Springwell Solar Farm

Environmental Statement
Appendix 8.1: Raw Data and Emissions Factors

Volume 3

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

EN010149/APP/6.3
November 2024
Springwell Energyfarm Ltd

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8.1 Introduction

8.1.1 This technical appendix to the **ES Volume 1, Chapter 8: Climate [EN010149/APP/6.1]** presents the raw data and emissions factors used to carry out the greenhouse gas assessment. This appendix is intended to be read in conjunction with the wider **ES Volume 1, Chapter 8: Climate [EN010149/APP/6.1]**, which includes the methodology and assumptions used within the assessment.

8.1.2 Emissions calculations apply the following format:

Activity data x emissions factor = emissions in mass of CO_2e

8.2 Construction of the Proposed Development

8.1.3 A large number of data sources have been supplied by the Applicant to estimate emissions from construction. These are summarised at a high-level below (**Table 1**: Construction stage assumptions and data sources), alongside assumptions that have been applied in the assessment.

8.1.4 It has been assumed that the construction period will last for a duration of 48-months.

Table 1: Construction stage assumptions and data sources

Component	Quantity	Methodology	Distance travelled by sea (km)	Distance travelled by Heavy Good Vehicle (km)
Battery Energy Storage System (BESS)	3,200,000kwh	Using publicly available data**[Ref. 8-1]**., assumed 6kg per kwh	10,000	500
BESS containers and control containers	1150 No. BESS containers and 385 No. control containers	Using publicly available data **[Ref. 8-2]**, assumed 2,033kg per unit (6m steel shipping containers)	10,000	500
Solar photovoltaic (PV) Modules	1,500,000 No.	, Weight of 37kg per module.	10,000	500
String inverters	2,033 No.	Assumed 124.5kg per unit, as per Environmental Product Declaration	10,000	500
PV framework	1.5kg per module	Using publicly available data **[Ref. 8-3]**	100	1,500
PV foundation	665,000m steel piles	23kg per m based on publicly available data **[Ref. 8-4]**	100	1,500
Switchgear	183 No.	422kg per unit based on Environmental Product Declaration	10,000	500
Main collector compound building	1 No.	Assumed constructed in the United Kingdom (UK). Modelled using One Click LCA software **[Ref. 8-5]**.	N/A	Default material delivery distances supplied by One Click LCA software.

Component	Quantity	Methodology	Distance travelled by sea (km)	Distance travelled by Heavy Good Vehicle (km)
BESS	1 No.	Assumed constructed in UK. Modelled using One Click LCA software **[Ref. 8-5]**.	N/A	Default material delivery distances supplied by One Click LCA software.
Transformers	7 No.	280t per transformer.	100	1,500
Inverter transformer stations	112 No.	Using publicly available data **[Ref. 8-2]**, assumed 2,033kg per unit (6m steel shipping containers)	10,000	500
Concrete	30,350m^3	2,400kg/m^3	N/A	80
Aggregate	6,300m^3	2,600kg/m^3	N/A	80
Direct Current Cables	12,000,000 linear metre	1116kg/km based on Environmental Product Declaration	N/A	80
Low Voltage Alternating Current cables	350,000 linear metre	536kg/km based on Environmental Product Declaration	N/A	80
33 kV cables	750, 000 linear metre	6.44kg/m based on Environmental Product Declaration	N/A	80
400 kV Alternating Current Cables	20,000 linear metre	18,700kg/km based on publicly available data **[Ref. 8-6]**	N/A	80
Stone	25,000m^3	1,602kg/m^3	N/A	80

Component	Quantity	Methodology	Distance travelled by sea (km)	Distance travelled by Heavy Good Vehicle (km)
Deer proof fencing	90,000 linear metre	48kg per 50m roll based on publicly available data **[Ref. 8-7]**	N/A	80
Palisade fencing	3,300 linear metre	27kg/m based on publicly available data **[Ref. 8-8]**	N/A	80

8.3 Operation of the Proposed Development

8.1.5 The Proposed Development is anticipated to generate 952,320MWh in the first year. A degradation factor of 0.4% has been applied each year to account for year-on-year reduction in yield. The operational energy generation is displayed below (**Table 2**).

Table 2: Operational energy generation

Year of operation	Year	Energy generation (MWh)
1	2030	965,000.00
2	2031	961,140.00
3	2032	957,295.44
4	2033	953,466.26
5	2034	949,652.39
6	2035	945,853.78
7	2036	942,070.37
8	2037	938,302.09
9	2038	934,548.88
10	2039	930,810.68
11	2040	927,087.44
12	2041	923,379.09
13	2042	919,685.57
14	2043	916,006.83
15	2044	912,342.80
16	2045	908,693.43
17	2046	905,058.66

Year of operation	Year	Energy generation (MWh)
18	2047	901,438.43
19	2048	897,832.67
20	2049	894,241.34
21	2050	890,664.38
22	2051	887,101.72
23	2052	883,553.31
24	2053	880,019.10
25	2054	876,499.02
26	2055	872,993.03
27	2056	869,501.05
28	2057	866,023.05
29	2058	862,558.96
30	2059	859,108.72
31	2060	855,672.29
32	2061	852,249.60
33	2062	848,840.60
34	2063	845,445.24
35	2064	842,063.46
36	2065	838,695.20
37	2066	835,340.42
38	2067	831,999.06

Year of operation	Year	Energy generation (MWh)
39	2068	828,671.06
40	2069	825,356.38
TOTAL		**35,736,262**

8.4 Emissions Factors

8.1.6 The emission factors used in the assessment are summarised below (**Table 3**).

Table 3: Emission factors used in the assessment

	Description	Emissions Factors	Unit	Source	Notes
Materials	Weathering steel	3.28	$kgCO_2e/kg$	TATA Steel 2020 **[Ref. 8-9]**.	Produced EU
	Aluminium	5.58	$kgCO_2e/kg$	ICE 2019 **[Ref. 8-10]**.	Produced in Europe
	Steel - cold rolled	2.73	$kgCO_2e/kg$	ICE 2019 **[Ref. 8-10]**.	World average
	Steel - plate	2.46	$kgCO_2e/kg$	ICE 2019 **[Ref. 8-10]**.	World average
	Insulating paper	1.76	$kgCO_2e/kg$	Guo et al., 2022 **[Ref. 8-11]**.	
	Copper	2.71	$kgCO_2e/kg$	ICE 2019 **[Ref. 8-10]**.	Produced in Europe
	Mineral oil	1401.00	$kgCO_2e/t$	DESNZ 2023 **[Ref. 8-12]**.	Primary material production
	Diesel	2.51	$kgCO_2e/l$	DESNZ 2023 **[Ref. 8-12]**.	Biofuel blend
	Ceramics	0.70	$kgCO_2e/kg$	ICE 2019 **[Ref. 8-10]**.	
	Non-structural mass concrete	0.09	$kgCO_2e/kg$	ICE 2019 **[Ref. 8-10]**.	
	Aggregates and sand, general UK	0.01	$kgCO_2e/kg$	ICE 2019 **[Ref. 8-10]**.	
Transport	All rigids	0.18	$kgCO_2e/tkm$	DESNZ 2023 **[Ref. 8-12]**.	Average laden
	Average container ship	0.02	$kgCO_2e/tkm$	DESNZ 2023 **[Ref. 8-12]**.	Average

Description		Emissions Factors	Unit	Source	Notes
	All rigids	0.21	$kgCO_2e$/tkm	DESNZ 2023 **[Ref. 8-12]**.	50% laden
	Average diesel van	0.23	$kgCO_2e$/km	DESNZ 2023 **[Ref. 8-12]**.	
	Average petrol car	0.16	$kgCO_2e$/km	DESNZ 2023 **[Ref. 8-12]**.	
Disposal	Mineral Oil - recycling	21.28	$kgCO_2e$/t	DESNZ 2023 **[Ref. 8-12]**.	Construction
Disposal	Other metals recycling	One Click 2024[1]	$kgCO_2e$/kg	One Click 2024 **[Ref. 8-5]**.	e.g., Aluminium recycling
Disposal	Structural steel recycling	One Click 2024	$kgCO_2e$/kg	One Click 2024 **[Ref. 8-5]**.	Steel recycling
Disposal	Concrete recycling	One Click 2024	$kgCO_2e$/kg	One Click 2024 **[Ref. 8-5]**.	
Disposal	Inert materials landfill	One Click 2024	$kgCO_2e$/kg	One Click 2024 **[Ref. 8-5]**.	
Water	Consumption	0.18	$kgCO_2e/m^3$	DESNZ 2023 **[Ref. 8-12]**.	
Water	Treatment	0.20	$kgCO_2e/m^3$	DESNZ 2023 **[Ref. 8-12]**.	
Fuel	Gas	0.35	$kgCO_2e$/kWh	DESNZ 2023 **[Ref. 8-12]**.	
Electricit	Europe	IEA 2023[2]	$kgCO_2e$/kwh	IEA 2023 **[Ref. 8-13]**.	Location based factor
Electricit	Europe	IEA 2023	$kgCO_2e$/kwh	IEA 2023 **[Ref. 8-13]**.	

8.5 Environmental Product Declarations

8.1.7 The Environmental Product Declarations used in the assessment are outline below (**Table**).

[1] Unable to share due to contractual obligations
[2] Unable to share due to contractual obligations

Table 4: Environmental Product Declarations

Asset	Emission category	Emissions Factors	Unit	Source
Solar PV modules	A1-3 Product Stage	217	$kgCO_2e/m^2$	Average of various Environmental Product Declaration's sourced from One Click LCA **[Ref. 8-5]**.
Solar PV modules	C1-4 End of Life	4	$kgCO_2e/m^2$	Average of various Environmental Product Declaration's sourced from One Click LCA **[Ref. 8-5]**.
BESS	A1-3 Product Stage	175	$kgCO_2e/kwh$	Romare and Dahllöf 2017. **[Ref. 8-14]**.
BESS	C3-4 End of Life	8	$kgCO_2e/kg$	Li et al., 2023 **[Ref. 8-15]**.
Transformers	A1-3 Product Stage	754,036	$kgCO_2e/unit$	Guo et al., 2022 **[Ref. 8-11]**
Transformers	C2-4 End of Life	7,808	$kgCO_2e/unit$	Guo et al., 2022 **[Ref. 8-11]**
Inverters	A1-3 Product Stage	4260	$kgCO_2e/unit$	EPD Italy 2023 **[Ref. 8-16]**
Inverters	C3-4 End of Life	33	$kgCO_2e/unit$	EPD Italy 2023 **[Ref. 8-16]**
Switchgear	A1-3 Product Stage	3780	$kgCO_2e/unit$	PEP Eco Passport 2022 **[Ref. 8-17]**
Switchgear	C1-4 End of Life	128	$kgCO_2e/unit$	PEP Eco Passport 2022 **[Ref. 8-17]**
Electricity distribution cable	A1-3 Product Stage	4950	$kgCO_2e/km$	EPD Hub 2023 **[Ref. 8-18]**
Low voltage cable	A1-3 Product Stage	3860	$kgCO_2e/km$	EPD Italy 2022 **[Ref. 8-19]**
30 kV cable	A1-3 Product Stage	17.79	$kgCO_2e/m$	PEP Eco Passport 2022 **[Ref. 8-20]**
11-400 kV conductor cable	A1-3 Product Stage	8.28	$kgCO_2e/kg$	EPD Hub 2024 **[Ref. 8-21]**
Palisade fencing	A1-3 Product Stage	2.72	$kgCO_2e/kg$	BRE 2022 **[Ref. 8-22]**
Circuit breaker	A1-3 Product Stage	728	$kgCO_2e/unit$	ABB **[Ref. 8-23]**
Circuit breaker	C1-4 End of Life	129	$kgCO_2e/unit$	ABB **[Ref. 8-23]**

Table 4: Environmental Product Declarations

Asset	Emission category	Emissions Factors	Unit	Source
Surge arrester	A1-3 Product Stage	9.9	$kgCO_2e$/unit	ABB **[Ref. 8-24]**
Surge arrester	C1-4 End of Life	3.4	$kgCO_2e$/unit	ABB **[Ref. 8-24]**
Distribution unit	A1-3 Product Stage	2570	$kgCO_2e$/unit	EPD Norge 2023 **[Ref. 8-25]**
Distribution unit	C3-4 End of Life	176	$kgCO_2e$/unit	EPD Norge 2023 **[Ref. 8-25]**

8.6 General Assumptions

8.1.8 The general assumptions used within the assessment are included in **Table 5** below.

Table 5: General assumptions

Category	Assumption	Source
Construction worker water use	45 litres/worker/day	BSRIA 2011 **[Ref. 8-26]**
PV cleaning water use	76 litres/mwh	SEIA 2023 **[Ref. 8-27]**
HGVs - deliveries	43% empty running factor	RICS 2023 **[Ref. 8-28]**
Sea - deliveries	0% empty running factor	RICS 2023 **[Ref. 8-28]**
Repair	25% of maintenance emissions	RICS 2023 **[Ref. 8-28]**
Landfill disposal distance	100km	RSK Assumption based on distance to specialist disposal facilities
Recycling disposal distance	100km	RSK Assumption based on distance to specialist disposal facilities
Service life	40 years	**ES Volume 1, Chapter 3: Proposed Development Description [EN010149/APP/6.1]**
One-way commuting distance for construction workers	25km	RSK Assumption based on proximity to nearby towns
One-way commuting distance for regular operational workers	25km	RSK Assumption based on proximity to nearby towns
One-way commuting distance for regular maintenance visits	25km	RSK Assumption based on proximity to nearby towns
One-way commuting distance for technician visits	100km	RSK Assumption based on similar project experience

8.7 References

- [redacted]
- [redacted]
- **Ref 8-3** Sun Works. Available from: [redacted]
- **Ref 8-4** British Steel. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://britishsteel.co.uk/media/jlybepgw/uk-sections-datasheets-100723.pdf
- **Ref. 8-5** One Click LCA Software. Available from: [redacted]
- **Ref 8-6** Thorne and Derrick. Available from: [redacted]
- **Ref 8-7** Ultimate One. Available from: [redacted]
- **Ref 8-8** First Fence. Available from: [redacted]
- **Ref. 8-9** TATA Steel (2020). Available online: [redacted]

- **Ref. 8-10** University of Bath (2019). Embodied Carbon, the Inventory of Carbon and Energy. Available online: [redacted]
- **Ref. 8-11**.Guo et al., (2022). The greenhouse gas emissions of power transformers based on life cycle analysis. Available online: [redacted]
- **Ref. 8-12** Department for Energy Security and Net Zero (2023) Greenhouse gas reporting: conversion factors 2023. Available online: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023
- **Ref. 8-13**.IEA 50 (2023). Emission factors 2023. Available online: [redacted]
- **Ref. 8-14**. Romare and Dahllöf 2017. The Life Cycle Energy Consumption and Greenhouse Gas Emissions from Lithium-Ion Batteries. Available from: [redacted]
- **Ref. 8-15**. Li et al., (2023). Assessment of the lifecycle carbon emission and energy consumption of lithium-ion power batteries recycling: A systematic review and meta-analysis. Available from: [redacted]
- **Ref. 8-16.** EPD Italy (2023). Available from: [redacted]
- **Ref. 8-17.** PEP Eco Passport (2022). Available from: [redacted]
- **Ref. 8-18.** EPD Hub (2023). Available from: [redacted]
- **Ref. 8-19.** EPD Italy (2022). Available from: [redacted]
- **Ref. 8-20.** PEP Eco Passport (2022) [redacted]
- **Ref. 8-21**. EPD Hub (2024). Available from: [redacted]

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- **Ref. 8-23**. ABB. Available from: [redacted]
- **Ref. 8-24.** ABB. Available from: [redacted]
- **Ref. 8-25.** EPD Norge (2023). Available from: [redacted]
- **Ref. 8-26.** Building Services and Information Association (2011), Rules of Thumb 5th Edition. Available from: [redacted]
- **Ref. 8-27.** Solar Energy Industries Association. Available from: [redacted]
- **Ref. 8-28.** Royal Institution of Chartered Surveyors (2023) Whole Life Carbon assessment for the built environment. Available online: [redacted]

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Application Document Ref: EN010149/APP/6.3
Planning Inspectorate Scheme Ref: EN010149