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Organization for Energy Planning

Project Description

Project No. 5 - Electrical Energy Conservation

prepared by

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Argonne National Laboratory

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OEP PROJECT DESCRIPTION

OEP PROJECT NO. 5

Electrical Energy Conservation

Objectives

The objectives of this project are to:

1) Identify actions that lead to significant electrical energy conservation, and

2) Develop a modeling and analysis capability within OEP for examination of such issues.

Achievement of these objectives requires some effort be devoted to data collection and modeling. However, the focus of the project is on specific categories of electrical demand and supply options that would lead to substantial improvements in the efficiency of electricity use. In addition, short training courses on various conservation topics and principles are recommended.

Anticipated Outputs

The expected outputs of this project are:

1) A set of recommended measures for electrical energy conservation,

2) A set of conservation measures that appear to have merit but require more in-depth analysis,

3) A comprehensive data base covering electrical energy consumption and generation,

4) A set of models and analytic methods within OEP that can be used to examine electricity conservation issues and other important electricity demand and supply problems, and

5) Materials for brief training courses on principles of electrical energy conservation.

Project Tasks

There are seven major tasks that comprise this project:

Task 1 Develop Electrical Energy Consumption and Generation Data Base

Task 2 Develop Simplified Methods to Aid in the Evaluation of Conservation Options

Task 3 Develop Investment Policy for Electrical Energy Consuming Technologies

Task 4 Evaluate Conservation Potential for New and Existing Electrical Generating and Transmission Equipment

Task 5 Examine Cogeneration Potential

Task 6 Identify Major Load Management Options

Task 7 Develop Training Programs in Principles of Electrical Energy Conservation

Schedule

The tasks listed above are all scheduled to be completed within 24 months after the project start. It is expected that significant follow-up efforts will be required to continue the work and training this project has begun. No estimates beyond the 24 month horizon have been made. The specific tasks are scheduled as shown below:

	Months in which Activity is Scheduled*
Task 1	1-6
Task 2	4-24
Task 3	2-13
Task 4	6-20
Task 5	8-21
Task 6	5-22
Task 7	5-24

*Measured in months numbered after project start.

Personnel

The project will require the following personnel:

OEP Staff	105 person-months
ANL Staff:	37 person-months
Contractor Staff:	41-48 person-months

Startup Requirements

Task 1 requires OEP to supply a task director at the project start. Within 6 months after project start, OEP will have had to provide senior staff to serve as directors for three tasks (this could be the same person for all three), a part-time energy system modeler, at least one engineer/economist

devoted full-time to the project, and a computer specialist. OEP staffing requirements increase after the first six months to a level of nearly five full-time equivalents over the final 18 months of the project.

Several subtasks require access to computing facilities. Some of these calculations may be fairly detailed and require many iterations, so it would be best if OEP had its own computer located at its normal working place.

OEP Project [illegible] Electrical Energy Conservation

Task 1. Develop Electrical [illegible]gy Consumption and Generation Data Base.

The objective of th[illegible] is to gather the detailed information needed to evaluate whether or no[illegible]fic conservation measures are worthwhile. The information needed inclu[illegible] highly disaggregated end use data as well as electrical supply data. [illegible]sk will make use of information developed by the National Energy Analy[illegible]oject (OEP Project No. 2); however, this task will involve a more detai[illegible]racterization of electric[illegible] demand and supply than is possible under the [illegible]nal Energy Analysis Project.

Subtask 1.1. Develop Data [illegible] Structure.

- o ANL will prepa[illegible] preliminary list identifying the structure and co[illegible] of the electrical energy data base.
- o OEP will revie[illegible] reliminary list, will develop further detail (such a[illegible]ifying specific end-use devices that should be separ[illegible] recognized), and will indicate major problem areas i[illegible] collection.

Subtask 1.2. Collect Ele[illegible]y End-Use Data.

- o Information on [illegible] of electricity will be collected in the most disag[illegible] form possible. For example, end-use appliances, [illegible] refrigerators and air-conditioners, will be classif[illegible]rately.
- o Data will be [illegible] into the major end-use sectors, such as industrial, [illegible]ial, and residential.
- o Industrial ele[illegible]y use will be identified by major industry and, wi[illegible]ssible, by end-use device.
- o The historical [illegible]e in ownership of electrical devices for household [illegible]rcial use will be tabulated if such data can be obt[illegible]

Subtask 1.3. Collect El[illegible]y Supply Data.

- o OEP will prepa[illegible]rmation on all existing and planned electrical ge[illegible] units. Required characteristics for each unit incl[illegible]acity, fuel type, heat rate, forced outage rate, [illegible]led maintenance requirements, age, operation and [illegible]nance cost, and historical capacity factor.
- o Hydroelectric g[illegible]ing units will also have information on historical [illegible]on of annual and seasonal generation

because of weather variation or other factors. Minimum flow requirements for navigation or irrigation needs will also be tabulated.

- The current expansion plan for the generating system will be identified.

- Historical data on supply of electricity by type of generation will be part of the data base along with overall electricity sales and losses in transmission and distribution.

- Historical and anticipated load growth information will collected.

- At least one complete year of hour-by-hour chronological load data should be part of the data base.

Subtask 1.4. Document Electricity Conservation Efforts.

- Explicit efforts for electricity conservation implemented to date will be identified and their estimated effects tabulated.

- Currently planned efforts and measures recommended by others will be documented together with projected electricity savings (if already estimated).

Subtask 1.5. Report Findings and Recommendations.

- The data collected will be tabulated in an informal OEP document. The report should be updated periodically as it will serve as a valuable reference for evaluating conservation options and other purposes.

- A set of recommendations will be included for collecting information that is missing or not readily available.

Task 1 Resource Requirements

Time Schedule	6 months
OEP Personnel	
1 Task Director	2 person-months
2 Support Staff Engineers	6 person-months
ANL Personnel	
Engineer	2 person-months
Other Contractors	
Assistance from other Egyptian government offices.	2 person-months

Task 1 Develop Electrical Energy Consumption and Generation Data Base

Subtask	Months From Project Start					
	1	2	3	4	5	6
1.1 Develop Data Base Structure						
1.2 Collect Electricity End-Use Data						
1.3 Collect Electricity Supply Data						
1.4 Document Electricity Conservation Effects						
1.5 Report Findings and Recommendations						

Task 2. Develop Simplified Met d in the Evaluation of Conservation Options.

The objective of this t obtain or develop simplified models and methods that will assist valuating electricity conservation options. In order to estim tential savings attributable to a proposed conservation option, must have methods readily available for analyzing electricity dema most disaggregated basis that data obtained in Task 1 (or expected ined) will allow.

This task will benefit orts devoted to Task 3 -- Energy Planning Model Evaluation of No. 2 - National Energy Analysis. Some of the models implemented oject may have sufficient electrical demand detail to be used direct s task. However, the capability to model disaggregated electrical at the level needed to evaluate conservation options probably insufficient in some models. The purpose of this task is to satis eeds.

Subtask 2.1. Develop or Obtain ctoral Models of Electrical Demand.

- o Evalu applicabili ting methods or models for industrial, commercial, ial, agriculture, and other end-use sectors.
- o Prefer engineering/ec approach that contains sufficient detail to uation of specific options, such as more efficient tors.
- o Develop or modify mod xplicitly fit conditions in Egypt.
- o Demand models should b e to key variables, such as electricity price, GN pita forecast, population, appliance ownership, an by industrial sector.

Subtask 2.2. Implement Models on uter.

- o A separate end-use odel for each important electrical end-use dem will be implemented on the OEP computers. These i dels are not expected to be overly complex but wil nalysis of major electrical conservation options fr mand point of view.

Subtask 2.3. Validate Models.

- o Using data from previ , the results of the output electrical demands wil pared with actual data on sales.
- o Discrepancies will be as necessary so that the models track historical ion reasonably well.

Subtask 2.4. Establish Reference Electricity Forecast By Sector.

- o Using current estimates of future economic activity and best estimates for key parameters, a reference electricity forecast by sector will be developed for at least 15-20 years in the future.
- o The reference forecast will be used to help evaluate conservation options.
- o Sensitivity to key parameters will be investigated.
- o Comparison with electrical forecasts by others will be made.

Subtask 2.5. Use models to Support Conservation Analysis.

- o OEP will use and modify the models as necessary to provide technical support for electrical conservation activities.

Task 2 Resource Requirements

Time Schedule	12 months
OEP Personnel	
Energy Modeler	6 person-months
Computer Specialist	8 person-months
ANL Personnel	
Task Director	2 person-months
Energy Modeler	3 person-months
Computer Specialist	2 person-months
Other Contractors	
Assistance in model implementation	3 person-months

Subtask	Months From Project Start																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2.1 Develop or Obtain End-Use Sectoral Models of Electrical Demand				—	—	—																		
2.2 Implement Models on ORP Computer					—	—	—	—	—	—	—													
2.3 Validate Models										—	—	—	—											
2.4 Establish Reference Electricity Forecast by Sector													—	—	—									
2.5 Use Models to Support Conservation Analysis																—	—	—	—	—	—	—	—	→

Task 3. Develop Investment Policy for Electrical Energy Consuming Technologies

The objective of this task is to establish a life cycle costing framework for evaluating electrical conservation options and to apply it in a study of efficiency standards for appliances. The output will be a methodology for assisting in the economic evaluation of specific conservation alternatives and a case study with recommendations on whether government efficiency standards or other policies, such as efficiency-based taxes on equipment, would save significant quantities of electrical energy. Because prices of electrical energy in Egypt may not reflect the full long-run marginal cost of production, policies such as these could result in substantial conservation of electricity. The evaluation framework will be suitable for OEP to establish training courses or workshops to train people in positions to make decisions on equipment purchases (e.g., pumps and motors) as well as others.

Subtask 3.1. Establish Life Cycle Costing Framework.

- ANL will prepare a life cycle costing methodology that can serve as the basis for decisions involving single products. For example, a typical comparison would be an efficient, more expensive (in terms of initial cost) refrigerator to a low initial cost but less efficient refrigerator.

- A report on the framework will review principles of engineering economics, time value of money, escalation and inflation, and criteria for project comparison.

Subtask 3.2. Review U.S. Experience on Improved Efficiency of Electrical Devices.

- ANL will review U.S. efforts to develop improved efficiency electrical devices, such as pumps, motors, and air conditioners.

- The technical as well as economic progress to date will be the featured outputs.

- A list of electrical devices and proposed efficiency improvements will be developed.

- Effort will focus on those devices that appear to have greatest applicability in Egypt.

- A report will be prepared to summarize findings.

Subtask 3.3. Evaluate the Potential Benefits and Costs of Standards for Electrical Equipment.

- o OEP staff will apply the principles of the life cycle costing framework to a case study of efficiency standards that specify minimal acceptable performance.
- o Benefits will be measured in terms of monetary savings and electrical energy (and capacity) savings.
- o In lieu of standards, other policies, such as placing sales taxes on inefficient equipment, will be evaluated.

Subtask 3.4. Promote Analysis of Investment Decisions.

- o OEP will elaborate on the framework and use appropriate parts of it to develop reference materials and brochures for potential users, including OEP and other governmental staff, professional purchasers of electrical equipment, and consumer organizations.
- o OEP will develop sample calculations appropriate for the different levels of sophistication of the various potential users.
- o These materials will form the basis for some of the workshops and training sessions listed in Task 7.
- o These materials will be maintained and revised beyond the major period of work, which finishes 13 months after the project start.

Task 3 Resource Requirements

Time Schedule	10 months (excluding extension of Subtask 3.3)
OEP Personnel	
Task Director	2 person-months
Engineer/Economist	7 person-months
ANL Staff	
Engineer/Economist	6 person-months
Other Contractors	
Technical Expert on Electrical Consuming Devices	4 person-months

Task 3 Develop Investment Policy for Electrical Energy Conserving Technologies

Subtask	Months From Project Start																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
3.1 Establish Life Cycle Costing Framework																								
3.2 Evaluate the Potential Benefits and Costs of Efficiency Standards for for Electrical Equipment																								
3.3 Review U.S. Experience on Improved Efficiency of Electrical Devices																								
3.4 Promote Analysis of Investment Decisions																		(maintain and revise materials)						

Task 4. Evaluate Conservation Potential for New and Existing Electrical Generating and Transmission Equipment

The objective of this task is to determine the electrical conservation potential of various actions directed at electrical supply, rather than electrical consumption as in Task 3. The emphasis is on the generating system; however, one subtask is devoted to identifying overall losses for the electrical system and possible ways to reduce them. This task requires a detailed examination of the generating system to determine whether measures such as increased preventive maintenance, upgrading of older equipment, and other improvements are worthwhile. Data obtained in Task 1 contribute importantly to this task.

Subtask 4.1. Examine Potential Improvements in Power Plant Efficiency.

- o OEP with assistance as needed from contractors and the Ministry of Electricity and Energy will examine potential improvements to existing generating unit heat rates, such as condenser modifications and poorly operating control valves. It is unlikely that sufficient effort can be dedicated to this task to actually implement specific improvements. However, the list of recommendations should serve as a starting point for a more in-depth analysis.

- o OEP with assistance will examine the original design heat rates for planned additions to the thermal generating system to determine whether potential exists for energy savings at low cost.

- o OEP will examine the potential for increases in net output from existing and planned generating capacity.

Subtask 4.2. Study Possible Upgrading and Life Extension of Existing Generating Units.

- o OEP with assistance from ANL and contractors will evaluate whether cost-effective life extension is reasonable for some existing generating units.

- o OEP will also study whether more rigorous preventive maintenance procedures would provide benefits sufficient to justify costs.

- o Life extension analysis will include both upgrades involving significant capital expenditures and less significant measures to extend operating life.

Subtask 4.3. Install a Production-Cost and Reliability Model.

- o OEP and ANL will conduct a brief survey of production-cost models that will suit OEP needs.

- o ANL will assist OEP in implementing a production-cost and reliability model that will serve as a valuable aid in evaluating the benefits of measures such as described in Subtasks 4.1 and 4.2.

- o Together with the data gathered in Task 1, such a model can be used to help analyze numerous economic and reliability issues facing the electrical generating system.

- o Benefits of measures such as in Subtasks 4.1 and 4.2 should be evaluated in a system context. For example, a unit with improved heat rate will probably operate more hours per year than it did previously. Without a system model, such changes are difficult to predict.

- o Although current domestic energy prices will be used for reference studies of the generating system, border (world) fuel prices should be examined at least for sensitivity analysis. Evaluations of conservation options may be justified in using world prices as a basis.

Subtask 4.4. Evaluate Electrical System Losses.

- o OEP with appropriate assistance will evaluate the losses that occur between generation of electricity and sales of electricity. This excludes losses within a generating plant which are already covered in Subtask 4.1.

- o The losses will be categorized to the extent data allows, e.g., transmission losses, distribution losses, and company use.

- o Recommendations for methods to reduce losses will be made.

Task 4. Resource Requirements

Time Schedule	15 months
OEP Personnel	
Task Director	3 person-months
Engineers/Economists	10 person-months
Transmission Specialist	4 person-months
Generating System Modeler	5 person-months
Computer Specialist	3 person-months
ANL Personnel	
Engineer	1 person-month
Generating System Modeler	3 person-months
Other Contractors	
Ministry of Electricity and Energy	1-2 person-months
Consultants on Generating and Transmission Technology	15 person-months

Task 4 Evaluate Conservation Potential for New and Existing Electrical and Transmission Equipment

Subtask	Months From Project Start																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
4.1 Examine Potential Improvements in Power Plant Efficiency																								
4.2 Study Possible Upgrading and Extension of Existing Generating Units																								
4.3 Install a Production-Cost and Reliability Model																								
4.4 Evaluate Electrical System Losses																								

Task 5. Examine Cogeneration Potential.

The objective of this task is to study whether selected opportunities for electrical energy and overall energy savings would result from cogeneration. The study would define whether further investigation appears warranted for particular types of cogeneration applications. Preliminary economic evaluation will be the primary indicator of benefits, but potential energy savings will also be noted.

Subtask 5.1. Gather Energy Use Data for Cogeneration Evaluations.

- o OEP will collect information on steam, process heat, and other thermal energy needs of important industries in Egypt. This will undoubtedly require more detailed information than was obtained in Task 1.
- o Characteristics of existing cogeneration and previous evaluations will be collected.
- o Non-industrial thermal energy needs will also be examined.

Subtask 5.2. Select Several Most Favorable Opportunities for Evaluation.

- o OEP will identify the apparent highest priority cogeneration opportunities.
- o ANL will assist OEP in determining whether and at what cost existing cogeneration technologies match reasonably well with the identified opportunities.
- o A preliminary list of high priority applications will be prepared for the following subtask. Expected changes in electrical pricing policy will be included in the evaluation.

Subtask 5.3. Perform Preliminary Economic and Technical Evaluation.

- o OEP staff will evaluate the overall cost of the selected cogeneration applications and cost of alternatives to cogeneration (the production-cost model in Task 4 will be helpful here).
- o The overall energy savings and effect on electrical supply for each application will be tabulated.
- o OEP will prepare a report covering data, methods, findings, and recommendations of the cogeneration study.

Task 5 Resource Requirements

Time Schedule	14 months
OEP Personnel	
Task Director	3 person-months
Engineer/Economist	14 person-months
ANL Personnel	
Engineer/Economist	2 person-months
Cogeneration Specialist	3 person-months
Other Contractors	
Assistance in Data Collection and Technical Information on Cogeneration	4 person-months

Task 5 Examine Cogeneration Potential

Subtask	Months From Project Start																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
5.1 Gather Energy-Use Data for Cogeneration Evaluations																								
5.2 Select Several Most Favorable Opportunities for Evaluation																								
5.3 Perform Preliminary Economic and Technical Evaluation																								

Task 6. Identify Major Load Management Options.

The objective of this task is to assess whether various load management alternatives offer significant and cost-effective opportunities for conservation of electrical energy. Load management is defined here as application of measures to influence the customer's use of electricity so as to modify demand and system load factor. Thus, pricing policies for electrical energy, such as time-of-day or seasonal rates, can be considered load management measures. The increases already expected in electricity prices provide an incentive for analysis of load management options both by OEP and by major electrical consumers. The improvement of system load factor means not only that some generating equipment would have fewer idle hours but also that peak load may be reduced in future years. The output of the task will be a report detailing the findings and recommendations of the load management study.

Subtask 6.1. Establish the Framework for Evaluation.

- o ANL will assist OEP in developing a framework for load management evaluation. The techniques developed in Tasks 2 and 3 and data from Task 1 will be helpful.
- o The framework should establish the measures of benefits and costs for the load management assessment.
- o The options having major load impacts will require use of the production-cost model implemented in Task 4.

Subtask 6.2. Evaluate Direct Load Control Devices.

- o A description of technically feasible devices must be established. The description should include technical characteristics and cost.
- o Potential energy and capacity savings for various levels of implementation of each device should be determined. Social and environmental effects should also be identified.
- o Both local (e.g., clock-timer) and remote (e.g., ripple) control systems should be evaluated.

Subtask 6.3. Evaluate Particular Options for Large Customers.

- o OEP will study whether large customers, e.g., industries, offer especially good opportunities for load management.
- o Off-season and/or off-peak loading of electric-intensive processes, such as in the cement industry, are examples of the options to be evaluated.
- o Interruptible power is another important option to be evaluated.

Subtask 6.4. Design of Electricity Tariffs to Provide Incentives.

- o OEP and ANL will study the design of electricity tariffs that provide customers with sufficient economic incentives to implement load-management strategies themselves. The expected changes to existing tariffs will serve as a starting point for study.

- o The difference between current tariffs and long-run marginal cost will be examined.

- o Seasonal and/or time-of-day tariffs based on the cost of service are typical steps to be taken. These tariffs allocate capacity costs mostly to times of high loads.

- o The production-cost model from Task 4 and the hourly load data from Task 1 will be used to study the variation of marginal energy cost during a year and the responsibility for capacity cost based on hourly contributions to system reliability.

Subtask 6.5. Report of Load Management Findings.

- o OEP will prepare a report identifying the best opportunities for load management.

- o The evaluation will include costs, energy and capacity savings, and unquantified effects (e.g., institutional barriers to implementation).

Task 6 Resource Requirements

Time Schedule	15 months
OEP Personnel	
Task Director	4 person-months
Engineer	8 person-months
Economist	10 person-months
ANL Personnel	
Engineer/Economist	3 person-months
Load Management Specialist	3 person-months
Other Contractors	
Technical Specialists on Load Control Devices	6 person-months
Tariff Design Consultants	4 person-months

Task 6 Identify Major Load Management Options

Subtask	Months From Project Start																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
.1 Establish the Framework for Evaluation																								
6.2 Evaluate Direct Load Control Devices																								
6.3 Evaluate Particular Options for Large Customers																								
6.4 Design of Electricity Tariffs to Provide Incentives																								
6.5 Report on Load Management Findings																								

Task 7. Develop Training Program in Principles of Electrical Energy Conservation

The objective of this task is to transfer information on electric energy conservation to appropriate groups. For example, there may be short courses of a few days offered by OEP to individuals charged with responsibility for purchases of major electrical consuming devices. Groups at which this task is aimed include industrial plant managers, consumer information officers, government regulators and workers involved with electrical energy conservation, consumer groups, and OEP staff. This task is not to duplicate any of the efforts devoted to Task 7 of the Industrial Energy Conservation Project (OEP Project No. 1); however, some of the individuals attending those training sessions may also benefit from additional offerings developed as part of this task.

Subtask 7.1. Economic Comparisons of Electrical Conservation Options.

- o ANL will assist OEP in developing training sessions of one or two days that can be offered to different sets of people, e.g., government officials, managers of industrial or commercial establishments, and teachers.
- o The principles of economic evaluation will be covered, e.g., present value and life cycle costing.
- o Simplified literature will be developed that could be widely distributed.

Subtask 7.2. Conduct Short Courses Tied to Specific Findings.

- o ANL will assist OEP in preparing and holding short courses intended to transfer important findings to relevant groups. For example, if Task 4 leads to some measures having good potential, it may be appropriate to have a set of seminars prepared for the staff of the Ministry of Electricity and Energy.
- o Tasks 2-6 each have potential topics which may warrant these convenient information-transferring courses.

Subtask 7.3. Training in Modeling.

- o OEP and ANL will offer training sessions in the use of techniques beyond Subtask 7.1 that were developed in this project. For example, end-use models developed in Task 2 could be applied to problems faced by other government agencies.
- o Assistance will be offered both from the technical viewpoint of the model and from the practical viewpoint of the computer user.

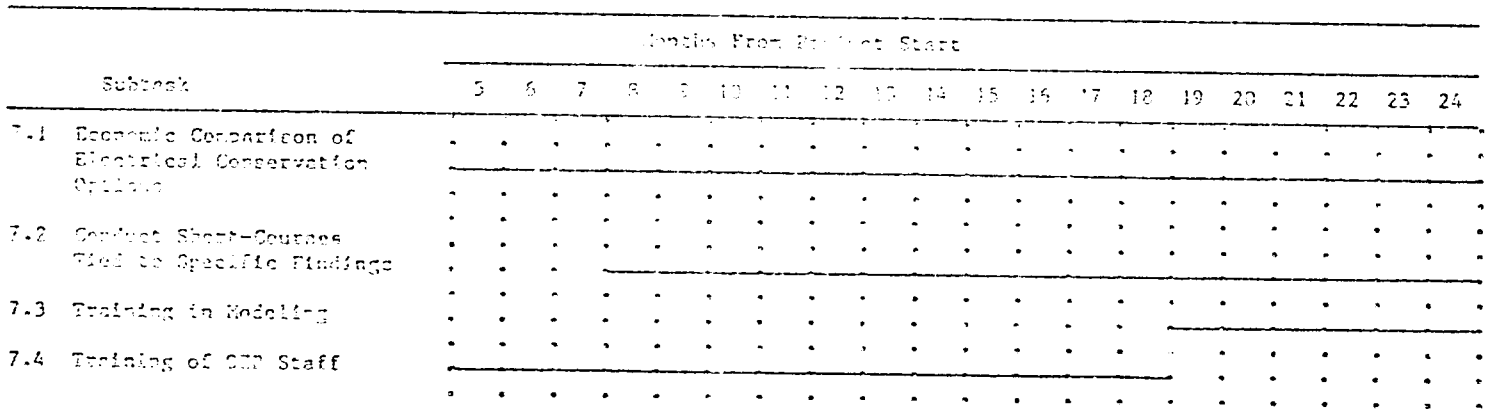
Subtask 7.4. Training of OEP Staff.

- It is anticipated that some groups training of OEP staff on selected topics will be warranted. ANL and outside consultants will conduct these sessions as needed.

- Individuals or small groups training may be conducted at ANL, e.g., use of ANL's production-cost and reliability model prior to OEP's selection of a model to be implemented in Cairo.

- OEP will evaluate the benefits of short but formal training sessions for its staff.

Task 7 Resource Requirements

Time Schedule	12 months
OEP Personnel	
Engineers/Economists	6 person-months
Computer Specialists	4 person-months
ANL Personnel	
Task Director	2 person-months
Engineers/Economists	3 person-months
Computer Specialists	2 person-months
Other Contractors	
Technical Specialists as needed	2-8 person-months

Task 7 Develop Training Program in Principles of Electric Energy Conservation