Climate Action Committee
Thursday 5 November 2026
8th Meeting, 2026 (Session 7)

The environmental impacts of hyperscale data centres

Introduction

1. The Climate Action Committee has agreed to undertake an inquiry into the environmental impacts of hyperscale data centres.

2. This paper provides background detail to inform the first evidence session as part of the inquiry.

Background

Parliamentary activity on data centres

3. The Scottish Parliament Information Centre (SPICe) published a blog post on data centres in June 2026.

4. On 3 September there was a Members Business Debate on Hyperscale AI Data Centres and a Scottish Green Party debate on 16 September 2026 on Hyperscale Data Centres.

5. The Economy, Tourism and Energy Committee took evidence on artificial intelligence and its impact on the economy on 8 September. It held a further session on energy use on 15 September.

6. The Social Justice, Housing and Local Government Committee (SJHLG) has planning within its remit and at its meeting on 9 September, questions were posed to the Minister for Public Finance, Hannah Mary Goodlad, on planning and data centres.

7. A public petition has been submitted by Action to Protect Rural Scotland calling for a moratorium on planning applications for all hyperscale data centres until their environmental impacts have been fully assessed. The Scottish Government has responded to the petition. The Public Petitions Committee considered the petition on 8 October and agreed to write to the Scottish Government to seek further information, and to the Social Justice, Housing and Local Government Committee to ask if the issues raised in the petition will form part of its work programme.

Previous Scottish Government activity on data centres

8. On 17 August, the Minister for Public Finance issued a new planning direction stipulating that Scottish Ministers should be notified of planning applications for new data centres within 7 days.

9. On 16 September, the Minister for Public Finance, Hannah Mary Goodlad announced that all applications for data centres with a power capacity exceeding 50 megawatts would require an environmental impact assessment (EIA). During the Scottish Parliament debate that day she also said new guidance for planning authorities would be produced by Christmas.

10. The Committee wrote to the Cabinet Secretary for Climate Action and Rural Affairs and the Minister for Public Finance on 21 September 2026:

- Letter from the Convener of the Climate Action Committee to the Cabinet Secretary for Climate Action and Rural Affairs and the Minister for Public Finance on the environmental impacts of hyperscale data centres in Scotland – 21 September 2026

11. The Minister for Public Finance responded on 8 October:

- Letter from the Minister for Public Finance on the environmental impact of hyperscale data centres in Scotland – 8 October 2026

12. The Convener also wrote to the Scottish Government on 15 October with further details on the inquiry:

- Letter from the Convener of the Climate Action Committee to the Cabinet Secretary for Climate Action and Rural Affairs and Minister for Public Finance on the inquiry – 15 October

Climate Action Committee Inquiry

13. The Committee agreed on 3 September 2026 to undertake an inquiry on data centres. It then agreed an approach to this on 17 September and 1 October.

14. The Committee has agreed an initial phase of work and to write to the Scottish Government on this in November. It will then consider whether to undertake further work and an approach to this at a future date.

Remit

15. The Committee wants to find out:

- about the potential impacts of the operation and construction of hyperscale data centres on:
    - water quality and consumption
    - air quality
    - nature and biodiversity, including soil quality
    - noise pollution
    - energy use, and associated generation (including of back up generation)

    - emissions, and where emissions could be avoided by, for example, using waste heat
- how any negative impacts, can be mitigated or avoided
- what systems are, or should be, in place to support avoidance or mitigation of negative environmental impacts
- what can Scotland learn from other countries on the environmental impacts of hyperscale data centres
- how building and running hyperscale data centres might impact on achieving climate and nature goals

The inquiry aims to:

- increase public awareness of the environmental impacts of AI use and data centres in Scotland
- contribute to public and parliamentary debate and understanding on this issue from an environmental perspective
- influence Scottish Government action to address the climate and nature crises through its policy on data centres

Call for views

16. The Committee launched a joint call for views with the Economy, Tourism and Energy Committee on 7 October 2026.

17. While the Committee wants to understand the environmental impacts of potential hyperscale data centre construction and operation in Scotland, the Economy, Tourism and Energy Committee is interested in understanding the possible economic and energy implications.

18. Responses are invited via both a detailed call for views and a short survey.

19. The consultation closes on 15 November 2026.

Committee visit

20. On Tuesday 20 October 2026, members of the Committee visited the DV1 data centre in North Lanarkshire, which was opened in 2016, to find out more about how existing data centres in Scotland operate.

Meeting 29 October

21. At its meeting on 29 October, the Committee heard from environmental groups before hearing from a panel from Ireland to hear about the experience of data centres in Ireland.

22. Details of the meeting, including the papers and official report when published can be found on the Committee's website:

- Climate Action Committee – Meeting 29 October 2026

Meeting 5 November

23. On 5 November, the Committee will hear from:

Panel 1:

- Andrew Weir, CEO, ScotlandIS
- Craig Melson, Associate Director, TechUK

Panel 2:

- Alejandro Gallego Schmid, Reader in Circular Economy and Life Cycle Sustainability, The University of Manchester
- Wim Vanderbauwhede, Professor in Low Carbon and Sustainable Computing, University of Glasgow
- Thomas Morstyn, Associate Professor in Power Systems, University of Oxford

Written evidence

24. The Committee has received written submissions from:

- Professor Wim Vanderbauwhede (Annexe A);
- ScotlandIS (Annexe B).

Next steps

25. The Committee will hear from four further panels of witnesses across 5 and 12 November, before writing to the Scottish Government to notify it of the evidence taken. The sessions that follow will focus on:

- 12 November:
    - Water consumption, waste and pollution
    - Waste heat use and the heat island effect

Clerks to the Committee
October 2026

Annexe A: Submission from Professor Wim Vanderbauwhede, 22 October 2026

Summary

- Q1. What are the potential impacts of data centres and their construction on the environment in Scotland, including water quality, air quality, nature and biodiversity and emissions?

Potential impacts are significant increases in greenhouse gas emissions, water usage and local levels of air pollution and the effects of significant increases in local ambient temperature on fauna and flora.

- Q2. Where there are negative impacts, can these be mitigated or avoided?

Many of the negative impacts can be mitigated by limiting the total data centre capacity and by distributing it over many smaller sites. What can't be avoided nor mitigated are the embodied emissions inherent in the construction of the data centre infrastructure and the manufacturing of the servers and networking hardware.

- Q3. What systems are currently in place to support avoidance or mitigation of negative environmental impacts and what is still needed?

(Outside of my expertise)

- Q4. What can Scotland learn from other jurisdictions on the environmental impacts of data centre construction?

The lessons to be learned from other jurisdictions are mostly precautionary: many of the negative impacts are already felt in other places that have seen rapid expansion of data centres.

- Q5. What impact would different levels of data centre construction in Scotland have on the ability to meet carbon budgets and anticipated statutory biodiversity targets?

The current level of planned expansion of hyperscale data centres in Scotland means Scotland will not be able to meet the decarbonisation targets. If the level of data centre construction in Scotland were considerably lower than planned, and if this capacity were deployed at a number of smaller sites rather than concentrated, then there would be no major impact on Scotland's ability to meet the targets.

Conventions for referenced sources

- In the evidence below, academic sources are listed as referenced and are referred to by number at the end. Sources from the Scottish government are labeled "(SCOT)" and sources from the UK government are labeled "(UK)". Other reliable sources, e.g. from trusted organisations or non-UK authorities, are labeled "(REL)".

Units of power and energy

- Data centre capacity is expressed as the total power a data centre can consume. The unit of power is Watt (W).
- Electricity generation capacity is expressed as the total power that can be generated. The unit of power is Watt (W).
- Energy consumption is expressed in Watt-hours (Wh), the amount of power in Watt consumed per hour. Yearly energy consumption is expressed in Watt-hours per year (Wh/y).
- The prefixes k, M, G and T are commonly used. They mean resp. a thousand (kilo, k) , a million (mega, M), a billion (giga, G) and a thousand billion (tera, T).

Q1. What are the potential impacts of data centres and their construction on the environment in Scotland

Q1.1. Water quality

26. The main impact of data centres on water is not so much on the water quality, in that they do not pollute the water directly, but more on the quantity of fresh water consumed. Data centres require cooling. If a river or canal is used as a source for evaporation cooling, surface water quality will be affected because the water level will drop. If groundwater is pumped locally, this will very likely lower the water table. [note: I discuss closed-loop cooling under Q2]. Evaporation-based cooling requires a lot of water: according to [1], the sustainability target specified by the Climate Neutral Data Centre Pact for new data centres is 0.4 l/kWh. The authors report that “evaporative systems typically report water usage effectiveness values up to 2.5 l/kWh”. A 550 MW facility such as proposed for the Ravenscraig site would, with 80% utilisation, consume 4.8 TWh/year [note 1]. Assuming the lower estimate of 0.4 l/kWh, such a facility would require 1.9 million m³ (4.8*0.4) of water per year for cooling. With the higher estimates, it could be as much as 12 million m³ per year. For reference, according to Scottish Water (REL), the average water usage per person is 180 l per day or 65.7 m³ per year so the data centre would use as much water as 30,000 people in the best case and 180,000 people in the worst case. If all planned data centres (9.7 GW according to evidence given by the National Energy System Operator NESO (SCOT) to the Scottish Parliament Committee on Economy, Tourism and Energy on 15 Sept 2026) were using as much water, the total data centre water consumption would amount to between 33.5 and 209 million m³ per year. The total water consumption in 2025 according to Scottish Water (REL) was 470 million m³ per year.

Q1.2. Air quality

27. Air quality will be affected by the use of internal combustion engine based backup generators. This would not be the case if battery storage was used instead, but considering the very large scale of the planned data centres (500 MW – 1 GW), it is not practically possible to power such a facility using batteries.

For example, the largest Battery Energy Storage System in Europe at Blackhillock in Moray has an operational capacity of 200 MW / 400 MWh, which means that it can deliver 200 MW for 2 hours. Therefore diesel generators are the only practical backup source.

28. Given the energy density of diesel is 10.7 kWh/l according to Oak Ridge National Laboratory (REL)), to power a 500 MW facility would require burning 37,000 l diesel per hour [note 2]. For reference, a single lorry idling consumes a few litres per hour. So the running backup generators of a 500 MW data centre are equivalent to twenty thousand HGVs idling at the same time.

29. Air quality will also be affected by the use of gas powered on-site electricity generation. For example, a study by EmPower Analytics Group (REL) reports that use of on-site power at a 96 MW data centre in Virginia could result in $53 million to $99 million in annual health damages as a result of the increased emissions of fine particulate matter (PM2.5). A more general discussion on the health issues caused by the rapid expansion of AI data centres is given in [2]. The authors found that "the growing demand for AI and computing technologies is projected to push the total annual public health burden of U.S. data centers up to more than $20 billion in 2028."

Q1.3. Nature and biodiversity

30. A significant impact on nature and biodiversity is related to local increase in ambient temperature. In [3] researchers studied 11,000 data centre locations and concluded that hyperscale data centres cause a "Data Heat Island Effect" which raises the local surface temperature in a radius of several miles around the data centre by several degrees. The effect is similar to the "Urban Heat Island" effect, about which there exists a large body of literature. Main impacts of heat islands on nature and biodiversity are increase in pests and activation of sleeper species that can become important pests, with further indirect effects on populations of other insects, e.g. butterflies; increased air and soil temperature and reduced soil moisture, which negatively affects in particular tree health. Furthermore, synergies between heat islands and global warming result in organisms being more frequently exposed to extreme climatic conditions.

Q1.4. Emissions

Planned data centre energy use

31. As mentioned under Q1.1. above, NESO has stated in their evidence to the Scottish Parliament Committee on Economy, Tourism and Energy on 15 Sept 2026 that 9.7 GW of data centre capacity is being planned in Scotland. Most of this is projected to come on line by 2035. In 2024 Scotland's capacity of data centres was estimated at 30 MW by the Department for Science, Innovation & Technology (UK). As discussed during that Committee meeting, there is quite some uncertainty on this number, but in any case NESO suggest that at least 5 GW of data centre capacity would be located in Scotland by that time.

Projected growth

32. As discussed in our work [4], both the International Energy Agency and McKinsey&Co have published growth projections for global AI data centre capacity. McKinsey&Co projects growth scenarios of 22% to 26% compound annual growth rate (CAGR) which is 7x to 10x growth in 10 years; the IEA estimates 5x to 7x in 15 years. If the data centre capacity in Scotland were to expand from 30 MW to 9.7 GW by 2035, this would correspond to an effective CAGR of 70%. This very steep growth is the result of the distribution of data centres in the UK, which have until recently been concentrated in England. According to the House of Commons briefing report "Data centres: planning policy, sustainability, and resilience" (UK), in 2024 the total installed capacity of data centres in the UK was estimated at 1.6GW. If, as proposed by NESO, 20% of the UK capacity will be located in Scotland, this would mean about 50 GW UK-wide by 2035. Data from Ofgem (REL) show that in 2025, 80 GW of the total connection applications were submitted. This suggests that the UK-wide CAGR is higher than the highest global growth scenarios: 50 GW by 2035 from a 1.6 GW baseline means a CAGR of 36.7%. As these growth predictions are exponential they are quite sensitive to the initial estimate and the duration of the growth. But even if we assume that the current installed capacity is 2 GW instead of 1.6 GW and that the 80 GW capacity will only be realised by 2040, the resulting CAGR would be 27.9%. So we can conclude that the projections for the rate of expansion of AI data centres in the UK exceed the global estimates.

Energy use in Scotland

33. According to the Scottish Energy Statistics Hub (SCOT), in 2024, Scotland consumed 146.2 TWh/y of energy. Oil and gas for heating amounted to 72.9 TWh/y (gas only 41.7 TWh/y gas), fuel for road transport 41.2 TWh/y; gross electricity consumption was 32.1 TWh/y and 13 GWh/y was other energy use. The key observation is that 78% of consumed energy (114.1 TWh/y) is from fossil fuels and needs to be decarbonised by 2045 according to the decarbonisation targets (SCOT).

Deployment of renewables

34. The current installed renewables capacity in Scotland (REL) is 15 GW. According to the Energy Statistics for Scotland (SCOT), the renewable electricity pipeline is as follows:

    - Capacity planning permission sought: 20.5 GW
    - Capacity awaiting construction: 15.1 GW
    - Capacity under construction: 3.5 GW

35. The Scottish Government's Renewable and low carbon energy Policy (SCOT) states that "By 2030 we aim to generate the equivalent of 50% of Scotland's overall energy consumption from renewable sources, and by 2045 we aim to have decarbonised our energy system almost completely."

36. With typical timescales from planning to full operation between 5 and 10 years, these are already ambitious decarbonisation targets.

37. Gas and oil heating currently consumes 8.32 GW [note3]. To estimate the renewable energy needed to decarbonise 50% of this (4.16 GW), let's assume that we replace it by air-source heat pumps and we assume a power-to-heat conversion efficiency of 300% [5]. This is the most optimistic case: not all heating can be replaced by heat pumps, so some of it might be from conventional electric heating or heat networks, which are much less efficient. We take into account transmission and distribution losses of 8% (UK) and growth in need for heating in proportion to the population growth (2.5% over 5 years (SCOT)). The for the most optimistic case we only need 1.5 GW [note4] of renewable electricity for heating. If we assumed that half of heating is conventional electrical (e.g. storage heaters) rather than heat pumps, the required renewable electricity capacity would be 2.9 GW [note5].

38. Road transport currently consumes 4.7 GW [note3]. For electrification of transport, we will assume optimistically that by 2030, efficiency of electric vehicles will be twice that of internal combustion vehicles in kWh/km terms. We further take into account a battery charging efficiency of 90% as per [6] and traffic growth of 2%-3% per year (UK). Then the energy needed to electrify 50% of road transport is 1.5 GW [note6]; if we assume on the other hand that efficiency of electric vehicles will only be as good as that of internal combustion vehicles, it would be 3.0 GW [note7].

39. So we estimate that the amount of electricity needed to replace 50% of fossil fuel energy for heating and transport with renewables is between 3.0 and 5.9 GW.

40. In total, Scotland produced 54 TWh of electricity in 2024 and exported 22 TWh in 2024 (SCOT). So gross electricity consumption was 60% and exports were 40%. Assuming this ratio stays constant until 2030, then 60% of the planned capacity would be available for consumption in Scotland. Assuming the renewables "capacity awaiting construction" is available by 2035 (which is quite optimistic), 11.1 GW would be available for decarbonisation [note8]. A more realistic assumption is that half of it will be available, which would amount to 6.6 GW [note9].

41. As the estimate of the capacity needed to replace 50% of fossil fuel energy with renewables is between 3.0 and 5.9 GW, and the estimate of the availably capacity is between 6.6 GW and 11.1 GW, meeting the target would seem feasible.

42. However, the uncertainty on the estimates is high and the ranges are quite close: assuming a scenario where the required capacity is at the high (5.9 GW) and the available capacity at the low end (6.6 GW), then an error of no more than 10% on each of these estimates would mean the targets would not be reached.

43. When we consider additional data centre energy consumption, there are two issues:

    - With data centre capacity growth as projected, an additional 5 GW to 10 GW will be required, so in the best case this would require 8 GW and in the worst case 16 GW [note10], which is far more than the expected additional capacity. Even for the average data centre growth case, 4.2 GW is needed

for decarbonisation and a further 7.1 GW for data centres, which is higher than the estimated amount of available renewables [note11].

- If there is insufficient electricity capacity for data centres, either due to insufficient generation or insufficient grid capacity, data centre operators will resort to on-site generation using natural gas, which will result in additional emissions.

44. As a result, purely as a consequence of the energy consumption of the data centres, meeting the current decarbonisation target will be very difficult if the projected data centre growth materialises. Even if the total data centre capacity in Scotland was only 1 GW, it would already reduce the likelihood of meeting the targets considerably. Therefore I consider it prudent to cap the total capacity of data centres for 2030 at 500 MW. This is already more than ten times the total current capacity.

Impact of embodied emissions

45. The emissions from data centres are not limited to the emissions from fossil fuel energy generation. The construction of the required infrastructure and the manufacturing of the servers and networking hardware contribute the so-called embodied or embedded emissions. We modelled embodied emissions of AI data centres in [4]. We applied our model to the scenarios for Scotland and conclude from the simulations that it contributes on average 1 MtCO2e/GW/year between 2025 and 2035 (MtCO2e means “megaton of CO2-equivalent emissions”). When these embodied emissions are taken into account, 5 GW of data centres would result in 5 MtCO2e of emissions per year, 10 GW in 10 MtCO2e. Scotland’s emissions were 39 MtCO2e in 2024 (SCOT), so data centres would add between 25% and 50% to Scotland’s total emissions in 2030. This would make it impossible to meet the decarbonisation targets, as the embodied emissions can never be avoided. If the capacity was capped at 500 MW, the increase in emissions would be 0.5 MtCO2e or 2.5% of the 2030 carbon budget, which might be considered acceptable.

Q2. Where there are negative impacts, can these be mitigated or avoided?

46. Of the negative impacts discussed above, some of them can in principle be remedied, though in practice it would only be possible if the rate of deployment of hyperscale data centres is controlled.

- Water quality is in principle the easiest issue to address: a data centre does not need to use evaporative cooling, it could use closed loop cooling. However, this approach is more expensive and less efficient, so it results in higher energy consumption. This in turn is likely to lead to increased emissions because as discussed under Q1.4. above, it is unlikely that renewables capacity can be installed as fast as required by the planned data centre expansions. As a result the use of gas generators instead is highly likely unless the growth is controlled.

- Air quality depends on the nature of electricity generation, including backup generation. If the generation were 100% renewable and backup generation was entirely battery-based, there would be no additional air pollution. However, as explained under Q1.2. above, this is quite unlikely to be the case.

- The impact of the "Data Heat Island Effect" can be most effectively mitigated by limiting the maximum power consumption (the "size") of the data centres. Another route is to use the heat e.g. for district heating using a heat network, but heating is only needed about half of the year, and the additional heat would have the worst effect in the warmer period of the year. It also means that the data centre must have both heat-reuse and cooling facilities, making it more expensive. A much-cited example is heating of swimming pools, because they are heated year-round. However, considering the number of swimming pools in Scotland and the energy needed to heat them, the heat from a single 100 MW data centre (about 1% of the planned capacity) would be sufficient to heat all of them.

- In principle, emissions could be remedied by ensuring that every hyperscale data centre must be powered 100% by renewables. As explained under Q1.4. above, this effectively requires limiting the rate of expansion of data centres to considerably below the rate of expansion of renewables. Heat reuse could mitigate the emissions to some extent, as it could be used to heat homes without a need for gas. However, it would require a lot less renewable energy and infrastructure to heat those homes directly using heat pumps or conventional electric heating. And even if all operational emissions of the data centre were mitigated, that would not mitigate the embodied carbon, which is considerable.

A note on heat reuse

47. Apart from being only a partial solution for the cooling of the data centre, and less effective than heating using heat pumps, the main issue with heat reuse is that it only works if the heat can be transported to where it is needed. Transporting the heat from hyperscale data centre would need a complex and expensive heat distribution network. From the perspective of optimising heat reuse, building smaller data centres located close to population centres is a better choice. In fact distributed smaller data centres have much smaller negative impacts overall — except for emissions. Hyperscale data centres are advantageous for the operators and data centre tenants but have much higher local negative impacts than the equivalent capacity distributed across smaller ones, e.g. no more than 10 MW.

Q3. What systems are currently in place to support avoidance or mitigation of negative environmental impacts and what is still needed?

48. This is not my area of expertise. As far as I am aware, the data centre operators currently have no legal obligations in that respect. The only mechanism is the planning application process. What is definitely needed is a mechanism to

consider the applications not in isolation but consider the wider impact, e.g. need for infrastructure work for power, water, gas or communication networks, and the aggregate emissions.

Q4. What can Scotland learn from other jurisdictions on the environmental impacts of data centre construction?

49. The main lessons to learn are precautionary. There are many reports of the effects of data centre construction in other countries. For example [7] focuses on reduced access to water for the local communities across Latin America, highlighting the issues that are caused by the lack of an overarching policy framework, so that the decisions are taken ad-hoc by local administrations.

50. The United Nations University report [8] includes an entire chapter with “Guiding principles for a responsible AI ecosystem” and a discussion on “turning them into concrete practices for measurement, design, governance, and everyday use”. In particular, this report discusses Ireland as a cautionary example of local grid stress from concentrated data centre infrastructure, leading to increased electricity prices and/or degraded electricity supplies. This has led the national grid operator EirGrid to pause new data centre connection approvals until 2028.

51. The report by CETEx, Centre for Economic Transition Expertise at the London School of Economics and Political Science [9] for the Parliamentary inquiry “Risks and opportunities to the sustainability of data centres in the UK” (UK) provides a good discussion relating to the US, discussing the trends of significantly increasing emissions from fossil-fuel-based electricity generation, increasing stress on local water supplies, negative impacts on air quality and reducing available productive land for agricultural purposes. They conclude that “Overall, the US example suggests a need for caution in moving forward with data centre expansion” because “the benefits of further data centre rollout are hypothetical and diffused across society, while the costs are immediate and highly concentrated in some areas”.

52. The Spanish Ministry for Ecologic Transition and Demographic Challenge has launched a public consultation on a Draft Royal Decree (REL) that would impose strict energy efficiency and sustainability requirements on data centres in Spain.

53. CarbonBrief has written an explainer (REL) about how China is managing the rising energy demand from data centres. The article details “policy developments and improved market mechanisms will bolster the adoption of green power by data centres”, while at the same time pointing out that “By 2030, China’s data centres are projected to consume anything from 400TWh to 600TWh of electricity, with associated emissions of perhaps 200MtCO2e”. Note that 500 TWh/y expressed in GW as above is equivalent to about 70 GW of data centre capacity, bringing the planned UK capacity on the same level as that of China.

Q5. What impact would different levels of data centre construction in Scotland have on the ability to meet carbon budgets and anticipated statutory biodiversity targets?

54. I have addressed this question in detail under “Q1.4. Emissions” above, but in summary, expansion of renewables is required to decarbonise heating and transport. If the UK has more renewables capacity than needed for this purpose then that capacity could be used to power data centres. However, I think it is clear from the above discussion that this will not be the case for at least another decade. Furthermore, at the planned capacity levels, the embodied carbon from the construction of these facilities and the manufacturing of the cooling infrastructure, servers and networking equipment will be very considerable. In other words, the current planned expansion of hyperscale data centres in Scotland would mean Scotland could not meet the decarbonisation targets.

55. If the level of data centre construction in Scotland were much lower than planned, e.g. no more than 500 MW in total (which is already more than 10x the current capacity), and if this capacity were achieved by building a number of smaller data centres rather than a single hyperscale one, then I don’t think there would be any major impact on Scotland’s ability to meet carbon budgets and anticipated statutory biodiversity targets.

References

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Notes

1. Calculation:

4.8 TWh/y

= utilisation × hours per year × capacity (MW) / Mega to Tera

= 0.8×24×365×550/1,000,000

2. Calculation:

37,000 l diesel per hour

= utilisation × capacity (kW) / energy density of diesel (kWh/l)

= 0.8×500,000/10.7

3. For convenience, in what follows we convert TWh/y to GWh/y by multiplying by 1,000 and then to GW by dividing by the number of hours in a year, in other words we divide the TWh/y figure by 8.76 to get the GW figure.

8.32 GW = 72.9 / 8.76

4.7 GW = 41.2 / 8.76

4. Calculation:Renewable capacity needed to decarbonise 50% of gas and oil heating using heat pumps only

1.5 GW

= 50% of gas and oil heating (GW) × heating efficiency × (1 + transmission and distribution losses) / heat pump power-to-heat conversion efficiency

= 4.16 × 0.975 x 1.08 / 3

5. Calculation:Renewable capacity needed to decarbonise 50% of gas and oil heating using heat pumps and resistive heating

2.9 GW

= 50% of gas and oil heating (GW) × growth in heating need × (1 + transmission and distribution losses) × (0.5/heat pump power-to-heat conversion efficiency + 0.5/electric heater efficiency)

= 4.16 × 1.025 x 1.08 x (0.5 / 3 + 0.5 / 1)

6. Calculation:Renewable capacity needed to decarbonise 50% of road transport

1.5 GW

= 50% of energy from fossil fuel for transport (GW) × projected growth in transport / electric vehicle relative energy efficiency × battery charging efficiency

= 0.5 × (41.2 / 8.76) × 1.15 / (2 × .9)

7. Calculation: half of the previous number because electric vehicle relative energy efficiency = 1

8. Calculation:

11.1 GW

= 60% of (Capacity awaiting construction + Capacity under construction) (GW)

= 0.6 × (15.1 + 3.5)

9. Calculation:

6.6 GW

= 60% of (50% of Capacity awaiting construction + Capacity under construction) (GW)

= 0.6 × (0.5 × 15.1 + 3.5)

10. Calculations:

8 GW

= 5 GW for data centres + 3 GW for 50% decarbonisation

16 GW

= 10 GW for data centres + 5.9 GW for 50% decarbonisation (rounded up)

11. We use the geometric mean; arithmetic means are resp. 4.4 GW and 7.5 GW

Annexe B: Submission from ScotlandIS, 29 October 2026

Executive position

56. ScotlandIS strongly supports the responsible development of hyperscale data centres in Scotland, recognising the significant opportunity they present to attract private investment, accelerate renewable-energy development, strengthen digital sovereignty and create high-value economic activity.

57. Scotland is particularly well positioned to capitalise on this opportunity, with its substantial renewable-energy resources, cooler climate and established engineering and technology expertise offering clear competitive advantages. We believe that, with the right infrastructure planning and a proportionate approach to environmental management, hyperscale data centres can make a valuable contribution to Scotland's economic growth and wider sustainability ambitions.

58. As with other major infrastructure developments, there are environmental considerations associated with energy, water, land use and construction. However, advances in technology, operational efficiency and renewable-energy integration provide significant opportunities to manage these effectively, while supporting investment in Scotland's energy infrastructure and its transition to a low-carbon economy.

59. The central policy question for this environmental inquiry is how Scotland can manage the effects of constructing and operating hyperscale data centres while capturing the strategic opportunity. ScotlandIS supports a clear, proportionate and investment-friendly approach that makes effective use of existing planning and environmental frameworks, encourages good practice in energy, water, air quality, nature, noise and emissions, and coordinates infrastructure planning. Any additional expectations should be practical, clearly defined and developed with industry, taking account of delivery costs and Scotland’s competitiveness. The relevant comparison is between realistic development scenarios, including the environmental consequences of meeting growing compute demand elsewhere.

Why this is an economic and strategic infrastructure question

60. Data centres support cloud services, AI, financial and public services, life-sciences research, cyber resilience and business continuity. Locating appropriately governed computing infrastructure in Scotland can provide domestic capacity, low-latency services, specialist employment, construction and engineering work, tax receipts, and opportunities for local supply chains. The economic case must distinguish direct construction and operations from wider enabled activity; gross investment is not the same as net Scottish value added.

61. Data sovereignty is a further strategic benefit, but requires precision. Scottish-hosted capacity can help organisations choose UK data residency, reduce some cross-border dependencies, and support security, resilience and procurement requirements. Physical location alone does not guarantee legal sovereignty, jurisdictional independence or protection from overseas access laws: operator

ownership, encryption/key control, contractual arrangements, jurisdiction and operational control all matter. Public bodies should specify these requirements explicitly.

62. The economic opportunity also extends beyond physical hosting. Scottish capacity could support domestic AI research, advanced computing, life sciences and resilience for critical services, while enabling organisations to procure appropriate UK data-residency options.

63. International experience demonstrates that data-centre investment can produce substantial economic activity. An Irish government publication of a KPMG study estimated €2.2bn of GVA, 19,500 jobs and €280m of employment-related taxes from Irish data-centre construction and operations in 2024 [1]. Sweden offers a further example: an industry-commissioned 2026 impact study estimates SEK 12.6bn in direct GDP contribution, within SEK 57.8bn including indirect and induced effects, and approximately 1,600 direct jobs [14]. Norway's government reports approximately 4,400 full-time equivalents associated with data-centre industry association members' activities in 2024 [15].

64. Note: These studies use different methodologies and geographies and should not be added together or treated as forecasts for Scotland. Ireland's fiscal surplus should not be attributed to data centres alone [2].

Energy demand: opportunity and constraint

65. The International Energy Agency estimates global data-centre electricity consumption at 415 TWh in 2024 (around 1.5% of global demand) and projects approximately 945 TWh by 2030 in its base case [3]. Scotland generated 38.5 TWh of renewable electricity in 2025, including 30.8 TWh from wind, and recorded 20.8 TWh of net electricity exports [4].

66. For scale, a hypothetical 100 MW facility operating at full demand throughout the year would consume 0.876 TWh annually. That is roughly 2.3% of Scotland's 2025 renewable generation, but this comparison is illustrative only: a facility's actual demand, renewable matching, network impacts and system emissions require hourly and locational assessment. A 300 MW campus at the same utilisation would require 2.628 TWh per year.

67. A data centre's operational carbon footprint is fundamentally shaped by the electricity used to power it: the cleaner the electricity supplied, the lower the emissions associated with running its servers and cooling systems. This gives Scotland a competitive advantage through its substantial wind resource. The strongest environmental outcomes will come from demonstrable access to low-carbon electricity, ideally backed by additional renewable generation and storage. As with any industrial development, construction materials, backup generators and equipment also contribute to lifecycle emissions; annual renewable contracts should not be confused with zero-carbon electricity in every hour.

68. Efficiency is also a commercial imperative. Power costs, capacity availability, customer procurement requirements and operators' sustainability targets create

incentives to improve power-usage effectiveness, cooling efficiency and carbon performance. Those incentives are helpful but do not replace verified reporting: operators should disclose electricity demand, carbon intensity, PUE, water-usage effectiveness and the treatment of backup power and embodied emissions.

69. Hyperscale operators can be anchor customers and investors for Scotland's next generation of wind projects. Long-term electricity offtake agreements and direct private investment can provide developers with bankable revenue, potentially helping projects progress without depending solely on public-sector procurement opportunities. Coupling demand with new wind, storage and transmission could unlock wider benefits for the energy system. This opportunity requires an executable grid-connection pathway, financially robust contracts and careful assessment of competing demand.

70. The scale of potential investment warrants serious consideration, but illustrative capital-cost comparisons need transparent boundaries. Figures discussed with industry include £5–7 billion for a 1 GW offshore wind project and, for a hypothetical 1 GW AI compute campus, around £10 billion in facility construction and £40 billion in GPU hardware. On those assumptions, wind capital expenditure would be approximately 10–14% of the combined £50 billion campus and hardware total.

71. Note: These are unverified, scenario-specific assumptions—not a Scottish project forecast or a like-for-like cost comparison. GPU purchases may be staged and repeated over shorter replacement cycles, while offshore wind costs vary by site, technology, connection and financing. They should not be presented as established investment commitments without attributable feasibility studies. The policy point remains that long-term corporate power-purchase agreements and direct equity investment could provide a complementary route to finance new wind capacity alongside Contracts for Difference and other support mechanisms.

72. Scotland's constrained wind generation represents a significant opportunity for productive electricity demand. NESO reported that curtailment reached 13% of hypothetical GB wind output in 2024/25, with constraints particularly affecting Scottish generation [5]. Strategically located data centres, flexible computing and storage could help use more of this output and improve the economics of further renewable investment. However, physical network connections and access rights are currently decisive barriers: a data centre cannot simply consume constrained electricity without the necessary connection, and continuously operating facilities still need reliable power when wind output is low. ScotlandIS therefore calls for coordinated grid-connection reform and location-specific opportunities to align demand with generation.

73. Grid investment and electricity prices require separate consideration.

74. Hyperscale developers may finance dedicated connections, substations and other enabling works; reinforcement of wider transmission assets is subject to regulated planning, ownership and cost-allocation arrangements. Where additional demand is well located and coordinated with new generation, storage and transmission, it may improve network utilisation and reduce some constraint

costs. Whether households and businesses benefit through lower bills is an empirical question, not an automatic consequence. Project appraisals should show the developer-funded share, network-wide costs, expected constraint savings and consumer impacts under realistic scenarios.

75. New large demand can help underwrite network upgrades, but it does not follow that consumer bills will automatically fall. The effect depends on who pays for reinforcement, tariff design, utilisation, avoided constraints and the timing of investment. ScotlandIS recommends a transparent, project-level assessment of net network costs and benefits, with consumers protected against inappropriate cost socialisation.

Water: distinguish current Scottish use from future hyperscale demand

76. A June 2026 published estimate for Scotland's 13 operating data centres puts their combined daily water use at approximately 97 cubic metres, equivalent to 0.006% of the roughly 1.6–1.8 billion litres supplied daily to Scottish homes and businesses [7]. This provides useful context for the current estate, not a forecast for new hyperscale campuses. Scotland's cooler climate and appropriately selected cooling designs can offer a competitive water-efficiency advantage, with each proposed facility assessed on its actual peak and annual potable-water requirements.

77. The Scottish climate can enable more hours of free-air or other low-water cooling, but it does not guarantee zero water demand. Closed-loop liquid cooling can circulate an initial fill with limited replacement water, while evaporative cooling may consume materially more. There are trade-offs: reducing evaporative water use can increase electricity demand. Microsoft describes next-generation designs that eliminate water evaporation for cooling while acknowledging a modest increase in power consumption compared with some evaporative designs [8].

78. Cooling technology should not be treated as a single category. Adiabatic cooling uses evaporation to assist heat rejection and can increase water consumption when active; Scotland's cooler climate may reduce operating hours for this mode, depending on design and weather. Liquid cooling increasingly supports high-density AI hardware; closed-loop coolant circuits can operate with limited make-up water. However, a closed-loop server-side circuit does not, by itself, mean the whole facility uses little water: the external heat-rejection system may still use evaporative cooling. The assessment should distinguish cooling-circuit water, site-wide potable-water withdrawal, actual consumption and discharge, including peak summer conditions.

79. ScotlandIS supports a water-efficiency-first approach: data-centre developers should minimise freshwater demand, assess non-potable and alternative sources before relying on treated drinking water, and favour closed-loop cooling where appropriate. Where occasional top-up water is required, operators should coordinate with water providers to avoid periods of local scarcity. Facilities near suitably sized wastewater treatment works may be able to use treated effluent for cooling, potentially reducing potable-water demand and, in some configurations,

energy use. Any such scheme must be tested for treatment requirements, abstraction and discharge permissions, thermal effects and practical deliverability.

Comparison with established Scottish industries

80. A meaningful comparison with established Scottish industries requires care over measurement. A historical SEPA analysis estimated malt-distillery abstraction at 76.49 million cubic metres annually—approximately 209,600 cubic metres per day [9]. That is around 2,160 times the reported 97 cubic metres per day supplied to Scotland's 13 existing data centres, but the ratio compares historical industrial abstraction with current metered data-centre supply: it is an illustration of scale, NOT a like-for-like consumption comparison. More recent Scotch Whisky Association reporting states that 99.6% of malt distilleries in its 2024 water-efficiency analysis operated within or better than its 12.5–25 litres per litre of pure alcohol target range [16].

81. For energy, the Scotch Whisky Association reports UK Scotch whisky industry Scope 1 and 2 associated energy use of approximately 3.44 TWh in 2023, including about 0.37 TWh of purchased electricity and substantial direct fuel use [10]. This is not a like-for-like electricity comparison with data centres. By way of illustration, a fully utilised 100 MW data centre would use 0.876 TWh of electricity per year—about 2.5 times the sector's reported purchased electricity, but only about one-quarter of its total reported energy use.

82. Other Scottish water-using activities, including aquaculture, hydropower, food and drink manufacturing and agriculture, provide further context. Research from the University of Strathclyde reports that hydropower, water supply and aquaculture each exceeded 200 million cubic metres of measured water use in at least one year within a 2008–2018 dataset [18]; these volumes include uses with very different return flows and cannot be equated with net consumption. The relevant principle is consistent scrutiny of local scarcity, source, return flows and economic benefit across industries—not an assumption that high use by one sector licenses high use by another.

International examples and lessons

83. Ireland – economic cluster formation with energy-system trade-offs. The Irish government's commissioned study attributes €2.2bn GVA and 19,500 jobs in 2024 to data-centre construction and operations [1]. At the same time, Ireland's Central Statistics Office reports data centres used 7.663 TWh, or 23% of metered electricity, in 2025 [11]. The lesson is to evaluate infrastructure, jobs and tax benefits alongside cumulative energy demand—not to assume a budget surplus is caused by data centres.

84. Hamina, Finland – industrial-site reuse and innovative cooling. Google's Hamina data centre occupies a former paper mill and uses seawater cooling, with an offsite heat-recovery project [12]. This shows how siting and infrastructure reuse can reduce some impacts.

85. Luleå, Sweden – inward investment and northern-climate advantage. Meta reports more than SEK 8.7bn invested in its Luleå facility and over 300 operational jobs supported [19].. The project demonstrates how cool climates, industrial capability and infrastructure can attract sustained investment.

86. Odense, Denmark – useful heat recovery. A Danish district-energy case study reports that surplus heat from Meta's data centre supports approximately 125,000 MWh of district heating annually, equivalent to nearly 7,000 households [13]. Comparable Scottish opportunities depend on proximity to heat customers, heat-pump economics and viable networks; they should not be counted as benefits before delivery is secured.

Emerging international approaches: Singapore and New Zealand

87. For Scotland, international good practice points towards clear national ambition, coordinated energy and digital infrastructure planning, early engagement with developers and local authorities, appropriate site selection and a stable, proportionate planning environment. ScotlandIS does not advocate importing prescriptive requirements from other jurisdictions. Instead, Scotland should use its existing frameworks effectively, remove avoidable uncertainty and work with industry to achieve credible environmental outcomes without undermining investment competitiveness.

88. New Zealand – renewable-energy potential as an investment advantage. New Zealand has promoted its renewable-electricity resources, temperate climate and regional opportunities in attracting data and AI infrastructure. Proposed projects illustrate the potential to connect digital investment with new energy generation, storage, industrial locations and skilled employment. These are emerging propositions, rather than evidence that all anticipated economic or environmental benefits have already been delivered. The lesson for Scotland is to present energy availability, suitable sites and efficient cooling as competitive strengths while assessing individual proposals on their merits. [21]

89. Singapore – strategic growth supported by efficiency. Singapore's Green Data Centre Roadmap, published in 2024, sets out plans to unlock at least 300 MW of additional data-centre capacity in the near term, with further expansion dependent on green-energy deployment. Its approach combines a clear national strategy with collaboration on energy efficiency, technology innovation and the allocation of new capacity. Singapore operates in a different land, energy and regulatory context from Scotland, so its specific controls should not be assumed to be directly transferable. The relevant lesson is the value of an explicit investment strategy and predictable processes. [20]

90. International developments demonstrate how other governments are increasingly treating data centres as strategic economic infrastructure, while seeking to address energy, water and environmental considerations through coordinated planning and engagement with industry.

Ensuring environmental responsibility alongside economic opportunity

91. The environmental case for hyperscale development should be assessed alongside the potential for new private investment in Scotland's energy and digital infrastructure. The International Energy Agency estimated that data centres used 415 TWh of electricity globally in 2024 and projected around 945 TWh by 2030 in its 2025 base case [3]. This growth reinforces the importance of where facilities are built, how they are powered and whether they enable additional clean generation. Scotland's 38.5 TWh of renewable electricity generation in 2025, including 30.8 TWh from wind [4], provides a strong foundation, but it does not remove the need for site-specific assessment of grid availability, emissions and cumulative demand.

92. That assessment must extend beyond electricity consumption. Standby diesel or other combustion generators may emit nitrogen oxides and particulates during testing or outages, even where routine operations use low-carbon power. Planning and permitting should therefore consider the type and number of generators, their expected testing and running hours, local air-quality conditions and feasible lower-emission alternatives. This is a practical safeguard that allows developers to demonstrate environmental performance rather than relying on broad sustainability commitments.

93. The same principle applies to communities and land use. Cooling equipment, transformers, backup plant, construction activity and traffic can create noise, while large campuses and their associated connections may affect soil, drainage, habitats and biodiversity. ScotlandIS encourages developments in locations well suited to industrial infrastructure, including established industrial areas and appropriately serviced previously developed sites, where feasible. Early site selection should take account of power and water availability, transport links, neighbouring communities and sensitive landscapes, with particular care around areas of natural beauty and ecological importance. This approach can help avoid unnecessary environmental pressures while providing developers with greater certainty. Proportionate baseline surveys and relevant noise, habitat and drainage evidence should inform decisions through established planning processes.

94. There are also opportunities to improve the overall environmental balance through design. Waste heat can be a useful resource where a viable district-heating network or industrial customer exists: the Odense example cited above reports approximately 125,000 MWh of annual heat supplied from a data centre [13]. In Scotland, that potential should be tested at the earliest design stage, but only delivered, usable heat—not theoretical recoverable heat—should count towards claimed benefits. Lifecycle assessment should likewise account for construction materials, servers and equipment replacement, refrigerants, backup systems and eventual decommissioning, not simply operational electricity.

95. For ScotlandIS, these considerations reinforce rather than undermine the case for a strategic approach. Scotland should welcome investment that supports cleaner energy, digital resilience and local economic opportunity, while

encouraging developments to respond to local environmental conditions. Clear guidance, proportionate assessment and consistent application of existing standards can provide confidence for communities and investors without creating unnecessary additional compliance costs. Regional and national infrastructure planning should also consider the combined effects of multiple projects and help identify suitable locations for future investment.

What Scotland should encourage in developments

- Independent appraisal of net Scottish value: construction and permanent jobs separately; Scottish supply-chain expenditure; business rates and relevant taxes; local skills; opportunity costs; and sensitivity to project scale.

- An hourly, location-specific energy assessment covering load, firm supply, additional renewable generation, power-purchase arrangements, network reinforcement, curtailment opportunities, backup power and lifecycle carbon.

- An agreed water plan covering potable demand, alternatives including treated effluent, annual and peak-day consumption, seasonal scarcity, water quality, discharge, closed-loop design and independently reported water-usage effectiveness.

- Early consideration of suitable locations, prioritising established industrial areas and appropriately serviced previously developed land where practical, while avoiding unnecessary impacts on valued landscapes, environmentally sensitive areas and nearby communities; planning and biodiversity assessments proportionate to site conditions.

- Clear, achievable commitments to investment, performance, community benefit, skills and reporting, agreed through appropriate existing processes and reflecting project scale and commercial deliverability.

- Data-residency and sovereignty requirements proportionate to the workloads being hosted, including legal jurisdiction, key management, operational control and resilience.

- Fiscal, community and skills benefits should be assessed explicitly. Developers may contribute through non-domestic rates, employment-related taxes and wider supply-chain activity, but the amount retained by Scottish public bodies depends on the applicable fiscal framework. Developers can also support apprenticeships, technical education, university partnerships, R&D and local procurement. ScotlandIS recommends that project proponents quantify these commitments, identify delivery partners and report realised outcomes rather than rely on headline investment totals.

- Fair grid-cost allocation and coordinated decisions across Scottish Government, Ofgem, NESO, network companies, Scottish Water, SEPA and planning authorities.

Recommendations to the Committee

- Adopt a strategic, location-sensitive approach that actively welcomes hyperscale investment, identifies suitable industrial and previously developed locations, and supports early engagement to address site-specific environmental and infrastructure considerations.

- Commission comparable, current Scottish cross-sector water and energy datasets, distinguishing withdrawal, consumption, return flows and energy carriers;

- Create a joint energy–digital infrastructure planning route to match credible data-centre demand with wind investment, flexibility, curtailment reduction and deliverable grid connections.

- Encourage transparent, proportionate project-level reporting of electricity use, carbon intensity, PUE, water consumption and sources, backup emissions, heat recovery and local economic outcomes, building wherever possible on existing reporting arrangements.

- Test a small number of investable demonstrators—such as a renewables-linked compute campus or treated-effluent cooling site—against explicit consumer, water and nature safeguards.

- Include data sovereignty, digital resilience and domestic compute capability in economic appraisal, without treating Scottish physical hosting as sufficient evidence of sovereignty.

- Protect communities and consumers by ensuring that private benefits are not achieved through unexamined socialisation of grid, water or environmental costs.

- Learn from international good practice: examine approaches in Singapore, New Zealand and comparable markets to develop a coordinated, investment-friendly framework that combines clear planning pathways, renewable-energy opportunities, appropriate site selection and proportionate environmental management.

Conclusion

96. ScotlandIS believes Scotland should actively welcome responsible hyperscale investment rather than treating data-centre development and environmental protection as opposing objectives. Scotland’s renewable resources, cooler climate, engineering expertise and need for secure digital infrastructure create a credible opportunity for private investment and long-term public value. Sensible site selection, including suitable industrial and previously developed locations, can help protect valued landscapes and environmentally sensitive areas while supporting efficient infrastructure delivery. An enabling, predictable planning framework, proportionate environmental assessment and constructive engagement with developers can support strong outcomes without imposing unnecessary costs that undermine Scotland’s competitiveness. This approach

can help data centres become anchor investors in renewable generation, grid infrastructure, specialist skills and secure computing capability, while encouraging efficient water use, appropriate network investment and tangible local benefits.

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