**Reconciliation**

**An exercise carried out by Ken Jones, TAG member - July 23, 2024**

**Part One – Carbon intensity values**

The ANR-developed greenhouse gas emission calculations use carbon intensity values based on the on-site combustion of fuels. There is an exception for electricity that determines the carbon emissions for electricity used in Vermont but produced outside of Vermont. These values have changed a small amount from the 1990 starting point of the inventory. This means that any re-consideration of the 1990 baseline on which the GWSA 2030 target is based requires a retrospective review of those historic emission factors. This paper does not include those considerations as they tend to be small.

In general, the Life Cycle Analysis adds upstream emissions to on-site combustion. There are still unresolved decisions regarding carbon sequestration that results in fuel production outside of the state.

The following table simplifies some of the assumptions, including the fact that propane emissions can vary depending on their application (residential v. industrial) and upstream emissions are changing depending on whether propane feed stocks are petroleum based on from natural gas extraction. For ease of presentation, these calculations use a blended figure for propane.

The figures in this table are only for demonstration and do not suggest specific numbers that will have to be resolved through a more complete deliberation when reviewing pacing and credit assignments

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Figures are in metric tonne per MMBTU | | | |
| Fuel | On site emissions (Inventory carbon intensity) | Upstream emissions | Life cycle carbon intensity | Percentage change between inventory and life cycle |
| Fuel oil | .0742 | .0142 | .0884 | 19.13% |
| Kerosene | .0734 | .0142 | .0876 | 19.33% |
| Propane | .0631 | .013 | .0767 | 20.59% |
| Natural gas | .0531 | .013 | .0661 | 24.5% |
| Other fossil | .075 | .014 | .089 | 18.7% |
| Wood | .0051 | .0145 | .02 | 292% |
| Electricity | .01 |  | .01 |  |
| R-100 | .0742 |  | .037[[1]](#footnote-1) |  |
| RNG | .0531 |  | 0[[2]](#footnote-2) |  |

A general conclusion from this table is that each of the fossil fuels will have greater emissions when considering the upstream releases. The proportional change is greater with natural gas than with the petroleum based fuels.

Wood, electricity and the renewable liquid and gaseous fuels are significantly different and will get their own focus in this paper.

**Step Two – Establishing the credit requirement**

The basis of the Clean Heat Standard is to facilitate the progress towards meeting the requirements of the Global Warming Solutions Act. The Clean Heat Standard should be considered against the emissions from the Residential, Commercial and Industrial sectors that are not captured in the other sectors. The ANR Greenhouse Gas Inventory reports a 1990 emission from this sector of 2.54 million metric tonnes and that establishes a target for 2030 of 1.52 million metric tonnes. An attempt to use the same methodology comes up with 2022 emissions of 2.92 MMteq suggesting a required reduction of about 1 million metric tonnes. Using the Life Cycle Analysis factors, changes the 1990 figure to 3.05 MMteq and a requirement to reduce 2022 emissions by a bit more than 1.2 MMteq.

As a simplification, the rest of the calculations here are based on a life cycle emission reduction of 1MMteq. As with other figures, the actual numbers will be the result of the final decisions by the PUC in credit establishment and pacing.

Step Three – Actual reconciliations

Scenario One – Focusing on even distribution of thermal reductions

In this scenario, all of the clean heat measures are installations that result in the reduction of fossil fuel combustion with no switching to electricity or lower carbon fuels. The reductions are assumed to be consistent across all fuels meaning that the same proportion of measures are applied to homes heating with each of the fossil fuels (but not considering electricity or wood). This assumption complies with an approach that credit valuation for installed measures use the blended fuel mix of the LCI sector and not differentiate between installations in buildings with different heating fuels.

Examples of the measures include weatherization, smart thermostats and low flow showerheads. A credit is defined as the annual reduction of one metric tonne of CO2 equivalents.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 2022 use (MMBTU)[[3]](#footnote-3) | Inventory emissions  (Mteq) | LCA emissions | Reduced use after measures | Inventory emissions | LCA emissions |
| Fuel oil | 16,200 | 1,202.2 | 1432.2 | 11,800 | 876.3 | 1044.0 |
| Kerosene | 20 | 1.5 | 1.8 | 14.6 | 1.1 | 1.3 |
| Propane | 9,600 | 606.0 | 730.8 | 7000 | 441.7 | 532.7 |
| Natural gas | 14,100 | 748.2 | 931.5 | 10,280 | 545.4 | 679.0 |
| Other fossil | 4,900 | 367.5 | 436.1 | 3,570 | 267.9 | 317.9 |
| Total |  | 2925 | 3532 |  | 2132 | 2575 |
|  |  |  |  |  |  |  |

In this scenario, the reduction in emissions is a 27.1% reduction from 2022 emissions regardless of the emissions factor (inventory or LCA) used.

Scenario two – preferential reduction of fuel oil use with less reduction of natural gas recognizing that MMBTU reductions of fossil fuel yield greater GHG emission reductions on a per MMBTU basis.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2022 use (MMBTU) | Inventory emissions  (Mteq) | LCA emissions | Reduced use after measures | Inventory emissions | LCA emissions |  |
| Fuel oil | 16,200 | 1,202.2 | 1432.2 | 10,450 | 775.5 | 923.9 |  |
| Kerosene | 20 | 1.5 | 1.8 | 14.6 | 1.1 | 1.3 |  |
| Propane | 9,600 | 606.0 | 730.8 | 7000 | 441.7 | 532.7 |  |
| Natural gas | 14,100 | 748.2 | 931.5 | 12,200 | 647.4 | 806.0 |  |
| Other fossil | 4,900 | 367.5 | 436.1 | 3,570 | 267.9 | 317.9 |  |
| Total |  | 2925 | 3532 |  | 2134 | 2581 |  |
|  |  |  |  |  |  |  |  |

In this scenario, while the LCA calculated reductions are 26.9% from 2022 values and the Inventory based reductions are 27.1% - a bit more, but not a drastic difference that would require large modifications of future target setting.

Scenario Three – the use of electrification (12,150 MMBTU) that results in some emission increases from the electric sector (possibly captured in future iterations of the inventory) countering a portion of the emission reductions from fossil fuel combustion sources.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 2022 use (MMBTU) | Inventory emissions  (Mteq) | LCA emissions | Reduced use after measures | Inventory emissions | LCA emissions |
| Fuel oil | 16,200 | 1,202.2 | 1432.2 | 11,800 | 876.3 | 1044.0 |
| Kerosene | 20 | 1.5 | 1.8 | 14.6 | 1.1 | 1.3 |
| Propane | 9,600 | 606.0 | 730.8 | 7000 | 441.7 | 532.7 |
| Natural gas | 14,100 | 748.2 | 931.5 | 10,280 | 545.4 | 679.0 |
| Other fossil | 4,900 | 367.5 | 436.1 | 3,570 | 267.9 | 317.9 |
| Electric | 0[[4]](#footnote-4) |  |  | 4,860[[5]](#footnote-5) | 48.6 | 48.6 |
| Total |  | 2925 | 3532 |  | 2180 | 2623 |

In this case the reduction considering the inventory is 27.2% and using life cycle is 27.5%. Again, not a large difference that does not require drastic changes in credit assignments.

Scenario Four – the sale of reduced carbon fuel oil

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 2022 use (MMBTU) | Inventory emissions  (Mteq) | LCA emissions | Reduced use after measures | Inventory emissions | LCA emissions |
| Fuel oil | 16,200 | 1,202.2 | 1432.2 | 10,000 | 742.1 | 864.1 |
| Kerosene | 20 | 1.5 | 1.8 | 14.6 | 1.1 | 1.3 |
| Propane | 9,600 | 606.0 | 730.8 | 7000 | 441.7 | 532.7 |
| Natural gas | 14,100 | 748.2 | 931.5 | 10,280 | 545.4 | 679.0 |
| Other fossil | 4,900 | 367.5 | 436.1 | 3,570 | 267.9 | 317.9 |
| R-100 |  |  |  | 3,600[[6]](#footnote-6) | 267.2 | 133.2 |
| Total |  | 2925 | 3532 |  | 2265 | 2548 |

This case shows a more significant difference in the two calculations. The inventory calculation which does not recognize a reduced emissions if the fuel is produced outside of the RCI sector (in or out of state) shows a 22.6% reduction (from the installed measures) while the LCA calculation shows a 27.9% reduction that includes reductions from fuel production.

Scenario Five – the sale of renewable natural gas

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 2022 use (MMBTU) | Inventory emissions  (Mteq) | LCA emissions | Reduced use after measures | Inventory emissions | LCA emissions |
| Fuel oil | 16,200 | 1,202.2 | 1432.2 | 11,800 | 876.3 | 1044.0 |
| Kerosene | 20 | 1.5 | 1.8 | 14.6 | 1.1 | 1.3 |
| Propane | 9,600 | 606.0 | 730.8 | 7000 | 441.7 | 532.7 |
| Natural gas | 14,100 | 748.2 | 931.5 | 9,280 | 492.3 | 613.0 |
| Other fossil | 4,900 | 367.5 | 436.1 | 3,570 | 267.9 | 317.9 |
| RNG |  |  |  | 2,000[[7]](#footnote-7) | 106.1 | 0 |
| Total |  | 2925 | 3532 |  | 2185 | 2509 |

As with the R-100 case, the inventory calculation shows a smaller reduction (25.3% than the LCA calculation (29.0%). This may require the PUC to re-state the reduction requirement in order to meet the GWSA goals. Another possibility for both of these last two scenarios is to request a modification of the GHG inventory calculation.

Scenario Six – Wood

I did not complete this scenario. It will require going back to 1990 and assigning a Life Cycle based emission amount and the history of wood burning is not well documented. Going back to 1990 resets the emission reduction requirement which may not be contemplated in terms of GWSA.

1. Recognizes crop capture of carbon dioxide [↑](#footnote-ref-1)
2. Assumes upstream capture of methane emissions [↑](#footnote-ref-2)
3. Using EIA data [↑](#footnote-ref-3)
4. The actual value in 2022 should not be zero, but to evaluate the CHS, we can consider only the incremental use of electricity resulting from qualifying installed measures (those taking place after 2022) [↑](#footnote-ref-4)
5. An increase from 2022 [↑](#footnote-ref-5)
6. When added to the fuel oil sales, the total is 13,600 MMBTU compared to the 2022 figure of 16,200 [↑](#footnote-ref-6)
7. When added to the natural gas sales, the total is 11,28 0MMBTU compared to the 2022 figure of 14,100 [↑](#footnote-ref-7)