# Carbon flux and Storage - State and Island level

The impact on climate change for each human use and land is expressed in comparable units through the $CO_2$ equivalents.

| STATE & ISLAND LEVEL<br>million metric tons of $CO_2$ equivalent ($mmtCO_2eq$) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **State** | **Oahu** | **Hawaii** | **Kauai** | **Maui** | **Molokai** | **Lanai** |
| Population[1] | 1,361,790 | 953,207 | 186,738 | 66,921 | 144,444 | 7,345 | 3,135 |
| Land area (acres)[1] | 4,034,560 | 382,080 | 2,577,920 | 353,280 | 465,280 | 166,400 | 89,600 |
| **FLUX - Annual emissions minus annual sequestration** | | | | | | | |
| Electric power[2] | 10.18 | 6.77 | 0.77 | 0.35 | 0.78 | 0.05 | 0.02 |
| Transport[2] | 9.79 | 9.25 | 1.28 | 0.54 | 1.38 | 0.09 | 0.04 |
| Food[3]* | 3.49 | 2.44 | 0.48 | 0.17 | 0.37 | 0.02 | 0.01 |
| Stuff[3]* | 4.02 | 2.90 | 0.47 | 0.18 | 0.41 | 0.02 | 0.01 |
| Waste[2] | 0.78 | 0.72 | 0.14 | 0.07 | 0.13 | 0.01 | 0 |
| Land use | | | | | | | |
| Livestock, ag, forest fires[2] | 1.05 | 0.09 | 0.48 | 0.1 | 0.13 | 0.01 | 0.1 |
| Grassland[4] | 0.81 | 0.02 | 0.66 | 0.03 | 0.06 | 0.01 | 0.02 |
| Urban trees[2] | -0.4 | -0.4 | no data | no data | no data | no data | no data |
| Shrubland[4] | -0.96 | -0.07 | -0.57 | -0.08 | -0.08 | -0.11 | -0.04 |
| Forest[4] | -1.96 | -0.23 | -1.11 | -0.23 | -0.25 | -0.08 | -0.05 |
| **TOTAL NET EMISSIONS / YR** | **26.8** | **21.49** | **2.59** | **1.13** | **2.93** | **0.02** | **0.11** |
| **Long term carbon storage** | | | | | | | |
| Forest[4] | 143.79 | 19.03 | 92.63 | 0.03 | 21.25 | 6.77 | 4.09 |
| Shrubland[4] | 22.31 | 1.84 | 14.67 | 0.01 | 2.05 | 2.78 | 0.97 |
| Grassland[4] | 51.97 | 1.48 | 44.16 | 0.01 | 4.31 | 0.78 | 1.22 |
| Soil / other land[4] | 5.70 | 0.02 | 5.34 | 0.00 | 0.29 | 0.03 | 0.01 |
| **TOTAL STORED** | **223.77** | **22.36** | **156.80** | **0.05** | **27.91** | **10.35** | **6.30** |

*Mostly imported.

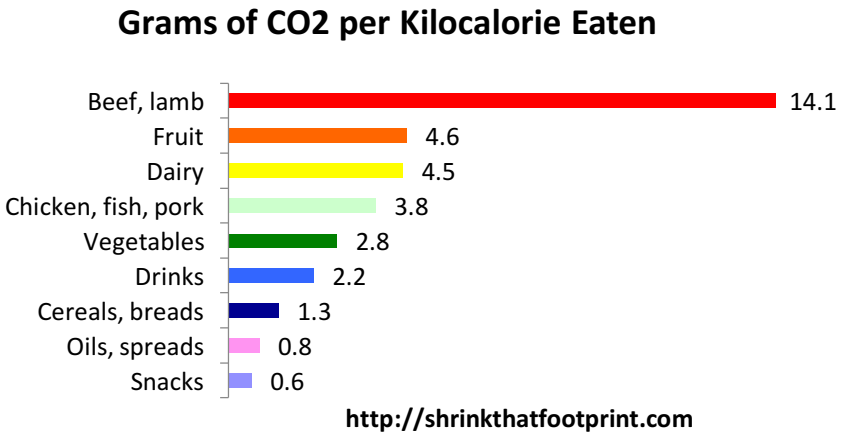
Sources


1 - https://energy.hawaii.gov/wp-content/uploads/2011/10/ghg-inventory-20081.pdf
2 - ICF International for DBEDt December 31 2008 (2007 for all island level data)
https://health.hawaii.gov/cab/files/2019/02/2015-Inventory_Final-Report_January-2019-004-1.pdf (2015 for State level data only)
3 - coolclimate calculator, UC Berkeley
4 - CAH USGS study 2017

# HAWAII'S CARBON "FOODPRINT"

The data we have for Hawaii's $CO_2$ emissions from food are based on population size, and averages for people who live in the US. Because of this, the data on emissions is not precise. However, we do have good data on many of the issues that will help you decide what to target as part of a plan to reduce Hawaii's $CO_2$ emissions from food.

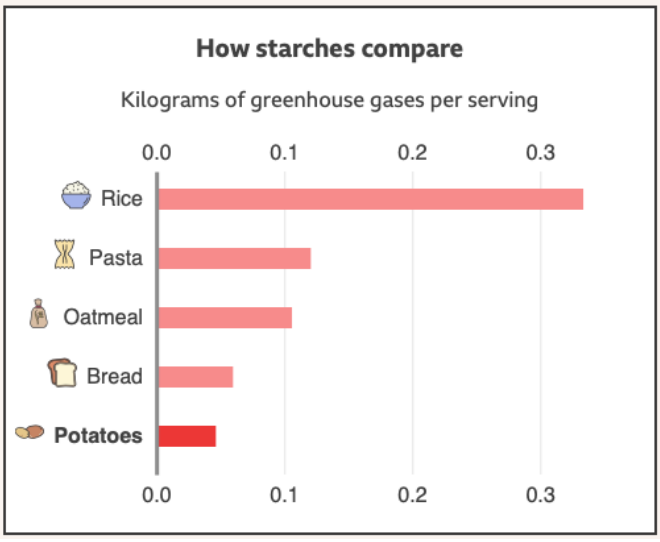
## WHAT WE EAT

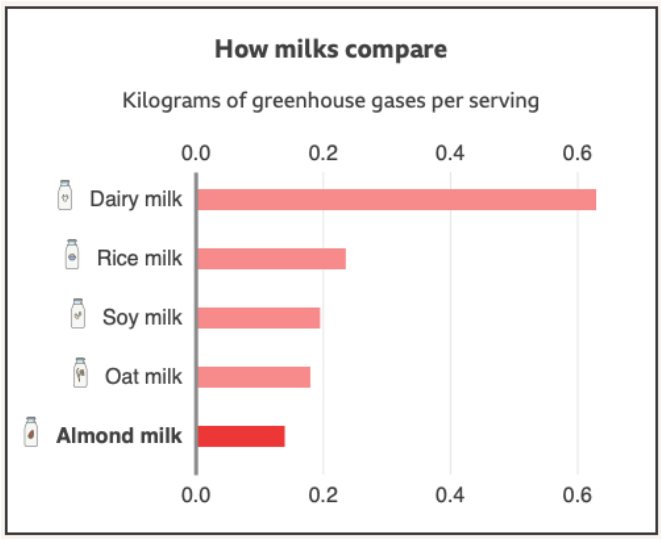



Adults need about 2,000 calories a day. The type of food we eat to get those calories will have a big impact on our carbon emissions. The graph shows that one calories from beef or lamb produces much more carbon than other foods. Why? Meat is inefficient, because the animals only convert a small portion of the energy from the plants they eat into meat. Cows and sheep are particularly inefficient and their digestive systems release large quantities of methane as a by-product of digestion, and more methane is released as their manure decomposes. You can see the CO2 emissions for common meals here: http://www.eatlowcarbon.org/food-scores/#

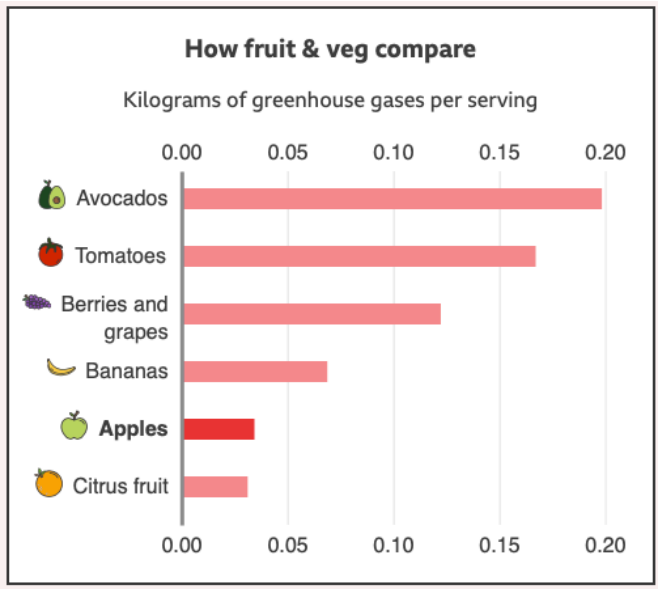
Vegans, produce the least carbon, followed by vegetarians. However, a diet low in red meat and cheese results in similar carbon reductions to a vegetarian and is good for your health.

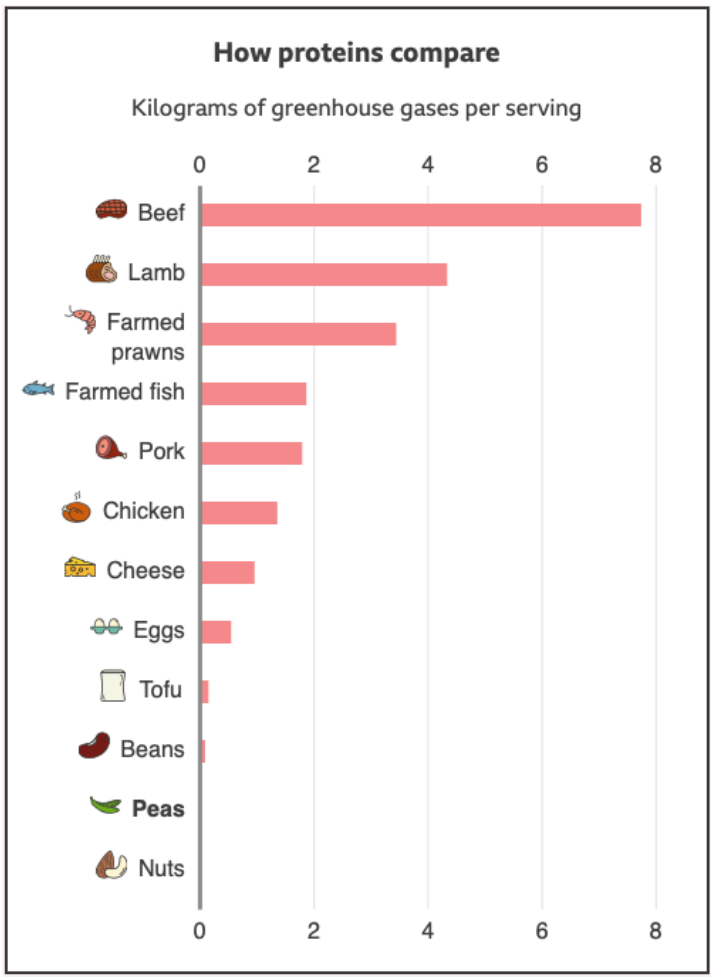
If your plan will include motivating people to change their diets, remember: If one type of food is reduced, another product of the same food type must be increased. You can see how products of the same food type (protein, starches, fruit & vegetables, and milk) compare in terms of CO2

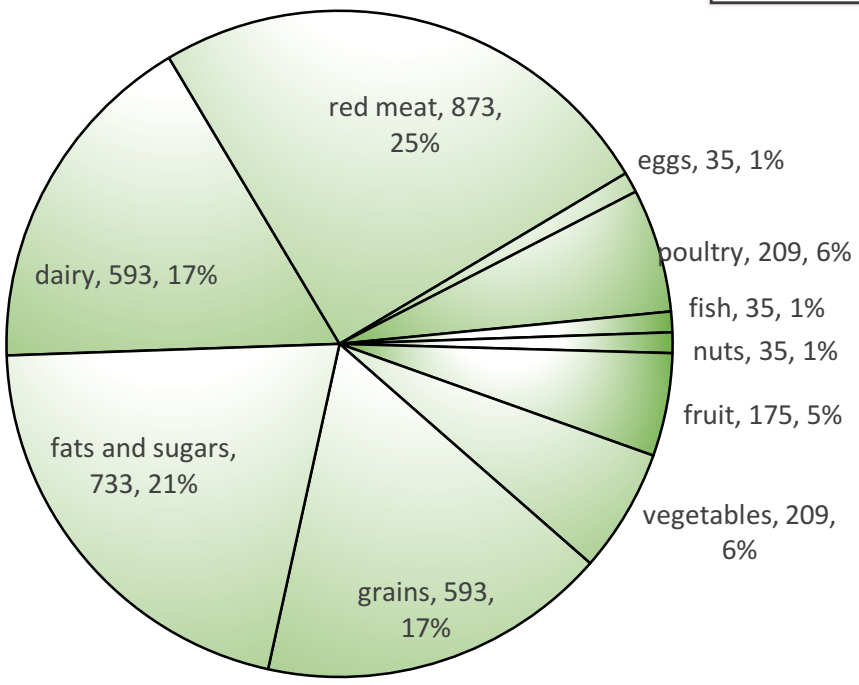


emissions. Calculate the change in CO2 emissions if one serving were to be substituted for another. Multiply the difference by how many times a year that substitution would take place. Multiply that by the population that would make that substitution to calculate the change in total CO2 emissions from food. Population data is listed in Table 1.




**Annual emissions by food group in Hawaii of 3490 thousand metric tons CO2 equivalent**

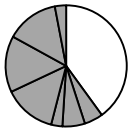
How much is currently emitted by food type?

This tells you the starting point of actual CO2 emitted in Hawaii for each food type so you know how much change is possible for any one food type.

## REDUCE THE AMOUNT OF FOOD NEEDED - WASTE LESS

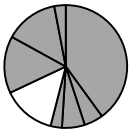
In the US, almost half the carbon used to produce and deliver food is wasted. 23% is wasted in the supply chain, and consumers waste 20%. $CO_2$ emissions can be reduced dramatically with no change in what we eat or how much we each just by reducing waste. People could shop for, serve and order realistic quantities. People could use leftovers in place of other meals. How would you get people to better plan and measure how much food to buy and prepare?

## TARGET SPECIFIC STEPS IN THE LIFECYCLE OF FOOD

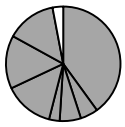


**Food Production 40%** See the last section of the "Land Use" resource for ideas to reduce $CO_2$ emissions during production.

Organic farming has many benefits, but it is not clear that it has lower greenhouse gas emissions than conventional farming. Conventional agriculture uses nitrogen-based chemical fertilizers produced in an energy-intensive process that converts inert nitrogen (N2) from the air into ammonia (NH3) by combining it with hydrogen extracted from water and methane. The fertilizer eventually degrades, is converted into nitrous oxide (N2O), a potent greenhouse gas, and released into the atmosphere. However, these products can make conventional farming twice as productive per acre of land as organic farming, reducing the need to convert additional forested land to farmland. Using renewable energy to manufacture fertilizers would definitely reduce emissions associated with agriculture.



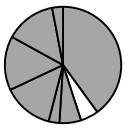
**Personal Transport 14%** Individuals making trips to purchase food is a relatively large part of the foodprint. This would be reduced with clean transportation. It could be reduced even before clean transportation is in place by changing habits. How would you motivate people to be more efficient about their shopping trips?



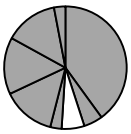
**Disposal 3%** Food waste that is disposed of in landfills decomposes underground, producing methane that seeps into the atmosphere.

Composting food scraps rather than landfilling them can drastically reduce their climate impact. That's because decomposition in the oxygenated environment of a compost pile produces carbon dioxide. In contrast, decomposition in the oxygen-poor depths of a landfill produces methane, which is a much more potent greenhouse gas.

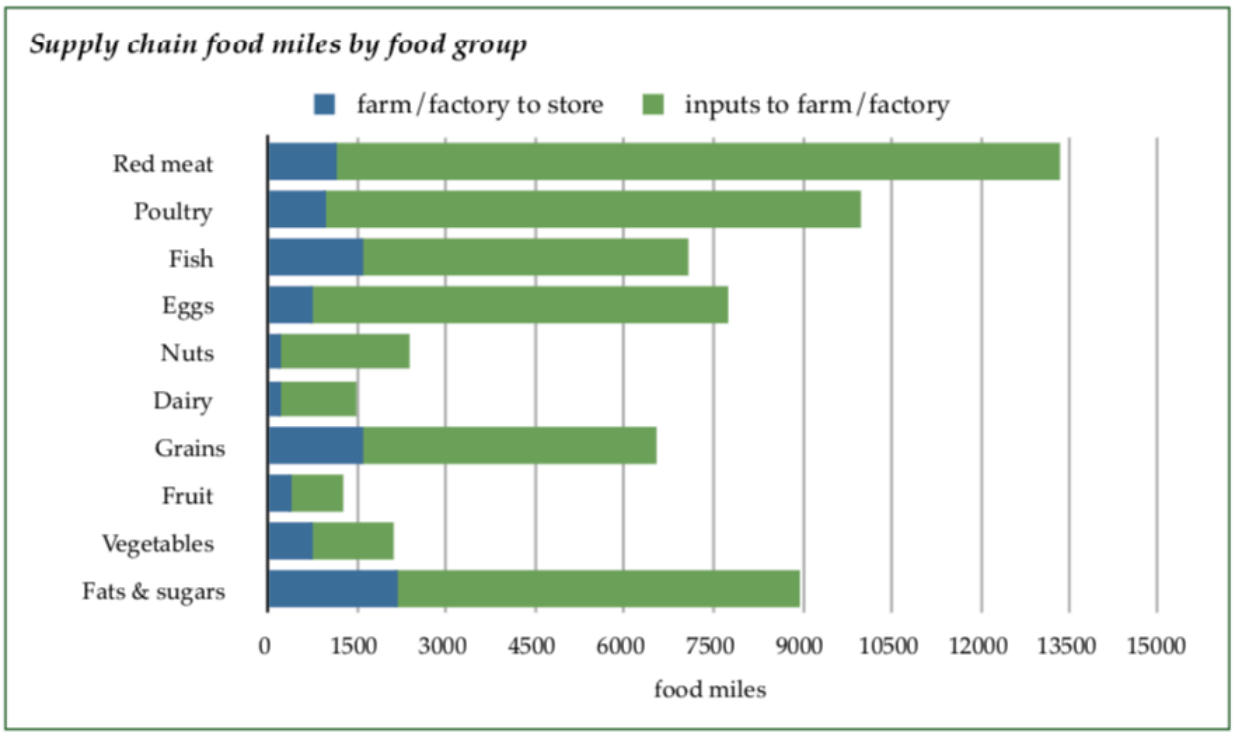
Another option is to burn the food (and other waste) as done at H-POWER on Oahu to generate electricity. This does not eliminate CO2 emissions from the waste, but it avoids emissions from the fuels it replaces. Alternatively, the methane emissions can be captured to use as gas. On Kauai, investments have been made in such as system.



**Packaging 5%** Food needs some packaging to remain fresh and sanitary. How can the amount of packaging, or the carbon intensity of the packaging be reduced?

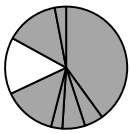


**Supplier Transport 6%** There are many benefits to local agriculture including food security, local jobs and health. However, local agriculture is not always less carbon intensive. Supplier transport is a small part of the CO2 emissions of food, and much of it (three quarters) comes before transport from the producer to the store. It is delivery of inputs like fertilizer or cattle feed. So, reducing supplier transport in Hawaii will have a positive impact only if the product is heavier than any imported inputs. Hawaii ranchers actually send their cows to the mainland after they are weaned to be fattened up on corn for 6 months there before being slaughtered and sent back as steaks. Transporting the corn is heavier and costlier. Having cows just eat grass is becoming more popular, but doesn't make financial sense for farmers, as it requires 1 ½ years before slaughter instead of 6 months.

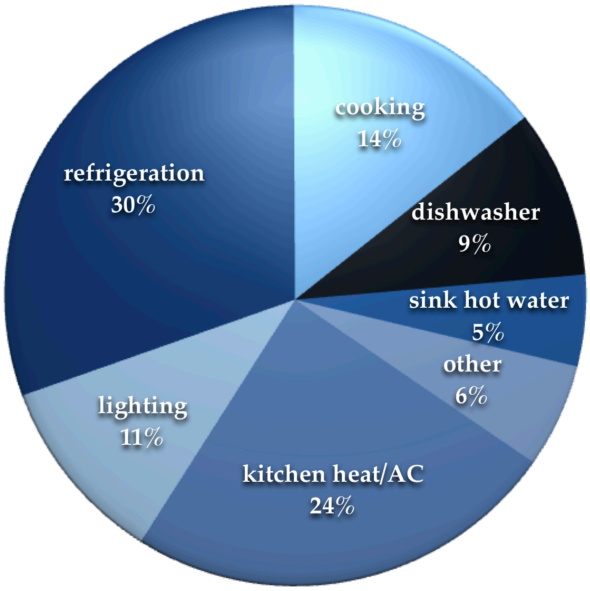


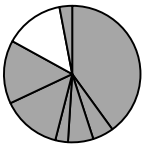

The graph below shows what is already being produced in Hawaii, and sometimes exported. It is evident that Hawaii produces a significant proportion of fresh food consumed, but no grains and hardly any processed foods. The non-fresh items are inefficient to produce in Hawaii from a cost standpoint, and probably also from a carbon standpoint. How could farmers of products which are locally carbon-efficient be supported to grow more food and thereby reduce supplier transport emissions?

| | Million kilograms 2010 | | |
|---|---|---|---|
| | Consumed | Produced Locally | Exported |
| Seafood | 26.4 | 54.5% | 6.8% |
| Other protein | 125.8 | 18.4% | 19.4% |
| Vegetables - fresh | 125.9 | 31.4% | 1.7% |
| Fruit -fresh | 119.5 | 49.4% | 18.2% |
| Grain - rice | 50.3 | 0.0% | 18.3% |
| Milk - fresh | 92.3 | 12.4% | 0.0% |
| other (including processed) | 5623.7 | 0.1% | 2.1% |

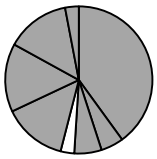


**Kitchen 15%** The carbon associated with storage, cooking and clean up comes from kitchen appliances, lights, AC and water use. Energy Star appliances are the most helpful, followed by lower carbon cooking. The most efficient is the microwave, followed by stovetop and ovens are the most carbon intensive. Hand washing and dishwashers are comparable, if you run full loads of dishes.



**Restaurants 14%** Restaurant kitchens are similar to home kitchens in their $CO_2$ emissions per meal prepared. If you are travelling just to go to the restaurant, then the carbon for that meal goes up relative to eating at home. Combining trips as well as kitchen energy efficiency are ways to reduce $CO_2$ from restaurant meals.



**Retail 3%** Stores selling food make up a small part of the carbon emissions.

## WHAT IS THE BEST WAY TO REDUCE HAWAII'S CARBON FOODPRINT?
## WHAT ARE THE TRADE-OFFS BETWEEN COSTS AND BENEFITS?

Sources:

https://agrifoodecon.springeropen.com/articles/10.1186/2193-7532-1-10

http://www.foodemissions.com/foodemissions/Calculator.aspx

https://kohalacenter.org/HISGN/pdf/carbofoodprint.pdf

https://www.bbc.com/news/science-environment-46459714

# Cost of Using Fossil Fuels

Hawaii sends almost $4 billion annually out of the State to purchase fossil fuels. Funds spent on fossil fuels do not contribute to the economy in Hawaii. Also, dependence on oil makes the State vulnerable to oil price fluctuations. 2017 purchases[1]**:**
$3,757,000,000 - oil
$46,000,000 - coal
$91,000,000 - natural gas

There are many current and expected financial costs to Hawaii associated with climate change. These include damage to coastal infrastructure from sea level rise and storm surges. Damage to property due to increase storms and flooding. Increased temperatures and decreases in trade winds result in the need to install and use more air conditioning. Lost agricultural productivity. Decline in Hawaii's fisheries as a result of coral reef damage. Declines in tourism due to more frequent extreme weather and damage to our shoreline and reefs.

Dependence on fossil fuels makes Hawaii vulnerable to port closures due to natural disasters or military conflict. Ports closed briefly during Tropical Cyclone Olivia in 2018.

There is a risk of accidents and oil spills that could negatively impact wildlife in the ocean as well as seabirds on the surface of the ocean. Over 1,000 oil spills have been documented since 1960.[2]

Burning fossil fuels results in smog, acid rain, soot and particulates increase, greenhouse gas emissions, and dispersal of some heavy metal contaminants. These are harmful to human health, especially for people with respiratory ailments such as asthma.[3] You can calculate caused or avoided pollution here. http://www.cleanerandgreener.org/resources/pollutioncalculator.html

## How does your solution compare to continuing to use fossil fuels?

[1] (www.eia.gov)
[2] https://www.livescience.com/9885-faq-science-history-oil-spills.html
[3] https://www.epa.gov/nutrientpollution/sources-and-solutions-fossil-fuels