Introduction.

My contention is that, because BESS as currently used, cause an increase in environmental damage compared to not using BESS, further BESS deployment should be paused until surplus power from renewable sources is available to charge them.

This representation calculates the CO2 environmental damage that will be caused by the proposed Lime Down site. Further, it calculates the CO2 environmental damage from the existing installed base of BESS in the UK.

The solar power industry does not wash its dirty laundry in public! Meaning that information on some of the negative performance aspects of the industry are not published. I have used Internet searches and AI supported searches to find the numbers for things like battery Round Trip Efficiency (RTE). In almost every case, a range of values is returned because until the values for a specific equipment are known it cannot be specific. In all cases, I have taken the mid-point in the value range for the calculation.

In consequence of the above, I would expect Lime Down Ltd and IGP to challenge the numbers. The best action for the examining team is to require Lime Down Ltd to provide details for the specific equipment planned and to have the analysis done by independent experts in the field. This will allow the reality of the situation to be properly understood and communicated.

The ostensible objective of Lime Down and like schemes is to help UK achieve net zero emissions, in fact, because of the massive carbon debt incurred in building the site and because of environmentally negative operational factors such as fossil fuel generation to charge the BESS, the scheme may never even break even in environmental damage terms.

The basic challenge: BESS operators are charging BESS overnight at a low tariff in order to sell that electricity the next day at a high tariff, and to profit from the tariff differential. The consequence is that the power used is generated using Combined Cycle Gas Turbines (CCGT). This conclusion is reached because the power generated to charge the BESS is additional to the normal demand and will be generated using CCGT. Look at gridwatch.co.uk for the evidence.

The issue is that there are a significant number of losses involved in the use of BESS in this way. These losses can be summarised as:

- **Transmission losses**. In the case of Lime Down, because of the extreme distance (25km) between Lime Down and the grid connection point at Melksham, transmission losses are estimated as:
- Based on typical technical parameters for a 400kV buried HVAC cable system (using XLPE insulated 1000mm² aluminium conductors), the estimated energy loss is approximately **1.2% to 1.8%** of the transmitted power over 25km. Assume **1,5%**
- For a 500MW transfer, this translates to roughly **6 MW to 9 MW** of power loss, mainly due to resistive (copper) losses, though capacitive charging currents in buried cables can increase losses depending on reactive compensation.

Transformer losses from 400kV to 132kV = **0.5%**

Transformer losses from 132kV to 690V = **1%** (690 V is the operational AC electrical connection voltage of the BESS systems as stated in the manufacturers data sheet. https://info-support.sungrowpower.com/application/pdf/2024/12/07/ST5015UX-2H-US_ST5015UX-4H-US%20Datasheet.pdf)

Battery Round Trip Efficiency (RTE) (Typical range between 90% and 95% but this degrades with age and charge cycles) Not quoted for the

Sungrow ST5015UX-2H-US_ST5015UX-4H-US units specified for Lime Down. Assume 93% RTE, hence **losses of 7%**.

Transformer losses from 690V to 132kV = **1%**

Transformer losses from 132kV to 400kV = **0.5%**

Transmission losses 1.5% back to the grid connection point.

Total Losses of 13% of the energy generated and supplied through the BESS taking advantage of tariff differential.

Because charging the BESS at night uses Combined Cycle Gas Turbine generation (CCGT) (The only source of additional load available at night) we must consider the environmental impacts of this use of generating resource.

Combined Cycle Gas Turbine (CCGT) electricity generation, while more efficient than older fossil fuel plants, causes significant environmental damage in the UK through greenhouse gas emissions, methane leakage, and impacts on water resources. While UK CCGT footprints have improved, reaching as low as **365 gCO2eq/kWh** for modern technology, they still contribute to the nation's climate change goals by requiring decarbonization. [1, 2, 3, 4, 5]

Key Environmental Damages

- **Greenhouse Gas Emissions:** CCGT plants are a significant source of CO2 emissions, responsible for a large portion of the 44.1 Mt CO2e total UK emissions from power plants (excluding biomass) in 2023.
- **Methane Leakage:** Methane, a potent greenhouse gas, can leak during natural gas production and transport, significantly increasing the life cycle GHG emissions of CCGT, sometimes

accounting for roughly 50% of the emissions from European natural gas supply.

- **Water Usage and Thermal Pollution:** CCGT plants require large volumes of water for cooling, which can lead to aquatic environmental damage by:
    - **Discharging water at higher temperatures** than the receiving water, affecting aquatic flora and fauna.
    - **Fish impingement and entrainment**, where fish are drawn into the cooling systems.
- **Air Pollution (NOx):** Combustion processes produce nitrogen oxides (\(NO_{x}\)), which contribute to acid rain and form smog, reducing local air quality.
- **Variable Efficiency Issues:** Operating CCGT plants below their optimum capacity, such as for backup power, can lead to higher fuel consumption and, consequently, increased emission intensities (both \(CO_{2}\) and \(NO_{x}\)) per MWh produced. [1, 2, 3, 4, 5, 6, 7, 8]

Total BESS capacity proposed for Lime Down are 270 x 5MWh (Sungrow ST5015UX-4HLN&ST5015UX4H-US-LN) batteries giving a total capacity of **1.350 MWh**

Assuming all CCGT operate with a CO2 emission of **365 gCO2eq/kWh = 365 kgCO2eq/MWh (**The best-case number)

One full charge of the Lime Down BESS causes 365 x 1.35 = **492.75kg of CO2 emissions** (Plus all the other environmental imapacts of course) **Over one year, this is 179.85375 Tonnes of CO2 emissions**.

Those CO2 emissions would be the same if the demand were met at time of that demand – during the day. Except that, using the BESS incurs losses of 13%, as calculated above.

179.85375 x 13% = 23.38 Tonnes per year of additional CO2 emissions due to Lime Down BESS losses. Over a 60 year operational life this is 1,403 Tonnes of added CO2 emissions.

The UK already has 10.5 GWh of installed BESS capacity.

While many of these BESS will be closer to their grid connection points, and will benefit from lower transmission losses than Lime Down, this is only 3% of the total losses. As battery RTE increases with battery age and charge cycles, and is the largest single contributor to the losses, assuming the same 13% loss to the installed base of BESS is probably being kind to the BESS installed base.

1,403 tonnes CO2 for 1.35 MWh = 17.32 tonnes CO2 per MWh per year. For the installed base of 10.5GWh = **181,860 tonnes CO2 additional per year from the installed base of BESS taking advantage of the tariff differential.**
https://www.renewableuk.com/energypulse/blog/stacking-up-the-storage-where-the-uk-battery-market-stands-in-2025/

Is the assumption of a 60 year operational life valid for Lime Down?
The SSEN paper on "The challenges with undergrounding at 400kV" https://www.ssen-transmission.co.uk/globalassets/projects/2030-projects/2030-project-documents/the-challenges-with-undergrounding-at-400kv.pdf says that the operational life expected of 400kV underground cables is 40 years, mainly due to deterioration in insulation and other factors. This is not consistent with a 60 year operational life for Lime Down.

Wiltshire county council has prepared a paper analysing the carbon debt incurred in construction of Lime Down. This calculates that the Lime Down scheme will only break even in terms of carbon emissions after 50 years. This suggests that schemes like Lime Down “front load” carbon emissions, and continue to increase CO2 emissions before any net benefit is delivered and, without the full 60 year operational life, will be of no benefit at all.

Is Lime Down a secure item of nationally important infrastructure?
No! With 25km of indefensible cable that will be a natural and easy target for any terrorist group or foreign power, it would be highly vulnerable. Additionally, the same SSEN paper cited above states that finding and fixing faults on buried HVAC cable systems can take months. Indeed, the SSEN paper contains a number of reasons not to use buried HVAC systems, any ne of whichundermines the case for Lime Down and its location being so far from the nearest grid connection point.

Conclusions.

The Lime Down solar scheme will damage the environment due to the operational model used to exploit tariff differential. Furthermore, its viability in terms of total carbon impact is negative without an operational life that is inconsistent with some of the components planned for the scheme. It will be a vulnerable element in our national energy infrastructure with either faults or “bad actor” interventions potentially causing months of disruption to availability. It is an ill-considered scheme in the wrong place, bad for the environment and consumers alike.

Written representation from Simon Durrant May 1st