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SAB Advisory Panel on EPA's Report on the Environment (ROE) 2014

Pre-Meeting Comments

July 29, 2014

Charge Question 1. Sustainability as the ROE 2014 Conceptual Framework: *Please comment on the concept of sustainability as an overarching conceptual framework for representing the relationships between indicators. Please also comment on the clarity by which the framework is depicted and discussed in the draft ROE and provide any recommendations to improve its description and intended purpose of representing the relationship between indicators?*

EPA should develop a clear definition of sustainability, or at least give better context for the definition now in use.

For too long, organizations, even including the National Research Council, have shied away from either endorsing or developing a clear definition. If EPA is to be promoting sustainability, then we need to know what this is.

The definition that EPA offers at http://www.epa.gov/sustainability/basicinfo.htm#sustainability is not a bad definition, although it seems a little awkward: "Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations."

This definition appears to be the same as that of Executive Order 13514. This "definition" is really a goal rather than a definition.

Another goal-based definition is that of WCED 1987, which is that sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

A third "definition" is the "Triple Bottom Line" approach, including environmental, economic, and social "pillars," which is subsumed as a goal in the EO 13514 definition of sustainability as a goal. But, how do we know when we've achieved sustainability? What is a sustainable condition? What is a sustainable future?

A clear definition of sustainability would be helpful in the first paragraph of the ROE sustainability page (http://cfpub.epa.gov/roe/chapter/sustain/index.cfm). Saying that something is "based on" something else is not really a clear definition of what that thing really is.

If a clear definition is beyond reach, then a sentence or two to the effect that sustainability is defined as a goal to be achieved would be helpful in terms of context.

Sustainability is a normative concept, which also implies that is it based on a value or policy judgment as to what are the key normative principles that should guide environmental policy and public policy more broadly. There is nothing wrong with a normative concept. However, it is important to distinguish the normative aspect of sustainability as a policy objective from the science issues related to how progress toward such a broad objective can be measured in the context of a wide range of specifics. Furthermore, if sustainability is normative, it would be useful to determine if it is a rights-based concept? Is it utilitarian? Or something else? Does it involve trade-offs? Is it relative or absolute?

If sustainability is an objective, or goal, it is useful to consider what are the barriers to achieving sustainability, which of them can be measured and how, and which of these are good candidates to be indicators. The NRC green book refers to metrics of performance, but perhaps some of these are also what EPA might consider to be an indicator.

Taking the "three pillar" ("triple bottom line") notion of sustainability, and further noting that the environmental pillar is not only about human interaction with the environment, in the next iteration of the ROE, EPA should attempt to incorporate indicators of environmental sustainability as part of the sustainability framework.

The Sustainability Framework Diagram: Refinement is Needed Based on Improved Formalism, Supported with Hyperlinks

"Sustainability offers a useful framework for addressing such challenges" (http://cfpub.epa.gov/roe/chapter/sustain/index.cfm). This implies that sustainability is not just a goal, but a framework. What does this really mean? The web page (http://cfpub.epa.gov/roe/frameworks.cfm#framework-sustainability) offers a diagram that shows nodes and their interconnections with arrows. This appears to be an influence diagram, but also suffers from being apparently somewhat ad hoc. An arrow from one node (e.g., society) to another note (e.g., environment), connected with respect to some influential factor (e.g., "restoration and protection") implies society influences the environment. Diagrams such as this should follow some underlying formalism. The meaning of the nodes and the arrows should be defined. Do the arrows simply mean that Node A influences Node B? Some arrows seem to be dealing with flows of materials, while others are dealing with flows of energy, exposure pathways, "labor and regulations" (?), and there are terms given that appear to not be associated with any arrow such as "ecosystem degradation" that are perhaps status indicators for a node. But if there are to be status indicators for a node, why do these appear only for the environment node and not the economy or society nodes? Another way of formalizing a diagram such as this is to think in terms of indicators of the "stock" within each node (e.g., what is the status of quantity, quality, of key stock indicators) and that arrows depict factors that deplete or augment the stock indicators. Perhaps there are better ways to conceptualize this, and perhaps the system is sufficiently complex that there is not a unique best and simple way to communicate this "framework." However, a framework that is communicated without formalized symbolic depiction is difficult to interpret and inconsistent in its scope and details. Thus, the diagram of this web page merits further consideration and perhaps revision to be suitable as an overall framework.

To take a small example, there is an arrow of somewhat indeterminate origin labeled “human exposure to waste”. If there were a hyperlink here, maybe I could find out what this really means, but without such a link, I can only guess. Does “waste” refer to solid waste? Superfund site contamination? Wastewater? Air pollution? How general is the term “waste”?

The general comment on the diagram is that it is a good starting point, but it should be refined and should take advantage of its web format to include hyperlinks for those who want to know what are the formal categories of nodes and their connectivity that are the basis for the diagram, what type of diagram is this, what are the definitions and explanations for each node and each connective influence, and, where feasible, references for those who want more information.

Be Careful about Choices of Hyperlinks

The hyperlink for “sustainability” located on the web page (http://cfpub.epa.gov/roe/chapter/sustain/index.cfm) , which links to (http://www.epa.gov/sustainability/), is quite frustrating for a reader. This link goes to a programmatic government bureaucratic depiction of sustainability programs and, setting aside the merits of such programs, and if what I want to know is the answer to my question “What is sustainability” I have to notice that there is another link to this page (http://www.epa.gov/sustainability/basicinfo.htm#sustainability) which gives me LESS information about sustainability than the page where I first started. The advice here is: don’t link to a page just because it is there. Think about your audience and what they are looking for, and give them some way to get to where they want to go without having them get bogged down in programmatic details that are not their main focus. There is nothing wrong with a link to Programs Promoting Sustainability at EPA., but that is not the same as explaining to a general reader what is the deeper meaning of sustainability.

Users of the ROE are probably not first and foremost interested in a programmatic overview of sustainability at EPA. They are likely to want to know: what is sustainability? What is the framework for sustainability? How can progress toward sustainability be quantified and measured? Furthermore, are there perhaps some important aspects of sustainability that cannot be quantified (or not easily or feasibly quantified now)? Also, how far does the ROE go in actually addressing metrics or indicators of progress toward sustainability? To the extent that this is a limited first version, it is important to say so, and to point out that this is a work in progress. Also, are there other similar frameworks and reporting tools analogous to this in other countries? Some users may be interested in links to such information if available.

What are the trends in consumption of natural resources?

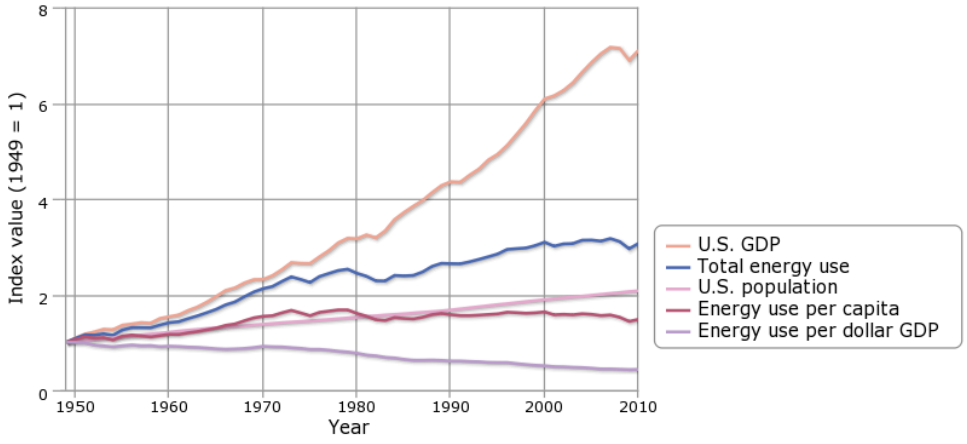
While this seems like a fine topic and is related to sustainability, the sustainability home page (http://cfpub.epa.gov/roe/chapter/sustain/index.cfm) could give at least a sentence that more clearly explains why this question is relevant to sustainability. Does this question imply that the answer would be trends in consumption should be lower to be sustainable? For any finite resource, is there such a thing as sustainable consumption? For example, is just reducing the rate of depletion of non-renewable natural resources sustainable? The page on Resource consumption

(http://cfpub.epa.gov/roe/chapter/sustain/resource.cfm) brings up some of these concerns, at least indirectly, but does not actually state what type of resource use would be sustainable. While perhaps it is self-evident that sustainable use of renewable resources should not exceed their "rates of natural regeneration" it is not so clear that the term "long-term rates of natural regeneration" is in fact truly sustainable – what if there is uncertainty and miscalculation as to these long term rates?

Furthermore, based on the "Triple Bottom Line" concept of sustainability, resource depletion rates cannot be considered independently of their economic and social consequences. For example, perhaps there is an economically and socially viable trajectory of gradual feedstock or resource substitution, for which initial rates of depletion may not be sustainable in the long-run from an environmental perspective, but for which there would be time to adapt or modify economic and social institutions leading to an overall long-term achievement of sustainability. To borrow a term from thermodynamics, the process of getting from the present to a sustainable future is "path dependent."

Related to the issue of a Triple Bottom Line, the Energy Use diagram based on intensity of U.S. Energy Consumption is quite relevant, and it is appropriate that this diagram includes not just per capita and per GDP indicators of energy consumption, but also shows total GDP and total population. While there can be imperfections in how resources are allocated in the economy, such as to activities that trend away from sustainability (e.g., consumers who purchase a large SUV instead of a smaller sedan that would also provide adequate transportation, because of perceived social status), nonetheless GDP is a first cut indication of economic activity. To the extent that ratios of energy use to GDP might increase during economic boom times because of choices that are not sustainability-oriented, there may be implications for policy. However, EPA should consider more sustainability-related metrics of both the economy and society.

Exhibit 3. Intensity of U.S. energy consumption, 1949-2010



Based on real (inflation-adjusted) GDP.

Information on the statistical significance of the trends in this exhibit is not currently available. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: EIA, 2011; Census Bureau, 2000, 2001, 2011; BEA, 2011

Because this diagram is based on indices that are arbitrarily set to unity in the year 1949, this diagram does not really deal with sustainability. It deals with relative trends, but relative trends are not sufficient to imply sustainability. The absolute indicators are more relevant for making judgements about sustainability. Thus, it would be helpful if the use can view the data both in normalized format for assessment of relative trends indexed to a base year, and also with absolute units to assess progress toward meeting any user-defined benchmark. For example, how much energy is consumed per capita, in terms of GJ/person-year, and how is that energy use distributed among key end use services (economic and social dimensions) of travel, heating, air conditioning, lighting, cooking, etc., is important. A user might want to benchmark US per capita energy use versus that of other countries or of potential best practices based on improved technology or perhaps based on emergence of new social norms.

Also, this diagram masks some trends that are counter to movement toward sustainability. By lumping all energy use into one total, the effect of consumer choice on energy consumption for personal transport is masked. Energy consumption for personal transport is influenced by social factors such as a preference for a big SUV or pickup truck. Perhaps technology can play a role in reducing the energy intensity of such vehicles, most likely with a trade-off of higher capital cost (e.g, for hybrid powertrains and/or lighter weight vehicle components). Some users may be interested in using the ROE site to gain information for answering such questions.

The basic message about the trends in U.S. economic growth versus trends in energy consumption is important. Future expansion of the sustainability indicators should include per capita and per GDP (or other) indicators for releases to the environment, preferably in a manner that can be directly related to the same categories of energy use either by resource or end use type.

Lifecycle and International Aspects of Sustainability

Somewhere the notion of life cycle should be mentioned and discussed. To what extent can indicators be used to obtain insight into life cycle issues? For example, taking transport as an example, a more sustainable car would be one that uses less nonrenewable resources to build, operate, maintain, repair, and dispose/recycle. Yet, many of the indicators appear to be focused on the operations aspect of the life cycle without more direct consideration of resource extraction, manufacturing, distribution, disposal/recycling. Furthermore, there are bounding issues not mentioned at all, such as sustainability of importing manufactured goods from other countries and how that should factor into sustainability assessment. From a life cycle perspective, every product that comes to the U.S. on a container ship from the massive ports in Asia (e.g., Hong Kong, Shenzhen, Singapore, etc.) entails energy use, emissions, and impact along the travel path, as well as long-range transport and deposition of fine particulate matter comprised of black carbon to the polar ice caps, and so on. The adverse health effects suffered by persons in China and other parts of Asia, exposed to fine particulate matter levels unimaginably high compared to levels in the U.S., have significant social and environmental impact outside U.S. boundaries. Likewise, sustainability or lack thereof in other countries can adverse effect the U.S., such as from hemispheric scale transport of ozone and fine particles from Asia, and the collective effect of life cycle emissions of greenhouse gases and black carbon

Difficulty with defining Sustainability – Reprise

Under (http://cfpub.epa.gov/roe/indicator.cfm?i=93#3), Energy Use limitations: "It is difficult to define exactly what constitutes "sustainability" in a complex realm such as energy, where the social and environmental impacts depend on the source (e.g., coal versus hydropower), the manner in which the source was produced (e.g., specific fossil fuel extraction methods), and the manner in which the energy has been used (e.g., where emissions are released and whether emissions control technology is used)." If the U.S. EPA cannot define what constitutes sustainability for the U.S. energy system, who can? Does this mean sustainability is unachievable because we don't know what it is? Or is it unachievable because it is not feasible without major structural changes in the economy or how society operates? The current U.S. energy system is NOT sustainable. Perhaps a more relevant question is: how much time can we operate with slow modifications to the current system. Of course, that is more of an analysis question and thus is not in the scope of the ROE per se, but the question of whether the current energy system is sustainable seems to be easy to answer: no, it is not. Will or can it transition to something that is more sustainable? – that's another question.

Do the Related Links Make Sense? → Undermining the Concept of Sustainable?

I was curious about the Science and Technology: Sustainable Practices link and visited that page. I found a section on Sustainable Transportation and looked at this as an example, since it is close to one of my main areas of research. What I found, however, was not sustainable transportation. The information is about ways in which the energy intensity of transportation might be reduced, but this is not the same as making transportation "sustainable." While this page may be beyond the scope of the ROE, the broader advice for EPA is to be careful about implying things are sustainable that really are not. On the other hand, there is value in moving toward sustainability. We seem to lack a term that conveys the idea: "while this technique is not actually sustainable in the long run, it is an attempt to better understand how we can reduce resource consumption, discharges to the environment, human exposure, etc., and represents a transition between the present and a future that might someday be sustainable pending further developments." This begs the question as to whether one system can be "more sustainable" than another system if neither is actually sustainable. I encourage EPA to come up with a term for the idea of moving toward sustainability even if not there yet, without giving the false impression that getting partway to the goal is sufficient.

Two of the Six Examples:

Each of the diagrams accessible from the Conceptual Framework page should have hyperlinks so that users can explore the explanation of the topics in the diagrams easily. It is helpful that the diagrams for Relevant ROE indicators link to those indicators, but it would help if the links opened a new page.

Acid Deposition: (overview diagram) There should be a statement of what is the problem and the key attributes of the problem. Acid deposition poses potential very serious challenges for acidification of aquatic systems, which leads to widespread fish kills. It can severely damage vegetation, leading to damage to forests and crops which affects ecosystem services and aesthetics. And so on. This is a well-studied problem for which there have been major programs, such as the National Acid Precipitation

Assessment Program (NAPAP) and various others, including a recent effort to explore a joint indicator of aquatic acidification based on deposition of sulfur oxides, nitrogen oxides, and ammonia as part of a review of the National Ambient Air Quality Standard for public welfare related to SOx and NOx. Thus, a lot is known about this problem, and the importance of it can and should be communicated more assertively.

Why is economic activity part of the "Society" box? Transportation is a means to an end – it provides the economic end use of movement from point A to point B. Thus, it is an economic activity. Why is it also listed as a social activity? See also comments above about the need for formalism in the structure of these diagrams. The social implications of transportation might be related to sense of personal achievement or satisfaction related to mobility, ability to engage in a productive job, ability to see friends, etc. "use of goods and energy" seems like an economic activity. What is the social aspect of this? "Quality of Life" is quite vague and cries out for a hyper link to explain what this is really about in relation to acid deposition. "Ecological condition" seems woefully inadequate given that environmental receptors of strong concern include surface waters, fish, forests, and somewhere in this diagram crops should likely be mentioned. For acid deposition, see integrated assessments, such as NAPAP or the Tracking and Analysis Framework, or the recent Integrated Science Assessment pertaining to the Sox/NOx secondary NAAQS , for more details on such issues.

Tese diagrams provide an opportunity for some historical context. The acid deposition problem was a very severe problem in the U.S. a few decades ago. There have been substantial reductions in emissions of SO2 and NOx that have substantially ameliorated this problem. Although it is not entirely eliminated, this is a huge success story for the EPA and, more importantly, for the U.S. it is also a huge success story in our relations with Canada, which was the recipient of a substantial amount of U.S. exports of sulfate and nitrate that caused problems across the border.

(Key Attributes Diagram): I am puzzled as to why "vehicle emissions" is part of society when this is a result of the economic activity of transportation. I don't understand quite why "tourism" and "productivity" are key economic attributes. One of the significant problems with acid deposition included human exposure to sulfate and nitrite aerosols, which was deemed in some studies to be a far more significant "cost" than loss of, say , recreational fishing (e.g., see the Tracking and Analysis Framework). Hyperlinks or at least mouse pointer activated pop up boxes with some explanations would be helpful.

(Relevant ROE indicators) – it would help if these would open in a different window. Nitrogen Oxides Emissions – results are shown only since 1990 based on the National Emission Inventory. However, there are national inventories of NOx (and SOx) from prior years back to about 1970. Although the implementation of the triennial NEI included some methods changes in how the inventory was estimated, it is useful to have the historical perspective on emissions from 1970, which is a key year in terms of being when EPA was founded and the first year of Earth Day, and also shows how much progress has been made. For ambient concentrations of NOx and SO2, it would help to have some explanation of why earlier data are not included… i.e why can't this time series go back to 1970? Why are "Benthic Macroinvertebrates in Wadeable Streams" an important indicator of impact of acid

deposition? This indicator seems weak relative to others for this topic area, and indicators that would be more relevant seem to be absent. On the other hand, the indicator for sulfate deposition tells an impressive story.

Yet, the treatment of economic and social aspects of acid deposition is quite weak.

Tropospheric Ozone (overview): the key issues for tropospheric ozone include adverse effects on human health, especially for children, outdoor workers, and older adults, damage to vegetation and crops (i.e. relative biomass loss for trees, crop yield loss, foliar injury), and others (e.g., damage to material surfaces). The adverse effects include morbidity and mortality from short-term exposure, and there is some evidence of mortality from long-term exposure. Ozone is formed as a result of precursor emissions of NOx and VOCs, which are related to a wide range of emission sources including fuel combustion, fuel storage and transport, solvent use, and other evaporative processes. When I look at this diagram, these are not the key messages that I am getting. Given that EPA has conducted extensive assessments and implemented extensive regulatory programs related to ozone, and that the number of people living in areas in non-attainment of the current ozone standard constitutes about 1/3 of the U.S. population, the overall significance of this topic comes across very weakly. Thus, the diagram is not well balanced with respect to the current scientific understanding of this topic. I don't really understand the meaning of some of the contributors, such as "production" (presumably this is a broad term, but there is no hyperlink here for a definition or explanation). It is not clear as to why "Household VOCs" is such an important part of the ozone problem that it merits one third of the boxes in the society node. If "Society" is meant to include end use services obtained from the economy, then it should also include heating, cooling, lighting, etc. which are often made possible using electricity which often is associated with NOx emissions and, depending on the fuels used, also with some VOCs.

(key attributes) does "industrial emissions" include electric utilities? The most substantial emission sources for NOx should be included here. Also, there is not adequate indication of key VOC emission sources. The link to "Asthma Prevalence" lacks sufficient context with respect to the ozone example. For example it is not the case that all asthma in the U.S. is caused by ozone. Similar context is needed for COPD. Those with asthma and COPD are advised to avoid high ambient ozone levels.

For these examples, some indication of what constitutes sustainability would be helpful. For example, in some cases, there are threshold below which effects are other not observed or may be small. Is a system sustainable if the exposure concentrations are below threshold? What if there is no threshold: is a system sustainable if the risk is considered *de minimus*? Have we achieved sustainability with regard to acid deposition? Is it acceptable to have trade-offs – e.g., to accept some ecosystem or health damage in favor of reduced compliance cost on industry?

Because of the way that the ROE is structured, there is not adequate integration/synthesis across the ROE indicators for each of the selected topical examples to really support a coherent story as to the observed history of the issue, whether it is moving toward being more sustainable, and implications. The ground rules of the ROE seem to be such that this type of synthesis and interpretation would be deemed outside the scope of the ROE. However, without synthesis and interpretation that is context

dependent (e.g., the interpretation of energy use, or NOx emissions, may differ in the context of acid deposition versus tropospheric ozone), a significant opportunity is lost to communicate important information to the public.

The groundrules of the ROE are such that the available indicators are not equally important for a particular example cases study, and that even more important relevant indicators are not available. Providing some context and explanation of the coverage (or lack thereof) of relevant indicators for a given topical example is essential to the reader.

The treatment of economic and social indicators of ozone is quite weak. For example, an issue that came up in the recent review of the policy assessment for the Ozone NAAQS by the EPA Clean Air Scientific Advisory Committee is the further need to consider distributional aspects of ozone exposure among populations in urban core versus suburban areas, which may also have environmental justice implications. Environmental justice seems to be missing as a topic in the ROE indicators.

Charge Question 2. Sustainability Indicators.

The selected sustainability indicators are important and useful. See also comments above. Of the four that have been selected, the weakest in terms of temporal coverage is the hazardous waste indicator. It would also help if there was a way to indicate how much is industry related versus household waste.

Anticipating New Trends that Affect Sustainability

In looking at the page for Freshwater Withdrawals, one wonders about the role of hydraulic fracturing and water usage. In discussing limitations, EPA should identify any near- or medium- term factors that might change the patterns of resource use. However, it is recognized that the ROE is more or less "evidence-based" and thus in general cannot be used to predict trends given structural changes in things such as the national energy mix. Nonetheless, this is an important limitation that should be mentioned as appropriate in the context of specific indicators. Energy use is also undergoing some interesting changes in recent years related to less use of coal and more use of natural gas, and has been impacted by the 2008 global recession. Thus, links between economic activity and energy use, and structural shifts in energy use, are observable with these data. However, given the international economy, it is difficult to evaluate sustainability without considering the international aspects of life cycles for products and services.

In further development of the sustainability indicators, I encourage EPA to consider how to augment the energy, freshwater, and MSW indicators with linkages to economic and social indicators in the spirit of the Triple Bottom Line.

As the sustainability aspect of the ROE is developed, it will be important to quantify relationships between indicators. This can be done without committing to "analysis" of such relationship. For example, analogous to what is done now for some indicators in terms of trend analysis, EPA could estimate various types of correlation, covariance, or other forms of dependence between indicators. Furthermore, linkage of resource use with indicators of environmental discharges, such as emissions,

environmental quality, and human exposure would be highly desirable. It is preferred if this can be done in a manner that enables a user to look at specific categories, such as the emissions trends related to coal as separate from natural gas, etc. Furthermore, it would be helpful to look for linkages between indicators that address life cycle issues.

Charge Question 3: Statistical Information

The effort to include confidence intervals and trend lines is helpful. Recognizing that EPA is trying to write the explanatory text for a broad audience, nonetheless it would be good to accurately describe the meaning of a confidence interval on the mean. For example, it is not the case that a 95 percent confidence interval should be interpreted that there is a 95 percent probability that the true mean is within the interval. The way that these intervals are developed is based on frequentist statistical theory, and the "correct" interpretation of an interval is that it has a 95 percent long-run frequency of enclosing the true but unknown population mean, if underlying assumptions are satisfied such as that the data are a random representative sample. The confidence intervals are based on random sampling error, which only takes into observed variability in the data and sample size. If there are biases in how the data were sampled, or if the data were not randomly sampled, then there can be biases in the estimated confidence intervals. Furthermore, if the sample sizes are small, and if there is large variability in a small sample, confidence intervals may not be normally distributed and may not be symmetric.

As the ROE is developed in the future, it would be helpful to explore relationships between indicators to get more insight with respect to factors that co-vary or that may be independent of each other.

Overall, there are relatively few indicators for which quantitative information is given regarding variability or uncertainty. Thus, there is need for ongoing work to improve the scope of treatment of these issues.