

Electricity Generation Mix by US Industrial Sectors: Disaggregating Electricity Generation and Modeling Interstate Transfers

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The environmental life-cycle impacts of a product, process or industry sector tend to be dominated by energy-related impacts, specifically electricity generation. The impacts from the electricity generation sector occur in the form of air pollution, fuel use, and global warming. It is important to have good measures of these impacts in order to quantify the possible implications for health, environment, economy, etc.

However, most current analyses which include electricity generation use aggregate measures for electricity generation mix and a great deal of detail is lost at the plant or state level. For example, in EIO-LCA (www.eiolca.net), all sectors consuming electricity are assumed to use the United States' average electricity mix which is largely fossil-fuel based – over 50% coal. However, certain sectors – based either on their geographical location or other factors – buy electricity with very different generation parameters than those of fossil fuel-based electricity. A good example of this would be aircraft manufacturing in the Pacific Northwest, which may purchase and use more than 80% hydroelectric power, which, in turn, would have a significant impact on the generation mix of the entire industry sector.

Existing data which places percentages of industry sectors in each state using Department of Commerce facility location, employment and shipment data is combined with electricity generation mix data from the Department of Energy to produce a sector-by-sector accounting of the *usage* mix as opposed to a single set of national values for generation mix. Also a part of this approach is the inclusion of an estimate of interstate electricity trading; in many cases the inclusion of import and export data has significant effects on the electricity consumed within the state. California, for example, uses over 30% imported electricity, much of which is coal generated.

The estimate of interstate trading is a physical one, based on the principle that electricity will flow along the least resistive (shortest) path from source to sink. An economic model using transactional, plant-level data would be less accurate from a usage standpoint: electrons generated in Canada will not make a point of traveling to California, simply because that is where they were purchased from. The method used is a linear optimization which minimizes a total “travel” cost by calculating two matrices – the first of which is a distance matrix that uses both “hop count” or, alternately, mileage, and second which is the amount of electricity exported from each state with a surplus to each state with a deficit.

These updated sector usage/generation mixes can then be used to derive a much more accurate picture of the effects of the electricity sector in life cycle analyses and an estimate of the total electricity needed across the supply chain to produce a particular product or service can be estimated – but with full sector-level generation mix detail. Of course, the more diverse the supply chain, the more the electricity mix of that product trends towards the US average, but there are some specific cases where significantly different effects are found. There are many relevant public policy concerns with such data, such as determining which sectors would be most sensitive to energy taxes, carbon taxes, etc. When the model is combined with historical facility location and state generation mix data trends can be analyzed, particularly effects of deregulation or shift in generation types. This paper reports on the progress and research results of this project and shows how they can be used to better inform decisions in the policy arena.