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Productive Capacity Assessment – Helios Solar Farm, 126 Taylor Road, Ongaonga

Prepared for:
Helios Energy Ltd

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1.0 EXECUTIVE SUMMARY

Helios Energy Ltd (Helios) propose to develop an Agrivoltaic solar farm across 239 ha of land located at and around 126 Taylors Road, Ongaonga, Central Hawke's Bay. The solar farm will be integrated with a programme for sheep grazing to minimise or mitigate any actual loss or potential cumulative loss of the availability and productive capacity of highly productive land (HPL) on the site. As Land Use Capability (LUC) Maps identify portions of the proposed lease footprint contain LUC Class 1 and Class 2 soils, the proposal must be assessed against requirements of the *National Policy Statement for Highly Productive Land*.

The proposed Agrivoltaic Solar Farm is characterised as specified infrastructure within the *National Policy Statement for Highly Productive Land* under which Clause 3.9(3) directs territorial authorities must undertake measures to minimise and mitigate any actual or potential loss of the availability and productive capacity of highly productive land while avoiding where possible reverse sensitivity effects on land based primary production.

Our assessment has identified that while LUC Class 1 and Class 2 areas are present, Helios have developed a proposal that avoids highly productive land as far as practicable in the first instance. Where the proposal cannot avoid LUC Class 1 and Class 2 areas, mitigation of the actual or potential loss of highly productive land will be undertaken by incorporating land based primary production into the project via grazing sheep across the lease area in accordance with the accompanying Land Management Plan.

The proposed lease area (239 ha) encompasses approximately 56.81 ha of LUC Class 1 and LUC Class 2 land within its extent. The remainder of the lease area, being approximately 182.19 ha, is classified as LUC Class 4 land. Within these mapped LUC Class 1 and Class 2 areas, constraints are present in terms of the soil typology mapped. Site investigations identified approximately 25.38 ha of LUC Class 2 land is subject to significant constraint due to lack of topsoil and very gravelly conditions while some 3.17 ha of LUC Class 1 mapped areas are underlain by a very shallow gravel pan. Based on these observations, AgFirst notes that the proposal would encompass a maximum of 10.21 ha of LUC Class 1 land and 18.05 ha LUC Class 2 land considered largely free from constraints, i.e. a total of 28.26 ha.

Within this 28.26 ha of LUC Class 1 and Class 2 unconstrained HPL (being approximately 11.3% of the total leased area), a maximum shaded area of 35% may occur when the panels are tilted parallel to the ground (i.e. at their maximum site coverage), meaning a total of 9.891 ha of HPL may see a reduction in pasture growth. International research from Alyssa et al. 2021 quantifies a potential herbage yield loss of 38% dry matter within shaded areas but noted that growth rates for lambs are not expected to be significantly reduced.

With regards to Clause 3.9(3) of the *National Policy Statement for Highly Productive Land*, the development of specified infrastructure and its use is considered an appropriate development for the area as:

- Measures to avoid, minimise, and mitigate impacts on productive capacity have been employed successfully such that the solar farm will form an integrated mixed-use model of Agrivoltaics and land based primary production; and
- The proposed Agrivoltaic Solar Farm does not introduce a landuse into an area of land based primary production that would be subject to impacts from those surrounding

land based primary production activities. Instead, the proposal diversifies an existing land based primary production activity to provide greater resilience within an area subject to significant climate and soil constraints. No reverse sensitivity effects are therefore expected to arise.

2.0 PROPERTY DETAILS AND OVERVIEW

Helios Energy Limited (Helios) is proposing to construct and operate an Agrivoltaic solar farm at 126 Taylor Road, Ongaonga. Designed for an operational life of 35 years, the project will generate and deliver power to the National Grid via a connection at Transpower's nearby Waipawa substation.

AgFirst Hawke's Bay (AgFirst) has been engaged by Helios to provide:

- An assessment of the proposed use of the land for the Project against the provisions of the *National Policy Statement – Highly Productive Land* (NPS-HPL), specifically:
  - The exemption pathway for new specified infrastructure to be established on HPL.
  - Describe and assess the effects of establishing and operating a solar farm on the productive capacity of the land;
  - Identify how Helios will minimise or mitigate any actual loss or potential cumulative loss of the availability and productive capacity of HPL; and
- Advice in the form of a draft Land Management Plan on how to manage a sheep operation within the Project, considering the land type and conditions in the area on matters such as:
  - Livestock and grazing management policies;
  - Predicted pasture growth and control;
  - Livestock numbers to be managed;
  - Farm infrastructure;
  - Irrigation (if required); and
  - Stock access.

2.1 Description and Location

The subject site outlined in red is made up of three land parcels (Figure 1) under three ownerships demarcated in yellow, green, and blue. The properties are legally described as:

- 126 Taylor Road, Ongaonga (Lot 4 DP 568563) (yellow);
- Lot 1 DP 27344 (green); and
- Lot 2 DP 21496 (blue).

The total area of the three landholdings is 403 ha, however 239 ha has been identified as the total lease area for the Project.

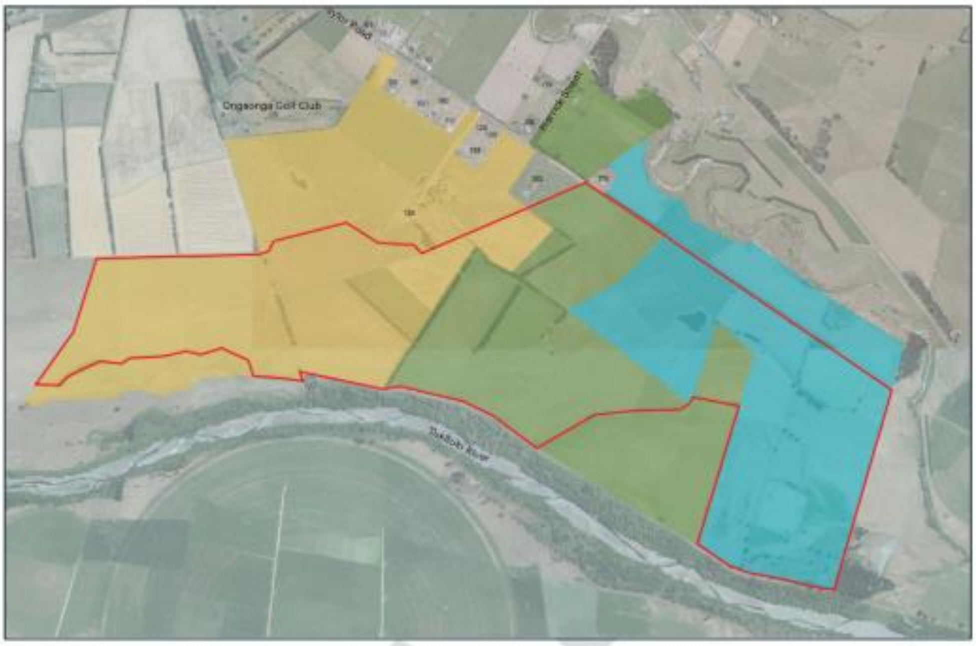

Figure 1: Image showing proposal area (red outline) and land parcels (yellow, green, blue).

2.2 Proposed Development

Development of the Agrivoltaic Solar Farm will comprise pile driven steel posts to support a Single Axis Tracking system, enabling solar panels to rotate slowly easy to west, following the course of the sun each day. Each panel measures approximately 1.2m by 2.4m and will be installed at a maximum height of 2.8m from relative ground level.

Solar panel heights are expected to range between 0.7 and 2.8m above relative ground level depending on the time of day and position of the panels on the tracking system. Additional development works for cabling and transformers will be necessary alongside connection to the Waipawa Substation. A copy of the proposed development plan is included as Appendix A while a schematic of typical solar panel construction is shown in Figure 2.

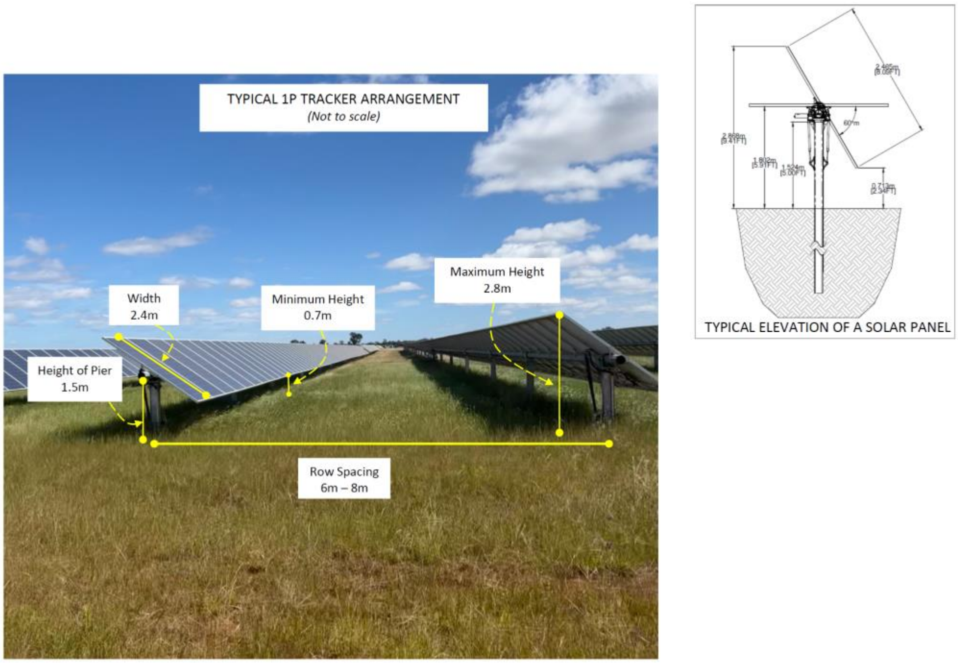

Figure 2: Typical Solar Farm Construction Details.

3.0 CURRENT LANDUSE AND COVERAGE

The full extent of the proposed lease footprint (239 ha) is currently utilised for pastoral farming enterprises, across all three landholdings. Some cropping has been undertaking in the south-east portion of the lease footprint.

3.1 Topography

While generally flat, the site has some notable changes in contour provided by overland flow paths and historic river flow footprints. The first terrace is adjacent to Taylor Road which then drops into an incised overland flow path, flowing from west to east across the centre of the lease footprint. This lower level remains across much of the site towards the south east, at which point a second small terrace is noted rising to a flat level adjacent to the Tukituki River.

A shallow gradient overall is noted with the western extent of the site 212m above sea level, sloping gradually to the east to 181m above sea level.

3.2 Existing Consents

A review of the Hawke’s Bay Regional Council consents database shows that no current regionally administered consents are recorded against the property while a review of the Hawke’s Bay Regional Council groundwater well database does not record any groundwater wells within the lease footprint.

3.3 Adjacent Landuses

Land uses surrounding the site are a mix of rural, (notably consistent with the land use of the lease area being pastoral grazing with small areas of cropping) and rural residential landuses with dwelling located adjacent and along Taylor Road to the west of the Project site. In the wider extent of Central Hawke’s Bay, rural landuse is dominated by pastoral enterprises with pipfruit orchards and viticulture also becoming prevalent.

3.4 Hazards

Review of the Hawke’s Bay Regional Council Hazards Portal identifies that a significant portion of the lease area has been identified as a flood risk (Figure 3), with the footprint of flood hazard correlating to the extent of Land use Capability (LUC) Class 4 land. No other hazards were noted to be present.

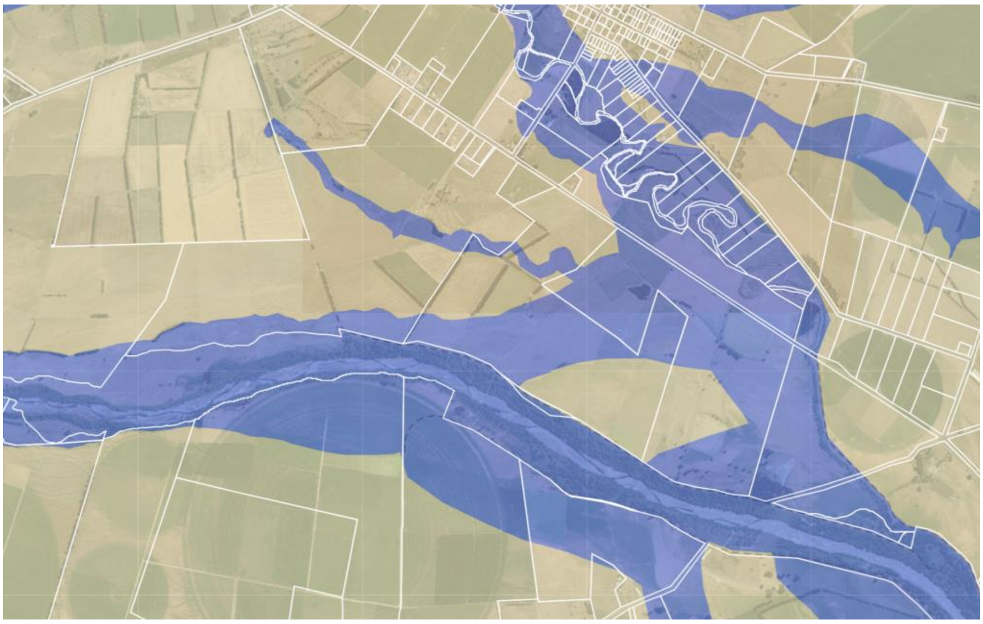

Figure 3: Flood Risk Areas (Blue = High Risk, Yellow = Low Risk).

4.0 LANDUSE CAPABILITY

LUC mapping has characterised land into seven classes based on its long-term capability to sustain one or more productive uses based on its physical limitations and site-specific management needs. Productive capacity is dependent on physical qualities of the land, soil, and environment with LUC Classes 1, 2, and 3 regarded as being highly productive.

LUC maps from Hawke's Bay Regional Council and Manaaki Whenua identify the Project site across a mixture of LUC classifications with Class 2 in the eastern portion (2w1), Class 1 (1c1) in the north-western and north-eastern portions and Class 4 (4s5) across the remainder of the site. LUC Class 1 and soils are defined as: "*Arable, subject to minimal limitations. It has high versatility and is suitable for cropping, viticulture, berry fruit, pastoralism, tree crops and Forestry*". LUC Class 2 land is similarly versatile, but does have minimal physical limitations for arable use, which are generally controllable by management and soil conservation practices.

The single most important limitations identified for the site are varied for each class as follows:

- Class 1 – climate;
- Class 2 – wetness; and
- Class 4 – Soils.

The LUC Mapping Classes across the Project site are shown on Figure 4.

Figure 4: Outline of the subject site, showing the location of LUC Class 1 (dark red) and Class 2 (orange) soils.

5.0 MAPPED SOILS

Soils mapped within the properties are variable with Ashburton_38a.1 and Rangitata_35b.2 soils corresponding to the LUC Class 4 extent through the centre of the site. Ashburton_38a.1 soils are Fluvial Raw Soil, lacking distinct topsoil and typically formed in alluvial sand, silt, or gravel deposited by running water and generated by hard sandstone parent materials. Soils are expected to be well drained with low vulnerability of water logging and moderate water holding capacity. Due to their age, high structural vulnerability and high nitrogen leaching potential are noted. Rangitata35b.2 soils are similar being a Typic Fluvial Recent Soil, but with a distinct topsoil layer formed and a B horizon being limited or weakly expressed. Rangitata_35b.2 soils are also well drained, with low vulnerability to water logging, but expected to have lower water holding capacity and also being at risk due to very high structural vulnerability and high nitrogen leaching potential. A low confidence of Ruamananoa_14a.1 soils occurring within the eastern extent of Class 4 soils is also noted. Ruamananoa_14a.1 soils are also a Fluvial Raw Soil consistent in characteristics with Ashburton_38a.1 soils, but expecting more loam characteristics as opposed to the sand dominance expected by Ashburton_38a.1.

Matapihi_28a.1 soils are mapped as corresponding to the footprint of LUC Class 2 Soils, being a Typic Recent Gley soil formed in alluvium from hard sandstone parent rock. Matapihi_28a.1 soils are poorly drained with moderate vulnerability of waterlogging and high structural vulnerability. While soil water holding capacity is high, a very low nitrogen leaching potential is expected and limited aeration in the root zone is likely to correspond.

Areas of LUC Class 1 soils in the northern portion of the Project site are expected to correspond to either Hastings_29a.1 (medium confidence) or Lumsden_8a.1 (low confidence), both Typic Orthic Gley Soils. Gley soils are strongly affected by waterlogging and have been chemically reduced causing reddish brown or brown mottles within light grey subsoils. Generally, these soils are poorly drained, have moderate vulnerability of water logging, high structural vulnerability and low risk of nitrogen leaching. Hastings_29a.1 soils are expected to have a loam topsoil and subsoil dominated by sand textures and a gravel content of less than 3%. In contrast, Lumsden_8a.1 soils have a silt dominant topsoil, with subsoil similarly dominated by silt and a very gravelly layer present between 45cm and 100 cm.

Drainage characteristics from Manaaki Whenua Landcare Research S-Maps are set out in Figure 5 below.

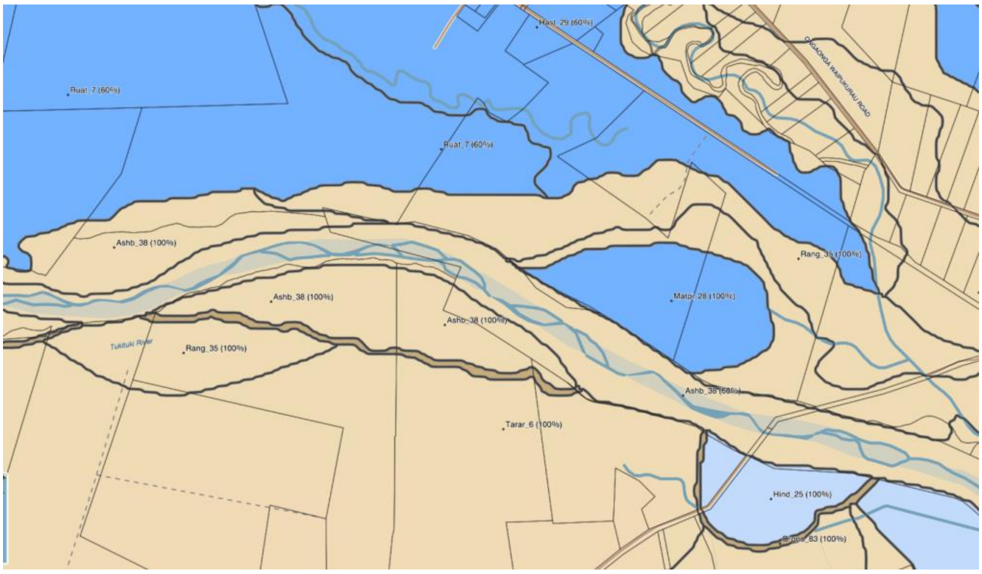

Figure 5: Landcare Research S-Maps Soil Drainage Characteristics (poorly drained in dark blue, well drained in tan.

6.0 SITE INSPECTION AND GROUND TRUTH

AgFirst undertook a site inspection and walkover on 20 February 2024 focussing on the central extent of the lease area, being the Bradley owner land (shown as green on Figure 1). This portion was the focus of assessment due to the variability shown in LUC and soil characteristic mapping. At the time of inspection, the site was being used for dry stock finishing with lambs being finished in the north and cattle being grazed across the south and out of the lease footprint.

Vegetative cover across this central extent of the lease area was noted as variable; clearly corresponding to the different soil types present, and responding to land management practices. Within the paddock adjacent to Taylor Road, a new pasture cover of clover mix had been established within recent seasons, and some areas of higher gravel content were visible with reduced sward cover. Moving towards the Tukituki River and evidenced in the change in topography to LUC Class 4 land, the pasture sward greatly reduced and the prevalence of weed species increased. Common Mullein (woolly mullein), a biennial weed species was prevalent, and unpalatable pasture grass species were also noted amongst the very gravelly soils.

Discussion with Mr Sam Bradley (landowner) at the time of the site inspection further verified the observations made within his portion of land, notably:

- The best areas of soil for his production purposes are the LUC Class 2 soils towards the Tukituki River. These have been omitted from the lease footprint due to the value they present for dry stock finishing and will continue to be used by Mr Bradley for drystock finishing during the operation of the solar farm;
- Soils throughout the centre of the site are very prone to drought impacts due to their gravel composition. The high levels of gravel at surface and lack of topsoil restricts the use of these areas as machinery cannot be used effectively and the lack of topsoil limits the duration in which high quality pasture can be grown;

- Lucerne has been planted in portions of Mr Bradley's landholding to improve productivity as it is a higher quality feed; however it is yet to be proven effective due to the ground composition and influx of weed species; and
- The overland flow path does carry water flow during rainfall events from upstream sources.

Copies of site inspection photographs are included in Appendix B.

6.1 Soil Profiles

Five test pits were excavated via hand spade during the site inspection to assess soil profiles present (Figure 6). Test pit logs are included in Appendix C.

Figure 6: Test Pit Locations[1] (green dots).

Consistent with the mapped extent, variable soil conditions were identified with distinct topsoil and higher quality soils present in the areas noted to be LUC Class 1 and Class 2, and lower quality soils present through the areas noted to be LUC Class 4. The extent of very dry gravelly soils mapped against the edge of the LUC Class 4 extent was noted to be inaccurate, and in fact correlates to the fence line and edge of the lease area, identified via a noted terrace height between LUC Class 2 and Class 4 extents in this western portion. The change from LUC Class 1 to Class 4 is also defined via a terrace, however test pit excavation noted that the soil changes more gradually than the initial terrace separation would suggest.

Rooting depth across test pits varied and corresponded to the different soil typologies, with rooting depth in the areas of TP01, TP04 and TP05 having good root structure and depth, and areas of TP02 and TP03 having very little root depth present. Earthworms were observed at TP04 consistent with observations of good topsoil structure, notable B horizon and some moisture holding capacity. The lack of earthworms at other test pits is a feature of the gravelly layer preventing any significant depth being reached and dry conditions at the time of the site

[1] HTP04 is within the Lease footprint, adjacent to the boundary however the scale of the map and acute angle distorts its true position.

inspection. Aside from TP04 where deep silt dominant soils were encountered and TP02 where the bank edge was utilised, gravel layers prevented the remaining three test pits from exceeding 300mm in depth.

7.0 PROPOSED LIVESTOCK GRAZING

In support of the proposed mix use model, a Land Management Plan for Livestock Grazing has been prepared alongside this Productive Capacity Assessment. The proposed management strategy for Livestock Grazing has been compiled to:

- Provide a self-contained system for grazing of sheep across the lease area where there are no requirements to utilise external grazing;
- Implement a mixed age terminal ewes flock will be implemented at 1670 head with lambs born from terminal ewes finished over summer autumn and last draft sold store of as finished depending on store market; and
- An additional 400 tail end lambs are retained and finished from October through to early November as a point of flexibility in the system to cope with fluctuating pasture growth.

Modelled pasture growth across the full 239 ha lease footprint has confirmed that for an average year, the proposed livestock numbers are appropriate for the conditions on site. A slow rotation of 60 days across the farm is proposed based on 10ha maximum paddock sizes, with flexibility to adjust to greater paddock subdivision to separate lighter condition and younger ewes for preferential feeding. Fertiliser application will be essential to maintain livestock production. Irrigation is not considered feasible or appropriate for the site due to the economics of irrigating pasture grass – that is, a high capital investment cost is required that will not be recouped due to the low returns obtained from sheep.

Profitability modelling confirms that the pastoral unit on its own will be profitable over the long-term basis, even with a reduction in net farm profitability due to the reduced rates of production.

This model has been compiled based on the full extent of the lease area of 239ha and does not distinguish the LUC Classes at a granular level.

8.0 PRODUCTIVE CAPACITY ASSESSMENT

Using the Manaaki Whenua LUC overlays against the proposed lease extent, AgFirst estimates that the proposed lease footprint encompasses 13.38 ha of LUC Class 1 land and 43.43 ha of LUC Class 2 land at the 1:50,000 mapping scale. The remaining 182.19 ha of development area is located on LUC Class 4 soils.

8.1 Identified Constraints

A site inspection undertaken by AgFirst has identified that conditions on site change gradually and a distinct terrace separates the LUC Class 4 from Class 2 characterised soils in the southeastern portion of the lease area. Test pit excavation and visual observations identified that 25.38 ha of mapped LUC Class 2 soils are subject to significant constraints due to the lack of topsoil and very gravelly soil conditions present in this area. Similarly, 3.17 ha of mapped LUC Class 1 soils are noted to have limitations due to a very shallow gravel pan being present in the northern portion of the site.

Discussions with landowners Mr Sam Bradley and Mr Duncan Holden noted that alternative primary production enterprises have been explored including lucerne and viticulture enterprises. However no other traditional land based primary production has proven to be suitable for the sites at this stage. Any alternate forms of land based primary production are likely to require appropriate volumes of water for irrigation, and as no water take resource consents currently exist within the lease area, this is also a notable constraint.

Based on observations and discussions, AgFirst considers that the proposal encompasses a maximum of 10.21 ha of mapped LUC Class 1 land and 18.05 ha of mapped LUC Class 2 land largely free from constraint for productive purposes. Therefore, a cumulative total of 28.26 ha out of the 239 ha lease area for the solar farm proposal (being approximately 11.8%) has been calculated as the maximum potential HPL that could be subject to loss of productive capacity if the solar farm development prevented the continuation of land based primary production.

8.2 Potential Impact of Shading

As the proposal is for a continued pastoral farming enterprise, the cumulative total of 28.26 ha of HPL and its associated productive capacity use loss will not arise. Rather, grazing will continue and as such, the impact of the panels on pastoral grass growth and quality will determine what, if any, productive capacity may be lost.

Alyssa et al. 2021[2], evaluated herbage yield and lamb growth in an Agrivoltaic system under a pastoral grazing in Oregon which identified:

- Solar pastures produced on average 38% less dry matter under fully shaded areas. Dry matter production did not differ between partially shaded or open areas;
- Pasture quality was improved under shaded areas;
- Lamb average daily liveweight gains per head were no different between solar and open pasture;
- Liveweight gains per hectare were not significantly different between solar and open pasture; and
- Stocking rate was higher under solar panels and pasture cover was lower, however it is unclear the reason behind the higher stocking rate.

Alyssa et al. 2021 suggest that the lower dry matter production under panels was offset by the higher pasture quality leading to no overall difference in livestock production. A copy of the abstract is included in Appendix D.

Panels assessed by Alyssa et al. 2021 were based on a 6-metre spacing; However panel size was not specified, and under panels areas were defined as 50% partially shaded and 50% full shaded. In applying this research to the New Zealand context and Helios's proposal, AgFirst suggests that a conservative approach is used for interpreting the Alyssa et al. 2021 research, and adopt the finding of a 38% reduction in dry matter production under fully shaded areas. Helios' Agrivoltaic Solar Farm design identifies the maximum area of shading from panels when titled parallel to the ground (i.e. at their maximum site coverage), and other infrastructure is 35% of the site area,

[2] Alyssa et al. 2021. Herbage yield, lamb growth and foraging behaviour in agrivoltaic production systems. Frontiers in Sustainable Food Systems. April 2021.

meaning 65% is not shaded when the panels are tilted parallel during the day (generally around midday).

Conservatively, a 38% reduction in dry matter production is expected across 83.65 ha with the remaining 155.35 ha unimpacted. Applying this to the maximum extent of LUC Class 1 and Class 2 land that is not subject to significant constraint (28.26 ha) identifies that a total of 9.891 ha of HPL within the 239 ha lease footprint may be impacted by a 38% drop in pasture production. This is less than 5% of the total lease footprint and is therefore negligible when assessing pasture growth across the full 239 ha lease area. The accompanying Land Management Plan demonstrates a profitable pastoral farming enterprise will be integrated with the agrivoltaics when this minor degree of shading of HPL is accounted for.

8.3 Impact of Proposal on Productive Capacity

Based on the findings of this assessment and recommendations outlined in the Land Management Plan to be implemented, it is considered sheep can be successfully grazed within the Project site as a complimentary agricultural application of the land, minimising or mitigating any actual loss or potential cumulative loss of the availability of HPL.

The NPS-HPL definition of productive capacity is focussed on land based primary production over the long term'. Production can therefore be divided into (a) the 35-year period under which the solar panels are installed and (b) after the Project is decommissioned and the land remediated. The Impacts of each of these are set out in turn below.

PRODUCTIVE CAPACITY DURING THE 35 LIFECYCLE OF THE PROJECT	
Physical characteristics	
Soil Type/Profile	No impact on soil type or profile will arise. Posts supporting the solar panels will be pile driven, in a similar fashion to most fence posts or kiwifruit support structures.
Soil Properties	Any minor soil disturbance caused by trenching is likely to be similar to installing water pipes in a farming situation and will not cause long-term or permanent change. Subsoil and topsoil will be separated and correctly backfilled during the trenching process in line with good solar practice internationally. Soil compaction will not change given the high gravel content of soils observed on site.
Soil Fertility	Soil fertility influences pasture production. It is important to note that soil fertility is a <u>temporary</u> factor that does not influence the underlying land use capability status of the land. Key influences of soil fertility include the soil parent material, rainfall, and removal of nutrient via production (e.g. meat), and application of fertiliser. The small change in livestock production to remove beef cattle and focus solely on sheep will likely result in a lower rate of nutrient

	removal via product, and thus lower levels of fertiliser applications will be required to maintain soil fertility. It is anticipated that soil fertility will be maintained during the project by applications of fertiliser.
Soil nutrient leaching	No change in soil nutrient leaching is expected. The areas are predominantly sheep grazed already, but the removal of beef cattle may result in a net positive impact.
Soil Drainage	Existing drainage network will be retained and maintained throughout the duration of the solar farm.
Contamination	The solar panels are predominantly aluminium, glass and silicon, with electrical components encapsulated within sealed glass, and framed with aluminium to be watertight. A very limited amount of lead (0.01%) has been noted by Helios within the photovoltaic panel but is sealed and has strong physical and chemical attachments to other componentry within the photovoltaic panel. No potential for contamination or chemical runoff will result from the proposal.
Versatility	Throughout the duration of the Project there will be some reduction in the ability to change land use. For example, it will not be a practical option to graze cattle on the property whilst the panels are in place. However, this is no different to many other land based primary production. For example, if the land were to be planted into forest, this would also limit the land use options throughout the duration of the timber crop. In fact, the Project enables a dual land use opportunity, which could also be expanded to integrate other options such as beekeeping.
Potential rooting depth	There will be no change to potential rooting depth for pastures or any plant as no impacts to soil will arise.
Pasture Production	There is limited research information available that quantifies the impact of solar panels on pasture production. A relevant research paper[3] suggested that dry matter within pasture production under solar panels (not the area outside the panels) would be reduced by 38%, although animal production was not affected (due to benefits of shade in hotter temperatures). The abstract of this research has been included in Appendix A of this report. The case study in question also considered a solar farm with fixed tilt solar panels rather than those which track the sun, have wider row spacing and allow more light to hit the ground as is proposed by Helios for the Project. Taking a conservative approach, on the assumption that the solar panels will cause some degree of temporary shading, it has been assumed that there will be some impact on the amount of solar

[3] Alyssa et al. 2021. Herbage yield, lamb growth and foraging behaviour in agrivoltaic production systems. Frontiers in Sustainable Food Systems. April 2021.

	radiation on the pastures and thus a reduction in total pasture production. While a 38% reduction is a conservatively high figure for the reasons outlined above, assuming this rate of reduction in pasture production, but taking into account the maximum temporary footprint of the solar array represents only 35% of the land area, annual pasture production would be temporarily reduced. This reduction has been accounted for, and grazing practices adjusted for the proposed stocking rates. As previously noted, studies (as well as anecdotal reports from sheep grazing operations in Australia) suggest that animal production need not be reduced to the same extent, although there is insufficient evidence at this stage to provide a definitive answer.
Legal constraints	There are no anticipated legal constraints.
Size and shape of land parcels	No change will result. The lease does not alter any boundaries
Infrastructure	There will be some adjustment to existing farming infrastructure required to facilitate the proposed change in landuse. This is no different to any change in land based primary production activity and does not impact productive capacity.

PRODUCTIVE CAPACITY AFTER PROJECT DECOMMISSIONING AND LAND REMEDIATION	
Physical characteristics	
Soil Type/Profile	No impact on soil type or profile will result. Pile driven posts and trenched cable will be removed, this will not affect the soil profile.
Soil Properties	Soil properties will be unchanged post development.
Soil Fertility	Soil fertility will be maintained via regular fertiliser applications as is noted in the accompanying Land Management Plan so no change will arise post decommissioning.
Soil Drainage	No change in soil drainage will result.
Versatility	The full versatility of land use options will be restored when the solar panels are removed.
Pasture Production	It is possible that some re-grassing of pastures may be required, this however is no different to any change in land based primary production activity.
Legal constraints	No change.
Size and shape of land parcels	No change.
Infrastructure	As per the terms of the solar farm leases agreed with each site landowner, all Project infrastructure will be removed, and the land returned to its original condition which will not limit in any way future versatile productive uses of the land.

9.0 REGULATORY ASSESSMENT

The National Policy Statement for Highly Productive Land (NPS-HPL) (Ministry for the Environment 2022) was approved by the Governor-General in September 2022. It's objective states:

> *Highly Productive Land is protected for use in land-based primary production, both now and for future generations.*

To achieve this objective, nine policies are included to recognise productive land as a finite resource, map and identify HPL in an integrated way, prioritise and support highly productive land to be used for land-based primary production, manage reverse sensitivity effects, and ensure that urban rezoning is avoided except as explicitly provided for within the policy statement. This includes avoiding rezoning and development of HPL for rural residential land use, avoidance of the subdivision of HPL, and HPL is protected from inappropriate use and development.

Helios propose to develop 239 ha of land into an Agrivoltaic Solar Farm, of which 13.38 ha is mapped as LUC Class 1 Land and 43.43ha is mapped as LUC Class 2 land by Hawke's Bay Regional Council and Manaaki Whenua. Site inspection, assessment and discussions has confirmed that 3.17 ha of LUC Class 1 and 25.38 ha of LUC Class 2 land are subject to significant long-term soil and climate constraints, meaning a cumulative total of 28.26 ha of LUC Class 1 and Class 2 land is encompassed within the proposed development footprint. As the proposal encompasses Class 1 and Class 2 land, Clause 3.9 of the NPS HPL is applicable for determining whether a proposed development is appropriate for the site.

Clause 3.9 of the NPS HPL protects highly productive soils by directing territorial authorities to avoid inappropriate use or development of HPL that is not land-based primary production. Clause 3.9(2) details what uses are considered appropriate for highly productive land where the measures in subclause (3) are met. Clause 3.9(2)(j) identifies appropriate development on highly productive land where it is:

> *(j) it is associated with one of the following, and there is a functional or operational need for the use or development to be on the highly productive land:*
> *(i) the maintenance, operation, upgrade, or expansion of specified infrastructure:*
> ....

Specified Infrastructure is defined as *Infrastructure that delivers a service operated by a lifeline utility.* Lifeline utilities are defined as an *entity that carries on a business described in Part B of Schedule 1* of the Civil Defence Emergency Management Act 2002, of which an entity that generates electricity for distribution through a network is confirmed to be a lifeline utility. The proposed Helios Agrivoltaic Solar Farm meets this definition of specified infrastructure as it is considered a lifeline utility.

To be considered appropriate, sub-clause (3) requires:

> *(3) Territorial authorities must take measures to ensure that any use or development on highly productive land:*
> *(a) minimises or mitigates any actual loss or potential cumulative loss of the availability and productive capacity of highly productive land in their district; and*
> *(b) avoids if possible, or otherwise mitigates, any actual or potential reverse sensitivity effects on land-based primary production activities from the use or development.*

9.1 Minimising and Mitigating Actual or Potential Cumulative Loss of Productive Capacity of Highly Productive Land

In designing the Agrivoltaic solar Farm and negotiating the lease footprint, Helios has implemented the mitigation hierarchy as far as practicable. In the first instance, the design avoids the full extent of highly productive soils in the southern portion of Bradley Land (shown in green in Figure 1) as this area has less limitations and more value within the pastoral farming enterprise compared to other areas of the site. While these are mapped as LUC Class 2 compared to LUC Class 1 adjacent to Taylor Road, this area has less limitations from the pastoral farming perspective. The northern portion of LUC Class 1 soils is included within the lease area, however it has been noted to form a proposed residential set back area and will be maintained in use for pastoral farming.

Site inspection and validation has noted that the 1:50,000 Land Use Capability Maps are inaccurate at the farm scale level and the transition from LUC Class 4 soils to Class 1 soils is more gradual than the desktop mapping would suggest. The areas of the site assessed by AgFirst identified significant constraints within the LUC Class 1 soil extent via a high gravel content close to surface, suggesting deeper soils are further north and west than the LUC maps suggest.

The solar farm design uses these features and effectively avoids most of the land that would be considered highly productive, meaning the proposed lease area only encompasses a total of 28.26 ha of HPL, largely free from constraints. As land based primary production will continue via sheep grazing, the impact of shading from the solar panels on pasture production is the only measure by which productive capacity could be lost. Based on the findings of Alyssa et al. 2021, and calculations provided by Helios for site coverage when panels are horizontal, AgFirst calculates a total of 9.891 ha may be impacted by shading, <5% of the footprint of the Agrivoltaic Solar Farm.

To address this 9.891 ha that may be impacted by shading, a Land Management Plan has been compiled to compliment solar generation activity with key steps in place to minimise any potential loss of productivity through grazing management best practice. Based on the recommendations set out in Land Management Plan and expected feed budget to be implemented by Helios complementary to the operation of the solar farm, any actual or potential loss of productive capacity is considered negligible and a profitable pastoral farming enterprise can be sustained within the lease footprint.

9.2 Actual or Potential Reverse Sensitivity Effects on Land Based Primary Production Activities

AgFirst notes that the proposed Agrivoltaic Solar Farm does not introduce an activity into the rural landscape that would be subject to adverse effects from typical land-based primary production activities. Instead, the proposed solar farm will integrate with sheep grazing to diversify an existing land based primary production activity to provide greater resilience within an area subject to significant climate and soil constraints.

In assessing the potential for reverse sensitivity effects to occur, AgFirst notes:

- The solar farm layout design has included a set back from existing rural residential dwellings to the north and north-west;

- Any sensitivity of the solar panels to dust deposition is no different to animal welfare in ensuring that excess dust does not cause a nuisance effect. Some dust is inevitable within a rural environment, and it is not expected that the installation of the panels will materially change risk;
- Activities immediately adjacent to the lease footprint are pastoral farming enterprises and the proposal is not expected to generate any reverse sensitivity effects on the continuation of those activities; and
- The current landowners will continue to graze livestock and undertake land based primary production activities such as cropping on their remaining landholdings. The landowners do not consider the solar farm operation to constrain their ability to do so.

As a result, no reverse sensitivity effects on land based primary production activities are envisaged to arise as part of the proposed development.

9.3 Appropriateness of the Solar Farm Development

With regards to Clause 3.9(3)(a) of the NPS-HPL, Section 9.1 above outlines the application of the mitigation hierarchy in this proposal to first avoid as far as practicable, and then mitigate any adverse effects on productive capacity. Having regard to Clause 3.9(3)(b), the proposal is not envisaged to generate any reverse sensitivity effects on land based primary production.

AgFirst considers that Clause 3.9(3) has been addressed and the development is therefore appropriate for its proposed location.

10.0 CONCLUSION

Helios are proposing to develop an Agrivoltaic Solar Farm across 239 ha at Taylor's Road, Ongaonga. Solar panels will be integrated with a sheep management programme to control vegetative growth as well as maximise the productive capacity of the site.

Our assessment has identified that while portions of the lease area are identified as LUC Class 1 and Class 2 soils, constraints are present within a significant portion of the site that restrict the full capacity of this area being realised. Notably, the soil typology itself provides significant restrictions due to the recent fluvial nature and generally low water holding capacity while the climate (low rainfall and high wind) further constrain use.

Detailed analysis of the proposed solar farm layout and lease area confirms that the proposed lease footprint avoids highly productive soils in the first instance, and where these cannot be avoided, mitigates potential loss of productive capacity via solar farm design and the accompanying Land Management Plan for Sheep Grazing.

Based on this assessment, AgFirst conclude that the proposed development will not result in any actual or potential loss, or cumulative loss of productive capacity across HPL within the lease area, and therefore the requirements of the NPS HPL have been addressed.

11.0 REFERENCES

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12.0 APPENDICES

APPENDIX A: PROPOSED DEVELOPMENT PLAN

APPENDIX B: SITE PHOTOGRAPHS

Plate 1: Northwestern portion of lease area looking south east from Bradley to Holden Land holdings. Mixed clover cover noted.

Plate 2: View north from within overland flow path showing terrace change. Soil quality noted to change across this gradient as well.

Plate 3: Variable topography of overland flow path and evidence of temporary ponding during wet season.

Plate 4: Boundary of lease area and transition from Class 2 to Class 4 soils. Note distinct change in pasture quality between left and right of frame.

Plate 5: Centre of lease holding showing poor pasture coverage and weed incursions.

Plate 6: View west from northern portion of site showing moderate pasture coverage on top terrace.

Plate 7: High Gravel content and shallow topsoil layer in area mapped as Class 1 soils (HTP05).

Plate 8: View north east across Bradley land holding into Duncan land holding. Undesirable grass species noted.

AGFIRST Independent Agriculture & Horticulture Consultant Network	**Test Pit Log** **Client: Helios Energy Ltd** **Site Location: 126 Taylor Rd** **Project: Agrivoltaic Solar Farm** **Reference: J001299** Coordinates: 1892218mE, 5575114mN Elevation: 192m Coordinate system: NZTM2000 Datum: NZVD2016	Test Pit: **HTP01** Date: 20/02/24 Logged by: COB
Depth M	**Material Description**	**Water**
Clay / Silt / Sand / Gravel 0.5 1.0 1.5 2.0 2.5	0-100mm Topsoil, dark brown, good organic matter and very good structure. Silt loam with minor gravel, but very dry. 100—300mm Silt amongst gravel. Some large cobbles. Very gravelly and unable to continue past 300mm depth. EOH 300mm	No ground water encountered within test pit.

Observations:

Paddock has been re-sown in a clover mix with good success as evidence by root mass and topsoil structure (as shown in plate). Distinct topsoil layer is present, however a very gravelly layer commences from 100mm below ground level. Some variability in vegetation cover across surfacer is noted, likely due to different gravel contents present and variable water holding capacity.

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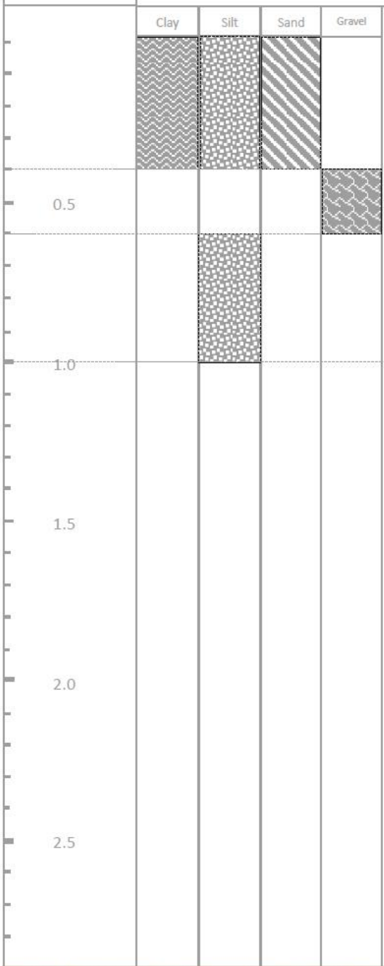
AGFIRST Independent Agriculture & Horticulture Consultant Network	**Test Pit Log** **Client:** **Helios Energy Ltd** **Site Location:** **126 Taylor Rd** **Project:** **Agrivoltaic Solar Farm** **Reference:** **J001299**	Test Pit: **HTP02**
	Coordinates: 1892115mE, 5574896mN Elevation: 194m Coordinate system: NZTM2000 Datum: NZVD2016	Date: 20/02/24 Logged by: COB

Depth M	Material Description	Water
	0-400mm Topsoil loam, silt dominant but good structure. Minor gravels at surface silty sand matrix, dry, limited vegetation, and incompetent materials. 400—600 mm gravelly layer approximately 200mm thick. Layer formed by rounded alluvial cobbles. Mixed size, but generally <30mm. 600—1000mm Silt, very hard and compact. Distinct orange mottling within silt, confirming water logging occurs. EOH1000	No ground water encountered within test pit.

Observations:

This test pit is still located on the upper terrace and has a good depth of silt loam topsoil present. Soil structure noted to be very good and moderate rooting depth for pasture species observed. Well defined gravelly layer was approximately 200mm thick, under which compact silts were present with distinct iron oxide mottling as sown in accompanying plate.

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Test Pit Log

Client: Helios Energy Ltd **Site Location:** 126 Taylor Rd

Project: Agrivoltaic Solar Farm **Reference:** J001299

Test Pit: **HTP03**

Coordinates:	1892167mE, 5574654mN	Elevation:	193m
Coordinate system:	NZTM2000	Datum:	NZVD2016
Date:	20/02/24	Logged by:	COB

Depth M	Clay	Silt	Sand	Gravel	Material Description	Water
0–0.1				Gravel	0—100mm very gravelly from surface, large boulders >100mm mixed with smaller fines. 100mm EOH	No ground water encountered within test pit.

Depth scale: 0.5, 1.0, 1.5, 2.0, 2.5

Observations:

Soil within this lower terrace is very gravelly from surface. Large boulders are present amongst fines, and vegetation coverage is sparse as a result of the very gravelly soils. Non palatable grass species noted amongst weeds, Common Mullein present in high densities. Refusal of test pit at 100mm on large rocks.

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Test Pit Log

Client: Helios Energy Ltd	**Site Location:** 126 Taylor Rd		**Test Pit:** HTP04
Project: Agrivoltaic Solar Farm	**Reference:** J001299		
Coordinates: 1892208mE, 5574370mN	Elevation: 192m		Date: 20/02/24
Coordinate system: NZTM2000	Datum: NZVD2016		Logged by: COB

Depth M	Clay	Silt	Sand	Gravel	Material Description	Water
0–0.15	X	X	X		0—150mm Organic Topsoil, with good rooting depth throughout. Good Structure and noted earthworms even in very dry conditions. Very minor gravel noted.	No ground water encountered within test pit.
0.15–0.75 (0.5)		X	X		150mm—750mm No distinct B horizon present, but light brown silty sand subsoil of uniform colour and consistency present to 750mm. Some tree roots encountered form nearby shelter.	
1.0					EOH 750MM	
1.5						
2.0						
2.5						

Observations:

Surface toposoil layer noted to have very good structure and good rooting depth throughout its full depth. As shown in accompanying plate, soil is quite dry however earthworms still present. No distinct B horizon observed, rather change in texture to silty sand noted. Uniform colour and consistency present through to 750mm below ground level.

AGFIRST	**Test Pit Log** **Client: Helios Energy Ltd** **Site Location: 126 Taylor Rd** **Project: Agrivoltaic Solar Farm** **Reference: J001299**	Test Pit: **HTP05**
Independent Agriculture & Horticulture Consultant Network	Coordinates: 1892040mE, 5575073mN Elevation: 194m Coordinate system: NZTM2000 Datum: NZVD2016	Date: 20/02/24 Logged by: COB

Depth M	Clay	Silt	Sand	Gravel	Material Description	Water
0.5 1.0 1.5 2.0 2.5					0-100mm Topsoil, dark brown, good organic matter and very good structure. Silt loam with minor gravel, but very dry. 100—300mm Silt amongst gravel. Some large cobbles. Very gravelly and unable to continue past 300mm depth. EOH 300mm	No ground water encountered within test pit.

Observations:

Consistent with HTP01, a distinct topsoil layer is present, however a very gravelly layer commences from 100mm below ground level. Some variability in vegetation cover across surfacer is noted, likely due to different gravel contents present and variable water holding capacity.

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APPENDIX D: LAMB GROWTH AND PASTURE PRODUCTION IN AGRIVOLTAIC PRODUCTION SYSTEM

Alyssa C. Andrew, Chad W. Higgins , Mary A. Smallman, Maggie Graham and Serkan Ates (2021). Lamb growth and pasture production in agrivoltaic production system. *AIP Conference Proceedings* , *2361.* doi:10.1063/5.0055889

Abstract

Agrivoltaic systems are designed to mutually benefit solar energy and agricultural production in the same location for dual-use of land. This study was conducted to compare lamb growth and pasture production from solar pastures in agrivoltaic systems and traditional open pastures over 2 years in Oregon. Weaned Polypay lambs grew at 120 and 119 g head−1 d−1 in solar and open pastures, respectively in spring 2019 (P = 0.90). <u>The liveweight production between solar (1.5 kg ha−1 d−1) and open pastures (1.3 kg ha−1 d−1) were comparable (P = 0.67).</u> Similarly, lamb liveweight gains and liveweight productions were comparable in both solar (89 g head−1 d−1; 4.6 kg ha−1 d−1) and open (92 g head−1 d−1; 5.0 kg ha−1 d−1) pastures (all P > 0.05) in 2020. The daily water consumption of the lambs in spring 2019 were similar during early spring, but lambs in open pastures consumed 0.72 L head−1 d−1 more water than those grazed under solar panels in the late spring period (P < 0.01). No difference was observed in water intake of the lambs in spring 2020 (P = 0.42). <u>Over the entire period, solar pastures produced 38% lower herbage than open pastures due to low pasture density in fully shaded areas under solar panels.</u> The results from our grazing study indicated that lower herbage mass available in solar pastures was offset by higher forage quality, resulting in similar spring lamb production to open pastures. Our findings also suggest that the land productivity could be greatly increased through combining sheep grazing and solar energy production on the same land in agrivoltaic systems.

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