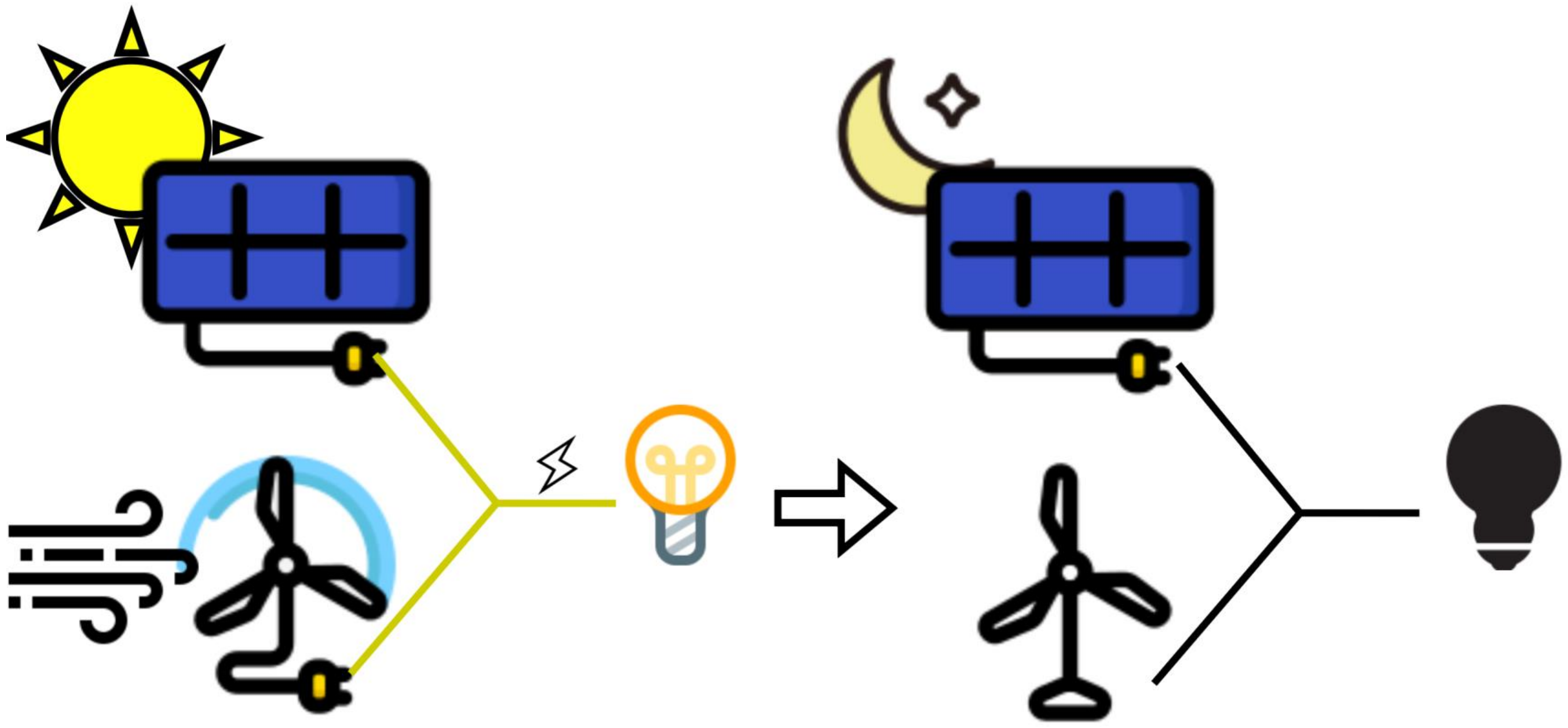
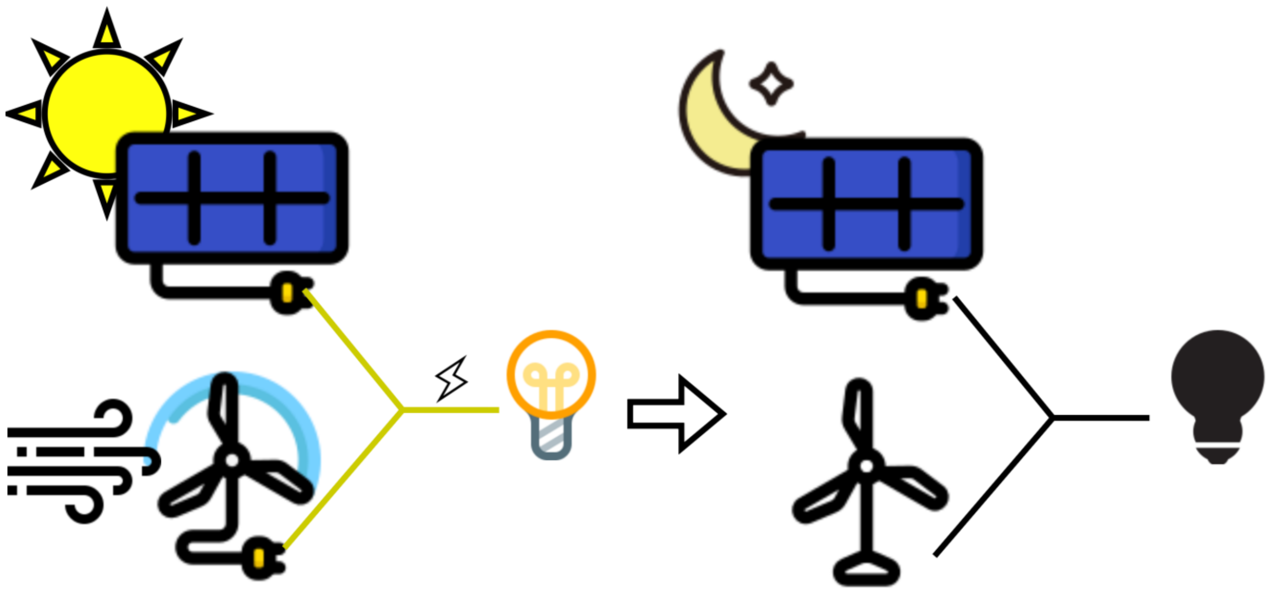
The Path Towards Fossil Fuel Disruption: Predicting Biofuel Costs with a Single Experiment and Thirty Seconds

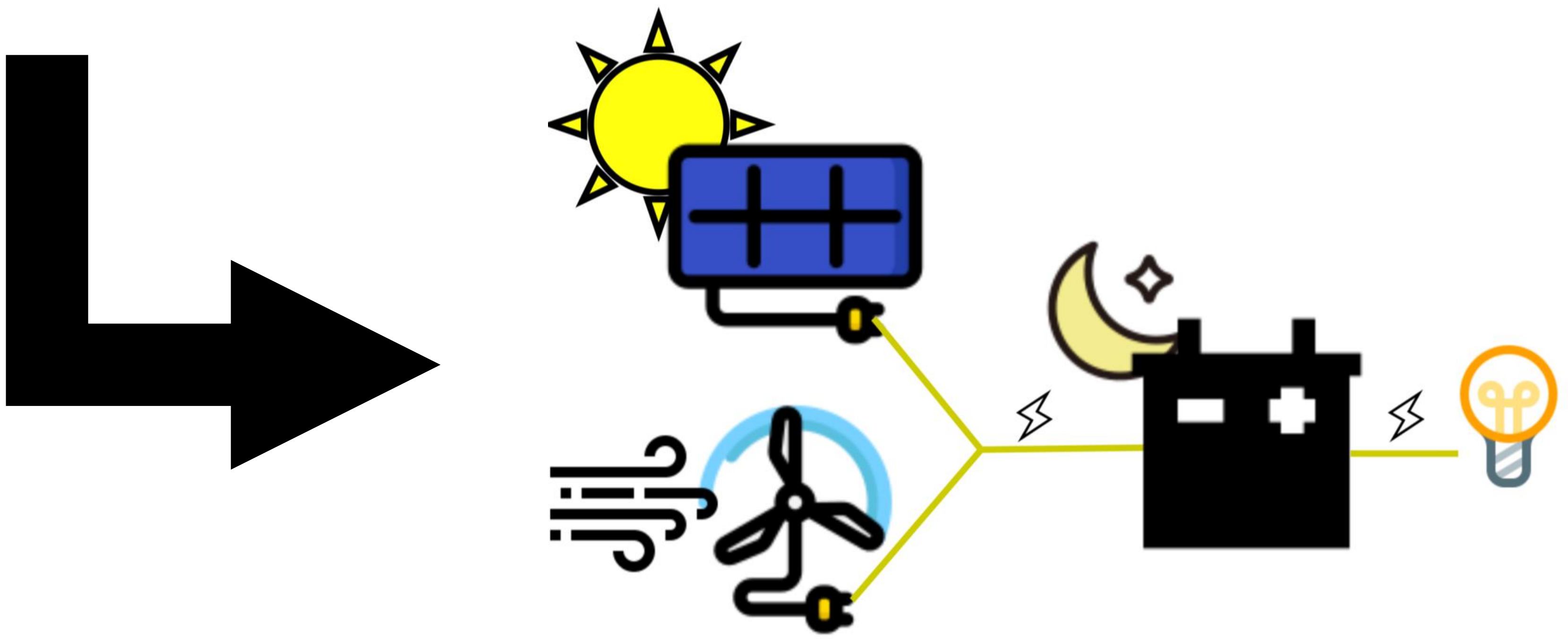
Muntasir Shahabuddin, Dr. Nikolaos Kazantzis, Dr. Michael Timko

Electrification is good, but limited by geography and time

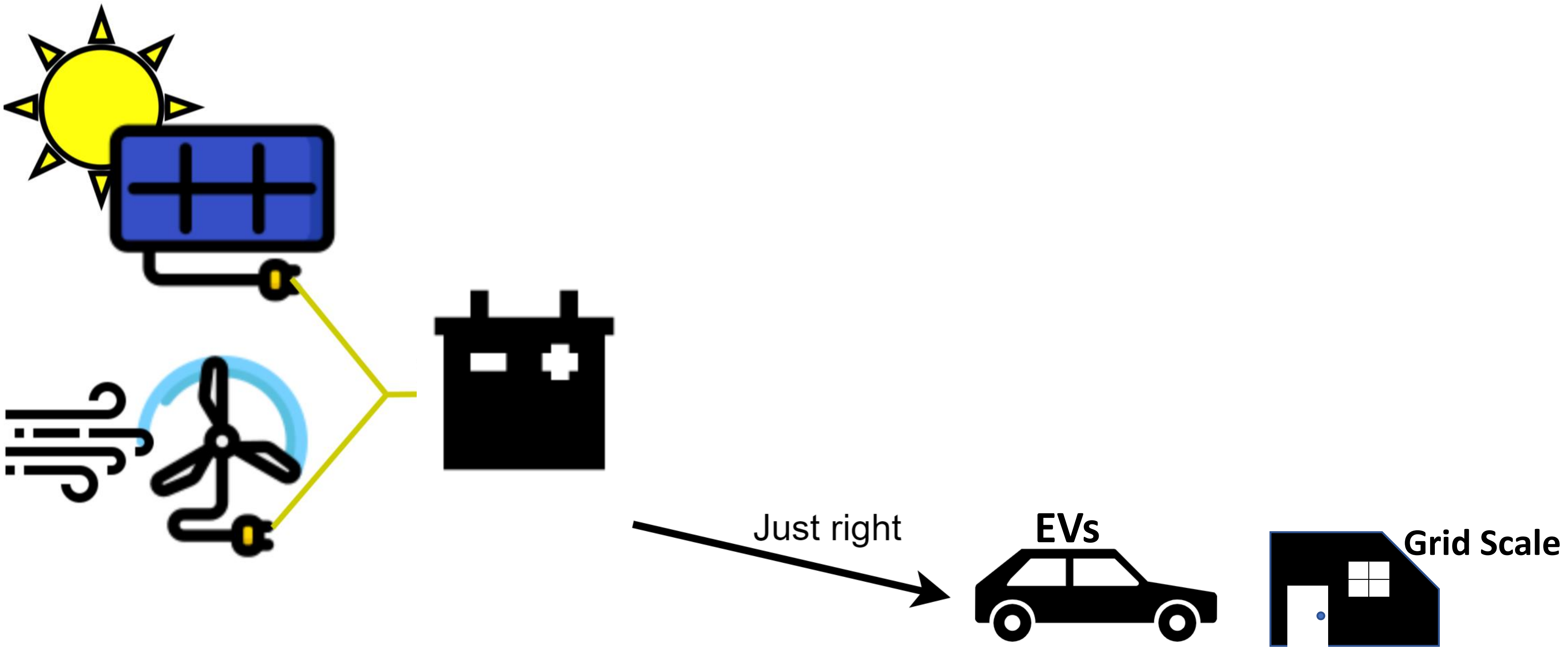




Energy storage lets us store during the day to use energy at night



Electrochemical energy storage works for most applications



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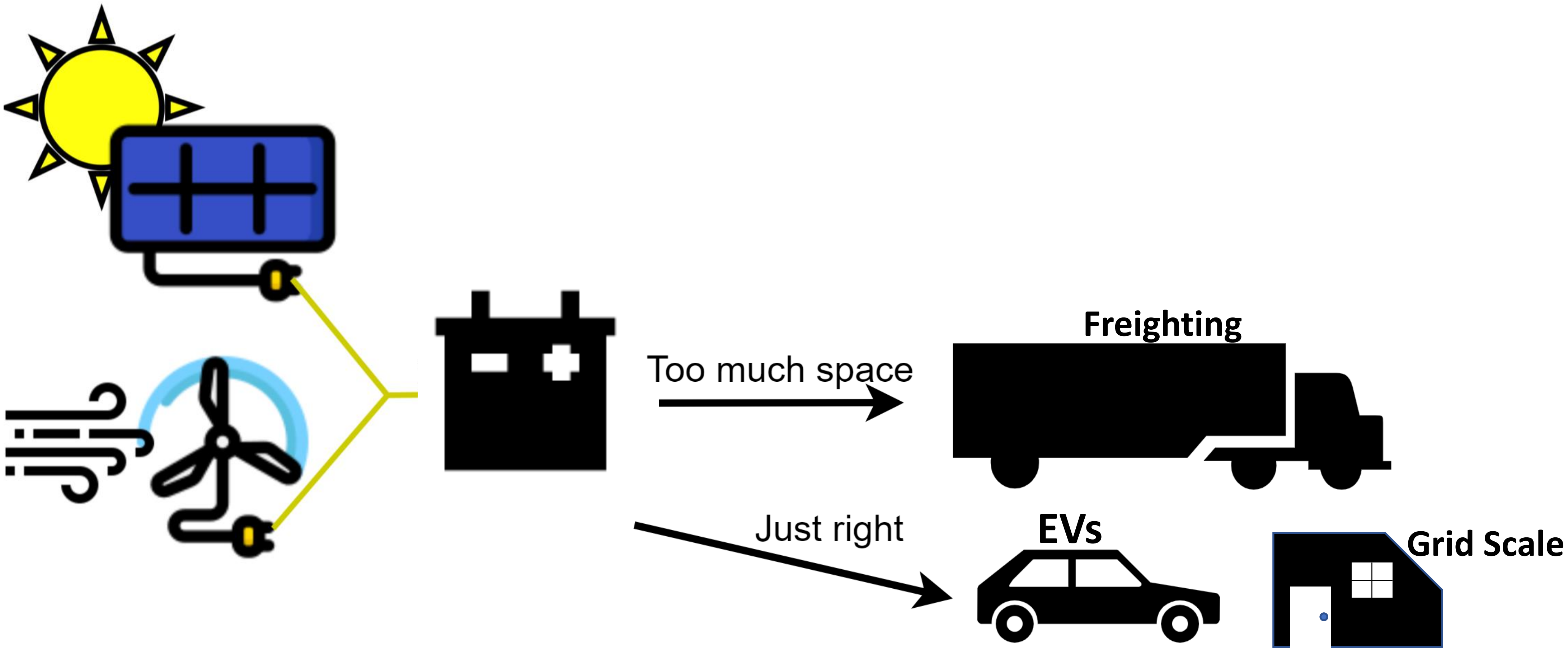

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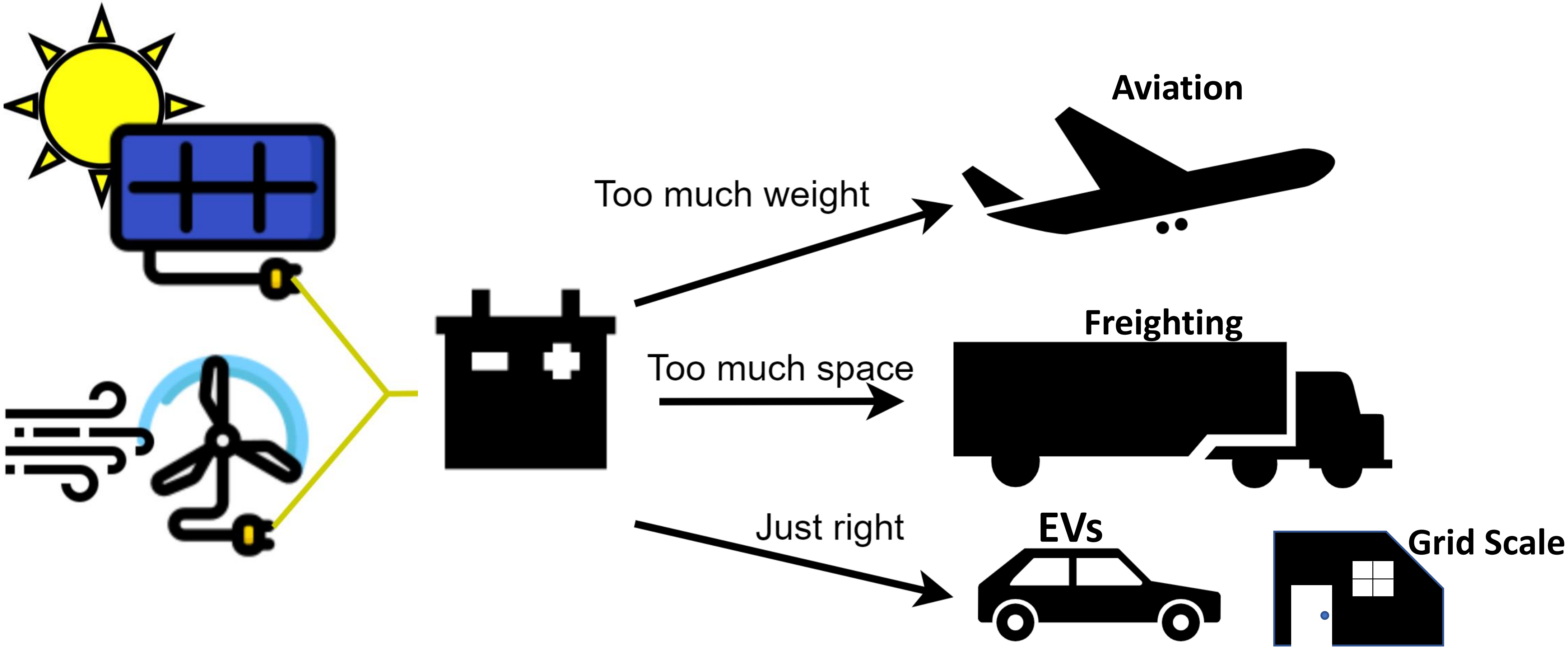
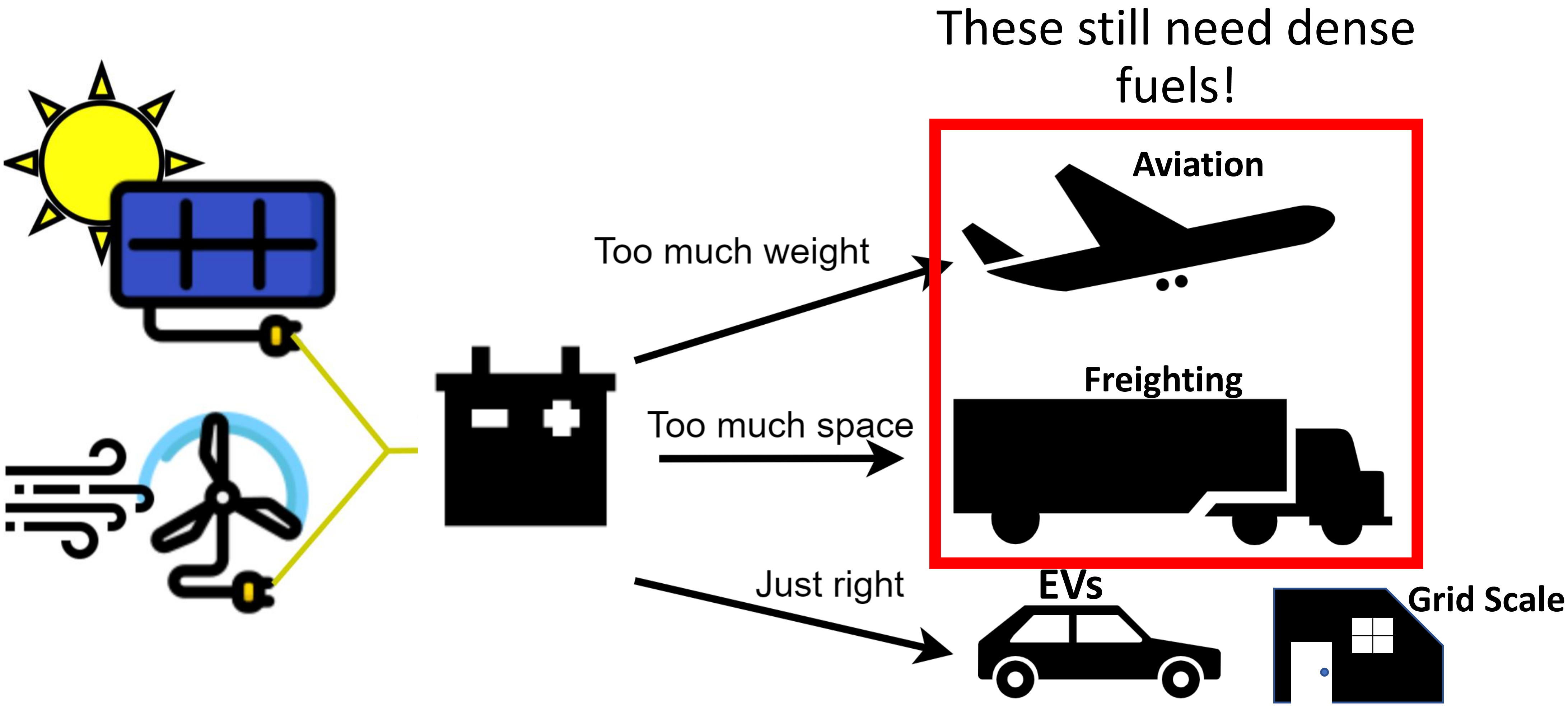
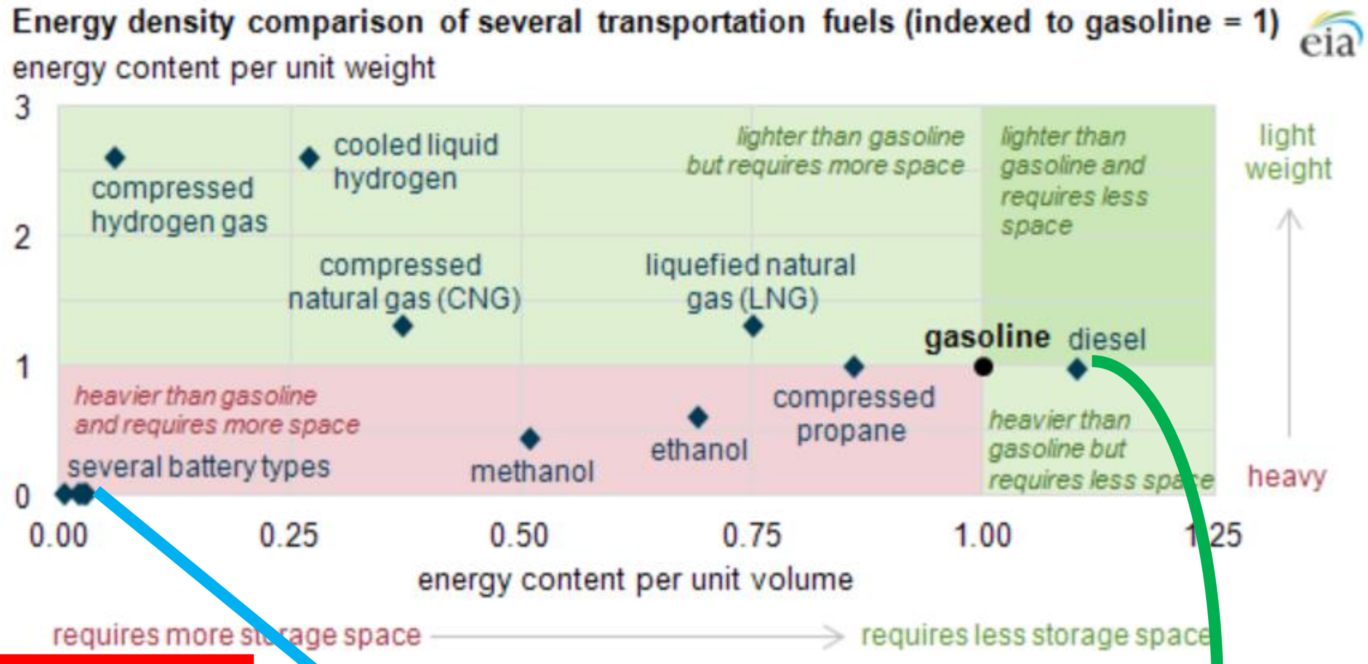
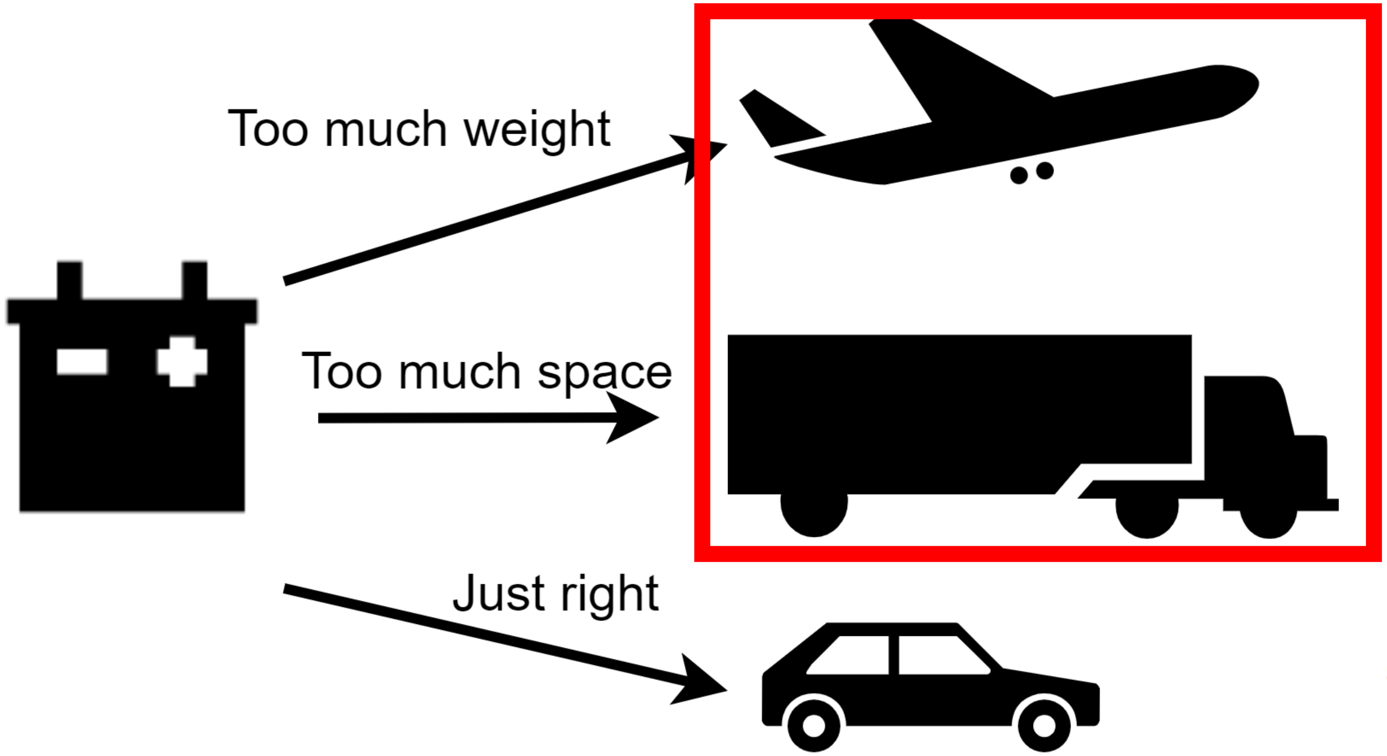



These still need dense fuels!
Aviation
Too much weight
Freighting
Too much space
Just right
EVs
Grid Scale

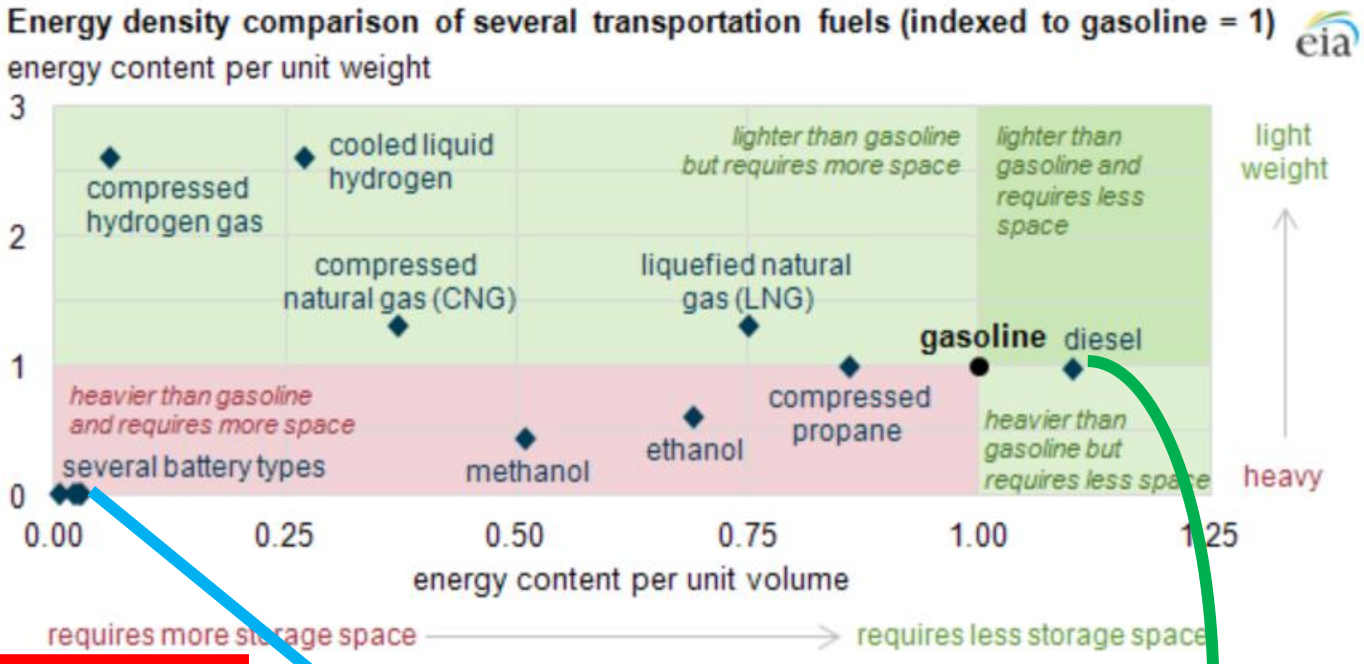


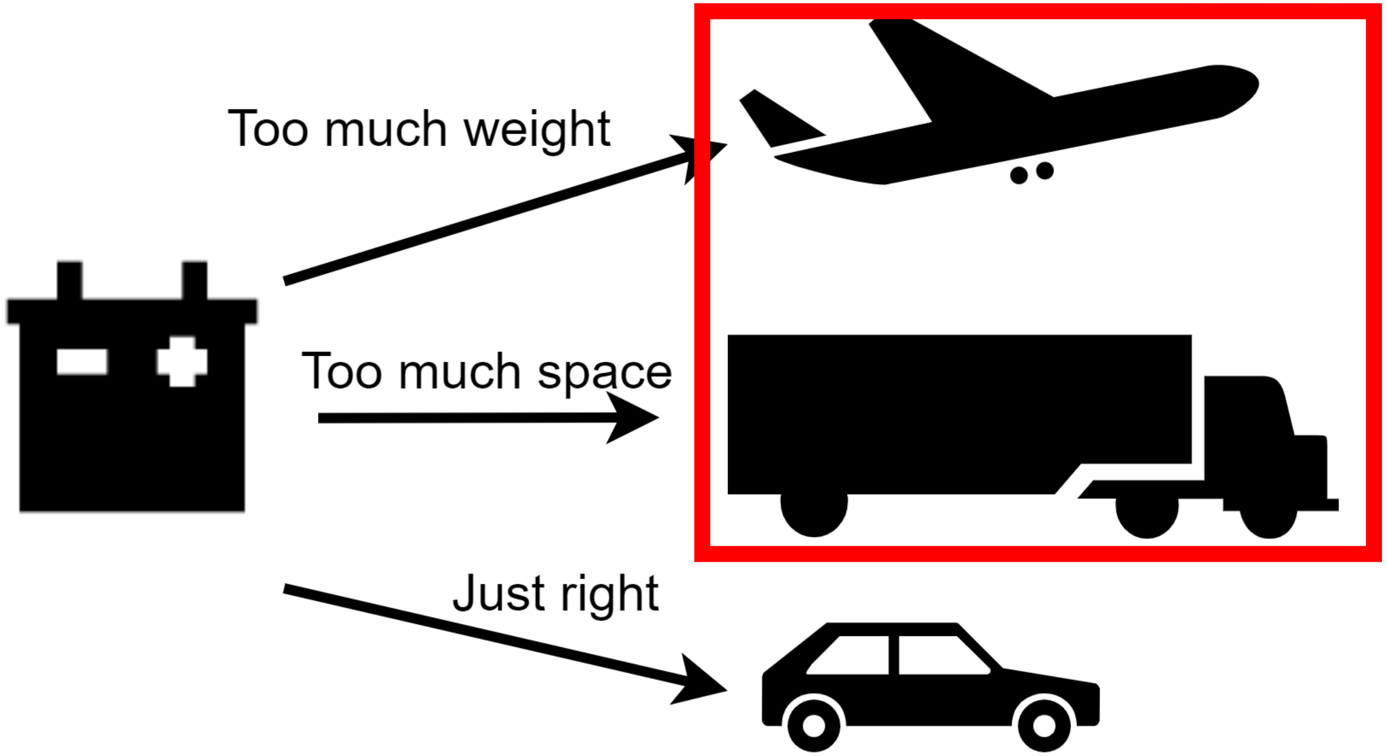
Source: U.S. Energy Information Administration, based on the National Defense University.

These still need dense fuels!



- Batteries struggle to meet the gravimetric and volumetric energy density of hydrocarbon fuels





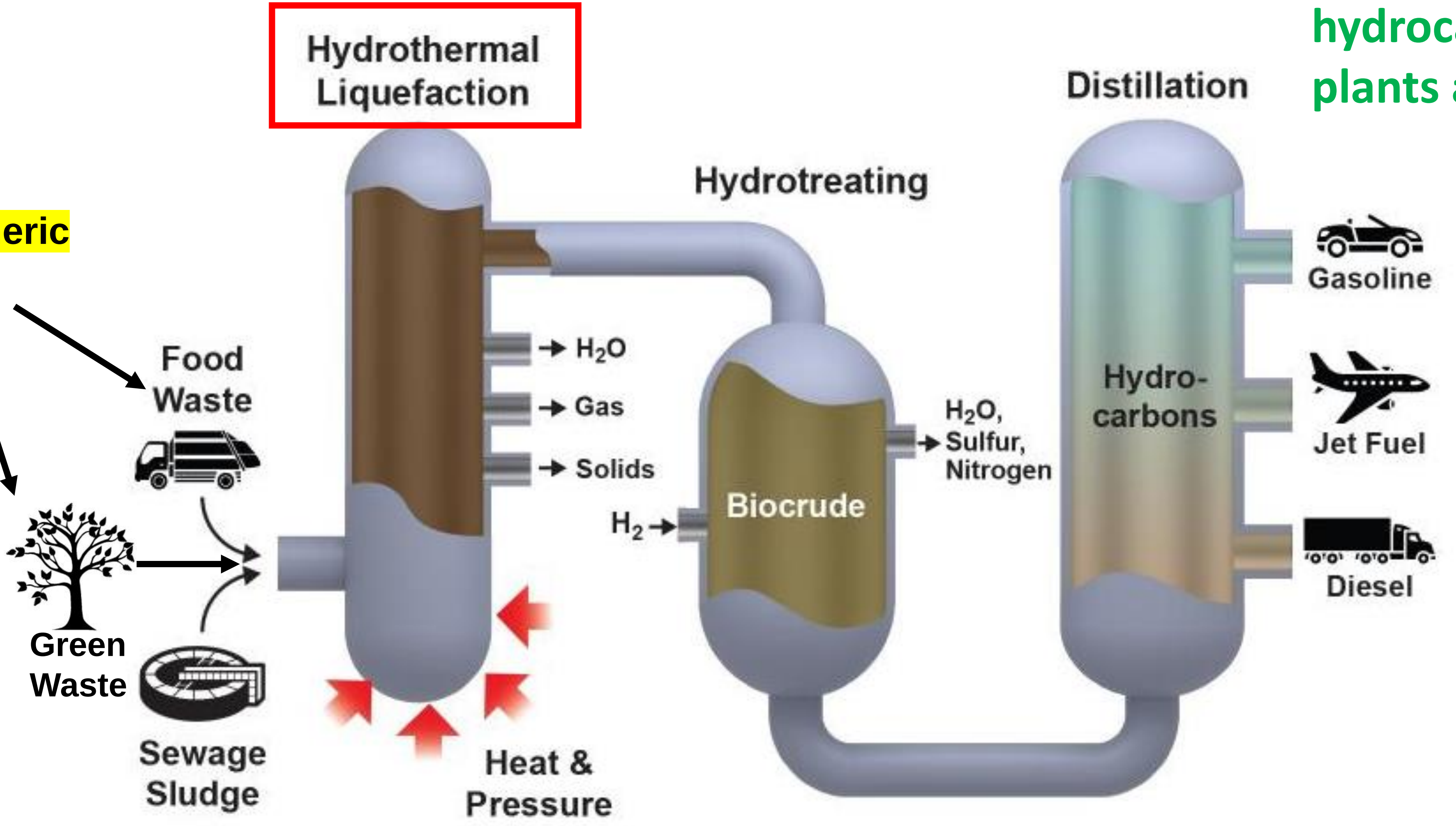
- **Batteries** struggle to meet the gravimetric and volumetric energy density of hydrocarbon fuels

But…hydrocarbon fuels are what got us into this mess. Are we just screwed?

This is the new tech that we study

We can produce hydrocarbon fuels from plants and waste!

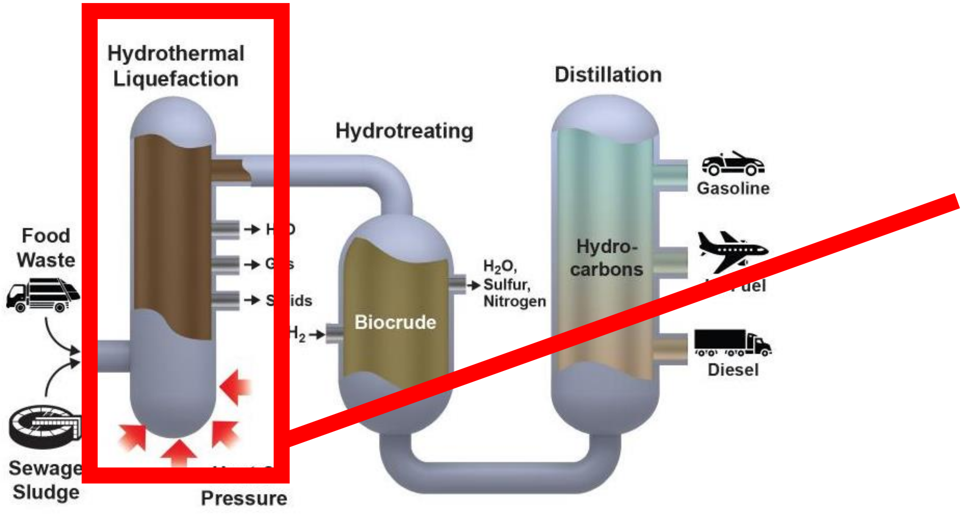
Atmsopheric CO_2



Atmsopheric CO_2

(Illustration by Michael Perkins | Pacific Northwest National Laboratory)

But the fossil fuel industry is mature and widespread. How can we deploy HTL to compete economically with fossil fuels?



If we build HTL plants, we need to know how much they cost through Techno-Economic Analyses

How much would the resulting fuel cost if we made it via HTL?

Contents lists available at ScienceDirect

Algal Research

journal homepage: www.elsevier.com/locate/algal

Techno-economic uncertainty quantification of algal-derived biocrude via hydrothermal liquefaction

Yuan Jiang*, Susanne B. Jones, Yunhua Zhu, Lesley Snowden-Swan, Andrew J. Schmidt, Justin M. Billing, Daniel Anderson

Pacific Northwest National Laboratory, 902 Battelle Blvd, Richland, WA 99352, United States

Contents lists available at ScienceDirect

Energy Conversion and Management: X

journal homepage: www.sciencedirect.com/journal/energy-conversion-and-management-x

Development of a mobile, pilot scale hydrothermal liquefaction reactor: Food waste conversion product analysis and techno-economic assessment

Aersi Aierzhati [a], Jamison Watson [a], Buchun Si [b], Michael Stablein [a], Tengfei Wang [c], Yuanhui Zhang [a,*]

[a] *Department of Agricultural and Biological Engineering, University of Illinois at Urbana-Champaign, Champaign, IL, United States*
[b] *Laboratory of Environment-Enhancing Energy (E2E), Key Laboratory of Agricultural Engineering in Structure and Environment, Ministry of Agriculture, College of Water Resources and Civil Engineering, China Agricultural University, Beijing, China*
[c] *Faculty of Geosciences and Environmental Engineering, Southwest Jiaotong University, Chengdu, China*

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

Techno-economic analysis of liquid fuel production from woody biomass via hydrothermal liquefaction (HTL) and upgrading

Yunhua Zhu [a,*], Mary J. Biddy [b], Susanne B. Jones [a], Douglas C. Elliott [a], Andrew J. Schmidt [a]

[a] *Pacific Northwest National Laboratory, Richland, WA 99354, USA*
[b] *National Renewable Energy Laboratory, Golden, CO 80401, USA*

Conceptual Biorefinery Design and Research Targeted for 2022: Hydrothermal Liquefaction Processing of Wet Waste to Fuels

December 2017

LJ Snowden-Swan
Y Zhu
MD Bearden
TE Seiple
SB Jones
AJ Schmidt
JM Billing
RT Hallen
TR Hart
J Liu
KO Albrecht
SP Fox
GD Maupin
DC Elliott

NREL

Process Design and Economics for the Conversion of Lignocellulosic Biomass to Hydrocarbons:
Dilute-Acid and Enzymatic Deconstruction of Biomass to Sugars and Biological Conversion of Sugars to Hydrocarbons

R. Davis, L. Tao, E.C.D. Tan, M.J. Biddy, G.T. Beckham, and C. Scarlata
National Renewable Energy Laboratory

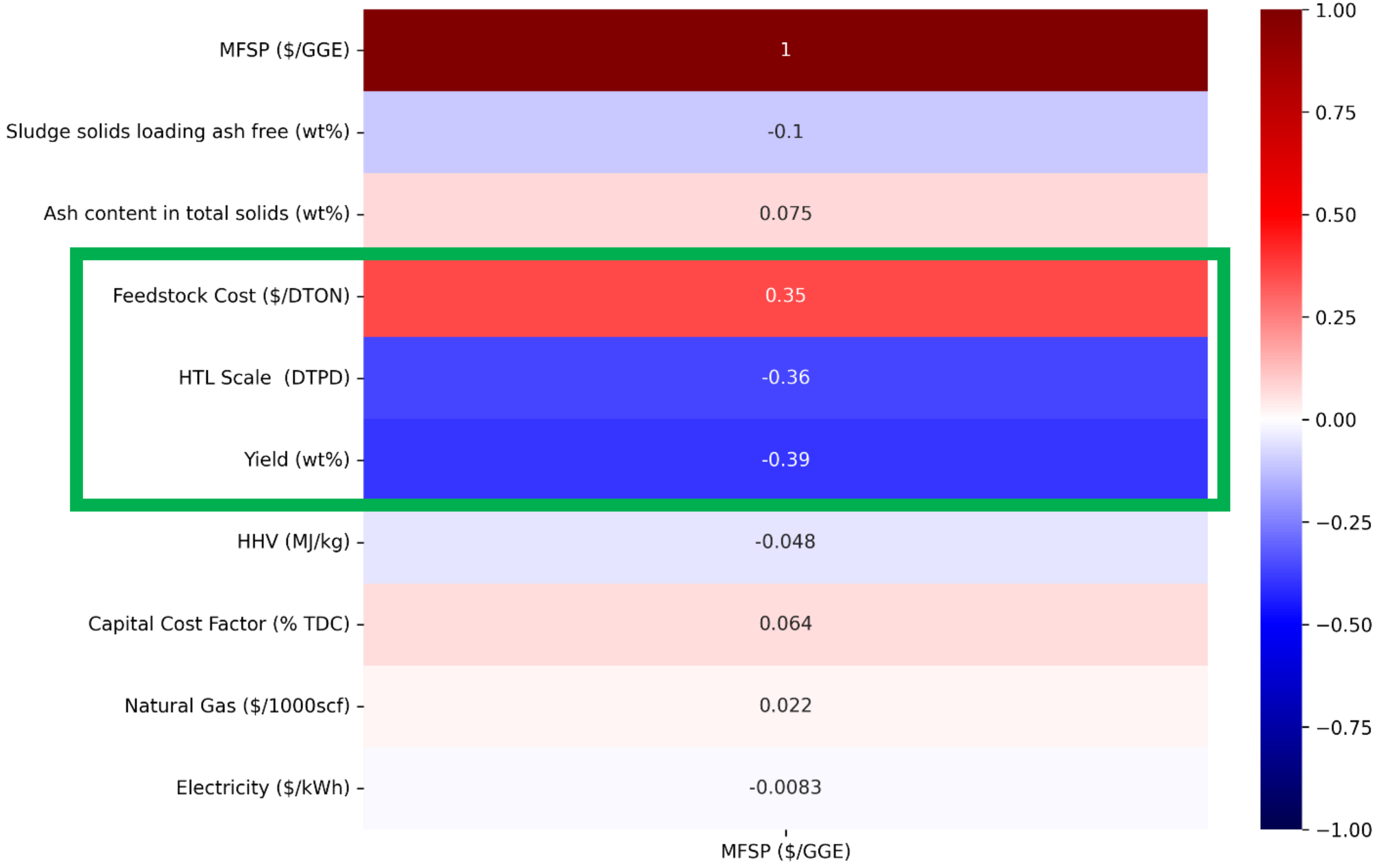
J. Jacobson and K. Cafferty
Idaho National Laboratory

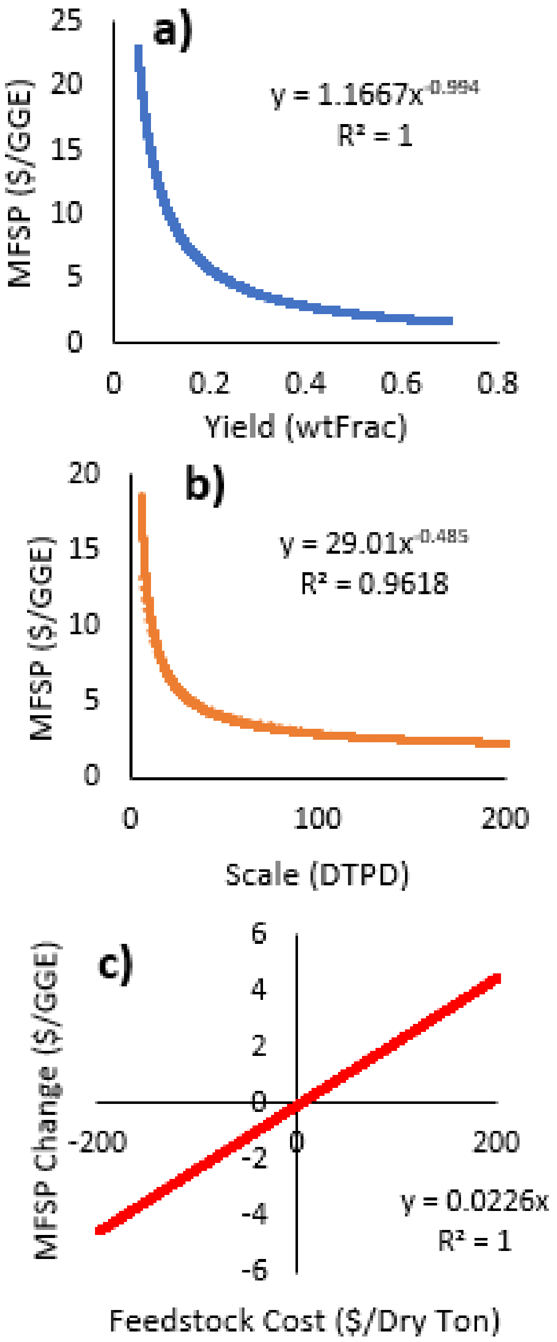
J. Ross, J. Lukas, D. Knorr, and P. Schoen
Harris Group Inc.

Is there a way to estimate the fuel cost outcomes of a new HTL plant with almost no time investment?

- Determine most sensitive variables
- Elucidate relationship between variables and fuel cost
- Regress model
- Quantify error against published TEA data

Dimensionality reduction – which variables are most significant?

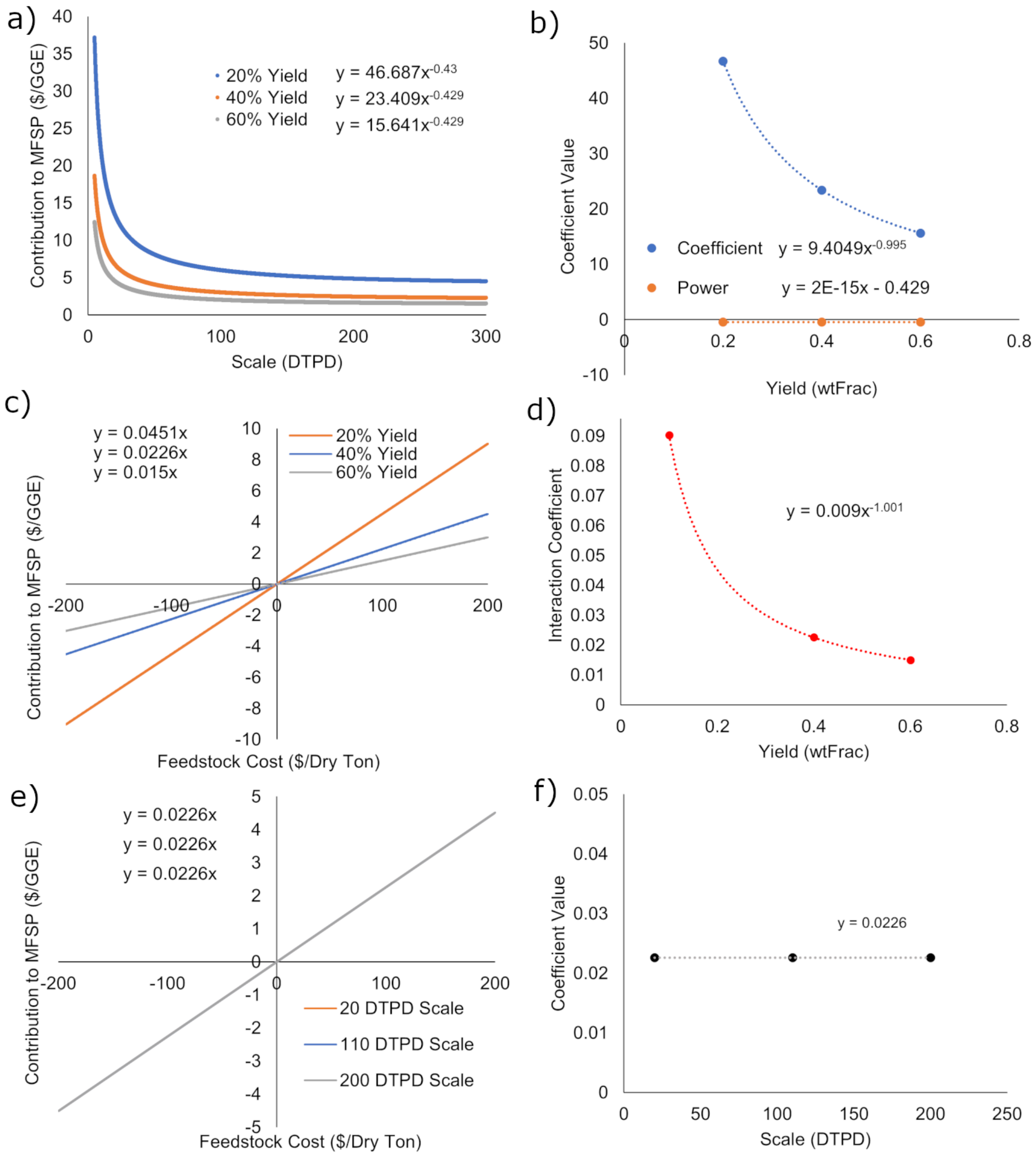




Yield has an inverse relationship w/ fuel cost because direct relationship with fuel production

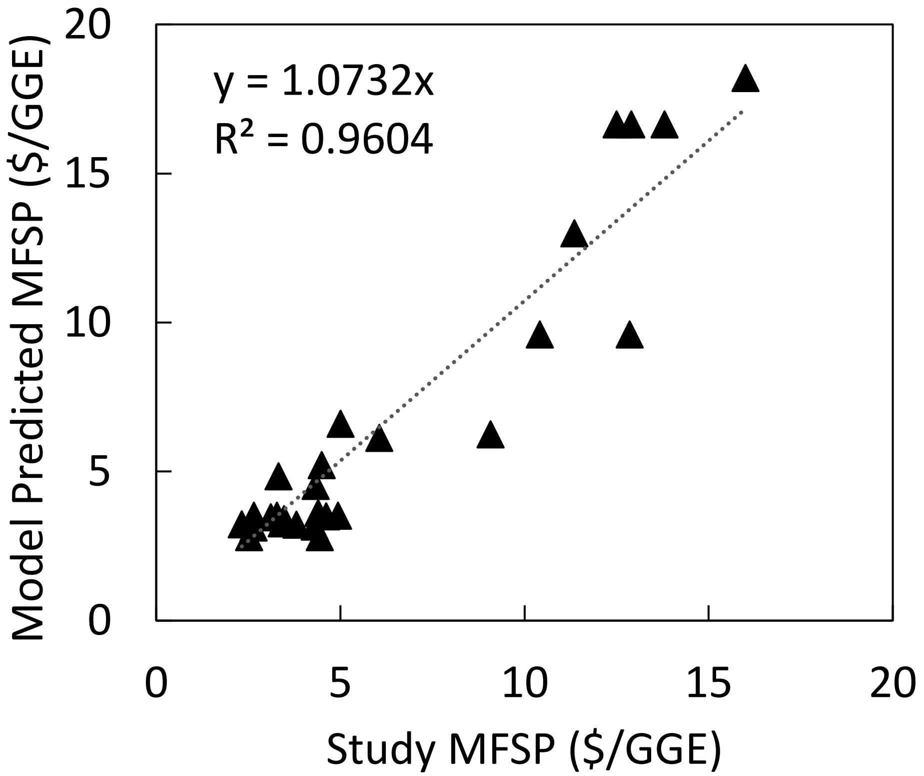
Economies of scale

Linear change in operating cost



$$MFSP = 6.607 * (Scale, DTPD)^{-.6577} * (Yield, wtFrac)^{-1.195} + 2.698 + 0.4268 * (Yield, wtFrac * 100)^{-1.062} * \left(Feedstock\ Cost, \frac{\$}{dry\ ton}\right)$$

Wow now we have a relationship for the variables how does it compare to real TEA data?



Statistical Metric	Value	Unit
Number of Points Considered	27	-
Mean absolute Error (MAE)	1.32	$/GGE
Root Mean Squared Error (RMSE)	1.74	$/GGE
Mean % Absolute Deviation	20.4%	-
Std. Dev. of % Abs Dev.	12.2%	-
Max % Absolute Deviation	45.9%	-
Min % Absolute Deviation	1.4%	-

How can we apply this?

$$MFSP = 6.607 * (Scale, DTPD)^{-.6577} * (Yield, wtFrac)^{-1.195} + 2.698 + 0.4268 * (Yield, wtFrac * 100)^{-1.062} * (Feedstock\ Cost, \frac{\$}{dry\ ton})$$

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Fuel cost = $3.35/gallon gasoline equivalent!

Of decentralized, depoliticized, low carbon-intensity hydrocarbon fuel

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