations further from the equator also have to deal with reduced winter sunlight hours when calculating solar panel and battery size. A realistic amount of power that a hybrid system could supply for an offshore wellhead platform is only a few kilowatts. The challenge is to design the facility to be able to operate within this power limitation. ▸▸▸

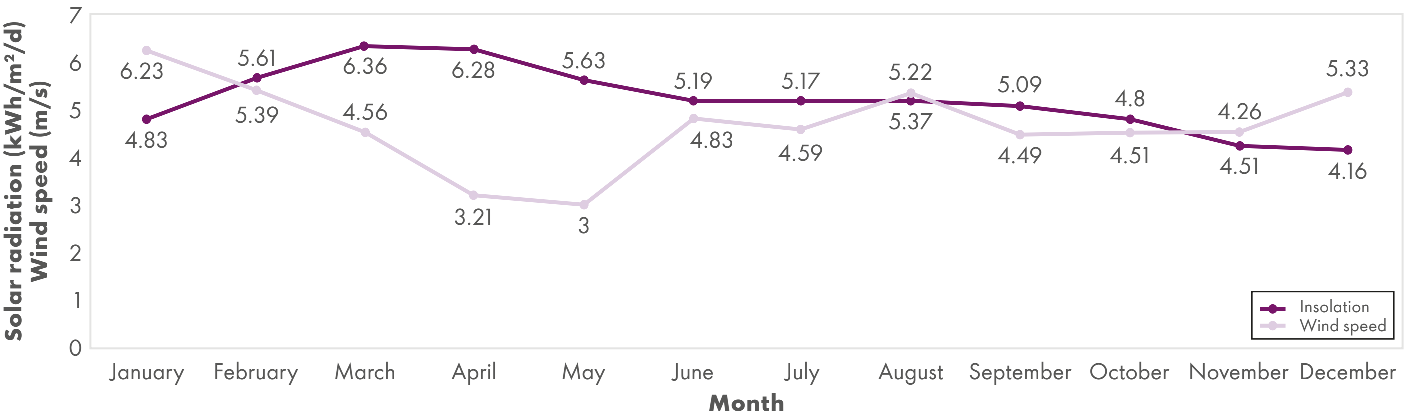

FIGURE 2

Insolation and wind speed offshore Malaysia. These data were obtained from the NASA Langley Research Center Atmospheric Science Data Center [Ref 1].

Wind energy in Malaysian waters

Although the utilisation of wind energy has grown significantly over the past decade in regions such as the USA and Europe, interest in wind energy is still insignificant in Malaysia. According to wind data from NASA, the average wind speed in the waters offshore peninsular Malaysia and Sabah and Sarawak states is 3–6 m/s [Ref 1]. This is considered relatively low for efficiently producing wind energy, which discourages its uptake in this part of the world. However, technological advances in wind turbine technology have led to wind turbines that can work in low wind speeds now being readily available on the market: an example is the Airdolphin from Zephyr. Such turbines have been proven in operation in various offshore oil and gas installations in South East Asia.

The climate in Malaysia

Understanding local seasonal climate change and energy patterns is critical to the efficient design of a renewable energy system. In Malaysia, the eastern part of the country is directly affected by the north-east monsoon, and the country typically experiences heavy rainfall in November, December and January.

During the monsoon season, the wind is normally stronger and solar radiation is at its lowest. However, during the dry season, insolation is at its maximum while wind energy is at a minimum (Figure 2). The mutually exclusive nature of these energy sources can be effectively exploited using a hybrid power system [Ref 2]. In such a system, and depending on the solar panel and wind turbine sizing and configuration, the battery autonomy time and therefore size can be reduced. This is what is envisioned for the hybrid power system for the Timi wellhead platform.

The Timi field and platform

Timi, a sweet gas field, was discovered in 2018 and is part of the SK318 production-sharing contract. Sarawak Shell is the operator and holds 75% of the equity; the other partners are PETRONAS Carigali (15%) and Brunei Energy Exploration (10%). The field will have a new, unmanned wellhead platform tied back to an existing Shell-operated hub platform via

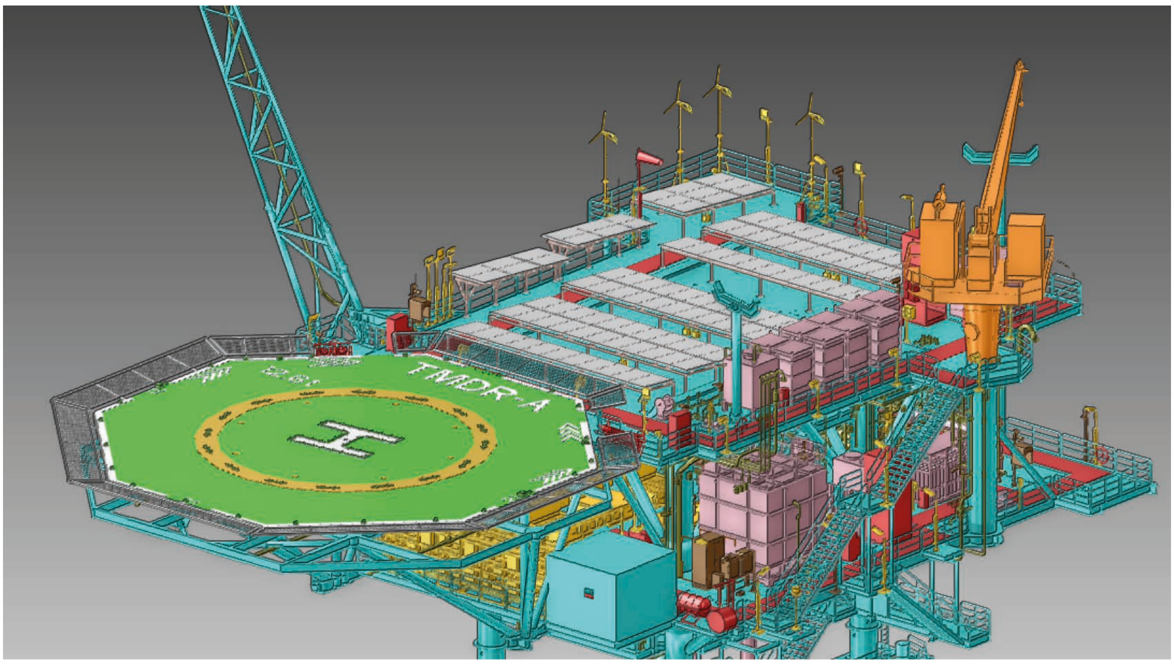

FIGURE 3

3D model of the Timi platform.

a new 80-km pipeline. Figure 3 shows the proposed wellhead platform arrangement: the Timi unmanned platform is about 60% lighter than a conventional tender-assisted drilling wellhead platform.

The Timi hybrid power system

The Timi wellhead platform will be the first in SMEP to be fully powered by a solar–wind hybrid power system. Figure 4 shows an overview of the hybrid system. The arrangement of the solar panels and wind turbines on the main deck is shown in Figure 3.

The solar panels and wind turbines will supply power to all normal loads such as the safety instrumented system/fire and gas system, the process control system, telecommunications, the wellhead control panel, hydraulic pump motors, chemical injection pump motors, helideck lighting and wells equipment. The total daily energy demand will be 73.6 kWh, which corresponds to an average load of 3 kW. Standby power will be supplied by a diesel generator rated at 40 kWe. It is planned to run the standby generator once a month during a maintenance visit to power AC loads such as the diesel and vent knockout pump motors, lighting and crane auxiliaries.

The AC battery chargers will be energised when required during abnormal operating conditions, for example, when the battery voltage falls below the defined minimum level. Nickel–cadmium battery technology was chosen because the battery chemistry is robust to temperature variations. More modern technology such as lithium ion batteries requires better control of temperature and, therefore, of heating and ventilation, which increases the power required.

Design considerations

Several factors were taken into consideration to ensure the optimum design of the hybrid energy system for the Timi platform. For example, all sensitive equipment, including batteries and controllers, will be installed in a shaded area below the main deck (Figure 5) to avoid performance degradation due to direct exposure to sunlight.

The solar photovoltaic panel frame supports are designed for a maximum wind speed of 33 m/s, which is much higher than the typical maximum 10-min wind speed of 20 m/s experienced in Malaysian waters in recent years. They are also demountable to facilitate the removal of solar panels during a well intervention campaign offshore, if required. Higher-efficiency solar photovoltaic panels were selected to reduce their footprint and weight, and a solar panel tilt angle of 5°, instead of the 15° specified in the Shell ▸▸▸

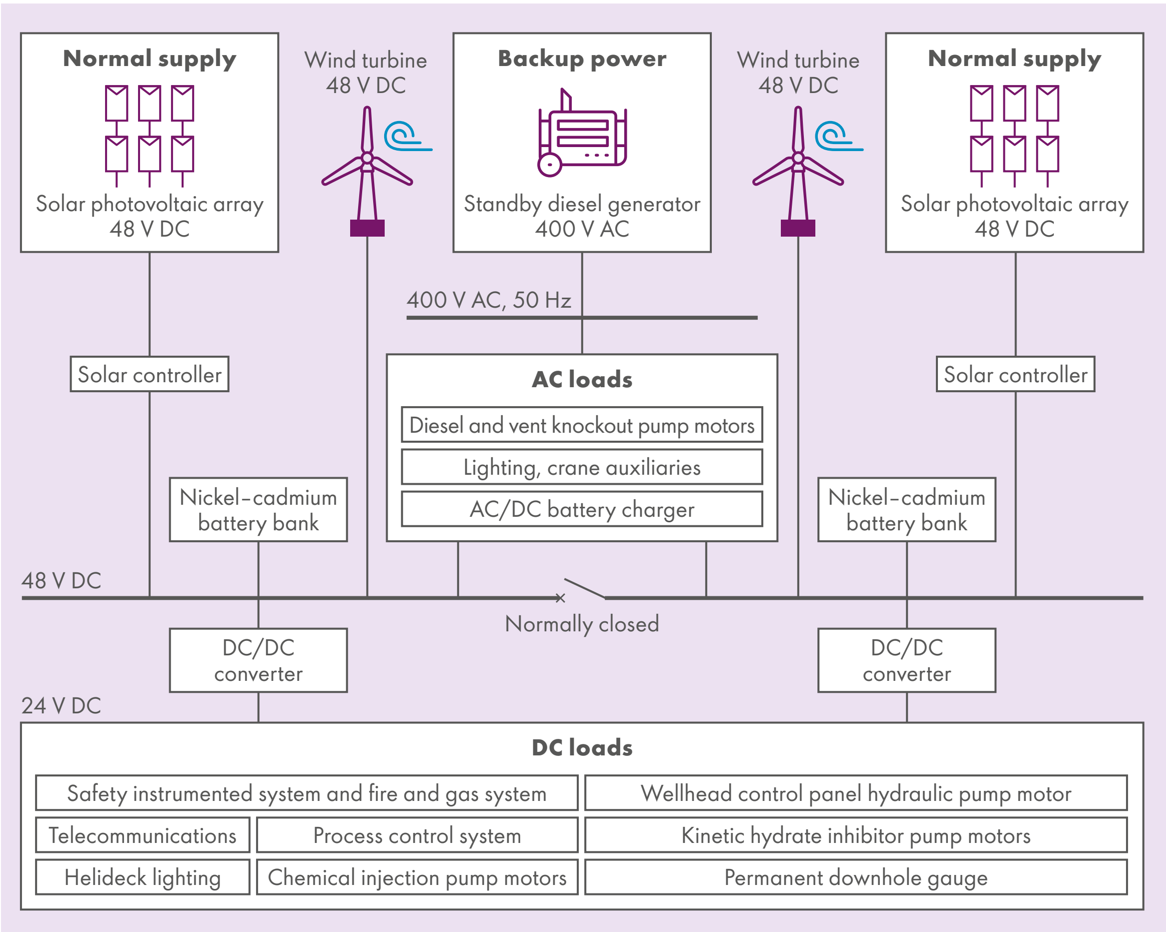

FIGURE 4
Timi hybrid system overview.

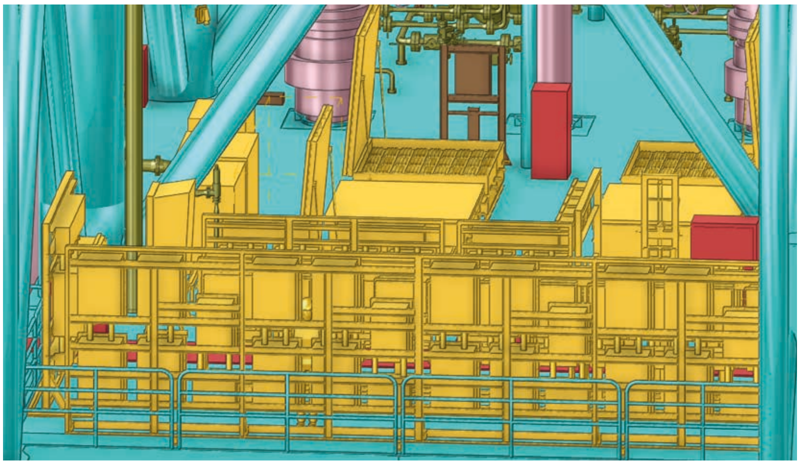

FIGURE 5
3D model of the electrical equipment on the cellar deck.

design and engineering practice for solar energy installations, will be used for better optimisation of insolation.

A higher voltage, 48 instead of 24 V DC, will be used at the power generation level to reduce the size of the cables and batteries and the number of controllers required.

A solar-powered platform in this region is normally designed for an autonomy of 5 d to cater for the cloudy days during the monsoon season. However, the wind speed is then typically higher, which makes up for the solar power deficit. Therefore, a 4-d autonomy was selected for Timi, which results in a smaller battery footprint and lower overall weight.

As another level of assurance, the standby diesel generator will automatically start when the battery charge level is low and will simultaneously power the platform and charge the batteries.

Finally, electrical parameter remote monitoring and automatic or remote control, combined with data trend monitoring from the host platform, will improve system availability, thereby reducing platform visits.

Conclusion

Understanding a specific location's climate conditions is crucial for determining what kind of hybrid system is most suited for that location. A hybrid power system offers a promising solution for an offshore unmanned wellhead platform for several reasons. It produces cleaner energy, is less complex and therefore easier to operate and maintain, and has a smaller footprint than conventional systems. Compared with the alternatives, it means reduced battery size, improved battery charging performance during the night and bad weather, and lower weight and capital and operating expenditure. Moreover, the system can improve overall power generation reliability during seasonal climate changes, such as the monsoon season, in Malaysian waters. ■

REFERENCES

[Ref 1] NASA, "The POWER project," power.larc.nasa.gov

[Ref 2] Hamdan, M. F., Yasir, M. F. and Kamal, A. F. M.: "Wind turbine hybrid – future small power generation for small field," Offshore Technology Conference Asia (2018) 174–179

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