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109758

**TASK ORDER NO. 9 COMPLETION REPORT**

**ARMENIA: POWER SUPPLY AND DEMAND**

**CONTRACT NO. LAG-I-00-98-00005-00**

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September, 2000

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**TASK ORDER NO. 9<sup>1</sup> COMPLETION REPORT**  
**ARMENIA: POWER SUPPLY AND DEMAND PROJECT**

**BACKGROUND**

The Government of Armenia has committed to the international community to shut down the Armenian Nuclear Power Station (ANPP) by year-end 2004. Given the dominance of the ANPP in Armenia's present electricity supply (it represents close to 50% of current electricity production), replacement power following its shutdown is vitally important. This Task Order was designed to review, in detail, a number of options for meeting part of the replacement power needs anticipated in the post 2004 period and to work towards actual Government approval and adoption of these resources.

Initially, this Task Order focused on several potential resource options including:

- "Mothballing" of units 2-2 and 2-4 of the Hrazdan Thermal Power Station with the possibility for restarting the units at a later date when the capacity was needed;
- Rehabilitation for both the Sevan-Hrazdan and Vorotan Cascades;
- Development of geothermal resources to reduce electrical load through end-use application; and,
- Demand-side management and energy efficiency.

Following discussion with USAID, it was decided to replace the Hrazdan 2-2 and 2-4 subtask with an energy investment planning assignment. The energy investment planning subtask recognized that the Government of Armenia was not well organized to evaluate and promote investments in the energy sector. Thus, the purpose of this subtask was to propose a framework for energy investment promotion designed to increase the likelihood of successful investment attraction.

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<sup>1</sup> Contract LAG-I-00-98-00005-00

This report describes the major results accomplished through this Task Order, identifies how each deliverable requirement was met and provides suggestions for follow-on activities should USAID, or other donors, desire to continue work in this area.

## **MAJOR RESULTS**

Overall, this Task Order contributed to several important accomplishments:

### **Hydropower Rehabilitation**

- The hydropower rehabilitation studies were by far the most comprehensive completed to date. Significant focus was directed at the Vorotan Cascade, given its relatively dominant role in hydropower production in Armenia. A rehabilitation plan including detailed equipment, material and labor needs was defined for each station on the cascade along with a financing plan to achieve the \$31 million required for the rehabilitation plan to be fully implemented.
- Other specialized studies in the hydropower sector were also completed. For instance, Hagler Bailly specialists investigated the condition of water tunnels diverting water from the Arpa and Vorotan rivers to Lake Sevan. The assessment indicated a serious need for rehabilitation of the Arpa-Sevan tunnel to prevent its collapse, along with the consequences such a collapse would pose for the water supply to Lake Sevan. Another study completed a preliminary assessment of the seismic safety of the civil works and impoundment structures on the Vorotan Cascade. The study identified the need for additional seismic safety work and noted that a public safety hazard may now exist.

### **Geothermal Resources**

- The geothermal subtask ruled out the likelihood that geothermal energy could play any significant role in reducing electricity usage through end-use substitution of low grade heating needs to geothermal energy. Geothermal resources in Armenia are characterized by relatively low temperatures and low flow rates, and are generally not located in proximity to potential end-users with any significant demand.

### **Demand-Side Management**

- The demand-side management subtask developed a screening tool for evaluating energy efficiency measures in terms of cost-effectiveness and their environmental impact. Training in the screening tool was provided, along with a Russian language version to facilitate its use among counterparts.
- One of the major contributions of this subtask included significant data collection on such items as saturation rates, costs of energy efficient technologies in the Armenian market, and estimated energy savings for various replacement technologies. Based on the analyses

completed, Hagler Bailly concluded that if reasonable promotion efforts were instituted shortly, the country could reasonably expect about 42 MW of peak coincident savings to be in place by the time the ANPP is scheduled for shut down, at a measure cost of \$18.9 million.<sup>2</sup>

- Additionally, a financing plan for energy efficiency was proposed based on a revolving fund concept. The fund's first year financing needs were estimated at about \$1.6 million.

### **Energy Investment Planning**

- The energy investment planning subtask focused primarily on: (1) critiquing the Government of Armenia's draft generation expansion plan and identifying a number of critical weaknesses; (2) independently forecasting the necessary operation and maintenance costs for generation, transmission and distribution over the next three years; and, (3) designing and promoting an investment planning framework for the country. Additionally, an updated generation database was developed for purposes of simulating the operation of the power system.

Overall, the Task Order developed a number of important work products that are continuing to be pursued through USAID's Task Order 13 of the same contract. For instance, Hagler Bailly is continuing to promote the Vorotan Cascade hydropower rehabilitation project and the investment planning framework remains under discussion with the Government.

### **DELIVERABLES REQUIRED BY THE TASK ORDER**

The contractually-required deliverables for this Task Order, and a description of how each deliverable requirement was met, are shown below in accordance with Article VI of the Task Order.

#### **Project Management Deliverables**

Four of the deliverables pertain to the overall Task Order and are not subtask specific. These include:

1. **Work Plans for Each Subtask**

Work plans for each subtask were prepared and submitted to USAID within the first 30 days of the Task Order's commencement. Based on discussions with USAID, Hagler Bailly did not prepare a work plan for the subtask to "mothball" Hrazdan 2-2 and 2-4 but instead prepared a recommended approach for a new energy investment planning subtask. USAID concurred with the proposed change in the Task Order's subtask and subsequently issued a modification.

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<sup>2</sup> Program administration costs are not included in this estimate.

## 2. Monthly and Quarterly Reports

These reports were prepared during the entire period of performance and summarized activities completed during the reported period, intended next steps, key personnel involved in the subtask and their activities and key issues/concerns encountered during implementation. The quarterly reports also discussed Task Order results and impacts achieved.

## 3. Task Completion Report

This report is designed to meet the requirements of the Task Order completion report.

Additional contractually-specified deliverables are listed below organized according to their appropriate subtask category.

### **Subtask A: Hydropower Rehabilitation**

Deliverables in this subtask include the following:

#### 1. Project Assessment Report

This deliverable was met through the completion of *An Assessment of the Rehabilitation Needs of Armenia's Large Hydroelectric Power Stations* (April 1999) prepared by Hagler Bailly. The scope of this study included a definitional review of the larger hydropower stations to gather all relevant information on the projects and their condition, part of the purpose of which was to define the planning priorities for later stages of hydropower rehabilitation. This definitional stage included: (1) evaluation of prior studies; (2) interviewing the current hydropower plant management; (3) interviewing other key individuals, including government representatives, contractors and power sector management; (4) site inspections; (5) interviewing representatives of the Armenian Hydropower Institute for information sources and capability; and, (6) identification of tasks for various Armenian parties.

The report recommended that the Vortan Cascade should be the main focus of the subtask for several reasons. The cascade is very important to system operations as it provides spinning reserve, peaking power, and critical voltage and frequency regulation for the electrical grid. The Vortan Cascade is also the only major southern generating facility and provides electrical balance to the system. The problems at the Cascade are urgent, yet a relatively small funding package targeted at these issues could be expected to significantly improve the conditions at the Cascade and preserve it for the long-term. Further, the Vortan Cascade is expected to contribute both more energy and operating flexibility than the Sevan-Hrazdan Cascade for the foreseeable future due to environmental and irrigation flow limitations at the Sevan-Hrazdan Cascade. While no other substantial rehabilitation is being done at the Vortan Cascade, rehabilitation efforts for the Sevan-Hrazdan Cascade are already in progress at both the Argel and Kanaker stations. While there remain substantial needs at some of the other hydropower projects on the Sevan-

Hrazdan Cascade, the capacity available at these projects is probably sufficient to fully utilize the limited water available in the immediate future.

## 2. Environmental Assessment

This deliverable requirement was satisfied through the report *Environmental Assessment of the Vorotan Cascade Rehabilitation Project* (October 1999) prepared by Burns and Roe Enterprises. This report reviewed the proposed rehabilitation project and made a number of findings on the environmental impact likely to result. The report concluded that “[i]mplementation of the proposed rehabilitation project ... will provide an overall positive environmental impact, as many of the rehabilitation elements will eliminate leaks and spills into the Vorotan River.” Nonetheless, the report recommended that some mitigation measures be included in the rehabilitation plan including the recycling of spent station batteries (to a facility outside of Armenia) and expansion of the oil spill containment measures to include the transformer areas at Shamb and Spandarian HPPs. These recommendations were included in the proposed rehabilitation plan.

## 3. Rehabilitation Report

This deliverable requirement was achieved through the completion of the report entitled *Vorotan Hydropower Cascade Rehabilitation: Project Planning and Technical/Financial Analysis Report* (November 1999) prepared by Hagler Bailly. This report provides the results of the project team’s assessment of the Cascade, including the electrical, mechanical and civil works. A detailed rehabilitation scope of work (suitable for bidding) is included in the report along with recommendations for its financing (based on a rehabilitate-operate-transfer model designed to attract private sector financing). The defined scope of work is such that if the plan is implemented the Cascade should not need further substantial rehabilitation work for at least 20 years.

The rehabilitation scope of work for the Cascade is expected to cost approximately \$31,000,000 including contingencies. The breakdown of costs includes repairs to civil works (\$1.5 million), electrical components (\$12.5 million), mechanical components (\$12.8 million) and various contingencies (\$4.1 million).

Significant effort focused on identifying a financing scheme for the Cascade rehabilitation plan. Although some consideration was given to multilateral loans as a source of partial financing, such lending is decreasing in favor of privatization and funding through public/private sector efforts. Thus, the primary effort involved developing a financing mechanism that could attract private sector capital. Several options were considered; following review and financial analysis, a rehabilitate-operate-transfer method was selected. It includes a 25-year concession to a private operator with the asset reverting to state ownership upon expiration of the concession. A “base case” financial model recommends a tariff of 15 drams per kWh (\$0.028) for the output from the Cascade. This tariff (assuming it is paid in full) will provide sufficient funding for rehabilitation, proper operation and maintenance of the Cascades and will likely yield, through a transparent

bidding process, an initial cash payment to the Government of Armenia. The financial model included with the report permits easy alteration of the key parameters to assess the potential tradeoffs between the tariff level, share of the cascade company stock to be retained by the Government, period of operating concession and initial purchase price.

Although the primary focus of the rehabilitation study is on the generating facilities of the Cascade, the inspection of the facilities and discussions with Armenian engineers resulted in several concerns regarding the Cascade's impoundment facilities. The impounding structures likely do not meet current seismic stability criteria and may have other safety deficiencies. In addition, the dams do not have appropriate instrumentation equipment to allow for proper monitoring of impoundment structures of this hazard level. As a result of this concern, further examination of this topic was undertaken and a report described in (5) below was prepared, with recommendations on dam safety.

#### 4. Tender Prequalification Documents

In addition to prequalification documents, Hagler Bailly developed a series of documents sufficient for bidding and tendering the rehabilitation project. These documents will only require minor modification by the Government of Armenia and the Vorotan Cascade enterprise for their use in the future. The documents include:

- The detailed statement of work for the rehabilitation;
- Instructions to applicants (submission instructions, proposal opening and evaluation procedures, finalization and award);
- Proposal format and content requirements (proposal security, tariff rate, financing plan, operations and maintenance expense schedule, project schedule, environmental monitoring plan, rehabilitation plan cost data);
- Description of the security package (including principles of the implementation, power purchase, O&M and EPC agreements, required insurance policies, necessary government approvals, etc.)

#### 5. Hydropower Seminar and Further Action Report (including the assessment of the Vorotan-Arpa-Sevan tunnel issue)

A subtask wrap-up seminar was held in February 2000 to present the results of the hydropower rehabilitation subtask. The seminar reviewed the technical, economic, environmental and financial modeling work completed during the assignment. Considerable discussion focused on the proposed method of financing the rehabilitation plan.

To respond to the requirement for a Further Action Report, Hagler Bailly prepared two documents, one of which was the *Review Report on the Conditions and Repair of the Arpa-Sevan*

*Diversion Tunnel* (April 2000). This report was based on an actual tunnel inspection conducted by Hagler Bailly personnel as well as review of other reports and discussions with Armenian officials. The report concludes that the tunnel is in need of significant rehabilitation, at a cost that could reach \$10,000,000.<sup>3</sup> There is the possibility of a partial or full collapse of the tunnel, although predicting the timing and extent of such a collapse is highly speculative. Should such a collapse occur, its impact would be severe on the water flow into Lake Sevan. It would also eliminate the possibility of diverting water from the Vorotan River to Lake Sevan (as is now planned and under construction) as the Vorotan waters would also rely on the Arpa-Sevan tunnel for transfer to Lake Sevan.

A second report on the safety of the civil works and impoundment structures on the Vorotan Cascade was completed. This report was only intended to indicate whether seismic safety considerations for the Cascade should be evaluated further. The study entitled *Armenia Power Sector – Dam Safety Conditions and Concerns Review Report* (June 2000) concludes that at least some of the impoundment structures on the Vorotan Cascade do not meet current earthquake stability criteria and have unsatisfactory instrumentation. Thus, their performance in the instance of a large magnitude earthquake is uncertain; also, a slowly developing problem over time is difficult to detect due to the lack of proper instrumentation. The structures of primary concern include the Vorotan Cascade dams (Spandaryan, Tolors, Angeghakot and Tatev) and the emergency spillway at the Argel Project in the Sevan-Hrazdan Cascade. In addition to further analysis and modeling, the report recommends development of emergency action plans for both Cascades to better protect public safety.

### **Subtask B: Geothermal**

Deliverables in this subtask include the following:

#### **1. Resource Assessment Report**

Burns and Roe, in association with GeoThermex, completed a *Geothermal Resource Evaluation Initial Assessment Report* (May 1999) based on the results of their field investigations in Hankavan, Arkazan, Martuni, Jermuk and Sisian. The report contains a basic assessment of geothermal well potential in Armenia and recommends a well testing program at Jermuk as it appears to have the best potential of the sites visited for utilization of geothermal energy. However, as noted below, additional analysis ultimately led Hagler Bailly to recommend to USAID that the subtask activities be suspended, given the very poor flow rates and low temperatures seen for all five sites examined, including Jermuk.

#### **2. Well Testing Procedures Report**

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<sup>3</sup> This is an estimate made by Armenian officials. Hagler Bailly's estimate is lower – approximately \$6,000,000 to \$7,000,000.

Burns and Roe/GeoThermex developed a well testing procedures report entitled *Well Test Procedure for the Jermuk Geothermal Area* (May 2000) that described a test protocol to evaluate the extent of the geothermal resource available in Jermuk. The well testing procedure was not implemented due to the suspension of activities under this subtask.

### 3. Memorandum Supporting Subtask Termination

Based on the results of the *Geothermal Resource Evaluation Initial Assessment Report* and site visits conducted by Hagler Bailly, a memorandum was prepared in July 1999 recommending termination of the subtask. The memorandum concluded that “[e]xisting sources of geothermal energy that are currently being utilized will continue to provide a limited source of thermal energy at selected areas in Armenia. Any expanded role of geothermal energy does not appear to be significant at this time due to the low demand in areas of available supply, and the very limited thermal utilization factor of the geothermal energy supply itself. Refurbishment and expansion of these supply sources does not appear to be economically justifiable in the near term.” Even if future conditions would make geothermal energy a viable resource, Armenia has the domestic capacity to develop this limited resource without the need for offshore technical assistance and/or funding. USAID concurred with Hagler Bailly’s recommendations and activities under this subtask were terminated.

#### **Subtask C: Demand Side Management (DSM)**

Deliverables for this subtask include the following:

##### 1. DSM Screening Tool

This deliverable requirement was met through the development of an MS-Excel based spreadsheet that provides a comprehensive way to assess the effectiveness of various efficiency measures in Armenia. To support the database development required for the screening tool, up-to-date information on technology usage, technology costs and market penetration was collected. Use of the model revealed a number of measures that appear cost-effective and warrant further investigation, primarily those measures that are targeted at reducing, or replacing, residential electric heating. Further, the fact that the model has been written in both English and Russian language versions increases the likelihood that the model can be used both within and outside of Armenia.

The model is documented in the Hagler Bailly report *Demand Side Management Screening Tool for Armenia* (March 2000).

##### 2. DSM Final Report

This deliverable requirement was achieved through the completion of the report entitled *Armenia – Final Report of the Demand-Side Management Project* (March 2000). This report summarizes the results of the subtask activities and projects that about 42.2 MWs of system peak coincident

savings (and 203 GWh annually) are achievable by the time of the ANPP shutdown if the Government initiates efforts shortly to promote the adoption of a number of efficiency measures. The greatest savings result from fuel substitution, replacing electricity with natural gas in several end-use applications.

### 3. DSM Financing Report

Hagler Bailly prepared a report entitled *Financing Energy Efficiency in Armenia* (April 2000) that examines various ways to address the problem of financing energy efficiency measures. Following a review of the credit situation in Armenia and the options available, a revolving fund concept was proposed. Initial first-year financing of \$1.66 million is recommended, an amount that would permit about \$1.2 million in loans to be issued during the first year. At the same time, the fund would need to grow to about \$6 million per year in order to cover its costs of operation. A unique feature of the proposal is the possibility of staging loans from the fund, with higher interest rates initially and lower rates for additional stages of borrowing, reflecting the consumer's established credit rating with the fund.

The report also discusses the possibility of a regionally-based fund among the South Caucasus nations if progress on resolving the Nagorno-Karabakh situation is made and reconstruction funds become available.

### 4. DSM Training Report

During the Task Order's period of performance, a number of training sessions were provided on the use of the screening tool. In February 2000, a seminar was conducted and report prepared that reviewed the following: (1) implications of energy efficiency on tariff methodologies; (2) DSM screening model overview; and, (3) an example of screening tool input and output.

## **Subtask D: Energy Investment Planning**

### 1. Review Report of the Armenian Produced Least Cost Plan

This deliverable requirement was met through the completion of the report *Review and Analysis of the Armenian Least Cost Investment Plan* (October 1999). Hagler Bailly reviewed the draft generation expansion plan prepared by the Ministry of Energy and identified a number of critical shortcomings in both data and planning techniques that compromise the validity and usefulness of the results. Due in part to this critique, Hagler Bailly is now working jointly with the Ministry of Energy on the preparation of a revised plan.

### 2. Energy Investment Planning Framework Report

This deliverable requirement was achieved through the completion of the *Framework Report: Initiation, Evaluation and Execution of Private Power Projects in Armenia* (November 1999). The report describes a process to increase the likelihood of successful investment attraction. A

recommended organizational structure to promote investment is outlined along with recommendations for the preliminary processing of solicited and unsolicited proposals. Information to be supplied by project sponsors and the format for such information is also described. Additionally, the report includes suggested guidelines and evaluation methods for the evaluation of proposals along with the recommended steps for the final appraisal of a project. This includes negotiation of implementation, power purchase and, where relevant, fuel supply agreements. Finally, the Government's recommended role in EPC contractor selection and project financing is also described.

### 3. Production Simulation Database, including Updated Operation and Maintenance Estimates

Hagler Bailly updated the database of the production simulation model used by the project team. Information on generation plant operating characteristics and load levels were updated and included in the RealTime™ database. Additionally, the results of an investigation of the operation and maintenance costs for generation and transmission facilities were also incorporated into the model. The model was initially used to test the Government's least cost generation plan. Now, as part of the ongoing Task Order 13, the data has been transferred to the WIPM model.

Additionally, to support the modeling efforts and to assist with other important reform initiatives (especially related to tariffs), the project team completed an analysis of the operation and maintenance requirements for the power sector. The results of the analysis were included in the *Generation, Transmission and Distribution Operation and Maintenance Requirements Study* (March 2000).<sup>4</sup> The study was conducted to determine the appropriate operation and maintenance (O&M) requirements for power plants (thermal, hydro, and nuclear) and transmission and distribution companies for the period 1999-2002 as well as to evaluate the adequacy of current O&M expenditures. To complete the study, Hagler Bailly reviewed all plans for generation, transmission, and distribution facilities in the country, including enterprise-specific business plans, visited all facilities to observe conditions in the field, and discussed O&M issues with company management and operating staff.

### 4. Investment Planning Framework Seminar and Further Action Report

In August 1999, a seminar was presented on the investment planning framework, the content of which directly aligned with the *Framework Report* described in (2) above.

## **SUGGESTIONS FOR FURTHER TECHNICAL ASSISTANCE**

Given that further technical assistance in this area is likely, a number of recommendations are offered based on the results achieved through Task Order 9.

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<sup>4</sup> Some of the efforts to prepare this document were provided under Task Order 13.

## Hydropower

- *Continue to support the Vorotan Cascade rehabilitation project:* At present, the Government of Armenia is absorbed by the debate regarding the privatization of distribution. To some extent, this has distracted the Government from focusing on generation requirements. Given that the Government appears to be moving forward with the distribution privatization, the timing will be right later this year to aggressively promote the Vorotan Cascade rehabilitation project as one part of an overall generation privatization strategy.
- *Priority should be given to identifying funding sources for the Arpa-Sevan tunnel rehabilitation due to the harm that could result from a partial or complete tunnel collapse:* The situation with the Arpa-Sevan tunnel is serious and Hagler Bailly estimates that approximately \$7,000,000 is needed to repair the tunnel (this is lower than the estimates developed by Armenian officials). Efforts should continue to contact donors and other funding agencies to assess the availability of funding sources. The Government would also be wise to redirect the funds now being used for construction of the Vorotan-Arpa tunnel to the repair of the Arpa-Sevan tunnel.
- *Further analysis of seismic safety of the impoundment structures on the Vorotan Cascade is recommended:* A program to fully inspect and evaluate four dams in the Vorotan Cascade should be undertaken in the near future. This effort should be preceded by a comprehensive data collection effort on the dams, including all geological information, construction information, as-built drawings, instrumentation details and data. The inspection review should include full spillway adequacy review and stability analysis, with particular focus on earthquake risk assessment. At a minimum, the dams need to have proper instrumentation designed and installed, including piezometers, seismic monitors, inclinometers and seepage monitoring points.
- *Spillway analysis at the Argel station is also recommended given that the reconstructed spillway does not, based on preliminary analysis, appear well-designed. A spillway collapse, similar to one witnessed in 1995, remains a possibility:* Hagler Bailly is concerned that the reconstructed spillway may not support large amounts of spillage. Modeling of the spillway and simulation of its operation is recommended. Should a problem with the design be confirmed, the model could also be used to test various “fixes.” The cost for such modeling and analysis is likely to be less than \$100,000.

## Geothermal Energy

No further technical assistance on geothermal energy is recommended at this time. The limited resource and utilization potential of geothermal energy is within the country's ability to develop at a later date if justified.

## **Demand-Side Management**

- *As part of the effort to develop a least-cost generation expansion plan now underway, explicitly model potential energy efficiency measures to better estimate: (1) their actual economic benefit and relative cost effectiveness in comparison with all resource options; and, (2) the potential environmental impact the measures may represent.* Ultimately, the benefit of a demand-side program in monetary terms can be best determined by its impact on the costs needed to meet the country's energy needs. This can be most accurately assessed through an integrated resource planning analysis.
- *Use the results of the least cost planning process (in terms of economic and environmental impacts) to update the screening tool:* The screening tool made a number of simplifying assumptions regarding the value of energy savings (based essentially on present tariff levels). From a public policy perspective, it is the value of the avoided energy that is relevant, rather than the present tariff levels. This value of avoiding energy use can best be estimated through the integrated analysis described above and the results of this economic analysis should be reflected in the screening tool.
- *Use the pilot weatherization and fuel substitution program being undertaken as part of Task Order 13 to confirm the savings estimates found in the current version of the screening tool:* Further, more work is needed to estimate the program administrative costs associated with a demand-side program, a task that can also be accomplished through the development and implementation of the pilot project.
- *From a policy perspective, accelerate the dialogue with the Energy Regulatory Commission on energy efficiency and the Commission's role in promoting efficiency:* As part of Task Order 13, Hagler Bailly is developing a regulatory policy paper discussing the ways in which a regulatory body can promote energy efficiency. Additionally, at least two staff of the Energy Regulatory Commission should be trained in both the use of the screening tool and ways to evaluate efficiency related initiatives.

## **Energy Investment Planning**

- *Use the ongoing generation expansion planning project under Task Order 13 to promote the planning framework developed through Task Order 9:* The planning framework developed and proposed would make a very positive contribution in organizing and rationalizing the investment promotion process. Given that Task Order 13 is already working towards the development of a least cost generation plan, the effort to promote the planning framework should be combined with the generation expansion plan. In other words, the project team should also promote the need for reorganizing the planning and investment attraction processes along the lines proposed in the Task Order 9 framework report as part of the generation expansion planning task.

## CONCLUSION

This project achieved its objectives by defining projects that could partially meet the needs for replacement power pending the shutdown of the ANPP, planned for year-end 2004. The hydropower rehabilitation subtask made substantial progress in fully defining a vitally needed program for the Cascade that, although not substantially increasing energy generation from the Cascade, will ensure that the Cascade remains available to partially meet the needs of the power system. The hydropower work also helped identify potentially serious threats to the Armenian power system resulting from the possibility of collapse of the Arpa-Sevan tunnel and seismic safety concerns on the Vorotan Cascade.

The geothermal work did not yield promising results. In fact, based on the site inspections and analyses completed, it is likely that geothermal energy offers little potential to play a significant role in the country's overall energy balance. Efforts are best directed elsewhere.

The demand-side management subtask significantly enhanced the amount of data available on energy efficiency measures and estimated the amount of electricity savings that could be realistically achievable by the time of the ANPP's planned shutdown. The screening tool developed through this subtask provides an analytical approach to identify those measures potentially worth promoting. To overcome the difficult issue of funding energy efficiency in the commercial environment found in Armenia, a financing plan, involving a revolving fund concept, offers an attractive option especially if regional reconstruction funds become available.

Finally, the investment planning subtask played an important role in the success of this Task Order. The critique of the Ministry of Energy's generation expansion plan was important enough to lead to a renewed joint planning effort involving Hagler Bailly, the Ministry of Energy and the Energy Regulatory Commission. The planning framework developed by the project team also attempted to lay a groundwork for the Government to increase the coherence of the investment attraction process and if adopted, should enhance the likelihood that private investment can be mobilized to help meet the country's energy needs in the post-ANPP period.