Ex post evaluation – Armenia

Sector: Energy (including energy efficiency, renewable energies) (CRS codes: 23030, 23210, 23220)
Project: Programme to promote renewable energies (Phases I and II), investment (2003 66 120*, 2009 66 507) and complementary measure (2004 70 153, 2009 70 285) in each case
Implementing agency: German Armenian Fund – Central Bank of Armenia

Ex post evaluation report: 2018

Phase I

		Investment (Planned)	Investment (Actual)	Comp. measure (Planned)	Comp. measure (Actual)
Investment costs (total)	EUR million	9.70	11.71	1.50	1.50
Counterpart contribution	EUR million	3.70	5.71	0.00	0.00
Funding	EUR million	6.00	6.00	1.50	1.50
of which BMZ budget funds	EUR millic	6.00	6.00	1.50	1.50

Phase II

Investment costs (total)	EUR million	26.00	54.00	1.50	2.11
Counterpart contribution	EUR million	8.00	36.00	0.00	0.00
Development loan**	EUR million	18.00	18.00	1.50	2.11

*) Random sample 2017; **) Complementary measure: only BMZ funds

Summary: In the first two phases of the programme, long-term local currency loans were provided through local commercial banks for investments in the rehabilitation, expansion and construction of small hydropower plants (SHP). A total of 29 SHP were financed. In addition, a complementary measure supported investors in preparing and implementing projects, commercial banks in granting and monitoring loans, and the programme executing agency in implementing them. The executing agency was the German Armenian Fund located at the Central Bank of Armenia.

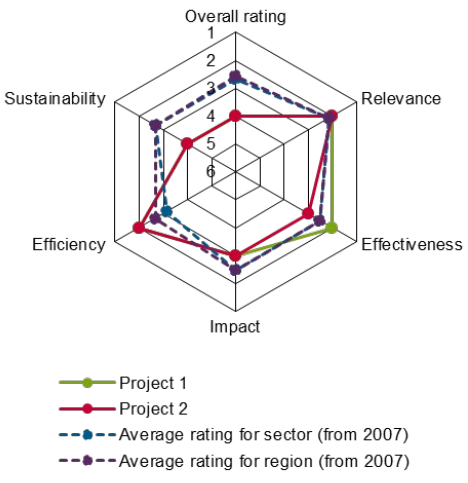
Objectives: The overarching development policy objective (impact) was to improve the regenerative power supply and its contribution to sustainable economic development and climate protection. The targeted outcome was the cost-effective use of small hydropower plants to supply electricity via long-term financing offers for private investors through local banks.

Target group: The target group of the projects was private investors/operators of SHP in Armenia, local commercial banks as well as the Armenian population benefiting from the better supply of electricity.

Overall rating: 4 (both phases)

Rationale: Despite good to satisfactory evaluations in the categories of relevance, effectiveness, impact and efficiency, (a) negative environmental impacts (primarily dysfunctional fish ladders and insufficient residual water volumes in the rivers), (b) financial risks, and (c) technical deficits in construction planning and execution significantly impair the sustainability of both projects and result in an unsatisfactory overall rating of 4.

Highlights: With the German Armenian Fund, an efficient and highly valued executing agency structure was established in the Armenian Central Bank, which is now also used by other donors. The environmental risks have triggered necessary discussions on standards for fish ladders and residual water volumes, and Armenia has taken on a pioneering role in the region in this regard.



Rating according to DAC criteria

Overall rating: 4 (both phases)

Relevance

Hydropower is Armenia's most important renewable energy source, with medium to large-scale hydropower contributing around a third of the national electricity supply (30% nuclear power, 40% thermal power plants) at the time of the phase I appraisal (2004). In 2004 there were just 29 small hydroelectric power plants (SHP) installed with an available capacity of 50 MW; these contributed 1.8% of the electricity generated. At the outset of both phases, Armenia had significant untapped potential for the development of small-scale hydropower, and a high level of private-sector willingness to invest in this area.

The programme supported the political objectives of the Republic of Armenia regarding energy in both phases, in particular through the development of locally available resources and the planned shutdown of the Medzamor Nuclear Power Plant by 2026. Due to the envisaged effect of the project stimulating private investments in small-scale hydropower, it was also in line with the efforts of the Ministry of Energy to increase private sector participation in the energy sector.

To generate private investment in small-scale hydropower production, long-term financing offers in local currency are required due to the long payback periods and tariff revenues in local currency. However, there was no corresponding long-term local currency financing available at the time of the appraisal, and nor is this currently available, without funding via development banks. Local banks can only refinance local currency loans through deposits with short terms and high interest rates (over 18%).

Under the programme, the Armenian Central Bank and the Armenia-based German Armenian Fund (GAF) were to receive long-term FC financing in euros, take on the currency risk and provide Armenian commercial banks with long-term local currency funding for private investment in small-scale hydropower production. The complementary measure was aimed at professionalising the financing of the corresponding investments by providing training for bank employees. The difficulties faced by Armenian commercial banks in obtaining adequate long-term local currency funding without having to rely on the GAF and international financial institutions were not included in the concept. However, these would possibly have overburdened the projects – which focus on promoting renewable energies via the private sector – by creating too many additional challenges. A budget loan was granted for phase I on the basis of its pilot nature, and a low-interest loan granted in phase II upon the establishment of the programme. The results chain – encouraging the private sector to invest in SHP production by providing long-term financing options in local currency and contributing to climate protection through the increased use of renewable energies – is plausible.

The relevance of bank loans in local currency for the promotion of renewable energies in Armenia via private investors remains high from today's perspective, despite the tariff regime now providing power plant operators with partial compensation for currency depreciations.

Relevance rating: 2 (both phases)

Effectiveness

The programme objective (outcome) for both phases, which was slightly adjusted for the ex-post evaluation (EPE), was the cost-effective use of small hydropower plants to generate electricity in Armenia through long-term financing offers for private investors via local banks. The achievement of the indicators defined during the project appraisal can be summarised as follows:

Phase	Indicator	PA target value	Ex post evaluation
PHASE 1	(I-1) Increasing the amount of electricity generated in the 13 power plants included under	>= 50%	Achieved; More than 150% increase. (16 GWh → 41 GWh)

	the programme.*		
	(I-2) Specific investment costs for a) facilities to be newly constructed, b) rehabilitation of existing facilities.	a) <= 1,500 EUR/kW b) <= 700 EUR/kW	Exceeded on average, but often at the expense of technical quality; a) 550 EUR/kW b) 300 EUR/kW
	(I-3) Share of loans (measured by volume) for which the debt servicing is regular	>= 95%	Achieved; (96%)
PHASE 2	(II-1) Sufficient utilisation of the respective nominal capacity of the plants	Electricity production divided by (available capacity x annual hours) average >= 30%	Achieved, with restrictions; (27%, taking into account additional power plant equipment financed from own funds).
	(II-2) Regular and complete debt servicing	>= 95% (of total volume)	Achieved; (96%)

* Measured as the difference between the production level of the existing (and then rehabilitated) power plants prior to the start of the measure and the production level of all power plants after the measure (including the new buildings).

With 7 newly built SHP plants, compared to just 6 rehabilitated SHP plants, the indicator (I-1) in phase I was clearly exceeded. Against the background of the ratio of new to rehabilitated sites, the target value selected was very conservative.

Indicator (I-2) could be achieved on average, but in many cases only at the expense of the technical quality of the installed equipment. With regard to the rehabilitated plants, the specific investment costs fell well short of the target level in all cases: 50% of the installations incurred costs of EUR 200/kW or less. The investment costs for the newly constructed plants in phase I were also below EUR 1000/kW and therefore well below the target level in 86% of cases.

The target value for the sufficient utilisation of nominal plant capacity in phase II (II-1) was only met with restrictions. Contrary to the recommendations of the consultant and using their own resources, 4 of the 29 power plant operators created more capacity than can be used by the existing water supply and thus reduced the average nominal capacity utilisation to below 30%.

The terms of financing were considered acceptable by the SHP plant owners during the interviews. While some repayments are still outstanding, regular repayments have been made on more than 95% of the loan portfolio (I-3 and II-2). However, a small number of loans (4%) required follow-up financing, four borrowers requested a one-year postponement of repayment instalments due to a dry season, and the repayment dates for two repayment schedules were adjusted within the respective loan terms.

In addition to the indicators listed above, example calculations for dynamic production costs were carried out for twelve of the power plants in the programme (eleven phase-II power plants, one phase-I power plant) in order to check their cost effectiveness. In contrast to specific investment costs, dynamic production costs also take into account actual electricity production, which seems appropriate when assessing the programme's objective ("cost-efficient use"). With the exception of three cases, the calculations produced values between EUR 0.03 and 0.065/kWh; such costs are considered low by typical international comparison and compared to the expected dynamic production costs for small hydropower plants. Cost-efficient electricity production has therefore been achieved. Nevertheless, the level may not be sufficient to ensure the long-term economic operation of the installations at the existing tariff level, even if such projections are associated with considerable uncertainty (see "Sustainability").

The analysis of investment and production costs also shows that the successful implementation of the programme – and the promotion of SHP plants by private investors overall – is strongly linked to the development of tariffs; the tariffs are therefore crucial to the project's impact logic. This aspect could have been anchored more firmly in the impact logic. In general, however, the tariff system in Armenia is considered to be progressive and cost-oriented. Furthermore, tariffs were analysed more explicitly in phase II of the project (when a tariff study was commissioned, for example).

The importance of the programme is also evidenced by the very high demand among Armenian banks and private investors: of the 21 commercial banks in Armenia at the start of the programme, 16 signed a master financing agreement with the GAF and 8 concluded contracts with 29 investors. Some applications submitted during phase I had to be partially postponed to phase II due to the high demand. In phases I and II, 29 SHP plants were newly constructed or rehabilitated, and capacities of 73 MW were developed.

The complementary measures included training and support for the executing agency, operators and banks. These measures succeeded in improving the technical quality of SHP in Armenia, particularly in phase II. The importance of the complementary measures and their effects beyond the project have been stressed by both the SHP plant operators and local banks. Through both phases of the programme, the qualifications of the bank employees generally served to professionalise the SME financing segment. Opening the banks up to "new" professional groups (engineers) has made investment decisions more holistic. However, the relatively weak influence of the executing agency, consultants and banks on investor decisions with regard to power plant design and construction, along with low/lacking standards in a weak regulatory environment, have led to reductions in quality by international comparison. Although the issue was addressed more intensively in phase II, it was not possible to bring about a significant improvement in the outcome.

In short, the impact indicators were largely achieved in both phases, but with minor restrictions or against a background of conservative targets in some cases. No significant shortcomings were identified in relation to programme effectiveness, but the above-mentioned quality losses led to weaker sustainability.

Effectiveness rating: 2 (Phase 1), 3 (Phase 2)

Efficiency

Implementing the programme through the Armenian banking sector and private investors has increased efficiency compared to an alternative course of implementation through the public sector. Since 100% of the SHP plants financed by the programme are operated by private investors, and with an average financing share of the GAF at 39.5%, the public funds used had significant leverage effects in both phases.

What's more,,considering the remote locations and small-scale structures,SHP is predestined for being implemented by the private sector. Given that a public structure would not have been equipped with sufficient administrative and technical capabilities, it would not have been possible to achieve the same SHP capacity during the same period with a public executing agency. Public investment is more suited to larger hydropower plants with higher risks and greater investment costs.

The implementation structure can be considered efficient: Thanks to its independence and mandate for monetary and exchange-rate policy, the Armenian Central Bank is the only institution that can efficiently transfer loans in EUR to local banks as refinancing lines of credit in the local currency (AMD) and bear the currency risk. Thanks to the programme-executing agency GAF, which is located within the central bank and has lean structures, continuity and capacities are ensured for all phases of the programme as well as for other FC programmes and other donors. Cooperation between the GAF and the partner banks is smooth.

SHP offers low production costs compared to other renewable energies. To increase the share of renewable energies it was important and expedient to include both the rehabilitation and the construction of new SHP plants in the programme.

Setting electricity tariffs for end users in the Armenian electricity sector is essentially in line with the objective of covering current costs, and thus with the principle of allocation-efficient tariffs. Replacement and expansion investments in the power plants are not covered by the tariffs. However, the design of the end-user tariffs does not create any significant distorting price signals. The low grid losses also ensure efficient

transport of the electricity generated in the SHP plants, with the result that the chosen programme alternative is also a production-efficient project.

In principle, the available water could have been used more efficiently by installing higher-quality turbines procured from international manufacturers. However, the current design seems acceptable from the point of view of efficiency, as the initial costs of turbines from international manufacturers are two to three times higher on average than the turbines which were used – the majority of which were locally manufactured with local options for maintenance. In addition, the instrument for local currency financing is suited for purchases in the local currency.

With regard to the complementary measures, one can note that the initially inadequate coordination between the technical and banking consultants improved over the course of the programme. The efficiency losses in phase I were mainly due to the fact that the technical consultant reviewed and voted in favour of a number of project proposals that later turned out to be ineligible for promotion from a banking perspective. In several cases, taking greater account of international technical standards in phase I could have prevented follow-up financing to improve the quality, operational stability and efficiency of the electromechanical equipment in phase II and may have reduced the future maintenance effort.

In addition to the assessments given here, please refer to the comments on the project's cost-effectiveness as outlined in the section entitled "Effectiveness".

Overall, the evaluation results in the "Efficiency" category were in line with expectations in both phases; no significant shortcomings were identified.

Efficiency rating: 2 (both phases)

Impact

The overarching development objective was to improve the regenerative power supply and its contribution to sustainable economic development and climate protection. The contribution to climate protection was reviewed as part of the EPE using the reduction in CO_2 emissions.

EPE indicator	Status PA, Target value	Ex post evaluation
(1) Reduction in CO_2 emissions	Status PA = 0 tCO_2 Target value: Owing to the inclusion of the indicator as part of the EPE, and against the background of the concept as an open programme, no target value had been defined at the time of the PA.	28,645 tCO_2 p.a.

At the start of the programme, there were 29 SHP plants (50 MW) in Armenia. During phases I and II of the programme, 29 SHP plants (there are 180 in Armenia today) were newly constructed or rehabilitated. With a capacity of 73 MW, around a quarter of the SHP capacity installed today was developed exclusively through the private sector. The impact of the programme on SHP development in Armenia was therefore considerable. SHP contributes around 13% (2004: 1.6%) of the total installed capacity in Armenia, while the share of total output is slightly lower.

The programme generates 168,500 MWh of electricity each year. In view of the average emission factor for power generation in Armenia of 170 kg CO_2/MWh (KfW table according to the Institute for Global Environmental Strategies (IGES), List of Grid Emission Factors), the programme makes a positive annual contribution to the reduction of CO_2 emissions:

Phase I: 170 kg CO_2/MWh * 40,500 MWh/a = **6,885 t CO_2 reduction** per year;

Phase II: 170 kg CO_2/MWh * 128,000 MWh/a = **21,760 t CO_2 reduction** per year.

According to the Armenian Ministry of Energy, only around one third of the electricity generated is provided to private households (including SMEs), meaning that more than two thirds is used for productive purposes. Using the electricity generated from SHP plants to stabilise the local electricity supply therefore benefits productive consumers above all. Furthermore, the programme generated employment impulses

on the labour market at remote locations during the construction phase, and to a lesser extent, during operation. Against this background, we can assume the project will contribute to the sustainable economic development of Armenia.

Unintended, negative social and environmental impacts were observed at a number of sites: a national NGO published monitoring reports for 6 SHP plants from phase I and 7 SHP plants from phase II. These reports indicated various social and environmental shortcomings, which were then confirmed during the plant visits carried out as part of the evaluation. Two issues came up repeatedly in the monitoring reports: a) deficiencies in terms of ecological outflow (residual outflow) and (b) the absence or dysfunctional nature of fish ladders. The SHP installations are all run-of-river power plants; however, the discharge line must nevertheless be supplied with sufficient residual water – if all water is routed through the turbines, the discharge lines will dry up, interrupting the water continuity required for the migration of aquatic fauna by the EU Water Framework Directive. Additionally, the existing shortcomings should have been corrected within the context of rehabilitation. In the absence of government regulations and standards, water continuity was not ensured (due to a lack of residual water volumes in the discharge lines and the dysfunctional fish ladders). Information on fish populations was not collected specifically for SHP due to missing steps in the necessary planning process[1], and it was therefore necessary to use information generally available. The lack of water continuity for aquatic fauna and the fact that general information on fish populations indicates migratory fish species in the rivers used by SHP plants suggests a threat to aquatic life in terms of abundance and biodiversity. A drastic reduction in fish stocks has been reported at some of the SHP sites. Although fishing is not the main source of income for the local population, the interventions make the work of fishermen much more difficult at certain sites, for example where they have to avoid certain river sections.

National standards – e.g. for fish ladders – have been lacking since the beginning of the programme and there is no monitoring or enforcement of minimum ecological flows by the authorities. Improved coordination with the Ministry of the Environment during the programme appraisal or more stringent requirements would have reduced the negative environmental effects of the programme from the outset. Significant improvements in environmental sustainability could not be achieved in the first two phases.

Inappropriate working conditions, such as poor or non-existent health and safety standards in many SHP plants, poor fire safety, and a lack of safety fences to prevent accidents, must also be regarded as unintended negative effects of the project.

Besides the negative effects, some positive effects were also identified during the evaluation. The programme triggered an important and constructive debate on environmental impacts, the establishment of standards and the technical quality of SHP in Armenia. Today, Armenia leads the way in the Eurasian Union's initiative for technical standardisation and SHP regulation. What is more, the programme promoted the general professionalisation of the banking sector, as confirmed in the interviews. Furthermore, the knowledge gained from consulting and training on the evaluation and modelling of infrastructure financing can also be used by banks in other SME financing programmes.

Overall, it remains clear that the programme has provided significant impulses for the development of renewable energies (in particular SHP) and is generating positive climate impacts. The initiation of a constructive environmental debate and the creation of greater awareness of technical quality standards are seen as positive developments. The project has also contributed to the professionalisation of the banking sector, which benefits other sectors too. In view of these positive effects, the programme impact is still considered satisfactory despite the obvious shortcomings. The ecological deficits are included in the assessment of sustainability, which also comprises environmental sustainability.

Impact rating: 3 (both phases)

[1] The planning process should include the following steps:

I. Definition of standards for fish ladders and residual water volumes

II. Investigation of the fish population at the respective SHP plants

III. If migratory fish are present, identification of the lead fish to determine the volume of residual water and design the fish ladder

Sustainability

The programme was profitable for the partner banks, which demanded a margin of up to 5% for the forwarding of GAF loans to investors. In addition, the partner banks benefit from cross-selling of other products to SHP investors as well as from portfolio diversification. Following good experience in phase I and/or II, partner banks are generally interested in continuing to co-finance other renewable energy projects – especially as they cannot provide long-term local currency financing for renewable energy without funding via the GAF or international financial institutions.

The interviewed investors described their investments as profitable. These qualitative statements are not necessarily in line with the example calculations for dynamic production costs though, nor with their comparison with the feed-in tariffs received (DPC = EUR 0.03-0.065/kWh, tariff = ~EUR 0.048/kWh). For the majority of investors, the tariffs for small hydropower production are able to support long-term, financially viable operation only if tariffs continue to increase by 4.4% p.a. (as has been the case over the last 4 years on average). This assumption is associated with high risks, however, as tariff increases are exposed to significant political influence.

A measurement campaign conducted as part of the complementary measure revealed that many of the built-in turbine generator units have efficiencies that are not in line with international standards and have low efficiencies for full load and particularly for partial load conditions. The low utilisation of the available hydropower potential at some of the SHP sites investigated results in low plant efficiency, which reduces the viability of these SHP plants and negatively impacts technical sustainability. Workshops on improving long-term SHP operation and plant maintenance in the context of the complementary measure have only absorbed this impact to some extent. There is a clear trade-off between purchasing local products in local currency or using international turbines at higher prices in foreign currency.

Overall, the environmental sustainability of the programme is insufficient in both phases. To make improvements, fish populations across the country (particularly for migratory fish species) would have to be examined more thoroughly, and national standards and regulations on ecological residual water volumes and fish ladders would have to be defined and applied to all SHP plants (run-of-river and pumped-storage power plants) for both new builds and rehabilitations. A functioning control system would be necessary as a basis for enforcing environmental and socially affordable standards and for ensuring that non-compliance with the standards is consistently followed up with sanctions (e.g. fines or the withdrawal of water-use licenses). In view of the hitherto insufficient regulatory influence of the Armenian authorities, the financing banks should provide for stronger links between the financing of SHP and the requirements and implementing provisions for improving the ecological situation.

In summary, at the financial-sector level, the provision of long-term local currency loans for private investment remains dependent on long-term funding in local currency via the GAF and therefore via international financial institutions. At the SHP level, financial sustainability is not guaranteed without restriction and the viability of SHP plants is reduced by low plant efficiency. In addition, there are no signs that the negative ecological effects will be promptly eliminated. The sustainability is therefore assessed as inadequate.

Sustainability rating: 4 (both phases)

Notes on the methods used to evaluate project success (project rating)

Projects (and programmes) are evaluated on a six-point scale, the criteria being **relevance, effectiveness, efficiency** and **overarching developmental impact**. The ratings are also used to arrive at a **final assessment** of a project's overall developmental efficacy. The scale is as follows:

Level 1	Very good result that clearly exceeds expectations
Level 2	Good result, fully in line with expectations and without any significant shortcomings
Level 3	Satisfactory result – project falls short of expectations but the positive results dominate
Level 4	Unsatisfactory result – significantly below expectations, with negative results dominating despite discernible positive results
Level 5	Clearly inadequate result – despite some positive partial results, the negative results clearly dominate
Level 6	The project has no impact or the situation has actually deteriorated

Rating levels 1-3 denote a positive assessment or successful project while rating levels 4-6 denote a negative assessment.

Sustainability is evaluated according to the following four-point scale:

Sustainability level 1 (very good sustainability): The developmental efficacy of the project (positive to date) is very likely to continue undiminished or even increase.

Sustainability level 2 (good sustainability): The developmental efficacy of the project (positive to date) is very likely to decline only minimally but remain positive overall. (This is what can normally be expected).

Sustainability level 3 (satisfactory sustainability): The developmental efficacy of the project (positive to date) is very likely to decline significantly but remain positive overall. This rating is also assigned if the sustainability of a project is considered inadequate up to the time of the ex post evaluation but is very likely to evolve positively so that the project will ultimately achieve positive developmental efficacy.

Sustainability level 4 (inadequate sustainability): The developmental efficacy of the project is inadequate up to the time of the ex post evaluation and is very unlikely to improve. This rating is also assigned if the sustainability that has been positively evaluated to date is very likely to deteriorate severely and no longer meet the level 3 criteria.

The **overall rating** on the six-point scale is compiled from a weighting of all five individual criteria as appropriate to the project in question. Rating levels 1-3 of the overall rating denote a "successful" project while rating levels 4-6 denote an "unsuccessful" project. It should be noted that a project can generally be considered developmentally "successful" only if the achievement of the project objective ("effectiveness"), the impact on the overall objective ("overarching developmental impact") and the sustainability are rated at least "satisfactory" (level 3).