The Cost of Moving Food

Exploring Food Sustainability Through the Lens of Transport
Time, Resources, Environmental Impact and Price

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Motivation - Why I care about this topic

- "Food" is a subject of great interest and passion for me: not just recipes and foodie-trends, but also in the topics of gastro-anthropology, socio-ethics, accessibility, and sustainability
- I desire to live a more deliberately sustainable lifestyle, including in the decisions I make regarding the food I choose to purchase and consume
- I wish to better understand the impact of the choices that I make, both in how they affect my own life, and how they affect the world around me

Motivation – Why you should care about this topic

- Food systems (including production, processing, and transport) are one of the leading sources of global greenhouse gas emissions, accounting for nearly 35% of the global total

  * Sustainable healthy diets – Guiding principles. Food and Agriculture Organization of the United Nations and World Health Organization, 2019.

- As a consumer, the decisions that we make (as an individual, a family, or a food-centric business) can have a significant cumulative effect on food production prices, practices, and environmental impact

- Sustainability is a hot topic of conversation right now within business and commercial institutions, academic study, government policy, geo-politics, and public interest

Data Questions

- How fast does cargo travel via different methods?
- How much fuel does it take to move one ton of cargo by these methods?
- How much CO2 is produced to move one ton of cargo?
- How much is spent (USD) in fuel to move one ton of cargo?

Approach

- Find and collect data
  - Most data found in CSV format from US Dept. of Transportation & US Dept. of Energy
  - Some data found in published graphs or charts in US.gov publications, or cited by US.gov, United Nations, or peer-reviewed publications
    - Charts converted to csv using Adobe Acrobat
    - Graphs converted to csv using GetData Graph Digitizer
  - Some data found as text information within articles on the subject
- Clean data
  - Drop unneeded columns and irrelevant rows
  - Rename select columns and variables for clarity
  - Reshape datasets into more useable arrangements
  - Fill gaps with cited data from relevant articles
- Exploratory data analysis
  - Understand the data
  - Build calculated columns and queries based upon the data available to find the answers to my data questions
- Data visualization
  - Isolate important metrics within my data, and convert the information into easily understandable visuals
  - Formatting and editing of visuals to maintain thematic consistency
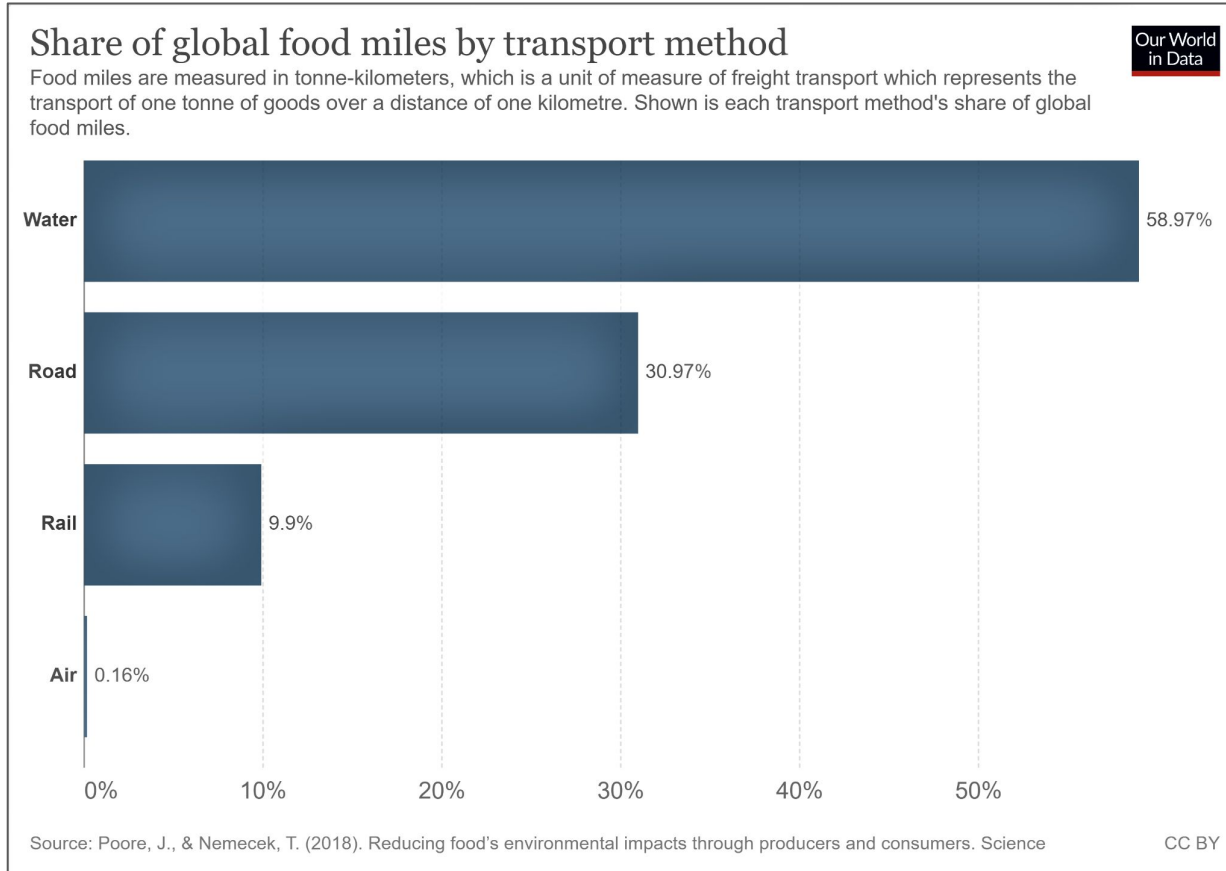 - Assembling visuals into a short presentation

Challenges

- Variable diversity within the scope of my data questions
  - Many of my questions center on how much fuel is consumed when moving cargo, but that depends upon the kind of fuel being used, the kind of vessel using it, and how much total weight that vessel is carrying
  - The data can be further complicated by a nearly infinite amount of sub-variables such as idling times, age and maintenance of the vessel, individual company policies, urban congestion, and the weather. These were not factors that I included in my data analysis, which necessitates an unknown measure of inaccuracy in my findings

- Variable diversity within the data itself
  - Some fuel measurements were listed in tons, others in gallons. And different types of fuel weigh different amounts
  - Fuel consumption levels were sometimes provided by amounts of fuel consumed by day, other times by hour, and other times by distance
  - Speed data was listed in kilometers per hour, miles per hour, and nautical knots across different data sets and different transportation types
  - The weight of a shipping container, or how much weight a transport vessel is carrying, can vary significantly depending upon what is in the container, necessitating a consistent method of determining averages in cargo weights across my datasets

Methodology

- **Convert all speeds to miles per hour (MPH)**
- **Convert all fuel measurements to gallons**
- **Determine average weights for cargo loads – convert all to tons**
  - For <u>ships</u>, ship size was given in ranges of standard TEU measurements – Twenty-foot Equivalent Unit, the size of a cargo container.
    - Maximum gross mass of dry goods (which excludes non-packaged liquid food cargo) per TEU is 52,910 lbs (5,140 container + 47,770 cargo). I used the total maximum weight of a TEU times the mean TEU capacity per ship-size-class to determine average ship cargo weights.
    - I dropped the largest size category of my dataset – 10,000+. As I had no information on what the upper ceiling was on that range, it was impossible to guess average cargo loads with any degree of accuracy.
  - For <u>planes</u>, most cargo planes are the same size and make as passenger planes, and the average size plane (Boeing 737) carries an average weight of 45,000 lbs of cargo *Smithsonian National Air and Space Museum
  - For <u>trucks</u>, my data provided maximum truck carrying weights (in lbs) by the old truck-class system (class 1-8), but my truck fuel consumption data was given using a newer government classification system of 3 categories. To determine an average cargo load of the new system, I filtered the old 8-class system into the new 3-category system and used the mean of the lower maximum weight plus the higher maximum weight within that category as the average cargo weight for trucks within that category.
  - For <u>trains</u>, I found the average non-liquid cargo load stated clearly within a published article as 30,000 tons per train
- **Filter all information through the lens of efficiency via ton-mile**
  - How far a ton of cargo can travel using the different methods
  - Calculated by multiplying how much weight a vessel is carrying by the miles-per-gallon of that vessel
  - The impact of different methods of transport, measured by 1-ton of cargo
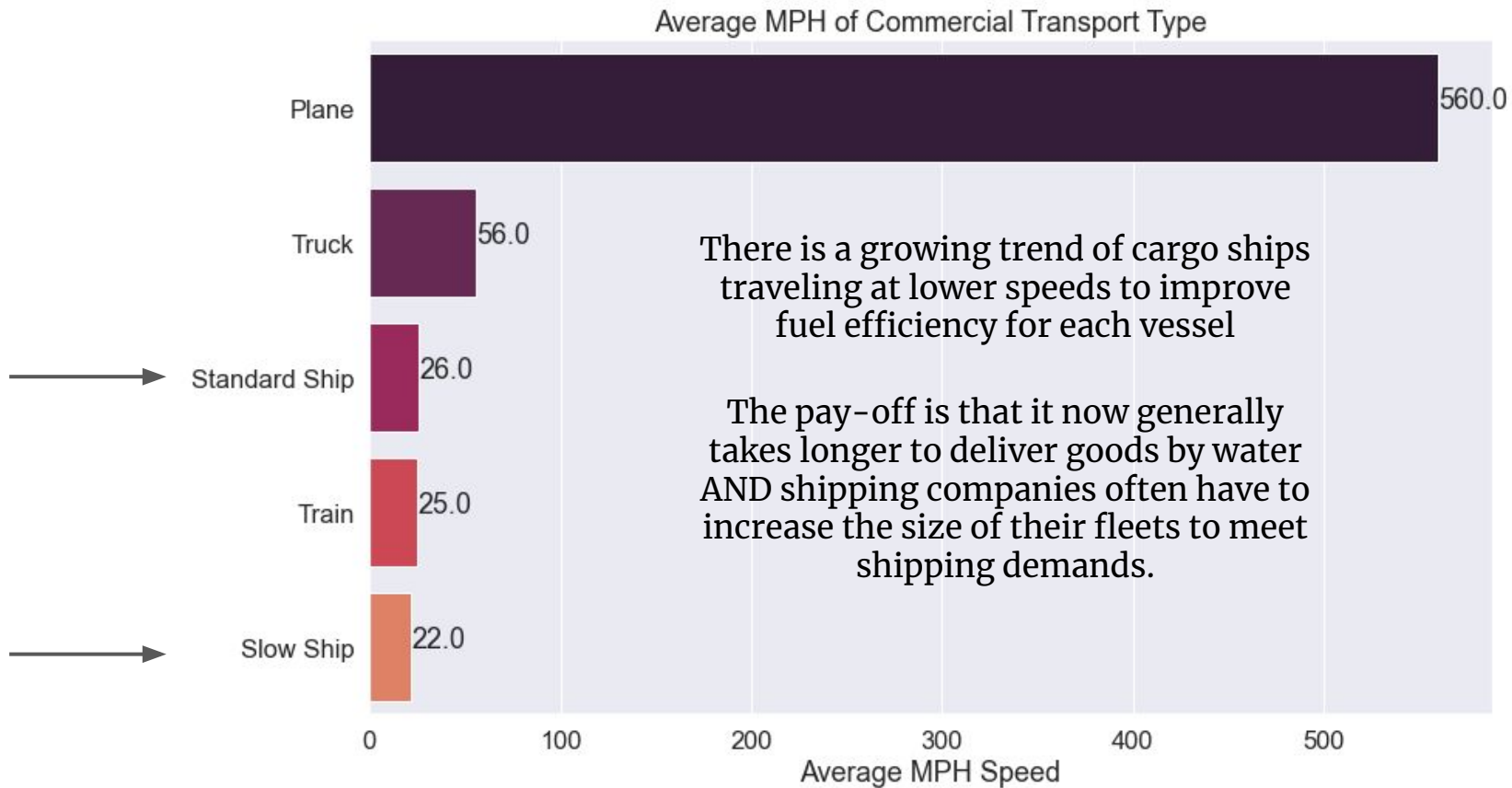
Where to start:
How does food get from the source to the market?

Share of global food miles by transport method

Food miles are measured in tonne-kilometers, which is a unit of measure of freight transport which represents the transport of one tonne of goods over a distance of one kilometre. Shown is each transport method's share of global food miles.

Our World in Data

Transport	Share
Water	58.97%
Road	30.97%
Rail	9.9%
Air	0.16%

Source: Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. Science   CC BY

How fast does food travel by these different methods?

Average MPH of Commercial Transport Type

Transport Type	Average MPH Speed
Plane	560.0
Truck	56.0
Standard Ship	26.0
Train	25.0
Slow Ship	22.0

Average MPH Speed

There is a growing trend of cargo ships traveling at lower speeds to improve fuel efficiency for each vessel

The pay-off is that it now generally takes longer to deliver goods by water AND shipping companies often have to increase the size of their fleets to meet shipping demands.

How fuel efficient are these modes of transport? How many miles per gallon (MPG) does each type get?

IT DEPENDS

Smaller Truck	10 tons	10 mpg	2 gallons 10 mi.
✓ Larger Truck	20 tons	7 mpg	1 gallon 14 mi

How fuel efficient are these modes of transport? ~~How many miles per gallon (MPG) does each type get?~~

IT DEPENDS

|				
Smaller Truck	10 tons	10 mpg	2 gallons	10 mi.
✓ Larger Truck	20 tons	7 mpg	1 gallon	14 mi

How fuel efficient are these modes of transport?

How many miles can a ton of cargo travel on a gallon of fuel (on average)?

# How many miles can a ton of cargo travel on a gallon of fuel (on average)?

Average Ton-MPG by Ship Size and Speed

How many miles can a ton of cargo travel on a gallon of fuel (on average)?

Average Ton-MPG (US Highway) by Truck Size

How many miles can a ton of cargo travel on a gallon of fuel (on average)?

Average Ton-MPG by Plane and Train
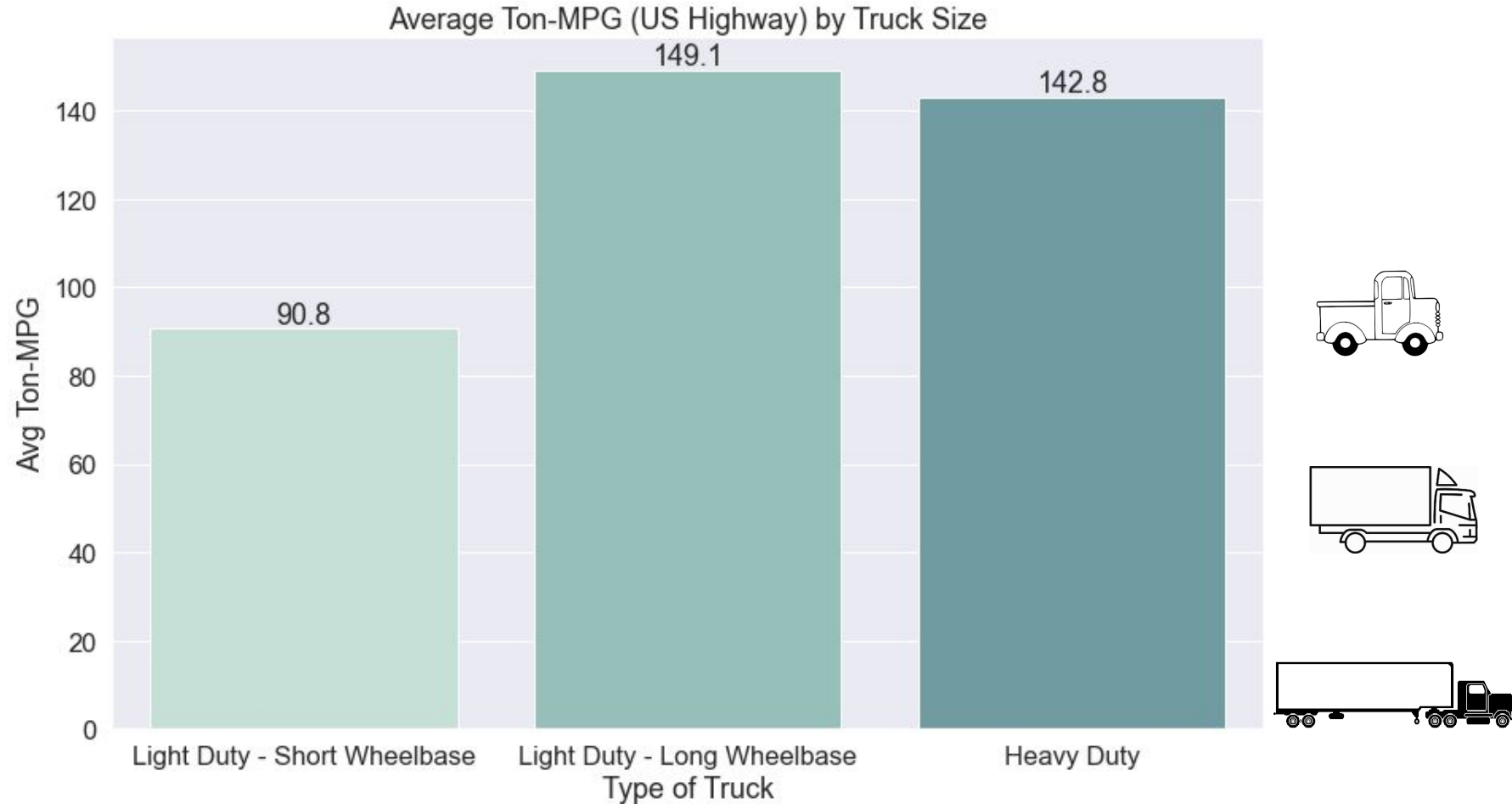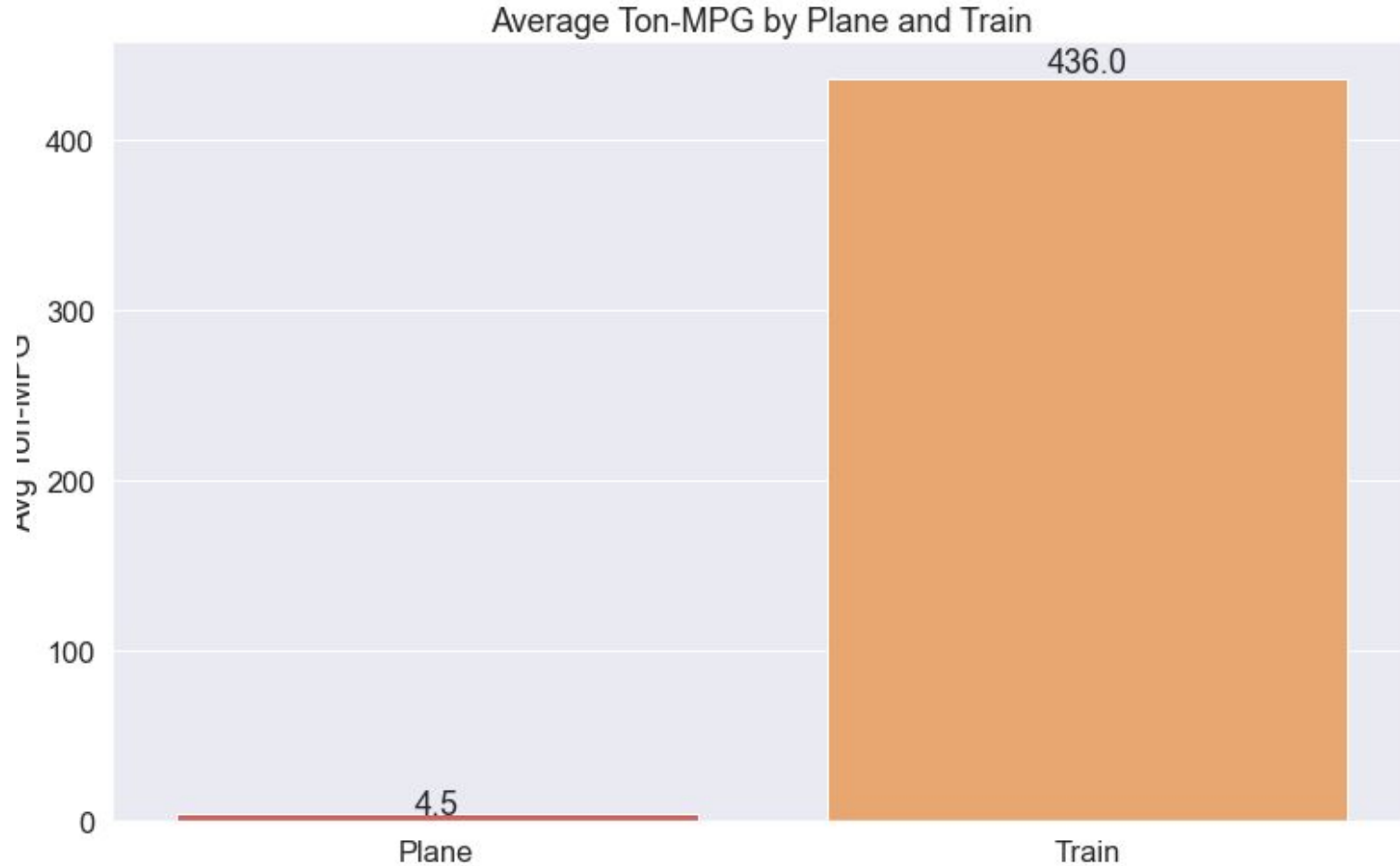
What kind of environmental impact do these different methods of transport have?

- The most direct impact when discussing transport, are greenhouse gas emissions from fuel consumption

- Fuel = CO_2

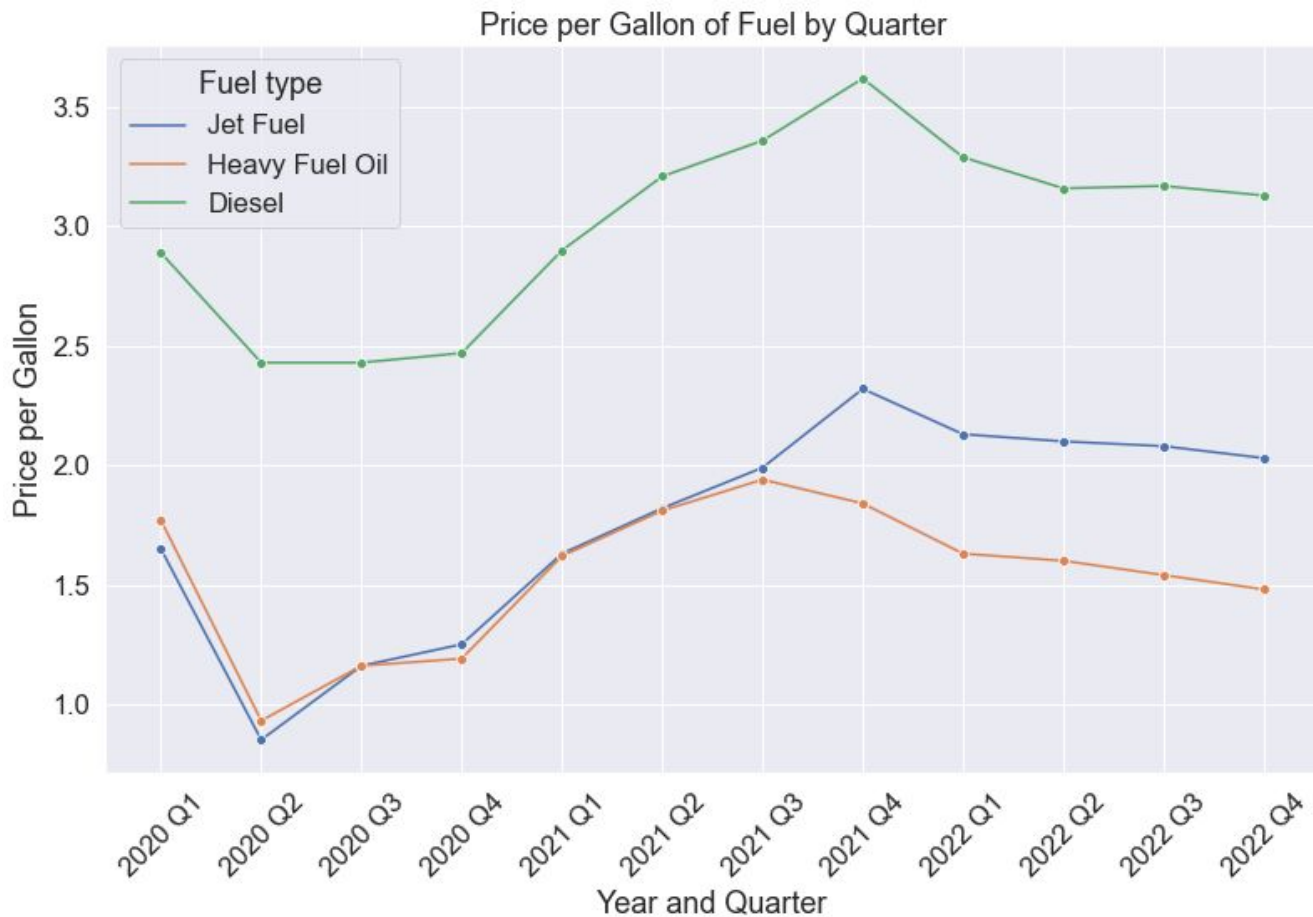- For every pound of carbon burned, three pounds of CO_2 are produced

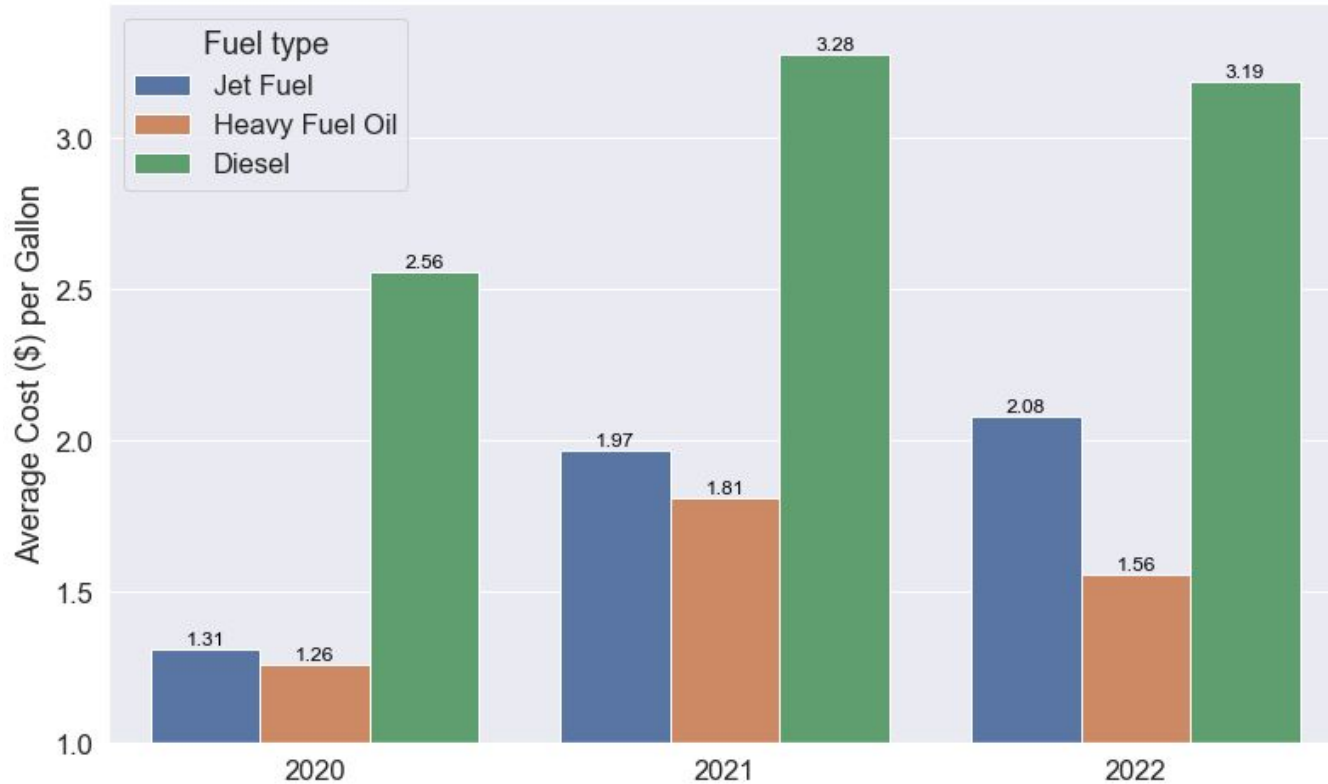CO2 Emissions per Gallon of Fuel
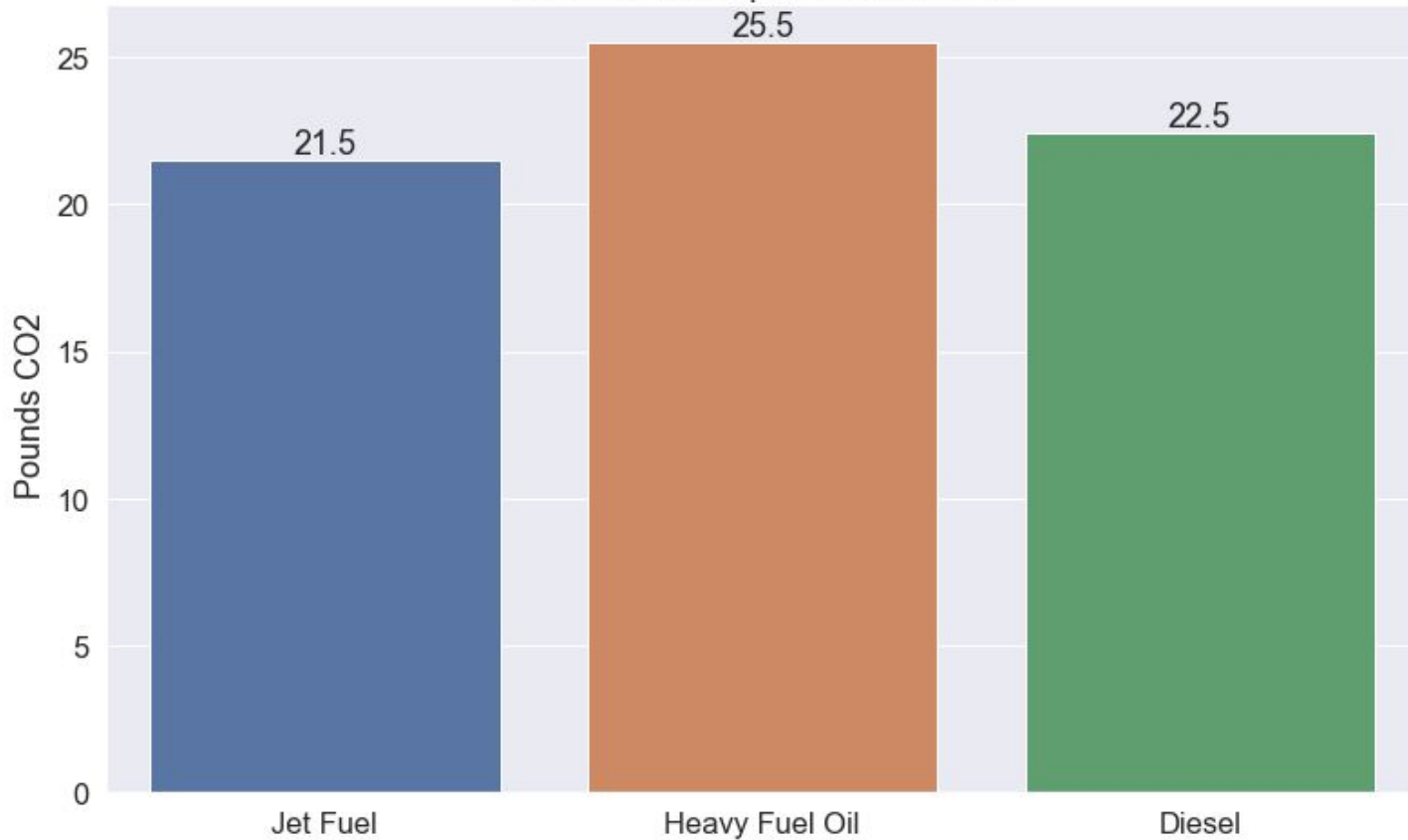
How much does fuel cost?

How much does fuel cost?

Price per Gallon of Fuel by Quarter

How much does fuel cost?

Average Cost (USD) per Gallon of Fuel by Year
(2022 projections from US Department of Energy)

What does this all mean?

How is all this data relevant to any decisions I make?

Leopold Center for Sustainable Agriculture

Iowa State University, 2001

"Food, Fuel, and Freeways: An Iowa perspective on how far food travels, fuel usage, and greenhouse gas emissions"

Average Distances from Farm to Market

Terminal Market vs. Ferry Plaza Farmers Market

Apples: 1,555 miles vs. 77 miles

Tomatoes: 1,369 miles vs. 117 miles

Grapes: 2,143 miles vs. 134 miles

Beans: 766 miles vs. 101 miles

Peaches: 1,674 miles vs. 173 miles

Winter Squash: 781 miles vs. 98 miles

Greens: 889 miles vs. 99 miles

Lettuce: 2,055 miles vs. 102 miles

How much time does it take food to travel?

How many hours does it take for food to travel 1000 miles?

How many gallons of fuel does it take for food to travel 1000 miles??