A2Dominion
Elmsbrook monitoring 2017-18
Data on travel, waste, water and energy use on site

Final Report

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Executive summary

This report forms the second in a series of annual reports showing the real-life results from monitoring the ground breaking Elmsbrook development – the UK's first ecotown. Data has been collated from a range of sources as part of a planning requirement to compare how the development is performing against the targets set within the Ecotown Planning Policy Statement (PPS). The 86 homes of the first phase have now been occupied for over a year- the initial move ins started April 2016. Since October 2017 residents started to move into the second phase of the development (46 of 71 currently occupied). In reporting terms, we are now in a position where a full year's data can be compared to the initial targets.

The monitoring procedure is complex with many different sources of information to collate, organisations to liaise and large amounts of data to analyse. However, it's a worthwhile exercise; as the findings allow us to assess current performance, learn important lessons and optimise the future operation of the development. Some of the monitoring data was impacted by technical failures, such as meter outages or server reboots causing false readings. Further equipment malfunction (e.g. PV inverter failure or water leaks) resulted in abnormal readings, requiring secondary analysis ("sense checking") to filter good from bad data. This highlights that even with a high level of automation and sub metering, it still requires an individual to interpret the quality of the data. Learning from these problems will ensure that information becomes more robust over time.

The most exciting aspect of this year's reporting is that the site as a whole (residential, energy centre and school) is already achieving true zero carbon (i.e. carbon neutral), proving that the true zero-carbon ambition is not only possible, but can even be achieved during early stages of construction. Whilst households are currently using more energy than the design estimate (electricity and heat) and are generating slightly less electricity from PV, the buffer from the school's PV generation and the running of the energy centre's Combined Heat and Power (CHP) gas turbine are enough to bring the balance to (minus) 25 tonnes of CO_2. Whilst the carbon balance is positively affected by the CHP, low heat demand means the supplementary gas boilers dominate current generation, so further efficiency savings can be expected once the development is fully occupied.

Taking energy use to one side, other sustainability indicators such as travel remain challenging. Due to the edge of town location and high proportion of commuters, the current modal shift figures are some way off their target, meaning Elmsbrook resident commute farther and are more car reliant than their neighbours in Bicester. Recycling rates are below county average, so will also require some concerted effort. Water use on Elmsbrook at present matches the UK average of 150 litres per person per day, despite the water efficient fittings and the rainwater harvesting. This exceeds the design target of 80 litres per person. These indicators highlight that although the development as a whole is true zero carbon, other environmental targets still require work. With monitoring only in its second year, lifestyle adjustments are still taking place and might not be a fair comparison to communities that are fully bedded in and settled.

Findings from both the annual resident survey and buyer's customer feedback survey are largely encouraging. Residents continue to be happy in their new homes, are more social ('know more of their neighbours') and rate their health above UK average. 38% said the eco town concept was the main reason to buy a home at Elmsbrook. The most liked design feature was again an eco-related feature with 46% (e.g. PV, rainwater harvesting) and 78% would

recommend buying a home at Elmsbrook. Demand for these ground-breaking new homes is continuing to grow, demonstrating that a more sustainable, healthy lifestyle within a fair share of the earth's resources is both viable and popular.

1 Introduction

This report has been prepared for A2Dominion by Bioregional and consists of the second set of monitoring results from Elmsbrook development in Bicester. Monitoring covers a period of 12 months (1 April 2017 to 31 March 2018) and includes data from 86 dwellings of the first phase and 32 of the second phase.

Information was collated from two main sources, survey questionnaires providing qualitative data and from monitoring equipment (e.g. the shimmy) providing quantitative data. Other data sources complete the picture around waste, travel and communal energy.

This year's reporting is particularly significant as it represents the first year with a full set of data, covering the breadth of the monitoring period. Previously, incomplete data was provided as the homes were not fully occupied, therefore potentially skewing the results.

Nevertheless, technical issues around the PV system have meant that some data was not collected correctly even though nominal a full year should be available. The flat blocks share a communal roof space and PV array which is not sub metered (figures have been collected manually). For this reason, the total electricity figure (as derived from a formula of generation, export and import) cannot be accurately predicted for those plots reducing the data set.

Data is generally presented in headline figures (bullet points) followed by a more detailed summary then graphs. Further important notes on the data or analysis can be found in in the first paragraph of the relevant section. Lastly the report provides conclusions and recommendations for how the sustainability features and the reporting can be approved upon.

2 Overview of the site

2.1 Environmental standards

Elmsbrook is the first phase of the UK's first eco-town, North West Bicester. The 393-home One Planet Community includes a primary school, community centre, an eco-business centre and local neighbourhood shops. The development included the following environmental features or standards:

- All homes built to Code for Sustainable Homes L5, incorporating triple glazing, mechanical ventilation (MEV or MVHR), rainwater harvesting and water recycling
- PV solar panels on every home
- Community combined heat and power plant
- Cycle and pedestrian routes, a bus stop within 400 metres of every home, live timetable updates in each home, communal charging points for electric vehicles and an electric car club
- 40% of the site is open space, with a net biodiversity gain targeted
- Water efficiency target of 80 litres per person/ day

2.2 House types, tenure and phasing

Elmsbrook consists of a mix of 2-5 bed properties, flats and bungalows. The development is made up of four phases, of which the first phase has been occupied for over 12 months (full set of data), the second phase has been occupied for about 6 months (incomplete data) and phases three and four are currently being constructed (no data). Further detail of the housing type and tenure for phases 1 and 2 is outlined below.

Table 1- House types and tenures by phase

Phase/ tenure	Detached units	Terraced units	Flats	Semi-detached units	Bungalow
Phase 1 – 86 dwellings occupied (12 months data)					
Private	12	26	0	4	0
Affordable	0	9	18	4	3
Shared ownership	0	7	6	5	0
Phase 2 – 46 dwellings occupied of 71 (average of 3 months data)					
Private	12	47	0	4	0
Affordable	0	0	4	0	4
Shared ownership	0	0	0	0	0
Total occupied – 132 dwellings	13	68	28	15	7

2.3 Buyer's profile

As you would expect with any development, motives for why buyers chose to move to Elmsbrook varied widely (e.g. quality, style, location and eco credentials). This was evident in the customer feedback survey; one representative response highlighted the reason for choosing Elmsbrook as follows:

> *"Multiple things; the quality of what was promised, the quality of the grounds, the roads, benches, the BBQ areas, the neighbourhood and so on. When we looked at the display home we were assured that the build quality would be a high standard compared to a development across the road in Kingsmead."*

That said, the customer survey does show that the eco-credentials of the development are a key attraction. In fact, of the 58 residents in the survey, approximately 40% stated that the reason for purchasing a property was explicitly due to the eco-aspects of the development. As one resident stated:

> *"It's due to the eco-side of things, like the rain water harvesting and the solar panels, and also the quality of the marketing suite."*

3 Overview of the data

This report has been largely collated as part of a desktop study with a small component off on site data collection by Bioregional.

3.1 Sources of information

All six sources of information featured in this report were provided by A2Dominion and their partners for the purposes of monitoring agreed planning conditions. Sources include:

- In house monitoring from Carnego (i.e. shimmy data)
- Waste data from Cherwell District Council

- Resident survey, buyers survey from A2Dominion
- Travel data from Mode Transport
- Energy centre data from Scottish Southern Electric (SSE)
- Gagle Brook Primary School from the White Horse Federation

3.2 Data analysis

The datasets were first spot checked for consistency. This included a high-level sensitivity analysis, to highlight any anomalies, 500% above the average. The data provider was then requested to check and resubmit.

Once this was completed, remaining anomalies above 500%, especially if these occurred for extended periods of time or in series were adjusted using an average of the last and next cell in the range. This improved the accuracy of data enormously, as server outages can account for random data anomalies to a factor of 5-10.

After this data screening and adjustment exercise, further detailed analysis was carried out in Microsoft Excel to produce totals, averages and graphs.

3.3 Data quality and limitations

Several important points should be noted when reviewing the data.

1. The flats share a communal roof space and PV array which is not sub metered. Therefore, only data on water, electrical import and heat can currently be collected for these types, with electricity and PV estimated.
2. Significant technical issues on PV inverters and rain water harvesting have caused data loss and anomalies which have impacted the quality of the data.
3. Further problems with the monitoring process have impacted around 10% of the dwellings where zero or reduced data was collected over the monitoring period.
4. Phase 2 data only covers around 6 months of occupation with staggered move in dates. Working out site wide averages is therefore only accurately possible once all phases are occupied. For this report most, data refers to Phase 1 only.
5. Because of data protection issues (GDPR), no exact information was available on the number of persons per household, so an estimation was required to determine water consumption per person. Designed occupancy numbers were taken from the A2D schedule of housing and adjusted using statistical occupancy information by tenure.

4 Detailed results

This section outlines the detailed results. For each category, the headline findings have been summarised for both phase 1 and 2, followed by more detailed analysis. At this stage phase 2 data provided was limited and so the findings draw on only a small subset of data.

4.1 Water

Dwellings are designed to be water efficient through use of low flow taps, smaller baths, low flush toilets and rainwater harvesting.

The headline figures:

- The average household water consumption is 375 litres per day (compared to 192 litres last year).
- The estimated daily average water consumption per person is 151 litres (compared 76 litres last year).

- Elmsbrook residents are currently above their water use target of 80 litres per person per day, with only 10% of phase 1 homes currently meeting this target.
- However last year's data was not a full year and winter heavy. Equipment failure problems this year could have further increased water use (e.g. defective valve in header tanks).
- The average water use in the UK is currently 150 litres per person per day[1].

Summary of results:

6. The three graphs below show the average daily household water use (Figure 1), daily per person water use (Figure 2) and % of homes meeting the water target for (Figure 3) phase 1 only.
7. Water usage looks to have increased significantly compared to last year, although some of these effects are likely caused by either metering problems or technical failure in the rainwater harvesting system.
8. One plot was a case in hand where water use was three times the UK average for a period of 68 consecutive days. A problem with either a faulty valve in the rainwater harvesting header tank (topped up by mains water) or a leak in the pipework are possible causes.
9. The Phase 1 data set includes 86 dwellings, monitored from 1 April 2017 to 31 March 2018 (on average 291 days of usable data).
10. Phase 2 data is largely incomplete with an average data set of 3 months. A direct comparison for the month of March showed an average daily household consumption of 206 litres in phase 2 compared to 423 litres for phase 1 (205%).
11. No information was available due to data confidentiality on the number of occupants per household, so an estimation was required to determine water consumption per person. Designed occupancy numbers were taken from the A2D schedule of housing and statistical occupancy information was applied (e.g. average number of empty bedrooms by tenure) which can be seen in table 2.
12. The school's data is incomplete but averages around $3m^3$ of water use for those months that were collected. The school uses rainwater harvesting to flush its WC's.

[1] Cambridge Water Company: http://www.cambridge-water.co.uk/customers/how-much-water-do-you-use Accessed 7th June 2018

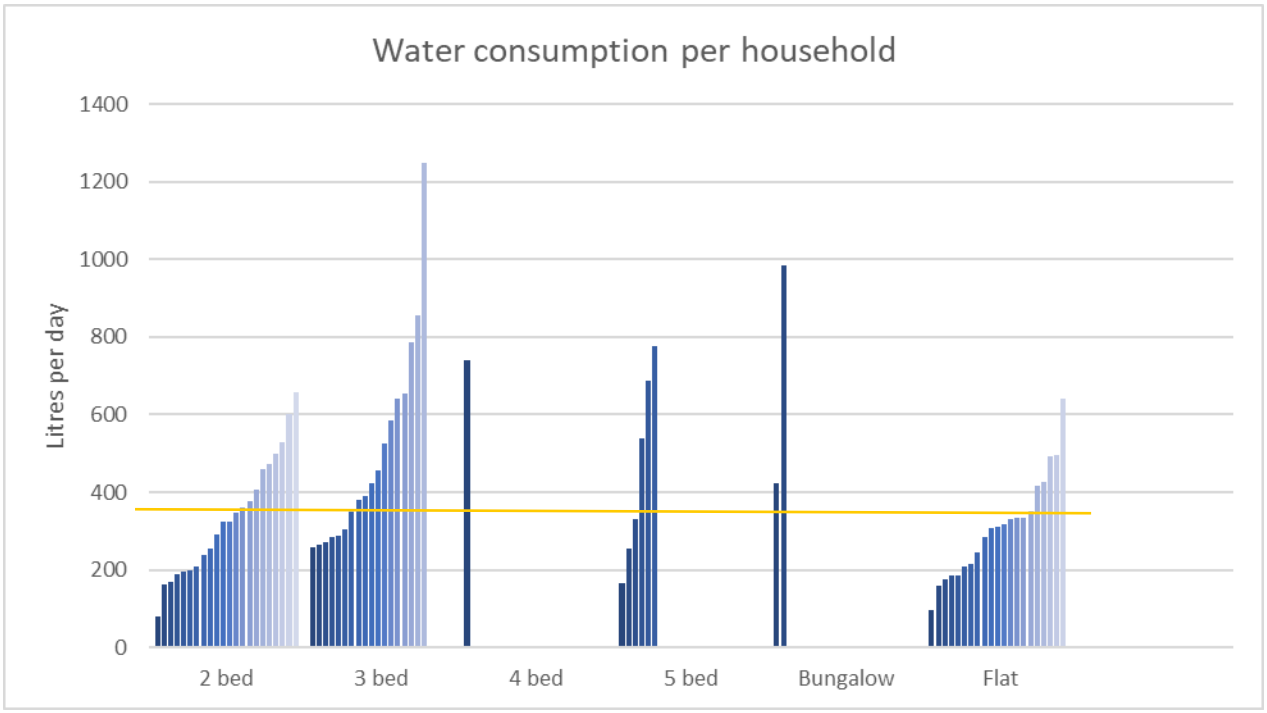

Figure 1- Average daily household water use by house type on phase 1. Orange = average all households, blue = actual per household.

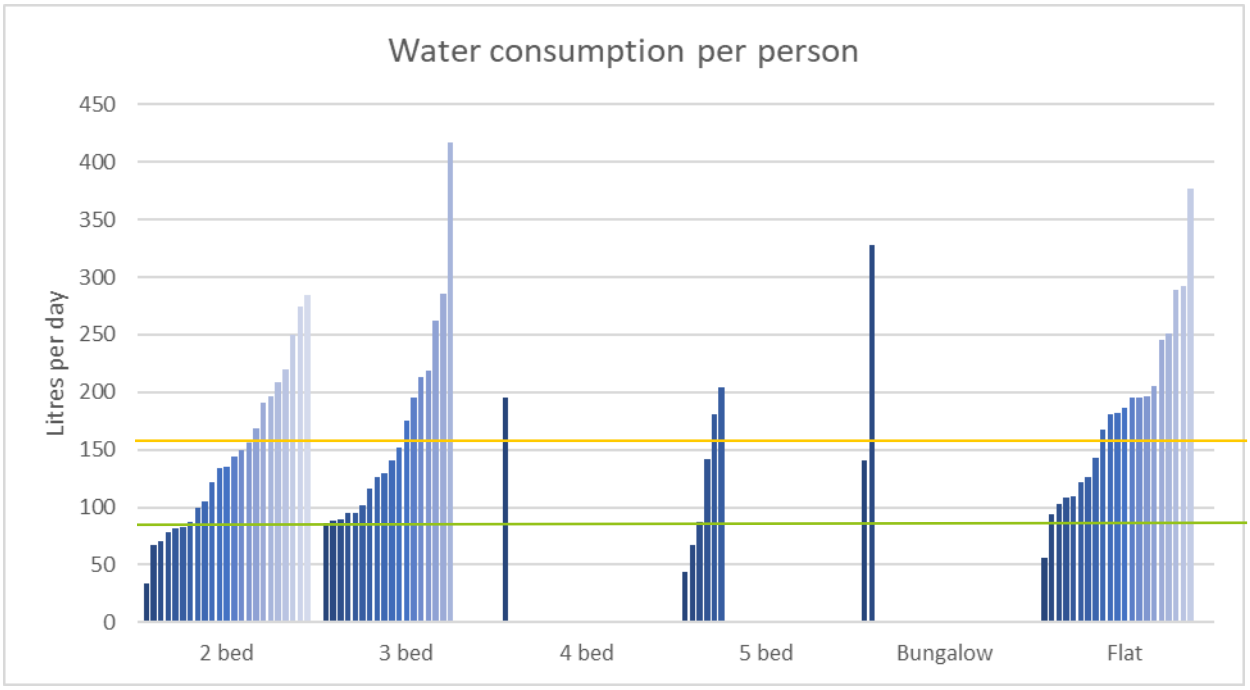

Figure 2 – Average per person water use by house type on Phase 1. Green = target, orange = average all households, blue = actual per person

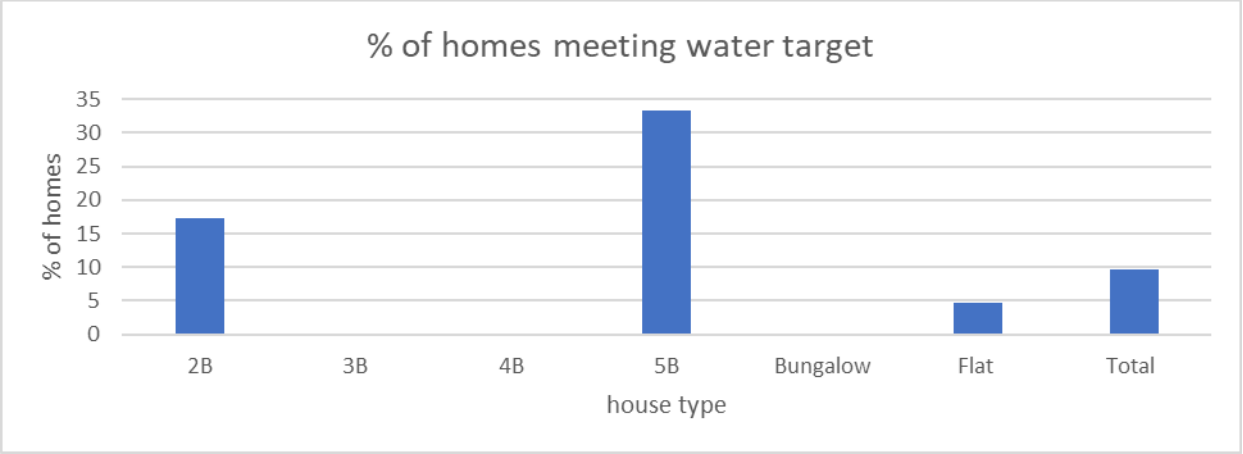

Figure 3 - Percentage of homes performing within water target of 80 litres per person per day on phase 1

Table 2 – Assumed occupancy average for per person water usage

	Flats	2B	3B	4B	5B	Bungalow
Designed occupancy	3	4	3	6	9	3
Assumed occupancy	1.7	2.4	3	3.8	3.8	3

4.2 Electricity use

Dwellings on Elmsbrook are designed to require less electricity, with energy efficient appliances and lighting fitted as standard. Each house utilises its roof space carefully to generate electricity from photovoltaics (PV). Metered data on PV generation, import and export can then be used to calculate electricity consumption for each dwelling.

The headline figures:

- The average annual household electricity use at Elmsbrook Phase 1 was 3,122 KWh (including manual export readings from the flats).
- This compares with a Bicester household average 4,311 KWh.
- Elmsbrook residents used 28% less electricity than their neighbours in Bicester. An average Elmsbrook household pays £295 for electricity compared to £604 paid by their neighbours in Bicester (UK average £592 for electricity[2]).
- The design stage benchmark figures for average electricity consumption were 2,932 KWh annually.
- Elmsbrook residents used 6% more electricity than predicted at design stage.
- 66% of phase 1 homes are performing within the electricity target (30.79 KWh/m^2).

Summary of results:

- The monitoring period was from 1 April 2017 to 31 March 2018, with on average 213 days of usable data for phase 1.

[2] https://www.ovoenergy.com/guides/energy-guides/the-average-gas-bill-average-electricity-bill-compared.html

- The graph below (Figure 4) shows the annual electricity consumption per household, for the different house types on Phase 1. Figure 5 shows that 66% of phase 1 homes meet the electricity target (30.79 KWh/m2).
- No direct comparison with the previous year is possible, as last year's data was incomplete.
- The flats are currently not sub metered for PV, so it's not possible to estimate their electricity usage accurately (Electricity = PV + import – export). This means that the calculated average is potentially slightly low as missing the generated and used on site component.
- The missing flats reduced the sample size from 62. Further metering problems, panel failures and inverter outages meant that only 53 plots produced reliable data throughout the year.
- Phase 2 hasn't produced any meaningful data to compare with.
- The school used 36,917 KWh of electricity over the monitoring period, of that 29,256 KWh was generated from PV. The school is currently not fully occupied.
- Peak time monthly electricity export for the whole site is around 78,224 KWh, which excludes the CHP's load (June).

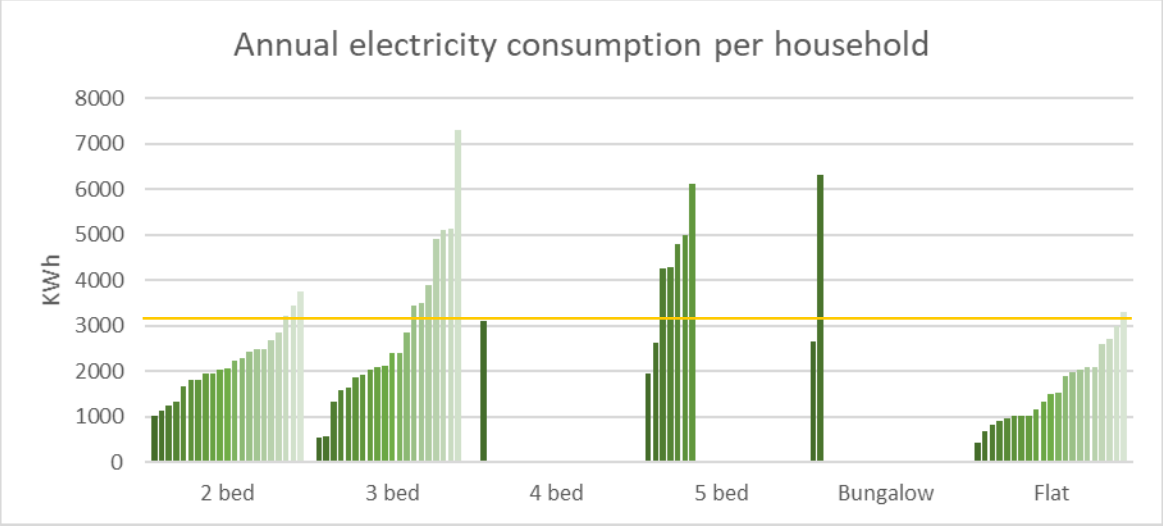

Figure 4 - Phase 1 electricity consumption per household and house type. Orange = average all dwellings, green = actual per household.

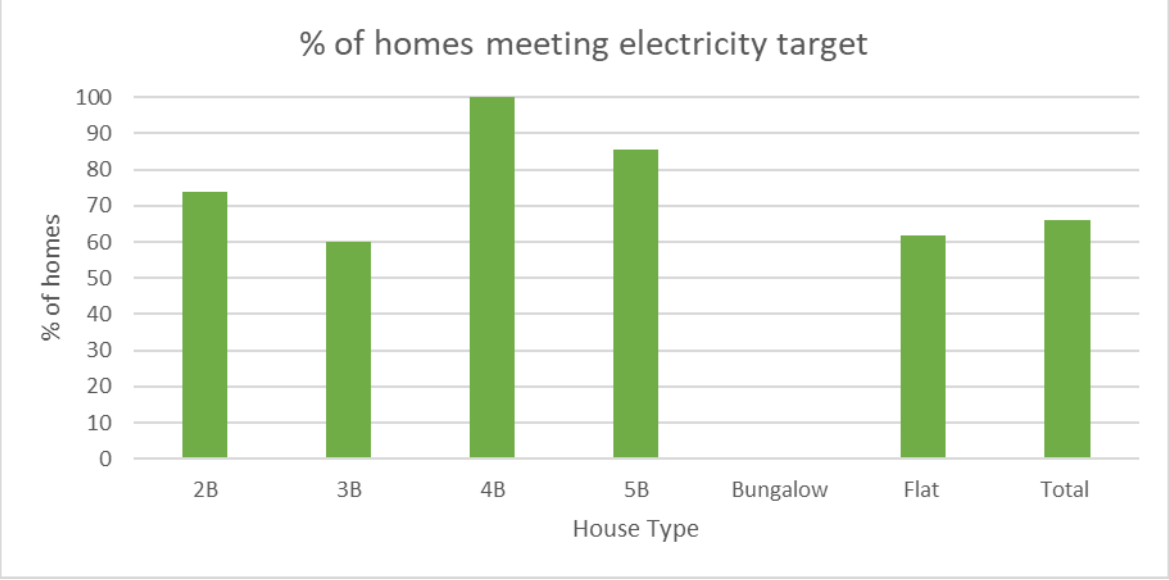

Figure 5 - 66% of homes performing within their electricity target on phase 1

4.3 Heat

Elmsbrook is served by an energy centre supplying heat for space heating and hot water demand via a district heating system. Data is collected at the point of use in the household (at the heat exchanger unit).

The headline figures:

- Over the monitoring period the average household at Elmsbrook Phase 1 was supplied with 5,473 KWh heat (hot water and space heating). Last year's data was incomplete but showed 4,023 KWh (26 % less).
- This compares to the design stage estimate of 4,269 KWh. Therefore, the actual 2017-18 heat usage is 28% higher than the design stage estimate. However, the UK also experienced unusual long periods of below zero temperatures in January and February ('beast from the east')
- The average annual Bicester household consumption is 12,755KWh (gas data only)[3]. This compares to the UK average of 15,462 KWh (gas only data).
- Elmsbrook residents used 57% less heat than their neighbours in Bicester.
- An average Elmsbrook household pays £744 for heating (a majority of that is standing charge), which compares to £510 for wider Bicester for gas[4] only (2014 figures). Factoring in the same amount of maintenance (and eventual boiler replacement) that is covered under the standing charge, the average Bicester wide heat charge would increase to £833.
- 26% of phase 1 homes are performing within the heat target (44.83 KWh/m^2).

Summary of results:

- Bicester wide heat usage figures are based on postcode gas figures plus £200[5] pounds gas safety (plus maintenance) and £123[6] boiler replacement costs.
- The graph below (Figure 6) shows the average annual yearly heat use by house type compared against the average design benchmark (in orange).
- 12 units on phase 1 had metering problems and not produced any usable data over the monitoring period.
- Total heat usage on both Phase 1 and 2 is 431,778 KWh over the monitoring period.
- Phase 2 data is largely incomplete with an average data set of 3 months. A direct comparison for the month of March showed an average daily household consumption of 28.96 KWh in phase 1 compared to 31.69 KWh for phase 2 (9% more).
- The data set includes 74 dwellings on phase 1 with an average 338 days of usable data and 14 dwellings on phase 2 with an average of 29 days of data.

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[3] "Postcode Level Gas Estimates: 2015 (Experimental) - GOV.UK". Gov.uk. N.p., 2017. Web. 6 June 2017.

[4] https://www.ovoenergy.com/guides/energy-guides/the-average-gas-bill-average-electricity-bill-compared.html

[5] https://www.which.co.uk/reviews/boilers/article/getting-the-best-boiler-service

[6] https://www.theheatinghub.co.uk/combi-boiler-prices

- Figure 7 shows the 26% of phase 1 homes are meeting the heat target (44.83 KWh/m^2).
- The school used 77,395 KWh over the monitoring period, but is currently not fully occupied.
- When looking at a period of time that has likely no space heating requirement (June-October) it becomes possible to estimate the hot water only demand on site (baseload) which is 2,673 KWh per year. This is significantly higher than the 1,518 KWh calculated from the design stage benchmark and the average floor area (95.24m^2).
- Conversely the resulting estimated space heating demand is almost on target with 2800 KWh achieved compared to the 2,752 KWh designed.
- Table 3 summarises the impact of the ventilation strategy on space heating demand. Only properties with similar orientation and footprint with more than 360 days data were considered for the analysis. Surprisingly, those dwellings with mechanical extract ventilation (MEV) where shown to have lower space heating demand than those with mechanical ventilation and heat recovery (MVHR). On average 3,188 KWh per year for MEV and 3,662 KWh for MVHR (29-33 KWh/$m^{2/}$ year), significantly higher than the design stage estimate of 15.94 KWh/m^2/year.
- Either the MVHR's are not achieving the stated efficiencies or residents are turning them of. That the ventilation systems differ for private and rented dwellings on site could further be an influencing factor.

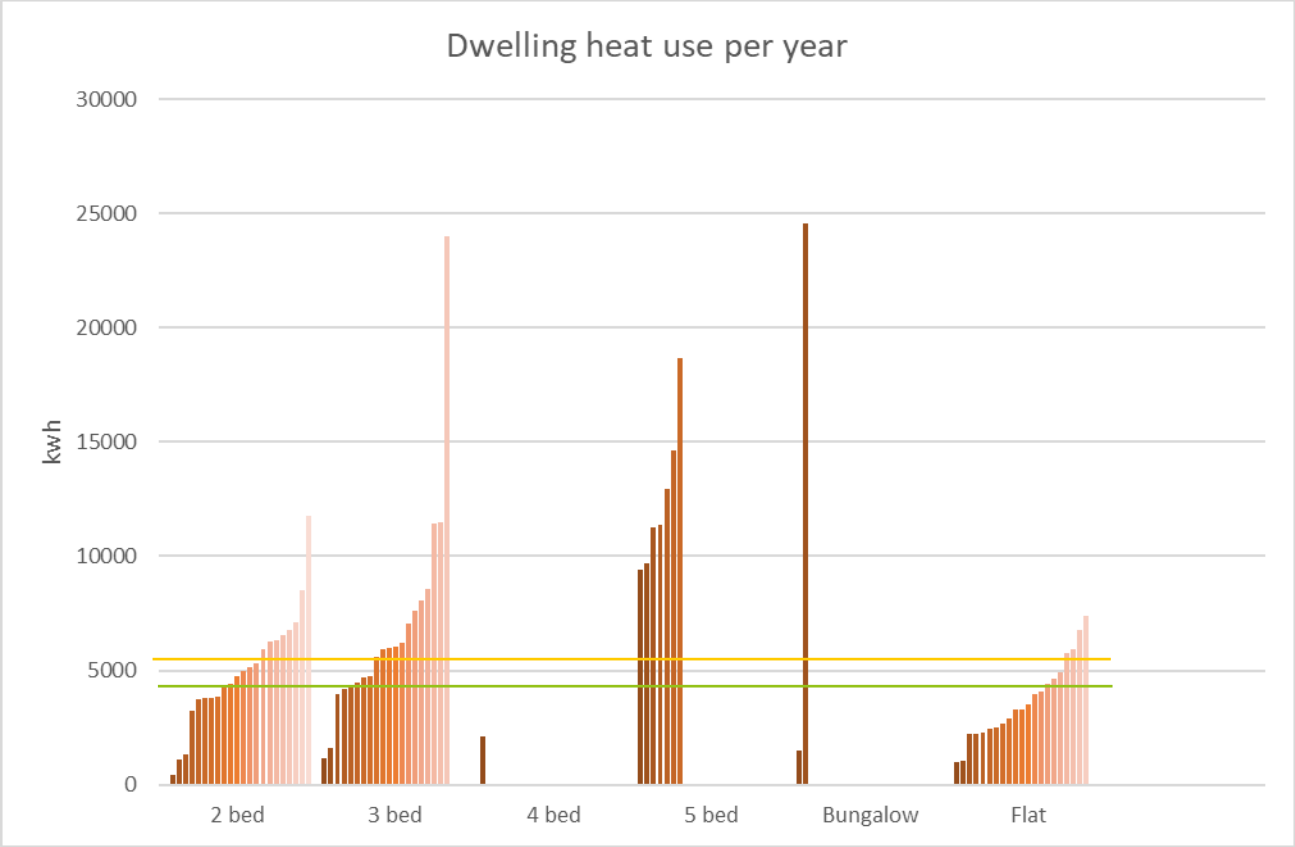

Figure 6 Phase 1 annual heat consumption by house type against benchmark. Green horizontal line = target, orange = benchmark; orange bars = individual dwellings

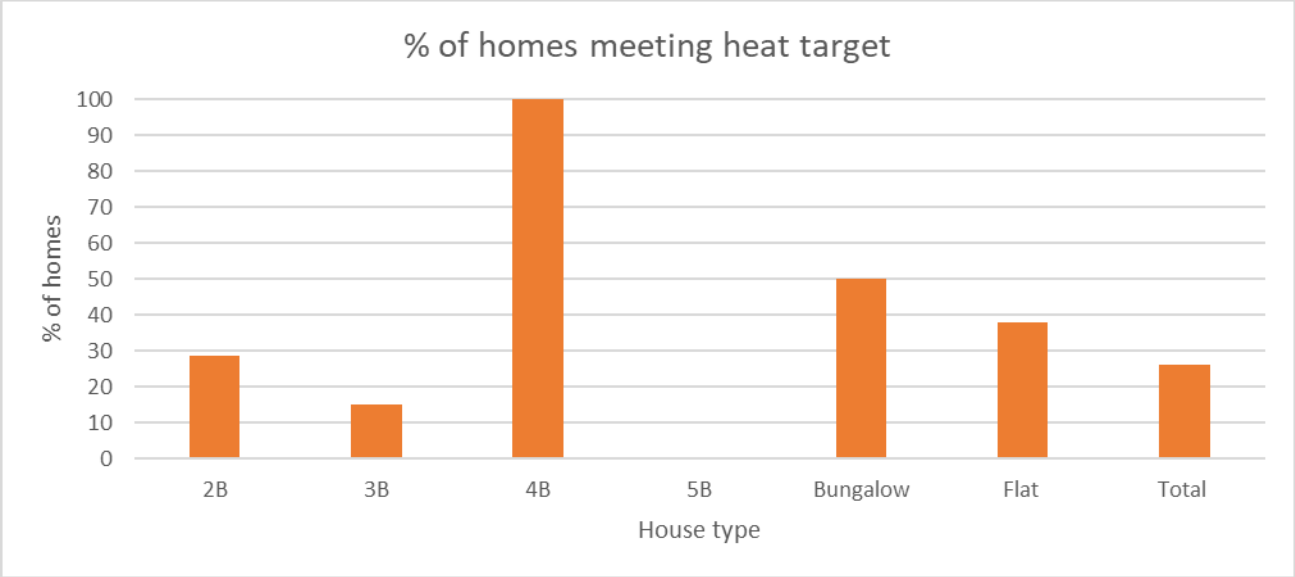

Figure 7 – Percentage of homes meeting the space heating demand

Table 3 – Impact of the ventilation strategy on space heating demand

Properties with	MVHR	Sample	MEV	Sample
2bed south to north orientation	5,263	4	3,663	5
2bed east to west orientation	2,059	1	2,918	7
3bed south to north orientation	1,091	1	3,493	9
3bed east to west orientation	2,549	2	2,540	5
Average	3,662	8	3,188	26

4.4 PV

This data refers to the electricity generated by the PV solar panels on each house.

The headline figures:

- Of 86 units in phase 1, 24 were not sub metered and a further 9 had inverter failure or metering failure with zero accounted generation.
- The resulting 53 households of phase 1 (monitored via the shimmy) produced a total of 132,774 KWh of electricity through their PV system over the monitoring period. Out of these 53 some had downtime as panels were being repaired/replaced.
- 132,774 KWh is 17% below the design stage estimate (i.e. less generation) of 160,709 KWh, calculated by PVsol- specialist PV software (adjusted to sample of 53 households)
- A yearly average of 2,505 KWh per monitored dwelling on phase 1 (PV sol estimate= 3,032KWh). The annual average for phase 2 is 2,376 KWh per dwelling (extrapolated

because less than a year). A daily average of 6.8 KWh per monitored dwelling over the monitored period on phase 1, 6.5 KWh on phase 2.

- 13 plots on phase 1 have 360+ days of data. Of those 13, 77% were within their SAP targets and 23% were within their PVsol target. Those in the sample meeting the SAP target where mostly duo pitch roofs or saw tooth's with little over shading. Those in the valleys with over shading were typically below target.
- The average generation of the sample of 13 was 110% of the SAP target and 91% of the PVsol target.

Summary of results:

- Our results only include Phase 1 data as Phase 2 is only partially occupied and doesn't have any plots with a full years' worth of data.
- As the flats are currently not sub metered (i.e. monitored via the shimmy) the Phase 1 data set only includes 62 dwellings (86-24). A manual reading of the flats export meter (Table 5) brings this total to 142,768 KWh. Because the starting dates and the 'on site use' component is not known the estimate is relatively crude and not a true reflection of actual generation (likely higher). If Phase 2 dwellings are added this figure rises to 151,381 KWh.
- A further nine dwellings suffered inverter malfunction not picked up by the households and resulted in significant periods of PV outage.
- Therefore, the PV total for phase 1 is realistically only made up of 53 households over the monitoring period was from 1 April 2017 to 31 March 2018.
- The graph in Figure 8 shows the annual PV generation by house type for phase 1 including plots affected by inverter malfunction (9 plots affected).
- Because the data for Phase 2 is largely incomplete and meaningless, we only looked at a direct comparison between phases for the best month (March 2018). The household daily average for phase 1 is slightly higher with 6.8KWh compared to 6.5KWh. Phase 2 only has an extremely small sample size (11 households) so house types and orientation will have a big influence on total generation.
- Allowing for the fact that the flats are currently unmetered, and some plots were affected by inverter malfunction on phase 1, an average of 176 days of usable data was available over the monitoring period.
- A manual meter reading for the school showed that the PV array was generating approximately 109,637 KWh over the monitoring period (pro rata).
- Over the same period the energy centre produced 25,628 KWh.
- Peak time monthly site wide PV export is around 54,044 KWh (June).

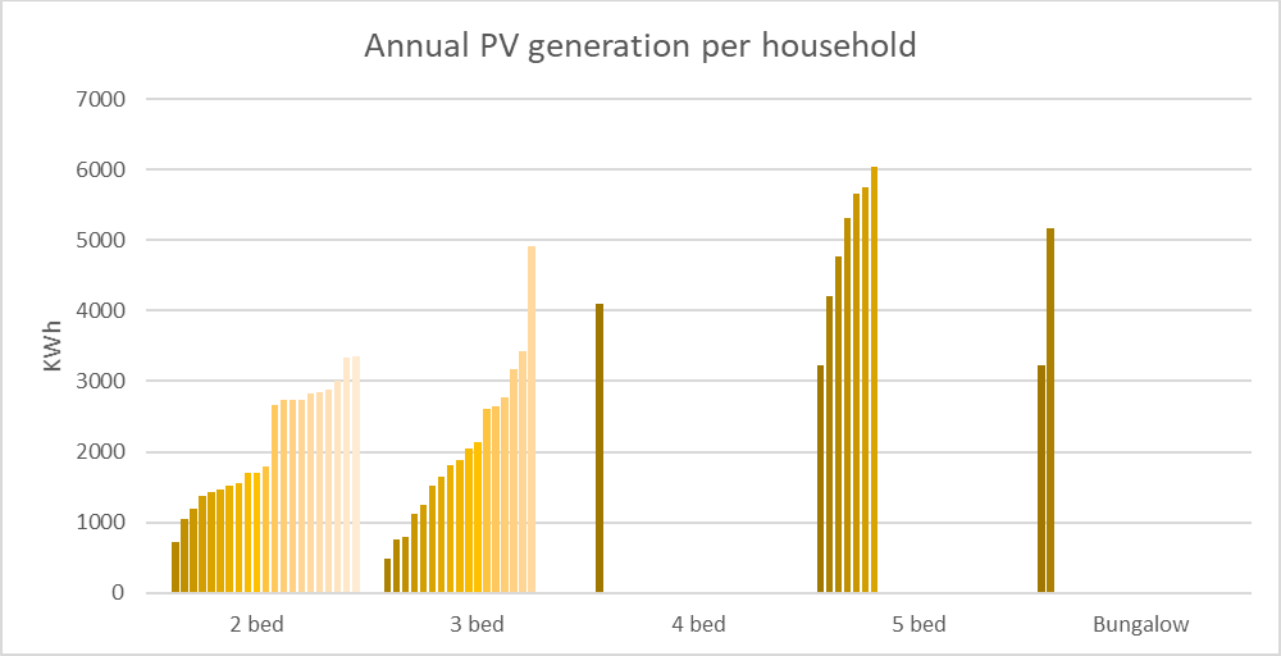

Figure 8 - Phase 1 annual PV generation per household by house type

Table 5 – Manual meter readings for the flats on phase 1 and 2.

Flats	**Export meter reading** (KWh)	**Completion date** (date)	**Days data** (d)	**Adjusted annual export** (KWh)
349-354 (Phase 1)	3,124	September 2016	577	1,976
370-375 (Phase 1)	3,428	November 2016	516	2,425
320-325 (Phase 1)	5,622	September 2016	577	3,556
343-348 (Phase 1)	3,220	September 2016	577	2,037
396-399 (Phase 2)	271	October 2017	275	543
TOTAL				10,538

*Inverter tripped, not generating PV at time of reading

4.5 Waste

This year's reporting includes waste data for the first time collected by weighing the waste collection trucks leaving Elmsbrook. Data provided by Cherwell District Council (CDC) includes recycling, refuse and garden & food (compost), between 21 April 2017 to 4 April 2018.

The headline figures

- The largest waste stream over the monitoring period was refuse (general waste), with 36,600 kg or 278 kg per household (based on 132 households)
- Thereafter compost at 17,900 kg, or 136 kg per household; and recycling at 14,000 kg or 106 kg per household

- Elmsbrook residents currently produce more residual waste (54% vs 45%) than the country average (Cherwell district). The overall recycling rate on site (dry recycling & compost) is 47% compared to 55% for the county.

Summary of results:

- The waste stream patterns over the course of the monitoring period are outlined in the graph overleaf (Figure 9).
- Refuse is the largest waste stream throughout the year, with, if anything, a slight increase over the summer months, followed by a slight decline towards winter 17/18.
- Compost reveals a more pronounced cyclical pattern, again rising in the summer (particularly during May/June 17), and falling as winter 17/18 approaches. As spring set in 2018, there are early signs the rate of compositing is on the rise again, as one would expect.
- In terms of trends, both dry recycling and composting show a gradual increase, while residual waste is slightly falling, which is encouraging.

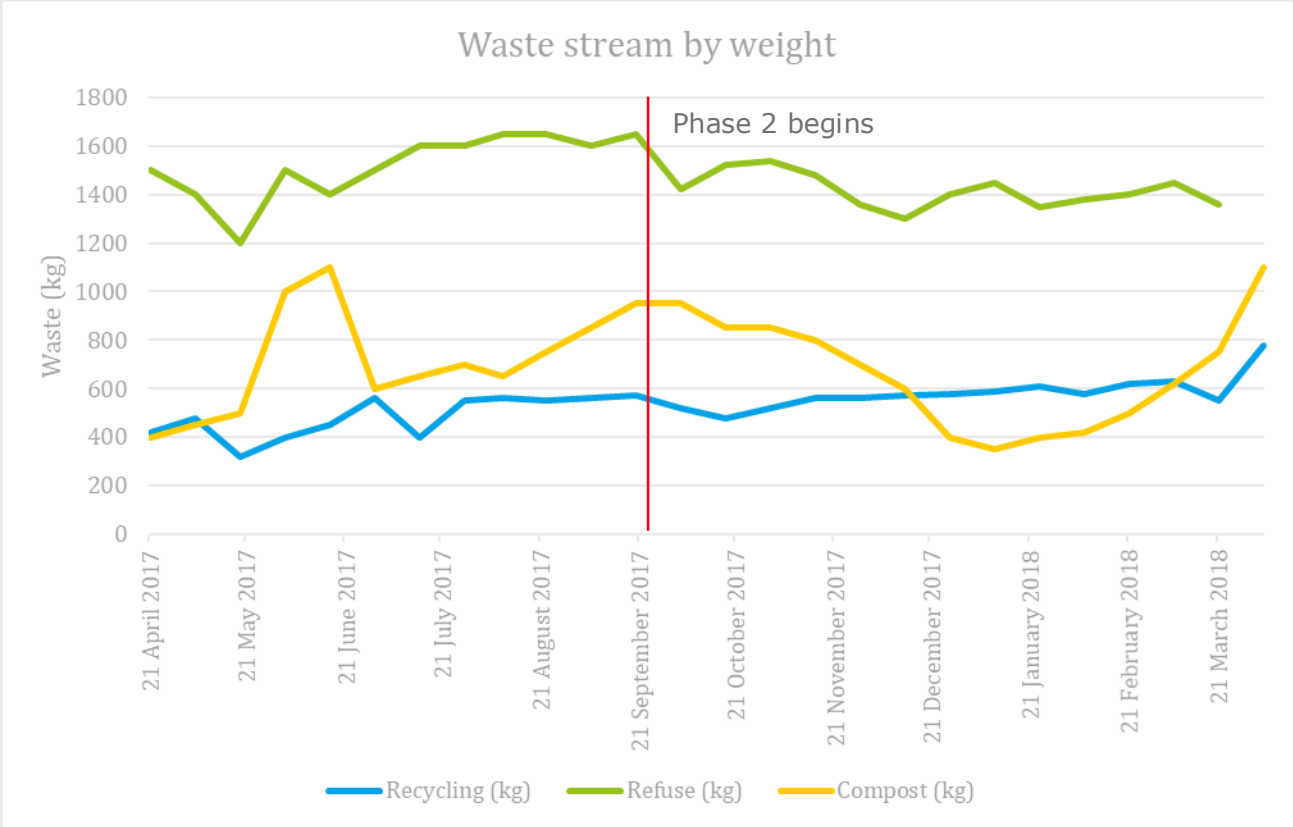

Figure 9 - Waste streams. Red line indicates when phase 2 begins

4.6 Transport

Elmsbrook has an ambitious modal shift target of 50% non-car journeys by year five of occupancy (car journeys currently 67% for Bicester). To encourage uptake of sustainable travel options, the developer has arranged a new bus service, an electric car club and Brompton folding bike hire.

The headline figures:

- Cars are currently the dominant mode of transport at Elmsbrook, with 250,450 journeys made over the monitoring period (84% of all journeys), on average 5.2 trips daily per household, compared to a Bicester average of 7-8 trips daily per household.

- This has reduced from 88% last year and compares to the somewhat more subjective responses from the resident surveys at 65%.
- Non-car journeys sit at 16%, compared to 33% for the rest of Bicester, some way short of the modal shift target (50%).
- It has to be noted that it is currently not possible to separate e-car use on site from normal car use from counter data.
- It is likely that construction traffic from the eco business centre, along with on-going maintenance site visits and staff / visitors to the Elmsbrook Sales Centre has impacted the counter data on car use, so actual car use might be lower.

Summary of results:

- The following graph (Fig. 7) summarises the number of journeys by different modes of transport over the monitoring period.
- Average monthly car journeys 20,871, bike 592, pedestrian 1,814, bus 372 and electric car 18.
- The number of vehicle movements increases in the winter, peaking in March 2018. Some of this will be from people moving into Phase 2.
- Pedestrian movements maintain a slow decline during the winter months; whilst cycling journeys remain consistent throughout the year.
- Bus data was provided by Mode transport planning and covers the period from April 17 – March 18. In this case, the number of tickets sold for bus stops at Charlotte Avenue and Gagle Brook School were recorded and multiplied by two based on the assumption that these are likely return trips.

A2Dominion supplied statistics on e-car club use from January 17 – September 2017, which have been extrapolated to March 18. Further detail specific to e-car usage is provided in

Table 6.

There are currently four e-car champions on site (phase 1) with another three on phase 2 to be appointed for next years reporting. The vehicle counting equipment cannot distinguish EVs as a sustainable mode of travel from standard cars and is therefore not reflected in the overall travel results.

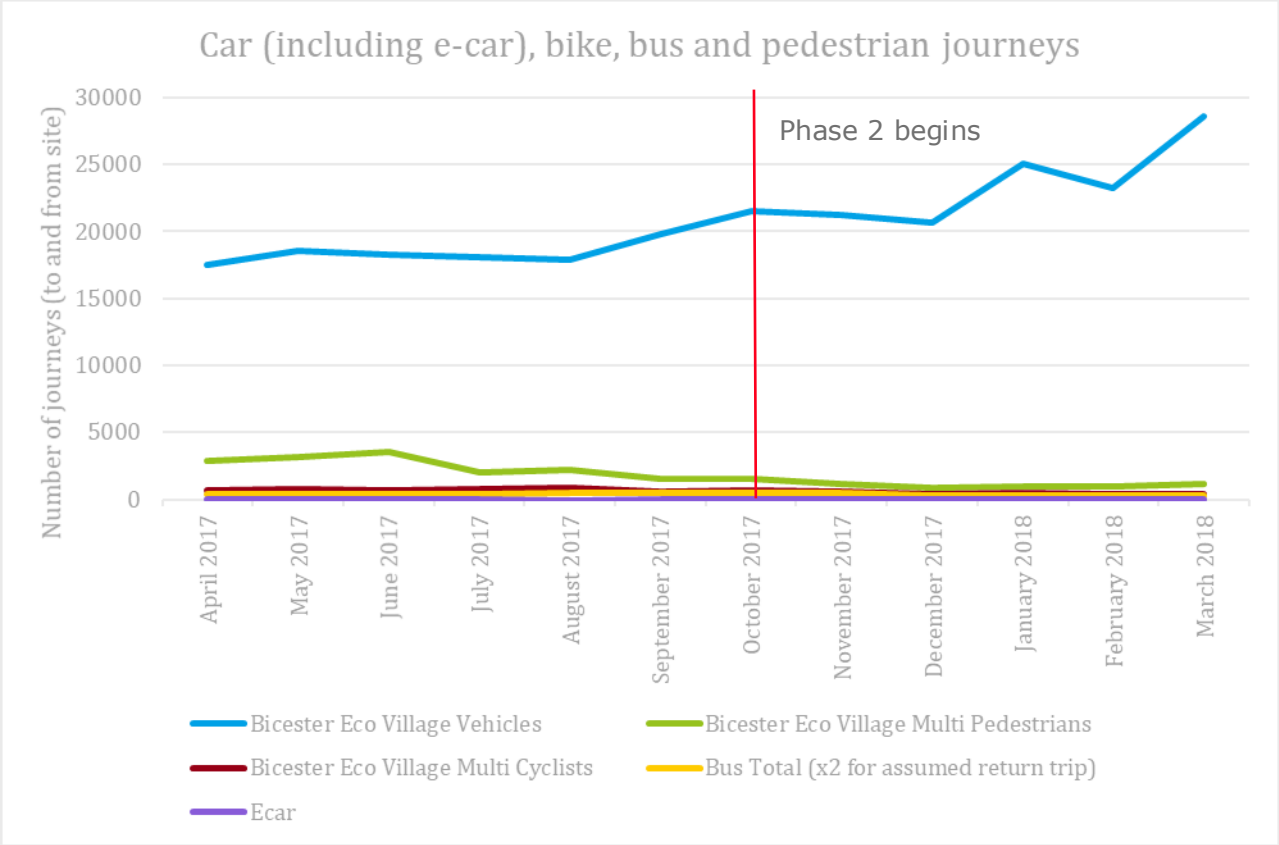

Figure 10 - Transport data over the monitoring period, sorted by mode.

Table 6 - E-car club headline figures

Members	30
Bookings	137
Members who have made bookings	16
Booked Hours	831
Actual Hours	595
Booking vs Actual	71.59%
Miles Driven	2,147
Miles per Hour booked	2.58
Miles per Hour Used	3.61

4.7 Energy centre

The Elmsbrook energy centre consists of a gas-powered combined heat and power (CHP) unit with backup gas boilers and a roof mounted PV array. Energy data was provided by Scottish Southern Electric (SSE), with the headline figures summarised below, and more detailed analysis follows thereafter.

The headline figures:

- The energy centre is currently using the gas boilers for extended periods of time, about three times more than the CHP. With the CHP supposed to meet most of the heat demand by the end of phase 2 this is currently some way off the expected trajectory.
- The energy centre generated 1,221,300 KWh of heat (CHP and boiler) to meet the space heating and hot water demand of 509,173 KWh on site (Phase 1,2 & school) at the point of use (table 7).
- Therefore approximately 58% of energy is currently being lost through either storage or distribution. The designed distribution loss was 28%. We recommend the losses being queried with SSE.
- The average annual CHP efficiency was estimated at 78% (design stage), the actual monitored efficiency is currently 72%.
- The average annual boiler efficiency was estimated at 87% (design stage), the actual monitored efficiency is currently 80%.
- The energy centres roof array generated 25,628 KWh of electricity of which 79% was used on site through equipment and lighting. This is the highest utilisation rate on site.

Table 7 - Energy centre data

	Total (KWh)	Monthly average (KWh)
CHP		
Electricity generated (kWh/year)	304,600	25,383
Heat output (kWh/year)	317,200	26,433
Gas consumption (kWh/year)	944,206	78,684
Boiler		
Heat output (kWh/year)	904,100	75,342
Gas consumption (kWh/year)	1,029,940	85,828
PV		
Electricity generated	25,628	2,136

Summary of results:

- Operationally the CHP ran 50% of days throughout the monitoring period with an average of 1.03 hrs per day, running averages of 2.05hrs blocks at one time. SSE commented: "the strategy is to lead with the CHP, thermal store then top up by boilers. Lower efficiency will occur if generation is low and there are lots of start/stops on the boilers."
- The following graph overleaf (Figure 11) shows the electricity generated against heat output over the monitoring period:
- CHP electricity generated, and heat output are aligned for most of the year, with electricity slightly greater than heat output; except in November 17, where heat output drops to 10,400 kWh.
- Both CHP electricity and heat output show a decrease, as expected, over the summer months, then a gradual increase in kWh with the onset of winter.
- Boiler heat output is greater than CHP, with the exception in April 17. Output really kicks in from September 17, at 27,000 kWh, to November, at 123,600 kWh. For the rest of the year the boiler heat output remains relatively stable.

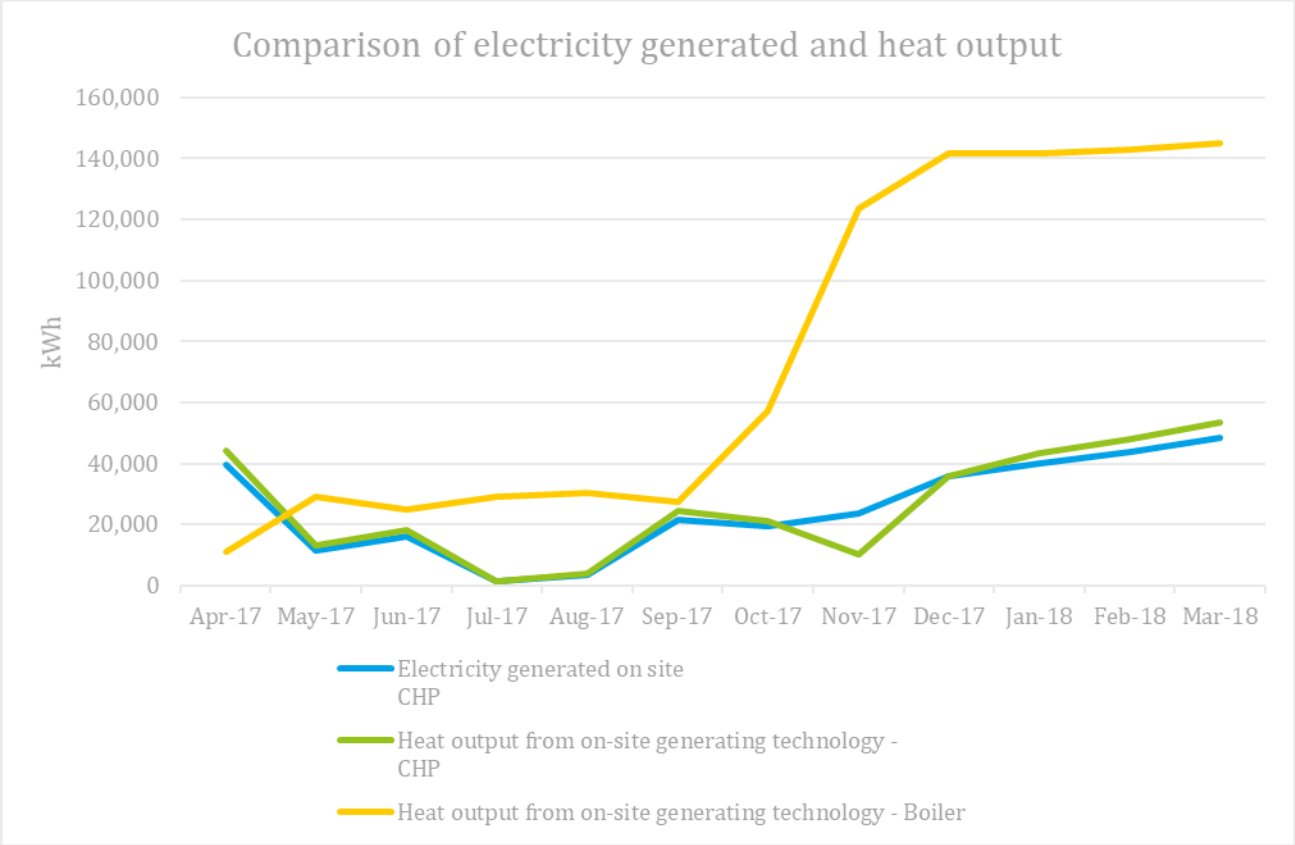

Figure 11 Electricity generated vs. heat output

- The following graph overleaf (Figure 12) shows gas consumption over the monitoring period.
- Gas consumption of the boiler is considerable higher than the design estimate (to a factor of 11), whereas the CHP is using about half the estimated amount. This can be explained by elevation running hours and output. Until full occupation of 393 homes the split between gas boiler and CHP is likely not going to match the design intent because there is not enough demand.
- Overall, it shows there is a gradual decrease in consumption from April 17 – July 17, then increasing through to March 18.
- Gas consumption is well balanced between the CHP and boiler for most of the year; except in April 17 and September 17 where the CHP consumption is noticeably greater, and vice versa for July and August 17.

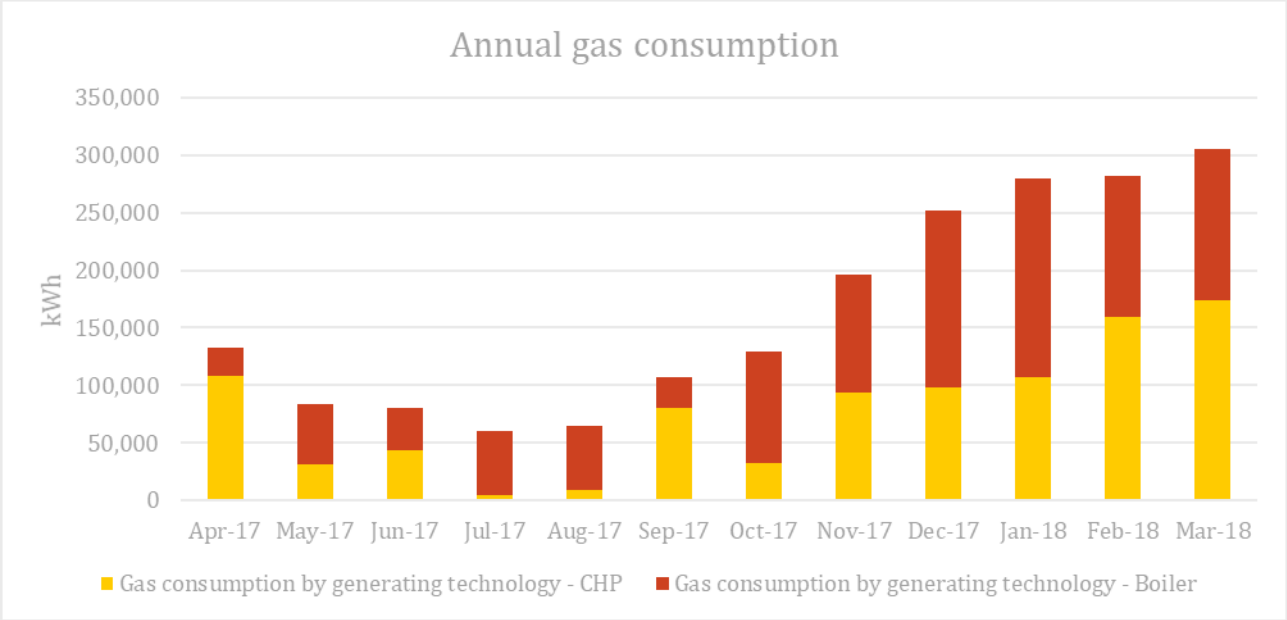

Figure 12 - Gas consumption vs. heat output

- The next graph (Figure 13) summarises the efficiency of the systems – based on heat output/gas consumption. It shows that the boiler is significantly more efficient than the CHP for most of the year. The overstated efficiency of the boiler in September and November 17, and the CHP in October 17, both above 100% have been queried with SSE who said the following: "The data in that October, September and November period has been apportioned incorrectly. We were using manual meter readings for the CHP gas until we had a BMS report set up this year, so a bit of that October usage belongs in September and in November."
- The total average efficiency over the monitoring period was 77%. The CHP efficiency was estimated at 78% at design stage, the actual monitored efficiency is currently 72%. The average annual boiler efficiency was estimated at 87% at design stage, whereas the actual monitored efficiency is currently 80%.

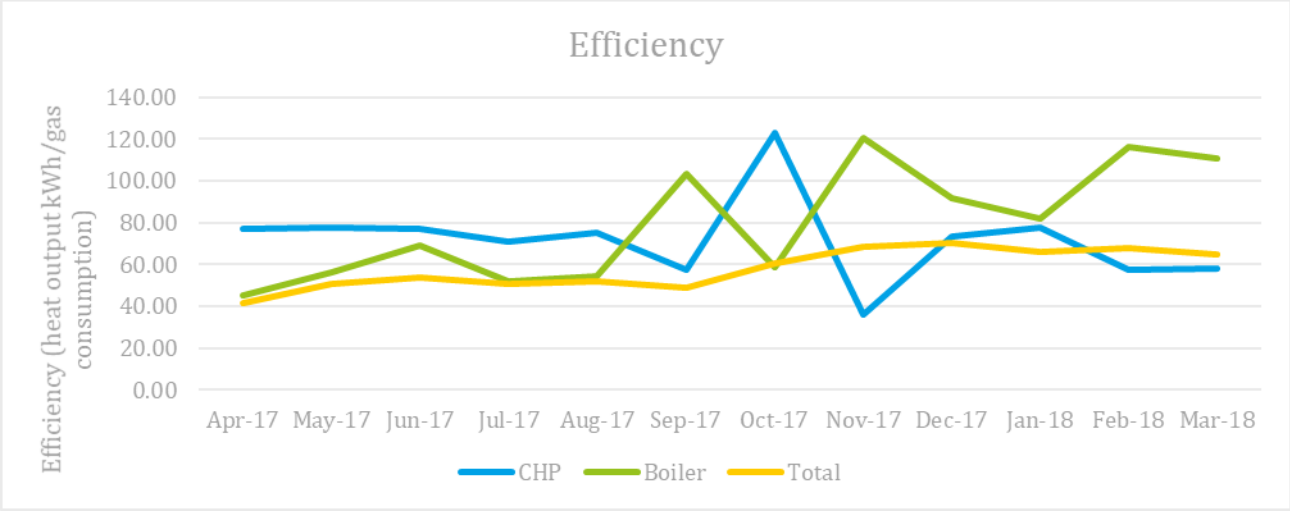

Figure 13 Estimated average monthly efficiency

4.8 True zero carbon

Elmsbrook is a 'true' zero carbon development, meaning both regulated energy (lights, pumps & fans) and unregulated energy (appliances & cooking) are accounted for. Reporting against this target ahead of completion is difficult, as every new dwelling coming online alters the true zero-carbon equation (e.g. energy centre CHP to boiler split). Performance is dynamic as external temperatures, sun hours, user behaviour and electrical grid carbon intensity all impact the final balance.

The headline figures:

- The average home on Elmsbrook is currently emitting 120kgCO_2 per year, that's very close to true zero carbon. An average UK household emits 2,447kg CO_2 (2016[7] data).
- The development as a whole (commercial, school and residential) is currently carbon neutral, meaning Elmsbrook buildings are emitting zero CO_2 emissions and saving the UK an additional 25 tonnes of CO_2 per year.
- The true zero-carbon status has been achieved earlier than planned and was not expected until phase 2 is fully occupied.
- It should be noted that the true zero-carbon school (having a large PV roof array) is a major contributor in achieving site wide true zero carbon status for this year's reporting.

Summary of results:

- The side-wide carbon balance has been calculated using the current SAP 2012 carbon factors of 0.208 and 0.398 kgCO2/ KWh. The reason for this is that the UK electricity grid has decarbonised since the energy strategy was written. So although the old SAP 2008 carbon factors used at design stage would be more favourable, they are outdated (not as robust) and would potentially expose the development to criticism.
- Using the carbon factors of the time of the application (2008) would change the true zero carbon equation to -62 tonnes CO_2. Changing the factors to the proposed future 2016 factors would change the figures to +7 tonnes CO_2.
- The energy and carbon balance is dynamic and will change from year to year. As dwellings come online, the energy centre adjusts to the new heat demand. Weather and sunlight hours also impact on heat demand and PV generation.
- With the new commercial centre coming online in the next few months, the energy balance could once again shift towards carbon emitting for next year's reporting.

[7] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/604408/2016_Provisional_Emissions_statistics.pdf

Table 8 – Energy balance over the monitoring period

Sub phase	Exported Electricity (KWh)	Imported Electricity (KWh)	Comments
Phase 1 - sub metered residential	109,010	155,735	53 properties, 9-meter failures, 24 flats unmetered
Phase 2 - sub metered residential	6,752	5,778	32 properties, less than a full year data, 4 flats unmetered
Phase 1 - manual meter reading residential	9,994	-	24 properties (flats), estimated start date, likely inverter outages, export data only
Phase 2 - manual meter reading residential	271	-	4 properties (flats), less than a full year, confirmed inverter outage, export data only
School - manual meter reading	80,381	7,661	Not fully occupied
Energy centre - PV	5,454	-	Early data meter readings, later BMS
Energy centre - CHP	304,600	70,997	CHP data from SSE
Commercial	-	-	Commercial centre not completed yet
Total	**516,462**	**240,171**	**KWh**

Table 9 – Carbon balance over the monitoring period 2017-18

Carbon	Unit	Sub phase	Notes:
14,123	kgCO2	Residential only	Elec only
-28,943	kgCO2	School only	Elec only
-9,735	kgCO2	Energy centre only	Gas and Elec
-24,554	**kgCO2**	**Site wide**	**Gas and Elec**

4.9 Resident survey

The Elmsbrook survey was advertised both on Facebook and on the shimmy device and hosted via Survey Monkey over a period of 2 weeks. A total of 22 responses were received. An example of the survey can be found in Appendix 3.

The headline figures:

- 17% of households responded to the survey and provided data. Most responses where received on the first three days of the survey going live.
- Changes to data protection laws (GDPR) have meant that the surveys could not be distribution on paper and resident could not be prompted by door to door visits either. This has likely impacted the total amount of responses received.
- Health and happiness strongly correlate with each other i.e. those that indicate good health also rate their perceived well-being highly.
- Those residents that rate their health and perceived wellbeing the highest also make use of the green spaces at least once a week. Those with the lowest perceived health levels use the green spaces only monthly or on an ad hoc basis.
- 81% of respondents indicated they feel healthy to very healthy (above neutral), compared to 58% UK wide who feel somewhat, mostly or completely satisfied with health (above neutral)[8].

Table 10 - Summary of survey results

Ref.	Question	Responses	Results
Health & Wellbeing			
1	On a scale from 1-10, how would you rate your perceived well-being? When considering your well-being think about your comfort, happiness, and prosperity (1 = the lowest well-being - 10 = the highest well-being)	22	The average response was 6.7. In this case, most people rated their perceived well-being highly, with 14/22 responses at 7/10 or above. There were 4 responses below the middle mark (5/10) and one particularly negative score (1/10) which skews the overall average. This could partly explain why the average is lower than last years (7.6) and at least represents a larger response rate. The ONS bundle well-being into 4 measures – 'overall happiness' being one – with the UK average at 7.5/10 in March 2017[9].
2	On a scale of 1-10, how healthy do you feel? (1=very unhealthy - 10=very healthy)	22	The average response was 6.68. Residents generally consider themselves to be healthy or very healthy. This is promising, if compared to what is reported by the ONS, which states that 57.8% of people in the UK are 'somewhat, mostly or completely satisfied with health'. Nevertheless, improvements could still be made, with 4 responses below 5/10 and 2 particularly negative scores (1/10 and 2/10).
3	During the last 7 days, how many days have you taken part in vigorous, moderate or light exercise over a period	22	Residents are exercising frequently, with the average response at 4.5 days of vigorous, moderate or light

[8] "Measuring National Well-Being: Life In The UK- Office For National Statistics". *Ons.gov.uk*. N.p., 2017. Web. 6 June 2017.

[9] https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/bulletins/measuringnationalwellbeing/april2016tomarch2017#how-do-people-rate-their-personal-well-being-in-your-area

	of 10 minutes or longer? For example: lifting, digging, cycling or walking, playing sport for longer than 10 minutes consecutively?		exercise. Some residents had even taken some form of exercise on each of the last 7 days. Only one response had not taken part in any exercise at all.
4	Which of the following parks or green spaces does your household make use of locally (if any)?	22	Respondents gave the following answers: Open countryside x 11, Nature reserves x 9, country parks x 5, play parks x 7, sports greens x 2, allotments x 1.
5	If you selected any of the greenspaces above, how often does your household use these?'	21	Respondents gave the following replies: Daily x 2, weekly x 9, fortnightly x 3, monthly x 2, ad hoc x 5
6	If you are in employment (including self-employed), how often do you have the ability to work from home?	22	Respondents gave the following replies: Not currently in employment x 2, every day x 2, more than 3 times per week x 1, less than 3 times per week x 5, never work from home x 12
7	How strongly do you feel you belong to your immediate neighbourhood?	22	Respondents gave the following replies: very strongly x 5, fairly strongly x 10, not very strongly x 4, not at all strongly x 2, don't know x 1
8	Do you regularly talk with people in the neighbourhood?	22	Respondents gave the following replies: strongly agree x 7, agree x 7, neither agree nor disagree x 5, disagree x 3
9	How many neighbours at Elmsbrook do you know to say "hello" to?	22	The most popular response was more than 15 neighbours. This is an early sign that there is a strong sense of community developing at Elmsbrook. Especially, if compared with the rest of the UK, where it is reported that a ¼ of people do not say hi to their neighbours; and 57% of the UK do not know the names of their neighbours[10].
10	Does your household compost your green and/or food waste?	22	Equal share of yes/no's, at 11 each.
11	Please indicate any activities any members of your household may like to attend/get involved with	21	Most popular activity was walking, with 15 responses. Other common activities included healthy cooking and eating, running, gardening, cycling and reducing energy.
12	Are you involved in any type of community governance activities? For example, do you volunteer locally, organise any events, participate in any clubs or groups?	21	5 residents responded with Yes, 16 No.
13	Are there any activities not listed above that you would like to see at Elmsbrook?	12	Responses were diverse. In particular there seems to be an appetite for more outdoor exercise classes, including yoga and Tai chi for

[10] https://www.housebeautiful.com/uk/lifestyle/news/a1916/neighbours-full-name/

			example.
Travel & Transport			
14	Please indicate the household's main mode (longest distance/travel time) of travel for the most frequent journey undertaken in a typical week	20	Car is the dominant mode of travel, with 17 responses. Only 3 responses indicated the train is the main mode. This aligns with the picture across the UK, where for example, 65% of trips in the UK were made by car[11].
15	Please indicate the distance travelled for the most frequent journey undertaken in a typical week	20	It appears that residents are making long journeys by car, with 50+ mile journeys being the most popular, with 7 responses.
16	Do you utilise any other travel modes as part of the most frequent journey travelled in a typical week?	19	Bus was the most popular, with 8 responses, followed by the car with 5 responses. Again, this confirmed less journeys are being made by other, more sustainable modes of transport, with only 2 responses by foot, and 2 by bike, for example. No responses for the car club vehicle were made.
17	Please confirm how many of each type of vehicle are kept at the residence	20	Petrol is the most common, with 15 responses. Then diesel (12), full electric (6), motorcycle (5) and hybrid (4).
18	Please state typical annual mileage of the vehicles identified in in question 34	17	The approximate average mileage for the first vehicle was 8,424 miles, 8,600 miles for the second vehicle and 2,500 for the third.
19	How often do you cycle to/from your household in a typical week?	19	Only 5 responses reported cycling to/from household in a typical week.
20	What is the main purpose of cycle trips made from your household?	12	Most cycle trips are made recreationally (9), with only 3 cycling as part of their commute.
21	What transport related measures provided at Elmsbrook has your household found useful? (e.g. Brompton Bike hire, E1 Bus Service, E car club, Electric Vehicle Trials, Events, Cycle Routes	15	Most respondents mentioned the bus service as very useful, followed by cycle routes, cycle hire and e-car club.

Below a selection of responses also illustrated in graph form (Q4, 14 and 15).

11 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/576095/tsgb-2016-report-summaries.pdf

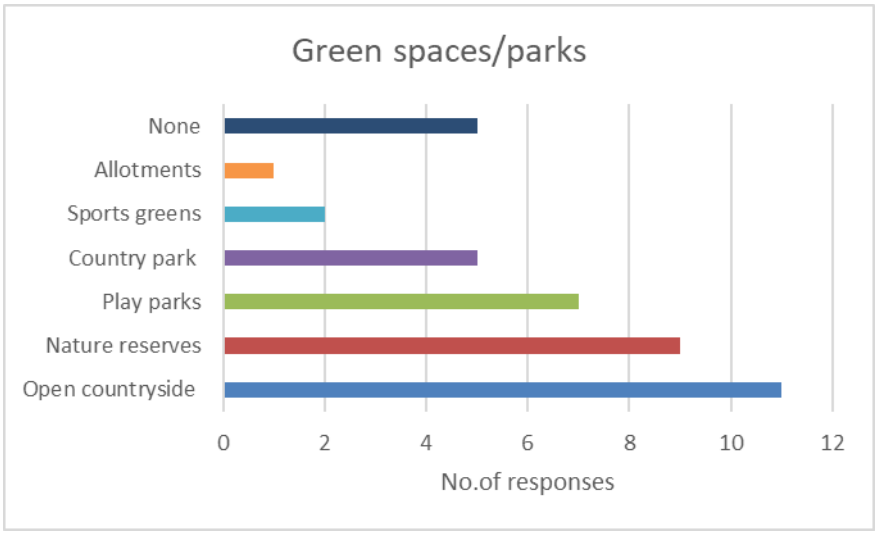

Figure 14 - Answers to the question: 'Which of the following parks or green spaces does your household make use of locally (if any)?'

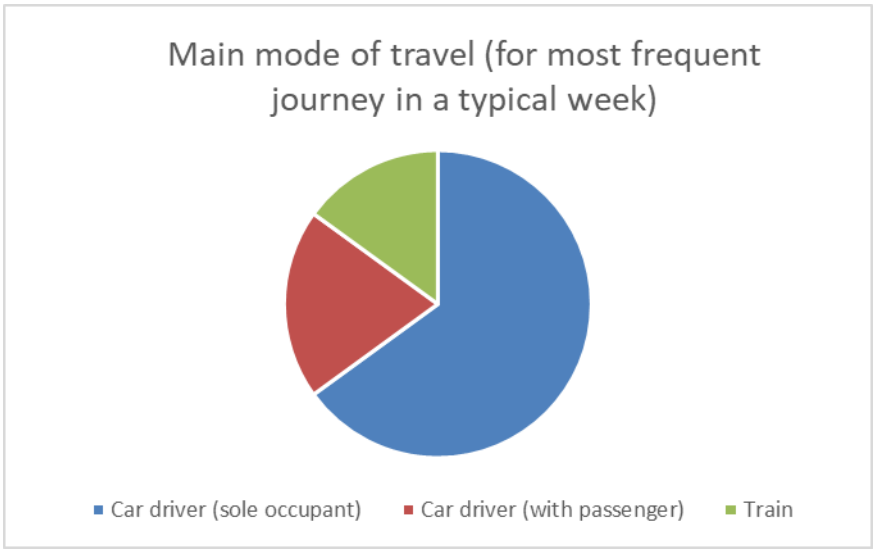

Figure 15 - Answers to the question: 'Please indicate the household's main mode (longest distance/travel time) of travel for the most frequent journey undertaken in a typical week.'

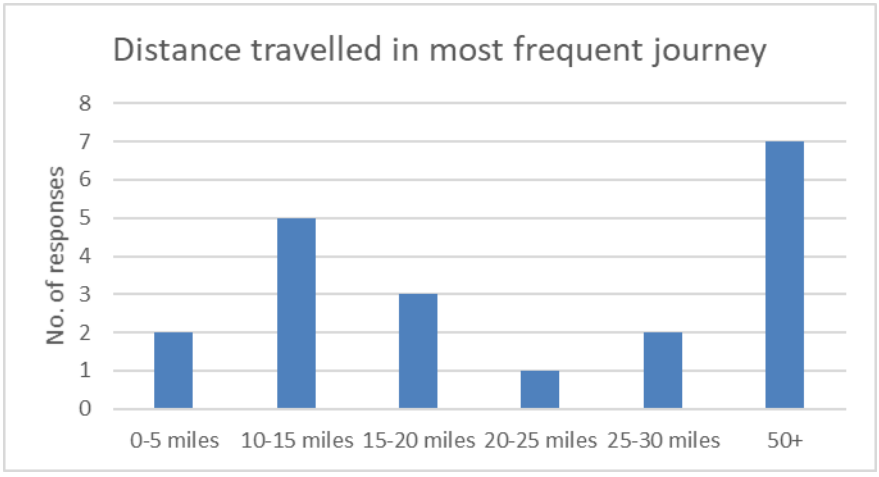

Figure 16 – Answers to the question: 'Please indicate the distance travelled for the most frequent journey undertaken in a typical week.'

4.10 Other

The S106 summary sheet- 'Elmsbrook Post Occupancy Monitoring' summarises most of the results of this report and can be found in the appendix of this report.

5 Conclusions and recommendations

5.1 Overview

This report presents the second set of Elmsbrook post occupancy monitoring results, the first with a quasi-complete data set. While the development as a whole (school, residential phases and energy centre) is performing above expectations (i.e. net zero carbon, or true zero carbon), the residential phases are using more electricity, heat and water than estimated at design stage, although this remains significantly lower than standard new builds. Currently this shortfall is covered by the school's PV and energy centre. Because the CHP engine is not running at capacity yet, the carbon balance has potential to improve further as more homes are built and occupied. Other sustainability indicators such as water, waste and transport are some distance off their target and will require more concerted effort over the next year.

With regard to the monitoring process, most systems are working well, however there are some small teething problems around both the data collection process (data either not logging or producing anomalies) and technical functioning of equipment (water leaks or inverter problems). For this reason, post occupancy monitoring has been immensely valuable as it will allow the developer to address and solve these problems (gone unnoticed otherwise), replace faulty equipment and inform behaviour change initiatives.

Despite a push needed in some areas, what remains true and promising, is that Elmsbrook residents are warming to the eco-design. In a recent survey, a large number of residents (47%) suggested their favourite design feature was eco-related and 57% quoted eco-related design principles as the element they liked the best about the development. For example, as one resident highlights:

> *"The house is very warm without putting the central heating on. The windows don't completely open, so they can be opened and let a breeze through but keeps the house insulated at night. I like the recycling of rain water for the toilets and bathrooms and I love the fact we are constantly saving money."*

Moreover, other positive feedback on the development more generally points to the sense of community, an important aspect of any One Planet Community:

> *"It's how people should live in the future; the houses are very sustainable. There's open community space. It's built with future living in mind. They use less energy and less water. The houses are more efficient, and it feels like an integrated community."*

Overall, the customer feedback was very positive. The main negative feedback was in relation to the lack of car parking, especially for visitors. Nonetheless, 40% indicated that the eco town concept was the main reason for purchasing their home and 45/58 residents recommended Elmsbrook as a place to live. The results so far demonstrate that a more sustainable, healthy lifestyle within a fair share of the earth's resources is both viable and popular.

5.2 The most important findings of the study

- Although it is impossible to estimate the developments exact carbon balance (e.g. some energy use relies on manual/ intermittent meter readings), it is safe to say Elmsbrook is currently carbon neutral, even saving the rest of the UK around 25 tonnes CO_2 this year alone. Per household (i.e. without school and energy centre contribution) Elmsbrook residents have a 2,300 kgCO_2 smaller carbon footprint than the average UK household (energy only). The exact carbon intensity will fluctuate with every passing year. Indeed, with the new commercial centre coming online over the next months it could impact the site wide carbon balance in next year's report significantly.
- Although electricity use is 6% higher than the design estimate (3,122 KWh), Elmsbrook residents use about a third less electricity than their neighbours in Bicester (4,311 KWh). This is because of low energy lighting throughout, efficient white goods (AAA, A++) and PV generation reducing the required electricity import. The UK average electricity use in 2013 was 4,192 KWh[12].
- Average heat demand (space heating and hot water) was around a third higher (at 5,473 KWh) than the design stage estimate of 4,269 KWh. Whilst the UK experienced unusual long periods of below zero temperatures at the start of 2018 it seems that space heating demand is closer to expected compared to hot water use. Elmsbrook residents use 57% less heat (gas data only) than their neighbours in Bicester (12,755 KWh), this is because homes are better insulated, have triple glazed windows and are more airtight than older homes. The UK average gas usage in 2013 was 15,462 KWh.
- PV generation was lower than estimated at design stage however a large number of dwellings were experiencing either equipment failure or monitoring problems. Of the 86 dwellings in phase 1 only 13 dwellings have more or less complete data sets (360+days). The average output from those dwellings is 110% of the SAP target and 91% of the PVsol target (using more sophisticated energy modelling software). The ones below design target generation are predominantly saw tooth roof elevations with over shading issues.
- Water use per person was up from last year's data and currently sitting around the UK average (150 litres per person), average household consumption was slightly higher than the UK average. Technical problems in the rain water harvesting system (faulty valves for mains top up) and metering could explain some of this increase, as well as difficulties obtaining exact household occupancy numbers because of GDPR. One plot was logging continuous water usage three times above the site average over a period of 60+days.
- Elmsbrook households currently produce more waste than the average household in Cherwell District with respective recycling rates of 47% and 55%, although the trend is moving in the right direction. Also, a portion of this is waste surely must be accounted for as part of the moving process.
- The energy centre is currently running largely on gas boilers opposed to the more carbon efficient CHP, impacting the carbon balance. Efficiencies are currently lower with 72% for the CHP (vs 78% estimated at design stage) and 80% gas boiler (vs 87% at design stage). Distribution losses are twice the designed estimate and we recommend that they are queried with SSE.
- Travel is moving in the right direction (from 88% car journeys to 84%) compared to last year's figures but still some distance off the modal share target of 50%. Most households commute large distances where the car seems to be the dominant mode of transport. However, as a small caveat, it is currently impossible to separate e-car use from normal car use and construction traffic could also have impacted this years reporting, so actual figures might indeed be lower.

[12] https://www.ovoenergy.com/guides/energy-guides/the-average-gas-bill-average-electricity-bill-compared.html

- Residents rate their health significantly higher than the UK average with 81% vs 58% above neutral.

5.2 Recommendations

Bioregional has made recommendations to A2Dominions to improve the quality of monitoring data.

6 Appendices

Appendix 1 - Summary of Elmsbrook data by house type (annual averages)

Phase 1 averages	PV generated (KWh)	PV used (KWh)	PV exported (KWh)	PV utilisation	Elec. imported (KWh)	Electricity (KWh)	Heat (KWh)
2 bed	2,092	550	1,543	26%	1,538	2,087	4,342
3 bed	1,983	560	1,423	28%	2,284	2,844	1,978
4 bed	4,366	1,330	3,036	30%	2,083	3,413	2,129
5 bed	5,313	1,466	3,847	28%	3,047	4,513	12,139
Bungalows	4,670	888	3,782	19%	3,228	4,116	11,544
Flats	N/a	N/a	416	N/a	1,970	N/a	3,641
Bicester average (existing, 2015 figures)	N/a	N/a	N/a	N/a	N/a	4,311	12,755
UK average (existing, 2013 figures)	N/a	N/a	N/a	N/a	N/a	4,192	15,462

Appendix 2 - Summary of Elmsbrook post occupancy monitoring

Source Objective	Ref	What	When	Method	Who	Results	Units
General Data	GD-1	No. homes occupied	Annual	Developer report	A2D	132	Number
General Data	GD-2	Affordable homes	Annual	Developer report	A2D	42	Number
General Data	GD-3	Delivery against timetable:	Annual	Developer report	A2D	Community house	Qualitative summary
General Data	GD-4	Occupancy correlated with Shimmy data and resident surveys	Annual	Question sent to residents via the Shimmy and included in survey	A2D	N/A	Numbers

Government Objective	GO-1	Average carbon footprint of residents	Biennial	Calculated	A2D via specialist contractor	N/A	tCO2/person/year
ET7 Zero Carbon	ET7.1	Total electricity generated on site by the CHP	Annual	Metering	SSE	304600	kWh/year
ET7 Zero Carbon	ET7.2	Electricity generated by PV by property	Annual	Metering	Carnego	See data tables	kWh/year
ET7 Zero Carbon	ET7.2b	Electricity generated by PV on each non-residential building	Annual	Metering	CDC + A2D to survey non-residential occupants	N/A	kWh/year
ET7 Zero Carbon	ET7.2c	Total electricity generated on site by PV	Annual	Metering	Carnego	149849	kWh/year
ET7 Zero Carbon	ET7.3a	Electricity generated on site Total	Annual	Calculated using metering data above from SSE and Carnego	A2D via specialist contractor	454449	kWh/year
ET7 Zero Carbon	ET7.3b	Net export of electricity to grid - PV	Annual	Metering	Carnego	124495	kWh/year
ET7 Zero Carbon	ET7.4a	Heat output from on-site generating technology - CHP	Annual	Metering	SSE	317200	kWh/year
ET7 Zero Carbon	ET7.4b	Heat output from on-site generating technology - Boiler	Annual	Metering	SSE	904100	kWh/year
ET7 Zero Carbon	ET7.4c	Gas consumption by generating technology - CHP	Annual	Metering	SSE	944206	kWh/year

ET7 Zero Carbon	ET7.4 d	Gas consumption by generating technology - Boiler	Annual	Metering	SSE	1029940	kWh/year
ET7 Zero Carbon	ET7.5 a	CO2e emissions by generating technology - CHP	Annual	Calculated using metering data above from SSE	A2D via specialist contractor	203948	kWh/year
ET7 Zero Carbon	ET7.5 b	CO2e emissions by generating technology - Boiler	Annual	Calculated using metering data above from SSE	A2D via specialist contractor	222467	kWh/year
ET7 Zero Carbon	ET7.6 a	Gas CHP running hours	Annual	Metering	SSE	363	hrs
ET7 Zero Carbon	ET7.6 b	Gas boiler running hours	Annual	Metering	SSE	N/A	hrs
ET7 Zero Carbon	ET7.7 a	Electricity demand By each non-residential occupier	Annual	survey + metering	CDC + A2D to survey non-residential occupants	N/A	kWh/year
ET7 Zero Carbon	ET7.7 b	Electricity demand Non-residential Total	Annual	calculated using info provided by all non-residential occupiers	A2D via specialist contractor	N/A	kWh/year
ET7 Zero Carbon	ET7.8 a	Electricity demand By household	Annual	metering	Carnego	See data tables	kWh/year
ET7 Zero Carbon	ET7.8 b	Electricity demand Residential total	Annual	Calculated	Carnego	186867	kWh/year
ET7 Zero Carbon	ET7.9	Site-wide Electricity demand Total	Annual	Calculated	A2D via specialist contractor	N/A	kWh/year

ET7 Zero Carbon	ET7.10a	Heat demand By each non-residential occupier	Annual	Metering	CDC + A2D to survey non-residential occupants	N/A	kWh/year
ET7 Zero Carbon	ET7.10b	Heat demand Non-residential Total	Annual	Calculated using info provided by all non-residential occupiers	A2D via specialist contractor	N/A	kWh/year
ET7 Zero Carbon	ET7.11a	Heat demand By household	Annual	Metering	Carnego	See data tables	kWh/year
ET7 Zero Carbon	ET7.11b	Heat demand Residential total	Annual	Calculated	Carnego	431778	kWh/year
ET7 Zero Carbon	ET7.12	Site-wide Heat demand Total	Annual	Calculated using information from Carnego and Non-residential occupiers	A2D via specialist contractor	N/A	kWh/year
ET7 Zero Carbon	ET7.13	Site wide carbon balance	Annual	Calculated	A2D via specialist contractor	N/A	tCO2/year
ET17 Water	ET17.1a	Mains water demand By each non-residential occupier	Annual	Metering	CDC + A2D to survey non-residential occupants	N/A	Litres per year
ET17 Water	ET17.1b	Mains water demand Non-residential Total	Annual	calculated using info provided by all non-residential occupiers	A2D via specialist contractor	N/A	Litres per year
ET17 Water	ET17.2a	Mains water demand By household	Annual	Metering	Carnego	See data tables	Litres per day

ET17 Water	ET17. 2b	Mains water demand Residential total	Annual	Calculated	Carnego	10098160	Litres per day
ET17 Water	ET17. 3	Any other significant metered water demands e.g. Landlord's supply to rainwater tanks in flats or homes, allotments, site wide meter point	Annual	Metering	A2D	N/A	Litres per year
ET10 Employment	ET10. 1	Employment space delivered on site	Annual	Developer report	CDC + A2D		m2
ET10 Employment	ET10. 2	On-site jobs created	Biennial	Survey of non-residential occupiers	CDC + A2D to survey non-residential occupants		Number FTE Jobs at 31 March and average FTE jobs for the year
ET10 Employment	ET10. 3	No. employees on site who live in NW Bicester	Biennial	Survey of non-residential occupiers	CDC + A2D to survey non-residential occupants		No. FTE that live in NW Bicester at 31 March and average FTE for the year that live in NW Bicester
ET10 Employment	ET10. 4	Home working	Biennial	Survey of residents	A2D		Number
ET12 Healthy lifestyles	ET12-1	Exercise frequency	A2D	Biennial	Survey of residents		%
ET12 Healthy lifestyles	ET12-2	Perceived health	A2D	Biennial	Survey of residents		Score from 1 – 10?

ET12 Healthy lifestyles	ET12-3a	Perceived wellbeing	A2D	Biennial	Survey of residents		Score from 1 – 10?
ET12 Healthy lifestyles	ET12-3b	Perceived health and wellbeing of non-residential occupants in their work environment	A2D	Biennial	CDC + A2D to survey non-residential occupants		Score from 1 – 10?
ET12 Healthy lifestyles	ET12-4a	Perceived comfort of homes levels: temperature, humidity	A2D	Biennial	Survey of residents		Biennial
ET12 Healthy lifestyles	ET12-4b	Perceived comfort of non-residential units levels: temperature, humidity	A2D	Biennial	CDC + A2D to survey non-residential occupants		Biennial
ET14 Green infrastructure	ET14.1	Extent of green infrastructure – public & private	Annual	GIS mapping of as-built areas. Followed by site walk round.	A2D		Percentage
ET14 Green infrastructure	ET14.2	Take up of allotments	Annual	Developer records	A2D		Percentage
ET14 Green infrastructure	ET14.3	Active users of GI	Biennial	Survey of residents	A2D		Percentage
ET16 Biodiversity	ET16.1	Report against delivery of the Landscape and Ecological Management Plan (LEMP)	Annual	Ecologist survey and report	A2D via specialist contractor		Qualitative report

ET16 Biodiversity	ET16.2	Area of key habitats	Annual	GIS / Ecologist report	A2D via specialist contractor		m2
ET16 Biodiversity	ET16.3	Number of indicator species	Annual	Ecologist report	A2D via specialist contractor		Summary of report findings
ET16 Biodiversity	ET16.4	Net gain in biodiversity	Annual	Ecologist calculation	A2D via specialist contractor		Number/percentage
ET16 Biodiversity	ET16.5	Community involvement in conservation or biodiversity measures	Annual	Developer report	A2D community involvement team		Qualitative report
ET19 Waste	ET19.1	No. residential properties serviced by waste contractor	Annual	CDC waste contractor	CDC		No.
ET19 Waste	ET19.2a	Residual waste - total residential	Annual	CDC waste contractor	CDC		Kg / year
ET19 Waste	ET19.2b	Residual waste - By property	Annual	Calculated	CDC		Kg / household / year
ET19 Waste	ET19.3	Residual waste - each Non-residential	Annual	Survey	CDC + A2D to survey non-residential occupants		Kg
ET19 Waste	ET19.4a	Recycling - total residential	Annual	CDC waste contractor	CDC		Kg
ET19 Waste	ET19.4b	Recycling rate - residential	Annual	Calculated	CDC		%

ET19 Waste	ET19. 5a	Recycling - each non-residential	Annual	Survey	CDC + A2D to survey non-residential occupants		Kg
ET19 Waste	ET19. 5b	Recycling rate - each non-residential	Annual	Calculated	CDC + A2D to calculate from non-residential surveys		%
ET19 Waste	ET19. 6a	Off-site composting - residential total	Annual	CDC waste contractor	CDC		Kg
ET19 Waste	ET19. 6b	Off-site composting rate - residential	Annual	Calculated	CDC		%
ET19 Waste	ET19. 7a	Off-site composting - each non-residential	Annual	Survey	CDC + A2D to calculate from non-residential surveys		kg
ET19 Waste	ET19. 7b	Off-site composting non-residential Total	Annual	Calculated	CDC + A2D		Kg
ET19 Waste	ET19. 8	Individual home composting	Annual	Survey of residents	A2D		Number
ET13 Local services	ET13. 1	Local services available	Annual	Report	A2D and CDC		n/a
ET13 Local services	ET13. 2	Walkability Index	Biennial	Online assessment	CDC		n/a
ET21 Transition	ET21. 1	Community development plans	Annual	Report	A2D		Qualitative summary

ET21 Transition	ET21.2	Delivery of monitoring programme	Annual	Report	A2D		
ET21 Transition	ET21.3	Delivery of programme of encouraging environmentally responsible behaviour	Annual	Report	A2D		Qualitative summary
ET22 Community & governance	ET22.1	Establishment of roles and responsibilities as set out in the S106 on governance	Annual	Report	A2D		n/a
ET22 Community & governance	ET22.2a	Number of community events	Annual	Report	A2D		Events per year
ET22 Community & governance	ET22.2b	Participation rates in community initiatives	Annual	Report	A2D		Numbers of people and percentages
ET22 Community & governance	ET22.3a	Participation in community events and initiatives	Biennial	Resident Survey	A2D		Number in past year
ET22 Community & governance	ET22.3b	Participation in community events and initiatives	Biennial	Non-residential Survey	CDC + A2D to survey non-residential occupants		Number in past year
ET22 Community & governance	ET22.4a	Satisfaction rating	Biennial	Resident Survey	A2D		scale of 1 - 10

ET22 Community & governance	ET22.4b	Satisfaction rating	Biennial	Non-residential Survey	CDC + A2D to survey non-residential occupants		scale of 1 - 10
ET22 Community & governance	ET22.4a	Resident involvement in community and governance	Biennial	Survey	A2D		Number / percentage
ET22 Community & governance	ET22.4b	Non - Resident involvement in community and governance	Biennial	Non-residential Survey	CDC + A2D to survey non-residential occupants		Number / percentage
ET22 Community & governance	ET22.5	Social capital	Biennial	Resident Survey	A2D		Number
ET11 Transport	ET11.1	Modal journey breakdown	Annual	Assessment using data below	TPC		%
ET11 Transport	ET11.2	Resident transport related carbon emissions	Biennial	Assessment using data below	TPC		tCO2/ person / year
ET11 Transport	ET11.3	Number of car journeys	Annual	Counters	TPC		Trip numbers (AADT)
ET11 Transport	ET11.4	Number of cycle/pedestrian journeys	Annual	Counters	TPC		
ET11 Transport	ET11.5	Car club membership	Biennial	Car club reporting to TPC	TPC		Membership numbers
ET11 Transport	ET11.6	Car club mileages	Biennial	Car club reporting to TPC	TPC		miles/year
ET11 Transport	ET11.7	Carbon intensity of car club vehicles	Biennial	Car club reporting to TPC	TPC		kgCO2/mile

ET11 Transport	ET11.8	Bus patronage and other bus related monitoring	Biennial	Bus company reporting to TPC	TPC		
ET11 Transport	ET11.9	Illegal/inappropriate parking	Biennial	Report	A2D Housing Management Team		
ET11 Transport	ET11.11	Journey breakdowns for each resident that participates in the survey (minimum 10% of households)	Biennial	Survey with travel diaries	TPC		
ET11 Transport	ET11.12	Car, bicycle, moped etc. ownership levels	Biennial	Survey	TPC		numbers /household
ET11 Transport	ET11.13	Personal car mileages	Biennial	Survey	TPC		miles/year + model
ET11 Transport	ET11.14	Car model	Biennial	Survey	TPC		
ET11 Transport	ET11.15	Carbon intensity for each car model	Biennial	DOT data	TPC		kgCO2 / mile
ET11 Transport	ET11.16	Frequency of bicycle usage	Biennial	Survey with travel diaries	TPC		Journeys / month
ET11 Transport	ET11.17	Annual bicycle miles	Biennial	Survey	TPC		Miles / Year
ET11 Transport	ET11.18	Qualitative feedback	Biennial	Survey	TPC		
ET11 Transport	ET11.19	Qualitative feedback	Biennial	Survey of non-residential occupiers	TPC		

ET11 Transport	ET11.20	Commuting distances for incoming workers	Biennial	Survey of non-residential occupiers	TPC		miles/year
ET11 Transport	ET11.21	Travel modes for non-residential occupants	Biennial	Survey of non-residential occupiers	TPC		miles/year
ET11 Transport	ET11.22	Mode breakdown for school children	Biennial	Survey of non-residential occupiers	TPC		%
ET11 Transport	ET11.23	Non-residential deliveries	Biennial	Survey of non-residential occupiers	TPC		Number /year