Novar 1 Wind Farm Repowering

Chapter 4 - Design Evolution and Alternatives

September 2026



4. Design Evolution and Alternatives

4.1 Introduction

4.1.1 This chapter has been prepared in accordance with Schedule 4 (2) of The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, which requires a description of the reasonable alternatives that have been examined for the project including design, technology, location, size, and scale, and an explanation of why the selected option was chosen, with a comparison of environmental effects.

4.1.2 The following text demonstrates that the design of the Proposed Development has been an iterative process and has evolved in response to the environmental and technical constraints that exist at the Site and in the surrounding area. In accordance with the mitigation hierarchy, the principal objective of the design process has been to avoid adverse effects from occurring in the first place and where this is not feasible, to minimise those effects by reducing their magnitude, extent, duration or likelihood. Where residual effects are unavoidable then compensatory measures have been proposed.

4.1.3 This chapter is supported by **Figure 4.1 Design Iteration** (**EIAR Volume 3a**) and the **Design and Access Statement** which is a supporting document to the EIAR and is referred to in the text as appropriate.

4.1.4 This chapter is structured to provide the following:

- An overview of the design principles for this Site;
- A review of the design principles;
- A history of design evolution and reasonable alternatives studied (noting that this is limited to those which are considered relevant to the Proposed Development); and
- A description of the main reasons for selecting the final Proposed Development.

4.2 Design Principles

4.2.1 In the early stages of the project, a number of principles were established to guide the design process. This considered:

- The existing site characteristics including local, national and international designations;
- The advice in planning policy such as NPF4;
- Relevant guidance including good practice and wind farm design guidance such as *Scottish Natural Heritage (2017) Siting and design of Wind Farms in the Landscape*[1]; and
- Feedback from pre-application engagement with statutory consultees.

4.2.2 It should be noted that wind resource was not a key consideration as the Site has demonstrable high wind speeds and established wind generation, proven by operation of the existing wind farm since 1997.

4.2.3 Table 4.1 outlines key design principles and details how these have been applied to specific topics through considerations and actions during the development process.

[1] NatureScot (2017) Siting and Design of Wind Farms in the Landscape (Version 3a). Available at: https://www.nature.scot/doc/siting-and-designing-wind-farms-landscape-version-3a [Accessed September 2025]

Table 4.1 Application of Design Principles for Novar Wind Farm Repowering		
Topic	**Design Principle**	**Response**
Site Design	Maximise the reuse of existing wind farm infrastructure.	▪ The hardstandings for T10, T6 and T3 would be located on existing turbine hardstandings, although they would be larger than the existing hardstanding areas. ▪ Construction Compound 3 is proposed to be located on an existing turbine location. ▪ 19.5 km of existing Internal Tracks would be upgraded and reused. ▪ The existing Access Route from the public highway to the Turbine Array is being reused but it needs to be widened. ▪ The new substation would be located on the site of the existing substation. ▪ Aggregates from turbine foundations, areas of hardstanding and Internal Tracks would where feasible, be processed on-Site for direct reuse in the repowering construction phase.
Site Design	Avoid wind turbulence from poorly spaced turbines	▪ Minimal overlap of ellipses[2] from proposed turbines and those of the existing Novar 2 Wind Farm.
Construction material	Maximise the amount of construction material that can be won on the Site.	▪ Two borrow pit search areas identified which were then narrowed down to one. It is estimated that the borrow pit search area could provide up to 96,000 m^3 of aggregate which is sufficient to satisfy the construction requirements of the repowered wind farm.
Slope stability	Avoid slopes greater than 10 degrees on straight sections of Internal Track and up to 200 m and 7 degrees on bends.	▪ Upgraded and new sections of Internal Track comply with these parameters.
Existing infrastructure	Avoid impact on existing infrastructure that crosses part of the Site.	▪ On-site swept path analysis indicates existing utility poles and pylons can be avoided.
Hydrology and hydrogeology	Avoid disturbance to deep peat over 1 m in depth.	▪ Desktop studies and Phase 1 and Phase 2 peat surveys have been undertaken to determine depths across the Site. Where feasible, areas of deep peat have been avoided. For example, the original T1 and T2 have been removed from the layout because of potential impacts on deep peat.
Hydrology and hydrogeology	Avoid impacts on existing watercourses.	▪ 50 m buffer applied to all watercourse crossings and in the majority of cases there would be no development activity within 50 m.

[2] Ellipses are buffers surrounding wind turbines used to represent spacing constraints.

Table 4.1 Application of Design Principles for Novar Wind Farm Repowering		
Topic	**Design Principle**	**Response**
Hydrology and hydrogeology	Minimise new watercourse crossings.	▪ New crossings are unavoidable given the number of watercourses across the Site, but all have been designed to accommodate a 1 in 200 (0.5%) annual probability flow, including suitable allowance for climate change.
Hydrology and hydrogeology	Avoid impact on Scottish Water Drinking Water Protected Area (DWPA) catchments.	▪ All proposed infrastructure located outside DWPAs.
Hydrology and Hydrogeology	Avoid impact on Private Water Supplies (PWS).	▪ 250 m buffer applied to all PWS therefore no direct impact.
Landscape and visual	Minimise prominence and influence on sensitive receptors such as Ben Wyvis Special Landscape Area, residential properties, hill walkers and road users. Create a balanced and coherent composition by avoiding turbines appearing at greatly different elevations.	▪ Wirelines of different layout options from 13 viewpoints were created to better understand landscape and visual effects. This modelled turbines at 180 m and 200 m and in different locations. In addition: ▪ All proposed turbines are within the footprint of the existing Novar 1 Wind Farm; ▪ Proposed turbines are slightly downhill from the ridge to minimise the disparity in scale with the existing Novar 2 Wind Farm as seen from local area.
Ecology and ornithology	Avoid impacts on sensitive habitats and species. Avoid adverse impacts on international designations such as the Novar Special Protection Area (SPA).	▪ Detailed surveys have been undertaken across the Site and wider area to identify the presence of sensitive habitats and species and the Proposed Development has been designed to minimise effects on these receptors through the use of appropriate buffers.
Ecology and ornithology	Minimise impacts on woodland and in particular, areas of Ancient Woodland.	▪ Tree survey undertaken to identify the quantity and quality of trees in the areas required to widen the existing Access Route. Where feasible, the requirement for tree felling has been minimised through realignment of the widened Access Route.
Noise	Minimise impact on Noise Sensitive Receptors (NSR).	▪ All NSRs mapped early in the design process and buffers applied (based on baseline monitoring results) to ensure there is sufficient distance to proposed infrastructure. All proposed turbines are outside the NSR buffers.
Cultural heritage	Avoid impacts on heritage receptors such as scheduled monuments.	▪ A minimum 5 m buffer would be applied between the Cladh Churadain Scheduled Monument (Asset 14) and proposed widening of the Access Route. A post-condition photographic survey would be undertaken following completion of these works.

Table 4.1 Application of Design Principles for Novar Wind Farm Repowering		
Topic	**Design Principle**	**Response**
		▪ Where the Access Route would pass through known heritage assets, any remains would be fenced off and vehicles would only use the existing Access Route extent. New ground-breaking works or use by vehicles of areas off the Access Route would be avoided. Where avoidance is not possible, archaeological monitoring through a watching brief within 50 m of the heritage asset extent would be undertaken to preserve by record any surviving features related to these assets.
Cultural heritage	Minimise impacts on built heritage receptors such as listed buildings and gardens and designated landscapes.	▪ Impacts on the setting of sensitive receptors such as Ardross Castle have been taken into consideration in the design of the Proposed Development.
Aviation	Avoid impacts on Inverness Airport radar.	▪ With the exception of T3, all turbines have been sited outside the Line of Sight of the Inverness Airport radar.
Aviation	Minimise the adverse effects of aviation lighting.	▪ There is an agreement with the Civil Aviation Authority for a reduced lighting scheme.

4.3 Interactive Web Map

4.3.1 Using ArcGIS Online, a web map was created to identify and collate all relevant environmental data. The web map facilitated the assessment of potential environmental impacts associated with different design options. For instance, it allowed for a clear understanding of how proposed layouts might affect sensitive habitats, watercourses, and cultural heritage sites.

4.4 Design Evolution and Alternatives Considered

4.4.1 **Figure 4.1 (EIAR Volume 3a)** summarises the Proposed Development design evolution from early feasibility layout to the design freeze layout. During the design evolution process, layouts A to G were produced. The following text explain the changes made through the main design iterations.

Do-nothing Scenario

4.4.2 The Site is occupied by the Novar 1 Wind Farm, which has been operational since 1997. It comprises 34 wind turbines providing an overall capacity of 17 Megawatts (MW). Each turbine has a hub height of 42 m, tip height of a 62 m and rotor diameter of 38 m. Planning permission for the existing wind farm is due to expire in 2031 and in accordance with the conditions attached to the permission, the wind farm would need to be decommissioned and the Site restored. Therefore, the wind farm would continue to generate approximately 17 MW of electricity up to 2031 but beyond this, all energy generation would cease, and the Site would no longer contribute to Scotland's renewable energy generation targets[3]. Policy 11f of NPF4 states that '*Areas identified for wind farms are, however, expected to be suitable for use in perpetuity*'. Therefore, the option of a cessation of generation on the site was dismissed as the long-term use of the Site as an operational wind farm demonstrates that it has suitable wind resource to support future renewable energy generation and existing Internal Tracks and areas of hardstanding on the Site present an opportunity to reuse existing infrastructure.

4.4.3 The existing conditions at the Site could support a repowered scheme which would generate enough electricity to meet the needs of approximately 45,453[4] households every year and for this reason the do-nothing option was rejected by the Applicant.

Alternative Sites

4.4.4 Nadara currently operates the Novar 1 Wind Farm on the Site under an agreement with the landowner and wishes to repower this specific wind farm therefore no alternative Sites were considered.

[3] The Climate Change (Emissions Reduction targets) (Scotland) Act 2019 (as amended 2024) commits to achieving net zero greenhouse gas emissions by 2045

[4] RenewableUK (www.renewableuk.com/energypulse/UKwed): 'Homes Powered Equivalent is calculated using the most recent statistics from DESNEZ showing that annual GB average domestic household consumption is 3,323 kWh (as of December 2025, updated annually). RenewableUK calculates homes powered as the number of megawatts installed (55.8 MW) multiplied by DESNEZ's 'all wind' load factor expressed as a fraction of 1 (0.309), multiplied by number of hours in a year (8,760), divided by average annual domestic electricity consumption (3,323 MWh) expressed in MWh = 45,453 homes powered equivalent [source accessed 09/09/2026].

Design Evolution

Layout A: Early Feasibility (March 2023) (12 turbines)

4.4.5 An initial indicative layout comprised eight turbines, and three areas of additional land were identified with the potential to accommodate additional turbines. Accordingly, four additional turbines were added to the initial layout, resulting in a 12-turbine scheme with maximum tip height of 150 m.

Layout B: Further Site Feasibility (December 2023) (10 turbines)

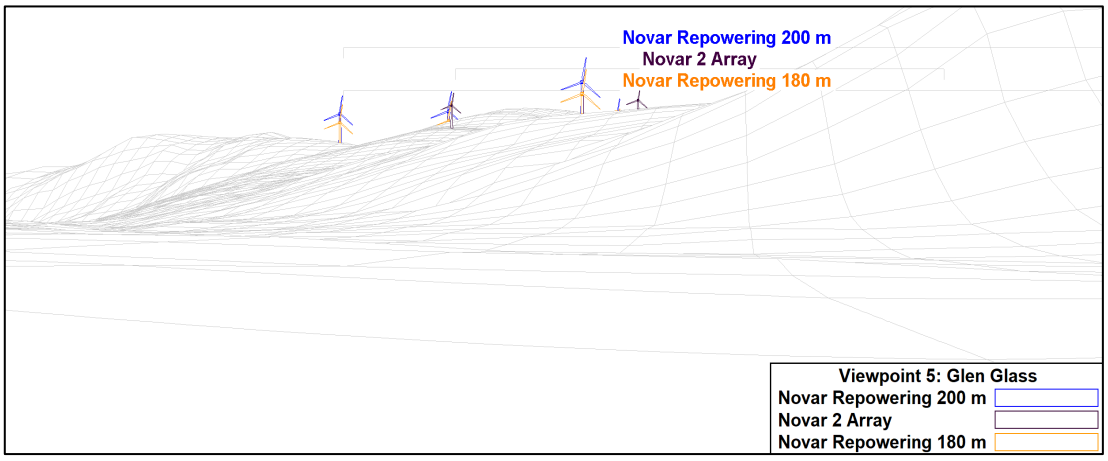
4.4.6 Layout B was created following further refinements to the design of Layout A. Three of the turbines were removed and one more was added to achieve more coherent and condensed layout. Layout B included 10 turbines with a 150 m tip height.

Layout C: Initial LVIA Review (February 2024) (10 turbines)

4.4.7 An initial LVIA review was undertaken in 2024 to consider landscape and visual constraints. After further consideration of wider turbine market and procurement factors, the Applicant also considered the potential use of larger turbines at the Site, with tip heights of up to 200 m.

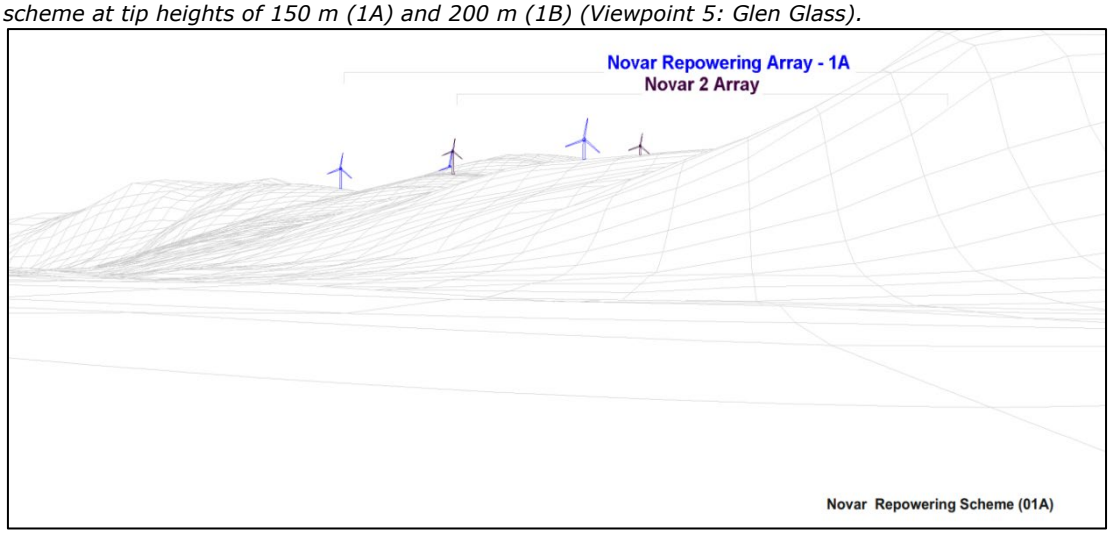
4.4.8 In Layout C, consideration was initially given to turbines of both 180 m and 200 m (maximum blade tip height). The initial LVIA review concluded that the difference in appearance between the 180 m and 200 m turbines was unlikely to be sufficient to affect the level of likely landscape and visual impacts. Wirelines presenting the difference between 180 m and 200 m turbines candidates were produced for three viewpoints, selected to represent a range of landscape and visual receptors at differing elevations and direction from the Proposed Development. Wireline 1 provides an example from Viewpoint 5.

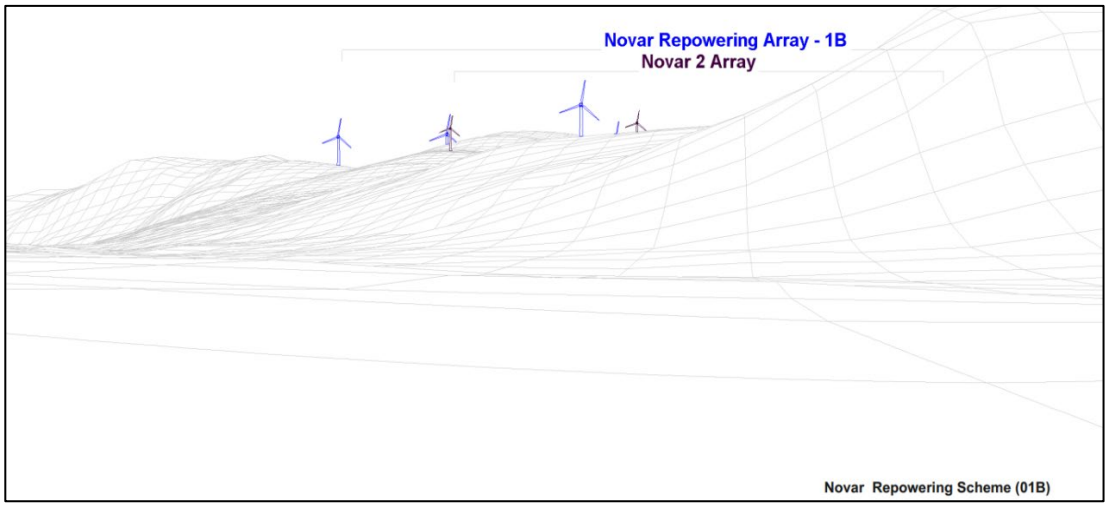
Wireline 1: Example of wirelines prepared in February 2024, comparing 200 m vs 180 m turbine (Viewpoint 5: Glen Glass)



4.4.9 Layout C with 200 m tip height turbines was presented as a worst-case scenario. Comparative wirelines with Layout B and C (150 m and 200 m tip height) were used to better understand the landscape and visual impacts, particularly in the context of the existing Novar 2 Wind Farm. Wirelines prepared from twelve viewpoints indicated that the greatest additional and overall effects would occur from lower-lying locations within straths and glens, including Viewpoint 5, shown in **Wireline 2**.

Wireline 2: Example of wirelines prepared in February 2024, comparing Novar 2 with the repowered scheme at tip heights of 150 m (1A) and 200 m (1B) (Viewpoint 5: Glen Glass).





4.4.10 As a result of this feasibility assessment, coordinates were refined, three turbines were removed, and one was added, resulting in a revised layout C with 10 turbines, each with a tip height of up to 200 m.

Layout D: Further LVIA Review (April 2024) (9 turbines)

4.4.11 Further landscape and visual analysis was undertaken in Spring 2024 to review the repowering layout and identify design recommendations to mitigate the potential landscape and visual effects.

4.4.12 The further LVIA review resulted in two layouts:

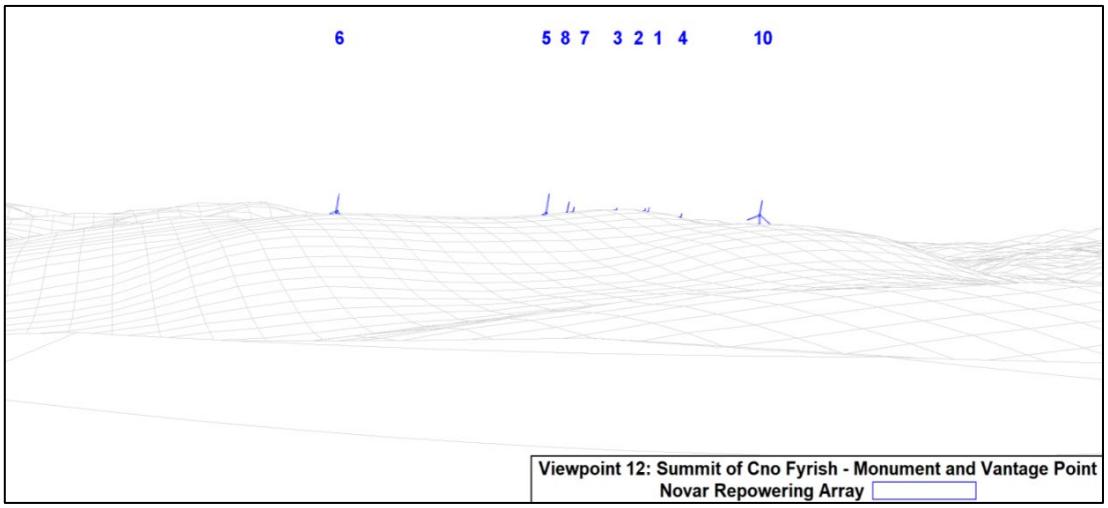
- Layout D1 (9 turbines, 180 m); and
- Layout D2 (9 turbines, 180 m).

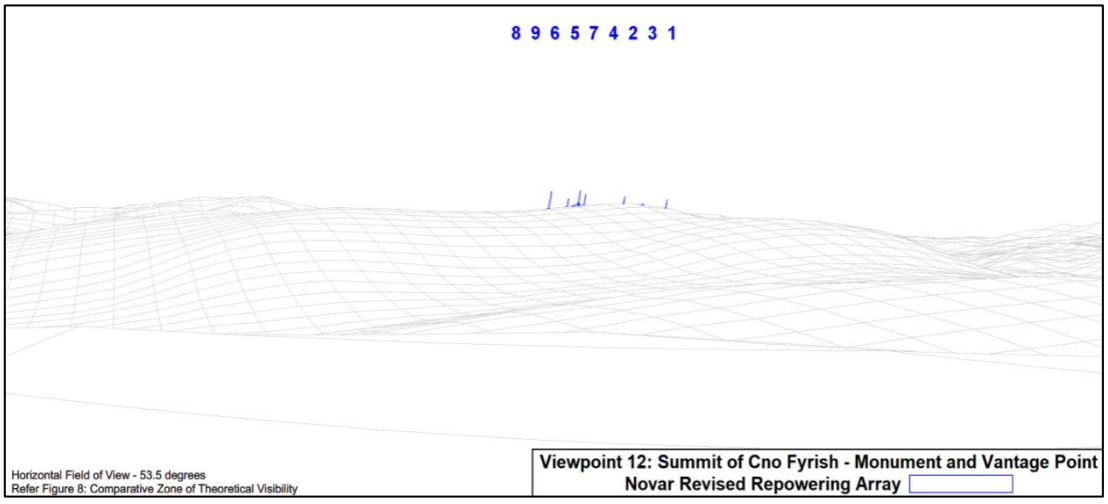
4.4.13 Layout D1 included T1 in the northwest of the Site, whereas Layout D2 included T10 in the south of the Site. The location of T9 also varies between the two layouts. All other turbines were in the same location across the two revised layout options. Initially Layout D1 was compared to Layout C and then Layout D1 and Layout D2 were compared to consider any differences between the inclusion of T1 or T10 as part of the revised array, as well as the varied location of T9.

4.4.14 The appearance of the revised Layout D1 was compared to Layout C in a series of wirelines provided for thirteen viewpoints. Layout D1 in comparison to Layout C represented a reduction in the effect of the Proposed Development at a number of locations, most notably at Cnoc Fyrish (Viewpoint 12) and Diebidale Forest (Viewpoint 13), and provided for a more balanced and coherent array. **Wireline 3** below provides an example of a wireline for Viewpoint 12.

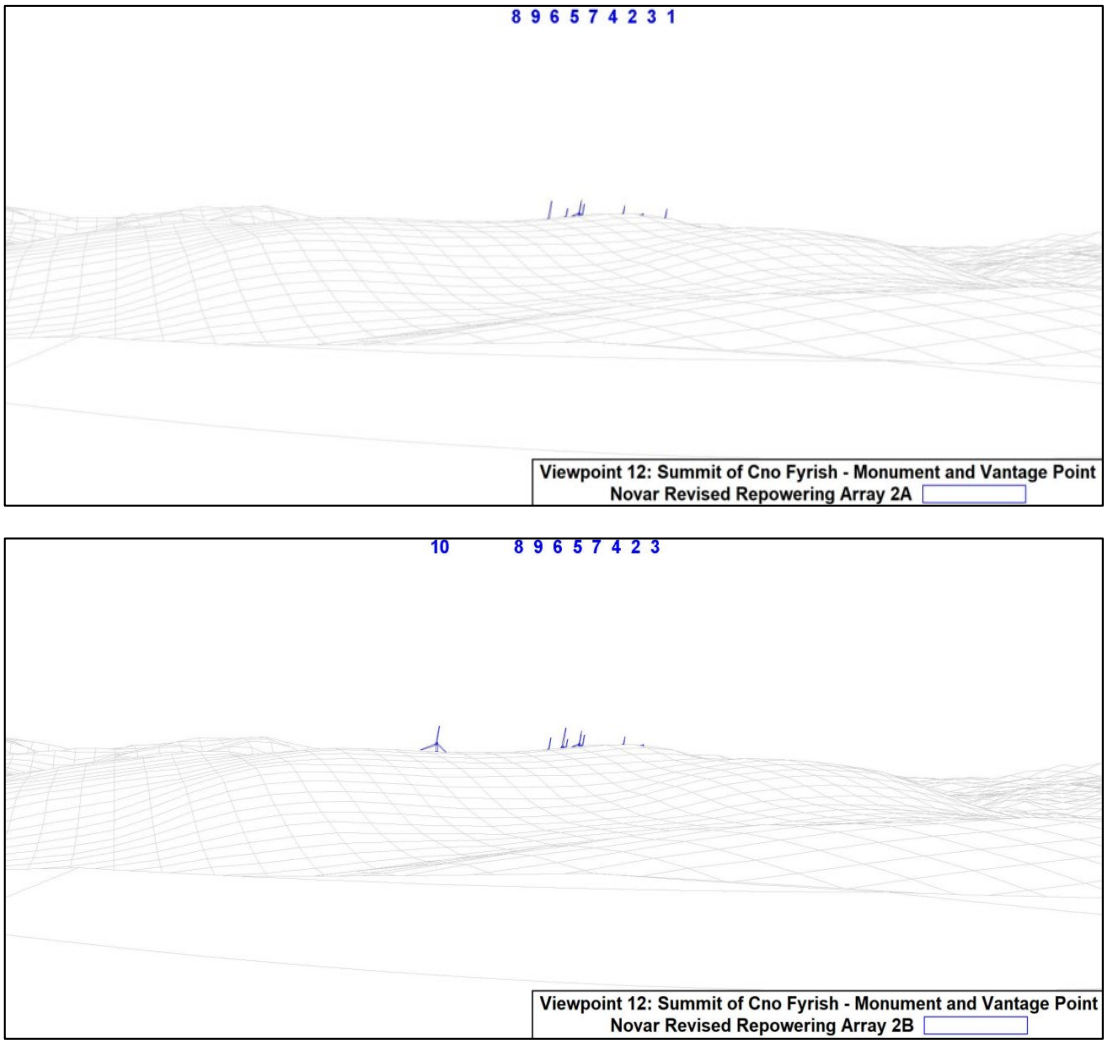
4.4.15 The comparison of Layout D1 and D2 concluded that, whilst there would be limited benefit from the loss of T1, the changes to the location of T9 and inclusion of T10 would introduce some qualitative disbenefits. On this basis Layout D1 was considered the preferred option, albeit marginally. Comparative wirelines for Layouts and D1 and D2 were produced for thirteen viewpoints. **Wireline 4** below provides an example of the wireline for Viewpoint 12.

Wireline 3: Example of wirelines prepared in April 2024, comparing Novar 1 Repowering Array (Layout C) and Novar 1 Revised Repowering Array (Layout D1) (Viewpoint 12: Cno Fyrish)





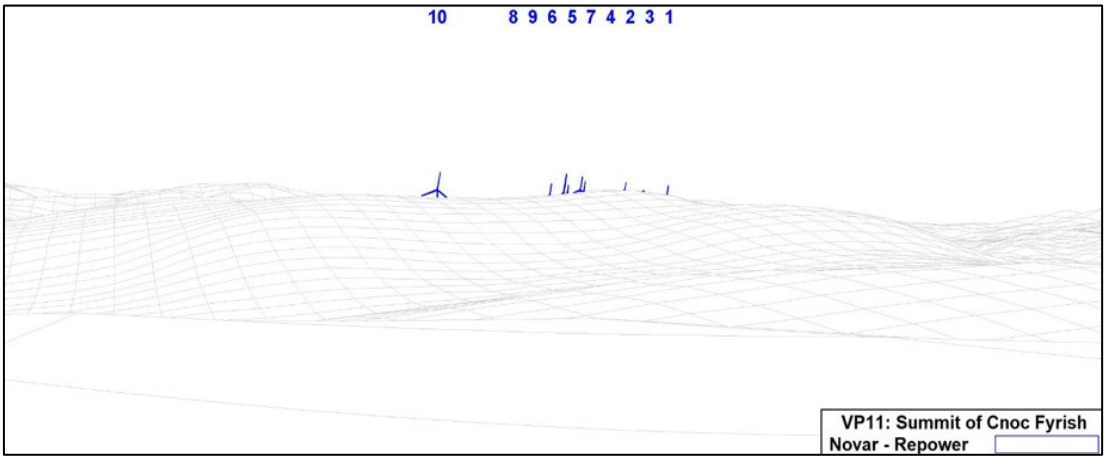
Wireline 4: Example of wirelines prepared in April 2024, comparing Novar 1 Revised Repowering Array 2A (Layout D1) and Novar 1 Revised Repowering Array 2B (Layout D2) (Viewpoint 12: Cno Fyrish)



Layout E: Scoping (January 2025) (10 turbines)

4.4.16 The scoping layout combined elements of Layouts D1 and D2, incorporating T1, T10 and a revised location for T9. This resulted in a 10-turbine layout with a tip height of 180 m. Wirelines were also prepared for the scoping layout, covering thirty viewpoints. **Wireline 5** provides an example, showing the scoping layout from Viewpoint 11.

Wireline 5: Scoping layout wireline (Viewpoint 11: Cno Fyrish)



Layout F: Design Chill (May 2025) (10 turbines)

4.4.17 In December 2024, the first design workshop was led by Ramboll's EIA coordination team and attended by discipline leads for LVIA, peat, ecology, ornithology and aviation, together with GIS support. Layout E was updated based on further environmental constraint information, leading to the development of an amended layout, which was informed by:

- Aviation radar information;
- Results of the Stage 1 peat probing survey;
- Presence of Drinking Water Protected Areas (DWPAs);
- Additional ecological survey information;
- Spacing turbines and forming a linear array; and
- Moving turbines closer to existing infrastructure and onto less steep areas.

4.4.18 In February 2025, an LVIA peer review was undertaken, resulting in further changes in design such as a recommendation to further review the gap between T7 and T8 and the location of T10 to provide a more linear arrangement with the rest of the scheme.

4.4.19 As a result of further surveys and environmental constraints reviews, the following turbine movements were made:

- T1 was moved northwest to address spacing of the layout;
- T3 was moved southwest closer to an existing Internal Track, out of line of sight to radar, to address spacing of the layout and to avoid deeper areas of peat;
- T4 was moved northeast closer to an existing Internal Track, out of line to sight to radar and to address spacing of the layout;
- T5 was moved northeast closer to an existing Internal Track, into a less steep area, into less deep peat and to address spacing of the layout;
- T6 moved southwest closer to an existing Internal Track, out of blanket bog and to address spacing of the layout;
- T7 moved west to address spacing of the layout;
- T8 moved northwest to address spacing of the layout;
- T9 moved west to address spacing of the layout; and
- T10 moved northeast out of a DWPA (Catchment) and to address spacing of the layout and to help with forming a linear array.

4.4.20 In May 2025, an engineering review of turbine locations was undertaken, alongside the preparation of a draft infrastructure design. Two possible options for T10 were considered

(T10A and T10B); T10A was the preferred option due to anticipated requirement for less excavation and fill.

Layout G: Design Freeze (November 2025) (9 turbines)

4.4.21 As result of review of the constraints outlined above and the findings of the Stage 2 peat probing survey, the following turbine movements were made:

- T1 was removed due to deep peat and blanket bog habitat;
- T2 was removed due to deep peat, blanket bog habitat and a DWPA (Catchment);
- T4 was moved west to accommodate hardstanding and to allow track to follow the alignment of the existing Internal Track;
- T5 was moved south to accommodate infrastructure and to allow track to follow the alignment of the existing Internal Track;
- T8 was moved south further away from the watercourse buffer to accommodate hardstanding and earthworks;
- T9 was relocated to the north to move turbine and hardstanding out of deeper peat;
- T10 moved west to accommodate turbine and hardstanding; and
- T11 was added to the layout to maintain a 9-turbine layout.

4.4.22 The Site has been modified as the land which previously accommodated the former T1 and T2 was no longer required. The Site area was reduced by 34.8 ha, bringing the current Site size to 314.8 ha.

4.4.23 The design freeze layout includes two access points:

- Main Vehicular Access Point: the junction of the Access Route and the B817; and
- Secondary Vehicular Access Point: the junction of the Secondary Vehicular Access Route and Boath Road (U1990). This would be used during the operational phase of the Proposed Development.

4.4.24 The Access Route needs to be widened to accommodate the delivery of turbines and associated equipment.

4.4.25 Visualisations for the design freeze layout are included within the **Volume 3b and Volume 3c of the EIAR**.

4.4.26 The final design freeze layout includes 9 turbines with a tip height of 180 m and is shown on **Figure 4.1: Design Iteration (EIAR Volume 3a)**.

Turbine Numbering

4.4.27 Throughout the design evolution process, the removal/addition of turbines resulted in the need to renumber turbines. Turbines renumbering is illustrated on **Figure 4.1 (EIAR Volume 3a)**.

4.4.28 Table 4.2 presents a comparison of turbine numbering across the scoping, design chill, and design freeze phases, alongside the final renumbering implemented for the completed design.

Table 4.2: Turbine Numbering – Scoping and Design Freeze

Scoping (Layout E) Numbering	Design Chill (Layout F) Numbering	Design Freeze (Layout G) Numbering	Final Design (Layout G) Renumbering
T1	T1		
T2	T2		

Table 4.2: Turbine Numbering – Scoping and Design Freeze			
Scoping (Layout E) Numbering	**Design Chill (Layout F) Numbering**	**Design Freeze (Layout G) Numbering**	**Final Design (Layout G) Renumbering**
T3	T3	T3	T1
T4	T4	T4	T2
T5	T5	T5	T3
T6	T6	T6	T4
T7	T7	T7	T5
T8	T8	T8	T6
T9	T9	T9	T8
T10	T10A	T10	T9
	T10B		
		T11	T7

4.5 Design Conclusions

4.5.1 The preferred design taken forward for assessment is described in detail in **Chapter 3: Site Description and Proposed Development (EIAR Volume 2)** and shown in **Figure 1.3a (EIAR Volume 3a)**.

4.5.2 The design process has resulted in a Proposed Development that balances efficient energy generation with environmental and technical constraints. The careful design of the layout of the proposed turbines and associated infrastructure, and the reduction in turbines from 12 (layout A) to 9 (layout G) has resulted in the avoidance or reduction of a number of potentially significant effects from the Proposed Development as far as reasonably practicable.