

EPA Climate Showcase Energy Study results

12.5.2014

Please refer to Excel spreadsheets for more detailed information

Before Move-in

Four households (1,2,14 & 15) provided complete energy use data for a 12 month period prior to moving into the TREE neighborhood. Their average household GHG emission for the year was 19,256 lb CO₂e, and monthly was 1605 lb CO₂e. Monthly they averaged .91 lb CO₂e per square foot (sf) of building area, and 582 lb CO₂e per person.

The average emissions of a typical Tompkins County (TC) household during the same time period were 15,162 lb CO₂e per year, 1263 lb CO₂e per month, .7 lb CO₂e per sf, and 468 lb CO₂e per person.

These four households generated 27% more GHG emissions on a per household basis and 24% more on a per person basis than the typical TC household. This demonstrates that households moving into TREE were not "exceptional" households, and when partial year data from 4 other households were factored in, the TREE group generated 49% more GHG emissions on a per household basis and 41% more on a per person basis than the typical TC household.

Before and After move-in comparison

Two households had one full year's energy use data before and after they moved into TREE. One was from Texas with before data from 2011-2012, and the other from Pennsylvania with before data from winter 2011-2012. Both had after data from winter of 2013-2014. Both used natural gas for heating and cooking the year before move-in.

Household 1. Texas

Prior to move-in, 4.5 people in a 3000sf house emitted 24,742 lb CO₂e over the course of the year. This equates to 2062 lb CO₂e per month, .69 lb CO₂e per sf per month and 458 lb CO₂e per person per month.

After move-in the household was reduced to 2.5 people and downsized to 1440sf. Their home had no renewable energy systems for 5 months, from October 2013 to February 2014. Solar thermal (ST) water heating was added in February 2014 and photovoltaic panels (PV) were added in March 2014. They reduced their GHG emissions by 95% overall to 1170 lb CO₂e over the course of the year. Emissions were reduced 91% per person to only 39 lb CO₂e per month. We can expect even lower emission levels during the next year with renewable energy systems fully installed.

Household 2. Pennsylvania

Prior to move-in, 2 people in a 1990sf house emitted 15,845 lb CO₂e over the course of the year. This equates to 1320 lb CO₂e per month, .66 lb CO₂e per sf per month and 660 lb CO₂e per person per month.

After move-in the household remained at 2 people but downsized to 1440sf. Unlike household 1, they had solar thermal water heating when they moved in, and were without photovoltaic panels for only 2 months. If household energy use had remained the same we could expect them to emit 27.6% less GHG because of the smaller house size, however they reduced their GHG emissions by 93% overall to 1033 lb CO₂e over the course of the year. Emissions were reduced 93% per person to only 43 lb CO₂e per month.

These 2 households emit 92% - 93% less GHG than typical Tompkins County households.

Evaluation of GHG reductions of TREE homes

It is difficult to appraise the performance of the TREE houses because the phased installation of renewable energy systems has created different patterns of energy use, over different seasons among the households. For example, some households had ST and PV upon move-in, however not all of them moved in at the same time, with many less than a years' data. Others provided a full years' data, but had renewable energy systems installed over time, like household 1 above.

Therefore houses have been grouped for obtaining average performance results in ways that can be considered "reasonably similar". In addition, because of the varying length of reporting periods, monthly results were considered to be the most useful metric of performance.

Evaluation A: All TREE houses (#1-11)

As a group, the 11 TREE houses had a monthly average emission of 293.2 lb CO₂e, a reduction of 1070.7 lb CO₂e or 78.5% below the emissions of a typical TC household. The group also averaged a 70.2% CO₂e reduction on a per person basis.

The lowest performing house of the group reduced emission 47% below TC average. This house (#9) had no renewable energy systems installed. The highest performing house (#8) was carbon negative during its 7 month reporting period (March 2014 – September 2014) at 113% below TC average, but with no winter months in the reporting period it should be considered atypical. For an evaluation of winter performance, see below.

Evaluation B: Houses with PV & ST (#1-8)

8 houses had renewable energy systems during all or part of their evaluation periods. As a group, they had a monthly average emission of 152.4 lb CO₂e, a reduction of 1211.4 lb CO₂e or 88.8% below the emissions of a typical TC household. The group also averaged an 87.4% CO₂e reduction on a per person basis.

The lowest performing house of the group reduced emission 64% below TC average. This house (#3) had no renewable energy systems installed for 6 months of its reporting period, from December 2013 to May 2014. ST was added in May and PV in July. The highest performing house was again #8.

Evaluation C: Houses with PV & ST during their entire reporting period (#4-8)

5 of the 8 homes with renewable energy systems had them for the duration of their evaluation periods, however 3 of them (#6,7 & 8) were evaluated for less than 10 months and one (#8) was not occupied during the winter. As a group, they had a monthly average emission of 108.7 lb CO₂e, a reduction of 1255.1 lb CO₂e or 92% below the emissions of a typical TC household. The group also averaged a 92.8% CO₂e reduction on a per person basis.

The lowest performing house of the group (#4) reduced emissions to 75% below TC average. The highest performing house was again #8.

Evaluation D: Houses with PV & ST during winter (#2,4,5 & 6)

This evaluation was used to determine the standard of performance for the houses with renewable energy systems in the Final Report.

4 households had renewable energy systems during the exceptionally cold 2013-2014 winter, the earliest occupied in September 2013 and the latest in December 2013, with their data running through spring and summer 2014. (Note that spreadsheet data is derived from utility bills, as such the months listed reflect the previous month's energy use.) They can present a reasonable picture of the performance which can be expected over the year, since they include the lowest and highest periods of solar potential. As a group, they had a monthly average emission of 132.3 lb CO₂e, a reduction of 1264.4 lb CO₂e or 92.7% below the emissions of a typical TC household. The group also averaged a 97% CO₂e reduction on a per person basis.

The lowest performing house of the group (#4) reduced emissions to 75% below TC average. The highest performing house (#6) was carbon negative during its 9 month reporting period (January 2014 – September 2014) at 104% below TC average. The runner-up achieved 103% below TC average (December 2013 – August 2014).

Evaluation E: Houses without ST or PV during all or part of their reporting period (#1,3,9 & 10)

5 houses either have no renewable energy systems or had no renewables for a significant time during their reporting period. These houses give a good indication of how well the building envelope and passive solar orientation works independent of renewable energy inputs.

As a group, they had a monthly average emission of 837.5 lb CO₂e, a reduction of 526.4 lb CO₂e or 38.6% below the emissions of a typical TC household. The group averaged only a 3.8% CO₂e reduction on a per person basis, likely because of the impact water heating has on the per person figure, and the higher-than-typical proportion of overall energy use which can be attributed to water heating in houses with a highly efficient thermal envelopes.

The lowest performing house of the group (#9) reduced its emission to 24% below TC average. The highest performing house (#11) reduced emissions to 47% below TC average, but did not have any winter months in its reporting period. However the runner-up (#3), at 43% below TC average, reached this level of performance between December 2013 and June 2014.

Evaluation F: Houses at least 10 months of data (#1,2,3,4,5, & 9)

This evaluation was used to determine the standard of performance for “all TREE houses” in the Final Report.

6 houses had 10 months or more of data, which we felt was necessary to derive a reasonable average of performance, since building energy use is a yearly cycle. The house mix includes mostly homes with PV, which are the majority in TREE, but also some homes that had no PV during some part of their reporting periods (#1,2, & 3), and one without any renewable energy systems (#9). This was the best cross-section of the entire neighborhood that could be obtained from the available data.

As a group, they had a monthly average emission of 314.5 lb CO₂e, a reduction of 1049.3 lb CO₂e or 79.4% below the emissions of a typical TC household. The group averaged 79.7% CO₂e reduction on a per person basis.

The lowest performing house of the group (#9) reduced its emission to 47% below TC average. The highest performing house (#1) reduced emissions to 93% below TC average, despite having no PV for 5 months during its 12 month reporting period.

Getting close to net-zero

2 houses achieved net-zero operation (produced more energy than they took from the grid) during their reporting periods. House #6, a 1440sf 2.1 person household, sent 385kwh back to the grid between January and September 2014, reducing average monthly emissions to 104% below TC average. Because winter months were included in this period, we can expect near net-zero operation over the full year. House #8 reduced its emissions to 113% below TC monthly average, but the reporting period did not include winter months. Though not net-zero, 3 other houses (#1,2 & 5) reduced their emissions to 93%, 93% and 89% respectively, below TC monthly average, and had 10-12 months of data. Because so much depends on household size and personal lifestyles, it is hard to say whether these households will achieve net-zero operation in the future, but they are close.