# *Positive Environmental Impacts from Reduced Levels of Energy Transportation – A Hidden Benefit of Self-Sufficiency?*

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## Overview

The move towards US energy self-sufficiency encompasses the idea of using energy where it is sourced. This echoes the move towards community based energy systems with distributed electricity production and mini-grids and shares common features with the move towards short food supply chains. The geographic concentration of sourcing, production and consumption can have positive environmental impacts, from reduced transport and also from reduced transport infrastructure needs, but these benefits remain 'hidden' in many real-life cases because of inconsistencies in the way we assign value to the environmental externalities associated with transport.

This study looks at two specific cases of energy sourcing to identify the incentives and measurement tools used to encourage positive environmental choices, with a focus on how transport is incorporated into our environmental evaluation models. The cases analysed here are:

A. A power plant in the region of York in England that replaced local coal with wood pellets shipped from the USA and Canada as fuel for electricity generation;

B. Renewable diesel and biodiesel fuels made from used fats in Asia or Europe and shipped to California as part of the Low Carbon Fuel System program.

These cases were chosen because they both involve the use of sophisticated environmental evaluation models (the BEAC and CA-GREET models) that explicitly take into account the life cycle equivalent carbon emissions related to transport. In both cases the transport emissions vary significantly between the scenarios but remain peripheral in the choice of alternatives as the key driver is the production process technology: electricity generation from coal or wood in Case A and variations in the fat rendering process and the type of energy used to drive this process for biofuel production in case B.

Both of these cases illustrate 'carbon leakage': the supplying country and the international transport space increase their carbon emissions to facilitate reductions in the final-use country. In theory we could reduce worldwide carbon emissions even more by using these low carbon fuels closer to the source (there is coal based electricity production in North America and Asia is a major user of transport fuels, mostly imported fossil fuels), but this doesn't happen because local subsidies in the end-use countries assign a significantly higher value to these fuels than the local markets do. This is an example of the 'wide discrepancies in the implicit price of carbon put on different emissions' through 'local Command and Control' policies discussed by Jean Tirole in his recent paper on Carbon Pricing.

The overall stakes of the potential for environmental benefits from the shorter fuel supply chains that increased national and regional energy self-sufficiency would bring are demonstrated by the importance of long distance transport of oil and coal which makes up 15% - 20% of worldwide ocean freight.

## Methods

This paper is a case study based on published models and study evaluations, and supplemented by a discussion with Michael Wang at the Argonne National Laboratory. The primary data comes from two publically available Excel models that provide excellent evaluation tools for transportation costs (among other things): the BEAC model from the UK DECC and the CA-GREET model used in the California LCFS program and based on the GREET model from Argonne National Laboratory.

The analysis focuses on life cycle ('well to wheel') evaluations of greenhouse gas emissions, measured as carbon dioxide equivalent emissions and referred to throughout as 'carbon emissions'. The life cycle evaluation includes multiple stages of transportation required to cover all aspects of the fuel sourcing process from the setup of the extraction site to the delivery to the final user.

This analysis does not assign a monetary value to carbon emissions, but assumes that each tonne of equivalent carbon emitted has the same environmental 'cost' no matter where the emission occurs. We mention in passing some of the related environmental issues (particulate pollution from coal, deforestation from woody biomass usage, indirect land use issues for biofuels and the food versus fuel conflicts) but the term 'positive environmental impacts' in the title refers to the possibility of reduced carbon emissions from fuel transport.

## Results

In Case A, the carbon emissions from transport (forest to pellet plant to England to York power plant) vary from 30 to 57 kg $CO2_e$ / mwh for the different sourcing options analysed (all North America to England), and the energy input to output ratio varies from 1 to 10 to 1.9 to 10. The carbon emissions of electricity production for the site are less than 200 kg $CO2_e$ / mwh for wood and 854 kg $CO2_e$ / mwh for coal, so the fuel choice impact overwhelms the transport impact, but the case nevertheless illustrates that transport to the site accounts for up to 16% of the total energy use (=1.9 / 11.9) and up to 22% of the final carbon emissions (=57 / 257).

For the used fats converted to renewable diesel and biodiesel fuels and sold in California, analysed in case B, the carbon emissions from transport vary from .33 to 2.29 kg $CO2_e$ / gallon and make up 7% to 48% of the total carbon emissions. The transport emissions directly impact the amount of the LCFS credits (which are a form of carbon payment) in all cases, but the penalty of long transport distances is compensated by gains from optimized production processes and effective management of indirect land use trade-offs so some of the major suppliers to the program are successful despite long and complex fuel supply chains.

| Comparitive values for Cases A and B - emissions for life cycle transportation only - sorted by gCO2e/MJ | | | | | |
|---|---|---|---|---|---|
| Scenario | Short Description | kg CO2e/mwh | kgCO2e/gal | kgCO2e/Mbtu | gCO2e/MJ |
| BEAC 32 | wood locally sourced in the UK | 2 | | 0.59 | 0.56 |
| LCFS Def | Default Dec12 Tallow Calif | | 0.33 | 2.41 | 2.28 |
| LCFS 48 | Dansuk S. Korea Mar13 UCO | | 0.51 | 3.68 | 3.49 |
| BEAC 1 | wood pellets from Southern USA | 32 | | 9.38 | 8.89 |
| LCFS 40 | RD Tallow Aus. Mar13 | | 1.41 | 10.28 | 9.74 |
| LCFS 175 | Biocom Spain Nov15 UCO | | 1.47 | 10.72 | 10.16 |
| BEAC 19 | same as 1) + indirect Brazil to USA | 53 | | 15.53 | 14.72 |
| LCFS 181 | Neste Mixed UCO Nov15 | | 2.29 | 16.69 | 15.82 |
| BEAC 9 | wood from British Columbia | 57 | | 16.71 | 15.83 |

## Conclusions

There are environmental benefits from reducing energy transport but these benefits are overshadowed by production technology choices. The use of life cycle carbon emissions calculators in project analysis and supplier qualification provides data on these impacts, and decisions made using these tools respond fairly well to standard criteria of economic efficiency. However, the overall economic choice process is distorted by the selective application of subsidies and carbon pricing in certain jurisdictions and leads to significant 'carbon laundering' phenomena and other regional distortions like deforestation. In addition, these environmental programs consume taxpayer money in the initiating countries and regions and generate public demand for tools to actively promote various forms of national preference.

The challenges that led to the creation of the tools analysed here remain in force and we will continue to face difficult choices around coal, wood, and biofuels in North America, Europe and Asia in the coming decade. The tools analysed here enable us to understand the transport impacts of our choices. These tools will continue to assist in future decisions but will not by themselves trigger a change in direction towards the shorter fuel supply chains implied by energy self-sufficiency and the incumbent improvement in input/output ratios. This change can only come from a conscious choice to pursue this objective. These tools will then assist us in measuring our progress.

## References *(partial list – see Proceedings Paper for full list of sources and footnotes)*

Dr Anna L. Stephenson and Professor David J. C. MacKay, "North American Woody Biomass for Electricity Generation in the UK" (2014), published by HMG DECC and the 'Bioenergy Emissions and Contrafactual Model' (BEAC) of the UK Department of Energy and Climate Change: https://www.gov.uk/government/uploads/system/uploads/...data/.../beac_2015.xlsm

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Tirole, 2016, 'Carbon Pricing', paper from the French government Sustainable Development website http://www.developpement-durable.gouv.fr/IMG/pdf/Carbon_pricing_Jean_Tirole_June_10_2016.pdf