

Climate Change and Renewable Energy

Inchinnan Solar Park

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Document Issue Date 11/08/2022

Version Number V7

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Introduction

- 1.1. This report highlights the key environmental benefit of the Inchinnan Solar Park; the generation of clean renewable energy for export to the national grid.
- 1.2. Renewable electricity is playing a crucial role in reducing greenhouse gas (GHG) emissions. It is essential for implementing the Scottish Government's approach to combatting climate change and achieving its 2045 net zero emissions target.¹

Legislation and Policy

Legislation

Scotland - The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019

- 1.3. The Scottish Government declared a climate emergency in 2019; in response, the target date for net-zero emissions of all greenhouse gases by 2045 was set in The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019² which is an amendment of the Climate Change (Scotland) Act (2009). The GHG emission reduction interim target for 2020 was updated from 42% to 56%³. The June 2021 report⁴ released by the Scottish Government charting GHG emissions for 2019 shows that the emissions are 51.5% down from the baseline of 1990 emissions but did not achieve the annual target of 55%.⁵
- 1.4. The June 2022 report⁶ released by the Scottish Government demonstrates that these targets have now been met for the first time, however this can largely be credited to the significant and temporary lifestyle changes seen during the covid pandemic, particularly the massive reductions in every-day and international travel. Urgent action is required if future targets are to be met.

UK –Climate Change Act 2008

- 1.5. The Climate Change Act 2008 set a target date of 2050 to reduce the UK carbon budget to 80% lower than the 1990 baseline and established the Climate Change Committee to advise on emission targets. The target was amended to 100% by 2050 in 2019 by The Climate Change Act 2009 (2050 Target Amendment) Order 2019. The Climate Change Committee have recently reported that: *“the UK is currently on track to meet its target of a 37% reduction by 2022, but it is not on track to meet its targets outlined in the fourth and fifth carbon budgets - a 51% reduction compared to 1990 levels by 2025.”*⁷

¹Scottish Government Publications, Weblink, Published May 2019, Paragraph 6, line 2, Accessed: 27/06/2022: <https://www.gov.scot/publications/global-climate-emergency-scotlands-response-climate-change-secretary-roseanna-cunninghams-statement/>

² Scottish Government Publications, Weblink, Published May 2019, Paragraph 6, line 2, Accessed:10/02/2021: <https://www.gov.scot/publications/global-climate-emergency-scotlands-response-climate-change-secretary-roseanna-cunninghams-statement/>

³ Scottish government: Climate Change (Scotland) Act 2009

⁴ Scottish Government publications, Weblink, Published June 2021, Accessed: 05/07/2021: <https://www.gov.scot/publications/scottish-greenhouse-gas-statistics-1990-2019/>

⁵ Scottish Government publications, Weblink, Published June 2021, Accessed: 05/07/2021: <https://www.gov.scot/publications/scottish-greenhouse-gas-statistics-1990-2019/>

⁶ Scottish Government, Scottish Greenhouse Gas Statistics 2020, Published: June 2022, Weblink to PDF: <https://www.gov.scot/binaries/content/documents/govscot/publications/statistics/2022/06/scottish-greenhouse-gas-statistics-2020/documents/scottish-greenhouse-gas-statistics-2020/scottish-greenhouse-gas-statistics-2020/govscot%3Adocument/scottish-greenhouse-gas-statistics-2020.pdf>

⁷ UK Parliament, Published May 2021, weblink: <https://lordslibrary.parliament.uk/climate-change-targets-the-road-to-net-zero/>

COP 26 Glasgow

- 1.6. The 2021 UN Climate Change Conference (COP26) was hosted in Glasgow from the 31st of October – 13th November 2021⁸. A key goal of COP26 was to “*accelerate action*”⁹ towards countries achieving targets agreed at COP21¹⁰.
- 1.7. COP26 witnessed 153 countries put forward new or updated emission targets strengthening the commitment made at COP21 to setting a maximum global warming temperature of 1.5°C¹¹.

Climate Change Impacts

The Impact of Fossil Fuels

- 1.8. On 9 August 2021, the Intergovernmental Panel for Climate Change (IPCC) released their most recent and comprehensive assessment of climate change (AR6) with reports compiled by 234 authors from 66 countries and 517 contributing authors.¹² The report provides a very significant, up-to-date, and authoritative insight into how the climate is changing, the driving factors behind these changes, and the projected changes within our climate system over the next few decades and centuries. The report summarises:

*“Scientists are observing changes in the Earth’s climate in every region and across the whole climate system, according to the latest IPCC Report: many of the changes observed in the climate are unprecedented in thousands, if not hundreds of thousands of years, and some of the changes already set in motion—such as continued sea level rise—are irreversible over hundreds to thousands of years”*¹³

- 1.9. The IPCC have confirmed that anthropogenic behaviour and activity have directly influenced global warming which drives climate change:¹⁴
- 1.10. The Intergovernmental Panel for Climate Change (IPCC) have identified the energy sector as a key area for combatting climate change:

*“Untamed levels of greenhouse gas emissions are already bringing increasingly dangerous consequences. Our climate challenge is a shared global challenge – and it is largely an energy challenge. Energy accounts for over two-thirds of global greenhouse gas emissions. This means energy must be at the heart of any solution.”*¹⁵

Extreme Climate Events

- 1.11. Although it is difficult to directly link a particular climate event to human-influenced climate change, the scientific consensus is that extreme climate events are more likely due to climate change. This includes unpredictable and life-threatening events driven by increasing temperature:

⁸COP26 Negotiations Explained, Weblink, published: date unknown, Accessed: 24/01/2022: <https://ukcop26.org/wp-content/uploads/2021/11/COP26-Negotiations-Explained.pdf>

⁹ ‘COP 26 Goals’ accessed: 06/07/21: <https://ukcop26.org/cop26-goals/>

¹⁰ Paris Climate Agreement-196 countries agreed to cut GHG emissions to limit global warming to 1.5°C <https://www.cop21paris.org/>

¹¹ ‘United Nations Climate Change, The Paris Agreement, Weblink, published: date unknown, Accessed: 10/02/2022:

<https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

¹² IPCC, Press Release, Published 09/08/2021: <https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/>

¹³ IPCC, Press Release, Paragraph 1, Published 09/08/2021: <https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/>

¹⁴ IPCC AR6, ‘Climate Change 2021: The Physical Science Basis, Summary for Policy Makers’, The Current State of the Climate, Page SMP-5, Paragraph A.1

¹⁵ IPCC, Weblink, newsroom post, Published July 2021, Accessed: 06/07/21: <https://www.ipcc.ch/2020/07/31/energy-climatechallenge/>

“With every additional increment of global warming, changes in extremes continue to become larger. For example, every additional 0.5°C of global warming causes clearly discernible increases in the intensity and frequency of hot extremes, including heatwaves (very likely), and heavy precipitation (high confidence), as well as agricultural and ecological droughts”¹⁶

- 1.12. Record temperatures were recently seen in England, Scotland, and Wales in July 2022 with the first ever red warning issued in England, and temperatures exceeding 40°C, something never before seen in the UK. This heatwave has had dangerous consequences including an estimated 1000 deaths¹⁷, fires, and significant damage to transport and energy infrastructure¹⁸. A climate attribution scientist from the Met Office confirmed that climate change has made the chances of temperatures like this much more likely and will continue to do so in the coming years and decades¹⁹.
- 1.13. Other recent extreme events, the likes of which are more probable due to climate change, include:
- Canada experiencing a heatwave which broke national records for 3 consecutive days culminating in temperatures of 49.6°C.²⁰ (June 2021)
 - Wildfires in Greece, Turkey, Siberia²¹ and California²² during the summer of 2021, and further wildfires in Spain and Germany in 2022.²³
 - Rainfall was recorded on the summit of Greenland’s ice cap for the first time in recorded history (August 2021) when temperatures were above freezing at 3,216 m above sea level.²⁴

Climate Change: Scottish Environmental Impacts

- 1.14. The climate challenges facing Scotland are well documented. ClimateXChange provide independent advice, research, and analysis to support the Scottish Government. Their website presents both low emission and high emission scenarios. For the high emission scenario, they have stated:

“By 2080 ... under a high global emissions scenario, average winters are projected to be around 19% wetter and 2.7°C warmer ... average summers are projected to be around 3°C warmer and 18% drier. Sea levels will continue to rise around Scotland’s coast. By 2080 under a low global emissions scenario, sea levels in Edinburgh are projected to around 19cm higher. Under high global emissions scenario, this is projected to increase by around 38cm.”²⁵

¹⁶ IPCC AR6, ‘Climate Change 2021: The Physical Science Basis’, Summary for Policy Makers, Page SMP-19.

¹⁷ NewScientist ‘40°C heatwave may have killed 1000 people in England and Wales’, published 28th July 2022, accessed 10/08/22.

¹⁸ BBC News, ‘Heatwave: Fires blaze after UK passes 40C for first time’, published 19th July 2022, accessed 20th July 2022. <https://www.bbc.co.uk/news/uk-62217282>

¹⁹ Met Office, ‘Record breaking temperatures for the UK’, published 19th July 2022, accessed 20th July 2022. <https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2022/red-extreme-heat-warning-ud>

²⁰World Meteorological Organization, ‘June ends with exceptional heat’, Published June 2021, Accessed: 06/07/21: <https://public.wmo.int/en/media/news/june-ends-exceptional-heat>

²¹BBC News, ‘Wildfires: How are they linked to climate change?’, 11 August 2021. <https://www.bbc.co.uk/news/58159451>

²²BBC News, summary of stories about Californian wildfires. <https://www.bbc.co.uk/news/topics/cjyq4rd3x3zt/california-wildfires>

²³ The Guardian, ‘Spain battles wildfires fuelled by one of earliest heatwaves on record’, Published 19th Jun 2022, <https://www.theguardian.com/world/2022/jun/19/spain-battles-wildfires-fuelled-by-one-of-earliest-heatwaves-on-record>

²⁴The Guardian, ‘Rain falls on peak of Greenland ice cap for first time on record’, 20 August 2021 Accessed: 25/08/2021: <https://www.theguardian.com/world/2021/aug/20/rain-falls-peak-greenland-ice-cap-first-time-on-record-climate-crisis>

²⁵Climate Exchange Scotland, Published January 2021, Accessed: 04/07/21:

<https://www.climateexchange.org.uk/blog/new-climate-projections-summary-for-scotland/>

- 1.15. Scottish receptors to climate change impacts have been identified by NatureScot, who envisage the following adverse impacts associated with climate change: loss of habitats; eradication of species; increase in invasive species; changes to soil; sea level rise; coastal erosion and ocean acidification²⁶.

Energy Security

Electricity

- 1.16. The International Energy Agency (IEA) defines electricity security as: *“the electricity system’s capability to ensure uninterrupted availability of electricity by withstanding and recovering from disturbances and contingencies.”*²⁷

Increasing Demand for Electricity in the Future

- 1.17. Modelling by BEIS (Department for Business, Energy, and Industrial Strategy) indicates increased electricity demand over the next two decades, potentially doubling by 2050. This will be driven by a shift to electric vehicles and electricity replacing gas for heating. Generation capacity will therefore have to increase significantly, to replace retiring capacity and keep pace with growing demand.²⁸ The growth in renewable electricity will need to be particularly fast, in response to both this increase in electricity demand and the simultaneous requirement to decarbonise electricity generation. Fossil fuel generation will be relied upon less,²⁹ reducing Britain’s dependence on imported fossil fuels from oil exporting countries.

Heat and Transport Fuel

- 1.18. At the time of writing the wholesale price of natural gas has risen markedly over the past year, putting smaller energy suppliers out of business, and leading to knock-on effects for household bills and electricity (much of which is still generated from gas). Investment in renewables is needed to reduce the reliance on gas and reduce the cost of electricity through increased competition.
- 1.19. Fears over petrol and diesel supplies led to panic buying and empty fuel pumps during September 2021³⁰. Gas and oil prices have since increased dramatically following the Russian invasion of Ukraine and are likely to stay high, pushing countries to find other sources of energy.³¹ Our reliance on petrol and diesel fossil fuels is not only bad for the environment but is a strategic vulnerability for the UK which can be alleviated by investment in the electrification of transport and new and diverse energy systems.

²⁶ NatureScot, Climate change impacts in Scotland. <https://www.nature.scot/climate-change/climate-change-impacts-scotland>

²⁷International Energy Agency (IEA), ‘Analytical Frameworks for Electricity Security’ Published April 2021, Accessed:13/07/2021: <https://www.iea.org/reports/analytical-frameworks-for-electricity-security>

²⁸BEIS, ‘Capacity of UK electricity generation assets in the 21st century, 2000 to 2019’, 2021, Page 7: [Accessible here](#)

²⁹UK Government, Press release: ‘End to coal power brought forward to October 2024’, June 2021, Accessed 29/07/2021:

<https://www.gov.uk/government/news/end-to-coal-power-brought-forward-to-october-2024>

³⁰BBC News ‘Petrol supply: Army put on standby to ease fuel supply issues’ 28 September 2021: <https://www.bbc.co.uk/news/uk-58713770>

³¹ UK Government, (2022) Research Briefing, number 9523, ‘Imports of energy from Russia’: <https://researchbriefings.files.parliament.uk/documents/CBP-9523/CBP-9523.pdf>

Progress Toward Renewable Electricity

United Kingdom

- 1.20. The electricity grid, market, and balancing mechanisms are complex and integrated across Great Britain (Northern Ireland is not included, it is part of EirGrid). Interconnectors also link Great Britain to Ireland and continental Europe. Generation located in Scotland has an effect throughout this network and it is relevant to consider Great Britain as a whole.
- 1.21. The 2021 Digest of UK Energy Statistics indicates that 38% of total energy generation was from fossil fuels, with a further 16% from nuclear and 43% from renewables³².
- 1.22. The average national carbon intensity of the grid per kilowatt hour in 2021 was 187.67 gCO₂ per kWh. In contrast, the post-installation carbon intensity of solar PV energy generation is recognised as 0 gCO₂ per kWh by National Grid. The role solar PV and other renewable sources can play in 'greening the grid' is evident through the vast difference in carbon intensity per kWh of generation.

Scotland

- 1.23. There was steady progress on increasing the installed renewable capacity in Scotland from 2009 to 2021 with installed capacity increasing from around 3,800 MW to 12,200 MW.
- 1.24. It is important that increases in renewable energy capacity in Scotland continue and rise faster than demand. This will become increasingly important as current installations begin to reach their end of life and have to be decommissioned.
- 1.25. Inchinnan Solar Park can play an important part in this as it will generate enough electricity to meet the annual demand of around 8,351 lower consumption dwellings³³ such as flats or energy efficient homes, or around 5,184 dwellings with median electrical consumption³⁴.

The Renewable Supply Mix in Scotland

- 1.26. Many renewable electricity sources are considered 'intermittent'. They are: "*Sources of electricity that exhibit uncontrolled increases or decreases in output.*"³⁵ Such technologies are often weather dependent. They include wind, solar, some hydro, and tidal. However, a broader variety of intermittent sources provides stability of generation and gives those working to balance the grid more options during fluctuations.
- 1.27. Scotland has strong wind and hydro generation, with these sources contributing 73% and 17% respectively to the renewable energy mix in Scotland³⁶. Solar on the other hand contributes less than 3% to the renewable energy supply. During periods of low wind, solar could provide valuable generation to balance the grid during variable demand patterns and seasonal variations. The proposed development helps Scotland build on its mix of renewable energy generation technologies

³²BEIS Digest of UK Energy Statistics 2021 (DUKES) Chapter 5: Electricity, pages 4-5, Published July 2021: [Accessible here](#)

³³Ofgem, Weblink, Accessed: 12/07/22: https://www.ofgem.gov.uk/system/files/docs/2020/01/tdcvs_2020_decision_letter_0.pdf

³⁴Ofgem, Weblink, Accessed: 12/07/22: https://www.ofgem.gov.uk/system/files/docs/2020/01/tdcvs_2020_decision_letter_0.pdf

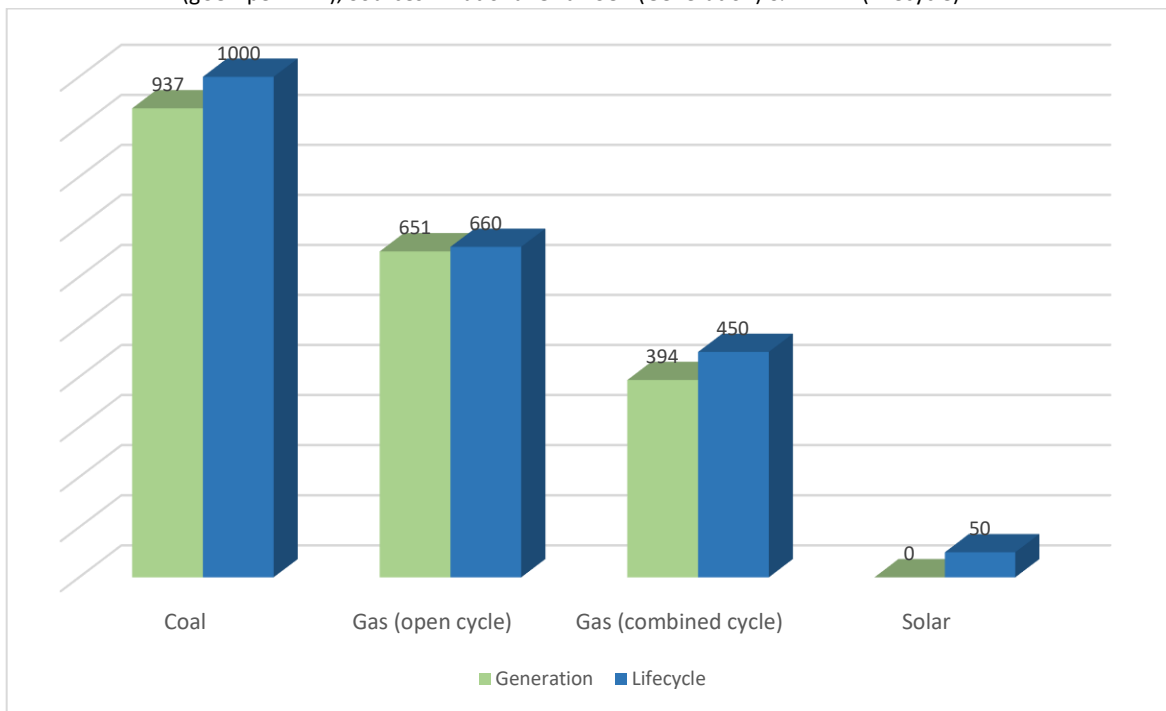
³⁵Parliamentary Office of Science and technology, Post Note, 'Intermittent Electricity Generation', Published May 2014.

³⁶Calculated from: Scottish Government, 'Energy Statistics for Scotland Q4 2021 Figures', Published March 2022.

Emissions During Generation vs. Lifecycle Emissions

- 1.28. Currently, greenhouse gas (GHG) emissions are released when the components of a solar park are manufactured and during construction on site, these can be referred to as ‘embedded emissions’. However, it would be incorrect to suggest that solar electricity generation is ‘just as bad’ as non-renewable electricity generation. All electricity generation technologies have embedded emissions from their manufacture and installation, but a whole lifetime assessment is useful if comparisons are to be made.
- 1.29.
- 1.30. Figure 1 below contrasts reputable figures for both the emissions from the operational generation phase in isolation, and emissions per kWh generated which take into account the lifecycle GHG emissions.

Figure 1: Carbon Intensity of Electricity Generated from Selected Sources (gCO₂ per kWh), Sources – National Grid ESO³⁷(Generation) & NREL³⁸ (Lifecycle)



- 1.31. The graph above shows the overwhelming benefit of moving from fossil fuel to solar generation, despite the presence of some GHG emissions from solar when the entire lifecycle is considered. As technology improves and supply chains are decarbonised these embedded emissions will decrease further.
- 1.32. Research suggests that the energy payback time for solar installations is just over a year. This being the amount of time it takes for the solar photovoltaic system to generate the energy required to have

³⁷National Grid ESO, ‘Carbon Intensity Forecast Methodology’ Dr Alasdair R. Et Al, 2021

<https://github.com/carbon-intensity/methodology/raw/master/Carbon%20Intensity%20Forecast%20Methodology.pdf>

³⁸NREL, National Renewable Energy Laboratory, ‘Life Cycle Assessment Harmonization’ (and accompanying documents)

<https://www.nrel.gov/analysis/life-cycle-assessment.html> Note that the research reviews a range of published sources and publishes a harmonized range, the figures in the graph are approximated from the range presented in the NREL research.

manufactured it³⁹. In relation to the current lifetime of solar panels being well over 25 years⁴⁰, this is an excellent energy payback time.

Problems with Nuclear as a Low Carbon Alternative

- 1.33. Together with renewables, nuclear generation is considered a low-carbon alternative to fossil fuels for electricity generation. It does not emit GHGs during operation.⁴¹ Nuclear generates 16.1% of Great Britain's total electricity⁴². However, the current cost to build, maintain, and decommission nuclear power plants makes them a less viable option than renewables.

Summary and Conclusions

- 1.34. Scotland and the UK must act if they are to remain on course to meet their carbon reduction targets.
- 1.35. The IPCC have detailed the consequences of our use of fossil fuels and accompanying greenhouse gas emissions. There is a scientific consensus that action is required to reduce these emissions and limit the harmful consequences of climate change.
- 1.36. Electricity demand is expected to increase in coming decades across Scotland and the UK. As we install more generation to respond to this increased demand, solar can provide diversity to the intermittent Scottish renewable electricity generation mix.
- 1.37. Solar has far fewer embedded emissions (in terms of g CO₂/kWh generated over the lifetime of the project) than fossil fuel electricity generation. Additionally, if more renewable energy is deployed embedded emissions will fall.
- 1.38. After hosting the COP26 in Glasgow in 2021, it is vital that Scotland, and the UK, now ensure they make progress towards achieving the ambitious climate goals agreed upon. Climate change is no longer a threat but a reality, and further action is required to mitigate the impacts of climate change upon the environment.
- 1.39. As a renewable energy project, Inchinnan Solar Park will help reduce greenhouse gas emissions and increase the renewable energy generation in Scotland, and the UK.

³⁹Dr. Harry Wirth, 'Recent Facts about Photovoltaics in Germany' Fraunhofer Institute for Solar Energy Systems (May 2021) p38

⁴⁰ REC Alpha Pure & Pure-R. <https://www.recgroup.com/en/alpha>

⁴¹World Nuclear, 'How can Nuclear combat climate change', Accessed 26/08/2021:

<https://world-nuclear.org/nuclear-essentials/how-can-nuclear-combat-climate-change.aspx>

⁴²The Department for Business, Energy, and Industrial Strategy (BEIS) 'Digest of UK Energy Statistics 2021' (DUKES) Chapter 5: Electricity, pages 4-5, Published July 2021:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1006701/DUKES_2021_Chapter_5_Electricity.pdf