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A2Dominion
Elmsbrook monitoring 2018-19: Data on travel, waste, water and energy use on site

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Contents

Executive summary

This report forms the third in a series of annual reports tracking the real-life performance of the UK's first ecotown (to Ecotown Planning Policy Statement - PPS), Elmsbrook, part of NW Bicester. The development is still one of the most comprehensively monitored with data on travel, energy, water, waste and a range of other sustainability indicators collected as part of a planning requirement.

Ongoing monitoring ensures that much of this learning (from design, construction to occupation) finds its way back to the decision makers and stakeholders at all levels. Feedback can influence lifestyle choices (i.e. residents), construction processes (i.e. the delivery team) and planning considerations. Effects can ripple out further to inform how other developments are designed and built, both nearby in the same local planning context and also more widely across the UK and the world.

The 87 homes of the first phase have now been occupied for over two years. We also now have the first (almost) complete data set from the second phase (a further 71 homes). This is good news for the quality and usefulness of our data. 'Bedding in' effects are reducing, people are starting to embrace their greener, more sustainable lifestyles. In practical terms this longer reporting period can bring new challenges as older first-generation meters are starting to fail. Without active monitoring these problems generate gaps in the data that can go un-noticed. This is something this reporting period has had to come to grips with.

The good news is that as these system issues occur, the monitoring process is learning to and having to adapt. Future phases are now fitted with higher specification meters and more robust equipment. App development will allow stakeholders to link with live data providing early warnings for out of range data. This allows both residents and A2Dominion to detect when there is say a possible water leak or inverter failure and so be able to respond quickly. The development is becoming 'smarter' through this process with more resilient warning systems. Learning is being fed back more efficiently

Unfortunately these monitoring issues also mean loss of data so the task of interpreting the data and truly understanding what is happening is more complex. Bioregional have developed a process for using the best data available to understand how the development is doing. Where systems (e.g. meters, inverters etc) have stopped logging data, extrapolation of site wide averages has become necessary to evaluate overall energy and carbon balances. This comes at a loss of accuracy, so conclusions for this year are more difficult to draw and should be treated with some caution.

Energy and carbon performance are highly dynamic processes. This year it looks like the overall performance of the development has not quite achieved its true zero carbon performance. The reason for this is a mix of factors, some data related, others operational with higher than expected system losses (energy centre), some CHP outages, commissioning heat losses and inverter failures. The good news is that learning from this is already fed back and in the process of being digested, so that next year's performance can be back on track.

The most exciting aspect of this year's reporting is that other sustainability indicators such as water and domestic electricity consumption have improved dramatically. Electricity use is below design targets and significantly below the Bicester wide average. Water use on Elmsbrook is now almost meeting design targets of 80 litres per person per day (compared to UK average of 150 litres per person per day). Travel remains challenging, mainly due to the edge of town location

and high proportion of commuters. The current modal shift figures are mostly unchanged, however a large proportion of electric and hybrid vehicle ownership on site ensures that ~30% of these journeys result in low emissions. Recycling rates are improving but still below county average requiring more concerted effort by all stakeholders.

Feedback from the annual resident survey continues to be encouraging. People in Elmsbrook are more social ('know more of their neighbours'), are happier and rate their health highly. Running costs for energy are well below Bicester average, meaning real money back in the pockets of Elmsbrook residents. Buying demand for these ground-breaking new homes is continuing to grow faster than the demand for other nearby new housing developments in Bicester, 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 third set of monitoring results from Elmsbrook Ecotown development in Bicester. Monitoring covers a period of 12 months (1 April 2018 to 31 March 2019) and includes data from 158 dwellings, 87 from the first phase of development and 71 from the second phase.

Information was collated from two main data sources, survey questionnaires providing qualitative data and from monitoring equipment (e.g. the shimmy) providing quantitative data. Other supplementary data sources complete the picture around waste, travel and communal energy. Last year was the first year with a full set of data for the 87 dwellings from phase one of the development and gradually from April 2018, dwellings from the second phase became occupied providing a larger data set for this year's report. There remains some incomplete data for some dwellings as not all homes were occupied for the breadth of the monitoring period.

Technical issues around the meters and PV system (affecting 31 dwellings) have meant that some data was not collected correctly, even though nominally a full year should have been available. The flat blocks share a communal roof space and PV array which is not sub metered (figures have been previously collected manually). Some PV inverters on these blocks have tripped resulting in generation failure for as much as a whole year. For this reason, the total electricity figure (as derived from a formula of generation, export and import) cannot be accurately reported for plots affected by these issues, reducing the data set.

Data in this report is generally presented in headline figures first (bullet points), followed by a more detailed summary of results, then in graphical form. Further important notes on the data analysis can be found in the first paragraph of the relevant report section. Conclusions and recommendations tie all chapters together, provide a summary of the headline findings and make recommendations for improvement.

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 One Planet Community will eventually include 393 homes, 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 level 5, incorporating triple glazing, mechanical ventilation (MEV or MVHR) and rainwater harvesting
- PV solar panels on every home
- Energy centre featuring combined heat and power (CHP) plant providing space heating and hot water via district heating to all buildings on site
- Cycle and pedestrian routes, a bus stop within 400 metres of every home, live timetable updates in each home, charging point 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/person/day

2.2 House types, tenure and phasing

Elmsbrook consists of a mix of 1-5 bed properties, flats and bungalows. The development is made up of four phases, of which the first phase has been occupied for over 36 months (full set of data) and parts of the second phase have been occupied for over 12 months (partial data). 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 overleaf in table 1.

Table 1- House types and tenures by phase.

Phase/ tenure	Detached units	Terraced units	Flats	Semi-detached units	Bungalow
Phase 1 – 87 dwellings occupied (Full year worth of data)					
Private	12	26	0	4	0
Affordable	0	9	18	4	3
Shared ownership	0	7	6	5	0
Phase 2 – 71 dwellings occupied (Partial data, some less than a year)					
Private	12	47	0	4	0
Affordable	0	0	4	0	4
Shared ownership	0	0	0	0	0
Total occupied – 158 dwellings	13	68	28	15	7

3 Overview of the data

This report has been collated as part of a desktop study with a small component of on-site data collection (e.g. meter readings) 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 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, 300% above or below the average. The data provider (e.g. Carnego) was then requested to check these data queries and resubmit.

Once this was completed, remaining anomalies above 300% were treated, but these remain small instances. If these issues occurred in series (i.e. on the same day) it generally indicates a server restart issue with resulting data spike. Those numbers were then adjusted using an average of the last and next cell in the range.

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. Shimmy data (water, heat, energy) was submitted in daily readings, but does have underlying hourly or even minute-by-minute readings available on request to Carnego.
2. 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 remotely, with electricity and PV estimates based on manual meter readings. These manual readings are less accurate as they don't cover the exact 365 days period. Last year's data was re-created based on move-in date estimates. This year's data is slightly more accurate as it has comparisons to work from last year.
3. Significant technical issues on PV inverters and metering equipment have caused data loss and anomalies which have impacted the quality and cover of data.
4. We have attempted to reconstruct the data through extrapolation, which will have an impact on accuracy.
5. Further problems with unplugged monitoring systems have impacted rented properties on site. A2Dominion head office arranged for a third-party provider to set up remote FITs reporting which resulted in some meters being unplugged accidentally.
6. Phase 2 data nominally covers a full year, however only 16 properties provided 360 + days of data due to late or part occupation with staggered move-in dates. Working out site wide averages is therefore still difficult.
7. 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 – 'shimmy' system

This section outlines the detailed results collected from the 'shimmy' system installed to households. For each category, the headline findings have been summarised for both phase 1 and 2 separately, followed by more detailed analysis. As mentioned in the previous section, phase 2 data were limited and so findings draw on only a small subset this phase.

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 (Phase 1 + 2) in 18/19 was 227 litres per day (compared to 375 litres in 17/18 and 192 litres in 16/17).
- The estimated daily average water consumption (Phase 1 + 2) in 18/19 per person was 84 litres, that's 5% above the design target of 80 litres per person per day. Last year's water use was 151 litres (in 17/18) and 76 litres in the previous year (16/17).
- Elmsbrook residents are currently almost meeting their water use target of 80 litres per person per day, with 77% of homes analysed meeting this target.
- Water use has significantly improved from last year's monitoring.
- The average water use in the UK is currently 150 litres per person per day[1].

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

Table 2 – Elmsbrook water consumption, year-on-year comparison.

	Average daily per person *(litres)*	**Average daily per household** *(litres)*
2018/19	84	227
2017/18	151	375
2016/17	76	192
Design target	80	Na
UK average	150	Na

Summary of results:

- Of 87 households on Phase 1, 62 logged data and the rest had metering problems. Of those 62 48 households consumed less than the water efficiency target of 80 litres per person per day (77%). The average for Phase 1 was 241 litres per day per household and 96 litres per person per day.
- Of 71 households on Phase 2, 60 logged data and the rest had metering problems or were part/ unoccupied. Of those 60, 46 households consumed less than the water efficiency target of 80 litres per person per day (77%). The average for Phase 2 was 212 litres per day per household and 72 litres per person per day.
- The three graphs below show the average daily household water use for all phases (Figure 1), daily per person water use for all phases (Figure 2) and % of homes meeting the water target for (Figure 3).
- Water usage looks to have decreased significantly compared to last year, although metering problems and technical failure in the rainwater harvesting system may have skewed last year's figures slightly. 2018/19 figures are similar to the first reporting year in 2016/17.
- The Phase 2 data set includes 71 dwellings, of which only 60 logged data. However, not all of the 60 plots were occupied and monitored throughout the full year (on average 284 days of usable data per household).
- No 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 statistical occupancy information was applied (e.g. average number of empty bedrooms by tenure) which can be seen in table 2.
- The school's data is unavailable because the BMS system was not set up correctly. The school uses rainwater harvesting to flush its WC's, so water use is expected to be below average.

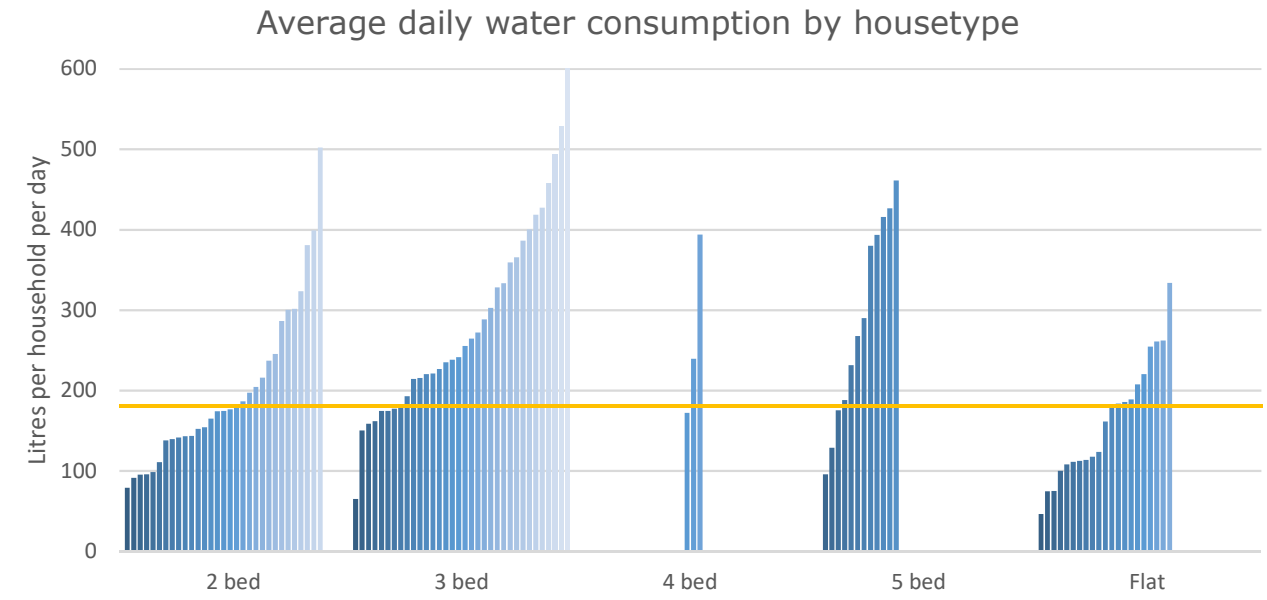

Figure 1- Average daily household water use by house type. Phases 1 and 2 combined. Orange = average all households, blue = actual per household.

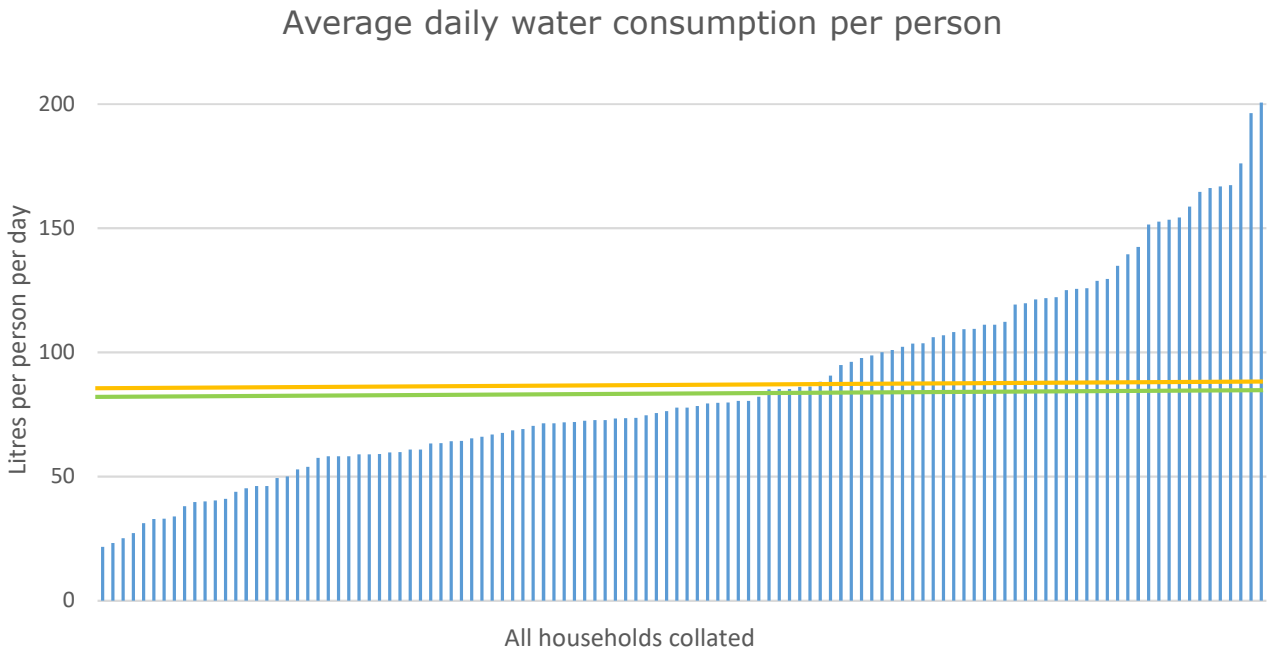

Figure 2 – Average per person water use. All households, phase 1 and 2 combined Green line = target, orange line = average, blue bars = actual per person.

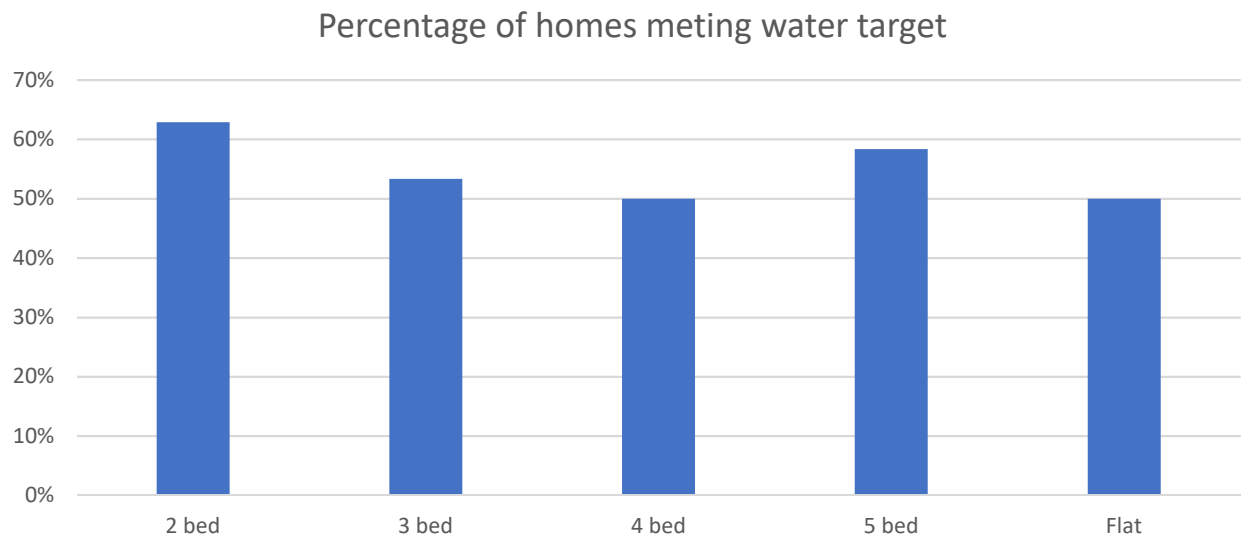

Figure 3 - Percentage of homes meeting their design water use target of 80 litres per person per day. Site wide phase 1 and 2.

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 was 2,550kWh for Phase 1 & 2 in 2018/19 (3,122kWh in 2017/18 for Phase 1).
- The design stage benchmark figures for average electricity consumption were 2,932kWh annually (or 30.79kWh/m^2). Elmsbrook homes use 13% less electricity than design stage estimates suggested. 82% of households in the data sample perform within this design target.
- Bicester's annual household average is 4,311kWh, meaning that Elmsbrook residents used 41% less electricity than their neighbours in Bicester.
- Metering problems have meant that the data sample was reduced to 83 of 130 possible households, or 64%.
- An average Elmsbrook household pays £230 per year for electricity compared to £604 paid by their neighbours in Bicester (UK average £592 for electricity[2]).

Summary of results:

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

- Electricity use is calculated using the formula = PV + import – export. This means that when one of those values is missing it becomes difficult to estimate electricity use accurately.
- For this reason a large number of plots that had missing entries were removed. This reduced the sample to 50 of 71 possible plots (4 are unmetered anyway) in Phase 2 and 33 of 87 (24 of which are not sub metered anyway). That's only 64% of a total possible sample of 130 (excluding flats).
- The remaining sample was analysed for days of data, as some entries included plots with less than 365 days (e.g. late occupation on Phase 2). Data with reasonable quality but missing entries, was extrapolated to 365 days (using daily sample averages). Ahead of this exercise the average days of data count was 249 on Phase 2- and 219-days average on Phase 1. A lot of plots on Phase 1 were affected by PV problems and monitoring failure as can be seen in this figure.
- The graph below (Figure 4) shows the annual electricity consumption per household, for the different house types on Phases 1 and 2. Figure 5 shows that ~ 82% of our data households analysed meet the design electricity target (30.79 kWh/m2).
- Houses with three bedrooms are performing the least well, with 73% of these types of homes meeting the design target.
- The flats are currently not sub metered for PV, so it is not possible to estimate their electricity usage accurately. This means that the calculated average is potentially slightly high as these missing plots are predominantly 1 and 2 bed properties.
- The school used 28,275 kWh of electricity over the monitoring period. Of that only 13,046 kWh was imported from the grid.

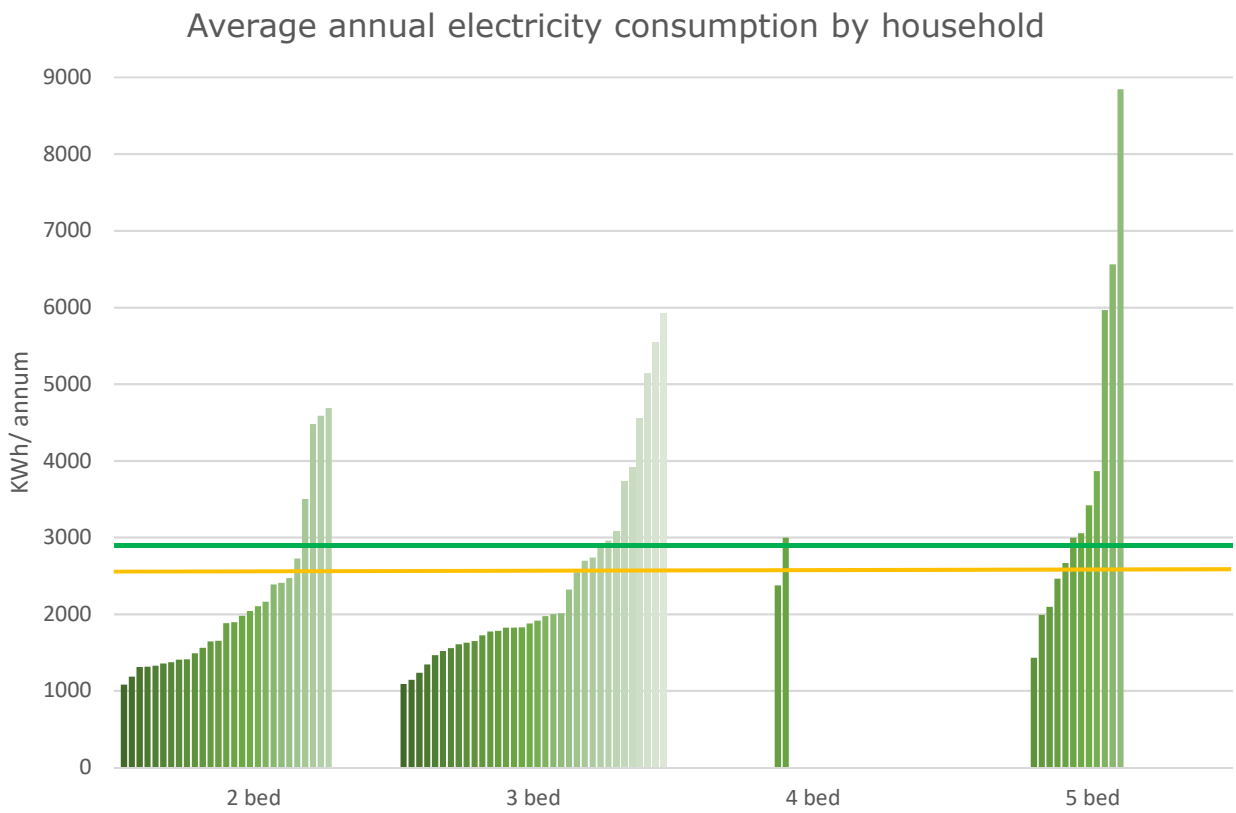

Figure 4 – Average electricity consumption per household and house type, Phase 1 and 2 combined. Bad data removed. Orange line = average all dwellings, green line = target, green bar = actual per household.

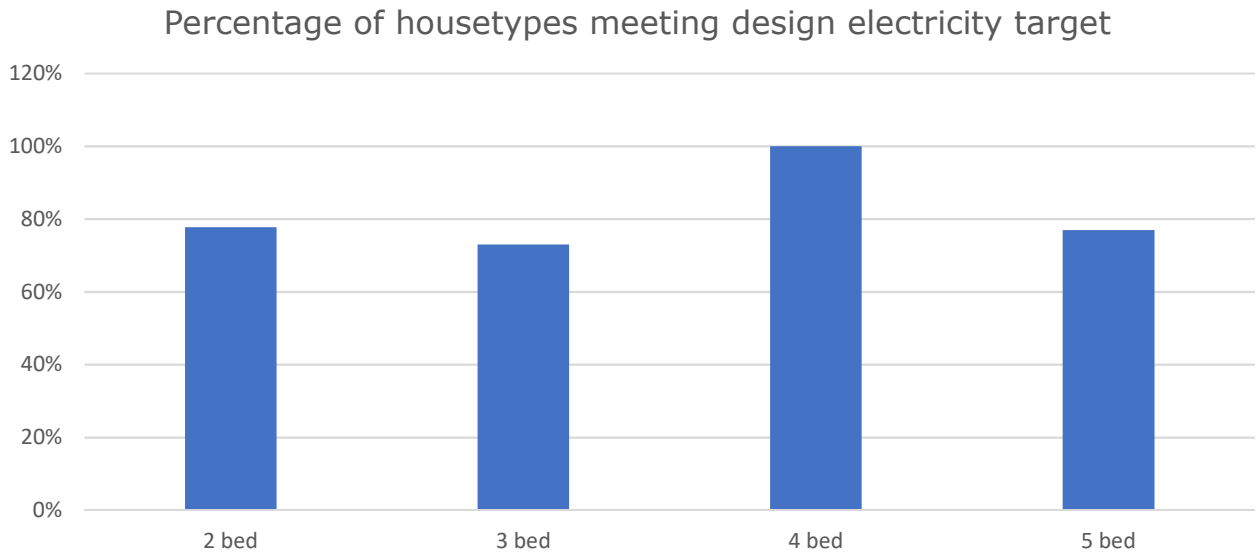

Figure 5 - Percentage of house types meeting design electricity target (30.79 kWh/m²), site wide Phase 1 and 2, bad data removed. No data available for flats as not sub metered.

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 on Phase 1 and 2 at Elmsbrook was supplied with 4924 kWh heat (hot water and space heating). Last year's data for Phase 1 showed 5,473 kWh and the previous year was incomplete but showed 4,023 kWh.
- This compares to the design stage estimate of 4,269kWh (or 44.83 kWh/m²). Therefore, the actual 2018-19 heat usage is 15% higher than the design stage estimate.
- The average annual Bicester household consumption is 12,755KWh (gas data only)[3]. This compares to the UK average of 15,462kWh (gas only data).
- Elmsbrook residents used 61% less heat than their neighbours in Bicester.
- An average Elmsbrook household pays £717 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, as compared with the Elmsbrook average of £717.

[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

Notes on the headline figures:

- Bicester wide heat costs of £833 are based on postcode gas figures plus £200[5] pounds gas safety (plus maintenance) and £123[6] boiler replacement costs.
- Fifteen units on phase 2 did not produce data for the first half of the monitoring period. Another nine had metering problems and did not produced any usable data over the monitoring period. After extrapolation of good quality data, 53 households of 71 in Phase 2 could be used. We estimate that 27% of these homes are meeting their design heat target, however extrapolation will inevitable add some degree of skew to this result (from seasonal variation).
- Similarly data collection problems meant that Phase 1 only had 58 useable datasets from 87 total. Of these, 60% are performing within the heat target (44.83kWh/m^2), compared to 26% of phase 1 homes in 2017/18.
- The total estimated heat usage (based on extrapolation) from both Phase 1 and 2 was 766,103 kWh over the monitoring period. The average of both phases meeting the design target is 44%.
- Phase 2 data is even less complete with an average of 285 days of data compared to 354 in Phase 1. Phase 2 is therefore more prone to overstating seasonal effects when extrapolating. The Phase 2 average is showing significantly higher heat usage with 6,313 kWh compared to Phase 1 with 3,654kWh.
- The school used 122,528kWh over the monitoring period, but required some extrapolation as 3 months of data where missing.
- The graph below (Figure 6) shows the average annual yearly heat use by house type for Phase 1 & 2.
- Figure 7 shows that 39% of sampled homes are meeting the heat target of 44.83kWh/m^2 with the flats performing the best.

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

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

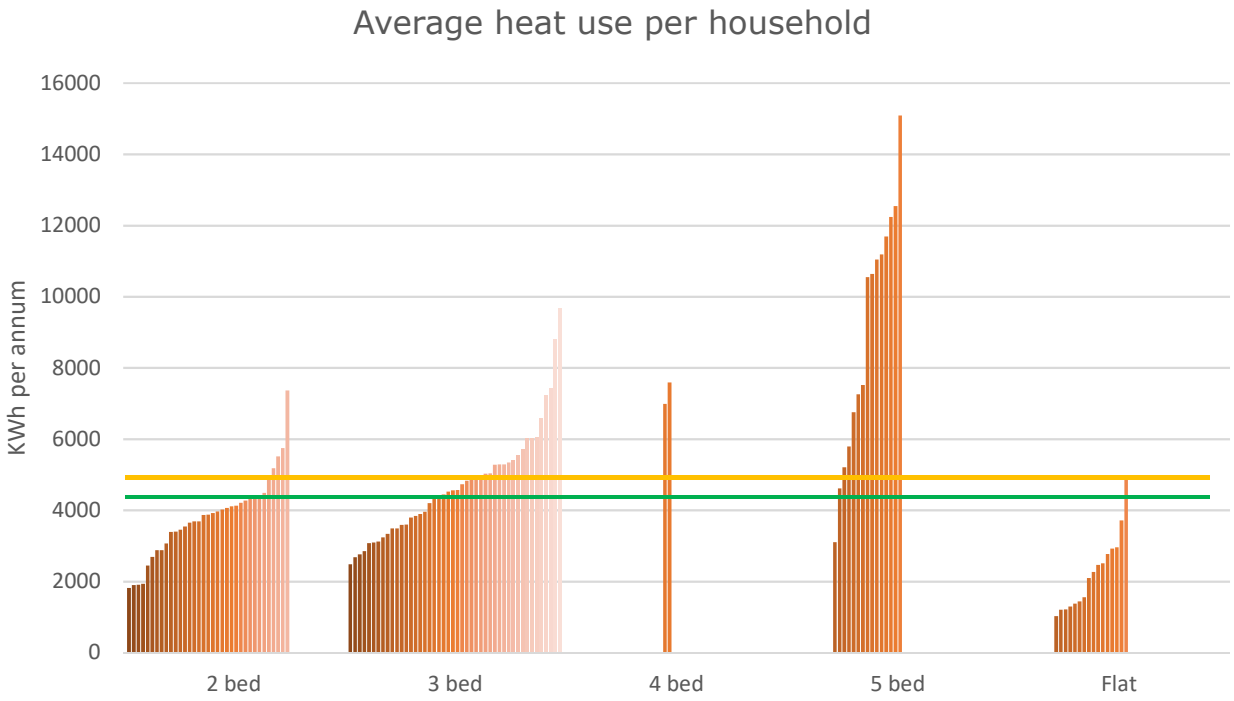

Figure 6 - Average annual heat consumption by house type against benchmark, site wide including phase 1 and 2. Orange line = average; green line = target; orange bars = individual dwellings.

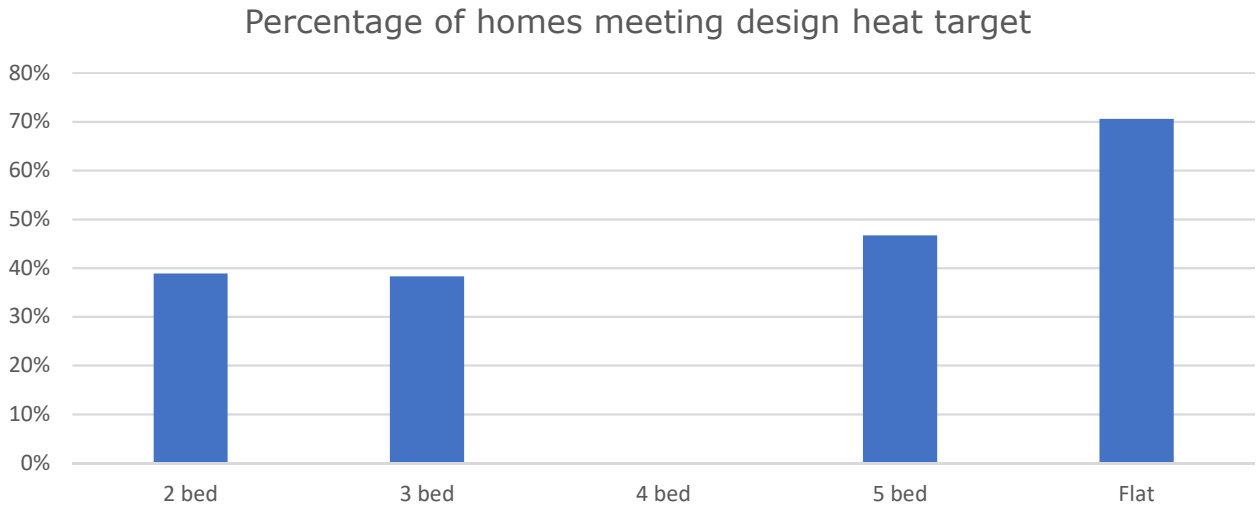

Figure 7 – Percentage of homes meeting the design space heating demand of 44.83kWh/m^2.

4.4 PV

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

The headline figures:

- The site wide, per dwelling generation average for 2018/19 was estimated at 3,361kWh.
- A large proportion of dwellings were affected by monitoring issues (28 plots on Phase 1 and 10 on Phase 2). Others were hit through inverter failure (e.g. the flat block on

phase 2 was 100% failure), so this data sample had to be heavily reconstructed through extrapolation.
- 35 households of phase 1 (monitored via the shimmy) produced a total of 133,952kWh of electricity through their PV system. Estimating phase wide yield through extrapolation gives a figure of 241,114kWh over the monitoring period.
- For Phase 2 the sub metered total was 175,289kWh (data from 57 plots). Extrapolating this figure gives an estimated figure for all phase 2 households of 206,041kWh.
- 447,155kWh total annual PV yield from all dwellings, estimated from extrapolation for both Phase 1 and 2.

Summary of results:

- Of 87 units in phase 2, 35 had useable PV data. 24 flats were not sub metered of which some had partial inverter failure. And a further 28 had inverter or metering failure with up to a 100% missing data.
- Some of the metering issues on Phase 1 were a result of equipment failure of the data loggers, stopping the remote data collection. Manual retrieval for that data by Carnego was at the time of writing this report unsuccessful.
- A large majority of data failure on Phase 1 however, was a result of unplugging the PV logging equipment and installation of a set of brand-new equipment (no access by Carnego). After some investigation it seems that this was ordered by A2Dominion head office to enable remote collection of PV meter readings for FITs payments. None of the local site team (A2Dominion) were aware of this altering of the meters. Carnego contacted the company (responsible for the data collection), to see whether this data could be retrieved to fill the gaps for this report. This wasn't possible and the company has since changed ownership. It was therefore decided to extrapolate all missing data where inverter failure was not confirmed.
- PV panel replacement on Phase 1 contributed to further data loss. Eleven homes did not start to generate electricity until mid-October 2018. Another twenty-eight were not generating for the first 1-2 months of the 18/19 monitoring period.
- Of 71 units in phase 2, 57 had useable PV data. Four flats were not sub metered. And a further 6 had inverter or metering failure with zero accounted generation.
- From design stage estimates we know that Phase 1 was supposed to generate around 282,000kWh per year, based PV Sol (specialist PV software). Our extrapolated estimate from meter data was 241,114kWh per year, around 14% less than the design stage estimates for phase 1. The margin of error could be relatively high though, as seasonal variations get distorted through extrapolation.
- The design stage estimates for phase 2 were 200,135kWh per year based on MCS calculations (a less accurate estimate compared to PV Sol). The extrapolated total for Phase 2 was estimated at 206,041kWh per year, 3% above the design stage estimate. Again, the margin of error could be relatively high, as seasonal variations get distorted through extrapolation.
- The flats are still not sub metered (i.e. monitored via the shimmy), 24 on Phase 1 and four on Phase 2. A manual reading of the export meters confirmed 100% generation failure on the Phase 2 flat block.
- Therefore, the PV total for phase 2 is realistically only made up of 48 households over the monitoring period was from 1 April 2018 to 31 March 2019.
- 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 89,827kWh over the monitoring period.
- The PV on the energy centre roof produced 22,952kWh compared to 25,628kWh in 2017/18.
- The graph in Figure 8 shows the annual PV generation by house type for Phase 1 and 2 households.

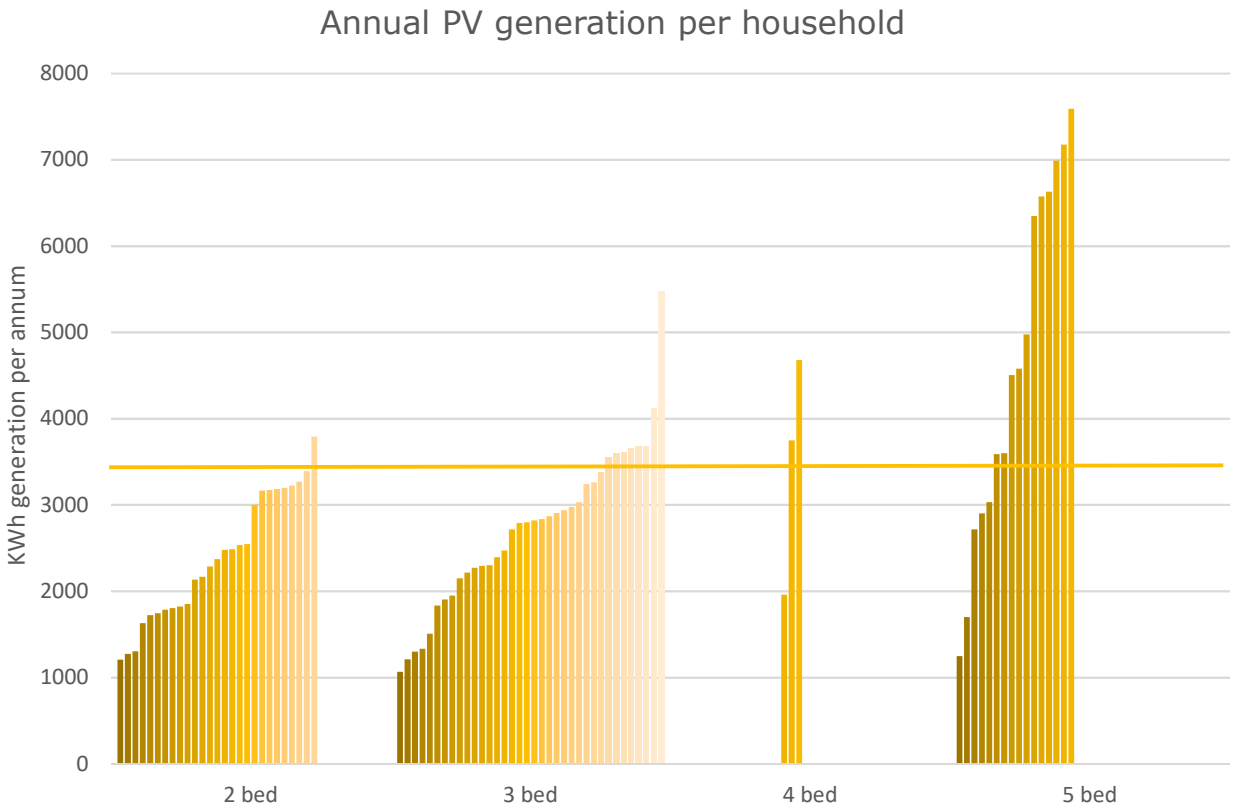

Figure 8 – Average site wide PV generation per household by house type. Orange line = site wide average.

4.5 Waste

Waste data is provided by Cherwell District Council (CDC) and is collected by weighing the waste collection trucks leaving Elmsbrook. The data includes recycling, refuse and garden & food (compost), between 4 April 2018 to 20 March 2019.

The headline figures:

- The largest waste stream over the monitoring period was refuse (general waste), with 296kg per household (based on 157 households). The CDC average (17/18 figures) was 244kg (18% less)
- Recycling totals at Elmsbrook were logged at 130kg per household over the monitoring period. The CDC average was 183kg, that's 17% more recycled waste.
- Compost waste was 111kg per Elmsbrook household, on average. The CDC average was 185kg, that's 67% more compost produced outside the development.
- As was the case last year, Elmsbrook residents currently produce more residual waste than the county average. Elmsbrook has an average recycling rate of 45% compared to 55% for the county.

Summary of results:

- County wide comparison figures are from the year 2017/18, so slightly out of date. Figures provided were total tonnes of waste, without information on the number of households. The CDC (per household) comparison was therefore derived from Elmsbrook totals factored for the correct county wide waste percentages. Actuals could differ.

- The waste stream patterns over the course of the monitoring period are outlined in the graph below (Figure 9).
- Refuse is the largest waste stream throughout the year, with this waste stream increasing slightly throughout the year, perhaps due to more homes becoming occupied.
- Compost reveals a more cyclical pattern, rising in the spring and summer months and falling as winter 18/19 approaches before picking up again in March 2019.
- In terms of trends, both refuse and recycling rates gradually increase which is symptomatic of increasing number of households becoming occupied throughout the year.
- Residual waste remains 55% of total waste produced at Elmsbrook, no change from 17/18 figures. The proportion of dry recycling has increased from 19.8% to 24.1% whilst the proportion of organic waste has decreased from 25.2% to 21% (Figure 10).

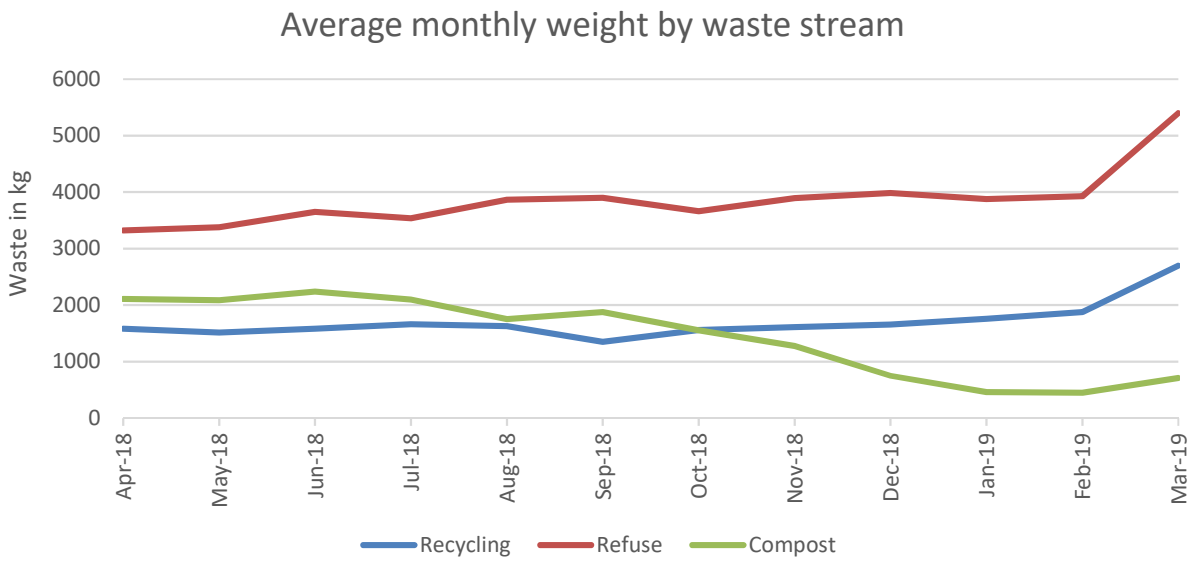

Figure 9 - Average monthly weight of waste streams based on two collections.

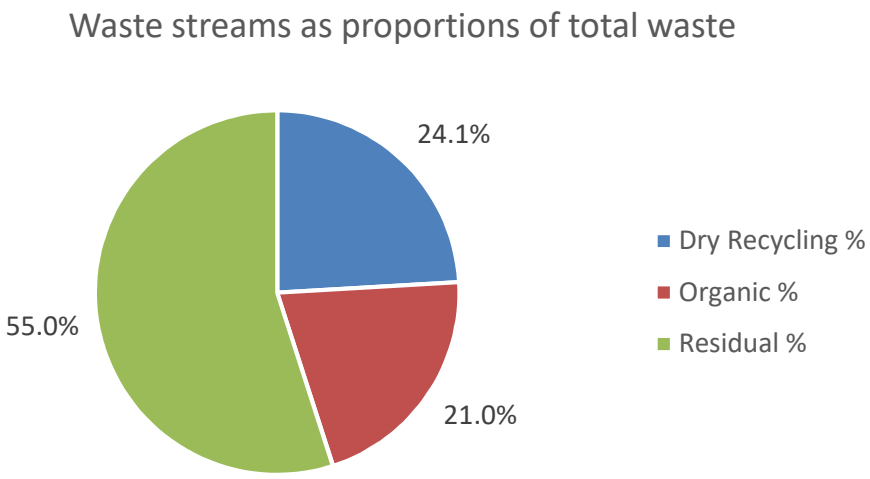

Figure 10 - dry recycling, organic waste (compost) and residual waste as proportions of total waste produced, 2018/19

Year on year comparison:

The figure below shows the average weight of each waste stream per household in 18/19 compared to 17/18.

- We can see that both recycling waste and refuse have increased in 18/19 compared to the previous year. Recycling waste has increased 23% per household, from 106kg to

30kg annually per household. Simultaneously, refuse has also increased slightly, by 6% from 278kg to 296kg annually per household.

- Conversely, compost waste has decreased 19%, from 136kg to 111kg annually per household.

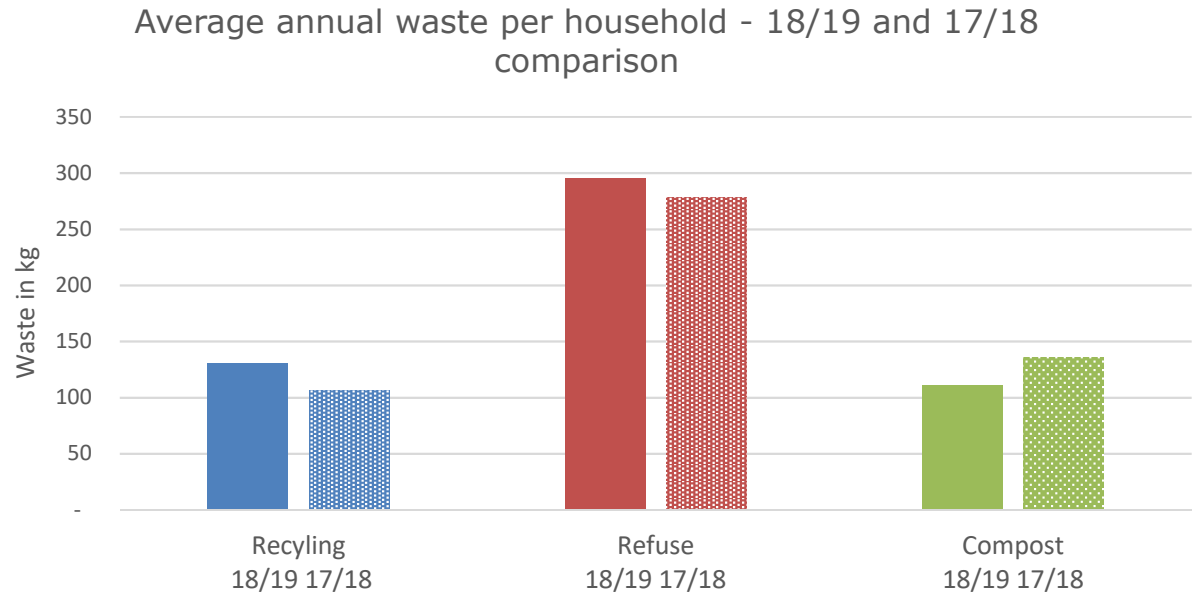

Figure 11 - Average annual waste per household, 2018/19 and 2017/18 year-on-year comparison.

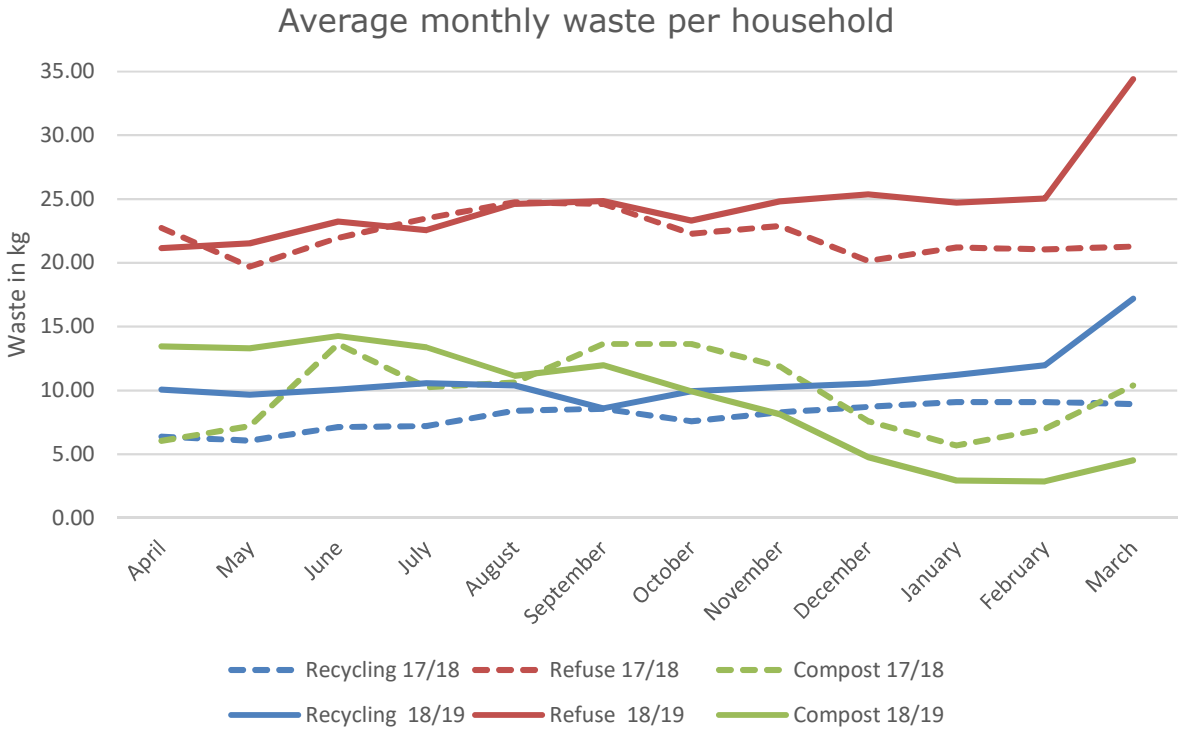

Figure 12 - Average monthly waste per household, site wide Phase 1 and 2, based on two collections. 2018/19 and 2017/18 year-on-year comparison.

4.6 Transport

Elmsbrook has an ambitious modal shift target of 50% non-car journeys by year five of full 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 continue to be the dominant mode of transport at Elmsbrook, with an estimate of 368,300 journeys made over the monitoring period (89% of all journeys), on average 6.4 trips daily per household derived from counters installed in the road and pavement
- There is a slight increase from last year, up from 84% (5.2 journeys per household per day), after a bigger decrease from 88% the year before that. It differs from the somewhat more subjective responses of the resident survey at 74%.
- Non-car journeys sit at 12%, compared to 33% for the rest of Bicester, some way short of the modal shift target (50%).
- These figures however don't distinguish between regular car, hybrid or full electric vehicles. From the resident surveys we know that 32% of the respondents own a hybrid or electric vehicle. Therefore one could reasonably assume that approximately 116,300 of those journeys were fully electric or hybrid. This compares against the UK average of 1.8% plug in vehicles (hybrid and full electric) of a total fleet of 34.9 million in 2019[7].
- Counting these electric or hybrid vehicle journeys as sustainable travel reduces the number of (conventional) car journeys to 61% .

Summary of results:

- Counter data is difficult to pinpoint to certain vehicle types without camera analysis in parallel. E.g. working out the exact split between motorbikes and cars and full electric vehicles is almost impossible without other data source (e.g. survey data).
- It also remains likely that construction traffic from the eco business centre has continued to impact the counter data on car use, so actual car use might be lower. It is still not possible to separate e-car use on site from normal car use from counter data which may also skew results. Further skew could arise from deliveries (post, supermarket) and parents driving their children to school.
- Table. 3 summarises the number of journeys made by different modes of transport over the monitoring period. As figure 13 shows, car journeys fluctuate throughout the year but remain constant around the 30,000 mark. Pedestrian and cycle journeys increase over the spring and summer months and it seems that cycling in particular displaces car journeys to some extent between May and August as the number of car journeys declines slightly.
- Both cycle and pedestrian journeys decrease from September/October during the winter months, picking up again in February/March.
- Bus data was provided by Mode transport planning and covers the period from April 18 – March 19. In this case, the number of tickets sold for bus stops at Charlotte Avenue, Elmsbrook and Gagle Brook School were recorded and multiplied by two based on the assumption that these are likely return trips.
- Tickets sold are estimated at 4,800 per year. Once passes (zero fare) and concessions are included this figure increases to 15,530 per year. An average of 1,294 journeys per month, or 8.2 journeys per household per month.

[7] https://www.fleetnews.co.uk/news/manufacturer-news/2019/04/15/plug-in-electric-car-registrations-up-76-in-2018

- Bus journeys remain constant over the year, with a slight increase in December 2018 as car journeys decline in this month.

Table 3 - Number of journeys by transport mode per month.

Journey type	Average monthly number of journeys		Year-on-year difference (%)
	2017/18	2018/19	
Car	20,871	30,690	47%
Bike	592	801	35%
Pedestrian	1,814	1,712	-6%
Bus (tickets sold)	372	400[8]	7%
Bus (tickets sold + concessions and passes)	Na	1,294[8]	Na
Electric car club (number of bookings)	18	14	-22%
Electric car club (booked hours)	1,342	1,580	18%

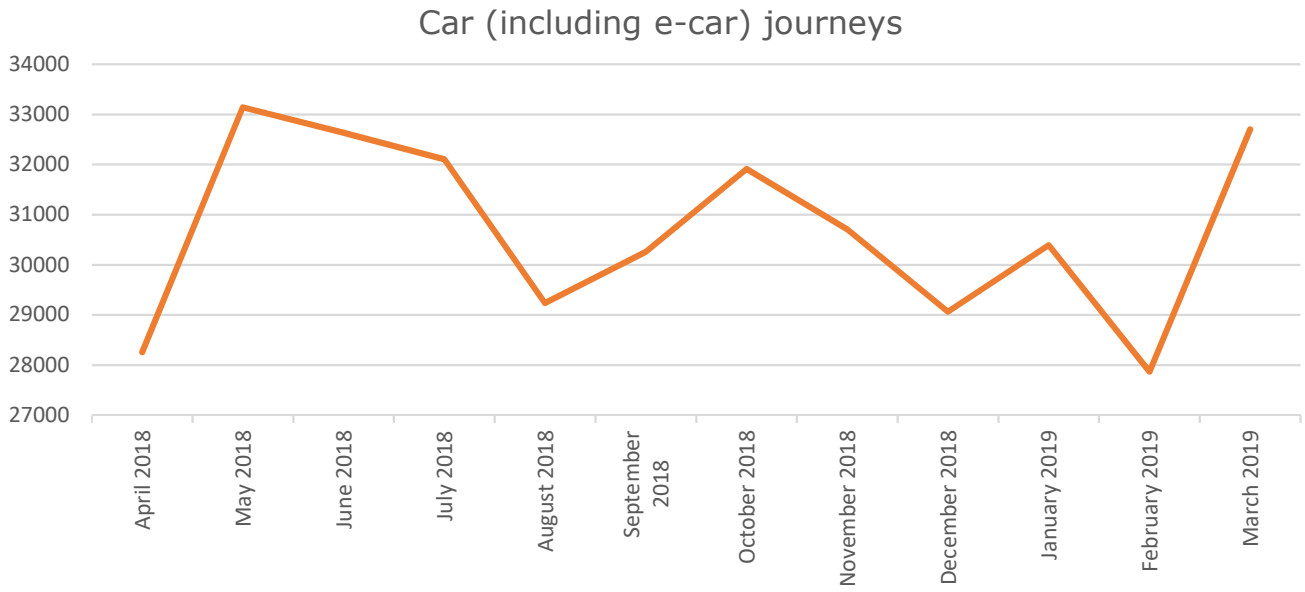

Figure 13 – Car data only over the monitoring period.

[8] Calculated from number of tickets sold at three Elmsbrook bus stations, multiplied by 2 as return ticket assumed. 2017/18 data used data from two Elmsbrook bus stations, one of which only came into operation in December 2017 resulting in 4 months of data during the reporting period. This might explain some of the increase in the number of bus journeys in 18/19.

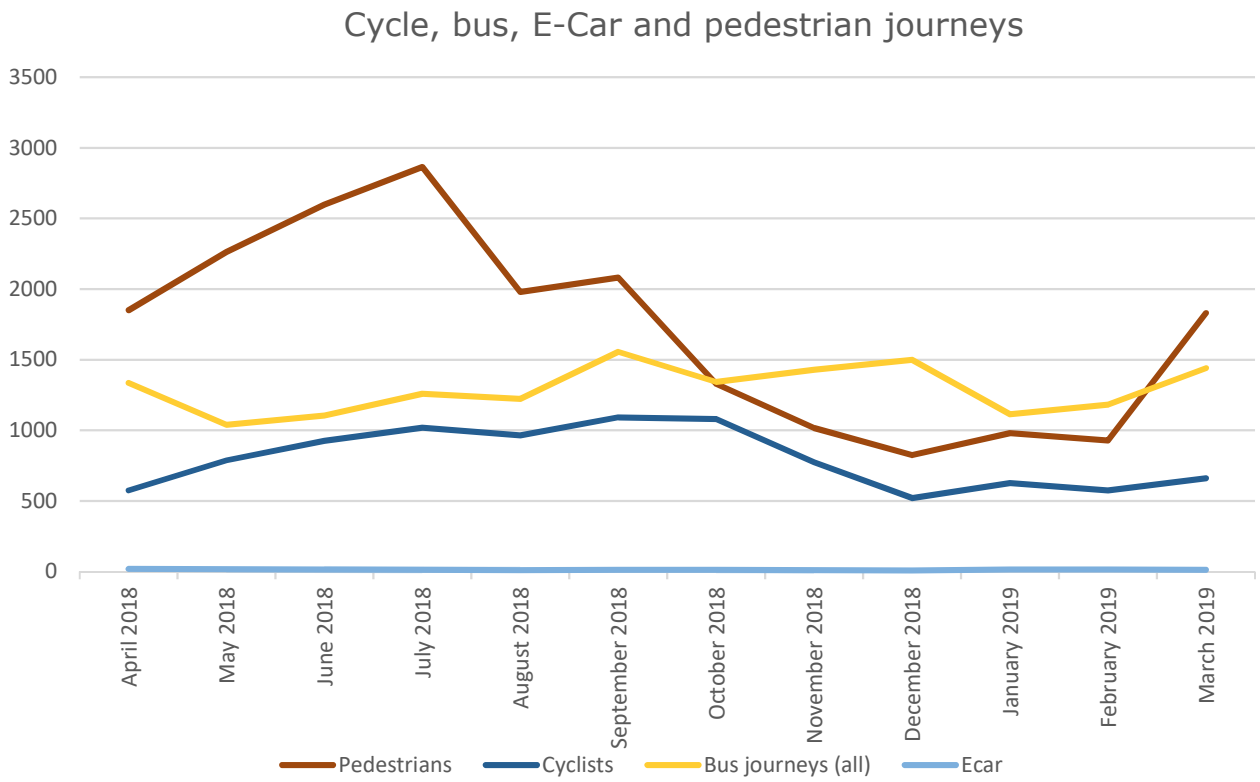

Figure 14 - Transport data over the monitoring period, sorted by mode (excluding car journeys).

Table 4 - Vehicles ownership per household broken down.

Types of vehicles per household at Elmsbrook	Number of vehicles	Percentage of total
Petrol	13	34%
Diesel	8	21%
Hybrid	7	18%
Full Electric	5	13%
Motorcycle	5	13%
Average per household	**2.11**	**100%**

NB: Sample 18 responses, from resident survey.

Car club data:

A2Dominion supplied statistics on e-car club use from April 2018 – March 2019. Details specific to e-car usage is provided in table 5.

- There are currently six e-car champions on site. Four champions for phase 1 of the development and another 2 champions for phase 2.
- The number of e-car club members and bookings has declined since 2017/18, down 33% and 60%, respectively. Also, there were fewer members who made bookings in 2018/19 compared to 2017/18, down 44%, from 16 to 9.

- However, despite the decrese in active membership, the utilisation rates of active members has increased.
    - The number of hours e-cars were booked increased 18% despite the 60% decrease in bookings.
    - Actual hours the e-cars were used increased by 153%, from 450 to 1,257 hours and miles driven increased 46%, from 3,978 to 5,822 miles.
    - Numbers of bookings have reduced (down 60%) but those bookings have been for more hours (up 18%) and for more miles (up 46%) than in previous years.

Table 5 - E-car club headline figures.

	2017/18[9]	2018/19	Year-on-year difference
Members	30	20	-33%
Bookings	189	76	-60%
Members who have made bookings	16	9	-44%
Booked Hours	1,342	1,580	18%
Actual Hours	450	1,257	179%
Booking vs Actual	34%	86%	153%
Miles Driven	3,978	5,822	46%
Miles per Hour booked	2.96	3.68	24%
Miles per Hour Used	4.29	8.83	106%

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 following thereafter.

The headline figures:

- A majority of the heat generated in the energy centre is still being supplied by the gas boilers (866,400kWh compared to 741,200kWh by the CHP).
- Although this split has changed from the previous year, with the CHP doubling output, the energy centre is still heavily reliant on the gas boilers. This increases the carbon intensity.
- The CHP is supposed to meet most of the heat demand (90%) by the end of phase 2 but continues to be significantly off the expected trajectory.
- Approximately 43% of heat energy generated is currently being lost through either storage, distribution or commissioning loads (58% in 2017/18). The designed distribution loss was 28%.
- The CHP delivered a monitored efficiency of 75%, as compared with a design stage assumption of 78% and a monitored efficiency of 72% in 2017/18.
- The boilers delivered a monitored efficiency of 87%, matching the design stage assumption.

[9] Data for 2017/18 has been updated since the release of last year's report which had calculated estimates based on data that did not cover the full reporting period.

Table 6 - Energy centre data.

	2017/18 totals (kWh)	2018/19 totals (kWh)	Year-on-year difference (%)
CHP			
Electricity generated (kWh/year)	304,600	661,900	117%
Heat output (kWh/year)	317,200	741,200	134%
Gas consumption (kWh/year)	944,206	1,866,069	98%
Boiler			
Heat output (kWh/year)	904,100	866,400	-4%
Gas consumption (kWh/year)	1,029,940	995,997	-3%
PV			
Electricity generated	25,628	22,952	-10%

Summary of results:

- Bioregional queried the high heat loss figure with SSE. A significant portion of this is likely commissioning heat load from the ongoing construction of Phase 3.
- Through discussion and agreement with SSE, we have estimated these commissioning heat losses on Phase 3 at around 342,167kWh (22% of total heat use), using the slightly conservative designed distribution losses for Phase 3.
- Removing the Phase 3 commissioning heat losses leaves storage and distribution losses on Phases 1 and 2 of around 354,321kWh, equating to 21% of total heat.
- The energy centre generated 1,607,600kWh of heat (CHP and boiler) to meet the space heating and hot water demand. This demand was estimated 911,112Wh on site (Phase 1, 2 & school) from heat sold figures by SSE.
- Heat output has increased by 32% from the 1,221,300kWh generated in 2017/18.
- Operationally, the CHP ran 91% of days throughout the monitoring period with an average of 6.2 hrs per day. Longer running hours for the CHP would improve the carbon balance.
- The energy centre roof PV array generated 22,952kWh of electricity of which 70% was used within the energy centre for equipment and lighting. This is compared to 25,628kWh in 2017/18, a 10% reduction in electricity generation.
- Figure 155 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 heat output slightly greater than electricity output, particularly in the winter months, October 18 – January 19.
    - There was a sharp increase in both CHP electricity and heat output in the winter months before decreasing again in February and March 2019.
    - Boiler heat output is greater than CHP for 6 months of the year at various times. It compensates for the CHP outage in July and August before dropping to 23,000kWh whilst the CHP kicks back in again to 100,000kWh in October 2018.
    - Boiler heat output runs slightly below CHP in the winter months but continues to steadily increase until March 2019 to 112,000kWh whilst CHP output decreases after January 2019, reaching 67,000kWh in March 2019.

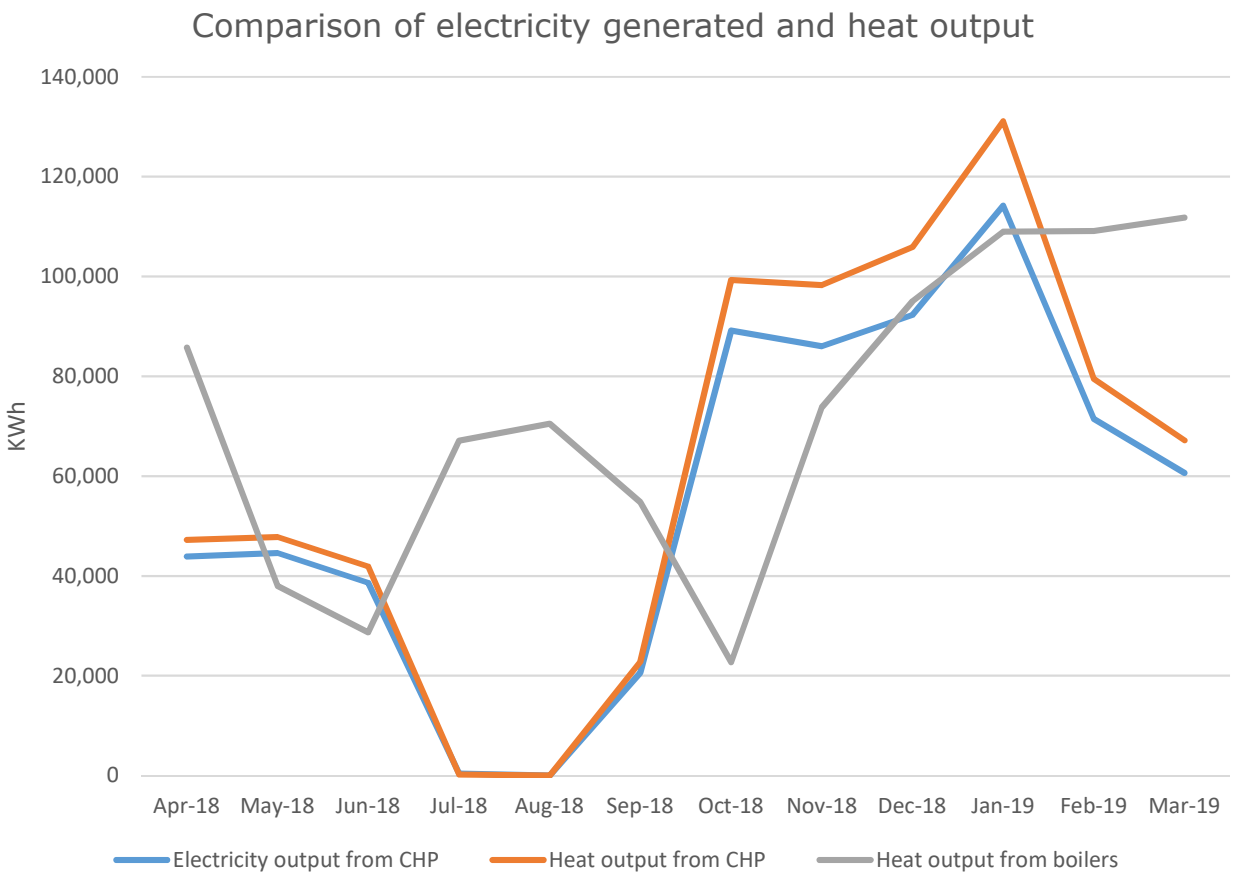

Figure 15 - Electricity generated vs. heat output from CHP and boiler.

- Figure 16 shows gas consumption over the monitoring period.
- Overall, there is a sharp decrease in consumption from March 2018 at 300,000kWh to April 2018 at 221,000kWh when gas consumption steadily decreases further over the summer months.
- The CHP had a prolonged outage over the summer (July and August 2018). This was queried with SSE who responded that they were experiencing high returns back from the network. A result of an underground bypass left open by the contractors working on one of the latest phases.
- CHP gas consumption is greater than boiler consumption across the year except from July and August when the CHP did not run.

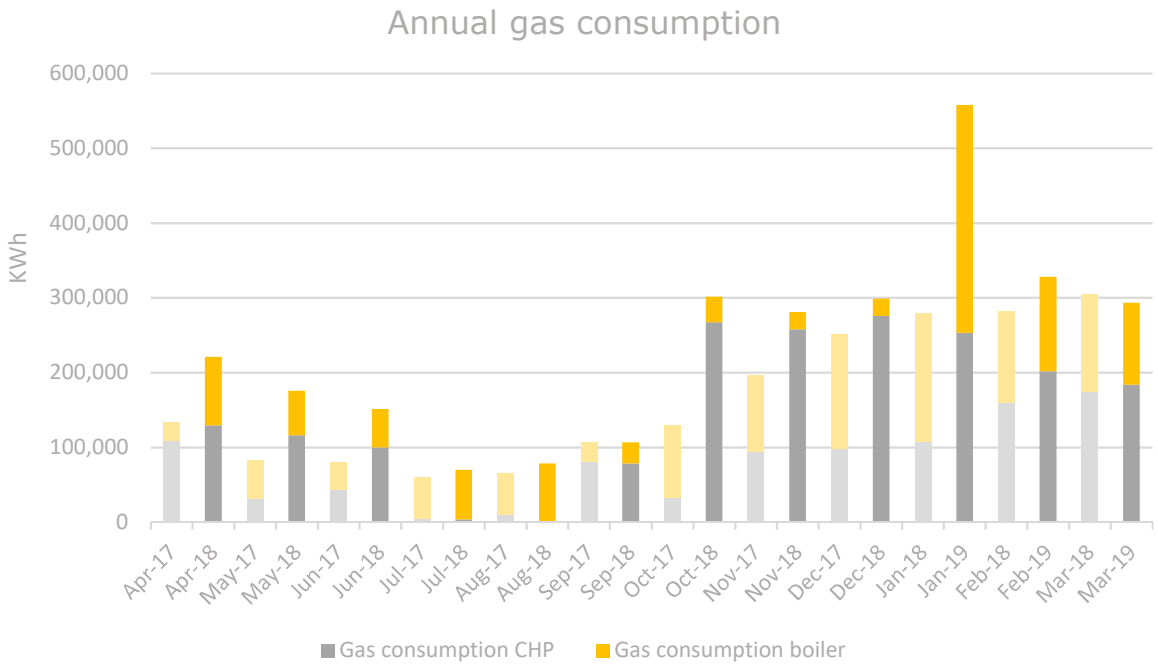

Figure 16 - Gas consumption by CHP and boilers, 2018/19 and 2017/18 comparison. Shaded bars show the consumption from the previous year.

4.8 True zero carbon

Elmsbrook was designed to be a 'true' zero carbon development, meaning both regulated energy (lights, pumps & fans) and unregulated energy (appliances & cooking) are accounted for and result in no net carbon emissions over the course of a year. As noted here previously, reporting against this target ahead of completion is difficult, as every new dwelling coming online alters the zero-carbon equation (e.g. energy centre CHP to boiler split). This balance is also highly dynamic as external temperatures, sun hours, user behaviour and electrical grid carbon intensity all impact the final figures.

The headline figures:

- We estimate that in 18/19 the average home at Elmsbrook emitted 741kgCO_2 (or 0.74 tonnes CO_2) per year based on SAP 2012 carbon factors (currently used in UK Building Regulations Part L). Data problems and operational issues this year mean that the level of confidence in this figure is low and could be over or understating the real performance.
- This figure compares to 5,424kgCO_2 (or 5.42 tonnes CO_{2e}) for an average UK household (all stock). That's around 14% of the UK average footprint for existing homes. It compares against an estimated new build footprint of 3,500kgCO_2[10] (Elmsbrook is 79% lower).
- The development as a whole (energy centre, school and residential) did not manage to achieve zero carbon over this reporting period with 115 tonnes CO_2 net emissions (last year: -25 tonnes net emissions CO_2 (site wide).
- There are many contributing factors to why 'true zero carbon' was not achieved this year, including CHP outages, increased gas use, distribution losses from the district

[10] http://transitionbath.org/impact-housing-standards-energy-costs-co2-emissions/

heating, commissioning heat use for Phase 3, metering problems and inverter failures, leading to lost PV output.
- Elmsbrook as a whole is still emitting significantly less carbon emissions than an equivalent new build development – around 438tonnes of CO_2 less during this year alone (site wide- school and energy centre included). It does not however contribute to offsetting wider UK CO_2 emissions over this reporting period.

Summary of results:

- We estimate that in 18/19 the average home on Elmsbrook emitted 741kgCO_2 per year. This year's figures were extremely hard to estimate accurately with CHP downtime in the energy centre, high commissioning heat loads, meter failures and other data collection issues. This year's analysis contains figures derived from extrapolated averages where missing data had to be reconstructed. The level of confidence in this figure is therefore low and could well be over or understating the real performance.
- Factors that have influenced the current site wide carbon footprint:
    - PV data from 31 dwellings was missing due to monitoring equipment failure/ data loss and had to be extrapolated. Extrapolation is not accurate as it does not consider the house types and the resulting variation in roof area (we estimate this being on the low side of actual yield). The PV offsets our energy use on site to a large extent, which is affecting the current carbon balance negatively.
    - Four flat blocks on Phase 1 (24 flats) have experienced some level of inverter outages. The resultant generation loss is hard to estimate as the data is collected through manual meter readings on site. A good proportion of that data will be missing and will have adversely affected the site wide carbon balance.
    - The single flat block on Phase 2 did not generate any PV over the duration of the year due to inverter outage that wasn't corrected. 100% of this data is missing and the PV output will have been lost
    - Large commissioning heat loads from Phase 3&4. Commissioning heat loads are basically hot water being circulated in the mains ring and sub rings to prevent the pipes clogging up. We tried to account for this based on the designed distribution losses and have removed this number from the carbon balance. We've contacted SSE to get an accurate figure but as the billing process to the contractor has not been finalised, there is no accurate figure available. SSE did agree with our methodology for conservatively estimating the interim load.
    - CHP outage for 2 months in summer 2018, with the gas boilers making up the difference.
    - The distribution losses from this year (and last) are consistently higher than the expected (or designed) losses. Some of this loss is due to the stage of build out but others are unexplained and will contribute to a shortfall in the carbon balance.
    - By the end of phase two, the proportion of heat supplied by CHP as compared with gas boiler split was intended to be 90:10 but this is currently not the case. In reality, the ratio is 65:35. Re-running the site wide carbon emissions calculations with the intended 90% CHP utilisation the development does achieve its true zero carbon status over the monitoring period.
    - Furthermore, last year's zero carbon balance was calculated using manual PV meter readings from the school and the flat blocks. Without previous readings for the exact time period, total usage values were proportionally reduced (to a single year). This could have overstated last year's figures to a degree, based on seasonal effects.
- We updated the average household footprint figure (used as UK carbon emission comparison) in this year's report, looking at two data sources. One is using a UK

government figure[11] of 147 Mt CO_2 for all emissions generated directly by households in 2016. The office for national statistics (ONS)[12] provides a figure of 27.1 million households for that same time period. This results in an average footprint of 5.42 tonnes CO_{2e}. Another source is using data from the committee on climate change (CCC)[13] from the year 2014. This source provides a footprint of 4.02 tonnes CO_{2e} (heating and electricity only). As the latter figure excludes hot water and is 2 years older, we have adopted the figure of 5.42 for comparison in this report.

- The side-wide carbon balance has again been calculated using the current SAP 2012 carbon factors of 0.216 and 0.519kgCO2/ kWh. The UK electricity grid has decarbonised since the energy strategy was written so although the old (SAP 2008) carbon factors would give a more favourable carbon balance, they are outdated and would potentially expose the development to criticism.
- Changing the factors to the proposed future factors (SAP 10) would change the figures to 306 tonnes CO_2 net emissions (site wide).
- The energy and carbon balance remain highly dynamic and will change from year to year. Switching new parts of the development online alters the energy balance and the utilisation of the energy centre. Ongoing construction results in commissioning heat loads. 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.
- It is likely that commercial considerations (by the energy centre operator) are currently driving the boiler to CHP split. Running the CHP outside peak time export tariffs might incur higher operational costs than using the boiler (better thermal efficiency) for the same gas consumption.

Table 8 – Energy balance over the monitoring period 2018/19.

Element	Exported Electricity (KWh)	Imported Electricity (KWh)	Gas imported (KWh)	Comments
Phase 1 - sub metered residential	252,557	174,697	Na	53 properties, extrapolated to 87
Phase 2 - sub metered residential	146,724	90,510	Na	32 properties, extrapolated to 71
School - manual meter reading	74,598	13,046	Na	Not fully occupied
Energy centre - CHP	661,900	141,281	2,252,895	CHP gas use minus commissioning heat load estimate.
Total	**1,135,779**	**419,534**	**2,252,895**	**kWh**

11 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794557/Consumption_emissions_April19.pdf

12 https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2016

13 https://www.theccc.org.uk/wp-content/uploads/2016/07/5CB-Infographic-FINAL-.pdf

Table 9 – 2018/19 carbon balance (Item x Carbon factor = Resultant carbon emissions).

Item		Carbon factor	Resultant carbon emission	Notes:
Electricity exported	-1,135,779kWh	0.519kgCO_2/kWh	-589,469kgCO_2	Favourable to balance
Electricity imported	+419,534kWh	0.519kgCO2/kWh	+217,836kgCO_2	Unfavourable to balance
Gas imported	+2,252,895kWh	0.216kgCO2/kWh	+486,625kgCO_2	Unfavourable to balance
Resultant site wide carbon balance			**+ 114,992kgCO_2**	Net emissions

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 20 responses were received at the time of submission of this report.

The headline figures:

- 14% of households responded to the survey and provided data. Most responses were received in the first week of the survey going live.
- Due to changes in data protection laws (GDPR), A2Dominion felt prohibited from distributing surveys in paper format and from encouraging resident responses with door to door visits. This has likely impacted the total number of responses received.
- 65% of respondents indicated they feel healthy to very healthy (above neutral, scores 6/10-10/10), compared to 58% UK wide who feel somewhat, mostly or completely satisfied with health (above neutral)[14].
- Below a selection of responses also illustrated in graph form (Q4, 14 and 15) the full tables of answers can be found in the appendix.
- A PhD study based on Elmsbrook, is going into much more detail than the findings of the resident survey and working with a larger sample of 90 adult residents (64 households). This data should be available in time for next year's reporting.

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

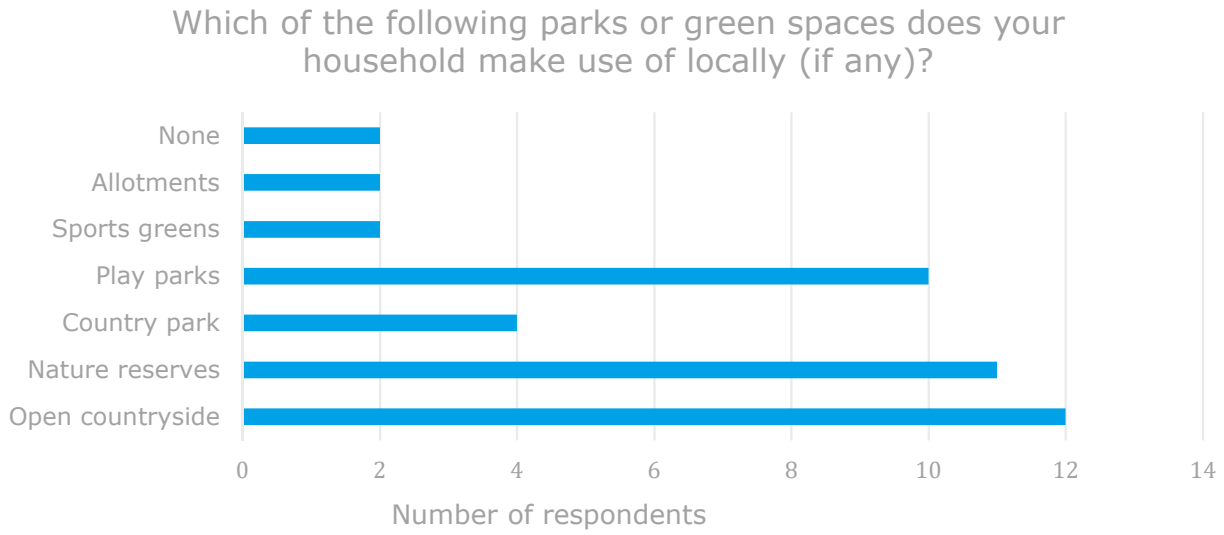

Figure 17 - Answers to the question: 'Which of the following parks or green spaces does your household make use of locally (if any)?'

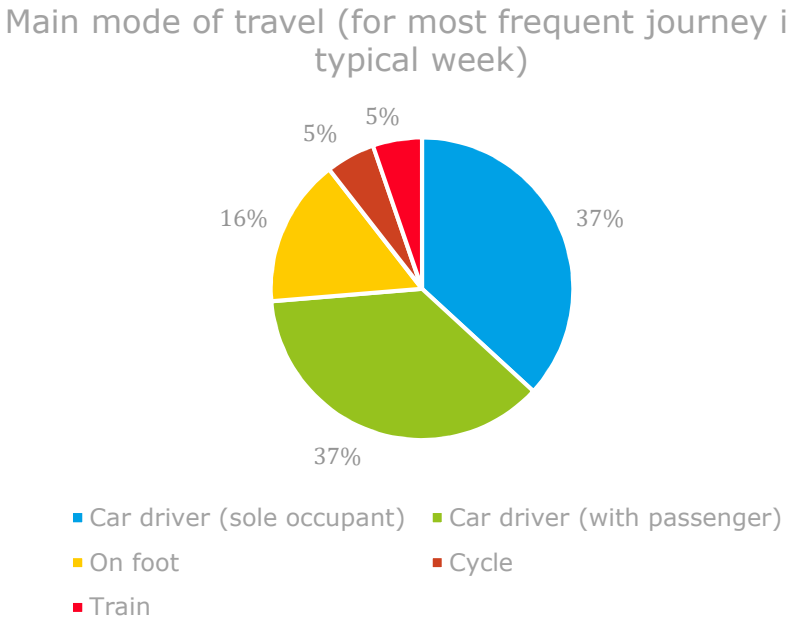

Figure 18 - Answers to the question: 'Please indicate the household's main mode (longest distance/travel time) of travel for the most frequent journey undertaken in a typical week.'

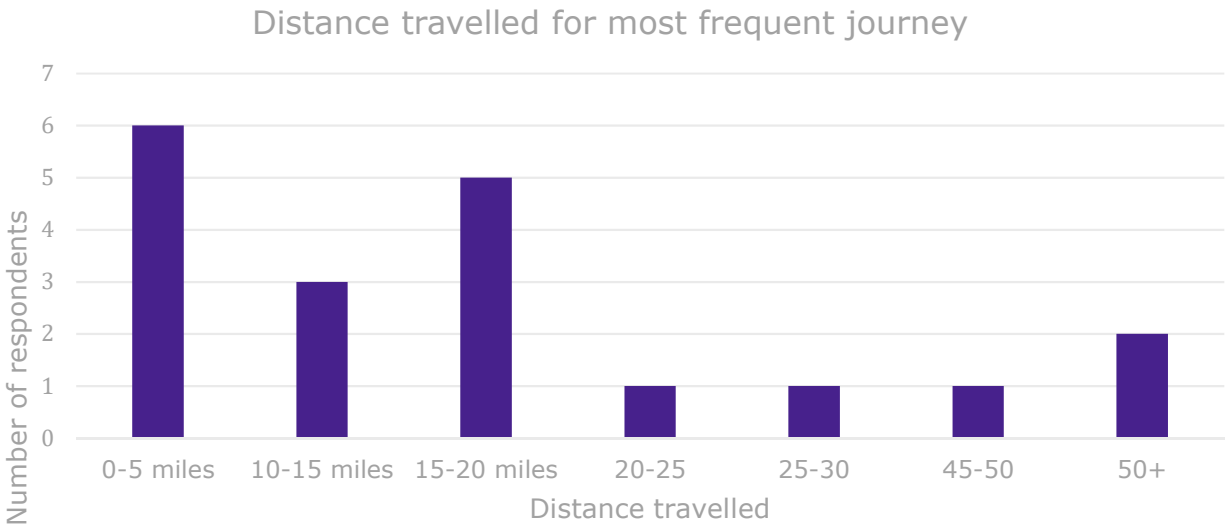

Figure 19 - Answers to the question: 'Please indicate the distance travelled for the most frequent journey undertaken in a typical week.'

5 Conclusions and recommendations

5.1 Overview

This post occupancy report forms the third in a series undertaken at the ground-breaking Elmsbrook development – the UK's first Ecotown.

Whilst the development (school, residential phases and energy centre) does not appear to repeat last year's true zero carbon performance, Elmsbrook is still considerably more environmentally friendly than an equivalent new built settlement. The exact carbon balance year on year is dynamic and depends on a range of factors (e.g. weather, user behaviour and operational reasons). This year's gas use (at the energy centre) was elevated due to larger distribution losses, increased commissioning heat demand (Phase 3 construction), CHP outages requiring the boiler to take over and some degree of data loss in the monitoring equipment. Because the energy centre is not yet running at the planned capacity, the CHP engine efficiency and CHP to boiler split, is likely to improve further as more homes are built reducing the carbon intensity.

The monitoring process was unfortunately fraught with unexpected problems during this reporting period. Some of the older, first generation metering systems on Phase 1 failed and stopped logging data. Rented properties on site were further affected by confusion around additional FITs metering by an external contractor, uncoordinated with the local site team through A2Dominion's head office. This resulted in original shimmy equipment being unplugged and not logging data. Lastly, some PV inverters tripped with resulting generation loss. All of the above problems have impacted around 40 dwellings on Phases 1 and 2.

Bioregional have attempted to reconstruct some of this lost data through extrapolation of averages, which unfortunately impacts the accuracy of results. Carnego (the data collection subcontractor) has responded to these problems by fitting a higher specification of metering system (also more robust) in phases 3 & 4. They've further developed an App which is able to monitor live data and send warnings for out of range data, rolled out to all households. This will allow both residents and A2Dominion to detect equipment issues and respond faster. Through these systems the development is becoming 'smarter' and to an extent more resilient, as feedback and learning is optimised.

Other sustainability indicators such as water and energy use have improved significantly over the last year. Transport and waste still require more continued effort by the developer, the community and other stakeholders. A2Dominion have committed to introducing an education initiative to help improve these results.

In this year's household survey, residents indicated that they feel part of a community (55%) and regularly talk to other people in the neighbourhood. Compared to the rest of the UK where 57% of people do not know the names of their neighbours, 37% of Elmsbrook survey respondents know more than 15 neighbours to say 'hello' to and 58% know 8 or more.

Overall, the resident feedback was positive. The main negative feedback was in relation to the quality of the cycle routes offsite (wider Bicester) as they tend to merge with busy, narrow roads. This will be fed back to the Oxfordshire County Council for their consideration. On the other hand, residents are utilising the bus routes more frequently than in previous years and have commented on the quality of this service.

Although 11 of the 20 residents who took the survey were involved in community governance activities, there was a clear appetite from residents to see a wider variety of community activities at Elmsbrook, such as being outdoors and exercising, social activities and activities for parents and babies. As phases 3 and 4 of the development get underway, the addition of extra residents may bring this greater offering of activities and expand on the One Planet Community that is already felt at Elmsbrook.

Despite technical elements of the development requiring improvement, Elmsbrook seems to be continuing to grow into a positive and happy community where residents generally consider themselves to have higher than average wellbeing and feel as though they belong to a community.

5.2 Key findings

- We estimate that in 18/19 the average home at Elmsbrook emitted 741kgCO_2 (or 0.74 tonnes CO_2) per year.
- That's 14% percent of the average UK household (5,424kgCO_2) and 79% lower than the average new build (3,500kgCO_2[15])
- The development as a whole (energy centre, school and residential) does not appear to achieve zero carbon over this reporting period with a balance of 115 tonnes CO_2 net emissions (i.e. carbon emitting).
- We estimate the carbon savings between Elmsbrook and a new built development of equivalent size at 438[16] tonnes of CO_2 for this year of reporting.
- There are many contributing factors to why 'true zero carbon' was not achieved this year, including CHP outages (covered by more carbon intensive boilers), high distribution losses, high commissioning heat use during construction of Phase 3, metering problems (leading to data loss) and inverter failures leading to lost PV output.
- Assuming a better CHP (~90%) to gas boiler split in the energy centre and using SAP 2012 carbon factors, indicate that the development could have potentially achieved its

[15] http://transitionbath.org/impact-housing-standards-energy-costs-co2-emissions/

[16] Based on dwelling average carbon footprint at Elmsbrook of 728kgCO2 (when school and energy centre are included) and 3,500kgCO2 for an average UK new build. 158 homes.

true zero carbon status under these parameters. Commercial considerations could be driving higher gas boiler usage.

- Dwellings are using 13% less electricity than anticipated at design stage, 41% less than an average Bicester household.

- 15% more heat (hot water and space heating) than design estimate but 3x less than Bicester average.

  Modal shift sits at 88% car journeys, up from 84% last year, a long way of the target of 50%. Bicester average is 67%.

- From survey responses we know that 32% of households on Elmsbrook own a 'plug in' hybrid or electric vehicle (compared to the UK average of 1.8% in 2019[17]). Accounting for these electric or hybrid vehicle journeys (as sustainable travel), would reduce the modal shift to 61% (conventional) car journeys

- As was the case last year, Elmsbrook residents currently produce more residual waste than the county average. Elmsbrook has an average recycling rate of 45% compared to 55% for the county.

- Elmsbrook residents used 84 litres of water per person per day. That's 5% above the design target of 80 litres per person per day. 77% of households analysed are meeting this target.

- The average Elmsbrook household saves £489 on their energy (heat and electricity). The Bicester wide estimate is £1,436 per household, once maintenance and eventual replacement of the boiler are factored in (£947 per year on Elmsbrook includes this in the standing charge).

5.2 Recommendations

Bioregional recommend the following actions to improve the efficiency of the monitoring process and quality of data:

- Household occupancy numbers are still only estimations and will affect the accuracy of water use data. We therefore recommend that next year's resident survey allows for a single question that checks both the number of adults and children and links that to the house type and number of bedrooms.
- The flats remain unmetered requiring on site manual meter readings. This affects the accuracy of electricity and PV calculations. Further equipment problems can run undetected if not hooked up to an automatic system. We recommend the installation of a PV sub metering system, similar to the other households on site.
- Commissioning heat loads currently make up a large proportion of the unaccounted system losses. These need to be factored into the zero-carbon equation for accuracy. The current way of estimation is very basic and reliant on design distribution losses. We recommend that these commissioning heat loads are therefore reported on by the energy centre provider in next year's data submission.
- Active monitoring of data is immensely useful to spot out of range values and address potential equipment failures ahead of large-scale data loss. With work by Carnego already underway, Bioregional recommend that this process is tested ASAP, in order to put in place a protocol that is practical. A2Dominion need to ensure that the relevant maintenance people have access to this data and resources to respond.

[17] https://www.fleetnews.co.uk/news/manufacturer-news/2019/04/15/plug-in-electric-car-registrations-up-76-in-2018

- Similar to above, Bioregional recommend that the shimmy App link out of range warnings to private households with message to inform them of potential equipment failure or malfunction.
- Bioregional further recommend improving the site wide survey response rates by working with community champions and clubs. This could go hand in hand with an information event and door knocking by the local team. A2Dominion should review the survey methods in order to achieve a greater response rate.

6 Appendix

Table 7 - Elmsbrook residents survey 18/19, summary of survey results

Ref.	Question	Responses	Results
Health and 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)	19	The average response was 6.16. 12 of 19 respondents rated their wellbeing either a 7 or 8. However, 4 respondents rated their wellbeing between 1 and 3 which negatively skews the overall average. There is a slight decrease from last year's 6.7 and the previous year's 7.6. The ONS bundle wellbeing into 4 measures – 'overall happiness' being one – with the UK average at 7.5/10 in March 2017[18].
2	On a scale of 1-10, how healthy do you feel? (1=very unhealthy - 10=very healthy)	20	The average response was 6.55. Residents mostly (65% of respondents) consider themselves to be healthy or very healthy (score 6-10). Compared to the ONS figure which states that 57.8% of people in the UK are 'somewhat, mostly or completely satisfied with health', this is a positive comparison. However, 3 respondents considered themselves very unhealthy and unhealthy (1-4) and 3 respondents gave a neutral response which leaves room for further improvements to be made.
3	During the last 7 days, how many days have you taken part in vigorous, moderate or light exercise over a period of 10 minutes or longer? For example: lifting, digging, cycling or walking, playing sport for longer than 10 minutes consecutively?	20	Responses from residents varies, with the average response totalling 4.25 which is slightly below the previous year's average of 4.5. The highest responses were 7 days and 3 days (6 and 5 responses respectively) whilst 4 residents took 2 – 0 days of exercise.
4	Which of the following parks or green spaces does your household make use of locally (if any)?	20	The most popular green spaces utilised by residents are open countryside (60%), nature reserves (55%) and play parks (50%). Other Country parks, sports greens and allotments are also used, although to a lesser extent (20%, 10%, 10%, respectively). Two respondents recorded not using any of the green spaces listed.
5	If you selected any of the greenspaces above, how often does your household use these?'	18	Respondents responded as follows: daily - 2 weekly - 9 fortnightly - 3 monthly - 2

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

			ad hoc - 5
6	If you are in employment (including self-employed), how often do you have the ability to work from home?	19	Respondents responded as follows: Not currently in employment - 3 Every day - 0 More than three times per week - 1 Less than three times per week - 7 Never - 8
7	How strongly do you feel you belong to your immediate neighbourhood?	20	Responses were almost evenly split – 55% felt very or fairly strongly that they belonged to their immediate neighbourhood whilst 45% felt not very or not at all strongly.
8	Do you regularly talk with people in the neighbourhood?	20	Responses were largely positive, with the following responses: Strongly agree – 6 Agree – 8 Neither agree nor disagree – 3 Disagree – 1 Strongly disagree - 2
9	How many neighbours at Elmsbrook do you know to say "hello" to?	19	The most popular response continues to be 'more than 15' (37% of respondents) with almost 58% of respondents knowing 8 or more neighbours to say 'hello' to. Elmsbrook is seeming to continue to create a sense of community compared to other areas of the UK where ¼ of people do not say 'hi' to neighbours and 57% of the UK do not know the names of their neighbours[19]. Only 3 residents responded 0 – 3.
10	Does your household compost your green and/or food waste?	20	Yes- 13 (65%) No – 7 (35%)
11	Please indicate any activities any members of your household may like to attend/get involved with	20	For a second year, the most popular response was walking. Followed by healthy cooking and eating, cycling, gardening/grow your own, nature trails, reducing energy, up-cycling and reusing.
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?	20	11 residents responded with 'yes' and 9 with 'no'. Community governance activities range from Bicester community groups, Elmsbrook community games group, Beavers, and school governor.
13	Are there any activities not listed above that you would like to see at Elmsbrook?	9	Responses were varied; ranging from outdoor exercising, social activities and activities for parents and babies.
Travel and 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	19	Car journeys were by far the most dominant mode of transport (70%), split between sole occupant and car driver with passenger. This is slightly above the UK

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

			average of 64% of trips made by car[20]. Interestingly, only one resident indicated train travel and one cycling.
15	Please indicate the distance travelled for the most frequent journey undertaken in a typical week	19	Short car journeys are the most popular, with 6 residents making trips between 0-5 miles. Medium distance journeys are also popular with 3 residents indicating their most frequent journey was 10-15 miles and 15-20 miles for 5 residents. In 2017/18, the most popular journey by car was 50+ miles with 7 responses, but this year, that number dropped to 2.
16	Do you utilise any other travel modes as part of the most frequent journey travelled in a typical week?	17	Car remained the most popular answer with 6 respondents, with bus also popular with 5. Only 2 people utilised cycling and no-one indicated walking. This indicates that there is still a long way to go to create a modal shift towards more sustainable transport modes.
17	Please confirm how many of each type of vehicle are kept at the residence	18	Residents responded as follows: Petrol car – 13 Diesel car – 8 Hybrid car – 7 Full electric car – 5 Motorcycle - 5
18	Please state typical annual mileage of the vehicles identified in in question 34	18	The approximate average mileage for the first vehicle was 6,250 miles, 7,056 miles for the second vehicle and 2,800 for the third.
19	How often do you cycle to/from your household in a typical week?	19	9 residents reported not cycling to/from the household at all in a typical week. Most other answers ranged from 1-2 times. The average cycle trip to/from the house was 1.3 per week per household.
20	What is the main purpose of cycle trips made from your household?	14	Cycle trips are made mostly for commuting to work or recreationally (5 each). With visiting family/friends and health other reasons (2 each).
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	19	Many respondents utilised the bus route with only a few citing Brompton bike hire and electric vehicle trials. Cycling was also popular, but residents commented on the quality of the cycle route due to it merging with busy and narrow roads.

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