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ALTERNATIVE FUELS STUDY:
POINT-OF-USE COMPONENT

Concept Paper

for

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CONCEPT PAPER

VEPCO ALTERNATIVE FUELS STUDY: POINT-OF-USE COMPONENT

The purpose of this concept paper is to outline a possible approach to conducting the point-of-use component of the VEPCO study of alternative fuels. The study is to provide a foundation for implementing a program to optimize the introduction of those point-of-use system options which are in the best interests of VEPCO and its rate payers.

Introduction

The VEPCO program will study alternatives to conventionally generated electricity for meeting future demand. The point-of-use component of the study is aimed primarily at end-use energy requirements, particularly in residential applications, but possibly in commercial and industrial settings as well. Energy that can be saved, shifted, or generated at the point of use has an impact on VEPCO load profiles, load duration, expansion plans, and corporate profits.

The study can have important implications in corporate planning by providing consistent comparisons on which decisions can be based. For residential applications the study would include:

- Conservation
- Solar space conditioning and water heating
- Heat pumps

These three generic technologies may be broken down further according to technology subset (active or passive), type of application (water heating, space conditioning, etc.), and market sector (new or retrofit). Systems studied should emphasize the major near-term options open to consumers. Consideration should be given to the impact of these technologies on both summer and winter peaks, since VEPCO may shift from summer peaking to a winter peaking utility. Conclusions must be pragmatic, taking into account the particulars of the VEPCO service area. To develop a business plan that optimally incorporates the technologies, comparisons must be made to identify the best choices. The following is an outline of analytical and field work that will provide information on parameters affecting users, the utility, and the market.

The study process has six interdependent activities that may be summarized as follows:

1. Performance Analysis
2. Market Research
3. Utility Impact Analysis
4. Comparative Analysis
5. Strategy Planning
6. Implementation

Figure 1 is a flowchart of the activities involved in this program. The interdependencies are shown by arrows, which also imply the chronological order.

Activity 1: Performance Analysis

1a: Define System Options - This step would define the system options for consideration. Table 1 is a list of possible measures that may be applied to point-of-use energy conservation or production. Initially, the three generic technologies may be considered as options, but eventually there will have to be refinements like the following examples:

- Heat pumps; high mass house; zone thermostats
- Heat pump; low mass house; superinsulation
- Passive solar space heating; forced-air ventilation for space cooling

It is important to consider the interactions among two or more of the technologies, since it will become ever more common for users to adopt combined approaches to deal with their energy needs. Most of the options available are relatively compatible with each other, but there are some complex interactions which must be addressed (i.e. effect of building mass on cooling load).

The technologies and system options listed are widely demonstrated, but the state of the art improves continually. This step would identify the technologies that are applicable to the VEPCO service area and the time frame in which they will become commercially ready. "Photovoltaic Cooling and Energy-Efficient Houses" is an example of system definition.

1b: Assess Performance Experience in VEPCO Service Area - The data base for heat pumps, solar hot water, conservation, and passive architecture includes experience within the VEPCO service area. Such experience is required in assessing geographic sensitivities. The data range from inventories of installations of solar water heaters to performance reporting on operating systems. Existing mailing lists, dealer networks, and other sources may be used as a starting point for this activity.

Data from current monitoring projects should be evaluated and, where necessary, new performance monitoring projects should be initiated for the technologies under study. To the extent feasible, performance data should be gathered for the geographical subregions served by VEPCO and in as many diverse climate situations as practical so that user, industry, and power company expectations are factually based. This step extends throughout the term of the alternative energy project. References such as "Determining the Performance and Cost Savings of Installed Solar Water Heaters" and "Solar Water Heater Performance Monitoring Program" provide a good basis.

1c: Simulate Performance - Prior knowledge of costs, benefits, and performance helps the end user make his investment decision. In the absence of consistent, detailed field data, simulations provide the only standardized predictor of performance and benefits. Internal consistency should be emphasized from the start. The analysts would determine the available data

**Figure 1. ACTIVITIES FLOWCHART FOR
ANALYSIS OF ENERGY OPTIONS**

Table 1

Alternative Measures for Point-of-Use Application*

SOLAR

Solar Domestic Hot Water

draindown
closed loop
drain back
breadbox
thermosyphon

Solar Space Conditioning

passive solar
 Trombe wall
 direct gain
 sunspace
 night insulation
building mass storage
water or rock mass storage
natural ventilation
active solar air system
active solar water system

Other

wind
photovoltaics
wood stoves and fireplace conversions

CONSERVATION

perimeter insulation
infiltration interrupt
setback thermostat (questionable with heat pump)
zone thermostats
duct/pipe/tank insulation
use or dump of waste heat
fans
 whole house
 ceiling
insulated windows/doors
hot water conservation

HEAT PUMPS

air source/standard
water source
d.c. powered

* Many combinations of measures may be viable.

and the most useful configuration of output results. All simulations would be performed on the same basis of assumptions.

On-line computer simulation programs, such as EMPSS, FCHART-4.0, DOE-2.1, and BLAST may be used to predict solar device outputs on a geographical basis by using SOLMET weather tapes or other sources of data. The economic benefits accruing to the user may be predicted by software such as RSOL, on the basis of rates provided by VEPCO and simulated operating characteristics of the hardware.

The outputs of this step provide hourly, seasonal, and annual micro (household level) load profiles and life-cycle benefits and costs. Sensitivity analyses may be run on internal building loads, hot water loads, system designs, rate structures, financing options, incentives provided by VEPCO, and tax rates, credits, and deductions. As performance data become available, the results of this step could be modified to reflect actual measurements. In addition, results of the simulation effort may lead to redefinition of the system designs to be evaluated.

The results of this activity might be illustrated by a synopsis presentation such as Figure 2.

Activity 2: Market Research

The purpose of this activity would be to define what level of conservation, solar, and heat pump usage will occur in the service area with and without overt commercialization support by VEPCO. The market for alternative technologies depends on supply and demand, but also on institutional factors. The penetration levels will depend on the factors analyzed in this activity. Sensitivity analysis would give insights into the effect of various market-related activities on penetration levels.

2a: Analyze Supply and Demand - The supply of these technologies is determined by prices and the infrastructure of suppliers and installers. The supply network for the VEPCO service area has been catalogued for the solar technologies and may be obtained for the others.

Demand is defined by factors that are much more difficult to characterize. The market may be quantified by population, new construction, product pricing, and consumer knowledge. In addition, the prices of electricity, gas, and oil drive the markets for point-of-use technologies. The cost of financing also enters into the determination of demand. See "Major Markets for Solar Heating and Cooling in Multifamily Housing," for example.

2b: Assess Incentives and Disincentives - Governments, utilities, and lenders compose the institutional environment in which suppliers and consumers interact. The decisions made by these entities may have great influence on the market place. This step would evaluate institutional barriers and the alternatives available to the institutional actors. In particular, the following should be analyzed:

- Utilities: financing plans; subsidies; deferred payment; rate schedules; other incentives
- Lending institutions: down payment requirements; collateral; qualification criteria
- Governments: property tax valuation/exemption; tax credits; depreciation schedules (for income properties); zoning laws/exemptions; building codes; PSC rulings

The first order of business would be to identify the institutional factors in the VEPCO service area. Documents such as "Multifamily and Commercial Codes Workbook," "Code Manual for Passive Solar Design," "State Solar Legislation Resource Book," and "Data Book for Renewable Energy Research in the Southern United States" provide a starting point for this step.

2c: Estimate Market Penetration - The market would be quantified under current and projected conditions. Future levels of penetration would be estimated under a few alternative sets of assumptions (i.e. inflation, electric rate escalation, hardware costs, etc.). Penetration may be expressed as a percentage of energy generated, percentage of customers, or number of customers.

Figure 3 is graphic example of the kinds of information resulting from Activity 2.

Activity 3: Utility Impact Analysis

Introduction of alternative energy technologies may affect the VEPCO load profile, load factor, reserve capacity margin, loss of load probability, dispatching, expansion plan, fuel costs and long-run costs.

3a: Evaluate Load and Operating Impacts - This step would aggregate by VEPCO subregion the micro load profiles generated in Activity 1. At different levels of penetration such aggregation will affect the load seen by VEPCO dispatchers. In general such load reduction and shifting on a micro level is out of the control of VEPCO, but it may be predicted stochastically. The literature suggests that at high penetration levels, historically accepted methodologies of setting reserve capacity and strategies for capacity expansion may have to deal more explicitly with these new technologies. As yet it is not well known whether, for example, passive solar homes help or hurt the utility. This step would tend to clarify the positive and negative attributes of the subject technologies as they impact VEPCO operations.

3b: Calculate Financial Impacts - VEPCO would use company methodologies to translate technical effects into economic and financial information.

Activity 2 is not independent of Activity 3. As options are identified in Activity 3 that have a positive aggregate impact on VEPCO, then further Activity 2 market analysis may be required to assess additional commercialization activities.

Figure 4 shows an example of how the results of this activity may be illustrated in summary form.

Activity 4: Comparative Analysis

In order to make long range decisions, consistent comparisons must be made among the alternatives. Groundwork for this activity will have been laid before beginning Activity 1; consistent data must be generated for comparison purposes. The results of this activity would be a ranking of choices for the utility.

Given the analysis of Activity 2 and Activity 3, comparisons may be drawn and the trade-offs identified. It is expected, for example, that few of the options will result in clear-cut, unambiguous advantage to VEPCO. Much more likely will be that gains in one area, say fuel costs, will be offset by losses in another, say load factor. This step will result in ranking the alternatives according to any agreed upon criterion, such as levelized cost of energy. Methodologies must be used that are comparable to those used elsewhere in VEPCO to permit comparisons among projects, resulting in optimal choices for the company.

4a: Prioritize - A ranking measure would be developed for users and for VEPCO, with factors weighted according to pre-established criteria. The user measure would be combined with the VEPCO measure to arrive at a ranking that takes into account both what is best for VEPCO and the rate payers and what is most attractive to the market.

4b: Refine System Options - Best options would be retained for additional consideration. Some options will be modified to reflect performance monitoring results.

4c: Assess Risk Factors - The rankings would be modified according to market uncertainties, questionable impact on VEPCO generation and distribution, or other uncertainties.

The analysis of Activity 4 may be summarized in a presentation such as Figure 5.

Activity 5: Strategy Planning

5a: Formulate Objectives and Strategy - For those system options found to be beneficial to VEPCO, quantified objectives would be established. These objectives would set reasonable targets for market penetration, energy and cost savings, resource allocation, and technical research and testing. Based on these targets, a strategy would then be formulated to define necessary actions. Components of the strategy could include:

- Customer education
- Industry support (equipment suppliers, homebuilders, engineers, etc.)
- Demonstration and market activities
- Financial incentives (VEPCO, state and local governments, lenders, etc.)

Figure 4. EXAMPLE SYNOPSIS OF UTILITY IMPACT ANALYSIS (Activity 3)

Analysis of: Solar Domestic Hot Water

LOSS OF LOAD PROBABILITY

% penetration	Utility Capacity mW			
	0000	0000	0000	0000
0				
2.5%				
5%				
7.5%				
10%				

PRESENT WORTH OF UTILITY SAVINGS

% penetration	capital	fuel	O&M	total
2.5%				
5%				
7.5%				
10%				

NOTE: Penetration expressed as % of VEPCO customers

- Product standards and certification support
- Reduction of code barriers
- Modification of rate structures
- Continued testing and performance monitoring
- Modification of VEPCO operational practices
- PSC rulings

5b: Develop Management Plan - Successful implementation of the approved strategy will depend on a clearly defined set of tasks, schedules, and budgetary controls. Such a management plan would be an internal activity of VEPCO.

Activity 6: Implementation

6a: Conduct Market and Field Test - For certain of the scenarios identified as attractive, sub-regional market tests may be advisable to verify effectiveness. This verification work would account for all of the factors inherent in the scenario including customer attitude, financing incentives, tax considerations, utility participation, and impact on utility finances. Such verification might require one or more years. The point of this step would be to characterize customer acceptance and usage profiles under varying scenarios. It is anticipated that such trials will be necessary in some cases before any PSC approvals would be forthcoming, and that PSC acquiescence might be required for some trials. The information needed will determine the extent of such efforts.

6b: Refine Plan - This activity would be undertaken by VEPCO, based on the results of previous tasks. The VEPCO program would include activities in many of the company's divisions, including both analytical and operational areas.

6c: Allocate Resources and Manage Planned Activities - This activity will involve a variety of legal, organizational, and financial components as well as technical considerations involving generation and distribution. The precise composition of this activity will be finalized after the previous work has been completed.

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Figure 3. EXAMPLE SYNOPSIS OF MARKET RESEARCH (Activity 2)

Analysis of: Solar Domestic Hot Water

MARKET PENETRATION ESTIMATE

FACTORS OF DEMAND

- ° Energy Prices

1982 1985 1990 1995 2000

Elect.
Gas
Oil

- ° Consumer knowledge of technology: _____

- ° Product Quality: _____

- ° Other: _____

FACTORS OF SUPPLY

- ° Dealer network: _____

- ° Installation and maintenance: _____

- ° Knowledge level of building contractors and architects: _____

- ° Other: _____

INSTALLED SYSTEM COSTS

BARRIERS

- ° Zoning restrictions: _____

- ° Building codes restrictions: _____

- ° Financing restrictions: _____

- ° Other: _____

INCENTIVES

- ° Solar access laws: _____

- ° Tax exemptions: _____

- ° Tax credits: _____

- ° Other: _____

**Figure 5. EXAMPLE SYNOPSIS OF
COMPARATIVE ANALYSIS (Activity 4)**

System Option	VEPCO Subregion	Criteria								Combined Score
		User				Utility				
					Score				Score	
A (base case)										
B										
C										
D										
E										

INSTALLED COST VS ELECTRIC BILL

LOAD GROWTH UNDER ALTERNATIVES

LIFETIME CASH FLOW

LIFE CYCLE BENEFIT/COST RATIO

Figure 2 EXAMPLE SYNOPSIS OF POINT-OF-USE ANALYSIS (Activity 1)

Analysis of: Solar Domestic Hot Water

- ° Estimated first year electric energy savings: \$ _____
(based on 4-person unit; 20 gal/day/person)
- ° Levelized cost of energy: _____
(compared to LCOE of purchased electricity of _____¢/kWh)

MONTHLY SYSTEM PERFORMANCE SIMULATION

VARIATION OF SYSTEM PERFORMANCE

EFFECT ON ELECTRIC LOAD

ECONOMIC PROFILE