Thailand - Improvement of Power Transmission and Distribution

Ex post evaluation report

OECD sector	23040 - Electricity transmission and distribution	
BMZ project ID	1992 65 687	
Project executing agency	Provincial Electricity Authority (PEA)	
Consultant	CES Consulting Engineers Salzgitter	
Year of ex post evaluation	**2006**	
	Project appraisal (planned)	**Ex post evaluation (actual)**
Start of implementation	12/1992	03/1995
Period of implementation	51 months	65 months
Investment costs	EUR 163.2 million	EUR 114.0 million
Counterpart contribution	EUR 111.3 million	EUR 61.1 million
Financing, of which Financial Cooperation (FC) funds	EUR 29.8 million	EUR 29.8 million
Other institutions/donors involved	World Bank	World Bank
Performance rating	2	
• Significance/relevance	2	
• Effectiveness	2	
• Efficiency	3	

Brief description, overall objective and project objectives with indicators

The programme comprises the construction of 16 115/22 kV transformer stations in the north and northeast of Thailand, their connection via 16 115/22 kV aerial lines of a total length of around 900 km to the national integrated grid of EGAT and the connection of the transformer stations on the low-voltage side to the existing regional 22 kV distribution networks that were previously supplied from neighbouring transformer stations. The existing connection points and supply lines had reached the limits of their load-bearing capacity. The measures were aimed at contributing to an improved, adequate, safe and cost-effective electricity supply in the programme provinces. The total cost of the programme was EUR 114 million. The foreign currency costs of the 16 substations and consulting services were financed by an FC composite loan of EUR 29.8 million.

The project executing agency was the Provincial Electricity Authority (PEA). The state-owned enterprise was established in 1960 and is in charge of the national power distribution outside the Bangkok metropolitan area. PEA serves 73 provinces and covers 510,000 km^2, almost 99% of the country. PEA is divided into 4 administrative regions (north, northeast, central and southern), which are made up of 3 districts each and are run by 905 branch offices. The PEA headquarters is located in Bangkok. In mid-2006 a total of 20,784 employees were working in the 12 district administrations (1990: around 27,000 employees) while 4,200 were working at the headquarters.

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Programme design / major deviations from the original programme planning and their main causes

The project comprised the construction of 16 115/22 kV outdoor transformer stations with a total transformer capacity of 550 MVA (object of financing), the construction of around 900 km of 115 kV double lines in single configuration, the connection of the transformer stations to the existing 22 kV grids and consulting services (object of financing).

During the implementation of the project, minor conceptual changes turned out to be advisable: (i) Of the eight Type A transformer stations originally planned in a reduced size, five were changed to the more complex category Type B which is easier to expand at a later stage. (ii) The three Type C transformer stations originally planned were fitted with a second row of 22 kV switch cabinets on the basis of revised load forecasts, so they had 15 instead of eight 22 kV switchboard sections. (iii) All 16 transformer stations were additionally fitted with 22 kV indoor capacitor banks for reactive power compensation and a computerised switchboard control system (CSCS) with a computer-based workplace. (iv) The overall length of the 115 kV lines had to be extended from 863 km to around 900 km on the basis of the final line layout.

The topography did not pose any problems for the 16 transformer stations. PEA acquired 16 plots for the stations with a total area of 36.4 ha; these plots are large enough for subsequent enlargements of the stations without the need for additional land acquisition. In accordance with long-standing practice, PEA obtained the easement for the construction of the 115 kV concrete poles from the Highway Department at no charge. The poles were erected alongside public roads with a clearance of 5 m. Problems arose only on a 36.4 km section of the "Chiang Rai 1 - Fang" line, which crosses a protected forest area. Lengthy environmental impact assessments and approval procedures delayed the start of construction on the "Mae Suai Junction – Fang" subsection until mid-2005. PEA expects the connection of the Fang transformer station to the EGAT integrated network to be completed by 2007 at the latest.

The design of the project, which was based on standard conceptions successfully implemented in Thailand, was appropriate. More favourable alternatives were not available. All components are properly aligned and well-adapted to the local conditions. All transformer stations were completed by 11 July 2000 and accepted by PEA. Since mid-2001 a total of 15 stations have been connected to the nationwide integrated power grid; the 115 kV connection line of the Fang transformer station, which so far has been used only to control load flows in the local grid, will be completed by 2007. The measures have provided 16 fully functioning transformer stations connected to the EGAT integrated network; they supply electricity reliably to the local grids which have a total length of 14,022 kilometres and supply 937,490 customers.

Key results of the impact analysis and performance rating

The programme objective was to provide sufficient safe and cost-efficient energy and capacity to meet the demand for electricity in the programme areas. The overall objective was to utilise the electricity for productive and consumptive purposes in order to contribute to the development of the areas supplied by the new transformer stations. The target group of the project is primarily composed of the productive power consumers in the programme regions, although it also benefits private electricity consumers.

The indicators for the achievement of the programme objective were: (i) to maintain the voltage level within international tolerance limits of +/- 5% after completion of the new 115/22 kV transformer stations; (ii) utilisation of 20% of the transformer capacity on average after entry into operation (1997) and roughly 40% on average two years later; (iii) no overload-related power cuts in the programme regions between 1996 and 2000 and reduction of the failure-related power down times to half.

The following indicators were to measure the achievement of the overall objective: (i) rise in annual electricity sales in the programme regions by an average of 5% - 8%; (ii) share of productive electricity use in the electricity provided at the various locations between 40% and 60% (51.6% on average); (iii) cost recovery from tariffs of at least 100% for the overall programme.

Measured by the indicators, the programme objective was clearly achieved. Random samples taken during the ex-post evaluation confirm reports by PEA stating that the deviations from the nominal voltage in the supplied areas usually lie within international tolerance limits. In regions where the

growing demand for power has already led to considerable strain on the networks, however, particularly in peak load times, variations in voltage and frequency may occur that exceed the limits of tolerance. Measures designed at enhancing the resistance and stability of these networks are planned or have been initiated. The strong increase in demand in the programme regions is also apparent in the utilisation of the transformer station capacities. Station transformer capacity utilisation in 2005 was just under 70% (weighted average). At some locations capacity utilisation even reached 100%. Power supply security also increased in the programme regions. According to PEA, overload-related power cuts have not occurred anymore. At the same time, the frequency and duration of power cuts have declined significantly. It can be concluded plausibly from the number of random samples taken that the duration of power cuts in most of the areas supplied has dropped by over 50%; the number of power interruptions has also dropped noticeably. It can be said in conclusion that all three indicators for programme objective achievement have been satisfactorily fulfilled.

With regard to the indicators for the overall objective, the situation is as follows: Since the transformer stations went into operation power consumption in the area supplied by the programme grew by an annual 5.2% on average while the share of productive electricity utilisation increased from 58.2% to 62.1%. The first two criteria for the achievement of the overall objective have thus been fulfilled. Cost recovery is likely for the overall programme as the project is partly financed by cost savings from power purchases, so that only a minor deficit must be covered by current revenues. Strictly speaking, however, the project fails to meet the cost recovery criterion as the rate of cost recovery from electricity sales revenues in the area supplied by the project is only between 90% and 95%. The fact that the power tariffs charged by PEA, which are the same across the country, are not financially viable in the north and north-east provinces is a structural problem. Cross-subsidisation in favour of private households and agriculture, which is part of the tariff system, works across the country but generates deficits at the provincial level if the share of power consumed by groups of customers needing subsidies is relatively high, as is the case in the programme regions, and the power supply is comparatively expensive given the low density of customers and consumers. Cross-subsidisation through the power tariff system between groups of customers and regions is a political requirement which PEA must meet. What counts for PEA is that it operates as an enterprise at full cost recovery on a consolidated basis, which has been the case in the past years. Demanding that it achieve 100% cost recovery specifically in the programme regions as well would not seem to be very practicable in our view because the PEA regional offices are not (yet) economically independent units.

At the time of project appraisal the programme was expected to yield an internal rate of return of 12.4% annually. The cost recovery rate of the overall programme was estimated to reach 115%. It was clear that deficits expected at individual locations would have to be financed by surpluses generated at other locations.

From today's perspective the benefits of the project as an individual economic unit present themselves as follows. The immediate benefit which PEA draws from the project consists in the fact that the cost of electricity purchased from EGAT at 230/115 kV hubs and its transmission through proprietary 115 kV lines is considerably lower than purchasing electricity at the end of a 115 or 69 kV line. Given the current wholesale rates, savings amount to around THB 168/MWh (EUR 3.49/MWh). This advantage must be weighed against the investment and operating cost of the transformer stations and the relevant infrastructure such as the 115 kV aerial lines. Given the timing of the investment costs (EUR 104.15 million without financing costs) and under the assumption that the annual operating and maintenance expenditure will amount to 2% of the investment costs (25 years), the programme would generate a return of just under 3.2% through cost savings from the purchase of electricity alone. This means that if a discount rate of 3.2% were applied the dynamic project-related production costs would be covered by the avoided expenditure on electricity purchases (cost neutrality of the project).

The savings from electricity purchases are no longer cost-covering if the costs and electricity quantities purchased are discounted at a higher rate than 3.2%. We consider the fact that the internal rate of return of the project is below the minimum threshold of 6.0% required for external support to be a drawback. At 6.0% the project-related production costs at current prices would be EUR 4.74/MWh (THB 228/kWh). The deficit of THB 60/MWh (= 228 - 168) would have to be financed from the surplus generated by PEA from electricity sales to the ultimate consumers after deduction of all expenditures (except those connected with the project). If there was no financial scope for this the additional costs would have to be passed on in the form of tariff increases. However, it is plausible to assume that the gross revenues will cover the already low deficit. The average sales proceeds from electricity achieved by EGAT at average costs of around THB 1750/MWh are currently just under 3,000 THB/MWh in the project areas. We estimate that the difference between proceeds from electricity sales and the

purchase price of THB 1250 is high enough to finance not only the electricity distribution costs on the low-voltage side (= 22 kV) and grid losses - after deduction of any subsidies from the PEA headquarters - but also the uncovered project costs of THB 60/MWh.

The overall economic benefit of the programme was not assessed at the time of project appraisal. There was only a comparison with alternatives which showed the project as being the most cost-effective solution. As the FC-financed project was an integral part of the cost-efficient expansion planning for the electricity sector we still consider it, from this perspective, to be of benefit to the economy overall.

Moreover, two further considerations underscore the overall economic benefit of the programme: The programme has enabled the electricity supply company to provide additional electricity to the consumers, and the supply has become more reliable. Both benefits are assessed by other consumers' willingness to pay the tariffs. On the basis of the average tariff which is currently being paid in the areas supplied (THB 2.96/kWh), it is fair to conclude that the customers would be willing to pay least an additional THB 0.27/kWh for the supply of an additional kWh (incremental willingness to pay). The same assumptions suggest that the consumers would be willing to pay up to THB 7.4/kWh for avoided power interruptions, which would result in an overall economic net benefit of around THB 5.5/kWh after deduction of the power acquisition costs paid by PEA. With regard to electricity supply security, we assume that the project will reduce the duration of power cuts by 48 hours per year and customer. It follows from this conservative assessment of benefits, and in consideration of the costs of the project as an economic unit, that the overall economic profitability of the programme would be just under 12%.

The immediate employment impacts of the project were limited to the short-term employment of up to 482 local workers. The programme has indirectly contributed to preserving existing and creating new jobs in manufacturing, trade and agriculture by providing reliable additional, cost-effective electrical energy used mainly productive for productive purposes. It generally helps to reduce poverty at the macro and sector level.

The project did not pursue the objective of protecting the environment or natural resources. The immediate negative environmental effects of the construction measures and land consumption of the project were insignificant or, in the case of the Fang transformer station, which was connected to an aerial line that crosses a conservation area, proved to be tolerable. The customary environmental protection and accident prevention requirements are being complied with for the transformer stations.

The risks of insufficient electricity supply from the EGAT integrated network and of delays in the expansion of the distribution networks on the part of the PEA, which were mentioned in the programme appraisal report, did not occur. Nor did the risk of excessively low electricity consumption materialise. The final section of the 115 kV connecting line belonging to the Fang transformer station is under construction so that the station will be fully operational by early 2007 at the latest. The transformer stations are operating without any major disruptions and capacity utilisation is higher than expected. The risks to sustainable project success can therefore be rated as minor.

In a summarised evaluation of the above aspects we rate the overall developmental efficacy of the programme as follows:

Effectiveness:

The programme objective was to provide sufficient safe and cost-efficient energy and capacity to meet the demand for electricity in the programme areas. The indicators for the achievement of the programme objective were: (i) to maintain the voltage level within international tolerance limits of +/- 5% after completion of the new 115/22 kV transformer stations; (ii) utilisation of 20% of the transformer capacity on average after entry into operation (1997) and roughly 40% on average two years later; (iii) no overload-related power cuts in the programme regions between 1996 and 2000 and reduction of the failure-related power down times to half. Measured by the indicators, the programme objective was clearly achieved. Random samples taken during the ex-post evaluation confirm reports by PEA stating that the deviations from the nominal voltage in the supplied areas usually lie within international tolerance limits. In regions where the growing demand for power has already led to considerable loads being carried by the networks, particularly in peak load times, however, variations in voltage and frequency may occur that exceed the limits of tolerance. Measures designed at enhancing the resistance and stability of these networks are planned or have been initiated. The strong increase in demand in the programme regions is also apparent in the utilisation of the transformer station capacities. Station transformer capacity utilisation in 2005 was just under 70% (weighted average). At

some locations capacity utilisation even reached 100%. Power supply security also increased in the programme regions. According to PEA, overload-related power cuts have not occurred anymore. At the same time, the frequency and duration of power cuts have declined significantly. It can be concluded plausibly from the number of random samples taken that the duration of power cuts in most of the areas supplied has dropped by over 50%; the number of power interruptions has also dropped noticeably. Overall, we rate the effectiveness of the project as satisfactory (rating 2).

Relevance/significance

The overall objective was to utilise the electricity for productive and consumptive purposes in order to contribute to the development of the areas supplied by the new transformer stations. The following indicators were to measure the achievement of the overall objective: (i) rise in annual electricity sales in the programme regions by an average of 5% - 8%; (ii) share of productive electricity use in the electricity provided at the various locations between 40% and 60% (51.6% on average); (iii) cost recovery from tariffs of at least 100% for the overall programme. As measured by its indicators, the overall objective of the programme was achieved. The increase in demand for electricity matched the predictions. Productive use of electricity in the project area is over 60% on average. Moreover, it can be plausibly assumed that the tariff revenues cover the cost of the overall programme. Consequently, the overall objective of supporting the development in the supplied areas by providing electrical energy that is mainly used for productive purposes was achieved to a satisfactory degree. Overall, we classify the project's developmental relevance and significance as satisfactory (sub-rating 2).

Efficiency

The programme represented a technically balanced and effective solution for improving the supply of electricity to which a more cost-effective alternative was unavailable. The costs of the programme remained within an acceptable range. The internal rate of return of the project is positive at 3.2% but below the minimum support threshold which is set at 6.0%. We rate the production efficiency as sufficient. All in all, the project is a financially worthwhile investment for the executing agency. The benefit of the programme for the overall economy is also sufficient to justify its costs (allocation efficiency). Overall, we rate the project's efficiency as adequate (sub-rating 3).

In a summary assessment of the above impacts and risks, we judge the developmental efficacy of the project to be satisfactory **(overall rating 2)**.

General conclusions and recommendations

Investment projects in the electricity sector can unfold their developmental impacts on a sustainable basis when they are implemented in a sector environment in which the sector performance is satisfactory (operational appraisal criteria as benchmark).

Assessment criteria

Developmentally successful: Ratings 1 to 3	
Rating 1:	Very high or high degree of developmental efficacy
Rating 2:	Satisfactory developmental efficacy
Rating 3:	Overall sufficient degree of developmental efficacy
Developmental failures: Ratings 4 to 6	
Rating 4:	Overall slightly insufficient degree of developmental efficacy
Rating 5:	Clearly insufficient developmental efficacy
Rating 6:	The project is a total failure.

Performance evaluation criteria

The evaluation of the "developmental effectiveness" of a project and its classification during the ex-post evaluation into one of the various levels of success described in more detail below concentrate on the following fundamental questions:

- Have the **project objectives** been achieved to a sufficient degree (project **effectiveness**)?

- Does the programme generate sufficient significant **developmental effects** (project **relevance and significance** measured in terms of the achievement of the overall developmental policy objective defined beforehand and its effects in political, institutional, socio-economic and socio-cultural as well as ecological terms)?
- Are **the funds/expenses that were and are being employed/incurred appropriate** with a view to achieving the objectives and how can the programme's microeconomic and macroeconomic impact be measured (**efficiency** of the programme design)?
- To the extent that undesired **(side) effects** occur, can these be tolerated?

We do not treat **sustainability**, a key aspect to consider when a project is evaluated, as a separate evaluation category, but rather as an element common to all four fundamental questions on project success. A project is sustainable if the project-executing agency and/or the target group are/is able to continue to use the project facilities that have been created for a period of time that is, overall, adequate in economic terms, or to carry on with the project activities independently and generate positive results after the financial, organisational and/or technical support has come to an end.