

## Energy Balance in India's International Trade: An Input-Output Based Analysis

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Regardless of the impact on environment, whether positive or negative, literature recognizes the growing volume of trade and the emissions (due to energy use) embodied in trade. Although studies acknowledged the importance of non-energy manufactured goods, the growing integration of international supply chains further emphasizes role of international trade in the changing energy use. In view of the increasing emissions embodied in trade, it is not appropriate to make sweeping generalizations on the impact of trade on environment. The energy balance due to embodied use could be significant for trade dependent economies. Also, it is difficult to predict *ex ante* the direction of energy balance for countries with varied compositions of exports and imports in terms of energy intensity of the traded products. And, India is a befitting case here due to the dissimilar structure of its exports and imports. We estimate the balance of embodied energy in India's international trade to study the key research objectives for the Indian economy: i) Are the energy balance and trade balance necessarily in same direction, ii) How has the energy balance performed over time with increasing openness of the economy, and iii) What are the sector-wise contributions to energy balance. The creation of a separate sector representing non-thermal electricity for analysis is another contribution of the present research. Non-thermal electricity, which essentially represents hydro electricity, has an increasing significance in the Indian economy. Although, electricity *per se* is not traded significantly in India, its embodied use across sectors of production improves the estimates of energy balance. Most existing studies exclude an electricity sector for analysis due to its dominantly thermal based generation. However, the present paper makes novel efforts to separate out the non-thermal component which is likely to expand in future given the growing emphasis on sustainable growth. The use of separate price deflators for output, export, imports and intermediate use for each of the sectors of analysis, is another highlight of the paper which is useful to obtain improved estimates. Also, the analysis has a sufficiently wide reference period which facilitates inter-temporal comparison. The methodology of this paper makes use of hybrid I-O as formulated by Miller and Blair (2009). Based on the location of the production and consumption of a commodity, products are classified into four categories (Lin and Sun, 2010). The energy and energy intensive sectors are identified for the analysis. The analysis is based on the four successive benchmark IOTTs. While it is a common practice to deflate the values of aggregated sectors, we have computed, mapped and obtained deflators for each of the 130 sectors. This is further helpful in obtaining robust price indices in instances where the commodities within a sector have noticeably different values of the price index. Our results for India at the aggregate level show overall deficit in energy balance as well as the trade balance through the reference period. Despite a higher value of energy embodied in overall imports (EEI) compared to energy embodied in overall exports (EEE), the growth rates provide an interesting insights. It is observed that over time, the composite energy sector has turned from an energy deficit to energy surplus category. This is primarily on account of India's expanding petroleum sector which registered growing exports. On the contrary, non-energy sector has turned into a energy deficit though it had a relatively insignificant energy surplus in the initial period. This points to the importance of embodied energy in traded goods.