



Short communication

Using energy flows to track and influence organizational dynamics and decision making

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As the readers of this article probably know, Dr. H.T. Odum's influence on ecological and environmental engineering thinking and processing is enormous and reflected in numerous technical scientific journal articles. However, energy systems analysis and the underlying organizing principles also have been adapted to other venues and disciplines with some important successes and breakthroughs. Basic features of Odum's energetics have been used and incorporated at the highest levels of government directly influencing decision-making and governmental processes. Four examples are discussed here: the first in California during Governor Jerry Brown's terms in office (1975–1983); the second in Washington, DC, in the early 1980s; the third illustrating applications to general resource management decisions in the water and wastewater utility industry in the US in the early to mid-1980s; and the fourth in the mid 1990s in Southern California.

1. California take one

After completing a Master's degree in biology I entered the graduate program with H.T. Odum, and completed a second Master's degree in 1976 at the University of Florida. In 1978, Governor Jerry Brown appointed me to the post of Assistant Secretary of Resources for Energy Matters. This was a cabinet level

appointment with State Senate confirmation. The position was newly created by Governor Brown, who had read Dr. Odum's *Environment, Power, and Society* (Odum, 1971) and wanted to incorporate his principles and thinking into his energy policy for the state of California. Four, relatively simple projects carried out during my term as Assistant Secretary illustrate the direct linkages between Odum's principles—especially his concepts of Net Energy (Odum, 1976a,b, 1977 as well as Odum et al., 1976) and changes in high-level governmental processes and analyses.

The first was a statewide net energy analysis that showed the significant energy losses associated with the state water project that essentially plumbed northern and southern Californians to the same water supplies. For many years the state water project was hailed as a tremendous energy producer based on reporting that hydroelectric production occurred during the transport process. However, there had not been an equivalent analysis of the energy inputs to the project to provide an objective assessment of its effectiveness.

Net energy was a startling new idea in California in the late 1970s. In a state that prides itself on being innovative and cutting edge there was a double blow embodied in the analysis. The net result showed that the state water project was the largest single energy user in the state when considering all forms of energy including hydro, fossil fuel, fossil fuel products, and solar energy used through out the system as is routinely done in net energy calculations. While not accepted widely by the traditional civil engineering

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leadership in the Department of Water Resources, the concept of net energy analysis became a mantra for the Resources Secretary, Huey Johnson and Governor Brown.

Today, I serve on the California Water Commission, appointed by now-Governor Gray Davis who was Governor Brown's former chief of staff. The Water Commission, among other duties, sets the rules and regulations for the Department of Water Resources' energy management, sales, operations and policies. Recently the California Water Commission adopted rules and regulations governing the California Department of Water Resources' energy purchasing and pricing programs. Of particular concern to the Commission were the lessons learned during the state's energy crisis that occurred a couple of years prior in the early 2000s.

The second example occurred as part of the Earth Day Celebration in 1978. The Governor had asked for a demonstration of the value and promise of solar energy as part of the celebration event. At that time the environmental community was very high on the use of solar energy as an alternative fuel source, touting it as a credible substitute for fossil fuels. Odum's energy quality principles led his students and followers to realize the value of solar energy for running natural ecosystems and for heating houses, but its limitations for many other uses in society due to its relatively low energy quality. Nevertheless environmental representatives in California were promoting photovoltaics, which combined high quality generators with low quality solar radiation. Based on H.T. Odum's net energy calculations, however, photovoltaics result in a net loss of energy.

I wanted to avoid a confrontation with the environmental supporters, but also wanted to be true to the Odum principles. This was not an easy assignment. As a result, I had the engineers prepare a shiny cylinder with solar energy facts and numbers featured on the outside, promoting the "ultimate solar energy machine". When members of the press were assembled the high tech looking cylinder was opened and inside was a healthy, green tree. Tags from the branches pointed out the air quality, water quality, carbon cycling, cooling and heating benefits as well as the low societal energy input requirements associated with the ultimate solar machine—the tree. It was well received by all generating a lot of positive press and dialog.

The third example came as a result of the "Ultimate Solar Machine" project. Convinced of the utility and importance of the concepts of net energy and energy quality, the Resources Secretary and Governor were receptive to a study of an energy budget for Capitol Park, which surrounded the Capitol building, Governor's office, the Senate and Assembly buildings. Martha Gilliland (former student of H.T. Odum and currently a University executive in the Midwest), Linda Fenner and I conducted an analysis of the landscaping benefits of the capitol park vegetation. The more than 300 trees, almost as many shrubs, ground covers and flowering plants provided significant heating and cooling benefits, without which the operational costs of those state structures would have almost doubled. We ultimately published this study in 1981 (Merriam and Gilliland, 1981). (Note: Merriam was my last name prior to Deister.)

The fourth project was a simple request by the California Energy Commission and the Resources Secretary to develop a policy requiring net energy analysis for all oil drilling applications that were presented to the California Coastal Commission. A simple primer on net energy analysis was included in the policy that was adopted by the Commission in 1980 and is still in effect today. The primer was published by the Florida State University's Institute of Science and Public Affairs in 1980.

2. Florida–California–Washington connection

After 2 years with Governor Brown I was offered a chance to return to my home state of Florida with newly elected Governor, Bob Graham. Eventually I ended up on the faculty at Florida State University directing the new Water Resource Center within the Institute of Science and Public Affairs. While at FSU I was contacted by the late Wilson Clark to co-author a paper on energy systems analysis of flows in the Middle East. Wilson had served with Governor Brown as a key energy advisor at the same time I was there and had left California to work as a consultant to the foreign affairs committee in the House of Representatives in Washington, DC. The analysis included oil, gas, solar, money, and politics as primary features. The result of the analysis predicted a nuclear power plant would be constructed in the near term and discussed the

potential implications of such a facility in the politically charged Middle East. Elsevier Press published the paper in an *Ecological Modeling* book 4 months before the Iraqi nuclear plant was commissioned (Merriam and Clark, 1981).

Wilson Clark was brought into highly restricted dialogs with key elected Washington leaders, which had a significant influence on some of the committee's information processing, tracking activities, and approaches. Wilson's untimely death less than a year later halted the project, but the initial inroad had been made, promoting and integrating the energy systems approach as an organizing methodology for complex problems.

3. Appropriate technology application

As a result of the work of Dr. Odum in Gainesville and others in California, during the late 1970s and early 1980s resource managers, utility leaders, city managers and others particularly in Florida, were exposed to various proposals for using natural systems to supplant, expand or replace traditional pollution treatment technologies. While at FSU I was of course, following Odum's work and collaborated with an economics professor pushing these ideas. The result was a paper that was originally presented at the Third International Conference on State-of-the-art of Ecological Modeling at Colorado State University in May 1982. Elsevier Scientific Publishing Company published those proceedings subsequently in 1983 (Merriam and Burggraf, 1983). The paper addressed and compared the economic and energetic measurement methodologies of the relative value of natural versus mechanical systems for solving environmental problems. Today, these ideas are state of the art in sewage treatment feasibility analyses and have had an enormous influence in Florida, Louisiana and California.

4. California take two

Venturing back to California in early 1990 I worked for a full service water, sewer, and recycled water utility in Southern California. At Las Virgenes Municipal Water District the use of recycled water had outstripped the supply during the summer months and

the engineers proposed constructing reservoirs to capture the winter recycled water supplies for use during the summer peak use months. Constructing any kind of reservoir for any reason in California is a daunting challenge due to the heightened environmental sensitivity and awareness of its population. It was apparent a highly organized, transparent and interactive outreach program was needed to bring regulators, water users, environmentalists, civic leaders, the senior utility staff and elected board of directors together in a productive, honest dialog. Recalling my graduate school days at the University of Florida (when faced with a new system, Odum's first thought was always "diagram it"), I developed an energy systems diagram of the roles, interests, sources of information, materials and resources, and other aspects of the program. That project took 2 years and resulted in using local groundwater basins to store the seasonal recycled waters instead of the originally proposed reservoirs. Several millions of dollars were saved in planning, design, construction and environmental mitigation costs due to this process.

Two papers were developed at the end of this project. The first, entitled "Making the Public a Partner in Project Development" (Deister and Tice, 1993) contained a comprehensive energy systems model depicting the various stocks and flows associated with the outreach and decision-making processes which has been subsequently used and referenced by industry users. Additionally, since publishing that paper many other utilities have sought my assistance in developing other similar programs, which has given me a chance to educate others on the multiple benefits of energy systems diagrams as a project organizing approach. The second paper was presented at the Water Environment Federal (WEF) 67th Annual Conference and Exposition in Chicago (Deister and Colbaugh, 1994).

In conclusion I have found a number of Dr. Odum's methods very useful in the realm of public decision-making. The procedures can be used in many different situations and can lead to significant savings in money, time and energy. Given the continued tremendous population and economic growth of Florida and California, the energy shortages faced by California in the early 2000s, and the possibility of further energy shortages in the near- and mid-term future, I believe the poignant and insightful ideas of

H.T. Odum will be applied increasingly in these and other states. In addition to the specific tools such as net energy analysis, one of the most valuable benefits of having worked with H.T. Odum is the use of systems diagrams to organize information and provide perspective—especially with complicated and complex problems. In politically charged environments I have found that sorting and categorizing stocks and flows and identifying relationships, often brings much needed clarity to situations. Finally, I can honestly say that having studied with H.T. Odum provided me with a set of skills that have enabled me to be successful in a variety of academic, public policy and public agency settings.

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