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ARMENIA INDEPENDENT POWER DEVELOPMENT AND PROMOTION PROJECT

EVALUATION OF POWER PROJECTS IN ARMENIA
For Development and Financing by the Private Sector

Ministry of Energy of Armenia

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USAID IPP Team

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EVALUATION OF PRIVATE POWER OPPORTUNITIES

FOR FINANCING

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EXECUTIVE SUMMARY

Purpose of the Study

Since its independence in 1991, Armenia has plunged into an economic and energy crisis situation, which, given the lack of domestic resources to address pressing investment and maintenance needs, has resulted in large scale deterioration of the country's basic infrastructure. One of the most severely affected areas has been the power sector which has deteriorated to alarming levels with adverse long term implications for the potential recovery and development of the economy.

Financing for power sector maintenance and upgrades has been limited and fallen short of minimum required levels. The state budget, until recently the main source of finance for the utility sector, has been severely strained by a wide array of critical funding needs, including an overwhelming imported fuel bill. The Government has managed, however, to rehabilitate and commission a 440 MW unit of the nuclear plant, with assistance from Russia. The World Bank and the US Agency for International Development (USAID) have financed emergency supplies and rehabilitation needs, and the European Bank for Reconstruction and Development (EBRD) is considering financing for the completion of a 300 MW thermal power generation plant.

Although the private sector is expected to be a catalyst in the power sector's long term development, there has been no significant financing of power projects by private developers, either domestic or foreign, due to financing and institutional barriers. At the same time, private sector participation has become an increasing priority for the various donor agencies, and it appears that future lending and assistance programs will increasingly become conditional on private sector involvement. Nevertheless, numerous constraints currently exist to private sector financing of projects. The greatest barrier is the unavailability of substantial investment equity and debt-financing for projects that would be the most viable from a private sector perspective. These projects tend to be the smaller hydro projects for which some equity capital seems to be available, yet are overlooked by the multilaterals because of their small size. Overcoming this financing barrier in the most timely manner, therefore, is the subject of this report. Various institutional barriers to private sector participation in the power sector also exist and are addressed in a more comprehensive manner in a separate report developed under this same USAID funded program.

This report is intended to be used as a plan of action for the facilitation of private sector participation in the Armenian power sector by the multilateral banks, bilateral assistance agencies, and other funding sources that may be available to Armenia. It has been prepared as a "bankable" proposal, addressing technical, financial and commercial aspects of project structuring on a private project-finance basis, to enable implementation of the optimal financing plan recommended here.

K&M Engineering and Consulting Corporation, member of the Hagler Bailly Consortium funded by USAID, has been tasked with the development of an overall strategy for the facilitation of private sector participation as investors in the Armenian power sector. K&M's recommendations are based on its experience in Armenia, and its hands-on experience as private investor in power and other infrastructure projects worldwide and as advisor to governments and other investors on issues related to private project development. K&M has also relied on previous studies conducted in Armenia by other consultants, in particular the least cost plan entitled Development Planning in the Armenian Power Sector developed by Lahmeyer International, with EBRD sponsorship, and the Draft T&D Rehabilitation and Restructuring Report prepared by K&M for the World Bank.

Selection of Projects for Private Sector Investment

The selection of new power generation projects as the focus of this report is based on two key criteria: demonstration that these projects are part of the ***least cost*** of all alternatives available, as identified in the Least Cost Plan referenced above, as well as a determination of the reasonable ***financeability*** of projects by the private sector.

One of the primary conclusions of this report regarding the financeability of projects is that in the short to mid term, the most promising projects for private sector participation are small/mid-size (up to 30 MW) renewable energy projects, particularly hydro-electric plants. This is based on the premise that larger and more capital-intensive projects will be less likely to materialize in the short term, given the institutional environment of the country. Many of the smaller potential projects have some facilities necessary for operation already constructed, and as renewable energy projects, would not be susceptible to fuel supply interruptions.

Private investors are risk-averse, and are unlikely to commit significant amounts of capital for power projects, especially in such emerging markets as Armenia, without reliable assurances of timely payments, stable operations, and fair pricing. As a result, it is unlikely that thermal projects, for example, will attract private sector interest in the short term, until reliable long term fuel supply is available in the country. Likewise, most large projects, including large hydro projects in the country are also not optimal projects for private investment given the lack of established creditworthiness of Armenergo, the likely power purchaser. Even with a sovereign guarantee to back-stop the purchasing utility's performance, however, it is also unclear how private investors would evaluate the creditworthiness of the Armenian Government, which is currently resource-limited and increasingly burdened with multilateral and bilateral debt.

Smaller projects based on renewable resources are more likely to find reliable purchasers, by filling a particular market niche, while ensuring relatively predictable operating performance due their

independence from fuel supply interruptions. A series of smaller projects may also be more attractive than a single large project, from the perspective of the purchasing utility, because these projects have shorter development and construction periods and can be staged in a manner that minimizes their impact on overall tariff levels in the country. Also, smaller projects can attract a larger number of equity investors, both domestic and foreign (as current development activity has already demonstrated), spreading project risks among numerous participants, as would be difficult to achieve with a single large project. As these smaller projects demonstrate success, it would then be more realistic to attract private interest in larger projects.

This study focuses mostly on small hydro projects given their feasibility both as least cost projects and privately financeable projects. Other projects identified as part of the Least Cost Plan, such as rehabilitation of large hydro projects, have not been explored in detail here as it is generally more challenging to package such projects as separate private entities. Such projects are important and should be financed in the short term through traditional utility/public sector initiatives and can be included in the investment program developed in this report when the success of smaller projects is demonstrated.

Summary of Recommendations

Numerous small to mid-size projects are under development in Armenia by private investment groups, both domestic and foreign, many of whom have demonstrated their ability to provide the required equity investments. The key barrier to financing of the projects targeted in this report is the current lack of debt financing mechanisms available to enable developers to fully capitalize and implement feasible project opportunities. The main reason for the lack of such mechanism is that the proposed projects are generally too small for individual appraisal and financing by the large multilateral development banks, which generally have minimum loan limitations. In order to meet this loan size requirement, therefore, this project recommends the creation of a single loan/investment fund to finance a portfolio of small projects that can be packaged to meet the optimal loan size requirements.

Another advantage of creating a single investment fund, as opposed to financing projects separately, is that it would provide development banks maximum flexibility in selecting and financing projects over time, through an intermediary mechanism, thus avoiding unnecessary delays and loan preparation expenditures. As it would otherwise be inefficient for funding agencies to evaluate and submit to their board for approval the proposed projects on an individual basis, the investment fund approach would in effect take advantage of economies of scale and spread development costs across numerous projects.

Once approved, this fund would be capitalized and operated as an independent entity with independent expert management, ensuring a commercial approach to project financing. The target group of projects for the fund would be those projects that have attracted capable private sector developers.

The fund can provide co-financing for projects based on a comprehensive set of selection criteria and a standard approach to project structure/agreements to minimize development/legal costs, as outlined in this report.

The investment fund, depending on the level of interest of international financial institutions and other donors, could be financed by multiple sources as it evolves. Utilizing a co-financing approach, the fund can support projects with a variety of structures in a manner that meets the financing, structuring, and procurement requirements of each of the funding institutions.

Initially, the primary financial function of the fund would be that of a lender implementing a revolving loan program that would ensure high turn-over of funds to sustain consecutively planned projects. Over time, as new sources of capital are attracted for projects, the fund can leverage additional funding based on its involvement in projects through co-financing mechanisms or insurance and loan guarantee instruments, thereby maximizing the number of projects it can support. Depending on its sources and requirements for funding, the fund could, in the future, also take equity positions in projects and become an equity investment mechanism for outside investors.

1.0 INTRODUCTION & BACKGROUND

1.1 Brief Overview of Energy Situation

As an extension of the former Soviet Union's Integrated Power System (IPS), a vast and complex integrated grid spanning 11 time zones, Armenia's electric infrastructure developed into a well-planned developed and sophisticated sector. During most of the 1980's the Armenian grid played a regional role as a net exporter of power to neighboring republics as well as to Turkey. As part of the accomplishments of its power infrastructure, which has hosted a sophisticated hydro cascade system (Sevan-Hrazdan), a nuclear plant, various thermal plants, and a well interconnected grid, Armenia can boast of a highly competent pool of scientists and engineers employed in numerous design institutes, manufacturing complexes, engineering and construction organizations, and utility operation and maintenance divisions.

Armenia, a country with no significant domestic fossil fuel energy resources of its own, has now inherited a power system that was essentially planned to complement the Trasncaucasus region as a whole and the entire IPS. The sector had become over-reliant on imported fuel resources which were abundantly available at the time, and had underdeveloped domestic resources that could more appropriately meet the country's strategic needs. As a result, Armenia today is deemed to have a surplus of constructed generating capacity while only a small fraction of its heat and power needs are being met.

Total installed capacity is currently approximately 3,200 MW, excluding the delayed 300 MW unit at Hrazdan. Of this, 1,756 MW is in thermal capacity, from combined heat and power plants, 440 MW from the nuclear plant, and 988 MW from hydro. However, only a fraction of total industrial and residential consumer demand, estimated at barely above 1000 MW by Lahmeyer International, is being met (particularly in winter times) due to an acute shortage of fuel, derating of actual capacities, seasonal limitations on hydro, and limitations in the use of the Sevan-Hrazdan hydro cascade for environmental reasons. It is estimated that only 25% of industry is capable of functioning, while residential areas have remained on a rotational black-out basis, receiving 3 to 5 hours of electricity per day in the winter. Additionally, only 5% of heating needs are being met according to the Ministry of Energy.

Armenia currently receives only a small fraction of its fuel needs due to the enduring economic and energy blockade by Azerbaijan and Turkey, and supply interruptions in Georgia. This has made a large portion of thermal capacity idle, and has led to a severe deterioration in existing equipment. Although fuel inflow has improved recently, and alternative supply options may be available in the longer term, fuel supply remains highly unreliable from a commercial perspective.

Armenia's large-dam hydro potential has also been severely limited recently, as much as by one half according to some estimates, due to the considerable environmental damage sustained by Lake Sevan. The lake acts as the main reservoir for most of the hydro capacity in the country, and its water levels have been significantly reduced by the substitution of thermal by hydro capacities for base load operations. Also, mounting rehabilitation needs and a recent accident at one of the largest hydro plants on the Sevan-Hrazdan cascade have put a further strain on already limited resources. Lake Sevan has a limited watershed for receiving inflows. Over many years, the lake level has been pulled down as the energy has been over-used in the absence of nuclear and fossil alternatives. At this point, the lake is best used only for peak generation.

1.2 Need for Power

As discussed above, although Armenia has what appears to be excess installed capacity, real available capacity falls far short of demand. Fuel supply is unreliable, and thermal capacities are highly derated and are at the end of (or have exceeded) their useful lives. Large hydro plants also need significant rehabilitation, but their use is limited compared to the past due to equipment damage and losses sustained by Lake Sevan. Although the Government has begun recommissioning the nuclear plant in multiple stages, it is expected that its use will be only temporary, until safer alternatives are found. Also, the recommissioned nuclear unit has not operated in optimal manner, especially during summer periods, due to the unavailability of complementary peaking units such as hydros. Moreover, unless in the near future the required resources are invested to replace, maintain and upgrade existing equipment, the deterioration of the entire infrastructure and the current crisis situation will become even more accentuated. As a result, the Least Cost Study has recommended encouragement of small-scale hydro projects on an IPP basis as one of the most feasible next-steps for resolution of the crisis. The near-term development of small/mid-scale hydros, therefore, would help meet the following needs:

- Deplace fuel imports to winter periods, when thermal plants are used more efficiently,
- Help regulate the nuclear plant more efficiently during spring/summer periods,
- Improve the long-term energy-independence of the country, and
- Introduce concepts of privatization and help commercialize the sector.

Power and heat shortages have already strained the social and economic fabric and dynamics of Armenia. A large part of industrial capacity remains idle, due mainly to the lack of reliable power supply, resulting in large scale sub-employment. Power that is delivered to key industries falls short of required reliability and quality requirements due to frequent interruptions and a lower grid frequency. Limitations in both power and heat in the past several years have also shown an adverse long term effect on public health, nutrition and education. Unless they are properly addressed, such social strains could, in the future, also have broader regional social and political implications.

It is not only important for the power sector to meet the current consumer demand in order to avoid a continuation of the social and economic crisis, but also to play a key role as a catalyst for future growth of industry and economy. According to the Lahmeyer Study, even under a base case scenario current demand may double in a very short period of time, reaching 1988 consumption levels in 10-13 years. To avoid posing a constraint to development, therefore, the power sector should be prepared to not only well exceed current sales levels, but also significantly improve the quality and reliability of service.

In order to meet its basic self-sufficiency requirements, the Armenian Government has recently restarted one unit of the Medzamor nuclear plant, and is planning to recommission another, older unit. Armenia's strategic program for resolution of the present crisis, however, also includes the following priorities:

- Increasing the country's strategic fuel reserves capacity
- Developing alternative fuel import routes
- Improved interconnection with neighboring countries
- Demand-side management and user-end efficiency improvements
- Transmission and distribution technical and non-technical loss reduction
- Development, to a maximum extent, of domestic energy resources, particularly hydro.

Much of this program will involve a transformation of the energy complex into a more accountable and viable system, through commercialization and/or privatization in order to finance and take advantage of efficiency opportunities. The area that is most promising to private sector involvement as an alternative source of finance, however, is domestic resource development.

One of the key factors affecting private sector investment decisions is the payment ability of Armenian consumers, both residential and industrial/commercial. It is not clear to what extent of the current national non-payments problem is a result of an inability of consumers to pay, as opposed to a lack of a strict system of collections. The government has recently instituted stricter measures for collection of electricity payments, resulting in a significant improvement in the power sector's collections rate. However, it does appear that the market in general has some difficulty in absorbing the current tariff level of 3.5 cents (14 drams), up from 2.3 cents in mid-1995. Therefore new projects should be planned in a manner that allows for the minimum overall rate impact with rate adjustments over time, to avoid economic disruptions that can result from further significant increases in the retail rate.

Despite the overall non-payments problem affecting the sector as a whole, however, numerous profitable market niche opportunities exist for private developers. For example, several industrial and commercial enterprises have been able to maintain successful operations, many earning foreign currency through exports, even during the worst period of the crisis, and may be able to enter into profitable long term power purchase contracts with small independent generators that can provide a

more reliable source of power. Numerous private domestic and foreign private groups have identified such opportunities and are in the process of developing projects to meet such needs.

Small projects, as selected and evaluated in this report as the most promising projects for private development can fill market niches in short periods of time, and also be phased in a gradual manner that corresponds with the market's ability to absorb inevitably higher prices.

1.3 Project Selection Criteria

There are numerous projects in Armenia that the electric power sector plans to implement, as outlined in Armenia's general sector development strategy in the previous section. However, the sector's ability to provide the large amount of financing required is rather limited, and actual financing made from international sources for projects will most likely be directed primarily towards emergency supplies and rehabilitation. As concluded in this report, one of the most promising sources of new investments is the private sector, with debt financing assistance from multilateral agencies.

The project selection criteria used to identify the target portfolio of projects presented in this report reflect the need to identify projects that meet both private investor as well as multilateral agency requirements. These projects therefore represent the least cost of all projects in the country that have the highest likelihood of being implemented on a private basis. Criteria were developed in three areas of focus, technical issues, commercial/institutional factors, and financial/economic considerations, to select a pool of the most promising projects.

A considerable amount of data and prior studies of the hydroelectric resource in Armenia is available to potential project developers. The rivers and water resources of Armenia have been managed and observed for a very long period of time and there are few new ideas for projects. The Armenia Hydro Projects Institute (the "Institute") has done several surveys of site identification and in some cases, more detailed work.

Many of the projects which appear on the inventory and study lists have been "licensed" to developers for implementation in the private sector. The projects have progressed at highly variable rates. Several of the project have moved to a stage of pre-construction design, where a detailed feasibility study has been completed, design drawings are completed and specific equipment for generation selected. These projects are stalled, awaiting a source of financing. Several other promising projects have had a variable amount of feasibility work completed. However, further investment in the projects to bring them forward to a stage where financing would be possible, has not been made. This is because of either a complete lack of capital resources of the developer, or an unwillingness to expend the full amount of funding necessary, with an uncertain financing outcome. The establishment of a financing fund providing some

expectation of project success at the end of the development process should accelerate the development process of the pool of small hydro projects. The successful implementation of the first projects by the developers will also encourage them to take over other, less successful projects for completion.

In order to consider the pool of projects and select projects which would be suitable for funding by a Hydroelectric Development Fund, several sources were used:

1. Prior studies and data (Identified in Section 4)
2. Interviews with Ministry of Energy and Fuel personnel
3. Interviews with Developers
4. Limited site visitation
5. Review of developer supplied information

This process identified a series of projects which would be suitable for the fund. These projects include some of the more attractive projects which were identified in previous Institute studies. They are also sites which are more advanced in the development process. The development process to some extent is a self-selection process, as only those projects which appear to be worthy of business investment by the developers progress to advanced stages.

In order to select projects to present in this document, the following criteria were used:

1. The project is under active development in the private sector. This criteria eliminates a number of projects that are stalled. It also precludes the rehabilitation projects, as those projects are owned by Armenergo and not available to the private sector at this point. Ultimately, some rehabilitation projects would be very attractive for funding and would result in an excellent resource for Armenia.

2. The project must be technically feasible. The projects which are presented in this document have enough detailed planning completed so that a reasonable estimate of costs and project production can be made. A full due diligence of the projects has not been completed, however, the information which is available on the sites must indicate that the project can be constructed, and would generate the output which is expected.

3. The project must be economically feasible under reasonable commercial terms within Armenia. As the energy market is not fully developed in the private sector none of the projects are situated such that they could attract commercial financing. However, the

projects cost of power was checked to determine whether it would be a competitive resource.

4. The project must be compatible with Armenian and World Bank standards. For most of the small hydro stations in Armenia, the environmental issues are minimal. Several of the selected stations are at release points of existing dams or irrigation works. These would have virtually no operational impacts and only any impacts during construction. The other new projects also make use of some existing works and would have limited impacts. There are no proposed impoundments which would cause resettlements or alter land and water uses.

The project identification process resulted in five projects which are ready to present to a fund such as the one proposed in this document, for financing. These projects are all at an advanced stage of development. There are, however some commercial elements which will need to be completed as discussed later in this report, prior to final approval and funding. The studies done for this presentation should not be considered to be due diligence level.

1. Jradzor Project - 4.8 MW
2. Garni Project - 1.0 MW
3. Kotaik Project - 2.2 MW
4. Yerevan Lake Project - 0.8 MW
5. Jrakhor Project - 4.8 MW

In addition to these projects, there is a set of projects which have not advanced as far in development, but appear to be "in the pipeline" to receive financing after some additional information is completed on the project details. Additionally, several of the more competitive projects as identified in the Lahmayer Study were selected for this list. These projects comprise a "second tranche" or would displace projects in the first tier, in the event that those projects find alternative sources of funding or became infeasible for an unforeseen reason.

1. Tashir Project - 1.8 MW
2. Kasakh Project - 1.0 MW
3. Mantash Project - 2.3 MW
4. Talin-2 Project - 2.0 MW
5. Gehki Project - 5.2 MW

More detail on the projects and their characteristics is provided in Section 4.0. There are a number of other projects which are potential small developments but suffer from a lack of development funding at this point.

These are relatively small projects that would operate as run-of-river projects. The power would not be dispatchable, but all operate on reasonable plant factors. However, individually and in the aggregate, the projects fit well into the Armenian system. Their production allows for reduction in the use of alternative fuels and savings of Lake Sevan water. Since the shortage in Armenia is energy and not installed capacity, these plants are directly beneficial to the system.

2.0 OVERVIEW OF POWER SECTOR

2.1 Organization of the Power Sector

Prior to the break-up of the Soviet Union, Armenergo was a regional distribution grid operating as part of the TransCaucasus grid, representing three regional utilities with a dispatch center in Tbilisi, Georgia. This grid was in turn part of a highly integrated power system extending throughout the former Soviet Union with a central dispatch center in Moscow. All aspects of this system were planned from the perspective of meeting shifting peak loads within the vast single national grid that covered eleven time-zones, without consideration for the specific characteristics and self-sufficiency needs of regional distribution grids.

Until late 1995 Armenergo was the state-owned utility which maintained and operated all generation, transmission and distribution assets for the Ministry of Energy. A 1995 restructuring by the Ministry of Energy led to the separation of the Hrazdan power station and the Sevan-Hrazdan hydro cascade from Armenergo. At the same time, all distribution was also separated from the utility and 55 distinct distribution enterprises have been created. These new entities are now restructured as state-owned enterprises, are intended to become self-supporting (i.e. self-financing) commercial entities, with possible consolidation and increasing private sector participation, in the near future. Armenergo now retains all high voltage transmission facilities, the Vorotan Cascade, the Yerevan and Vanadzor thermal power plants, and small hydro facilities.

The recent economic and energy crises affecting Armenia have taken a toll on the financial situation of the Armenian power sector. Chronic non-payments in both the public/industrial and residential sectors and low tariffs (relative to operating costs) have impaired Armenergo's ability to cover operating and maintenance costs and implement system upgrades.

The financial viability and creditworthiness of Armenergo and the newly created enterprises will be a key factor in determining the level of private sector interest in investment in the sector. For development of large projects Armenergo would most likely be the purchaser of power for resale throughout the country, and will need to either demonstrate its creditworthiness as a purchaser or obtain a financeable back-stop guarantee for payments from the Government. Greater flexibility exists, however, in structuring smaller projects where the lower levels of capital investments required increases the number of purchasers that could qualify as creditworthy buyers of power. Depending on their size, therefore, smaller projects can be structured to sell power to either local distribution companies, industrial end-users, Armenergo, or other qualifying parties.

Short term prospects for some improvement of the creditworthiness of the power sector are relatively good. The current round of commercialization and restructuring, in addition to major improvements in

the manner in which the entire sector is regulated, would increase accountability throughout the system and improve its viability. By mid-1996, there was already significant demonstrated improvement in payment discipline, particularly within the residential sector, leading to a marked improvement in actual collections.

Also, the additional power generated by the nuclear plant would further increase both quantity and quality of service, thereby improving the operational and financial situation of the power system. In a short period of time, therefore, the financial situation of the entire system can be redressed to a level that provides the required assurances for entrepreneurial developers to project-finance a series of small projects. Over time, as the number of new small projects expands and the sector's creditworthiness and track record is demonstrated, one or more larger scale private projects could be developed at reasonable financial terms.

2.2 Institutional Environment

One of the Government's most ambitious reform programs was recently developed and introduced for the power sector. A series of policy reforms were introduced at the beginning of 1995 with the intent to gradually transform Armenergo into a commercially viable entity. One such measure was to index Armenergo's tariffs to the Dram/Dollar exchange rate. Another measure has been to allow Armenergo to disconnect non-paying customers from the grid, with exceptions provided for vital industries.

The most fundamental institutional changes in the power sector were introduced through a series of decrees in December of 1995, calling for the reorganization of Armenergo, and its restructuring into multiple distinct commercial entities. Thus, the power generation and distribution functions, as well as other divisions of the organization have become mutually independent state enterprises and will be commercialized as joint stock companies in the near future. In addition, a special Tariff-Setting Committee was formed to establish electricity, heat and natural gas tariffs, establishing the nucleus for a future regulatory agency. These reforms are intended to increase the accountability and efficiency of power sector organizations, provide transparency to operations and pricing development throughout the complex, and provide incentives for more effective payments collections.

Government policy towards private sector involvement in the power sector will be critical to the realization of the financing strategies presented in this report. Along with the creation of a source for debt-financing for projects, the development of a proper framework of operation and regulation for independent private generators will be critical to maximize investor interest and ensure timely and efficient development and implementation of projects. Recommendations for the development of a legislative and regulatory framework conducive to private power development have already been developed and submitted to the government. Many of these recommendations have already been approved, and others are under consideration. Most importantly, the Ministry of Energy is currently

preparing an institutional improvement strategy to enable a $90 million World Bank loan (for transmission and distribution) to commercialize and upgrade the power sector, and the following improvements can be expected to be instituted as a result:

- Enactment of energy legislation that enables private ownership of generation,
- Institution of an independent and transparent industry regulator to ensure fairness in tariff setting and viability of the utility sector,
- Restructuring of the power sector to create commercially viable enterprises, and
- Improvement of the financial health of the sector through improved management, collection systems, and financial discipline and accountability.

Additionally the following measures should be considered and adopted to specifically encourage hydro IPPs:

- Develop and pre-approve in principle a standard power purchase agreement and other private project financing contracts, if necessary (e.g. implementation agreement),
- Identify a pre-determined purchase price for procurement of new capacities based on indigenous resources (e.g. 6 cents/KWh for first package of projects, 8 cents/KWh for next package, etc.), and
- Re-engineer hydro licensing process into a one-stop efficient permitting system.

Some of these reforms would naturally take some time to develop and implement, and large-scale private power development activity may not be a near term reality. The potential large plants are limited in number and would appear to be more expensive than the better small scale opportunities. An opportunity exists, therefore, to complement these reforms with the establishment of a true track record for private sector involvement in the energy sector, through the promotion, in the short term, of small private stations that can be developed even prior to the institution of various reforms, on a contractual basis. The demonstration of a number of successful small/mid-scale private projects will be critical in attracting investor interest in larger-scale and more complex projects of different technologies in the future.

3.0 FINANCING OPTIONS

Financing of electric power sector projects in Armenia is one of the major challenges to the transformation of the power sector into an industry tailored to the uniqueness of the country's energy situation and one capable of meeting basic energy demands. This section provides an overview of the various options that exist to obtain financing for the planned expansion of utility and generation assets. Each of the financing options presented requires a unique set of approaches to structuring the asset ownership, repayment terms, and contractual requirements of a given project. For each option, the main characteristics and preconditions for financing are outlined and implications regarding project structuring are presented.

The extent to which these financing options will be available to the Armenian power industry is largely driven by the sensitivities of each of the sources to the overall financing environment of the economy, and in some cases, to the progress of the Armenian Government in implementing certain reform measures. Many of the sources presented here have been active lenders to Armenia, yet in some cases future lending requirements have changed towards a greater emphasis on private sector involvement. The purpose of this section is to clarify approaches and requirements of the various sources in order to find projects that can balance lender interests with private investor requirements and other commercial and institutional realities.

3.1 Sources of Investment

Among the most active multilateral/bilateral funding sources in Armenia, the World Bank and the European Bank for Reconstruction and Development (EBRD) are seen as the two of the most likely sources of debt financing for power sector projects. Both banks have made significant loans to the sector, all on a sovereign basis, lending directly to the Government for public sector projects. EBRD has partially financed the 300 MW fifth unit of Hrazdan power station, as a state-owned plant. The World Bank, through its concessionary loan program through the International Development Association (IDA) has mainly financed emergency supplies and rehabilitation projects.

At the same time, funding sources traditionally available in more developed markets, such as export credit agencies and other bilateral/multilateral equity and loan investors have not been active in Armenia. Bilateral lending sources, such as US EximBank and Overseas Private Investment Corporation (OPIC) have to date not played a role in Armenian projects mainly because no private power projects have been developed at a significant scale that would warrant major equipment exports and other project financing and coverage. The World Bank's International Finance Corporation (IFC) has also not been involved in Armenia because the typical size of projects financed by IFC, which provides equity co-financing for private projects, is deemed to be non-financeable in the current Armenian environment.

International private sector capital, which itself would mobilize many of the funding sources mentioned above, has adopted a very conservative approach to investment in the country due to the small market size and perceived levels of risk. Private investors have also not been offered any unique pre-arranged incentive packages to offset concerns regarding perceived political, legislative and regulatory uncertainty in the country. In this environment of transition and uncertainty, and until a track record for private power is established in the country, traditional investors in significant size projects in the short term would require high levels of risk coverage through sovereign and multilateral guarantees, and most likely expect unreasonably high returns on invested capital.

3.2 Self-Financing

The Armenian power sector developed into an integrated and reliable electric infrastructure through prudently planned investments by the public sector. Today, the corporatization of this system promises a stream of revenues to Armenergo and its successor enterprises to sustain increasing levels of maintenance and growth in the sector. The utility sector will soon be phased away from government subsidies and become self-financing. The Tariff-Setting Committee, and a National Energy Commission (NEC) in the near future, will ensure proper tariff setting to enable viability and growth in the sector.

In this transitional stage of the power sector and the economy, however, a widespread non-payments problem has caused a chain reaction that has left Armenergo and other companies with very limited cash and other resources. Yet numerous funding programs, such as work on recommissioning of the nuclear plant and completion of the Arpa-Sevan channel, have gone forward despite the limitations in resources. Design, engineering, construction and operation services continue to be performed by experienced enterprises and institutes that are incorporated into the Ministry of Energy structures. In addition to the cost advantages, continuation of sector development through locally available resources also requires minimal financial and contractual structuring as compared with other forms of financing.

Yet as the non-payments situation improves through appropriate policy changes and corresponding World Bank investments, the optimal investment option for the power sector is to out-source capital investments to third parties in the near term, and utilize its improved financial situation to fund higher levels of maintenance and operational activities. This would enable the utility sector to achieve a level of financial health that enhances investor confidence in the sector.

3.3 Multilateral and Bilateral Financing for Utility

One of the most attractive options available to the utility sector is to obtain government-guaranteed debt financing from multilateral institutions such as EBRD and the World Bank and bilateral aid

agencies. Under this option the government of Armenia would obtain long term low interest loans to finance capacity and system expansions. This has been the most relied-upon mechanism utilized by Armenia and other developing countries to date.

Traditionally, multilateral institutions have adopted the first of two approaches in lending to developing countries. This approach has been to provide capital earmarked for a specific executing organization, generally government-owned, with full government guarantees backing the repayment of the loans. The World Bank's numerous loan programs to Armenia, and EBRD's financing of the Hrazdan #5 unit were structured based on this approach. A variation of this approach can be for a multilateral agency to provide a loan to the government with specific earmarking of the loan to a private group or utility. One example of such financing is in the World Bank's financing of a private utility group, Tata, servicing customers in and around the city of Bombay in India. In this example, the government of India fully guaranteed this loan which could only be activated for the benefit of Tata. Upon transformation of Armenergo into a private entity, this financing approach may also be available to Armenia.

The second approach for multilateral financing is one that requires that the beneficiary of the funds be a specific private project, rather than a government program or even a private entity with multiple projects. This approach is increasingly becoming the preference of multilateral agencies, particularly for projects in the Newly Independent State (NIS) and Eastern Europe. For example, the 900 MW Krasnodar project in Russia, the first World Bank lending program in Russia, is being structured as an independent project with private shareholders. Several funding programs of multilateral agencies, such as the IFC, only participate in private projects under this second approach. This approach is discussed in greater detail in section 3.4.

Unlike private equity or commercial bank financing, multilateral agency financing with host government guarantees requires a different prioritization of project-specific issues. Here, such issues as high rates of return, extensive risk mitigation, and a comprehensive and long term project contractual framework do not necessarily drive investment decisions. The focus is shifted to a larger extent upon issues of sovereign repayment capabilities, utility's credit-worthiness, the criticality of infrastructure investment, the economic viability of the project, and progress of the government in implementing industry reforms.

Multilateral funding agencies also typically have a variety of standard requirements that need to be met, especially for public-financing type projects. A main such requirement is that all procurement for projects that are financed through multilateral funding implement strict international competitive bidding procedures for sourcing of equipment and services. This requirement may at times delay implementation of the project, frustrate government efforts to maximize local content and even raise costs. EBRD can waive some competition requirements in the event the project financed is privately

developed. These important considerations need to be factored into the manner in which projects are structured and promoted for financing in Armenia.

Due to a transitioning regulatory structure and limited private investor interest in the Armenian power sector at this stage, obtaining traditional multilateral agency financing will be the Armenian government's preferred approach to financing projects. This approach can be adopted in parallel to the institutional reform processes currently under way, and unlike private sector financing, would not require more complicated structuring techniques to guarantee higher returns commensurate with project-specific risks. Given Armenia's current economic situation, Armenia may continue to be eligible for loans under this traditional approach. In the near to long term, however, a greater emphasis on private sector involvement will open far greater options for financing, especially if the current trends and requirements of the international funding agencies continues.

3.4 Multilateral Financing Under IPP Structure

Despite the traditional multilateral financing approach generally utilized in most developing countries, there seems to be a greater commitment by multilateral institutions to adopt an approach that is more similar to the second approach described above. Increasingly, multilateral institutions seem to be shifting away from their tradition of government-guaranteed program lending to an approach that emphasizes IPP-style project structuring and financing as well as a greater level of private sector involvement in funding projects. This has especially been the case for these institutions' approach to lending in the NIS and Eastern Europe.

Another example of this trend is the World Bank's approach to power sector lending in Pakistan. Here, the World Bank initiated the Private Sector Energy Development Fund (PSEDF), guaranteed by the Government of Pakistan, to provide financing and sponsorship specifically to the Hub River Power Project, a fully private IPP. The PSEDF is funded by several bilateral sources along with the World Bank. The Fund provides loans to investors who offer equity and secure other supplemental loans. The fund has now participated in the financial structuring of several projects and has contributed to the commercial atmosphere in the Pakistan power sector which has seen five projects reach financial closure.

EBRD had also in some cases adopted the traditional sovereign guarantee approach to financing projects in the NIS and Eastern Europe, most notably with its loan for Hrazdan #5. Nevertheless, EBRD has made private sector involvement a key requirement for future lending, especially in Armenia and other countries where it has already made initial loans through the government. In Russia, for example, EBRD has financed no government-sponsored power projects, but is currently expected to finance a private IPP under development by a foreign investor. EBRD now generally acts as a private

commercial bank that is willing to assume NIS political risk, but financing projects solely based on their structure and commercial viability.

In a country such as Armenia where private sector interest for large scale projects is limited, multilateral agencies can play a key role as catalysts for new IPPs. First, as there is a lack of commercial bank interest in lending in such countries, multilaterals are likely to be the only major source of debt financing for those investors that are prepared to make equity contributions. This is clearly the case for small hydro developers in Armenia. Second, it is typical that once the international community becomes aware of a multilateral's interest in financing a private project in the country, private developer interest is raised and the country becomes more attractive as investors gain a higher level of confidence. Finally, multilateral agency involvement in projects, due to the expertise of the banks and the due diligence exercised, generally helps keep a transparency to projects and provides a degree of informal arbitration, ensuring against unreasonable demands by either negotiating side.

The development of private power projects with multilateral agency financing and support can also leverage additional sources of financing which may not be available to public-sector financed projects. For example, a project could be structured with supplementary equity financing from IFC, debt financing and insurance from OPIC, and equipment financing by bilateral export credit agencies. Also, additional financial services such as project insurance through the Multilateral Investment Guarantee Agency (MIGA) of the World Bank, can be made available to secure certain risks of the project. Furthermore, through the utilization of the World Bank's commercial debt guarantee program, commercial bank lending could also be made available to private projects. To ensure the successful utilization of these various sources of financing, particularly for a critical first project, Armenia should ensure that a highly experienced and innovative private project developer, with specific experience in developing complex power projects with multi-source financing is selected.

In Armenia, therefore, given trends in multilateral financing and an undeveloped environment for purely commercial private power development, the optimal financing strategy for the near to long term should be based on a combination of multilateral lending and private equity investment for independent generation projects. Nevertheless, a mismatch exists between the types of projects that the private sector has so far been interested in, and those that the multilaterals can finance. Private developers, mostly domestic and some foreign, have been developing small to mid size projects ($1-15 million), which allow for rapid commissioning of projects with lower levels of risk exposure. In general, larger-scale private investment would most likely become more attractive only once these small projects have shown success. At the same time, however, multilateral lending agencies generally have lower limits on the size of their loans for IPPs and similar projects. EBRD's lower limit, for example, is $50 million.

To bridge this gap, therefore, this report recommends the capitalization of an investment fund that can then on-lend to smaller projects. This would comply with minimum loan size limitations, and allow for financing of the small-mid size projects until the track record and environment is developed to facilitate the development and financing of larger projects.

3.5 Commercial Bank Financing

Commercial bank financing is often coupled with private equity investments in power projects. In many developing countries, projects have been increasingly structured on a non-recourse financing basis, with 20-30% private equity investment and 70-80% debt financing from a commercial financial institution. Generally, the rate of return expected by the lending institution is lower than that of the private investor because most of the commercial risks are assumed by the private developer. In many countries, multilateral institutions and the host government provide additional guarantees to protect the debt aspect of financing from commercial risks. As a result, lenders, who would generally have primary rights to the project's assets in case of default, agree to a lower return, thereby increasing potential returns for the equity shareholders.

Foreign commercial banking activity in Armenia has to date been limited to the opening of a Marine Midland (UK) branch for money transfer, savings, and other retail functions. It is not clear whether the bank will in the future engage in project financing. Domestic banks have themselves focused on short term high return opportunities such as trade finance and currency trading to maintain the high returns demanded by their creditors, and are not expected to play a significant role in the financing of large, long term projects such as those required in the power industry. Recent indications are that most Armenian commercial banks have become increasingly unreliable due to high levels of bad debt and lack of appropriate regulatory oversight. In the short term, therefore, commercial banks will not be a realistic source of financing. However, as a successful IPP track record is established through the development of viable small projects, commercial banks would in the future be more likely to participate in a well-structured larger project that offers a financeable risk.

3.6 Alternative Financing Approaches

One of the most appropriate means to structure the financing for projects would be to develop a centralized fund that utilizes all of the various sources of financing for numerous projects. This would extend the co-financing approach into an institutionalized mechanism that can be replicated for more than one project without requiring a time-consuming financial structuring process for each project. If well structured, this funding mechanism can be one of the most effective means of providing needed financing while meeting the requirements of each of the participating financial institutions.

The centralized fund would have the advantage of supporting the types of projects that the private sector has also selected for initial development: the small to mid-size renewable projects. An established fund would have the flexibility to adapt to any structuring scenario as the need arises, in a timely manner. The fund therefore can not only leverage additional private sources of capital, but also enable Armenian projects to access additional financing sources that is typically only available for large private power projects.

3.7 Other Sources of Financing

Beyond the major sources of financing outlined here, a variety of more limited sources for funds may be available that can be best tapped through an enterprise fund that is proposed in this report. One example is the resources of the worldwide Armenian diaspora which has shown an ability to mobilize financing for projects that are well structured and implemented. This participation could be increased with the development of a professionally-managed mechanism that ensures the efficient and effective channeling of resources into beneficial and commercially sustainable projects. Once multilateral and bilateral support as well as professional and independent management is demonstrated for the fund, this diasporan resource therefore could be involved in a minor and passive investor position. At the same time, individual diasporans could most likely also pariticipate as equity investors and developers in the projects directly, once the debt-financing capability of the fund is publicized (at least one Armenia-American has already shown interest as a private developer of Armenian hydro projects).

Other limited sources of financing also exist in the form of programs associated with or funded by bilateral agencies, or private or non-profit organizations established to promote development of renewable energy resources. The financing capability of some of these programs may be limited to the financing of certain project development costs (e.g. feasibility studies). In general, these sources can be most effectively utilized as part of an effort to leverage the resources of the investment fund which can act as a central mechanism that channels complementary resources into specific projects, and avoid duplication of efforts.

3.8 Conclusions for Project Structuring

One of the fundamental themes that emerges from this brief overview of financing options is the growing emphasis placed by financing institutions on a greater level of private sector involvement, whether domestic or foreign, in attracting financing for power projects in Armenia. Through a centralized fund mechanism, the current debt-financing needs of the private sector can be met while ensuring compliance with requirements and guidelines of financing sources.

From a private sector financing perspective, it appears that the most attractive projects in the short to mid-term will be small/mid-size renewable projects due to various commercial considerations. Thermal

projects, although much needed to replace existing aging capacities, would most likely not attract significant private interest in the current situation or near future; for two main reasons. First, the fuel supply issue needs to be permanently resolved to ensure commercial viability of projects. Second, thermal projects generally need to be developed at relatively larger size to achieve efficiencies, and large capital investments by the private sector would most likely not be feasible in Armenia until the success of smaller ones is demonstrated.

Hydro rehabilitation projects, which are at the top of the least cost list of projects, are also relatively more challenging than smaller ones for the private sector due to several reasons. First, large hydro projects generally carry significant construction risk exposures due to uncertainties arising from high levels of required civil works, and associated cost and liability implications. Second, most hydro rehabilitation opportunities are at large hydro sites located on the Sevan-Hrazdan cascade. As this cascade is unlikely to be used at previous operating levels, for environmental reasons mentioned earlier, the private sector may not view such projects as commercially attractive unless higher output levels can be guaranteed.

Finally, structuring of rehabilitation projects, which are generally subcomponents of the large state-owned hydro plants, into commercially distinct packages may become problematic as a difficulty would arise in valuing the incremental private equity share of a rehabilitated plant, with additional difficulties arising in determining a proper distribution of operating responsibilities. Such projects could be feasible when a track record of private power operation is established in the country, and investor confidence regarding the utility sector's cooperation with independent plants is enhanced. Until then, such rehabilitation projects would most ideally be accommodated through traditional multilateral funding programs.

The additional advantage of financing small projects is that they have short construction and commissioning schedules, and they can be phased in over time as required. This phased approach would enable the utility to raise retail tariffs at a gradual pace, in accordance with the market's ability to absorb new rates.

4.0 OVERVIEW OF PROJECTS

4.1 Overview of the Hydroelectric Resource

The Republic of Armenia has a substantial potential for development of hydroelectric resources within the country's borders. It is the most abundant internal resource for the generation of electrical energy indigenous to the country. A significant amount of the resource base has already been developed.

The total hydropower potential of Armenia is estimated at 6 billion kwh annually, and 3400 MW at a 20% capacity for peaking plants. Of this theoretical total, about 1,000 MW has been developed, which produces about 1.5 billion kwh. The development of the remainder of the resource will depend on the environmental and economic competitiveness of the resource.

The majority of the installed capacity of Armenia is in the two cascade developments, the Sevan-Razdan and Vorotan. The Sevan-Razdan Cascade consists of five plants and a total of 527 MW of installed capacity. The production of the cascade is limited due to the long term drawdown of Lake Sevan. Thus these plants are optimally used for peaking and emergency power. The plants were installed beginning in the 1930s with the last plant completed in 1961. The Vorotan Cascade consists of three plants with 402 MW of installed capacity. These projects were constructed in the 1970s and 1980s. There are a few other small hydroelectric projects around the country.

The importance of hydroelectric power for Armenia's power mix has increased because of the periodic shutdown of the nuclear plant facilities and the interruption of imported fossil fuels to thermal power plants.

Due to its long history of irrigation and water resource management, most of the water courses in Armenia have very good, long term data regarding river flows. The conflicting uses of irrigation and municipal water supply are also well known and documented.

A number of studies have been completed on the hydroelectric resources in Armenia and virtually all of the potential sites of different sizes have been identified. Most work within the country has been completed by the Armenian Hydro Project Institute in Yerevan. This group maintains much of the hydroelectric expertise in-country, as they have designed the works now in place. Other studies have reviewed and assessed hydroelectric resources within the country. The Lahmeyer study was done in 1994 as part of an overall utility review and planning activity. The study selected a series of variable sized projects for study. The most promising were incorporated for inclusion in the generation planning work which Lahmeyer undertook. The study looked at projects as large as 109 MW and as small as 400 kw, in some detail. The specific costs of power from the projects varied from 3.8 US cents/kwh to over 20 US cents/kwh.

The Lahmeyer Study attempted to inventory all of the small hydropower resources in the country. The inventory was published in their study as an Annex and is reproduced here as Appendix A. The aggregate identified in this effort was 188 schemes totalling 160 MW.

A study undertaken by K&M Engineering in 1993 also looked at the short and long term possibilities for upgrading and rehabilitating existing projects and developing new projects. The study identified five sites at which rehabilitation would be attractive. Four of these sites had equipment ready to ship for rehabilitation, but the projects did not get completed. Additionally, a series of small projects was identified as attractive, based on available data and prior studies by the Hydro Project Institute.

Prior to these cited studies, the Hydro Project Institute had identified about 40 sites in Armenia where they believed that development was economically attractive. These totaled 723 MW of capacity and 2240 Gwh of energy. About 400 MW of this total was in small projects, of less than 20 MW at each project. A sub group of about 87 MW of small projects were identified as the most attractive for near term development. None of these projects has been implemented.

The larger scale hydro development within Armenia consist of five projects:

Loriberd	48 MW
Shnokh	75 MW
Megri	105 to 140 MW
Agrichi	22 MW
Surmali	48 MW

Progress has been limited on these projects. The international independent power market has shown interest in only the Loriberd Project. Progress has been slow due to lack of elements in place to facilitate the financing of the project, which has slowed the development investment by the potential developer.

The Megri Project is one of the more attractive potential projects in Armenia, but it lies on the border with Iran and would be a joint development between the countries. The difficulty of enacting such a scheme in the private sector has eliminated it from international interest.

4.2 Projects Selected for Potential Funding

After reviewing the available project information and discussing the status of development of the hydroelectric projects in Armenia, a set of projects has been selected for presentation for funding.

These projects are those which are furthermost along in the development process and have most technical and commercial elements in place. There are also a number of other projects which would follow these projects in funding.

The project selected for initial funding consideration are in Table 1. More detailed information follows in separate subsections for each project. Site visits were made to all of the selected projects, except for Jradzor.

TABLE 1
DEVELOPMENT PROJECTS FOR FUND CONSIDERATION

PROJECT	DEVELOPER	SIZE MW	ENERGY GWH	EST. COSTS (US$ M)
Jradzor	ESI Energy & Construction	4.8	22	$7.0
Garni	Energia (Armenia)	1.0	3.3	$0.6
Kotaik	Energia (Armenia)	2.4	8.4	$1.3
Yerevan	Energia (Armenia)	0.8	5.9	$0.6
Jrakhor	Baghaberd (Armenia)	4.8	25	$2.5
TOTALS		13.8	64.6	$12MM

4.3 Jradzor Hydro Project

Project Description: The Jradzor Project is located in the Ashotsck district in North-west Armenia. It is on the right bank of the Akhurian River and utilizes water on the right bank of the Akhurian canal. The project would operate primarily during non-irrigation months, as the water would by-pass the project during the irrigation months of July to October.

The project would make use of existing irrigation works, including the irrigation canal. Other works to be constructed include a forebay to collect flows, a 1.2 meter diameter penstock, 670 meters long, and a powerhouse containing multiple francis turbine units for generation.

The project operates under 139 meters of head at 4 m3/sec. A general project layout is included in this section.

Project Sponsor: The sponsor for the project, ESI Engineering and Construction, holds a license for the Jrakzor Project from the Ministry of Economy. ESI is a US corporation located in West Palm Beach, Florida. It also maintains an office in Yerevan. The sponsor is a developer of hydropower and other energy projects, internationally.

History and Status: The Jradzor project has previously been identified by planning groups as one of the best projects in Armenia. The project was licensed by ESI in 1994. In the interim, their development efforts have resulted in obtaining a signed power purchase agreement and implementation agreement with Armenergo and the Ministry of Energy and Fuels. ESI is currently working on financing for the project, but has not been able to secure a source at this time.

Operations: The project will operate at a high level of output during the months of November to June, when irrigation waters are not used. There is a long period of record for the irrigation and non-irrigation season, minimizing the hydrologic risk.

Project Cost and Schedule: The total cost of the project is estimated to be US$7 million. This total is estimated to be a very reasonable and conservative estimate. It does not include interest during construction. The major cost items are for the powerhouse and generating equipment. The project is estimated to have a construction period of one year.

4.4 Hydropower Plant - Garni Irrigation Works Garni, Armenia

Project Description: The project would include the installation of generating equipment and a powerhouse in the existing irrigation works located near Garni. Currently the irrigation system includes a pipe under high pressure which descends down one mountain side and raises to irrigation works on the other side of the valley.

The planned project will include an installation of generating equipment in the valley so that water will be released into the valley river after generating power. The new works will consist of a branch off of the existing pipe, shutoff valves, a powerhouse, turbine/generator units and transmission equipment to operate during the non-irrigation season. Thus, the project works will consist mainly of powerhouse construction and equipment installation.

The project will operate at a steady, rated flow of 1.1 m /sec, under 130 meters of head. Rated output will be about 1 to 1.2 MW. The annual average long term energy output from the project will be 3.3 Gwh.

The project is located nearby to an accessible roadway near the village of Garni, about 30 minutes from Yerevan. Construction of the project will be simple as there are no flooding hazards or water handling problems.

Project Sponsor: The sponsor of the project is Energia, Ltd, an enterprise of the Patian family. This group is involved in several other private enterprises in Yerevan. There are no other partners in this project. Energia holds licenses for two other hydroelectric projects in the Yerevan vicinity.

Project History: The sponsor has been active on the project since 1992. The Ministry of Economy of Armenia issued an operating and construction license to Energia, Ltd in March, 1992. The Government of Armenia approved the use of 0.66 hectares of land for the project in July, 1993. Studies of the project and survey and preliminary design have been accomplished as of July 1994 by the institute Armhydrovodkhoz. The design for the project was approved for construction in July, 1995 by the State Commission for construction. Although some project drawings were completed, none were available for this report.

Project Operations: The project will utilize waters released from the irrigation system during the winter months of November to April (6 months) after completion of the irrigation season. The project releases will not change frequently, and the project will frequently run at full output.

Due to a long history of irrigation schedules, the hydrology risk of the project is minimized.

Cost and Schedule: The project sponsors have estimated the construction costs of the project to be about $600,000, not including the costs of interest during construction and/or other owners costs. Of this total, about $450,000 is for the equipment. The equipment costs have been estimated from budget quotes from Russian and German manufacturers. All prices were in the same range. The costs of the project powerhouse may be somewhat low, however the total project cost should be in the range of 10% above the estimated cost.

Procurement of the equipment would take about 9 months from order and the construction of the powerhouse and installation of equipment would take about 4 months, overlapping about 2 months with the equipment delivery. This later work would be scheduled during the non-irrigation season.

4.5 Hydropower Plant - Kotaik Irrigation Canal Kotaik, Armenia

Project Description: The project will be constructed in replacement of existing spillway works in an irrigation system. It is located about 30 minutes outside of Yerevan on an existing irrigation system.

Currently, irrigation flows from another reservoir enter into a channel/chute spillway and are delivered into the irrigation system through the spillway. The spillway is in need of repair and is currently being replaced by a penstock, which will be pressurized by the hydroelectric project. The project will only operate during the irrigation season.

Flows will be fairly constant at 4.5 m /sec. The head generated by the project is 64 meters. Output is estimated at 2.4 MW. The project power will be sold into the grid.

Annual power production is estimated to be 8.4 Gwh.

Project Sponsor: The project is being developed by Energia, Ltd. This company is an enterprise of the Patian family, who is involved is several other private enterprises in Yerevan, Armenia. The company is working with the local irrigation authority who is providing the replacement construction of the penstock. The power will be sold to the Armenergo Grid, or to small local enterprises.

Project History: Energia, Ltd. began implementation of the project in 1992. A construction and operations license was granted to Energia in July 1992. Studies were conducted by the Hydro Project Institute. These included surveying and preliminary design works. The design has been accepted by the Kotaik Regional Executive Committee and 1.5 hectares of land has been set aside for the project.

No power contract has been signed for the project at this time.

Project Operations: The project will operate on a set release which will be established by irrigation needs. The project should not need full time attendance due to the limited number of changes which will be made to the operation. The site is very accessible and will be readily available for monitoring by plant personnel.

Costs and Schedule: The total project cost has been estimated by the developer at $1.2 million (US). This total is solely construction costs and does not include any interest during construction or other owner's costs. Of this total, about US$950,000 is for equipment. Budget quotes were received from Russian and German suppliers varying from $850,000 to $1,050,000. The replacement pipeline is costing about $100,000. The powerhouse and other works comprises the remainder.

Equipment delivery time would be about 10 months, with the actual field construction to be about 4 months, for a total construction period of one year.

4.6 Yerevan Water Storage Reservoir, Hydropower Installation Yerevan, Armenia

Project Description: The project will be constructed at the outlet works of the existing Yerevan Storage Reservoir. The reservoir includes an existing dam and outlet works which release water to several irrigation systems downstream. Releases are currently done in a manner to dissipate energy.

The outlet works which exist include a conduit through the existing dam which is designed to be pressurized. The conduit currently exits into a concrete structure which dissipates the flow energy.

The new project will consist of replacement of some of the outlet piping, construction of a new powerhouse and installation of turbine generating unit(s) and connection with the local system.

The project develops 14 meters of head, on average. Flow is fairly constant at 6 m /sec. The output of the plant is estimated to be 4.8 Gwh/annually.

Project Sponsor: The project is being developed by Energia, Ltd. This company is an enterprise of the Patian family. A local technology development company is a partner in the project and hopes to utilize the power from the project if the company builds a new factory. If the technology company does not use the power, it will be sold to Armenergo, the country utility.

Project History and Status: Energia, Ltd has been working on the project since 1992. The Ministry of Economy issued a license for construction and operation on October 19, 1992.

The Executive Committee of the Yerevan City Council adopted a resolution in July of 1993 to provide land for the project.

Design, surveying and engineering works have been carried out by designing cooperative Hydrotechnik. The project design has been approved by the State Examination Commission.

The project has signed an equipment contract with INSET of St. Petersburg, Russia and construction contracts. The construction of the project has started, utilizing the resources of Energia and some small loans. This project may push forward prior to the establishment of the proposed fund.

Project Operations: The project operations would be set based on the release from the Storage Dam for other purposes. This release is very constant due to downstream users. Thus, the release from the project would be set manually in the powerhouse and not changed until it was done so manually by a change in downstream needs. Other outlet works exist for extraordinary releases from high flows.

Cost and Schedule: The project costs have been estimated by the owner and engineer to be US$550,000. Of this amount, $430,000 is for equipment purchasing, mounting and commissioning.

The project equipment is ready for shipping and construction has started. If finances allow, the project would be completed in late summer 1996.

4.7 Jrakhor 1 Hydroelectric Project Vokhchi River, Kapan Region, Armenia

Project Description: The project is located near the town of Kapan in the southwestern area of Armenia. The project will produce power and sell to the grid of Armenergo, or directly to a large user, the Aangezoor Copper-Molybdenum mine which is upstream on the river.

The project will utilize existing impoundment and diversion works which are constructed on the Vokhchi River. These works will require some rehabilitation. There is an existing 3.2 km diversion tunnel. These works were constructed in 1952, but not used.

The tunnel currently daylights with no control structure at the downstream end. A small volume of water currently is passed through the tunnel and delivered to an intake for a downstream project by a concrete chute spillway. An open intake will be constructed at the tunnel outlet, feeding a new 480 meter long penstock. The penstock will feed the powerhouse, delivering flow to an intake for a downstream project.

A total of 98 meters of head is developed at the project. The design flow will be 6 m /sec, with the minimum flow to be 0.75 m /sec. The intake elevation for project flows is 1241.3 meters (maximum) and the tailwater level is 1140 meters.

Sponsor: The project is owned and licensed to Baghaberd-HEG, Ltd. This company is privately held. The license for construction and operations was issued to the company on March 2, 1992 by the Ministry of Economy of Armenia.

Engineering: Engineering works on the project to date have been done by Armhydroenergoproject, of the Ministry of Energy of Armenia. Surveying of the area is completed and the final designs and construction can proceed after final selection of equipment and financing arrangements are complete. Designs are complete for the reconstruction works and a conceptual powerhouse civil design has been done for the use of one of the quoted units.

Production: Based on the data from a long term gage on the Vokhchi River, with adjustments for upstream plant uses, instream flows and water consumption, the long term average annual energy production will be 25 Gwh. There is a long term hydrologic record available for the river. Deductions have been taken for conservation flows and use by the municipality and upstream industrial user.

Operations: The project will operate using allowable diversions from the upstream dam. Withdrawals for the mining operation will be taken upstream of the diversion. Sanitary and consumption flows will be passed at the diversion. It is anticipated that the diversion amount would be set by float control and controlled by the powerhouse units.

Cost and Schedule: The total project construction costs as estimated by the Hydro Institute is $2,000,000. This total is for civil works and generating equipment only (construction costs) and does not include any soft costs or interest during construction. The equipment costs, based on supply by the Russian company, INSET, is $1,700,000. Alternative supply costs from German manufacturers range from $1.6 to $2.0 million. Thus, the equipment costs are reasonable. The powerhouse costs are estimated to be $70,000, which seem to be low. The other civil costs of $220,000 seem to be low. However, the penstock has already been arranged for purchase from existing surplus stock, insuring a lower cost than might otherwise be expected. Still, it appears that the costs may be estimated low by a significant factor. Even so, the total development costs on the project will be low, compared to project output.

The project equipment delivery schedule will take about 1 year. Construction works would take about eight months, for a total construction period of about 14 months.

4.8 Other Planned Projects

In addition to these five projects, which are at more advanced stages of development, there are as many as 40 small hydro projects which the Hydro Institute has identified as likely economic developments. Three projects have been selected as examples of projects not as advanced as the selected projects, but likely to proceed to construction, if ultimate funding for worthy projects can be made available. These projects are similarly ones which take advantage of existing works. Other projects from the large pool of potential development are available to follow after these most competitive and advanced projects.

TABLE 2
OTHER PROJECTS IN DEVELOPMENT OR IDENTIFIED AS COMPETITIVE

	SIZE	ENERGY	EST. COSTS

PROJECT	DEVELOPER	MW	GWH	(US $ M)
Tashir	Lusan Association	1.8	9.75	$1.5
Kasakh	Institute of Radio Physics	1.1	5.7	$1.5
Mantash	Hydro-EK	2.3	18 (est.)	Not Avail.
Talin-2	None-Lahmeyer Report	2.0	10.3	$5.6
Gehki	None-Gehki	5.2	20.5	$9.2
Total (Without Mantash)		10.1	46.25	$17.8

Tashir Project: The Tashir Project is under development by Lusan Associates. The project does not yet have a license issued, as it is subject to competition and a possible change in licensing procedure. The project is in the Stepanavan Region of Armenia. The development group has about 30% of the capital for the project, but needs to raise more. Costs are estimated to be US$1.5 million. The costs seem reasonable, except for a low equipment cost. The Project would develop 1.8 MW and 9.8 million kwh annually. Total project head is 82 meters. The project would consist of a diversion, 4 km of penstock and a powerhouse. A feasibility level design with development of topography and project details remains to be finished. The developer will be interested in doing other projects if the Tashir Project is successful.

Mantash Project: This project has had limited work done on it by the developer, Hydro-EK. However the project would appear to be very economically competitive. The project would consist of installing turbines in water supply pipes which currently have pressure reducing valves. The project is 120 km from Yerevan. There is 0.5 m3/sec and 600 to 800 meters of head, which would result in about 3,000 kw of capacity and a high amount of energy as the flow is year round.

Kashakh Project: This project is under development by the Institute of Radio Physics. It has a head of 58 meters and flow of 2.8 m3/sec., resulting in a capacity of about 1.1 to 1.3 MW, depending on final sizing. The long term average annual production is estimated to be 5.7 Gwh. Costs for the project are estimated to be US$1.5 million, based on pre-feasibility information. This estimate takes into account a conservation flow for the river. The project would include a diversion structure, diversion channel, penstock and powerhouse. The developer has contracted with the Hydro Institute to perform the engineering work, but lacks funding. If successful project financing can be proven, it is likely that the project could attract funding to move forward. The developer wants to consume the power at the Institute of Radio Physics and Electronics.

Talin-2 Project: This project was identified in the Lahmeyer Report as being one of the lower cost alternatives for small to medium hydropower development. It is not known if a developer is pushing

the project forward, but it is not as visible in the development community as the other projects selected. The project is located about 6 km from Ckarakert and has very good access roads to the site. The project would make use of the existing Talin canal works, adding a new weir, headrace canal, penstock and powerhouse. The project would develop 2 MW at 55 meters of head. The rated discharge is 4.5 m^3/sec. According to the Lahmeyer Report, the civil works cost would be about 80 percent of the construction costs of $5.1 million. The project would generate primarily during the irrigation season of April to November. Generation would be fairly constant during this period. The project is much like the Kotaik project which is more advanced in development. There are two other possible developments along this canal, but these projects are not as attractive as Talin-2.

5.0 PROJECT STRUCTURING

This section addresses in general and project specific terms the types of risks which are inherent in the project developments and the types of structures and agreements which must be in place to effectively manage the risks of the project. The section also discusses the governmental incentives which are necessary to assist the projects to be completed.

5.1 Risk Analysis

The development of independent power projects is a detailed exercise in risk management and allocation. For projects under development in Armenia, there are a number of risks which are beyond the ability of any single or group of developers to mitigate with any agreements. These elements are generally the overall political stability issues and the general legal and commercial framework of the parties.

However, there are a number of commercial, financial and technological risks which can be overcome by proper project development practice by the private parties. These risks can be allocated by appropriate contracting procedures by the developer. The proposed fund can facilitate these contracts by requiring them to be in place prior to funding.

A significant treatment of the institutional risks are presented in the Report on the Review of Institutional Framework done by the USAID IPP Team in March of 1996. Many of those risks are repeated here, but are not treated in depth in this document.

5.1.1 Political Risks

For project developments and investments in emerging economies, a major factor is the political stability of the host country. While the Armenian government has been stable since the creation of the CIS, its location and history as part of the Soviet Union make the continued maintenance of the current political structure a factor in any consideration of investment in the Armenian economy. However, political risk insurance is available to international investors to ameliorate this risk. The internal Armenian entrepreneurs do not have such insurance available to them for their domestic investments, but appear to be willing to assume them nonetheless.

A major sub-sector of the political risk is the certainty of laws and legal environment in the country. The existing Armenian law provides for rights of individuals to engage in private business and allows for a variety of corporate structures. Despite the development of these laws, there is no supporting system of commercial codes or an established set of regulations and court

activity which provides for a level of certainty of contract and transaction enforcement. This is a problem inherent in much of the developing world and international developers have different ways of dealing with this problem. The government of Armenia can continue to make progress in development in this area, which will send a signal to the international community that Armenia is proceeding in the right direction in this regard.

The Armenian law currently extends guarantees against expropriation, nationalization and unlawful confiscation without fair compensation. Foreign enterprises are also allowed unrestricted transfers of capital, including revenues, profits, compensation, interest payments, and liquidated investments in hard and domestic currency. An open currency exchange market exists in Armenia and commercial banks can be used for international conversions and other transactions. However, the internal commercial banking market remains limited and large currency transactions could be limited by these market sizes. Outside investors can hedge these problems with international currency traders for a sum. However for the small transactions of the internal developers, the currency exchange could be a problem.

The threat of war or terrorism is also perceived as higher in the Caucasus than most other regions. Again, for international developers, insurance can be purchased to mitigate losses from these risks. For the internal developers, this risk is one which must just be borne, however as they are more knowledgeable about the internal risks posed by the political situation, they are better positioned to make a determination as to whether the investment is sufficiently safe.

5.1.2 Commercial Risks

The commercial risks faced by the small hydroelectric developers similar to those that small project developers worldwide are facing. Unlike fuel fired projects, there are no ongoing risks of supply disruption or price dislocations. The commercial risks are primarily on the side of the purchaser to deliver and get paid for production. At this point, the project developer has limited financeable choices in the market for electricity, either Armenergo, a distribution company or an industrial user.

Armenergo and the newly emerging distribution companies are still in the process of restructuring and consolidating and may take some time to evolve into creditworthy purchasers. At the same time, these companies also depend on a redressing of the non-payments stituation, which will occur in stages, but continue to represent a commercial risk to the developer. Industrial users can also become direct purchasers of power from generation plants, depending on their proximit to potential generation sources, but in many cases (depending on the project size) may not have the production levels required to justify use of all of the producers' power or have limited financial strength to make any long term purchase agreement financially meaningful.

A less cash intensive credit enhancing measure to avoid non-payment problems is to have a governmental guarantee for payment for project power. This method is typically not used for small hydro projects, due to the amount of approvals necessary for the guarantee and the additional accounting necessary for the government. For small projects, an Armenergo similar type of guarantee to backstop payments may be sufficient. A more realistic approach for the short term may be to establish centralized resources, potentially in the form of the enterprise fund suggested in this report, to provide guarantees for certain commercial risks as required.

5.1.3 Project/Technology Risks

The project and technological risks are those that the project developer retains much control over and usually is forced to take directly and manage. The level of risk for each area is usually project specific and can be mitigated by proper planning and management. The risk areas discussed for these small hydro projects in Armenia are:

- Construction
- Schedule
- Operating
  - Equipment
  - Performance
- Maintenance
- Water
- Permit/Regulatory
- Construction Risk
- Liability/Casualty Risks

Project construction risk is a concern that the project will not be finished as designed at the budget financed. In the case of hydroelectric projects, this is often a large risk on projects, due to unknown conditions in foundations, tunnels or other major civil works features. When the unknowns are encountered, there is a significant cost increase incurred in completing the project. This risk is lower in most thermal projects, where equipment is the major portion of the project cost. This risk is usually mitigated by the provision of a completion guarantee by the primary contractor on the job. The guarantee is backed by a bond or other financial mechanism that can be drawn upon to fund completion of the project in the case of default by the contractor. In the case of these small projects, such guarantees will not be available and would likely add significantly to the complexity and costs of the project.

However, in most instances of these small projects, the civil works are already in place and only in need of some modification. In many of these cases, the impoundment facilities and water conveyance facilities are in place and only a powerhouse and equipment need to be added. There is less risk in constructing these facilities than in dams, tunnels and long canals.

Cost overrun problems in small hydroelectric facilities in the US also arose from having an inexperienced engineer design and estimate the project. Frequently the cost of certain elements were left out of the project. Examples of these include the costs of certain auxiliary equipment, foundation treatments and electrical intertie costs. This problem can be mitigated by having experienced engineers responsible for the entire project and having the project design and cost reviewed by an experienced, independent engineer.

Schedule Risk

The non-completion of a project results in not only a loss of revenue, but in added costs due to extended interest during construction. Further, schedule delays are usually associated with some other sort of construction problem as discussed in the prior subsection. Thus the schedule or non-completion problems are very serious for the project developer. Schedule risk also can arise from a lack of incentive for the equipment supplier, shipper or civil contractor to complete its assignment on time. The schedule risk can usually be acceptably mitigated by having a liquidated damages clause in the contract. While such a clause does not necessarily avoid delays, it does force the attention of the contractor to perform as promised. Liquidated damages usually take the form of a daily amount paid to the contracting party by the late party. Usually, liquidated damages clauses will add to the cost of the construction contract, but this addition is money well spent.

Operating Risk - Equipment

Operating risk in this instance is defined as the situation where the project is not capable of producing power as projected. We are dividing this risk into equipment risk and performance risk. Equipment risk is that where the turbine and generator do not meet generation efficiency as promised. If the equipment does not meet the guaranteed efficiency, there is little that can be done over the life of the project so that the developer can recover to the point where the project produces revenues as originally anticipated.

In order to limit the equipment risk, there are generally two measures to take. First, the company guaranteeing the efficiency should agree to liquidated damages in the instance where the project does not meet efficiency. It should be noted, however that proving an efficiency lapse in small hydroelectric turbines is a very difficult enterprise, usually with the cost of proof exceeding the

value of the production loss. Thus, the liquidated damages are very difficult to prove and recover. The greater value of the liquidated damage clause is to have the supplier stand behind its equipment.

The second way to avoid efficiency problems is to purchase equipment from a very experienced and well known provider. The type and model of equipment should have been provided previously in another application that is available for reference. Many companies have come and gone in the small hydro turbine business in the United States, which only proves that design and production of these turbines takes much experience. Purchasing equipment from unproved sources, whether from local or international sources should be avoided.

Operating Risk - Performance

The performance risk outside of the equipment is in the plant system itself. There can be design flaws in the project which may not allow the equipment to produce as designed, due to lack of head or flow to the turbine. It also may be caused by excessive electrical loss due to transformer problems. The most common performance design flaw is in the water delivery system. Frequently, an inexperienced designer will undersize canals or penstocks. The higher velocities either limit the actual volume of water which will get delivered or will cause head losses in the system which will relate directly to lost power. Once a penstock or bifurcation is installed, the losses can no longer be corrected. Thus, it is most important to have experienced engineers design the water delivery systems with a minimum of losses and account for such losses in project energy estimates.

Maintenance Risk

Maintenance risk is defined as improper maintenance carried out on the mechanical and electrical equipment in the project. This can occur due to improper operator training or by not making the budget allocation for maintenance on the equipment as needed. Fortunately, the types of equipment in small hydro plants do not need excessive maintenance. However, it is important that the equipment be maintained as specified by the manufacturer. The owner or project lender can be assured of proper maintenance practices by making sure that an appropriate budget is set and properly used.

Water Risk

Most small hydro projects are run of river. This means that they do not have significant storage capabilities and are reliant on current river flows to produce power. This means that the project is

quite subject to the hydrologic cycle and short and mid term droughts. The developer of the project must look at prior records and plans to be able to financially breech the periods of drought which will occur.

Water risk can be well assessed where there is a long term period of gauging flows. Fortunately for the small hydro industry in Armenia, there is a long period of record for most water bodies. This long record is available due to the well organized water resources institute, which has overseen the irrigation system management and the long standing water resources body.

Water risk can be handled financially by having the lender and owner agree on some level of low water credit line or by keeping an account of revenue held back which will be sufficient to carry the project through reasonable drought periods.

Regulatory/Permitting Risk

There is an inherent risk that the project would not be operated in accordance with regulatory authorities directives or permits. In many countries, this could result in fines or loss of rights. The permitting law currently in Armenia is not sufficiently well developed to pose this type of risk.

Of more importance is the securing of water use rights to be sure that the project will have the water for generation. A loss of water could occur if upstream parties gained the rights to divert or consume water which the project would otherwise have as an entitlement. In the instance of Armenia, where irrigation is common, such a diversion is foreseeable. Additionally, there runs some risk that the irrigation district that is supplying the water could change its release patterns to the detriment of the project. These risks can be eliminated by having clear permits for the water use and clear contracts with the supplier in the case where an irrigation district is controlling the water use.

Liability/Casualty Risks

Operating projects would be subject to a number of risks of damage to the plant or individuals due to an unforeseen incident at the project such as explosion or flooding. The occurrence of one of these casualties could cause damage to the plant, injury or loss of life to a worker and an associated loss of revenue to the plant. These risks are usually covered by commercial insurance in many countries. In Armenia, there is no commercial insurance system to underwrite such losses. The typical costs for commercial insurance would run from 1.5 to 2.5 percent of the annual revenues of the project. The variance in cost depends substantially on the scope of the coverage and the market conditions at any given year.

As this time, without any insurance system available, the plant owners would be assuming this entire risk. Significant damage from an accident or operator error could result in a large cost for repair to the plant. If capital is not available for the repair, the project would not be fixed, not produce any revenue and leave the initial investment in the plant stranded with no method of repayment.

Should a lender's fund be made available to these projects, one item which should be considered would be the payment of a certain portion of revenues into a fund by all the projects. This fund would act as repair insurance for any significant unforeseen problems resulting from an unexpected occurrence.

5.2 Structuring Approach

In order to successfully develop hydroelectric projects in Armenia, the risks mentioned above must be addressed by the developers. These can be managed by securing a group of contracts which address the risks appropriately. These contracts will dictate the primary structure of the project development organization. For the typical hydroelectric project the developer will take the lead role. In Armenia, the current developer group is comprised of small companies dominated by one project proponent, companies established in other industries who are branching out to power provision for a variety of reasons and companies organized solely for the purpose of developing power projects. This latter group is comprised mostly of groups formed of construction and industrial companies in the locality of the proposed project.

For the projects which are deemed to be feasible and attractive by a developer, a series of hurdles must be completed to prepare the project for financing, construction and development. Meeting these hurdles takes significant work and investment on the part of the developers, however this level of investment is small compared to the amount required for construction. The primary elements which must be met for all the projects include:

a. Provision of land rights
b. Provision of government permission under Armenian law
c. A sufficient long term market for the power
d. A project design sufficiently complete to identify equipment and construction costs.
e. A completed equipment supply agreement
f. Hard evidence of the construction and other costs required to complete the project.
g. Projected revenues sufficient to provide a return to investors and/or provide for debt service and coverage of debt payments.

Thus, the project team that the successful developer will bring to the financing community will include:

a. The project ownership and equity for the project, including the ongoing role of the developer or owner. The developer must be able to identify the sources of equity capital and how the ownership structure will work.
b. A power purchaser
c. A design engineer with experience and some track record in hydro design
d. A general contractor or a team of two or three contractors who are under contract or are able to guarantee construction costs or portions of construction costs.
e. An equipment supplier for the turbine, generator and other necessary goods for completion of the project.
f. A qualified operator for the project.

5.3 Project Agreements/Documents

In order to secure the development elements and structure as provided above, the project must put together the following agreements prior to expecting to close financing and have the project funded by equity participants or lenders.

a. Land Rights Agreement: The developer must show that the land rights are secure for the project. In many cases in Armenia, this is done by the regional land use commissions or by the irrigation district authorities who own existing facilities utilized in the small hydro projects.
b. Governmental Permitting: Currently, a license must be obtained by the project from the Ministry of Energy to develop, construct and operate a project. The rights given by these current permits are vague and it is not clear that the rights and responsibilities of the licensee are appropriately defined. A proposal for regulatory reform is being considered which will aid developers ultimately in securing appropriate rights for project development.
c. Water Rights Permit: This permit may be part of other governmental permitting. However, some specific document should be in place to prove that the hydro project has the rights to use the water and that only certain amounts can be diverted from the river above the project. Without these rights, the project could lose the rights to divert water, or an upstream user could take water the project needs to make planned generation.
d. Power Purchase Agreement: A long term (ten years or more) PPA is necessary for the project to justify investment. This period is a minimum required to repay the capital investment for these small projects. The PPA will either be with Armenergo or an

industry with a sufficient operation and financial standing to provide payment for the power purchased. The PPA needs to have supply and acceptance terms well defined. The prices to be paid for the power must be defined and payment times and terms must be articulated. The PPA should also addresss water risk issues and define a water credit line and other incentives awarded to projects to stimulate interest.

e. Equipment Contract: Appropriate equipment for the project must be selected by a qualified turbine/generator supplier. The contract must show the complete scope of supply and guarantees on how the project will perform under the project conditions of head and flow. The contract must contain dates certain for delivery of equipment design details, embedded parts and complete supply. It also should contain considerations for spare parts and warranty of the equipment.

f. Construction Contract(s): A contract will be necessary for the completion of the civil works on the project. The contractor should be able to guarantee completion of the project in a certain period of time, accounting for the supply of the equipment portions. The construction contracts must include the full scope of mechanical, electrical and civil works to complete the interconnected and generating project. Note that the completed construction contracts may not be finished at the time the project goes forward to financing. Until the equipment detailed design is started, a complete final powerhouse design cannot be completed and an exact final construction price may not be able to be finalized. During this process, a qualified engineer who can work with the developer and prospective construction contractors is necessary to be able to provide for a complete project cost estimate which is defensible.

g. Operations Contract: If the Owner is not qualified or interested in operating the project, some contract must place this responsibility with another party. The contract should include projected activities, level of attendance at the project, maintenance schedules and activities and the costs of these activities. If the developer is operating his own project, he should be able to prove to lenders or other equity participants that his work force is qualified and trained to operate the project properly.

There may be other contracts necessary for the developer to have in place depending on the specific project situation.

5.4 Government/Utility Incentives

Based on the background of this sector, there are several constraints that the project developers face and which will be difficult to overcome in the current climate. The government and Armenergo can assist the developers in bringing a domestic and efficient power source to market. The limitations which cause the biggest problems for the developers at this point are:

a. Limited and unclear authority of developer in the current license program. The current license does not provide the developer with clear rights and responsibilities and is of an insufficient length (7 years) to design, build and operate a project in a time frame to repay the capital invested. The government must provide the developer with a clearer picture of how the projects will be permitted and regulated and define the agency which will take a lead in regulation. A comprehensive permit would also provide the developers with the appropriate authorization for water and land use, avoiding the need for other permits.

b. Provide a target pricing structure for the project power. A target tariff provided by Armenergo or successor companies would provide the developers with a benchmark rate at which they would know they can sell project power. The rate can be set at a level that Armenergo would pay to obtain other generation, expend to fuel other plants or construct new plants. The rate should attract the ultimate development of the competitive hydroelectric resources available to the hydro power community. If the rate is too low to attract projects, Armenergo should then purchase their power from the alternative economic source. However, given the competitive nature of the projects reviewed, a significant amount of energy should be supplied by the small developers, at a relatively low tariff, allowing for offsetting of fuel imports and saving water in Lake Sevan.

c. Provide for standard power contracts for Armenergo or other governmental purchasers to use. For these small projects which are 5 MW or less, a long and detailed PPA is not necessary or desirable. A simple contract has been developed in many markets which covers the major points of supply and purchase. A standard contract would assist the industry in defining the roles of the parties in the industry.

6.0 ECONOMIC AND FINANCIAL ANALYSIS

This section reviews the existing and projected structure of the five most advanced private developments selected in Section 4.0. It reviews the agreements in place and has a discussion of the projected economics of the projects.

6.1 Project Structures and Pro Forma Statements

Simplified project pro forma financial projections have been completed based on preliminary information provided by the developers or developed from estimates and experience in other projects. The information is preliminary and should not be substituted for any due diligence or analysis which should be done on the projects by any potential lender or investor.

Based on the potential lending by multilateral banks and the current typical market conditions for project financing in world markets, the following scenario has been established as a sample for the projects:

Equity:	30% of total project costs
Debt:	70% of total project costs.
Interest during construction	capitalized
Loan term:	10 years
Construction Costs:	As provided by the developer
Operations Costs:	Estimated
Energy Revenues:	Based on information provided by Developer

The effect of taxes on the project have been neglected in this preliminary analysis.

6.2 Jradzor Hydro Project

The Jradzor Project has been under development by ESI Energy and Construction for several years. The project has many of its rights perfected.

Project Agreements:

Land Rights - The project utilizes lands near existing irrigation works. The land rights are understood to have been granted by the local land use agency. A copy of the permit has not been reviewed.

Governmental Permitting - ESI holds a permit for the project under the current licensing system. The system should be reformed to better define the rights and responsibilities of the developer.

Water Rights - The project uses water which is not diverted by the irrigation system during the non-irrigation season. It is not clear how the water rights are perfected.

Power Purchase Agreement - A PPA has been signed with Armenergo. A copy of the agreement has not been reviewed.

Equipment Contract - It is not known whether ESI has a signed equipment agreement at this time.

Construction Contract - It is not known whether ESI has a construction contract pending or signed.

Operations Contract - ESI is planning to operate the project with its own resources.

Project Pro Forma

The project pro forma reflects a limited rate of return to the investor of less than 15% at a sale price of 5 cents/KWh. This is well below market for most projects. It probably reflects a conservatively high investment cost on the project. As a detailed estimate was not available for this analysis, it is not clear why this project estimate is much higher relative to the other projects. Nevertheless, the project would behighly profitable if a higher "bid price" of 5.5 cents were announced as a special incentive to procure new capacity.

Project Proforma
Yerevan Lake Project
Capacity = 0.8
Investment Cost $600,000

	Operating Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
REVENUES															
Power Production -kwh	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000
Revenue US $/kwh	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Total Annual Revenue	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000
EXPENSES															
Operating Labor	$6,000	$6,180	$6,365	$6,556	$6,753	$6,956	$7,164	$7,379	$7,601	$7,829	$8,063	$8,305	$8,555	$8,811	$9,076
Maintenance	$2,000	$2,060	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610	$2,688	$2,768	$2,852	$2,937	$3,025
Spare Parts	$500	$515	$530	$546	$563	$580	$597	$615	$633	$652	$672	$692	$713	$734	$756
Repair Allowance	$3,000	$3,090	$3,183	$3,278	$3,377	$3,478	$3,582	$3,690	$3,800	$3,914	$4,032	$4,153	$4,277	$4,406	$4,538
Phone & Electric	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513
Accounting & Legal	$2,000	$2,060	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610	$2,688	$2,768	$2,852	$2,937	$3,025
Vehicles	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513
Insurance Allowance	$4,720	$4,862	$5,007	$5,158	$5,312	$5,472	$5,636	$5,805	$5,979	$6,159	$6,343	$6,534	$6,730	$6,931	$7,139
Property Taxes	$5,900	$6,077	$6,259	$6,447	$6,641	$6,840	$7,045	$7,256	$7,474	$7,698	$7,929	$8,167	$8,412	$8,664	$8,924
Total Operating Expenses	$26,120	$26,904	$27,711	$28,542	$29,398	$30,280	$31,189	$32,124	$33,088	$34,081	$35,103	$36,156	$37,241	$38,358	$39,509
Net Operating Revenue	$209,880	$209,096	$208,289	$207,458	$206,602	$205,720	$204,811	$203,876	$202,912	$201,919	$200,897	$199,844	$198,759	$197,642	$196,491
Project Investment	($600,000)														
Net Annual Revenue	-$390,120	$209,096	$208,289	$207,458	$206,602	$205,720	$204,811	$203,876	$202,912	$201,919	$200,897	$199,844	$198,759	$197,642	$196,491
Unleveraged IRR-Pre Tax	53.06%														
Project Loan Amount	$420,000	$378,000	$336,000	$294,000	$252,000	$210,000	$168,000	$126,000	$84,000	$42,000	$0	($9)	($9)	($9)	($9)
Interest Payment-Annual	$42,000	$37,800	$33,600	$29,400	$25,200	$21,000	$16,800	$12,600	$8,400	$4,200	$0	($1)	($1)	($1)	($1)
Principle Payment	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$9				
Total Loan Payments	$84,000	$79,800	$75,600	$71,400	$67,200	$63,000	$58,800	$54,600	$50,400	$46,200	$9	($1)	($1)	($1)	($1)
Post Debt Payment Revenu	$125,880	$129,296	$132,689	$136,058	$139,402	$142,720	$146,011	$149,276	$152,512	$155,719	$200,888	$199,845	$198,760	$197,643	$196,492
Debt Coverage Ratio	2.50	2.62	2.76	2.91	3.07	3.27	3.48	3.73	4.03	4.37					
Net Investment Cost	($180,000)														
Net Annual Revenue	($54,120)	$129,296	$132,689	$136,058	$139,402	$142,720	$146,011	$149,276	$152,512	$155,719	$200,888	$199,845	$198,760	$197,643	$196,492
Unleveraged IRR-Pre Tax	241.50%														

6.3 Garni Hydro Project

The Garni project is one of three under development by Energia, a domestic Armenian company. They have hired the local Hydroelectric Institute to work on the engineering aspects of the project. Energia has been active on the project since 1992.

Project Agreements:

Land Rights - The Government of Armenia has approved the use of 0.66 hectares of land for the project in July of 1993.

Governmental Permitting - Energia holds a construction and operations permit for the project which was issued in March 1992.

Water Rights - The project uses water which is diverted but not used by the irrigation system during the non-irrigation season. An agreement with the irrigation authority exists for the use of the facilities and water.

Power Purchase Agreement - No PPA has been signed at this time. The developers were expecting to sign a PPA to sell the power to Armenergo at 4 cents/kwh.

Equipment Contract - Energia has equipment quotes from a Russian supplier and two western suppliers for equipment at costs close to that estimated by the engineer.

Construction Contract - It is not known whether Energia has a construction contract pending or signed. The construction works are relatively simple.

Operations Contract - Energia is planning to operate the project with its own resources.

Project Pro Forma

At an assumed tariff of 5 cents/KWh, the Garni Project shows a high return on equity and sufficient coverage ratios for financing the project. These estimates may be somewhat optimistic since the soft costs in the total investment cost may be low. However, even with these costs included, the project should be a very viable undertaking.

Project Proforma
Garni Hydropower Project
Capacity = 1.2 MW
Investment Cost $600,000

	Operating Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
REVENUES															
Power Production -kwh	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000
Revenue US $/kwh	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total Annual Revenue	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000
EXPENSES															
Operating Labor	$6,000	$6,180	$6,365	$6,556	$6,753	$6,956	$7,164	$7,379	$7,601	$7,829	$8,063	$8,305	$8,555	$8,811	$9,076
Maintenance	$2,000	$2,060	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610	$2,688	$2,768	$2,852	$2,937	$3,025
Spare Parts	$500	$515	$530	$546	$563	$580	$597	$615	$633	$652	$672	$692	$713	$734	$756
Repair Allowance	$2,000	$2,060	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610	$2,688	$2,768	$2,852	$2,937	$3,025
Phone & Electric	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513
Accounting & Legal	$2,000	$2,060	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610	$2,688	$2,768	$2,852	$2,937	$3,025
Vehicles	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513
Insurance Allowance	$3,300	$3,399	$3,501	$3,606	$3,714	$3,826	$3,940	$4,059	$4,180	$4,306	$4,435	$4,568	$4,705	$4,846	$4,992
Property Taxes	$4,125	$4,249	$4,376	$4,507	$4,643	$4,782	$4,925	$5,073	$5,225	$5,382	$5,544	$5,710	$5,881	$6,058	$6,239
Total Operating Expenses	$21,925	$22,583	$23,260	$23,958	$24,677	$25,417	$26,180	$26,965	$27,774	$28,607	$29,465	$30,349	$31,260	$32,198	$33,164
Net Operating Revenue	$143,075	$142,417	$141,740	$141,042	$140,323	$139,583	$138,820	$138,035	$137,226	$136,393	$135,535	$134,651	$133,740	$132,802	$131,836
Project Investment	($600,000)														
Net Annual Revenue	-$456,925	$142,417	$141,740	$141,042	$140,323	$139,583	$138,820	$138,035	$137,226	$136,393	$135,535	$134,651	$133,740	$132,802	$131,836
Unleveraged IRR-Pre Tax	29.90%														
Project Loan Amount	$420,000	$378,000	$336,000	$294,000	$252,000	$210,000	$168,000	$126,000	$84,000	$42,000	$0	($9)	($9)	($9)	($9)
Interest Payment-Annual	$42,000	$37,800	$33,600	$29,400	$25,200	$21,000	$16,800	$12,600	$8,400	$4,200	$0	($1)	($1)	($1)	($1)
Principle Payment	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$9				
Total Loan Payments	$84,000	$79,800	$75,600	$71,400	$67,200	$63,000	$58,800	$54,600	$50,400	$46,200	$9	($1)	($1)	($1)	($1)
Post Debt Payment Revenu	$59,075	$62,617	$66,140	$69,642	$73,123	$76,583	$80,020	$83,435	$86,826	$90,193	$135,526	$134,652	$133,741	$132,803	$131,837
Debt Coverage Ratio	1.70	1.78	1.87	1.98	2.09	2.22	2.36	2.53	2.72	2.95					
Net Investment Cost	($180,000)														
Net Annual Revenue	($120,925)	$62,617	$66,140	$69,642	$73,123	$76,583	$80,020	$83,435	$86,826	$90,193	$135,526	$134,652	$133,741	$132,803	$131,837
Unleveraged IRR-Pre Tax	57.13%														

6.4 Kotaik Hydro Project

The Kotaik project is also an addition of generating facilities at constructed works. The owner is Energia, who is working with the local irrigation authority to complete the project, as partners.

Project Agreements:

Land Rights -The Kotaik Regional Executive Committee approved 1.5 hectares of land for use by the project.

Governmental Permitting - Energia holds a construction and operations permit for the project which was issued in July 1992..

Water Rights - The project uses water which is diverted by the irrigation works. After use in the plant, the project returns the water to irrigation canals. An agreement with the irrigation authority exists for the use of the facilities and water.

Power Purchase Agreement - No PPA has been signed at this time. The developers were expecting to sign a PPA to sell the power to Armenergo at 4 cents/kwh.

Equipment Contract - Energia has equipment quotes from a Russian supplier and two western suppliers for equipment at costs close to that estimated by the engineer.

Construction Contract - The irrigation authorities have already placed a new penstock in the ground for use by the project. The remaining civil works will be construction of a powerhouse. It is not known whether Energia has a construction contract pending or signed.

Operations Contract - Energia is planning to operate the project with its own resources.

Project Pro Forma

The project provides returns of about 30 and 50% on equity for pre-tax unleveraged and leveraged positions, respectively, at a tariff of 4 cents/KWh. This level of return may be optimistic, due to possible underestimating of soft costs and utility interconnection costs for the project. However, the good returns on the project reflect the simple nature of the project works.

Project Proforma
Kotaik Hydro Project
Capacity = 2.4 MW
Investment Cost $1,300,000

	Operating Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
REVENUES															
Power Production -kwh	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000	8,400,000
Revenue US $/kwh	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Total Annual Revenue	$336,000	$336,000	$336,000	$336,000	$336,000	$336,000	$336,000	$336,000	$336,000	$336,000	$336,000	$336,000	$336,000	$336,000	$336,000
EXPENSES															
Operating Labor	$10,000	$10,300	$10,609	$10,927	$11,255	$11,593	$11,941	$12,299	$12,668	$13,048	$13,439	$13,842	$14,258	$14,685	$15,126
Maintenance	$3,000	$3,090	$3,183	$3,278	$3,377	$3,478	$3,582	$3,690	$3,800	$3,914	$4,032	$4,153	$4,277	$4,406	$4,538
Spare Parts	$500	$515	$530	$546	$563	$580	$597	$615	$633	$652	$672	$692	$713	$734	$756
Repair Allowance	$3,000	$3,090	$3,183	$3,278	$3,377	$3,478	$3,582	$3,690	$3,800	$3,914	$4,032	$4,153	$4,277	$4,406	$4,538
Phone & Electric	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513
Accounting & Legal	$2,000	$2,060	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610	$2,688	$2,768	$2,852	$2,937	$3,025
Vehicles	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513
Insurance Allowance	$6,720	$6,922	$7,129	$7,343	$7,563	$7,790	$8,024	$8,265	$8,513	$8,768	$9,031	$9,302	$9,581	$9,869	$10,165
Property Taxes	$8,400	$8,652	$8,912	$9,179	$9,454	$9,738	$10,030	$10,331	$10,641	$10,960	$11,289	$11,628	$11,976	$12,336	$12,706
Total Operating Expenses	$35,620	$36,689	$37,789	$38,923	$40,091	$41,293	$42,532	$43,808	$45,122	$46,476	$47,870	$49,306	$50,786	$52,309	$53,878
Net Operating Revenue	$300,380	$299,311	$298,211	$297,077	$295,909	$294,707	$293,468	$292,192	$290,878	$289,524	$288,130	$286,694	$285,214	$283,691	$282,122
Project Investment	($1,300,000)														
Net Annual Revenue	-$999,620	$299,311	$298,211	$297,077	$295,909	$294,707	$293,468	$292,192	$290,878	$289,524	$288,130	$286,694	$285,214	$283,691	$282,122
Unleveraged IRR - Pre Tax	28.71%														
Project Loan Amount	$910,000	$819,000	$728,000	$637,000	$546,000	$455,000	$364,000	$273,000	$182,000	$91,000	$0	($9)	($9)	($9)	($9)
Interest Payment-Annual	$91,000	$81,900	$72,800	$63,700	$54,600	$45,500	$36,400	$27,300	$18,200	$9,100	$0	($1)	($1)	($1)	($1)
Principle Payment	$91,000	$91,000	$91,000	$91,000	$91,000	$91,000	$91,000	$91,000	$91,000	$91,000	$9				
Total Loan Payments	$182,000	$172,900	$163,800	$154,700	$145,600	$136,500	$127,400	$118,300	$109,200	$100,100	$9	($1)	($1)	($1)	($1)
Post Debt Payment Revenu	$118,380	$126,411	$134,411	$142,377	$150,309	$158,207	$166,068	$173,892	$181,678	$189,424	$288,121	$286,694	$285,215	$283,692	$282,122
Debt Coverage Ratio	1.65	1.73	1.82	1.92	2.03	2.16	2.30	2.47	2.66	2.89					
Net Investment Cost	($390,000)														
Net Annual Revenue	($271,620)	$126,411	$134,411	$142,377	$150,309	$158,207	$166,068	$173,892	$181,678	$189,424	$288,121	$286,694	$285,215	$283,692	$282,122
Unleveraged IRR - Pre Tax	52.44%														

6.5 Yerevan Water Storage Reservoir Project

This project, also developed by Energia, will be constructed at existing outlet works at a dam in the city. The project is simple and easy to build. The project has progressed further than the other projects and may be under construction at this point.

Project Agreements:

Land Rights - The Executive Committee of the Yerevan City Council adopted a resolution in July of 1993 to provide land for the project.

Governmental Permitting - Energia holds a construction and operations permit for the project which was issued in October 1992.

Water Rights - The project uses water which is released from the dam for irrigation works. After use in the plant, the project returns the water to irrigation canals. An agreement with the irrigation authority exists for the use of the facilities and water.

Power Purchase Agreement - No PPA has been signed at this time. The developers were expecting to sign a PPA to sell the power to Armenergo at 4 cents/kwh. The developer is also negotiating with a private enterprise to purchase the power.

Equipment Contract - Energia has signed an equipment supply agreement with INSET, a Russian supplier.

Construction Contract - Some of the simple construction works on the project have started. The project has progressed slowly due to lack of funding.

Operations Contract - Energia is planning to operate the project with its own resources.

Project Pro Forma

The project pro forma shows extremely high returns on the project, selling power at 4 cents/kwh. The project may have a higher cost, when all financing costs and costs due to delays are factored in. The project is very efficient and easy to build.

Project Proforma
Yrevan Lake Project
Capacity = 0.8
Investment Cost $600,000

	Operating Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
REVENUES															
Power Production -kwh	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000	5,900,000
Revenue US $/kwh	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Total Annual Revenue	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000	$236,000
EXPENSES															
Operating Labor	$6,000	$6,180	$6,365	$6,556	$6,753	$6,956	$7,164	$7,379	$7,601	$7,829	$8,063	$8,305	$8,555	$8,811	$9,076
Maintenance	$2,000	$2,060	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610	$2,688	$2,768	$2,852	$2,937	$3,025
Spare Parts	$500	$515	$530	$546	$563	$580	$597	$615	$633	$652	$672	$692	$713	$734	$756
Repair Allowance	$3,000	$3,090	$3,183	$3,278	$3,377	$3,478	$3,582	$3,690	$3,800	$3,914	$4,032	$4,153	$4,277	$4,406	$4,538
Phone & Electric	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513
Accounting & Legal	$2,000	$2,060	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610	$2,688	$2,768	$2,852	$2,937	$3,025
Vehicles	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513
Insurance Allowance	$4,720	$4,862	$5,007	$5,158	$5,312	$5,472	$5,636	$5,805	$5,979	$6,159	$6,343	$6,534	$6,730	$6,931	$7,139
Property Taxes	$5,900	$6,077	$6,259	$6,447	$6,641	$6,840	$7,045	$7,256	$7,474	$7,698	$7,929	$8,167	$8,412	$8,664	$8,924
Total Operating Expenses	$26,120	$26,904	$27,711	$28,542	$29,398	$30,280	$31,189	$32,124	$33,088	$34,081	$35,103	$36,156	$37,241	$38,358	$39,509
Net Operating Revenue	$209,880	$209,096	$208,289	$207,458	$206,602	$205,720	$204,811	$203,876	$202,912	$201,919	$200,897	$199,844	$198,759	$197,642	$196,491
Project Investment	($600,000)														
Net Annual Revenue	-$390,120	$209,096	$208,289	$207,458	$206,602	$205,720	$204,811	$203,876	$202,912	$201,919	$200,897	$199,844	$198,759	$197,642	$196,491
Unleveraged IRR-Pre Tax	53.06%														
Project Loan Amount	$420,000	$378,000	$336,000	$294,000	$252,000	$210,000	$168,000	$126,000	$84,000	$42,000	$0	($9)	($9)	($9)	($9)
Interest Payment-Annual	$42,000	$37,800	$33,600	$29,400	$25,200	$21,000	$16,800	$12,600	$8,400	$4,200	$0	($1)	($1)	($1)	($1)
Principle Payment	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$42,000	$9				
Total Loan Payments	$84,000	$79,800	$75,600	$71,400	$67,200	$63,000	$58,800	$54,600	$50,400	$46,200	$9	($1)	($1)	($1)	($1)
Post Debt Payment Revenu	$125,880	$129,296	$132,689	$136,058	$139,402	$142,720	$146,011	$149,276	$152,512	$155,719	$200,888	$199,845	$198,760	$197,643	$196,492
Debt Coverage Ratio	2.50	2.62	2.76	2.91	3.07	3.27	3.48	3.73	4.03	4.37					
Net Investment Cost	($180,000)														
Net Annual Revenue	($54,120)	$129,296	$132,689	$136,058	$139,402	$142,720	$146,011	$149,276	$152,512	$155,719	$200,888	$199,845	$198,760	$197,643	$196,492
Unleveraged IRR-Pre Tax	241.50%														

6.6 Jrakhor 1 Hydroelectric Project

This project would consist of completion of partially constructed facilities near a river in south Armenia. The developer, Baghaberd-HEG, Ltd., has paid the engineers for a significant amount of work and planning on the project. The civil works would be somewhat more extensive on this project than the Energia Projects and similar to or simpler than the works for Jradzor.

Project Agreements:

Land Rights - The project would utilize works owned by Armenergo. The developer has an agreement with the utility to use the lands and works.

Governmental Permitting - Baghaberd-HEG holds a construction and operations permit for the project which was issued in March 1992..

Water Rights - The project uses water from a diversion of the Vokhchi River. It is not clear whether the water rights are perfected for this project.

Power Purchase Agreement - No PPA has been signed at this time. The developers are expecting to sign an agreement with a local Copper-Molybdenum mine to sell the power at 3 cents/kwh. The mine appears to be a financially stable enterprise.

Equipment Contract - Baghaberd-HEG is planning to procure equipment from western suppliers, either Ossberger Turbines or Voith Hydro, both world wide suppliers.

Construction Contract - Baghaberd has purchased penstock for the project and has discussed construction with several local companies. It is not known if a final contract has been negotiated.

Operations Contract - Baghaberd is planning to operate the project with its own resources.

Project Pro Forma

The projected costs and revenues for the project indicate that the project is very feasible. The project civil cost estimate may be somewhat low, however even with additional contingency built into the project, it should be economic to complete.

Project Proforma
Jrakhor
Capacity = 4.8 MW
Investment Cost $2,500,000

	Operating Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
REVENUES															
Power Production -kwh	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000
Revenue US $/kwh	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Annual Revenue	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000
EXPENSES															
Operating Labor	$12,000	$12,360	$12,731	$13,113	$13,506	$13,911	$14,329	$14,758	$15,201	$15,657	$16,127	$16,611	$17,109	$17,622	$18,151
Maintenance	$5,000	$5,150	$5,305	$5,464	$5,628	$5,796	$5,970	$6,149	$6,334	$6,524	$6,720	$6,921	$7,129	$7,343	$7,563
Spare Parts	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513
Repair Allowance	$10,000	$10,300	$10,609	$10,927	$11,255	$11,593	$11,941	$12,299	$12,668	$13,048	$13,439	$13,842	$14,258	$14,685	$15,126
Phone & Electric	$3,000	$3,090	$3,183	$3,278	$3,377	$3,478	$3,582	$3,690	$3,800	$3,914	$4,032	$4,153	$4,277	$4,406	$4,538
Accounting & Legal	$4,000	$4,120	$4,244	$4,371	$4,502	$4,637	$4,776	$4,919	$5,067	$5,219	$5,376	$5,537	$5,703	$5,874	$6,050
Vehicles	$5,000	$5,150	$5,305	$5,464	$5,628	$5,796	$5,970	$6,149	$6,334	$6,524	$6,720	$6,921	$7,129	$7,343	$7,563
Insurance Allowance	$15,000	$15,450	$15,914	$16,391	$16,883	$17,389	$17,911	$18,448	$19,002	$19,572	$20,159	$20,764	$21,386	$22,028	$22,689
Property Taxes	$18,750	$19,313	$19,892	$20,489	$21,103	$21,736	$22,388	$23,060	$23,752	$24,464	$25,198	$25,954	$26,733	$27,535	$28,361
Total Operating Expenses	$73,750	$75,963	$78,241	$80,589	$83,006	$85,496	$88,061	$90,703	$93,424	$96,227	$99,114	$102,087	$105,150	$108,304	$111,553
Net Operating Revenue	$676,250	$674,038	$671,759	$669,411	$666,994	$664,504	$661,939	$659,297	$656,576	$653,773	$650,886	$647,913	$644,850	$641,696	$638,447
Project Investment	($2,500,000)														
Net Annual Revenue	-$1,823,750	$674,038	$671,759	$669,411	$666,994	$664,504	$661,939	$659,297	$656,576	$653,773	$650,886	$647,913	$644,850	$641,696	$638,447
Unleveraged IRR - Pre Tax	36.13%														
Project Loan Amount	$1,750,000	$1,575,000	$1,400,000	$1,225,000	$1,050,000	$875,000	$700,000	$525,000	$350,000	$175,000	$0	($9)	($9)	($9)	($9)
Interest Payment-Annual	$175,000	$157,500	$140,000	$122,500	$105,000	$87,500	$70,000	$52,500	$35,000	$17,500	$0	($1)	($1)	($1)	($1)
Principle Payment	$175,000	$175,000	$175,000	$175,000	$175,000	$175,000	$175,000	$175,000	$175,000	$175,000	$9				
Total Loan Payments	$350,000	$332,500	$315,000	$297,500	$280,000	$262,500	$245,000	$227,500	$210,000	$192,500	$9	($1)	($1)	($1)	($1)
Post Debt Payment Revenu	$326,250	$341,538	$356,759	$371,911	$386,994	$402,004	$416,939	$431,797	$446,576	$461,273	$650,877	$647,914	$644,851	$641,697	$638,447
Debt Coverage Ratio	1.93	2.03	2.13	2.25	2.38	2.53	2.70	2.90	3.13	3.40					
Net Investment Cost	($750,000)														
Net Annual Revenue	($423,750)	$341,538	$356,759	$371,911	$386,994	$402,004	$416,939	$431,797	$446,576	$461,273	$650,877	$647,914	$644,851	$641,697	$638,447
Unleveraged IRR - Pre Tax	84.92%														

6.7 Summary

This set of example projects indicates that there is an economically justified small hydroelectric industry in Armenia. If the hurdles defined in Section 5 can be overcome, and financing can be found to initiate the projects, the industry should be able to make a contribution to the energy resources of Armenia and stimulate internal economic growth through the project construction and operations process.

The analysis also indicates that the projects can be made lucrative and worthwhile for private developers if a "bid price" approach is utilized whereby the government awards projects on the basis of a predetermined power purchase price developed for each project or group of projects. Such tariffs would range from 4 to 5.5 cents/KWh, as indicated in the proforma presentations. This approach, in addition to providing added incentives for rapid development and efficient operation to developers, would also reduce the burden (in terms of costs and delays) on the government and purchaser to negotiate and periodically readjust wholesale tariffs for each small plant.

7.0 FINANCING APPROACH

7.1 Concept & Structure of Investment Fund

Pre-financing project development costs for investors, and project preparation and appraisal costs for international lending organizations, are generally very high, and do not necessarily vary directly based on the size of the projects under evaluation. In Armenia, for example, most experienced international private power developers would not expend high up-front costs to develop small/mid-size projects for financing, because even very high returns from those projects would not compensate for the initial fixed costs expended. By the same token, international lending and assistance organizations have not pursued funding of individual small projects. Yet the private sector of Armenia has identified small to mid-size hydro stations as an attractive investment opportunity, and numerous projects are now under development as all-equity deals. Some of these projects may soon be completed and operational, yet many other good projects will not reach full financing due to the unavailability of debt financing.

The investment fund concept described in section 3 provides a mechanism of spreading up-front loan preparation costs across numerous small projects, thereby enabling multilateral agencies to lend to ultimate small/mid-size projects on a commercial basis. Through an on-site fund manager working within the guidelines of the funding sources of the investment fund, small projects totaling up to 50-60 MW of projects, equivalent to one mid/large size projects, can be financed within the first two years of operation of the fund. Through a standardized approach in financing terms (project agreements, loan documents, etc.) and structuring creativity (in commercial aspects, financial instruments) projects can be efficiently evaluated, approved and funded without the time-consuming process required for a more traditional project funding approach.

To achieve the objective of becoming an effective and sustainable financing mechanism for private power, the investment fund would have to be managed independently and operate on a purely commercial basis. This will not only ensure a transparent and fair process, but also establish a model for effective commercial operations in a country that is still transitioning to a market based economy. In general, the success of the investment fund will depend on the following factors:

- Independent Fund Management Outside of Government Influence
- Quick, Un-Bureaucratic Decision-Making for Fund Transactions
- Field-Based Implementation Meeting Lender Guidelines and Requirements
- High Level of Accountability, Both for Borrowers as well as Fund Management
- Pre-Financing Training in Project Development
- Post-Loan Training of Borrowers in Business Management
- Development and Implementation of Innovative Financial Instruments to Fully Leverage Fund Resources

- Coordination and Leveraging of Other Sources of Financing

The proposed organization structure of the Fund, as discussed in section 7.3 reflects the primary success factors identified above: the necessity for an un-bureaucratic decision-making process along with a high level of accountability by the fund manager. The proposed structure envisions the selection of a resident fund manager to maintain the fund and conduct transactions. Ultimate responsibility for the Fund would rest with a Review Board composed of representatives of the key lenders of the fund. This Board would have overall responsibility for the successful operation of the fund, and will have oversight of the fund manager.

The sources of financing for the fund could be a single major multilateral lender at first, and develop into a multi-source lending mechanism involving numerous agencies with varying requirements.

7.2 Financial Instruments & Lifecycle of the Fund

The life cycle scenario for the fund has been developed based on the principle of transforming the fund into a sustainable, locally managed and independent operation over time. This transformation is proposed in three stages, as outlined in Figure 1.

a) Stage I: Initiation: The investment fund can be initially capitalized through a one-time investment by a single source, such as a multilateral agency, to implement a revolving loan program for financing of projects. The management of the fund can also be initially supported through grant funding from one of the bilateral assistance agencies, to ensure the participation of a qualified international fund manager, with a local subcontractor. At the outset, the investment fund's role would be as the primary project-finance lender for a package of projects up to 14 MW, with a fund capitalization of $8.5 (assuming 70/30 debt/equity financing).

b) Stage II: Transition: During the transition stage of the fund, additional sponsors can be incorporated in to the fund structure to expand its coverage and also diversify its financial instruments. The fund can at this point engage in co-financing projects, or financing projects on a multi-package basis to allow for the matching of specific investments with the requirements of various fund sponsors. The fund can also acquire an equity investment role for highly attractive projects for which a single private investor may not be found to commit the entire equity required. At this stage, the fund could reach a span of 21 MW with a capitalization of $24.

c) Stage III: Sustainable Operation: In the long term, the fund can be managed by local organizations that have gained sufficient experience through hands-on involvement in its

management and operations. The financial instruments of the fund can become increasingly sophisticated, depending on the existing possibilities to leverage additional resources. For example, on a large project, the fund can provide loan guarantees to a commercial lender that could finance part of a large project. At this stage, the fund could reach a span of 60-80 MW with a capitalization of $70-90.

7.3 Management of the Fund

As described above, the management of the fund would consist of a Review Board consisting of the key sponsors of the fund, and a fund manager based in-country to implement the policies and guidelines of the Board with relative autonomy to facilitate efficient operations. To ensure full accountability, responsibilities of these two functions would be as follows:

a) ***Responsibilities of the Review Board***: The Review Board would have ultimate responsibility for the direction and activities of the fund, including approval of overall capitalization and operational guidelines, financial instruments, and project selection criteria. The Board would be responsible for selecting and hiring the fund manager, and would have quarterly review meetings to approve major projects presented by the manager. The Review Board would have responsibility for approving loans greater than $1 million per project or more than 70% capitalization, in cooperation with the manager. The Board responsibilities would also include

- Selection of the fund manager and local subcontractors
- Development and update of fund operating procedures, including contractual and procurement requirements
- Development and update of manager performance criteria
- Retroactive review of fund manager's lending (transactions less than $1 million) and fund maintenance activities
- Joint review of funding proposals for highly leveraged (more than 80%) transactions or loans over $1 million, with fund manager
- Development of policies for activities of the fund manager, including prioritization of project selection criteria.

b) Responsibilities of the Fund Manager: The selected fund manager would be responsible for the day-to-day operations of the fund, including maintenance of fund resources on a revolving loan basis. The fund manager would be responsible for soliciting and reviewing funding proposals and evaluating applications. The fund manager would also have authority to conduct lending transactions for loans that are smaller than $1 million, and would be required to present to the Review Board proposals for funding larger than $1 million (or

highly leverage transactions) for decision. In general, the fund manager would be responsible for the following:

- Soliciting proposals for funding, development of application/business plan guidelines
- Reviewing applications and providing loans of up to $1 million
- Coordinating available technical assistance and training efforts to benefit the loan program (training in business plan preparation, management training, technical input)
- Providing monthly updates to the Review Board, with comprehensive reports on a quarterly basis, including loan performance and fund performance indicators
- Developing innovative financing mechanisms that leverage fund resources and meet lender guidelines,
- Matching of funding activities with various requirements of the fund's sponsors,
- Resolving registration, accounting and tax issues, and coordinating day-to-day activities with agent banks.

c) Fund Manager Selection Criteria: Selection of the fund manager would evolve into a field-based activity as the fund gradually evolved into an independent, viable and sustainable operation as described in the "Fund Life-Cycle" section of this report. Regardless of the life-cycle phase of the fund, however, the criteria in selecting the Fund Manager would emphasize the following attributes:

- Experience with revolving loan funds and other types of investment funds
- Related experience in Armenia/CIS and understanding of Armenian energy and business environment
- Innovative approach to financial arrangements and business solutions
- Innovative power project structuring and financing experience
- Understanding of power project design and technologies
- Understanding of multilateral agency procurement guidelines
- Experience in small enterprise development and training.

d) Fund Manager Accountability: The performance criteria used by the Review Board in evaluating the activities of the fund manager on a quarterly basis would be based on the following:

- Financial health and utilization rate of fund
- Justification of loans made based on selection criteria
- MW expansion impact of loans
- Analysis of loan performance and pay-back

- Leveraging of funds with other sources of financing

The fund management function, at least initially, would be led by an experienced international financial consultant, with assistance from local consultants. Over time, as local consultants gain the necessary exposure and experience, a greater part of the day-to-day management aspects can be handled locally, thereby decreasing the fund's overhead costs.

7.4 Operation of the Fund

This section is a summary of the economic and financial structure of the projects for financing and the scenario for financing the projects. The proposed financial debt pool is referred to in this section as "the Fund."

In order to qualify for the Fund, the project must be structured to meet criteria for successfully completing a project:

- Project rights must be completely secured:
  - the permitting rights must be satisfied including environmental permits and the governmental licensing requirements satisfied.
  - Land rights must be secured from governmental, agency or private holders

- The project must have economic feasibility; Project revenues must support the investment, plus ongoing costs of operations and maintenance.

- The project must be technically feasible; the project must be able to be constructed at a cost supportable by the projected revenue stream and produce sufficient power to justify revenues.

- The project must be environmentally sound; the project must meet the permitting requirements and other Fund requirements of sound environmental practice.

7.4.1 Project Structuring

Each funded project should be set up as a fully commercial enterprise. The projects would have a complete set of agreements which would allow for a commercial private power financial transaction. The transaction would not however occur in this market due to small size of the transaction and the credit problems in the country.

Debt funding by the Fund would be for a maximum of 70 percent of total project costs. These costs would include the project's development costs, interest during construction, legal and lending fees, engineering, design and construction management fees and all other owner's costs. Total debt on the project would be limited to 80% of the total costs. Thus, the project developer must produce at least 20% of the total costs in equity. The equity may include the developers costs and reasonable fees.

To receive a loan commitment and funding for a project, the applicant would go through a three stage process.

1. Submit preliminary information on the project and receive a letter of interest on the project and a list of requirements to receive a loan commitment.
2. Apply for debt funding, providing fulfilled requirements of the Fund. At this point, the Fund conducts due diligence activity and will make a qualified loan commitment to the project.
3. Receive funding for the project after all requirements are fulfilled.

At the preliminary information stage, the project should have a completed feasibility study, have most development agreement and be able to prove the financial feasibility of the project. Information to be submitted would include the developed project technical information, including details on project costs and production, and include the expectations of project revenues, including the power purchaser. The project also should have a license under the Armenian system.

The Fund would respond to the preliminary information with a Letter of Interest. The LOI would provide the developer/owner with a preliminary indication of the eligibility of the project for funding and the necessary items which must be completed prior to gaining a loan commitment.

At the time of application for a loan commitment, the Fund would require that detailed information on the project be submitted. The items would include:

1. Final conceptual designs of the project, including drawings of all new project features, sufficient for use in producing the final construction drawings and specifications.
2. Detailed information on the project production including the hydrology study, gage data, equipment performance from the equipment supplier, and detailed calculations of the project production during high, low and average years. System losses would be included in the calculation and a pattern of revenues from variable flow years could be studied.
3. Detailed cost estimates for project construction and other costs, including supplier quotes or contracts, construction bids or detailed quantity estimates to justify project costs.4.

4. An executed power purchase agreement for project power which fully justifies the revenue stream estimated for the project.
5. Fully executed project land rights under Armenian law.
6. A completed and in-force federal license and all permits necessary to complete and operate the project during the term of the funding.
7. Any implementation agreement necessary with federal authorities. This may only be necessary where some special land use or resource use is involved.
8. Fully justified non-construction costs, including development costs, owner's costs, insurance and other outside soft costs of the project.
9. An implementation schedule for the project, including a detailed construction sequence and schedule.
10. A complete financial projection model of the project, showing quarterly cash flows of the project for the first five years and annual cash flows for the next ten years or the projected project life.
11. Financial information regarding the project developer/owner, including the total investment to date, and the source of the equity needed to complete the project. Financial data on the equity provider must be submitted to show the security of the equity to be provided.
12. Other sources of funding such as Export-Import loans on project equipment.

At the completion of the application and the payment of a nominal fee, (e.g., $5/kw) a review process would be initiated by the Fund. The process would be undertaken by a limited number of specialists or a single individual who would coordinate the process with certain specialists, as needed. At the end of a period of 60 days after completed information is submitted, the project would be given a commitment letter from the fund, or rejected and the application fee returned. The application fee would not cover the costs of complete review of the project, which would need to be subsidized by the lending agency. Alternatively, the review costs or review personnel could be covered through an agreement with an international AID fund while the Fund is being established. However, it would be a requirement of the developer to gain a review of the project for fitness.

At the time of the commitment letter, the developer would be required to pay a commitment fee to secure the funds. The developer would be provided a list of items to complete financial closure. The largest of these items would likely be completed contracts for the construction of the project, including supply of all equipment and civil/mechanical/electrical works. These items would be a requirement for financial closing and project debt funding. It is proposed that the Fund provide a single construction/operation loan, rather than require the developer to secure separate sources of capital for these project phases. The interest on the construction loan would be capitalized into the long term loan.

The initial funding at closing would only reimburse portions of the project expenditures. Any development fees would not be funded at this point, but would be credited to the developer. Up to 70 percent of actual out of pocket expenses would be funded. As the construction progresses, disbursements to the developer would only be made after completion of the expenditure.

7.4.2 Project Selection Criteria

Upon establishment of the fund, it can be expected that there will be a number of projects which will apply for loans. The projects should be selected in accordance with risk measurement parameters set up for the projects. These would include:

a. Projects which have proven financial backing, including sufficient equity and reserve to complete the project should it encounter cost overruns or schedule delays.
b. A project pro forma financial statement, with proven or defensible cost and revenue projections. The project should provide for adequate coverage ratios for debt repayment (minimum of 1.3 with average greater than 1.5 over project life). The project revenue streams must be coming from a secure financial entity.
c. The project must have agreements in place or near signing.

Figure

APPENDIX A

SMALL HYDROPOWER POTENTIAL IN ARMENIA

SMALL HYDRO POTENTIAL IN DEBED RIVER BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh		< 6 USc/kWh	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Dzoraget HPP 1	100	1.2	1020	3.4	0.38	1020	3.4	0	0.0
2	Dzoraget HPP 2	70	2.0	1190	4.2	0.41	1190	4.2	0	0.0
3	Dzoraget HPP 3	70	2.8	1670	7.1	0.48	1670	7.1	1670	7.1
4	Dzoraget HPP 4	70	2.8	1670	7.1	0.48	1670	7.1	1670	7.1
5	Dzoraget HPP 5	70	4.5	2700	16.0	0.68	2700	16.0	2700	16.0
6	Khachachkut HPP 1,2,3,4	80	0.2	160	1.0	0.72	0	0.0	0	0.0
7	Alaverdi HPP 1,2 r.Alav.	80	0.2	163	0.5	0.36	0	0.0	0	0.0
8	Akhtamar HPP 1,2,3,4 r.Akhtamar	75	0.3	190	0.6	0.37	0	0.0	0	0.0
9	Provolnaya HPP Urut	100	0.4	425	1.5	0.40	425	1.5	0	0.0
10	Lemadjur HPP 2 r.Lemadjur	100	0.6	510	2.2	0.49	510	2.2	0	0.0
11	Lemadjur HPP 1 r.Bordak	100	1.2	1020	4.5	0.50	1020	4.5	0	0.0
12	Kharakhala HPP 1,2,3,4,5,6,7	75	0.7	470	1.4	0.34	470	1.4	0	0.0
13	Sarvenget HPP 1,2 r.Sarvach	70	0.4	208	0.8	0.41	0	0.0	0	0.0
14	Sarvenget HPP 3,4	70	0.6	476	1.6	0.38	476	1.6	0	0.0
15	Sarvenget HPP 5	75	0.8	498	1.7	0.39	498	1.7	0	0.0
16	Sarvenget HPP 6,7 r.Mecaru	100	0.9	765	2.3	0.34	765	2.3	0	0.0
17	Metsaru HPP	105	1.0	892	3.9	0.50	892	3.9	0	0.0
18	Chknakh HPP 1	125	0.4	425	1.9	0.50	425	1.9	0	0.0
19	Chknakh HPP 2	125	0.4	425	1.9	0.50	425	1.9	0	0.0
20	Ledjhandjh. HPP 1	110	0.5	467	1.2	0.30	467	1.2	0	0.0
21	Chanakhchi HPP 1,2,3	100	1.8	1530	6.2	0.47	1530	6.2	0	0.0
22	Sisimadan HPP 1,2	80	0.2	136	0.5	0.39	0	0.0	0	0.0
23	Kharachoban HPP 1,2	115	0.5	469	2.0	0.49	469	2.0	0	0.0
24	Pambakh HPP 1,2 r.Geduk	80	0.2	163	0.5	0.36	0	0.0	0	0.0
25	Pambakh HPP 3,4 r.Pambak	80	0.5	326	0.2	0.08	326	0.2	0	0.0
26	Gerger HPP 1 r.Gerger	115	0.5	440	1.2	0.31	440	1.2	0	0.0
27	Gerger HPP 2,3 r.Gerger	75	1.5	956	3.8	0.46	956	3.8	0	0.0
28	Paghazodjur HPP 1	85	0.2	144	0.5	0.38	0	0.0	0	0.0
29	Paghazodjur HPP 2,3,4	85	0.2	144	0.5	0.38	0	0.0	0	0.0
30	Teckhut HPP1,2,3 r.Kistum	75	0.3	190	0.5	0.32	0	0.0	0	0.0
31	Shnochk HPP 1,2 r.Shnochk	75	0.3	190	0.6	0.37	0	0.0	0	0.0
32	Antaramut HPP	125	0.4	425	1.5	0.40	425	1.5	0	0.0
33	Vanadzor HPP r.Vanadzor	75	0.7	471	1.5	0.35	471	1.5	0	0.0
34	Shagali HPP 1	75	0.3	191	0.7	0.40	0	0.0	0	0.0
35	Shagali HPP 2,3 r.Zamanakl	75	0.3	191	0.7	0.40	0	0.0	0	0.0
36	Samaghbur HPP r.Sarbulat	100	1.6	1394	3.4	0.28	1394	3.4	0	0.0
37	Deghin HPP 1,2 r.Deghin	80	0.7	503	2.0	0.45	503	2.0	0	0.0
38	Deghin HPP 3 r.Deghin	100	0.6	510	2.5	0.55	510	2.5	0	0.0
39	Deghin HPP 4 r.Deghin	110	0.5	467	2.7	0.66	467	2.7	0	0.0
40	Shamut HPP 1,2 r.Lorut	125	0.8	850	2.0	0.27	850	2.0	0	0.0
41	Aghnidzor HPP 1 r.Marz	115	1.8	1760	5.7	0.37	1760	5.7	0	0.0
42	Aghnidzor HPP 2 r.Marz	85	2.4	1734	6.2	0.41	1734	6.2	1734	6.2
43	Geghatargomer HPP r.Marz	70	0.8	476	1.6	0.39	476	1.6	0	0.0
44	Shahumian HPP 1r,Karbi	125	1.2	1275	3.7	0.33	1275	3.7	0	0.0
45	Akhner HPP 1,2,3,4 r,.Kistum	100	0.6	510	1.6	0.36	510	1.6	0	0.0
46	Vardadjur HPP 1,2	85	0.2	144	0.4	0.29	0	0.0	0	0.0
47	Dzorashen HPP 1,2 r.Dzorashen	85	0.2	144	0.3	0.20	0	0.0	0	0.0
48	Tazakent HPP	85	0.3	217	0.6	0.32	0	0.0	0	0.0
49	Mago HPP 1,2 r.Mago	75	0.2	153	0.3	0.19	0	0.0	0	0.0
50	Pumbi HPP 1,2 r.Pamb	90	0.2	183	0.6	0.34	0	0.0	0	0.0
51	Mardz HPP 1	125	0.3	325	0.9	0.33	325	0.9	0	0.0
52	Bazum HPP 1	95	0.1	97	0.6	0.71	0	0.0	0	0.0
53	Bazum HPP 2	110	0.5	468	1.8	0.44	468	1.8	0	0.0
	Total			32520	122.5		29512	112.5	7774	36.4

SMALL HYDROPOWER POTENTIAL IN ARMENIA

SMALL HYDRO POTENTIAL IN AGHETEV RIVER KURA TRIBUTARIES' BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh)		< 6 USc/kWh)	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Khachagbur HPP 12,3,4,5,6,7	70	3.6	2142	3.8	0.20	2142	3.8	2142	3.8
2	Khachagbur HPP 8,9	70	4.5	2677	5.8	0.25	2677	5.8	2677	5.8
3	Lusadzor HPP 1,2,3,4	75	0.6	382	0.8	0.24	382	0.8	0	0.0
4	Gosh HPP 1,2,3,4,5 x)	70	6.0	3570	13.6	0.43	3570	13.6	3570	13.6
5	Polad HPP 1,2,3	100	0.5	425	1.2	0.33	425	1.2	0	0.0
6	Polad HPP 4	100	0.9	765	1.7	0.25	765	1.7	0	0.0
7	Bidan HPP 1,2	75	1.2	765	2.6	0.39	765	2.6	0	0.0
8	Dilijhan HPP 1	75	1.2	765	2.6	0.39	765	2.6	0	0.0
9	Dilijhan HPP 2,3	75	0.3	191	0.7	0.42	0	0.0	0	0.0
10	Dilijhan HPP 4,5	75	0.6	382	1.3	0.38	382	1.3	0	0.0
11	Kubishev HPP 1,2,3,	110	0.4	420	1.3	0.36	420	1.3	0	0.0
12	Aghetev HPP 1	70	3.0	1785	5.3	0.34	1785	5.3	1785	5.3
13	Aghetev HPP 2-4	70	3.0	1785	5.3	0.34	1785	5.3	1785	5.3
14	Aghetev HPP 5,6	70	7.6	4522	14.3	0.36	4522	14.3	4522	14.3
15	Charvashan HPP 1	125	0.4	425	1.6	0.42	425	1.6	0	0.0
16	Charvashan HPP 2	110	0.5	467	1.6	0.38	467	1.6	0	0.0
17	Charvashan HPP 3,4	109	1.8	1500	5.4	0.41	1500	5.4	0	0.0
18	Kharachanchey HPP 1-4	75	0.3	191	0.8	0.45	0	0.0	0	0.0
19	Kharachanchey HPP 5,6	75	1.0	640	2.3	0.40	640	2.3	0	0.0
20	Getik HPP 2	105	0.5	446	1.2	0.32	446	1.2	0	0.0
21	Getik HPP 1	85	2.4	1734	6.1	0.40	1734	6.1	1734	6.1
22	Barnabad HPP 1,2	125	1.2	1275	3.3	0.30	1275	3.3	0	0.0
23	Voskepar HPP 1	95	0.1	97	0.5	0.59	0	0.0	0	0.0
24	Voskepar HPP 2,3	95	0.1	97	0.5	0.59	0	0.0	0	0.0
25	Revazlue HPP 1-7	85	0.2	144	0.5	0.37	0	0.0	0	0.0
26	Karmradjur HPP 1,2		0.1	104	0.7	0.73	0	0.0	0	0.0
27	Khndzorut HPP 1	125	0.8	850	3.1	0.42	850	3.1	0	0.0
28	Khndzorut HPP 2	120	0.8	816	3.0	0.42	816	3.0	0	0.0
29	Khndzorut HPP 3	110	1.0	935	2.8	0.34	935	2.8	0	0.0
30	Khndzorut HPP 4 x)	49	1.2	490	2.0	0.47	490	2.0	0	0.0
31	Khndzorut HPP 5	49	1.2	490	2.0	0.47	490	2.0	0	0.0
32	Chikhlaili HPP 1	90	0.3	230	0.8	0.38	230	0.8	0	0.0
33	Chikhlaili HPP 2	90	0.3	230	0.8	0.38	230	0.8	0	0.0
34	Sadjaghat HPP	1	0.4	425	2.1	0.55	0	0.0	0	0.0
35	Agedzor HPP 1	75	3.0	1912	6.6	0.39	1912	6.6	1912	6.6
36	Agedzor HPP 2	75	3.0	1912	6.6	0.39	1912	6.6	1912	6.6
37	Akhun HPP 1	100	1.2	1020	2.4	0.27	1020.	2.4	0	0.0
38	Akhun HPP 2	100	1.2	1020	2.4	0.27	1020	2.4	0	0.0
39	Akhun HPP 3	100	1.2	1020	2.4	0.27	1020	2.4	0	0.0
40	Tavush HPP 1	75	0.6	382	1.3	0.40	382	1.3	0	0.0
41	Tavush HPP 2	75	0.6	382	1.3	0.40	382	1.3	0	0.0
42	Tavush HPP 3	75	0.6	382	1.3	0.40	382	1.3	0	0.0
43	Tavush HPP 4	75	0.6	382	1.3	0.40	382	1.3	0	0.0
44	Tavush HPP 5	75	0.7	446	1.6	0.41	446	1.6	0	0.0
	Total			41020	128.5		39771	122.9	22039	67.4

SMALL HYDRO POTENTIAL IN AKHURIAN RIVER BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh)		< 6 USc/kWh)	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Voskhegugh HPP 1,2	70	0.8	480	1.3	0.31	480	1.3	0	0.0
2	Eghnadjur HPP r.Chivinlz	100	1.2	1020	2.9	0.32	1020	2.9	0	0.0
3	Mantash HPP 1,2,3	100	0.6	510	2.5	0.56	510	2.5	0	0.0
4	Geghadzor HPP	125	0.4	425	2.1	0.55	425	2.1	0	0.0
	Total			2435	8.71		2435	8.7	0	0.0

SMALL HYDROPOWER POTENTIAL IN ARMENIA

SMALL HYDRO POTENTIAL IN KHASAKH RIVER BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh)		< 6 USc/kWh)	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Tsakhahovit HPP 1,2	110	1.2	1120	2.4	0.25	1120	2.4	0	0.0
2	Gegharond HPP 3-9	100	1.2	1020	2.4	0.27	1020	2.4	0	0.0
3	Gegharond HPP 1,2	110	0.9	840	2.0	0.26	840	2.0	0	0.0
4	Arkhashan HPP 1-8	75	0.6	382	0.9	0.26	382	0.9	0	0.0
5	Arkhashan HPP 9,10	75	1.5	960	2.3	0.27	960	2.3	0	0.0
6	Amnur HPP 1-6	100	1.8	1530	4.5	0.34	1530	4.5	0	0.0
	Total			5852	14.4		5852	14.4	0	0.0

SMALL HYDRO POTENTIAL IN HRAZDAN RIVER BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh)		< 6 USc/kWh)	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Meghradzor HPP 1,2	75	0.8	478	1.4	0.33	478	1.4	0	0.0
2	Megrhradzor HPP 3-5	70	3.2	1900	6.0	0.36	1900	6.0	1900	6.0
3	Dalar HPP 1,2	80	1.4	952	2.7	0.32	952	2.7	0	0.0
4	Tedjh-Get HPP 1,2	100	1.2	1020	2.8	0.31	1020	2.8	0	0.0
5	Bdjni HPP 1,2	70	0.4	208	0.6	0.32	0	0.0	0	0.0
6	Bujhakan HPP 1,2	70	0.4	208	0.6	0.35	0	0.0	0	0.0
7	Tsakhamarg HPP 1,2,3	100	1.2	1020	3.8	0.42	1020	3.8	0	0.0
	Total			5786	17.9		5370	16.7	1900	6.0

SMALL HYDRO POTENTIAL IN SEVAN RIVER BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh)		< 6 USc/kWh)	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Martuni HPP 1,2,3,4	100	1.8	1530	3.8	0.28	1530	3.8	0	0.0
2	Gagharkuni HPP	100	0.6	510	1.2	0.27	510	1.2	0	0.0
3	Badara HPP 1,2,3	110	1.0	897	2.2	0.28	897	2.2	0	0.0
4	Mairaru HPP 1,2,3,4,5	75	0.7	485	1.1	0.26	485	1.1	0	0.0
5	Masrik HPP 1,2	75	3.2	2040	5.1	0.29	2040	5.1	2040	5.1
6	Babatgan HPP 1,2	75	0.3	160	0.6	0.41	0	0.0	0	0.0
	Total			5622	14.0		5482	13.4	2040	5.1

SMALL HYDRO POTENTIAL IN AZAT RIVER BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh)		< 6 USc/kWh)	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Baiburt HPP 1,2	70	2.6	1547	5.1	0.38	1547	5.1	0	0.0
2	Karasu HPP 1,2,3	75	1.4	892	2.4	0.31	892	2.4	0	0.0
3	Darband HPP 1,2	120	1.0	1020	3.1	0.35	1020	3.1	0	0.0
4	Azat HPP 1,2	75	1.6	1020	3.2	0.36	1020	3.2	0	0.0
5	Karmir HPP 1,2,3	75	1.6	1020	3.2	0.36	1020	3.2	0	0.0
6	Ghokht HPP 1,2,3,4,5	70	2.6	1547	4.7	0.35	1547	4.7	0	0.0
	Total			7046	21.7		7046	21.7	0	0.0

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SMALL HYDROPOWER POTENTIAL IN ARMENIA

SMALL HYDRO POTENTIAL IN ARPA RIVER BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh)		< 6 USc/kWh)	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Elis HPP 1,2	90	2.1	1606	3.3	0.23	1606	3.3	0	0.0
2	Daraurt HPP	110	1.5	1402	3.5	0.28	1402	3.5	0	0.0
3	Artabunk HPP 1,2,3	75	4.0	2550	6.2	0.28	2550	6.2	2550	6.2
4	Artabunk HPP 4	50	3.9	1658	5.6	0.39	1658	5.6	1658	5.6
5	Artabunk HPP 5,6	75	0.5	318	1.0	0.36	318	1.0	0	0.0
6	Artabunk HPP 7,8,9,10,11	70	3.2	1904	4.5	0.27	1904	4.5	1904	4.5
7	Arpa HPP 1,2,3	75	2.0	1275	3.2	0.29	1275	3.2	0	0.0
8	Arpa HPP 4,5	75	4.0	2550	6.2	0.28	2550	6.2	2550	6.2
9	Arpa HPP 6,7,8,9	90	0.3	190	0.7	0.42	0	0.0	0	0.0
10	Gerger HPP 1,2	75	4.0	2550	6.7	0.30	2550	6.7	2550	6.7
	Total			16003	40.9		15813	40.2	11212	29.2

SMALL HYDRO POTENTIAL IN MEGRI RIVER BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh)		< 6 USc/kWh)	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Shishkert HPP 1,2,3,4	75	0.5	318	1.2	0.43	318	1.2	0	0.0
2	Megri h. P 1,2,3	70	1.1	625	2.0	0.37	625	2.0	0	0.0
3	Megri HPP 4,5,6,7,8,9	70	4.0	2380	7.6	0.36	2380	7.6	2380	7.6
4	Vardnadzor HPP 1,2,3,4	90	0.3	230	0.7	0.35	230	0.7	0	0.0
5	Vank HPP 1	125	0.8	850	2.7	0.36	850	2.7	0	0.0
	Total			4403	14.2		4403	14.2	2380	7.6

SMALL HYDRO POTENTIAL IN VAKHCHI RIVER BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh)		< 6 USc/kWh)	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Geghi HPP 1,2,3	125	1.2	1275	4.8	0.43	1275	4.8	0	0.0
2	Adjhati HPP 1,2	125	0.8	850	3.2	0.43	850	3.2	0	0.0
3	Karabash HPP 1,2	75	0.5	318	1.0	0.36	318	1.0	0	0.0
4	Davidbek HPP 1,2	75	0.5	318	1.0	0.36	318	1.0	0	0.0
5	Bednadzor HPP 1,2	95	0.5	404	1.1	0.31	404	1.1	0	0.0
6	Tsav HPP 1,2	125	1.2	1275	5.0	0.45	1275	5.0	0	0.0
7	Kadjharan HPP 1,2	100	1.8	1530	6.4	0.48	1530	6.4	0	0.0
8	Sankar HPP 1,2,3,4	90	0.3	230	0.8	0.40	230	0.8	0	0.0
9	Sankar HPP 5	95	0.3	242	0.9	0.42	242	0.9	0	0.0
10	Avsarluget HPP 1,2,3,4	70	0.7	416	1.2	0.33	416	1.2	0	0.0
11	Musalam HPP 1,2,3	70	1.4	833	2.3	0.31	833	2.3	0	0.0
12	Katnarat HPP 1,2,3	95	0.2	194	0.7	0.41	194	0.7	0	0.0
13	Vachaganaget HPP 1,2	75	0.5	318	1.1	0.39	318	1.1	0	0.0
	Total			8203	29.5		8203	29.5	0	0.0

SMALL HYDRO POTENTIAL IN VOROTAN RIVER BASIN

No.	Scheme	Design Head	Design Flow	Installed Capacity	Energy Generation	Plant Factor	Economic Viability < 10 USc/kWh)		< 6 USc/kWh)	
		(m)	(m3/s)	(kW)	(GWh/a)		(kW)	(GWh)	(kW)	(GWh)
1	Vorotan HPP 2,3,4	50	1.6	680	2.0	0.34	680	2.0	0	0.0
2	Vorotan HPP 1	952	1.6	952	2.8	0.34	952	2.8	952	2.8
4	Arikhidgur	125	0.8	850	2.5	0.34	850	2.5	0	0.0
5	Darbas	80	1.4	952	3.0	0.36	952	3.0	0	0.0
6	Dragadsidzor	110	0.5	467	1.6	0.39	467	1.6	0	0.0
7	Airiget	95	0.8	650	2.0	0.35	650	2.0	0	0.0
8		95	0.8	650	2.0	0.35	650	2.0	0	0.0
9		110	1.6	1500	4.6	0.35	1500	4.6	0	0.0
	Total			6701	20.5		6701	20.5	952	2.8

SMALL HYDROPOWER POTENTIAL IN ARMENIA

SMALL HYDRO POTENTIAL AT EXISTING RESERVOIRS

No.	Reservoir	Design Head	Design Flow	Installed Capacity	Energy Generation	Active Storage	Economic Viability < 10 USc/kWh		Economic Viability < 6 USc/kWh	
		(m)	(m3/s)	(kW)	(GWh/a)	(mcm)	(kW)	(GWh)	(kW)	(GWh)
1	Sovetashen	20	0.1	18	0.1	1	0	0.0	0	0.0
2	Bashkend	21	0.1	16	0.1	2	0	0.0	0	0.0
3	davidbek	30	0.2	46	0.2	3	0	0.0	0	0.0
4	Halavar	25	0.2	46	0.2	4	0	0.0	0	0.0
5	Algedzor	28	0.2	59	0.3	4	0	0.0	0	0.0
6	Sevaberd	52	0.2	91	0.4	4	0	0.0	0	0.0
7	Sarnaghbur	30	0.3	68	0.3	4	0	0.0	0	0.0
8	Vardnakar	36	0.3	98	0.4	5	0	0.0	0	0.0
9	Tavush	26	0.8	180	0.8	5	0	0.0	0	0.0
10	Tavtur	50	0.3	148	0.7	6	0	0.0	0	0.0
11	Mantash	40	0.5	164	0.7	7	0	0.0	0	0.0
12	Martsiget					10				
13	Akhumian	30	1.2	297	1.3	10	0	0.0	0	0.0
14	Gekhin	71	8.3	5019	22.0	12	5019	22.0	5019	22.0
15	Megri					16				
16	Melkia					22				
17	Karput					23				
18	Ger-Gers	62	1.1	593	2.6	23	593	2.6	0	0.0
19	Getik	55	0.8	388	1.7	23	0	0.0	0	0.0
20	Goris					24				
21	Armaluis					30				
22	Vedi	40-70			1.9	35				
23	R.Alagiazverghovie					35				
24	Fioletovo					40				
25	Dhogaz	43	2.7	1004	4.4	43	1004	4.4	0	0.0
26	Lernatat					48				
27	Azat Tolorsk	37	4.7	1483	6.5	60	1483	6.5	1483	6.5
28	Tolor					80				
29	Kan	45	2.0	762	3.3	80	762	3.3	0	0.0
30	Aparan	35	3.6	1072	4.7	81	1072	4.7	0	0.0
31	Arznilic					100				
32	Hoktemberian	62	4.8	2533	11.1	120	2533	11.1	2533	11.1
33	Armanis	49	9.9	4107	18.0	135	4107	18.0	4107	18.0
34	Miasnikian					135				
35	Eghvard	24	8.1	1643	7.2	220	1643	7.2	1643	7.2
36		25	2.5	525	2.3	220	525	2.3	0	0.0
37	Akhurian	39	12.9	4266	18.7	510	4266	18.7	4266	18.7
38	Khndzorut									
	Sum			24626	110		23007	100.8	19051	83.5

OVERVIEW OF SMALL HYDRO POTENTIAL IN ARMENIA

No.	River Basin	Number of Schemes	Installed Capacity	Energy Generation	Economic Viability < 10 USc/kWh		Economic Viability < 6 USc/kWh	
			(kW)	(GWh/a)	(kW)	(GWh)	(kW)	(GWh)
1	Debed	53	32520	122	29512	113	7774	36
2	Aghetev	44	41020	129	39771	123	22039	67
4	Akhurian	4	2435	9	2435	9	0	0
5	Kasakh	6	5852	14	5852	14	0	0
6	Hrazdan	7	5786	18	5370	17	1900	6
7	Sevan	6	5622	14	5462	13	2040	5
8	Azat	6	7046	22	7046	22	0	0
9	Arpa	10	16003	41	15813	40	11212	29
10	Megri	5	4403	14	4403	14	2380	8
11	Vakhchi	13	8203	30	8203	30	0	0
12	Vorotan	9	6701	21	6701	21	952	3
13	Existing Reservoirs	25	24626	110	23007	101	19051	84
	Total	188	180217	543	153575	515	67348	238
					138 schemes		28 schemes	

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