IS IT POSSIBLE TO POWER A CABLE TERMINAL STATION USING ONLY GREEN ENERGY THUS REDUCING ITS CARBON FOOTPRINT?

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Abstract: This paper reports on a case study to understand the potential for Terminal Stations (TS) to be "off-grid", powered purely by green energy generated and stored on-site.
Year on year there is an increasing demand for submarine data capacity. This increase brings about increased energy usage and increased carbon footprint. This paper will examine whether the current and future submarine systems can be supplied by renewable energy.
In the face of rising public interest, companies, including telecom service providers are increasingly held accountable by their customers and stakeholders, concerned about environmental responsibility and good stewardship. Google have publicly declared that, since the beginning of 2017 they are procuring 100% of their power from renewable sources [1]. Is it time for the traditional telcos to follow their lead to keep public support and meet or exceed COP15 targets?
Two models are examined: firstly, a green, zero-carbon footprint, terminal station that uses renewable energy from wind turbines and solar panels with capacity to store surplus energy in batteries. Secondly, in countries where it is available, a terminal station has the option to purchase low or zero carbon electricity from green energy providers supplying the grid.
This study aims to establish if a fully equipped station at full design capacity can be entirely powered by renewable and stored energy.
It explores the relationship between cost and availability of renewable power solutions.
It will take into account factors such as peak load during winter and summer to ascertain the range of power requirements over a year. It is expected that some locations will be more economically viable than others due to light levels, wind speeds and the level of maturity of the green energy market.

1. INTRODUCTION

Subsea telecoms systems and the TS's that house them require continuous power from installation, commissioning and subsequently throughout their life cycle (nominally 25 years). In order to meet stringent submarine system availability targets it is industry practice to equip TS's with comprehensive backup power systems. These backup power systems assure power continuity, including diverse duplicated national grid feeds, Uninterruptable Power Supply (UPS) and generators, see Figure 1.

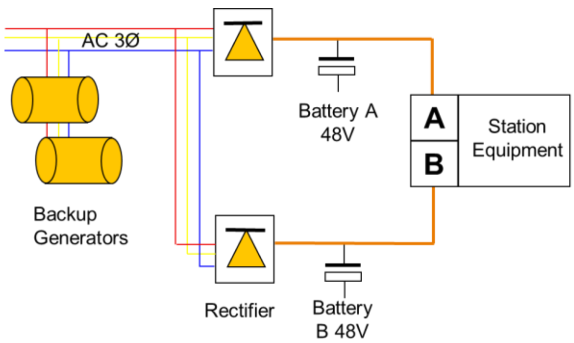

Figure 1: Typical station powering

The carbon footprint associated with powering a TS is the sum of the component contributions, where electricity from the grid makes up the majority of the carbon footprint.

Governments are implementing regulatory policies to reduce greenhouse gasses and reduce the carbon footprint of commercial supply. Consequently, in the future a TS's carbon footprint will reduce proportionally as the percentage of the renewable supply to the grid is increased. In Europe where there has been considerable investment in renewable power it is feasible to purchase renewable tariffs from the grid. However, this not possible in all countries.

This study looks at reducing the TS carbon footprint using wind, solar and batteries only. In order to keep up with the increasing capacity demand and expansion the industry must install more equipment, it is important that growth is powered sustainably. Telecommunication companies and Internet Content Providers (ICP) should reduce their impact on the environment, as it may be considered unacceptable for large companies to ignore their corporate social responsibility with their carbon footprint. Increasing stakeholder engagement and improved public image can also help a company's competitive position.

2. ENVIRONMENTAL BACKDROP

The COP15 agreement sets targets for cutting greenhouse gas emissions by 20% to 50% from 1990 levels dependant on the country [2]. The EU is targeting a reduction of at least 40% by 2030 in compared to 1990 levels and 27% of all energy to be sourced from renewables. [3].

These targets could be met if most industries reduce their energy demand from fossil fuel sources. Better efficiency as well as reducing the carbon footprint are essential. The EU directive has been applied into the ITU-guidelines [4] ITU-T L.1460 recommendations titled - Connect 2020 greenhouse gases emissions to meet the objectives of the COP15 Agreement. It is a global initiative to reduce greenhouse gases generated by the telecoms sector and they are to be decreased per device by 30% by 2020, compared to a baseline year, yet to be defined. The ITU recognise in their guidelines that there is a need to change the way in which systems are developed to improve the energy efficiency of Information Communication Technology (ICT) goods, networks and services from a full lifecycle point of view which is covered in ITU-T L.1460.

Power requirements required to operate long-haul TS were examined together with the viability of using renewables based on the power consumption of a typical TS taken over the course of five years. This information was used by a renewable electricity supplier to analyse potential costs, available technologies and power availability to run the station viably.

It is important to note that it is possible to procure a tariff sourced from 100% certified renewable sources within the UK which is reportable as having zero carbon emissions for Scope 2 emissions. Thus connecting to the grid could be carbon neutral without the need to go off grid.

3. CABLE LANDING STATION POWER CONSUMPTION

Electricity consumption data from a typical terminal station shows the electricity demand required to run the station over different seasons changes with temperature (see Figure 2). Additional cooling is needed during the summer months.

In any given year, power consumption varies due to external environmental conditions, and increases due to growing data demands.

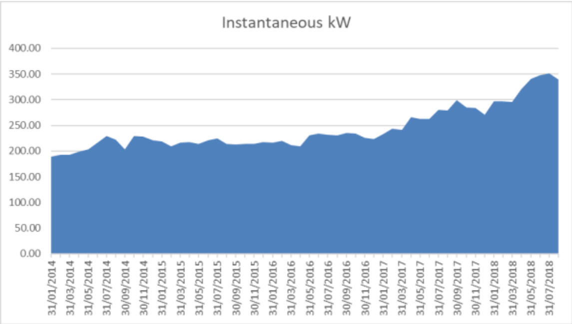

Figure 2: – Instantaneous power usage 2014-2018.

The data in Figure 2 over the last five years shows instantaneous power requirements, with the maximum approaching 350kW. Given the continuous operation the total annual consumption is in the region of 3GWh. To best match this load different proportions of solar panels, wind turbines and batteries were considered. The right combination of generating technologies is required to achieve a high availability at the lowest cost. This will require careful consideration for each TS due to differing wind and light levels.

Surplus generation can be stored in a battery array and used later – for instance at times of no wind or darkness. With a large CapEx budget, it would be possible to meet the power requirements of the system without using the grid as a backup. The relationship between the size of solar panels, wind turbines, battery size and the percentage availability with respect to cost, was investigated. This study evaluated the cost of a reasonable level of availability over realistic payback time. The aim is to guide future planning of cable systems based on a sensible renewable energy solution.

4. RENEWABLE ENERGY SOURCES

In the UK in summer, the peak power consumption of a cable landing station could be met by solar energy alone with batteries storing excess generation to cover night time. However, the intermittent nature of renewable generation and the cost restrictions of deploying very large battery arrays means that a balance needs to be struck between availability and the total cost of deployment.

Recognising that the most important factor is ensuring the continuous operation there will always be a requirement for a grid connection and need for a backup generator. Furthermore, at times when the renewable generation is producing more power than the system requires this can be stored in the battery, and the surplus can be exported to the grid to offset the initial cost.

The base load for the terminal station is large and continuous and it will vary in the event of an undersea telecoms cable power fault. In this case the system may require more power.

A mix of solar and wind power together with battery storage was considered to determine the optimum balance to reduce carbon footprint, reduce electricity from the grid and with a reasonable return time on the investment.

5. RENEWABLE ENERGY GENERATION AND STORAGE ANALYSIS

The initial installation of the solar panels and wind turbines involves various approvals including planning permission. There would also be a carbon cost in the building and deployment and for the purposes of this study, these impacts have not been considered, given the fact that any solution deployed would have an embedded carbon footprint.

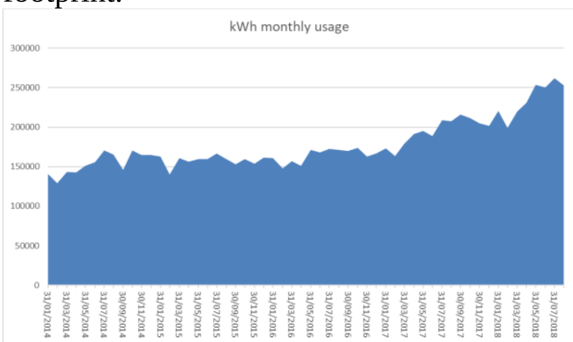

Figure 3 – kWh usage per month 2014-2018.

The cable landing station draws a large amount of power, in 2017 3GWh was consumed over the course of the year. This represents approximately 8.2 MWh per day. For context, a cable station uses more energy in a day that two average UK houses use in a year!

The operational expenditure on electricity at the cable landing station is expected to be in the region of $410 - $520k per annum, and grid supplied electricity is increasing year on year in the UK.

To understand the relationship between cost and availability simple assumptions on the installed cost of the technologies is shown in Table 1 below. These costs include a simplistic allocation toward the civil works and any grid connection upgrades required. Further work to determine an accurate cost would be required on a case-by-case basis.

Technology type	installed cost per kWp
Solar photovoltaic	$850 - $900
Wind turbine	$900 - $1,000
Battery storage	$1,250 - $1,350

Table 1. Assumed cost of renewable technologies per kilowatt peak (kWp).

The output from a given size of solar panel array over the course of a year is broadly predictable in the UK, and is shown in Figure 4

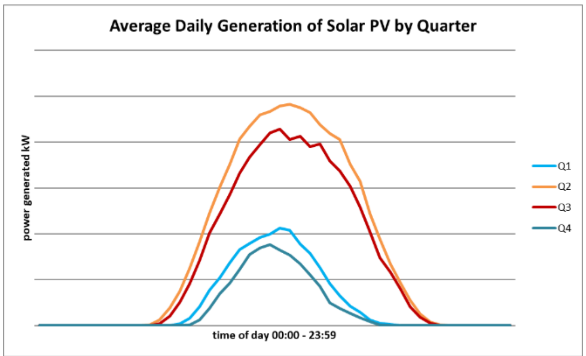

Figure 4 – Average generation of solar power Pv by quarter.

However, the generating capability and output of a wind turbine is far less predictable on an hour-by-hour basis across the day, week, month and year. Therefore, only real generation data from a selection of sizes of wind turbines located as close as possible to the case study cable landing station was used. The average generation across each quarter of a mix of wind turbines has been considered which is shown in Figure 5.

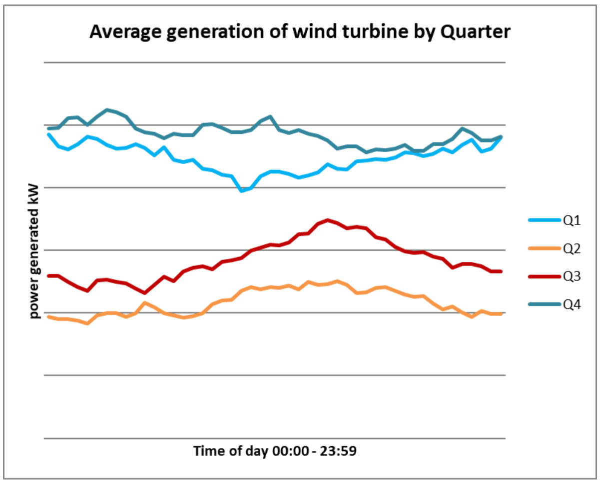

Figure 5. Average generation profile throughout the day from a turbine closely located to the cable landing station

A battery storage solution can be sized to suit the instantaneous power required (kW) and the duration of the total power it can deliver over time (kWh)

For the cable station under consideration in the case study, the battery array has been sized to deliver an average instantaneous power of 350kW, in the event of no power being available from the installed renewable generation. It would be theoretically possible to simply increase the duration of discharge of the battery to cover all eventualities, but for the purposes of this paper it is assumed that the maximum discharge period of the battery is eight hours. There is also consideration that the battery takes time to charge up before it can then discharge again. Modelling the combined generation of renewable energy from solar and wind and taking a reasonable assumption of the ability of the battery to store any excess and be able to deliver back to the system to meet any subsequent shortfall in availability, this yields the following:.

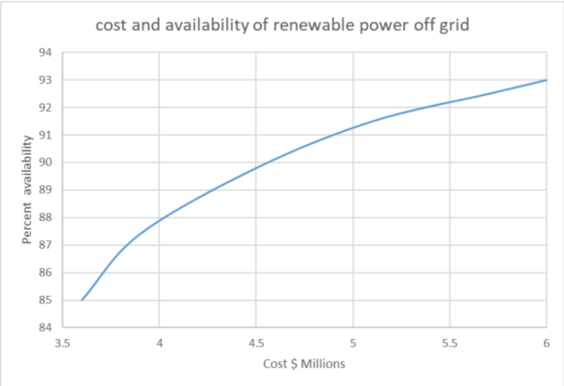

Figure 6: Total cost of installed renewable generation and storage against % availability of renewable electricity.

Figure 6 shows that gains in availability get progressively more expensive, and with an unlimited budget it would be possible to get to 100% availability. However, it might be more practical to aim for 90% availability.

It is worth considering that any surplus energy generated could be sold back to the grid to offset the investment.

From Figure 6 if the point on the curve where the cable landing station experiences approximately 90% availability with an expected Capex of $4.5M, there would be a considerable amount of power exported back to the grid. It is estimated this exported power to be approximately 1.8GWh pa. At the time of writing this power it could be sold back to the grid in the UK for approximately $80/MWh, yielding $144k.
So, the net effect of the installed capacity of solar, wind and a battery array that together cost $4.5M, would yield a reduction in the operating electricity cost of approximately $520k per annum together with an income of $144k from the electricity exported.

Analysing these figures this investment could potentially become cost neutral within 7-8 years. These figures do not include any extra income stream potential for grid services – i.e. money paid to the site for taking or giving electricity at times of grid stress.

Keeping the running costs on a similar level to running off the grid is key to winning support for moving to carbon neutral energy providers. If deciding to purchase renewable carbon neutral energy from the market it needs to be competitive to market rates.

6. OBSERVATIONS

It is entirely possible to make the cable station carbon neutral in operation from a mix of renewable technologies. However, more research is required to understand if it is feasible for cost-effective 100% availability. Achieving 100% availability would present enormous cost for subsea cable providers where Capex and Opex are restricted.
Having renewable installations on-site creates extra concerns around operation and maintenance service contracts.

In the UK it is also important to note that the weather is unpredictable. Geographically speaking solar energy would be much more feasible in regions where there is a high amount of uninterrupted sunlight hours. However, in these regions the power gathered from the wind might not be suitable. In the UK if a company wishes to go carbon neutral the best option will be to deploy a certain amount of renewable technologies, evaluated on a site-by-site basis and then to procure a renewable tariff and become carbon neutral that way. Going off grid may be more suitable for countries where a zero carbon tariff is not available.

Although viability for the deployment of renewable technologies is very much case-by-case dependent, there is a huge potential

for the subsea stations to be carbon neutral in operation and therefore to help meet the ITU guidelines commitment which are based on the Paris Agreement.
The renewable energy power companies have technology available, which can certainly provide the required energy commitments of running a cable landing station. Future capacity upgrades will require the installation of more equipment, which in turn entails increased power consumption. Deploying renewable generation technologies should be considered, also by incorporating a battery array on the site that can be made as "off-grid" as budgets will allow.

Other renewable energy technologies are being developed and deployed, such as tidal energy. In time, these sources might be a preferable source due to the constant movement of the tide all year round producing a more constant energy supply. This could provide a more stable solution to powering.

7. CONCLUSIONS AND SUMMARY

If subsea telecoms providers who build cable stations allocate budget to deploy renewable electricity generation, and increase the "self-generated" availability, then we believe this will show significant opportunity to greatly reduce the carbon footprint. Further, the Capex could show an acceptable return on investment, within 7-8 years of build.
An approach that seeks to deploy a mix of technologies, considered on the site-specific requirements to reduce the operating carbon footprint would help meet ITU guidelines and the COP15 targets.

As the costs for the renewable technologies continues to decrease, and the cost of non-renewable electricity from the grid increases, the case for renewable energy becomes more compelling.

More detailed research and analysis will need to be done and it is hoped this paper can provide a useful starting point. But, if the telecoms industry were to adopt renewable electricity, either by buying 100% renewable from the grid, or by generating its own as detailed in this paper, then several million tonnes of CO_2 would be prevented from entering the atmosphere.

8. REFERENCES

[1] https://sustainability.google/projects/announcement-100
[2]EU Commission https://ec.europa.eu/clima/citizens/eu_en
[3] EU Commission https://ec.europa.eu/clima/policies/strategies/2030_en
[4] https://www.itu.int/rec/T-REC-L.1460-201808-I/en ITU guidelines

