# Grain Conditioning Study 2020


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# 01 | Summary

The energy analysis determined that two drying cycles analyzed in the 2020 grain conditioning study had an average weather normalized natural gas consumption of 8.7 GJ and an average electricity consumption 169 kWh per drying cycle. This relates to a total weather normalized energy consumption of 18.7 GJ (combined energy use of two drying cycles), a specific energy of 3.37 GJ/Tonne of moisture removed, and associated greenhouse gas emissions of 1.08 tonnes of carbon dioxide equivalent ($tCO_2e$). Of the combined 2019 and 2020 in-bin drying systems analyzed within this grain condition study, the energy use benchmark was found to be 8.55 GJ/Tonne of moisture removed (5.59 GJ/Tonne of Moisture Removed for indirect systems and 9.59 GJ/Tonne of Moisture removed for direct-fired systems). This resulted in the two cycles submitted for the 2020 study consuming, on average, 61% less energy than typical in-bin drying systems (Figure 1).

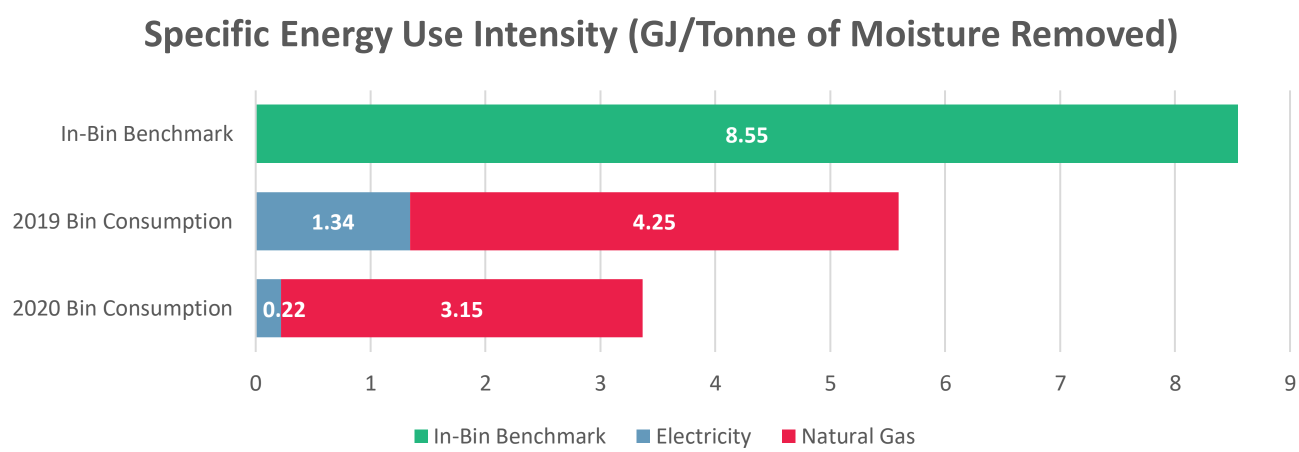


Figure 1: Energy Use Intensity

Table 1 displays comparative drying data from 2019 and 2020 data. As shown below, energy costs and emissions were much higher in 2019,almost three times the amount of grain was dried within 2019 compared to 2020, and was slightly less efficient. This is like caused by the use of the Air missile and reduced operational times seen in 2020.

Table 1: Actual Measured Annual Drying Data Comparison

| Year | Total Grain Dried (Std. Tonnes) | Moisture Removed (Tonnes) | Measured Electricity Consumption (kWh) | Measured Fuel Consumption (GJ) | Normalized Total Specific Energy ($GJ/T_{Moisture\ Removed}$) | Total Energy Costs ($) | Total Emissions ($tCO_2e$) |
|---|---|---|---|---|---|---|---|
| 2019 | 136 | 9.8 | 3,644 | 65.4 | 5.59 | 447 | 5.4 |
| 2020 | 182 | 5.5 | 337 | 18.3 | 3.37 | 110 | 1.1 |

Of the two drying cycles submitted within the 2020 grain conditioning study, both were canola. These bins ranged in moisture contents, grain temperatures, and supply air temperatures, and resulted in non-weather normalized specific energy values of 3.1-4.0 GJ/Tonne of moisture removed for 2020 bins (Table 2). Values in this table are actual measurements and recordings from the 2019/2020 harvest and are not weather normalized. Energy costs were calculated for each drying cycle using actual natural gas and electricity measurements. Supply air temperatures were not available for 2020 due to a sensor fault mid-way through drying.

Table 2: Drying Characteristics of 2019 Bins

| Year | Grain Type | Total Grain Dried (Bushels) | Initial Grain Moisture | Final Grain Moisture | Average Supply Air Temperature (°C) | Airflow (CFM/Bu) | Electricity Use (kWh) | Natural Gas Use (GJ) | Specific Energy ($GJ/T_{Moisture\ Removed}$) | Energy Cost ($) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2020 | Canola | 4,000 | 12.6% | 8.6% | N/A | 0.6 | 232 | 10.5 | 3.1 | 67 |
| 2020 | Canola | 4,000 | 11.6% | 9.5% | N/A | 0.6 | 105 | 7.3 | 4.0 | 43 |
| 2019 | Canola | 2,200 | 14.5% | 8.1% | 31.4 | 1.2 | 611 | 15.5 | 5.5 | 91 |
| 2019 | Canola | 2,150 | 13.2% | 6.0% | 27.5 | 1.2 | 992 | 21.4 | 7.1 | 134 |
| 2019 | Canola | 2,125 | 14.5% | 6.5% | 23.4 | 1.2 | 2,041 | 28.6 | 9.3 | 222 |

# 02 | Recommendations

Drying that occurred in 2020 was more energy-efficient and less costly than in 2019, and was mainly associated with prolonged drying run times in 2019, and the air missile distribution system utilized in 2020.

In the 2019 grain condition study, it was observed that most indirect heaters outperformed direct-fired heaters regarding energy efficiency. This proceeded to lead to more investigation into the comparison between these two heater types and resulted in an indirect fired heater being utilized on your site. Utilizing the two heater types on the same site was intended to reduce variables, such as producer methodology, bin type, and air distribution. In this comparison, three direct-fired heating cycles and two indirect fired heating cycles were utilized. The indirect fired heaters did not appear to have lower specific energy compared to direct-fired heaters, however, they did appear to have the lowest and third-lowest specific cost; resulting in less expensive grain drying. Some other interesting findings within the grain study was the savings incurred from burner maintenance, which reduced gas related consumption by 12% on a continuous dryer, and a rooftop exhaust fan, which appeared to reduced overall specific energy by actively exhausting humid air opposed to passively venting it. More information on these findings can be found in the 2020 grain conditioning report.

Funding may be available through the Efficient grain Dryer Program, which will cover 50% of expenses for eligible energy efficiency upgrades. Information on this program can be found at https://cap.alberta.ca/CAP/program/EFFICIENT_GRAIN_DRYER.

Table 3 displays all in-bin dryers analyzed within this study. All fuel consumption and specific energy values are weather normalized, meaning they are adjusted to simulate drying at an ambient outdoor temperature of 10°C. Although drying occurred at a range of outdoor temperatures, adjusting the fuel use allows for an even comparison between in-bin drying systems by removing outdoor ambient temperature as the primary factor affecting energy consumption.  Colors observed withing the table represent different system types and are described below.

Your Bins: (green)  Solar Heated Bins: (yellow)  Other Indirect Fired Bins: (blue)

Direct Fired Bins with internal Mixing Augurs: (orange)  Direct Fired Bins: No Colour

Table 3: 2019 & 2020 In-Bin Drying Summary

| Year | Location | Grain Type | Fuel Type | Total Grain Dried (Tonnes) | Total Moisture Removed (T) | Supply Air Temperature (°C)* | Airflow Per Bushel (CFM/Bu) | Specific Energy ($GJ/T_{Moisture\ Removed}$) |
|---|---|---|---|---|---|---|---|---|
| 2020 | South | Wheat | Solar | 54 | 2.3 | 13.9 | 2.2 | 0.6 |
| 2020 | South | Wheat | Solar | 106 | 2.1 | 16.9 | 1.1 | 1.2 |
| 2019 | South | Wheat | Solar | 99 | 1.3 | 15.9 | 1.0 | 1.5 |
| 2020 | South | Wheat | Solar | 49 | 2.1 | 17.3 | 2.5 | 2.3 |
| 2019 | South | Wheat | Solar | 61 | 0.5 | 16.0 | 0.9 | 2.8 |
| 2020 | North East | Canola | Natural Gas | 91 | 1.9 | 40.0 | 0.6 | 3.2 |
| 2020 | North East | Canola | Natural Gas | 91 | 3.6 | 40.0 | 0.6 | 3.4 |
| 2020 | Central | Barley | Natural Gas | 73 | 2.2 | 13.3 | 1.4 | 3.8 |
| 2019 | South | Wheat | Solar | 17 | 4.1 | 30.9 | 1.2 | 4.0 |
| 2019 | North West | Barley | Diesel | 111 | 4.1 | 30.9 | 1.2 | 4.4 |
| 2020 | North East | Wheat | Natural Gas | 122 | 1.8 | 26.6 | 0.9 | 5.0 |
| 2019 | North East | Wheat | Natural Gas | 122 | 2.5 | 20.8 | 1.0 | 5.1 |
| 2019 | North East | Canola | Natural Gas | 50 | 3.0 | 31.4 | 1.3 | 5.1 |
| 2019 | North East | Wheat | Natural Gas | 122 | 5.7 | 15.4 | 1.0 | 5.3 |
| 2019 | North East | Canola | Natural Gas | 49 | 3.2 | 27.5 | 1.3 | 5.6 |
| 2020 | Central | Barley | Natural Gas | 159 | 5.9 | 37.1 | 1.5 | 5.9 |
| 2019 | North West | Wheat | Diesel | 138 | 5.4 | 31.9 | 1.1 | 6.0 |
| 2019 | North East | Canola | Natural Gas | 48 | 3.5 | 23.4 | 1.3 | 6.0 |
| 2019 | Central | Barley | Natural Gas | 100 | 1.3 | 15.9 | 1.0 | 6.1 |
| 2019 | North West | Wheat | Diesel | 138 | 5.6 | 41.0 | 1.1 | 6.4 |
| 2019 | Central | Wheat | Natural Gas | 216 | 6.7 | 52.1 | 0.7 | 6.7 |
| 2020 | North East | Wheat | Natural Gas | 122 | 1.8 | 36.7 | 1.0 | 6.8 |
| 2020 | Central | Barley | Natural Gas | 54 | 2.1 | 35.6 | 5.3 | 7.1 |
| 2019 | Central | Barley | Natural Gas | 185 | 4.5 | 43.4 | 0.8 | 7.2 |
| 2019 | Central | Wheat | Natural Gas | 176 | 4.6 | 43.3 | 1.0 | 7.6 |
| 2020 | Central | Barley | Natural Gas | 65 | 2.4 | 22.1 | 1.5 | 8.0 |
| 2019 | Central | Barley | Natural Gas | 185 | 2.9 | 41.7 | 0.8 | 8.3 |
| 2019 | Central | Canola | Natural Gas | 98 | 4.5 | 49.4 | 1.6 | 8.3 |
| 2019 | Central | Barley | Natural Gas | 100 | 0.5 | 16.0 | 0.9 | 8.6 |
| 2020 | North East | Wheat | Natural Gas | 54 | 0.5 | 18.6 | 2.5 | 8.6 |
| 2019 | Central | Wheat | Natural Gas | 216 | 3.0 | 46.3 | 0.8 | 8.7 |
| 2020 | North East | Wheat | Natural Gas | 68 | 1.0 | 21.9 | 2.0 | 8.7 |
| 2019 | North West | Wheat | Diesel | 138 | 1.9 | 46.3 | 1.0 | 8.9 |
| 2020 | Central | Barley | Natural Gas | 104 | 2.9 | 21.9 | 0.9 | 8.9 |

* Supply air temperatures only display temperatures when the burner is operational

| Year | Location | Grain Type | Fuel Type | Total Grain Dried (Tonnes) | Total Moisture Removed (T) | Supply Air Temperature (°C)* | Airflow Per Bushel (CFM/Bu) | Specific Energy (GJ/$T_{Moisture\ Removed}$) |
|---|---|---|---|---|---|---|---|---|
| 2020 | Central | Wheat | Natural Gas | 162 | 3.0 | 37.3 | 2.0 | 10.6 |
| 2019 | Central | Wheat | Natural Gas | 176 | 2.4 | 49.3 | 1.0 | 10.7 |
| 2019 | Central | Barley | Natural Gas | 189 | 3.7 | 45.6 | 0.8 | 10.9 |
| 2019 | North East | Canola | Natural Gas | 57 | 1.4 | 15.7 | 1.5 | 11.0 |
| 2020 | Central | Barley | Natural Gas | 174 | 4.9 | 42.6 | 1.4 | 12.1 |
| 2019 | North East | Wheat | Natural Gas | 122 | 2.8 | 17.8 | 1.0 | 12.2 |
| 2020 | North East | Wheat | Natural Gas | 81 | 0.8 | 23.8 | 1.5 | 12.5 |
| 2019 | North East | Canola | Natural Gas | 57 | 1.6 | 16.0 | 1.5 | 12.6 |
| 2020 | Central | Canola | Natural Gas | 132 | 3.9 | 54.9 | 1.7 | 12.7 |
| 2019 | Central | Barley | Natural Gas | 109 | 2.3 | 38.3 | 1.7 | 13.1 |
| 2019 | Central | Wheat | Natural Gas | 230 | 4.5 | 52.7 | 0.7 | 13.9 |
| 2019 | North East | Wheat | Natural Gas | 54 | 1.6 | 25.1 | 2.6 | 14.5 |
| 2019 | Central | Wheat | Natural Gas | 216 | 3.0 | 50.7 | 0.8 | 14.6 |
| 2019 | North East | Canola | Natural Gas | 57 | 2.0 | 26.0 | 1.6 | 14.7 |
| 2019 | North East | Wheat | Natural Gas | 108 | 2.1 | 18.0 | 1.0 | 14.8 |
| 2019 | North East | Wheat | Natural Gas | 95 | 2.1 | 27.4 | 1.3 | 18.5 |