

Developing an Effective Sustainability Chemical Indicator for Energy usage, Conservation and Efficiency

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Abstract:- The primary objective of this paper is to facilitate the development of effective indicators for energy that educate community members and promote positive change toward long-term sustainability. This paper discusses characteristics of good sustainability indicators and proposes criteria to assess the quality of data available and usefulness of proposed energy indicators. It provides a detailed example of the evaluation process for selecting possible energy indicators, highlighting tradeoffs in the decision-making process. Indicators allow complex data to be condensed into a manageable source of meaningful information that can educate citizens, inform decision-making, and promote direct action. There is a nationwide trend toward developing indicators at a community level that address broad concepts, such as quality of life or sustainability. Indicators addressing energy usage, conservation, and efficiency form a critical component of these community sustainability indicator projects.

INTRODUCTION

To assess the state of the environment, to identify causes of current problems, or to judge how near a community is to their desired goals, reliable information is needed to help policy makers and community members understand current conditions. Indicators are quantitative or qualitative metrics that simplify, quantify, and communicate information about complex phenomena. When developed within a larger context, such as part of a community "visioning" process, indicators can be valuable tools that facilitate change and help move toward sustainability within a community. Due to the environmental impacts of energy production, current patterns in energy usage, energy conservation, and energy efficiency are a vital component of any community sustainability indicator project. The objective of this paper is to facilitate the involvement of energy professionals in the development of effective indicators for energy by providing the tools needed to develop effective indicators that will help reduce energy consumption.

Characteristics of Effective Sustainability Indicators:

Table 1 outlines ten "lessons learned" that address the quality of indicators, the process of developing indicators, the usefulness of indicators, and their ability to influence policy (Cobb and Rixford 1998).

Table 1. Lessons Learned from the History of Community Indicator Projects

Useful sustainability indicators should move beyond just describing current conditions and suggest ways to achieve greater sustainability. In other words, they should imply what to *do* to make the situation better. There are four major components of effective sustainability indicators that distinguish them from other indicators. Any single sustainability indicator should possess at least one of these factors, while a package of indicators in comprehensive project promoting sustainability should represent all of these factors.

- 1) Highlight Linkages.
- 2) Be Forward Looking.
- 3) Examine Distributional Equity.
- 4) Be Developed with Diverse Community Input

Criteria for Indicator Selection:

Table 2 presents 14 criteria to address the quality of the data to be used, and to emphasize sustainability and usefulness to the community. (Criteria terms adapted from Taylor Norris Associates, Redefining Progress, and Sustainable Seattle 1997).

LESSON	DETAILS
Improving the Quality	
<i>Having a numerical measure does not necessarily mean that you have a good indicator.</i>	The most successful indicators tend to reflect qualities in addition to quantities, though they are often more difficult to construct.
<i>Effective indicators require a clear conceptual basis.</i>	It is vital to determine what exactly one is trying to measure when evaluating the appropriateness of the indicator. Assumptions must be clarified in order to assess whether they are appropriate, or merely convenient.
<i>The symbolic value of an indicator may outweigh its value as a literal measure.</i>	The value of the indicator may be more in the message it communicates than the numerical value, per se. A measure that might be less precise, but easier to understand, will likely be more effective.
<i>To make them actionable, look for indicators that reveal causes, not symptoms.</i>	The more an indicator reflects the underlying cause(s) for perceived problems, the more it will motivate to address root causes rather than symptoms; e.g., a single root cause, such as automobile use, influences a wide variety of problems.
Improving the Process	
<i>There is no such thing as a value-free indicator.</i>	Every act of measurement involves some sort of bias and value judgment. The clearer these judgments are, the easier it is to determine if they are aiding or interfering with the overall goal.
<i>Comprehensiveness may be the enemy of effectiveness.</i>	Short lists of representative indicators are frequently more digestible and engaging to community members and therefore more powerful than a long, comprehensive report.
<i>Challenging prevailing wisdom about what causes a problem is often the first step to fixing it.</i>	Indicators should address issues that the community cares about in a way that can challenge current thinking where necessary to achieve change.
Increasing Usefulness	
<i>Indicators need a theoretical context in order to be effective.</i>	Indicators must be presented within a context, such as community goals, and with interpretation in order to help readers understand their significance.
<i>Don't confuse indicators with reality.</i>	As indicators only serve as proxies, it is important that they be presented in a way that makes it clear that they do not represent the entire picture.
<i>Measurement does not necessarily induce appropriate action.</i>	Indicators are tools, not ends in and of themselves. Therefore they only make sense as a tool to the extent that they are signals as part of a larger plan of action.

Table2. Criteria for Evaluating Sustainability Indicators:

Table 1 and 2.

QUESTIONS FOR ASSESSING DATA QUALITY	QUESTIONS FOR ASSESSING USEFULNESS
Accessible & Affordable	Balance Local and Nonlocal Sustainability
<i>How easily can the data for each indicator be obtained and how much does it cost?</i>	<i>Is it focused on local sustainability at the expense of sustainability elsewhere?</i>
Comparable (standardized)	Compel, Interest, Excite
<i>How easily does this compare with indicators used for other local projects?</i>	<i>Does the indicator resonate with the intended audience? Is it attractive to the media?</i>
Consistent & Reliable	Focus on Resources and Assets
<i>Is the information source likely to produce high quality data over a number of years?</i>	<i>Does the indicator focus on problems or assets in the community?</i>
Credible	Lead by Focusing on Causes
<i>Is the indicator believable to the community as a whole?</i>	<i>Does it help to forewarn of future problems and focus on causes rather than symptoms?</i>
Measurable	Make Linkages and Relationships
<i>Does the data exist for the indicator, or is there a practical way to obtain it?</i>	<i>How does this indicator link to Economic, Social, and other Environmental Issues?</i>
Relevant	Relate to the Whole Community
<i>Does it help to communicate what is important about the issue to the community?</i>	<i>Does the indicator affect the community as a whole or only one narrow group?</i>
Valid	Understandability
<i>Is the measure truly measuring what it is intended to measure, and not a by-product?</i>	<i>Is the indicator simple and clear enough to be understandable to the whole community?</i>

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a) *Criteria Assessing Data Quality:*

Accessible & affordable.The availability of data is perhaps the most fundamental criterion for indicator selection. There needs to be accessible information that is affordable to obtain or a viable alternative. Even where data on the issue are available, it may require extensive manipulation to make them appropriate for use.

Comparable (standardized).Standardizing indicators to allow comparisons with similar indicators from other communities allow comparisons across communities. It also facilitates aggregation to a regional or statewide level. The assessment may require tradeoffs with 'relevance'

criteria assessing how well the indicator reflects community interests.

Consistent & reliable. For it to be useful, the community must be able to trust what the indicator communicates. Therefore, it is important that the indicator be based upon consistent data that provide a reliable picture of the issue it is measuring. Another factor to consider is whether the necessary data will be available over time.

Credible. The indicator needs to make sense and be believable to the audience for which it is intended. Credibility may depend on the reputation of the data source. However, an indicator can be reliable or valid without being believable to the community.

Measurable. In order to obtain data for an indicator, the indicator must be framed in a way that is measurable using numerical data. Secondly, it needs to be framed in a way for which data already exists, or there is a practical method of collecting the needed data.

Relevant. A possible indicator may be very sound in terms of other criteria, but be virtually useless because it does not actually address the question being posed, e.g., the number of acres of wetlands does not communicate how much pollution is seeping into them. Continually striving to connect the indicators to community goals should aid in determining relevance.

Valid. Indicators should be valid in that they should actually measure what they are intended to measure. This is subtly different from using a proxy indicator, which then relies on a theoretical model relating the proxy measure to the question being asked.

b) Criteria Assessing Usefulness to the Community:

Balance local and nonlocal sustainability. Indicators should measure local sustainability in a way that recognizes the community's place in the regional and global community. They should not inadvertently promote local sustainability at the expense of other communities.

Compel, interest, excite. It is important that the indicator communicate information in a way that inspires interest, which is the genesis of action. Also, it is useful to develop indicators that are straightforward enough to be easily reported by the media.

Focus on resources and assets. To the extent possible, indicators should highlight community assets and resources that could be enhanced rather than problems or negatives. Exceptions include situations where the negative view is more gripping to the community.

Lead by focusing on causes, not symptoms. As sustainability is rooted in the notion of future conditions, the indicators that are chosen should represent a long-range view that helps to forewarn of future problems. Also

focusing on causes rather than symptoms can inspire a proactive approach to addressing issues.

Make linkages and relationships. As discussed earlier, an essential component of effective sustainability indicators is that they illuminate the linkages and connections among environmental, economic, and social aspects of the community. It is also important to include a discussion of linkages in the presentation of the final report.

Relate to the whole community. A diverse group of community members should select indicators that examine the equitable distribution of problems and assets reflecting the full range of citizens in the community.

Understandable. An indicator should be reasonably clear and simple enough to be understandable to the community it is intended to reach, a good measure in terms of statistical methodology risks being ineffective if the community as a whole does not understand it.

Choosing an Indicator for Energy

This section outlines the process for evaluating an indicator for energy against the 14 criteria recommended above for sustainability indicators. This example illustrates what the evaluation process might look like for a group developing sustainability indicators.

Indicators for Energy Consumption, Conservation, and Efficiency

Table 3 illustrates examples of each of these types of indicators that are currently in use in indicator projects across the country.

In addition to those listed here, there are many other possibilities for energy indicators depending on project needs. For example, possible indicators at the municipality level, include the percent of street lights or interior lighting in municipal buildings that are energy efficient, a ratio of city energy cost and tax dollars per capita, or the percent of community facilities that have had energy audits.

Table 3. A Sample of Energy-Related Indicators in Existing Projects

Analyzing an Indicator:

In terms of long-term sustainability, most communities are concerned with reducing consumption of energy. However, communities most often use to indicators measuring usage rather than energy efficiency or conservation due to the relative ease of obtaining data on consumption. To illustrate the process of analyzing a proposed indicator, I consider the most common energy-related indicator-annual residential electric consumption per household. **Table 4** summarizes how this indicator rates on the 14 criteria for data quality and usefulness in terms of promoting reduced consumption. Overall it rates moderately well, scoring high on criteria for data quality

but less well on the criteria for usefulness to the community.

Improving the effectiveness. Household energy consumption varies greatly by factors such as number and age of residents, work and recreational activities, and size of home and yard, as well as any energy efficiency measures taken. Setting a goal depending on the current state, for example a 10% reduction of 1999 per capita would provide additional context. This would allow community members to gauge the impact of their consumption reduction activities, though would not imply savings from existing efficiency measures. A related indicator could report the number of households that met the goal.

Another way to improve the usefulness would be to promote "self-benchmarking" by community members. For example, reporting household consumption on a monthly rather than yearly basis would allow community members to compare the indicator against their household utility bill. It is critical to help community members understand how their actions affect the whole community. Self-benchmarking is private, easy to use and will help bring the message home in a way community members can easily understand and will be motivated to act. The self-benchmarking process could be further enhanced with a chart adjusted by number of household members, seasonal energy use or other factors affecting household consumption patterns (e.g. use of electric heat or water heaters).

The indicator report should also include examples of ways to decrease energy usage, and references to local energy efficiency resources, such as those commonly found in residential energy audits. Therefore, if a household finds it has a high rate of energy usage compared to the community average reflected in the indicator, suggestions for solutions will be readily available. This will facilitate action by helping the household understand the activities that contribute to energy consumption and steering household members toward further information.

Table 3.

Relating to Fuel Consumption	Relating to Energy Efficiency Activities
Total or average annual residential electricity consumption by city	Number of offices and homes that have energy audits
Percent energy consumption from nonrenewable	Heat loss of residential buildings
Renewable energy consumption (percent or kWh)	Percent of buildings using low energy lighting
Annual commercial energy consumption	Average energy efficiency rating of homes
Annual electricity and/or natural gas consumption per capita	Number of new homes that are energy efficient using an existing rating method
Residential electricity and/or natural gas consumption per household	Percentage of new buildings designed by 'green' architects
Gasoline consumption per capita	Relating to Energy Cost
Households per residential MWH consumed	Cost of electricity
Ratio of renewable to nonrenewable energy consumption	Energy and machinery expenses as a percent of gross farm income
Commercial/industrial natural gas terms or MWH consumed per employee	Energy cost per tax dollar

Table 4. Evaluating Indicators: Annual Electricity Consumption per Household

TABLE 4.

CRITERION	ASSESSMENT
Data Quality	
<i>Accessible & Affordable</i>	Probably; data historically available at low or no cost, unclear how deregulation will effect this; minimal data manipulation needed
<i>Comparable (standardized)</i>	Yes; standardized and easily comparable to other communities
<i>Consistent & Reliable</i>	Yes; high quality data that will be available indefinitely
<i>Credible</i>	Yes; already widely accepted as a measure of electricity consumption
<i>Measurable</i>	Yes; framed in a way that easily lends itself to numerical data
<i>Relevant</i>	Somewhat; does not directly indicate efficiency efforts or consumption sources
<i>Valid</i>	Yes; meets scientific standards for measuring what it is intended to measure
Usefulness to the Community	
<i>Balance Local and Nonlocal Concerns</i>	Somewhat; does not indicate where the electricity is produced or substitution factor
<i>Compel, Interest, Excite</i>	Somewhat; motivates and is easily used by the media
<i>Focus on Resources and Assets</i>	No; focuses on consumption, resources saved by reduced consumption more positive
<i>Lead by Focusing on Causes</i>	No; does not imply causes or the solution directly
<i>Make Linkages and Relationships</i>	No; does not show linkages, e.g., to transportation, air quality, or resource use
<i>Relate to the Whole Community</i>	Yes; covers the entire community who uses electricity
<i>Understandable</i>	Yes; clear what information it communicates

Recommendations & Conclusions

While there is no single best approach when developing community sustainability indicators for energy, the following recommendations are designed to aid efforts to develop effective indicators for energy. They focus on developing indicators within the context of a broader community-based process; however the recommendations are also transferable to projects focusing solely on indicators for energy.

- **Tie indicator selection to community goals.** They should be seen as tools to be used in order to meet community goals rather than ends in themselves. The indicator project should have a clear purpose and fit into a larger community empowerment strategy.

- **Customize the 14 recommended criteria to evaluate proposed indicators.** Each project should customize and determine relative weights of Data Quality & Usefulness to the Community.

- **Set goals, targets or thresholds for the indicators.** This will provide necessary context for the target audience to understand the issue in order to galvanize community action.

- **Make the indicators as personal as possible.** Citywide measures will be less effective than indicators reported on a smaller scale. Use ratios and per person or per household measures, such as per capita measures of energy use to resonate with citizens.

- **Highlight linkages and interpret results in presentation of indicators.** Identifying linkages within and among environmental, economic, and social issues is a fundamental principle of sustainability indicators.

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