

This research uses the metaphor “The economy is society’s metabolism” as a springboard to develop a rigorous theoretical framework for a better system of national accounts which goes “Beyond GDP” and is relevant to the age of resource depletion. All stakeholders need a new way to understand our economy in the context of the biosphere’s ability to provide essential natural capital, and the authors suggest that detailed information about materials, energy, embodied energy, and energy intensity should be routinely gathered, analyzed, and disseminated from a centralized location to provide markets and policymakers with a more comprehensive understanding of the biophysical economy.

After arguing that the stock of manufactured capital is an important driver of material and energy demands imposed upon the biosphere, a new accounting framework is derived from the laws of thermodynamics to reflect the fact that material and embodied energy accumulate within the capital stock of economic sectors. This framework extends the Energy Input-Output (EI-O) techniques first developed by Bullard, Herendeen, and others to estimate energy intensity of economic products. Implications from the new framework are discussed, including the value of economic metrics for policy-making, the need for physically-based rather than product-based EI-O formulations, a re-assessment of the concept of economic “growth,” and an evaluation of recycling, reuse, and dematerialization. The framework also provides an opportunity to assess an array of definitions for Daly’s “steady-state economy” in relation to the ideal of a sustainable economy.

This work: presents an improved methodology for input-output modeling, which is the current basis of national accounting used by the U.S. Bureau of Economic Analysis (BEA); provides a concrete linkage between energy input-output modeling and BEA national accounting; develops an input-output methodology that is fully consistent with 1st and 2nd Laws of Thermodynamics; and uses input-output flows of material and energy and capital accumulation within the US automobile industry to illustrate the new methodology. It ends with a list of steps to be taken toward creating a more comprehensive system of national accounts:

- National accounting agencies worldwide should develop and maintain balance sheets of both natural and manufactured capital in addition to national income statements,
- All stocks and inter-sector flows should be provided in physical as well as financial units,
- In the US, the Bureau for Economic Analysis (BEA) should restart detailed Capital, Labor, Energy, Material, and Services (KLEMS) reporting,
- National accounting agencies should routinely estimate the energy intensity of economic products,

and all of the above should be estimated and disseminated on an annual basis.

Keywords: Bio-economics - Biophysical economics - Direct energy flows - Eco-thermodynamics - Ecological economics - Economic growth - Embodied energy flows - Energy flows metabolism - Energy intensity - Industrial ecology - Input-output analysis - Life cycle assessment - Macro-economics - Material flow analysis - Material flows - Metabolic economy - National accounting - Net Energy analysis

Related subjects: Ecology - Energy Technology - Environmental / Development / Agricultural Economics - Policy, Economics, Management & Transport - Sustainable Development