Shining the Light on "Dark Energy":

Systems Energy Assessment (SEA), for a true measure of Business Impacts

J.L. Henshaw[i], Bill Baue ed.[ii]

There's a fascinating mental error contained in the standard measures of resource use and related impacts of business, that I and my colleagues (Cary King and Jay Zarnikau of the University of Texas, Austin) recently identified. It exposes confusion about how businesses work as systems of parts, leaving us in the dark about many of them. Standard methods use business records of their own energy and material purchases for their technology. Similar records from technology supply chains can be obtained too, adding to the total traceable resource demands.

What that omits are the resource demands for the other parts of businesses, the resource demands for services other than technology now not counted. It's also a story of forensic systems science, how we noticed the discrepancy and found a "Scope 4" assessment method to match resource impacts with the products those resources were used to deliver. We found omitted energy use, for example, being commonly 80% of the true total.

The "natural law" used to correct the problem for energy use is graphically displayed in Fig.1, showing global GDP, Energy use, CO2 and economic energy Efficiency all following parallel growth curves. It makes each a good implied measure of the others. By definition an average business's share of the whole economy's impacts will equal its financial share, using a slowly changing ratio from the data. For energy in particular, careful study indicates $1 = "one equal share of the whole" is a generally reliable first estimate. Studying how far from average each business expense is refines the estimate, and lets the traceable and hidden demands to be combined. That fills the big gap between the energy businesses are really using and what we previously had information about.

The international standard assessment methods such as Life-Cycle Assessment (LCA)[iii] and the Greenhouse Gas Protocol (GHG)[iv] count business impacts using available business records. It treats business records as being physical measures of business operation. The error is overlooking that businesses only record what is needed to control their

operations. They don't need to control how the self-managing services they pay for use resources to deliver their service, just the price.

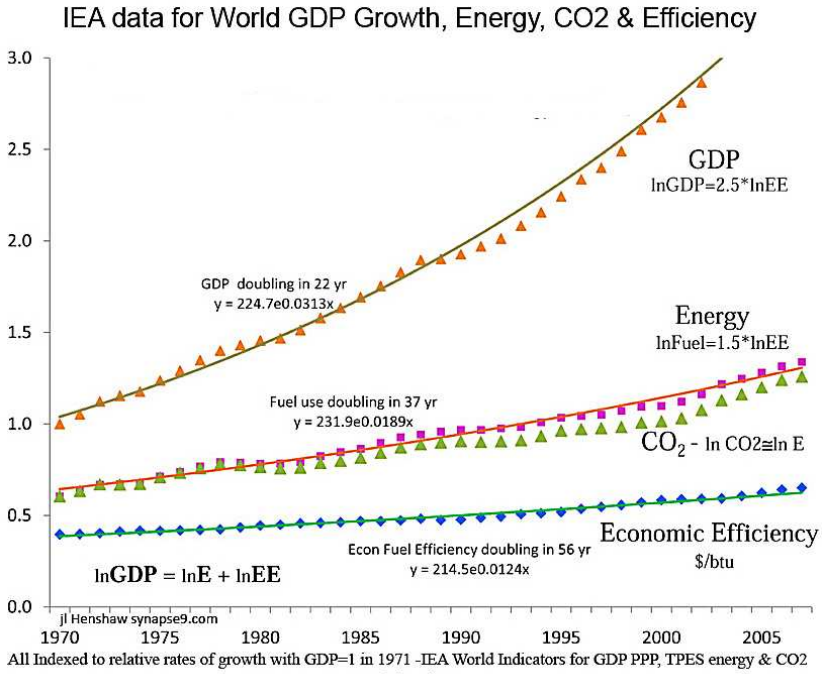
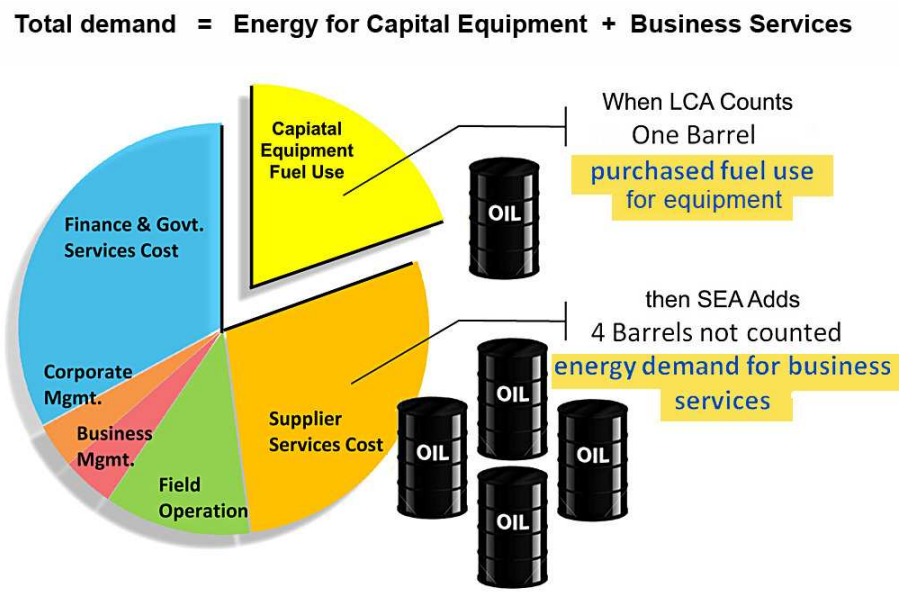


Fig. 1

Because the GDP, energy & CO2 growth curves are parallel, $1 of GDP has implied responsibility for causing a proportional share of the economy's global impacts - Figure 1

My co-authors and I first noticed the problem as a discrepancy between business accounts and world accounts of energy use, studied the problem in detail for a typical 50 turbine wind farm with a 20 year life, and reported results in the paper Systems Energy Assessment(SEA)[v]. The relative energy demand for each part of the business we found is Figure 2.

The outsourced energy uses are from the delivery of services by staff and consultants, the legal, management and engineering costs, non-capital goods, financial services and public services paid for through fees and taxes. Every direct energy cost also has outsourced services attached, like the cost of extracting and delivering fuels that has energy costs too. The rule is that, lacking other information, the implied energy demand for any expense is first counted as "average" as better information is looked for, not counted as 'zero' and ignored.



The SEA case study results. The energy costs for capital investment were only 20% of the total needed to deliver wind energy to market - Figure 2.

I first noticed the omission looking at rough energy use estimates for products and businesses, seeming low and not discussing what might be going uncounted. Comparing with the global average for energy per $GDP too many seemed well below average, even energy intensive products like building construction. That was the tell-tale sign of something very big.

The case study began with an LCA estimate from a government sponsored study for wind farm capital investment costs. We then completed the business model that would be needed to deliver the wind energy to market and investigated all its costs.

Economics has long been both a science of money and of the organization of businesses and economies. So it's surprising that impact assessments counted only one narrow category, the recorded purchases of energy and materials, having receipts to count. Business decision makers are clearly accountable for those purchase decisions, and they do also seem to be the most resource intensive costs. They're just not the only nor the largest source of business energy and other resource impacts.

Business decision makers also purchase and are responsible for employee, professional, and all other services needed to operate, making the business responsible for the environmental costs. While such services are less energy intensive per dollar, they also comprise bigger parts of business budgets. They are usually the source of a business's largest energy demand and source of energy impacts. They were all counted as "zero", instead, as if "no information" had no cost, as one category of resource

demands got called the whole, like counting “apples” and calling them “trees.”

It’s much more than just inaccurate. It creates total misconceptions, as if businesses might reduce energy demands by simply outsourcing, thereby hiding impacts in purchased services. Measurement errors of this type, on the scale of 500 percent and larger, are apparently occurring in both quantitative and qualitative metrics of business sustainability generally. Even comparing similar businesses for the same metric becomes hard to define, as the uncertainty of the built-in undercount will be easily as large as the total included count.

Why economists didn’t approach the study of businesses as physical systems, and didn’t use physical science methods of measurement, has lots of reasons. It’s fairly traditional to treat our information as reality, and to find it hard to know what we’re missing. So the vague questions that arose may have seemed unimportant to pursue. Now anyone doing comprehensive reporting (CSR) can see how the true measure of outsourced impacts will drastically change anyone’s “triple bottom line” for comparing options. Getting these numbers wrong also alters investment profiles, introducing bias in competitive investment market assessments, picking the wrong winners and losers.

The technical point where SEA departs from LCA is with the assumption physical scientists call a “null hypothesis”, i.e. what to do when you have no information. The established methods assume a lack information is a “zero impact”, and just ignore it. SEA assumes if you can define it “average” is more accurate than “zero”. What makes it work here is ultimately that prices are a good proxy measure of energy impacts.

From a macroeconomic view every dollar a business spends ends up going to a diverse cross section of the world economy’s human end users. So, any dollar spent will represent a widely distributed sampling of typical end consumption habits, so not far from “average”. It’s specifically those end recipient costs that are passed up the supply chain to accumulate as the end product cost too, and become the price to the purchaser. So, “average” energy per dollar is a direct normative measure of the energy impacts paid for in the product price.

For SEA we then adjusted that proxy measure for each category of business costs for delivering the product to market, and found a way to combine them with the direct measures. We feel confident that others repeating the effort will need to take the same approach and use the same starting

assumptions. Further discussion of applications for this new kind of information is found in the discussion section of the research paper[iii] and on the website[vi], also in a proposal for using SEA to define balance sheets of assessed economic liabilities[vii], and for relating financial and energy ROI's in a paper by co-author C. King[viii].

Science has long had difficulty studying systems in nature that work by themselves, finding it easier to describe control relationships with sets of equations. By defining a way to measure the energy use of businesses as whole systems, SEA also opens a new door to measurement and study of other kinds of whole self-managing systems too. It points to how their own internal organization can serve as a self-defining closed boundary, for studying them as net-energy systems with accountable energy budgets.

Perhaps lacking a way to study how businesses as systems use the environment points more than other things to how we got into our intractable conflict with the earth. We've been describing the natural world with the information we had, unaware of what we were missing, including the concept of "whole systems" with which the idea of "missing parts" can then be defined. That this blindspot apparently causes us to be blind to much of what would matter most to us, makes it a good thing to begin to correct.

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[i] J.L. Henshaw, http://www.synapse9.com/jlh-blurb.htm - Short bio

[ii] Bill Baue, http://www.sustainablebrands.com/users/bill-baue - Guest ed, Sustainable Brands "New Metrics of Sustainable Business" issue http://www.sustainablebrands.com/news_and_views/new-metrics

[iii] Life-Cycle Assessment (LCA) http://en.wikipedia.org/wiki/Life-cycle_assessment

[iv] Greenhouse Gas Protocol (GHG) - http://www.ghgprotocol.org/

[v] Henshaw, P. H. et all, Systems Energy Assessment(SEA) - http://www.mdpi.com/2071-1050/3/10/1908

[vi] Henshaw, P. H., SEA reference website - http://synapse9.com/SEA

[vii] Henshaw, J.L., Budgeting For "The Commons" Needs Business "Ecobalance" Sheets - http://www.synapse9.com/signals/2012/06/05/budgeting-the-commons-needs-business-ecobalance-sheets/

[viii] King, C., Hall, C., Relating Financial and Energy Return on Investment http://www.mdpi.com/2071-1050/3/10/1810