Critical Questions in Structuring Energy Technology Organizations

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This paper identifies and evaluates characteristics of over 30 "Energy Technology Organizations" (ETOs) in the U.S. and Canada involved with technology demonstrations, education, consultation, or research on energy efficiency in buildings and industrial processes. The information summarized in the paper was obtained in a survey conducted by the North Carolina Alternative Energy Corporation (AEC) in 1992, and updated in 1994. The paper offers assistance to any organization which operates or is planning to begin an ETO by postulating a series of critical questions the organization should address.

The ETOs surveyed were found to have a variety of operational objectives and other organizational characteristics. Key characteristics discussed include organizational objectives and formats, operational issues, achieved results, cost-to-establish, and operating costs. Strengths and weaknesses of the various approaches are discussed.

The paper concludes that careful matching of the ETO's organizational design to the founders' objectives is key to meeting the organization's goals-something not all ETOs surveyed did. Three critical questions an organization should consider in planning an ETO are:

1. Are there initial conditions or constraints already in place that dictate key decisions about the ETO?

2. What are the critical objectives for the ETO and why?

3. How does the ETO further the founding organization's goals and plans?

Introduction

This report documents and analyzes the results of a survey of energy technology organizations (ETOs) conducted by the North Carolina Alternative Energy Corporation (AEC) beginning in the spring of 1992. The purpose of the survey and analysis is to assist in planning for technology centers. The survey found that there are many existing ETOs, and a number more on the horizon. For the purposes of this report, an ETO is defined as any organization that offers energy demonstrations, education, consultation, or research on technical energy issues (i.e., not policy issues). These are the types of organizations that were surveyed.

Approximately 30 ETOs were directly surveyed for this report by AEC. In addition, AEC staff have visited or have worked with at least a third of these organizations. The survey attempted to capture basic, preliminary information from these organizations.

The ETOs surveyed take on many forms. Some are large organizations with ties to one or more utilities, with access to substantial funds. Many have ties to a university, and some have both a university connection as well as a utility relationship. Still others are small nonprofit organizations, struggling to get by on grants and small contracts.

Table 1 (A-D) provides a descriptive overview of the ETOs surveyed, including:

- Sponsorship
- Size of Facility
- Cost to Establish
- Size of Operating Budget

Table 1A. Results of Survey of Energy Technology Organizations

Center Name	Year Open	Sponsor Util	Gov	Com	Univ	PNP	Size Sq-ft
Amer. Elec. Power Smart House	1992	X					6,000
Arizona Public Service	1994+	X					
Center for Energy Studies, UT Austin					X		154,000
Florida Solar Energy Center	1975		X		X		
Ga. Power Energy Planning Center		X					
GTE Sylvania Lighting Center				X			5,000
Georgia Power TAC	1988	X					19,500
Hawaii Natural Energy Institute					X		10,000
Industrial Electrotechnology Lab	1990	X			X	X	4,800
Industrial Technology Institute	1982					X	100,000
Iowa Energy Center	1992		X				
Kansas Electric Util. Research Prog.		X					
Lighting Research Institute	1982					X	
Minnesota Building Research Center					X		
NC Alternative Energy Corp.	1980					X	12,000
NY State Energy R&D Authority			X				30,000
NAHB Research Center	1967					X	
Ontario Hydro		X	X				
PG&E Pacific Energy Center	1992	X					35,000
Philips Lighting Center				X			20,000
Portland General Electric		X					
Rensselaer Lighting Research Center	1988	X	X		X		17,000
SC E&G Energy Information Center	1984	X					
SC Energy R&D Center	1981		X				
Seattle City Light-Lighting Design Lab	1989	X	X		X	X	6,700
San Diego G&E	1993	X					
Southern California Edison CTAC	1990	X					45,000
Southface Energy Institute						X	3,000
TVA Energy Center	Closing	X					5,000
Wis. Center for Demand-Side Res.	1990					X	4,200

Sponsor - Category of principal organization(s) funding and managing ETO
- Util - Utility company
- Gov - Federal, state or local governmental entities
- Com - Private, commercial company
- Univ - University
- PNP - Private non-profit entity

Table 1B. Results of Survey of Energy Technology Organizations

Center Name	Staff: Prof.	Support	Tech.	Vol.	Stud.	Operating Budget ($1,000)	Est. Cost Establish ($1,000)
Amer. Elec. Power Smart House							
Arizona Public Service							
Center for Energy Studies, UT Austin	200						
Florida Solar Energy Center	55					3,000	
Ga. Power Energy Planning Center							
GTE Sylvania Lighting Center							
Georgia Power TAC	7	1					
Hawaii Natural Energy Institute	20	20	40		20	4,000	
Industrial Electrotechnology Lab	5	1.3	2		4	1,000	1,200
Industrial Technology Institute	60	65				11,000	
Iowa Energy Center							
Kansas Electric Util. Research Prog.	2	2					
Lighting Research Institute	2	1		12		500	
Minnesota Building Research Center	2.5						
NC Alternative Energy Corp.	22	8			1	3,100	
NY State Energy R&D Authority	68	15			7	18,000	
NAHB Research Center	45	15					
Ontario Hydro							
PG&E Pacific Energy Center						5,000	7,000
Philips Lighting Center							
Portland General Electric							
Rensselaer Lighting Research Center	26				20	2,500	
SC E&G Energy Information Center							
SC Energy R&D Center							
Seattle City Light-Lighting Design Lab	3	2	1			460	950
San Diego G&E							
Southern California Edison CTAC	65	10				5,000	
Southface Energy Institute	4		4	X			
TVA Energy Center	3	0.5		X			
Wis. Center for Demand-Side Res.	2	1				700	

Staff - Approximate numbers by category
Prof.- Professional management and technical staff
Support- Non-technical support staff (e.g., secretary, receptionist)
Tech.- Technical support staff
Vol.- Unpaid volunteer staff including tour guides, consultants and advisors
Stud.- Undergraduate and graduate students working on research or in intern positions
Operating Budget - Values, where present, provided by ETO
Est. Cost Establish - Reported cost to establish ETO

Table 1C. Results of Survey of Energy Technology Organizations

	Facilities					Outreach			
Center Name	**Demn**	**Class**	**Train**	**Test**	**Mobile**	**Tour**	**Train**	**Consult.**	**Pub.**
Amer. Elec. Power Smart House	X	X	X			X	X		
Arizona Public Service									
Cent. for Energy Studies, UT				X					X
Florida Solar Energy Center	X	X	X	X		X	X	X	X
Ga. Power Energy Planning Cent.	X	X	X			X	X		X
GTE Sylvania Lighting Center	X	X	X		X	X	X		
Georgia Power TAC	X			X		X	X	X	X
Hawaii Natural Energy Institute				X					X
Industrial Electrotechnology Lab	X	X	X	X		X	X	X	X
Industrial Technology Institute				X			X	X	X
Iowa Energy Center									
KS Electric Util. Research Prog.									X
Lighting Research Institute							X		X
Minn. Building Research Center									
NC Alternative Energy Corp.	X	X	X			X	X	X	X
NY State Energy R&D Auth.				X			X		X
NAHB Research Center				X			X		X
Ontario Hydro				X				X	X
PG&E Pacific Energy Center	X	X	X			X	X	X	X
Philips Lighting Center	X	X	X			X	X		X
Portland General Electric				X		X		X	
Rensselaer LRC	X	X	X	X			X		X
SC E&G Energy Info. Cent.	X	X				X	X		X
SC Energy R&D Center							X		X
Seattle City Light-LDL	X	X	X			X	X	X	X
San Diego G&E									
Southern Cali. Edison CTAC	X	X		X		X	X	X	X
Southface Energy Institute					X	X	X		X
TVA Energy Center	X					X			
Wis. Cent. for Demand-Side Res.							X		X

Facilities - Physical facilities available at ETO
- Demn- Displays of technology intended for tours
- Class- Dedicated space for training and seminars
- Train- Lab space for hands-on training
- Test- Lab space for customer trials and research
- Mobile- Mobile or portable training equipment and demonstrations

Outreach - Technical transfer activities
- Tours- Guided or unguided visitor displays
- Train.- Technical seminars, workshops and training programs
- Consult.- Individual technical assistance
- Pub.- Publications, slide shows, videos and other media tech-transfer activities

Table 1D. Results of Survey of Energy Technology Organizations

	Research Activities				Project Activities		
Center Name	Fundamental	Application	Demonstrat.	Testing	In-House	Field	Contract
Amer. Elec. Power Smart House					X		
Arizona Public Service							
Cent. for Energy Studies, UT Austin	X	X			X	X	
Florida Solar Energy Center	X	X	X	X	X	X	
Ga. Power Energy Planning Center							
GTE Sylvania Lighting Center							
Georgia Power TAC			X	X	X		
Hawaii Natural Energy Institute	X	X			X	X	X
Industrial Electrotechnology Lab		X	X	X	X		
Industrial Technology Institute	X	X	X	X	X	X	
Iowa Energy Center							
Kansas Electric Util. Research Prog.		X					X
Lighting Research Institute	X	X					X
Minnesota Building Research Center							
NC Alternative Energy Corp.		X	X		X	X	X
NY State Energy R&D Authority		X	X		X	X	X
NAHB Research Center		X	X		X		
Ontario Hydro		X	X	X	X	X	X
PG&E Pacific Energy Center							
Philips Lighting Center				X			
Portland General Electric			X	X	X		
Rensselaer Lighting Research Center	X	X	X		X	X	
SC E&G Energy Information Center							
SC Energy R&D Center		X	X				X
Seattle City Light-LDL		X	X		X	X	
San Diego G&E							
Southern California Edison CTAC				X	X		
Southface Energy Institute		X	X			X	
TVA Energy Center							
Wis. Center for Demand-Side Res.			X			X	X

Research Activities - See "What ETOs Do" (page 2) for explanation of terms
Project Activities - How research activities are carried out
In-House- Work done in ETO facilities with ETO staff
Field- Work done by ETO staff in customer facilities
Contract- Work done by contractor managed by ETO staff

- Staffing
- Type of Facilities
- Approach to Outreach
- Research Activities
- Project Activities (other than research)

Characteristics of Energy Technology Organizations

Goals and Key Objectives of ETOs

All the ETOs surveyed have some combination of goals relating to saving kW or kWh, improving load factors or power quality, or economic development (usually focusing on industrial customers). In pursuit of those goals, the ETOs surveyed can be described by four categories of key objectives. Few, if any, of the ETOs are purely one of the types listed below; most are a combination of two or three of the types:

1. Provide outreach to customers—probably the most common objective, although apparently proving somewhat difficult to manage and to justify. Most centers have some element of this.

2. Provide assistance to customers—more than just a demonstration area. May involve anything from general energy seminars to serious, fundamental research. Many provide one-on-one consultation to customers, usually design professionals. The key is that the ETO is dedicated to providing services that produce results (i.e., implementation, kW and kWh savings.)

3. Provide a vehicle for combining utility resources—such as AEC. These organizations combine the resources of two or more utilities, generally in pursuit of objective #2.

4. Generate funds for university faculty–an example of this is Hawaii's Natural Energy Institute (Takahashi, 1992). Academia is a tried-and-true grounds for basic research using faculty and students. ETOs have not ignored this resource, but are as vulnerable as any other organization to the vagaries of shifting funding priorities.

What ETOs Do

Again, there are four identifiable categories. They are related to, but do not link directly to, the four types of objectives:

1. Project Coordination and Implementation—an organization where several organizations, usually utilities, join together in different types of projects. These projects can range from general education to research and development. In North Carolina, AEC manages projects in everything from process industry to rural churches (Elliott, 1992). In Wisconsin, the Center for Demand Side Planning coordinates and plans Demand Side Management (DSM) programs for the state's utilities (Feldman, 1992). New York's State Energy Research and Development Authority (NYSERDA) manages a wide range of projects including contracted research for utilities (Walmet, 1992).

2. Research and Development—a facility or organization that is involved in some level of research and development (R&D) of technologies. R&D itself can be broken into four levels of activities:

   1. Fundamental Research
   2. Applications Research
   3. Application Demonstrations
   4. Customer Testing

   Examples of R&D-oriented ETOs include AEC's Industrial Technologies Laboratory (IEL) (Elliott, 1992), Seattle City Light's Lighting Design Lab (LDL) *(Lighting Design Lab, 1992),* and Georgia Power's Technology Applications Center (TAC) (Birdwell, 1992).

3. Customer/Public Relations—a facility that focuses primarily on "foot traffic" (public displays, non-technical tours). Examples of ETOs that are largely this type, or have substantial customer centers within them, are Southern California Edison's Customer Technology Applications Center (CTAC) (Pearson, 1992), Pacific Gas and Electric's Pacific Energy Center (PEC) (Chase, 1992), and the Tennessee Valley Authority's (TVA) Energy Center (Connelly, 1992). Several of the private commercial lighting centers, such as the Philips Lighting Center, also have a heavy customer center flavor (Bunch, 1992).

4. Education and Consultation—these ETOs include those that have an emphasis on workshops and seminars, such as Southface (Creech, 1992), in-depth training programs, such as at the Florida Solar Energy Center (FSEC) (Greene, 1993), and AEC (Neal, 1992, Aldridge, 1994), and those that offer direct one-on-one education, or consultation, such as the LDL *(Lighting Design Lab, 1992).*

How ETOs are operated

Sponsorship. ETOs are organized in a wide variety of ways. Many of these organizations are sponsored by a single organization but develop relationships with partners and trade allies, and use advisory committees that extend beyond the sponsoring organization. This allows them to tap technical experts and customer representatives to help direct the ETO's activities.

Three groupings of ETOs are characterized by single sponsorship:

- utility sponsored facilities that have a customer relations focus,
- university sponsored ETOs that focus on generating funds to support faculty who conduct research, and
- state agencies that are out-growths of state energy offices and focus on contract management.

Most of those organizations with multiple sponsors have staff that are actively involved with applications research and training at their facilities. The majority have both utilities and universities as at least two of the partners.

Staffing. The general trend in staffing is for the number of professionals and technicians to increase as the number of supported technologies increases. A facility that focuses on a single technology, such as LDL in Seattle *(Lighting Design Lab, 1992), can* operate with four technical and two support staff. An ETO with a broad technology and marketing focus, such as CTAC (Pearson, 1992), has a technical staff of 65 with ten support staff.

Based on the experiences at CTAC (Hartnett, 1992), IEL (Elliott, 1992), and other ETOs, it is important to carefully manage technical expertise, which is a limited resource. It is important to protect technical experts from what one ETO refers to as "tourists" who do not require a technical expert to tour a facility. To address this problem, that ETO established a "traffic manager" who separates visitors who require the services of a technical staffer from those who do not. The non-technical visitors— "tourists"—are led through the facility by utility field staff, which has the added benefit of increasing the technical knowledge of the field staff.

Physical Space Requirements. It appears that the minimum space required for an ETO is about 5,000 square feet of dedicated space. Typically, these small ETOs are limited in focus, and are part of a parent organization which houses much of the ETO's infrastructure. Examples are the IEL (Elliott, 1992) and GTE's Sylvania Lighting Center (Blake, 1992). Facilities that support a broader range of activities, such as PG&E's Pacific Energy Center (Chase, 1992), CTAC (Pearson, 1992) and Georgia Power's TAC (Birdwell, 1992), require additional space in the 20,000 to 45,000 square foot range. Typically, the more diverse the market and technology focus, the larger the building (and staff). The largest ETOs with over 100,000 square feet of space are principally involved with research and require extensive specialized laboratory space (Table 1A).

Several ETOs cautioned against the use of areas for multiple but mutually exclusive purposes, such as tours and training. While multiple usage may be attractive to managers who approve budgets, it can create conflicts. CTAC (Hartnett, 1992), LDL *(Lighting Design Lab, 1992)* and the AEC Lighting Resource Center (Schrum, 1992) all reported conflicts between staff who schedule and conduct tours and those who perform technical functions, consultation, and/or training. Especially if an ETO desires high foot traffic, technical spaces function best if separate.

Accessibility/Travel Time. Several ETOs said that it was important for customers to be able to easily travel to, locate, and find parking near the ETO. LDL provided detailed information on its customer use patterns. They noted that travel time to the lab affected how many people used the facility and, even more important, how many implemented the information they received *(Lighting Design Lab, 1992).* Portland General Electric originally established its Energy Resource Center 25 miles outside of Portland, but has moved its Lighting Resource Center and other functions into the city (Stewart, 1994). For consultations with commercial customers, travel times over an hour appear to discourage use. However, for training, especially multi-day training such as provided by FSEC (Greene, 1992), Southface (Creech, 1992), and AEC (Neal, 1992 and Aldridge, 1994), travel times appear less significant.

Results of ETO Activities

In large measure, the selection of the type of activities engaged in by an ETO pre-determines the sponsor's perception of success. For instance, ETOs which focus on customer relations and general education (foot traffic), such as Georgia Power's TAC and Residential and Commercial Center, CTAC, and South Carolina Electric and Gas's Energy Information Center, are generally thought of as successful. Similarly, many ETOs which focus on the delivery of training programs, such as Southface (Creech, 1992), AEC (Neal, 1992 and Aldridge, 1994), FSEC (Greene, 1992), the Rensselaer Lighting Resource Center (Leslie, 1992), and Seattle City Light's LDL *(Lighting Design Lab, 1992),* are considered extremely successful by their sponsors.

Obtaining quantifiable energy savings is not as easy. Commercial lighting has proved to be one of the most successful focus areas for generating rapid and quantifiable power and energy reductions as seen in the programs at both CTAC (Pearson, 1992) and LDL *(Lighting Design Lab, 1992).* Ontario Hydro (Holiday, 1992) and IEL (Elliott, 1992) have been successful with providing information on electric motors. ETOs such as CTAC and TAC have been less successful with promotion of electrotechnologies for a number of reasons:

- limited opportunities for the center to replicate process modifications;
- unwillingness to allow outsiders to “interfere” with manufacturing processes;
- a preference for lobbying for reducing pollution regulations rather than change a process in order to comply;
- new technologies in most cases take several years to receive acceptance, and when implemented it can be difficult to capture the results because of the elapsed time, confidentiality concerns, and the complexity of gathering data in an industrial process.

In spite of a lack of measurable results (and keep in mind that most of these ETOs are in their infancy, organizationally speaking), many ETOs served a valuable role in enhancing the customer and national perceptions of the sponsors as industry leaders (leadership being loosely defined as doing something few other organizations are doing). The presence of the centers has also served an important economic development role for the area in which it is located (Hartnett, 1992 and Birdwell, 1992).

Cost to establish an ETO

Cost to establish an ETO will depend on a number of factors, including whether the space is new, renovated, or leased. The most important contribution to cost is the level of sophistication in the finishings, equipment and display components of the center. These “add-ens” to the basic construction costs are somewhat controllable, but have everything to do with the value of the center.

Few ETOs are willing to release actual cost figures. However, based on figures that have been provided, it appears that costs for the final product run between approximately $110 and $250 per square foot in addition to basic cost-to-construct figures (Table 1). Assuming that construction runs $65 - $80 per square foot (for renovation) then a reasonable range for final product would be in the $175-$330 per square foot range. This includes basic construction, land costs, site preparation, outfitting of offices, classrooms, and demonstration areas, furnishings, equipment, development of displays and so on. Note that these are very rough estimates, due to lack of dependable information.

Using these figures, estimated costs to establish an energy technology center based on four scenarios of size and complexity are shown in Figure 1. For these scenario estimates, a figure of $160 per square foot for add-on costs has been used.

Critical Questions

In analyzing the existing ETOs, the following critical questions arise. These questions can be grouped into three major categories: initial conditions, objectives, and intra-organizational concerns.

1. Are there “initial conditions” or constraints already in place that will dictate some of the decisions about a center?
   - Are there constituents whom the center must serve?
   - Are there partners/allies who must be involved?
   - Must the center cover a particular geographic territory?
   - Is there a place/area that the center must be located? Existing space?
   - Are there capabilities that the center must have? Teleconferencing, classrooms, training/seminars, laboratory-based training, public demonstration space?
   - Are there certain technologies that must be included? How many?
   - Is it critical that the center is perceived as a national leader?

2. What objectives are most important to the establishing organization(s)? Why?
   - To immediately implement technologies?
   - To achieve and document quantifiable results (kW/kWh)?
   - To produce long term economic results for customers, for the service territory?
   - To generate “foot traffic”?

	Size (sq.ft.)	Type	Cost/sq.ft.	Basic Cost	Finished Cost
A	1,200	PR/Outreach	$65	$78,000	$270,000
B	4,800	IEL type	$80	$384,000	$1,152,000
C	12,000	TAC (1 tech.)	2,000 sq.ft. office @ $65 10,000 sq.ft. lab @ $80 **Total**	$130,000 $800,000 **$930,000**	$2,850,000
D	30,000	TAC (2+ tech.)	5,000 sq.ft. office @ $65 25,000 sq.ft. lab & demo @ $80 **Total**	$325,000 $2,000,000 **$2,325,000**	$7,125,000

Figure 1. Costs to Establish an Energy Technology Center

3. How does the center fit in with the establishing organization's management, goals and plans?

   - Where does the management of the center reside?
   - How much are the establishing organizations willing to spend?
   - When will the center open?

Conclusions and Recommendations

Results from the ETOs have been mixed. Many centers produce foot traffic but not necessarily verifiable energy savings. Industry-focused centers offer opportunities for savings, but results are difficult to obtain and harder to document. The authors offer five general recommendations which are based on our analyses of the experiences of existing ETOs and of the national picture regarding ETOs in general:

1. If the center wishes to establish itself as a national leader by breaking new ground, then residential building science should be a focus. Such a center should include site-built and manufactured housing.

2. If the center needs immediate, quantifiable results, then commercial lighting should be a focus. Lighting retrofits are relatively easy to manage, savings are immediate and substantial, and data is fairly easy to obtain *(Lighting Design Lab, 1992).*

3. If the center is to support traditional economic development and/or the development of electrotechnologies, then process industry should be a focus. IEL in North Carolina (Elliott, 1992), and the Alabama Resource Center (Lassiter, 1992) provide models for what can be done with industry. However, the organizers must be prepared to accept that results are long term and sometimes cannot be documented.

4. If the center is to provide customer outreach or some types of customer assistance to its entire service territory, then it should consider a center with satellites or with mobile components. Experience at AEC (Neal, 1992 and Schrum, 1992) and with ETOs nationally *(Lighting Design Lab, 1992)* indicates that customers are unlikely to travel more than 1 to 1-1/2 hours for an event that is less than two days long.

5. Finally, whatever answers are given to the above, the developers of an ETO should carefully select their objectives, decide precisely what will constitute success in meeting those objectives, and design a management information/evaluation system that will capture the data needed.

The establishment of an ETO is a complex, time consuming, and expensive proposition. Any group planning to organize an ETO should approach the task deliberately. We recommend they first develop a clear vision, purpose and goal for the center, beginning with the three critical questions posed in this paper.

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