Previous frameworks for both economic and energy input-output (I-O) modeling have made the assumption that flows into and out of each economic sector balance, meaning that there is no accumulation of economic factors—resources, labor, capital—or embodied energy within any of the sectors. This may be an adequate assumption for a sector of the economy operating at `steady-state'. However, the assumption introduces errors in energy intensity estimates (e.g., kilojoules required per dollar of economic output) in analysis of sectors that are growing rapidly, or any sector that has a non-negligible proportion of input factors (with their associated embodied energy) accumulating as capital within the sector. This issue takes on particular importance as modern societies encounter fossil fuel depletion-induced energy transitions and move toward “greener” economies via voluntary carbon emissions reductions.

Development of manufacturing facilities for new goods during a technological transition (e.g. rapid transition to electric vehicles) requires a high rate of capital investment. This capital investment increases materials and energy embodied within the sector itself. The traditional I-O framework assumes no change in economic structure, i.e. no accumulation or depreciation of capital and no technological change. The previous I-O framework does not account for capital investment (and associated embodied energy) when estimating the energy and resource intensity of the produced goods. Nor does it account for the energy flow rates required during these types of transitions. Thus, the previous I-O framework cannot correctly predict or evaluate the energy requirements of the production ramp-up.

The transient analysis method presented herein provides a better description of physical factors, particularly energy and material flows. It accounts for accumulation of capital stock in economic sectors, thereby providing a dynamic picture of energy and economic transitions. In short, this method provides new tools to help navigate the significant changes underway in modern economies.

An illustrative example that runs through the book is the US auto industry, which is clearly important in any energy transition because transportation consumes a high proportion of liquid fuels and automobile production is a capital intensive endeavour. Thus, major capital investment will be required to support a technological transition away from liquid fossil fuels to renewable energy.

\_\_\_\_ As we change our metaphor from economy as “engine” to economy as “organism,” understanding how economies metabolize materials and energy is essential. \_\_\_\_

An improved understanding of “economic metabolism” can promote better prescriptive formulations as we enter a new regime of economic and social adjustments to a world of finite resources.

* 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.
* Uses input-output flows of material and energy and capital accumulation within the US automobile industry to illustrate the new methodology.