Comment on Applicant response to ExQ1 Q1.3.5 (Timeline)

[APP/8.18, p10] The Applicant has clarified the construction timeline.

Subject to obtaining the necessary consents, construction is anticipated to commence in 2025, and is anticipated to be completed ready for operation in 2027 [APP/1.2; 2.1.3]. It is anticipated that construction will commence no earlier than 2025 and be completed in approximately 24 months, with operation therefore anticipated to commence in 2027 [APP/4.1; 1.2.5]. Subject to being granted consent and following a final investment decision, the earliest the construction of the Scheme could start is 2025 and construction will require approximately 24 months, with operation therefore anticipated to commence around 2027. [APP/4.1; 3.3.1]. Subject to being granted consent and following a final investment decision, the earliest construction could start is in 2025. … will require an estimated 24 months, with operation therefore anticipated to commence in 2027 [PEI Non-technical Summary; 4.2.1]. Subject to being granted consent and following a final investment decision, the earliest construction could start is in 2025. Construction … of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027 [Consultation Report APP/5.2; p14]. subject to being granted consent and following a final investment decision, the earliest construction could start is in 2025. Construction … of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027 [APP/5.2; S-0028]. Construction … of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027 [APP/5.2; S-0149]. Construction … of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027 [APP/5.2; S-0236]. Subject to being granted consent and following a final investment decision, the earliest construction could start is in 2025. Construction … of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027. [APP/5.2; S-0207]. Subject to obtaining the necessary consents, construction is anticipated to commence in 2025, with operation anticipated to commence in 2027 [ES Vol 1 APP/6.1; 1.2.1]. Subject to being granted consent and following a final investment decision, the earliest construction could start is in 2025. Construction … of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027 [ES Vol1; 2.6.1]. the most rapid feasible construction programme for the Grid Connection Cables and solar farm are anticipated to be 12 months and 24 months [ES Vol1; 6.4.9]. subject to the DCO Application being granted consent and following a final investment decision, the earliest construction could start is in 2025. Construction … of the remainder of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027 respectively, with operation therefore anticipated to commence in 2027 [ES Vol1; 8.4.2]. Subject to being granted consent and following a final investment decision, the earliest construction could start is in 2025. Construction … of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027 [ES Vol1 Ch16; 16-26]. Subject to being granted consent and following a final investment decision, the earliest construction could start is in Q4 2024 and construction will require an estimated 18 to 24 months, with operation therefore anticipated to commence around 2027 [ES Vol2 A-1-1; 2.4.1]. Subject to being granted consent and following a final investment decision, the earliest construction could start is in 2025. Construction … of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027 [ES Vol4; 4.3.1]. Subject to obtaining the necessary consents, construction of the Scheme is anticipated to commence in 2025, with a target of being completed ready for connection from 2027 [APP/7.1; 7.6.4]. Subject to obtaining the necessary consents, construction is anticipated to commence in 2025 and be completed ready for operation in 2027 [APP/7.2; p13]. Subject to obtaining the necessary consents, construction is anticipated to commence in 2025 and be completed ready for operation in 2027 [APP/7.2; p16]. Subject to obtaining the necessary consents, construction is anticipated to commence in 2025 and be completed ready for operation in 2027 [APP/7.2; p20]. Subject to obtaining the necessary consents, construction is anticipated to commence in 2025, with a target of being completed ready for operation in 2027. Construction … of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027 [APP/7.7; 2.2.1]. Subject to being granted consent and following a final investment decision, the earliest construction could start is in 2025. Construction … of the solar farm will require an estimated 24 months, with operation therefore anticipated to commence in 2027 [APP/7.16; 3.3.1] …

… might prompt a non-expert to believe that construction would commence in 2025 with operation therefore anticipated to commence in 2027.

Apparently not.

The Applicant's Deadline 1 response to Q1.3.5 corrects this misunderstanding, without resorting to obfuscation, misdirection or waffle:

Subject to the grant of the Development Consent Order, the Applicant would seek to bring the connection date forward with National Grid, if the Scheme can be completed prior to 2029. If this is not viable due to the National Grid upgrade works required, the Scheme will commence building 2 years prior to the connection date, to ensure that the connection is made on the due date. The programme would be arranged to minimise/avoid any period of time between the completion of construction and the connection date.
The draft DCO **[AS-008]** allows construction to begin after the required pre-commencement requirements are approved and up to five years from the date the DCO comes into force. Although the EIA specifically mentions 2025-2027 for construction, where relevant, the technical assessment considers the effect should this be delayed or be protracted for any reason (it is not expected feasible to begin earlier than 2025) and have the potential to create different effects. It is not expected that a later construction period (say 2027-2029) or longer construction period would cause new or different effects to those already outlined in the ES. The latter is more critical to the assessment of impacts and is considered in the technical assessments; for example Chapter 8 Ecology **[APP-060]** (paragraph 8.4.2) states

"Should the construction programme be extended this will not change the results of the EcIA [Ecological Impact Assessment] with respect to flora, as the impact is not affected by the duration of activity but rather the change or loss of any habitats. The impact on fauna is likely to be similar if the construction period is extended, with respect to any habitat loss. The assessment is also considered to represent a worst case in terms of impacts to species. For example, although it is acknowledged that a longer construction period could result in prolonged disturbance, this is unlikely to occur for the majority of the Site due to the sequential nature of the construction programme."

i.e.

1. The National Grid connection date is 2029. [It always was, since 2021]
2. Construction might start two years before the connection date. [i.e. 2027]
3. If the connection date is brought forward, something different might happen.
4. Actually, the DCO[1] [AS-008] says that work does not need to start for five years. [i.e. 2030]
5. Yes, the EIA did mention 2025-2027 for construction. [Pre-application document, 2022]
6. It's fine [APP-060]. Flora and fauna species are not upset by schedule slippage events.

Would BOOM please draw our attention to other clauses that might be misunderstood by a non-expert?

[1] The legally binding statutory document.

Comment on Applicant response to ExQ1 Q1.4.2 (Single Axis Tracker)

The Applicant's reply [APP/8.18, p14] deserves a response. This concerns the rationale for selecting Single Axis Tracker (SAT) over Fixed South-Facing (FSF) for PV arrays.

The Applicant's parent company, Boom Power has previously designed sites in Australia utilising SAT and is comfortable with the high performance of this technology.

This, according to the internet, is not quite correct (see box). Nevertheless, the performance of SAT <u>in Australia</u> is probably excellent. This benefit is also endorsed – apparently a roughly 10% advantage for SAT over FSF – for East Yorkshire in the Statement of Need [APP/7.1]. However, the quality of the scientific method in this submission is, in my opinion, disappointing (see Appendix).[1] In particular, no consideration is given to SAT's fundamental dependence on geographic latitude.

At the equator, the advantage of tracking dominates. As you move further north or south, the benefit diminishes, because the angle of the incident light shifts further away from 90°. FSF (which does not have benefit of tracking) can be orientated to face the sun directly at its peak elevation, regardless of latitude.

Colinsville (Whitsunday Solar Farm) is at 21°S on the edge of a desert and enjoys cloudless skies. Wressle is at 54°N. At 54°N any SAT benefit has all but evaporated, as confirmed by online analysis software.[2]

The attraction of conventional (FSF) PV is that it has no moving parts so requires virtually zero maintenance and repair. The installation cost of SAT is far greater (plus the spare part inventory), and long-term reliability is compromised by the electro-mechanical complexity.

If the ExA is not "*comfortable*" that this solar design is built on deficient science – in terms of SAT and Overplanting methodology – it might request a fundamental re-analysis prior to considering an SoS recommendation for SAT-configured PV at 54°N.

<u>The Applicant's parent company</u> is Boom Developments Ltd, which has two employees (the directors). <u>Boom Power</u> Ltd, a company set up in 2019 by [redacted] has 17 employees (as of 2022) including some former staff of Wirsol Energy Ltd. Wirsol had been set up by [redacted] in 2014 as the UK arm of German solar company Wircon GmbH. Wircon also had an Australian arm, <u>Wirsol Energy Pty Ltd</u> (set up in 2017) based in Sydney. The latter company enjoyed considerable success in Queensland and Victoria for a few years before being sold in 2023 to Malaysian company Gentari for a rumoured 1bn AUD. Wircon became Stavert Energy GmbH in 2024. There was indeed at least one Wirsol Pty farm, Whitsunday Solar Farm (69 MWp), that used SAT frames (from Array Technologies Inc). The farm was built by Bouygues Construction Australia.

[1] The author of the Statement of Need identifies himself in the document. To his credit, the author lists his university qualifications, which do not include Physics or Engineering.
[2] e.g. pvWatts at the US Government National Renewable Energy Laboratory (https://pvwatts.nrel.gov/pvwatts.php). The simulation includes recorded local meteorological data. Solar farm designers use proprietary packages such as RatedPower.

Appendix. The Need for Overplanted SAT (Author Analysis)

Withing the Statement of Need [APP/7.1], the project-specific analysis starts at 6.4.12.

Site Selection

[6.4.13] Based on data in the government's DUKES Table 6.2, BOOM derives a Load Factor (LF) value of 10.4% (average 2016-2022). This is lower than the value calculated by the government statisticians, which can be found in DUKES Table 6.3.[3] This BOOM LF is converted to 910 kWh/yr/kWp, which, in turn, is somewhat lower than the 922 kWh/yr/kWp presented in ES Climate Change [APP/6.1, 6.4.5].

[6.4.14] Nevertheless, this value is used to construct imaginary lines on a map of 1994-2018 data [Figure 6-2]. Happily, East Yorkshire lies to the east of the Aberdeen–Manchester divide.

This faux-science is a distraction. The map speaks for itself:
south-east, good; north-west, bad; Yorkshire is in the middle.[4] That's it.

Technology Selection

The detailed analysis of PV panel configuration (FSF, SAT or E-W) is in section 6.5.

[6.5.2] *There are currently three main configurations of solar panel used in the UK*.

No. There is one: FSF, as used in all operating UK solar farms.
Domestic PV on roofs that do not face south settle for east-west (E-W).

[6.5.11] *Spacing FSF panels further apart increases the ratio of acres / MW*. This is just the definition of 'acres per MW.' It applies equally to FSF, SAT, E-W and electric toasters.

[6.5.12a] *SAT requires more land per MW(p) but has the potential to generate more MWh/MWp than FSF.* Why does it require more land? And how much more MWh/MWp? Where is the evidence?

There is no further analysis of SAT in this section, and latitude is not mentioned. But there are two encouraging graphs in a subsequent section. Figures 6-5 and 6-6 demonstrate that SAT provides around 10% higher energy yield than FSF [6.6.23] (and see below). This is highly relevant, but there is no explanation beyond "Author Analysis." The author must reveal the source data and describe how these curves were derived. Are these using data from the Australian installations?

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[3] It is likely that the low LF figure arose because the notes to DUKES Table 6.2 were overlooked: recorded Capacity data is end-of-year; Generation data is whole-year.

[4] The map was great for Longfield (Essex, *one of the higher solar irradiation areas*) and possibly Sunnica (Cambridgeshire, still *one of the higher solar irradiation areas* apparently), but it was getting a bit tenuous at Gate Burton, Cottam and Mallard Pass (Lincolnshire). It is no help at all once you reach Yorkshire. [Humbeat Ltd: Statements of Need]

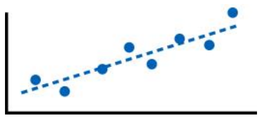
Overplanting

[6.6] In a departure from conventional design practice, BOOM focuses on using overplanting to compensate for PV panel degradation [6.6.4 &c]. This is reasserted in the answer to ExQ1 Q1.5.1 and other recent responses [APP/8.18]. Representative power curves [Figure 6.4] show that an overplanted system exceeds the Connection Capacity (Export capacity) when new, but that with degradation over time the output eventually peaks below it (Author Analysis).

Overplanting ratio

Graphical analysis is employed to determine optimum overplanting ratio [6.6.23]. There is no explanation[5] as to how the curves (SAT and FSF) were derived [Figure 6-5].

"Straight lines of best fit" are superimposed to aid visual analysis, despite the fact that the curves are self-evidently neither empirical nor straight.

> Technical term: A *line of best fit* is used to infer an underlying trend in a dataset of empirical (experimental) values exhibiting random variation. If the underlying function is assumed linear, a *straight line* is used.
>
> 

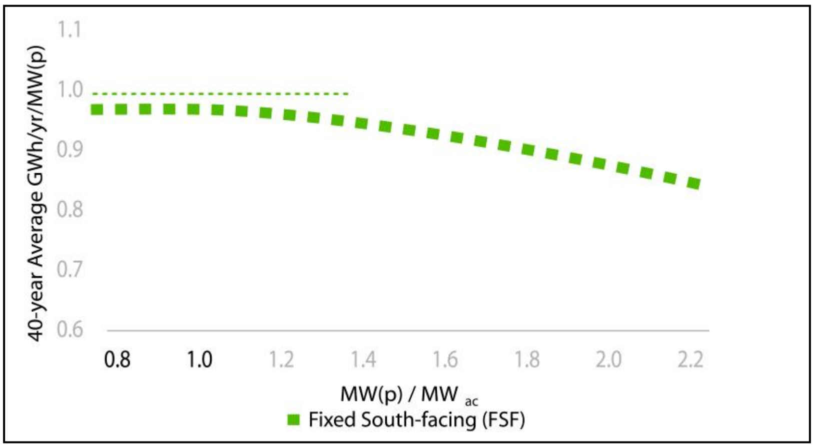
It seems that the "best fit" line is used to determine an x-coordinate where the slope of the line exceeds the gradient of the curve. This, apparently, gives the optimum overplanting ratio (Author Analysis). Why??

The 1.5 value is just the half-way point on the line. If the plot had been extended to 4.4 $MW(p)/MW_{ac}$ rather 2.2, and a longer "best fit" line was drawn, presumably an optimum overplanting ratio around 3.0 could have been deduced.

Figure 6-6 is even more baffling.

One would expect a plot of energy-per-panel against overplanting ratio to be horizontal to the left of $MW(p)/MW_{ac}$=1.0 (dashed green line, right), rather than drooping off.

What is the explanation for the droop?

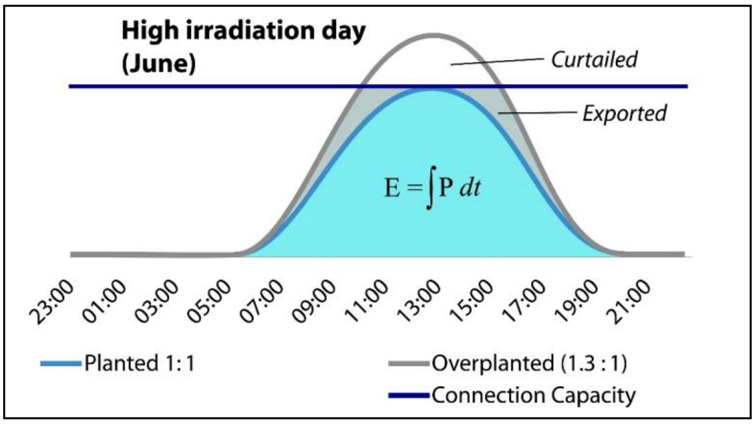


Again, the reader is invited to perceive an 'inflection point' in the curve, this time at around ratio = 1.3 (Author Analysis). There is simply nothing to see there. Bizarrely, there is a hint of 'kink' at around 1.5 for the SAT curve, but without authentication of the "*inputs*," nothing consequential can be inferred from either this or the previous graph.

[5] *"derived from inputs which are appropriate for all solar schemes generally"* [6.6.24] is absurd.

Economic rationale for overplanting

Although panel output is indeed affected by degradation (and soiling, high temperature, etc), overplanting is conventionally justified solely on financial grounds.



At 30% overplanting, some of the panel energy on a high-irradiation day will be discarded ('curtailed,' see figure). However, the exported energy will still exceed that of a unity-planted scheme (blue). At lower irradiance (e.g. left panel in Fig 6-4), all the additional energy from overplanted panels is exported.

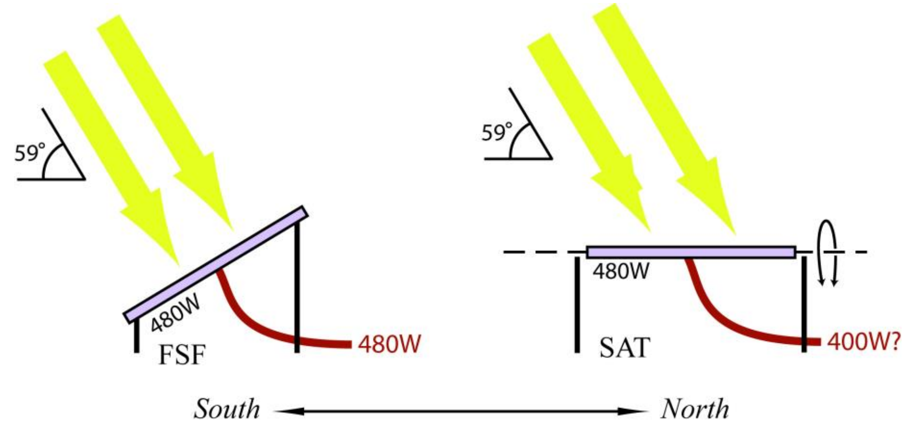
In determining the optimum overplanting ratio, long-term additional financial yield is weighed against the additional up-front cost (panels and land). With excess overplanting, curtailment predominates. Other parameters, such as maximum inverter input voltage, must be considered at the design phase.

It is certainly true that degradation will contribute to the calculation of long-term yield, but overplanting is not (for most solar designers) a technique to overcome the consequences of panel ageing. It pays dividends, literally, from day one.

Comment on Applicant response to ExQ1 Q1.5.1a (Power)

The Applicant has clarified that, currently, the proposed Installed Capacity is 480 MW and the Export Power is 400 MW. The final values will depend on the detailed design process, available technology, overplanting, etc.

With trackers (SAT), unlike fixed panels (FSF), the incoming light never achieves normal incidence (90°).



Peak illumination. For illustrative purposes only. Approximate values. (Author Analysis)

At maximum sun elevation (59°), the SAT incidence angle will be 31° (90° – 59° = 31°). Assuming a *cos* θ solar incidence relationship (for a first approximation), 411 MW DC will be produced by a 480 MW SAT array: 480 cos (31°) = 411.[1]

If the Scheme aims to <u>export 400 MW</u> with 1.3:1 overplanting[2] and (optimistically) total overall losses of 5%, then they should be working with a target SAT <u>Installed Capacity of 638 MW</u> at this stage of the design process, not 480 MW.

$$638 \, cos(31) \times \frac{1}{1.3} \times 95\% = 400$$

That is what I would have written if this was an A Level exam question. I am sure the Physics Examining Authority in those days would have been using the same model answer.

What equation is BOOM using?

Further clarification must be sought for the 480 MW Installed Capacity figure.

[1] A 1kW panel produces a peak output of about 1kW DC (FSF) in central UK.

[2] Statement of Need [APP/7.1] evaluates 1.3–1.5 overplanting ratio. This (1.3) is the less demanding value.

Comment on Applicant response to ExQ1 Q1.5.1b (Power Density)

In the final paragraph of its answer to Q1.5.1 [APP/8.18, p15], the Applicant addresses the "power density" figure (acres per MW) of its proposal. They consider the government's expectation of 2–4 acres per MW to be lacking "detailed technological assumptions or methods for how this has been derived."

The Applicant deserves some sympathy for this opinion. The Applicant deserves no sympathy for its solution – eliminating 1836 acres from the calculated land mass, in order to arrive at a satisfactory figure of 3.83 acres/MW. Nor does it deserve sympathy for using 480 MW (Installed capacity) rather than the output 400 MW (Export power): "MW of output" is specified in the NPS EN-3 language.

The area to be considered is the totality of land that is lost to agriculture and/or public enjoyment in order to fence off the PV generating complex. It is not just the square metres covered in solar panels, substations and related paraphernalia.

The proposal defines the following regions [Statement of Reasons, APP/4.1, 1.3, and elsewhere; areas in hectares]:

966.4	Solar PV plus substations
107.9	Ecology Mitigation (biodiversity net gain)
23.5	Interconnecting Cables
168.9	Grid Corridor (to NG Drax)
9.77	Access routes to site
1276	**TOTAL**

The ecology areas must be excluded.
The Grid Corridor may be excluded if its land is available for agriculture/public once the cables are buried (rather than fenced off – is this specified in the proposal?).

This leaves 999.67 ha. Using the 400 MW figure, this equates to 400 kW/ha (6.2 acres/MW).
If the Grid Corridor is a public exclusion zone: 1168.57 ha; 342 kW/ha (7.2 acres/MW).

Strictly speaking, public rights of way should be also excluded, although their use as public byways is probably at an end. It is hard to conceive that anyone will want to take a dog for a relaxing evening stroll through a dystopian landscape.[1]

The particularly poor power density figures for East Yorkshire compared to other solar farms[2] arise from the fact that the proposal uses a multitude of fields scattered over a vast area. It is entirely appropriate that the performance metric reflects the wider disruption to the environment caused by a patchwork-quilt landscape methodology.

[1] Unless they have run out of dog-poo bags.
[2] see Appendix 6 of *Deadline 1 Submission - Written Representation* on the project's Documents webpage.