Land North West of Bicester

Technology Appraisal for Zero Carbon Homes (EXTERNAL USE)

On behalf of **Firethorn Developments Limited**

Project Ref: 49656/001 | Rev: 2 | Date: February 2021

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Document Control Sheet

Project Name: **Land North West of Bicester**

Project Ref: **49656**

Report Title: **Technology Appraisal for Zero Carbon Homes (EXTERNAL USE)**

Doc Ref: **49656 210126**

Date: **March 2021**

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For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
1	8/2/21	Working Draft	JR	MD	JR
2	18/2/21	Final	JR	RB	JR
3	23/3/21	Adjusted heat network efficiencies	JR	RB	JR

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1 Introduction

1.1 Background

1.1.1 This Technology Appraisal for Zero Carbon Homes report has been prepared by Stantec UK Limited on behalf of Firethorn Developments Limited to support the development of an energy strategy for the outline planning application of the proposed residential development at the site, Land at North West Bicester (NW Bicester).

1.1.2 The development proposals comprise up to 550 residential units with one electric vehicle charging point (EVCP) per unit. The description of the development is as follows:

"Outline planning application for residential development (within Use Class C3), open space provision, access, internal estate roads, vehicle and cycle parking, drainage and all associated works and operations including but not limited to demolition, earthworks and engineering operations, with the details of appearance, landscaping, layout and scale reserved for later determination."

1.1.3 The purpose of this report is to provide a clear understanding of the impact of specific energy technologies on both carbon emissions and energy over the next thirty years at NW Bicester.

1.2 Ecotown and Zero Carbon Homes

1.2.1 Cherwell District Council's (CDC) Local Plan Policy ESD 3 requires all new development to achieve zero carbon development through a combination of fabric energy efficiency, carbon compliance and allowable solutions in line with Government policy.

1.2.2 The North West Bicester Supplementary Planning Document (SPD) reiterates the Local Plan requirements to the Masterplan Energy Strategy which sets out the requirement for new homes to deliver large solar arrays on all roofs, energy efficiency and connection to a district heat network supplied with heat from biomass and gas combined heat and power (CHP). In addition, the SPD notes the opportunity for future connection to the Ardley Energy from Waste (EfW) Plant.

1.2.3 The SPD defines zero carbon development as no net carbon dioxide emissions from the development relating to *all* energy use from buildings over a year (regulated and unregulated energy). This excludes emissions from transport, embodied carbon and greenhouse gas emissions that are have not been considered such as refrigerants in heat pumps and land use change.

1.2.4 In addition, it notes that Code for Sustainable Home Level 5 should be achieved, which in itself requires 100% of all regulated energy demand to be supplied through directly supplied renewable energy (not low carbon energy).

1.2.5 The SPD also layers new energy demands into the project that are not included within the carbon emission calculation but impact the overarching energy strategy.

1.2.6 No evidence was established at the time of the Local Plan or SPD of the impact of the future decarbonisation of the national grid on technology selection, or the distribution network operator's (DNO) ability to manage new power loads from future development scenarios.

1.3 Future Homes Standard

1.3.1 Since both the establishment of the Local Plan and SPD, Government have consulted on future standards from new homes in the UK. The outcome of the consultation sets a trajectory for energy efficiency in new homes up to 2025. This includes defining how Part L of the

Building Regulations will be defined in 2021 and 2025 and how the Standard Assessment Procedure 10 (SAP) calculates the carbon dwelling emission rates for new homes[1]. Specific fabric energy efficiency standards have been defined by Government that targets new homes to be 'zero carbon ready' by 2025. The Government also notes that these standards will not require 'carbon offsetting'.

1.3.2 In establishing the Future Homes Standard, Government have identified new development should leverage the benefit of the decarbonised grid electricity over the next decade, not least the use of electric led heating technology to replace natural gas.

1.3.3 Within the defined changes expected for SAP 10.2 is the requirement for clear disclosure on heat loss from heat networks, with defaults currently set as either 50% to 100% of heat supplied through district heat networks.

1.3.4 Government intends to ensure new transitional arrangement are applied within Part L. This requires each home to be registered to Building Control, rather than the whole development. This will ensure that developments will be require to meet the continual changes to Part L over time rather than locking in to the Part L standard on project commencement.

1.3.5 This will have important implications for cost planning and 'robustness' of strategy and technology selection.

1.4 Key Considerations for Developing True Zero Carbon Homes at North West Bicester

1.4.1 In establishing an energy strategy for NW Bicester, the technical approaches to supply heat and power needs consideration against the changes in Building Regulations Part L over the next decade.

1.4.2 An existing approach to heating technology was adopted that did not considered the future scenarios of power decarbonisation. Whilst biomass CHP and/or connection to the Ardley EfW was recommended within the Ecotowns energy masterplan, neither approach has been adopted.

1.4.3 Under the changes to the Building Regulation 2021, homes connected to district heating networks supplied by gas boilers and gas CHP will fail Part L of the regulations. In addition the transitional arrangements will be based on each dwelling, not the whole scheme, so technology selection will have to consider future changes to the Building Regulations.

1.4.4 Within the existing policy no account for power capacity was considered within the local distribution network. With requirements for EV's, electric cooking and the potential need to decarbonise the existing heat network or on plot heating through electric led approaches, there is a significant risk of a limited power capacity for the wider Ecotown.

1.5 Purpose of this report

1.5.1 The purpose of this report is to provide a clear understanding of the impact of specific energy technology on both carbon emissions and energy demand over the next thirty years at NW Bicester.

1.5.2 The report reviews how the carbon emission benefits of heating technology will be impacted by the future changes to carbon emission factors of the Building Regulations in 2021 and 2025 in light of the new transitional arrangements in Part L. Consideration has been given to the

[1] https://www.gov.uk/government/consultations/the-future-homes-standard-changes-to-part-l-and-part-f-of-the-building-regulations-for-new-dwellings.

quantity of renewable generation and/or approaches to carbon removal needed to achieve the SPD definition of zero carbon homes.

1.5.3 It is recognised that developing an energy should start with reducing energy demand in the first instance through plot design and then building energy efficiency. The level of building energy efficiency will be dictated by a range of variables not least development viability, forms of construction (such as modern methods of construction, MMC) and changes to Part L.

1.5.4 Adopting energy efficiency standards that go beyond the expected trajectory of the Building Regulations will be considered separately.

2 Technology Appraisal

2.1 Introduction

2.1.1 This chapter sets out the methodology and results of appraising the carbon impact of heating technology.

2.2 Methodology

2.2.1 A 2 bedroom semi-detached home has been taken to establish a notional house for the purpose of energy modelling. The fabric performance has been specified to meet the standards and performance of defined within the Government's Indicative Future Homes Standard Specification. The notional house has been presented in Appendix 1 for reference.

2.2.2 A Standard Assessment Procedure (SAP) model has been developed in both Stroma's FSAP2012 and FSAP 10 (Beta version), the latter presenting the Government's computation model for Part L Building Regulations for 2021 (i.e. SAP10). Please note that there will be future updates of SAP10 that will change the analytics of SAP modelling.

2.2.3 Changes in heating technology have been applied to the notional house within the SAP models and adjusted to meet the carbon emission scenarios of the Government's SAP10 to compare annual carbon emission performance. The following heating technology scenarios have been assessed:

1) Gas boiler;
2) Night storage heating with smart controls and air source heat pump hot water cylinder;
3) On plot air source heat pumps (ASHP);
4) Community heating connected to a 65:35 ratio of gas CHP and boilers; and
5) Community heating connect to centralised ASHP;

2.2.4 Please note for the existing district heat network combines both gas CHP and boilers. The assessment of heat network efficiency has been based on data provided by SSE Enterprise, dated 10th March 2021.

2.2.5 Annual carbon emission performance has then been appraised over a 20 year period against the Departments for Business, Energy and Industrial Strategy (BEIS)'s National Grid greenhouse emission projections. The emission factors used within the analysis are presented in Table 2.1 below.

Table 2.1 Future projections of grid decarbonisation

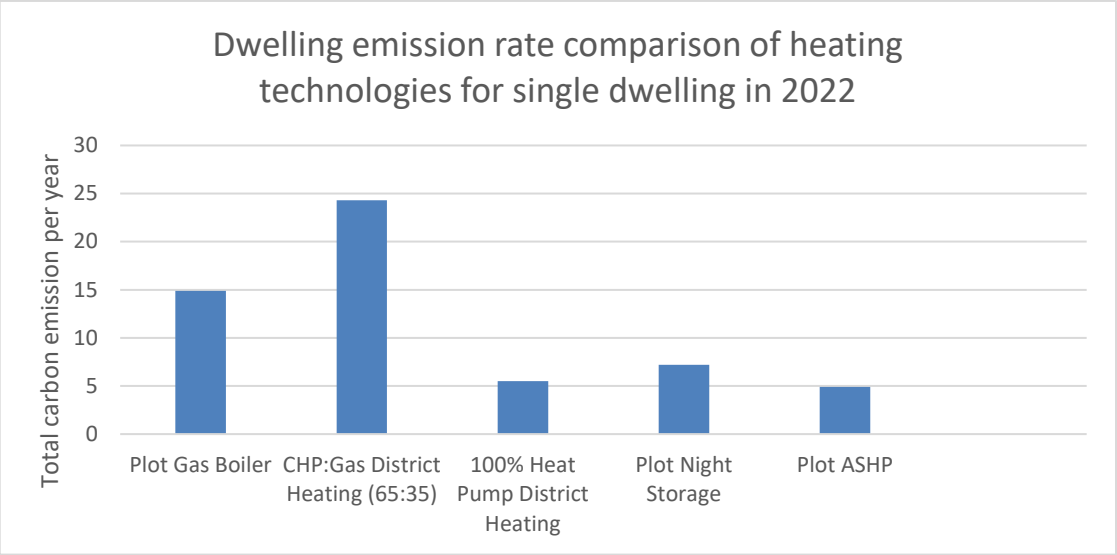
	Electricity (kg/CO_2kWh)	Gas (kg/CO_2kWh)	Source
2021	0.136	0.210	SAP 10.1
2025	0.100	0.210	UK Greenhouse Gas Projections (April 2019)
2030	0.044	0.210	UK Greenhouse Gas Projections (April 2019)

2.2.6 Each scenario was tested for 10, 20 and 30 year total carbon emissions based on these projections. Future grid carbon emission scenarios were assumed constant from 2030 onwards.

2.3 Results

2.3.1 Figure 2.1 below present the dwelling emission rate for each heat technology scenario within SAP based on SAP10 emission scenarios for the year 2021.

Figure 2.1 Total dwelling emission rate per annum of heating technologies

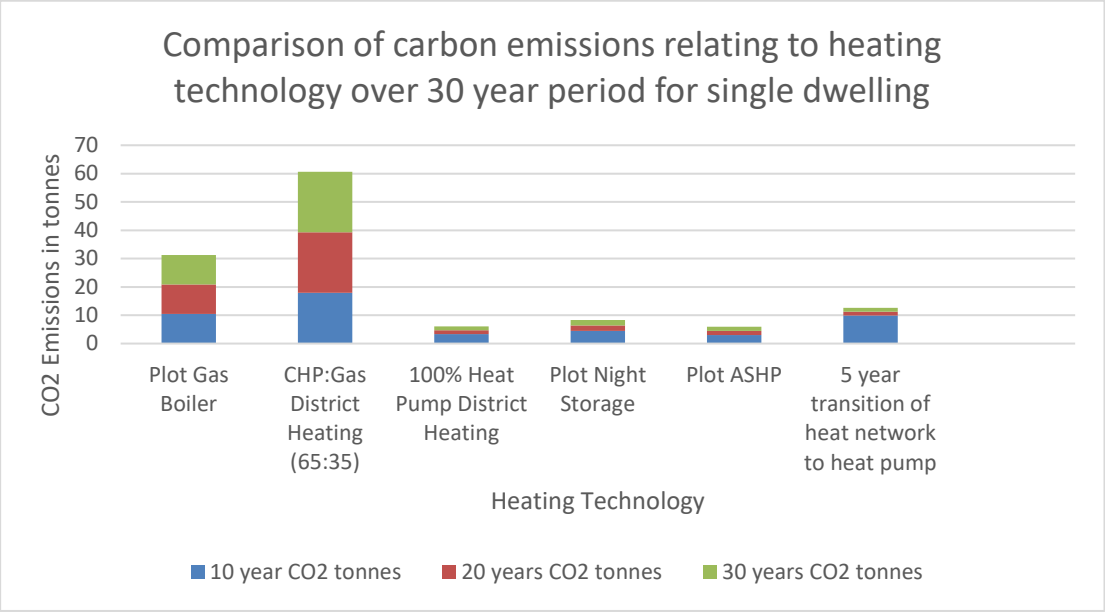


2.3.2 The analysis shows the impact of the carbon performance of district heating with gas CHP due to the heat losses defined by SSE Enterprise and the decarbonisation of the grid which means gas generated electricity has a higher carbon intensity than grid electricity.

2.3.3 It should be noted that the analysis also showed that homes connection to a heat network supplied by gas CHP and boilers would fail Part L of the Building Regulations in 2021.

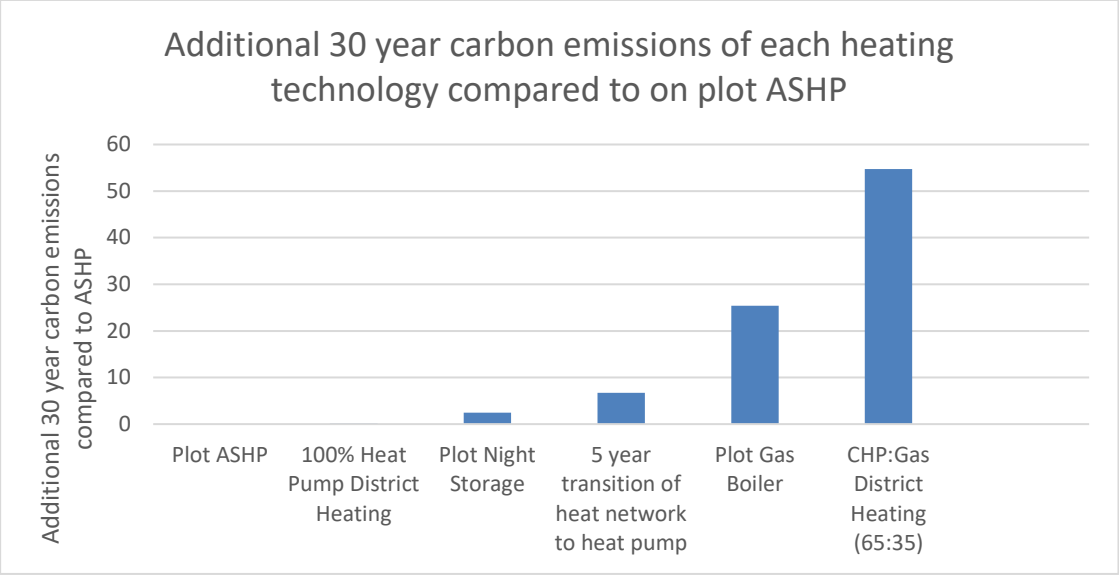
2.3.4 The impact of grid decarbonisation for each heating technology is presented in Figure 2.2 below for a single dwelling. This analysis also reviewed the potential to decarbonise the existing SSE Enterprise heat network through transfer to a heat pump led network over a 5 year period.

Figure 2.2 Comparison of heating technology over a 30 year period



2.3.5 The results show that, due to the decarbonisation of power over the next 30 years, individual dwelling electric solutions (such as night storage heating with smart controls and on plot ASHP) offer the lowest carbon emission rates of all approaches. Heat pump led community heat networks also offer potential low carbon heating, but this is slightly higher than individual plot heat pump solutions due to the heat losses[2] related to district heating. Unless the existing district heat network is decarbonised immediately, night storage heaters would offer a lower carbon solution than connecting to the heat network. A comparison of carbon emission impact compared to on plot heat pumps is presented in Figure 2.3 below.

Figure 2.3 Comparison of carbon emissions for heating technology against the lowest carbon heat technology (ASHP)



[2] 50% within SAP10 relating to district heating designed to Association of District Energy Standards (note heat networks without this accreditation will have heat loss factor of 100% losses).

2.4 Meeting Zero Carbon Home at North West Bicester

2.4.1 The Future Homes Standards sets a direction of travel for new homes towards using electric led heating technology. The adoption of a fabric energy efficiency standard equivalent to the anticipated Future Homes Standard and low carbon heating technology will still require further carbon emission reduction to achieve the true zero carbon definition.

2.4.2 The Ecotown energy masterplan notes that this should be provided by both on plot solar generation and/or directly connected offsite solar generation renewable generation.

2.4.3 Table 2.2 below sets out the additional solar energy generation required to achieve zero carbon status for the wider site[3].

Table 2.2 Scale of Renewables or Nature Based Solution to enable zero carbon for up to 550 homes

	Plot ASHP	Plot Night storage	District heating: heat pump	District heating: CHP/Boilers (65:35)
Estimated total regulated carbon emissions from heating technology over 30 years	3,250 tonnes	4,600 tonnes	3,300 tonnes	33,350 tonnes
Estimated unregulated carbon emissions over 30 years	3,000 tonnes	3,000 tonnes	3,000 tonnes	3,000 tonnes
Solar generation to achieve regulated zero carbon	1.6MW	2.3MW	1.9MW	8.3MW[A]
Solar generation to achieve true zero carbon	3.3MW	4.0MW	3.6MW	10MW

N.B. [A]This does not account for decreasing carbon emission impact of solar power over 20 year in offsetting gas related carbon emissions.

2.4.4 Assuming a 4kW array per property the development of up to 550 homes could deliver approximately 2.2MW of solar generation. This would provide the required renewable supply to achieve all regulated emissions for electric led heating.

2.4.5 There is also an opportunity for carbon offsetting to be used to achieve true zero carbon. Attached in Appendix B is schedule 8 'Carbon Offsetting' which has been agreed with CDC for the exemplar application. This provides an opportunity for the 'owner' to firstly calculate the carbon dioxide emissions of the completed development and then to pay the site balancing amount.

2.4.6 An alternative to offsetting is to provide an offsite solar solution to achieve true zero carbon. This could accommodate the whole renewable energy supply or just a proportion depending on the quantum of on-site generation on buildings.

[3] Please note this is a simple extrapolation of the modelled notional house to the 550 home development.

2.4.7 To achieve true zero carbon an offsite solar array, directly connected to NW Bicester, of between 1 to 2MW would be required for electric led heating approaches. A gas led approach would need significant offsite solutions.

3 Conclusions

3.1 Conclusions

3.1.1 Over the next five years, national Building Regulation will require developers to strategically plan energy infrastructure against the rapid decarbonising grid power infrastructure.

3.1.2 This assessment has looked at the implications and variables associated with heating technology options and future grid decarbonisation for achieving energy and carbon emission reductions at NW Bicester.

3.1.3 The summary of findings are presented below:

1) Over the next five years the greatest influence on carbon emission reduction potential of new homes will be the decarbonisation of grid electricity. The adoption of electric led heating approaches on each housing unit offers the maximum carbon benefit.

2) Zero carbon homes and Code Level 5 can be achieved through a combination of FHS and solar generation.

3) New homes will fail Part L of the Building Regulations if they are connected to a heat network supplied by gas boilers and CHP beyond 2021.

4) In lieu of none of the prefer technology options establish for the Ecotown coming forward, to deliver true zero carbon, offsetting or offsite renewable energy project will be required. The offsite location could accommodate all the renewable energy generation for the development within a single location.

5) Decarbonisation of the heat network is critical to achieving minimum compliance to the Building Regulations and reducing the need for offsite renewable generations.

Appendix A Fabric Energy Efficiency Standards

	Indicative FHS specification
Floor U-value (W/m2.K)	0.11
External wall U-value (W/m2.K)	0.15
Roof U-value (W/m2.K)	0.11
Window U-value (W/m2.K)	0.8
Door U-value (W/m2.K)	1.0
Air permeability at 50 Pa	5.0 m3/(h.m2)
Heating appliance	Low-carbon heating (e.g. Heat pump)
Heat Emitter type	Low temperature heating
Ventilation System type	Natural (with extract fans)
PV	None
Wastewater heat recovery	No
y value (W/m2.K)	0.05

Appendix B Schedule 8 ‘Carbon Offsetting’

SCHEDULE 8

Carbon Offsetting

1. **Carbon Offsetting**

1.1 The Owner covenants with the District Council:

1.1.1 prior to First Occupation of the Northern Site to pay the Northern Site Initial Carbon Offsetting Contribution to the District Council;

1.1.2 not to Occupy or allow or permit Occupation on the Northern Site unless and until it has paid the Northern Site Initial Carbon Offsetting Contribution to the District Council in accordance with the terms of this paragraph;

1.1.3 prior to First Occupation of the Southern Site to pay the Southern Site Initial Carbon Offsetting Contribution to the District Council;

1.1.4 not to Occupy or allow or permit Occupation on the Southern Site,unless and until it has paid the Southern Site Initial Carbon Offsetting Contribution to the District Council in accordance with the terms of this paragraph.

2. Following completion of the development of the Northern Site pursuant to the Hybrid Planning Permission, the Owner shall undertake and submit to the District Council an assessment of the carbon dioxide emissions of the completed development of the Northern Site pursuant to the Hybrid Planning Permission so as to calculate the Balancing Amount for the Northern Site .

3. Following completion of the development of the Southern Site pursuant to the Hybrid Planning Permission, the Owner shall undertake and submit to the District Council an assessment of the carbon dioxide emissions of the completed development of the Southern Site pursuant to the Hybrid Planning Permission so as to calculate the Balancing Amount for the Southern Site .

4. The Owner covenants:

4.1 to notify the District Council of the Northern Site Balancing Amount within 20 (twenty) Working Days of the completion of the development on the Northern Site pursuant to the Hybrid Planning Permission;

4.2 to notify the District Council of the Southern Site Balancing Amount within 20 (twenty) Working Days of the completion of the development on the Southern Site pursuant to the Hybrid Planning Permission;

4.3 in the event that the Northern Site Balancing Amount is greater than zero, to pay the District Council the Northern Site Balancing Amount within 20 (twenty) Working Days of completion of the development of the Northern Site pursuant to the Hybrid Planning Permission

4.4 in the event that the Southern Site Balancing Amount is greater than zero to pay the District Council the Southern Site Balancing Amount within 20 (twenty) Working Days of completion of the development of the Northern Site pursuant to the Hybrid Planning Permission

5. In the event that the Northern Site Balancing Amount is less than zero the District Council covenants to pay to the Owner a sum in pounds which is equal to the amount by which the Northern Site Balancing Amount is less than zero within 20 (twenty) Working Days of the Owner's notice in accordance with paragraph 1.4(a) above.

6. In the event that the Southern Site Balancing Amount is less than zero the District Council covenants to pay to the Owner a sum in pounds which is equal to the amount by which the Balancing Amount for the Southern Site is less than zero within 20 (twenty) Working Days of the Owner's notice in accordance with paragraph 1.4(a) above.