Ex post evaluation – Sri Lanka

Sector: Electricity transmission / distribution (23040)
Project: Electricity distribution in Greater Colombo (BMZ No. 1999 66 698)*
Implementing agency: Ceylon Electricity Board (CEB)

Ex post evaluation report: 2018

		Planned	Actual
Investment costs (total)	EUR million	88.98	53.24
Counterparty contribution	EUR million	47.05	11.32
Financing (development loan)	EUR million	41.93	41.92

*) Random sample 2016

Summary: The project included (i) the construction of two 132kV/33kV and two 132kV/11kV substations in Sri Jayawardenapura, Dehiwala, Marandana and Havelock Town, each with two 31.5 MVA transformers, and (ii) the connection of the substations to Colombo's 132kV municipal network by building a 15-km long 132kV underground cable system with integrated fibre optic cables and (iii) consulting services during planning and implementation. The project closed the 132 kV ring and helped to fulfill the n-1 criterion which is necessary to ensure the security of the supply of electricity as supply is guaranteed even if one system component fails. The remaining funds were used to finance a new 33 kV switchboard plant and two 132 kV/33 kV transformers with 31.5 MVA each in the Kotugoda transformer station, and consulting services (supplementary measure).

Development objectives: The overarching development objective (impact) of the project was to contribute to the economic development of Sri Lanka through an economically efficient and cost-covering supply of electricity.

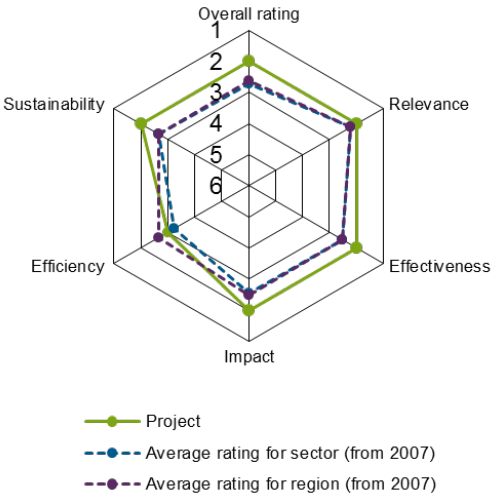
The aim of the programme (outcome) was to meet the increasing demand for electricity in Colombo from the national grid from 2001 and 2002 respectively.

Target group: The industrial and commercial enterprises, administrations, shops, hotels, banks, hospitals, embassies, ministries and the population living in the Colombo area.

Overall rating: 2

Rationale: The project had a positive impact and was an important prerequisite for meeting the sharp increase in electricity demand in the greater Colombo area since 2006. Thus the project has significantly supported the economic growth of the last decade. Operation and maintenance are carried out by qualified personnel at a high level. Weak points included the four-year delay in completion and the use of incompatible data protocols for communication with the control centre. The communication problems were resolved in 2017 by connecting to a new control centre.

Highlights: --



Rating according to DAC criteria

Overall rating: 2

Ratings:

Relevance	2
Effectiveness	2
Efficiency	3
Impact	2
Sustainability	2

Relevance

Between 1983 and 2009, Sri Lanka found itself in the grip of an armed conflict - predominantly affecting the north and east of the country - between the government and Tamil separatists; this ended after more than 25 years with a military victory for the government troops. The location of the present project - the capital city of Colombo in the west of the country - was scarcely affected by this civil war, and thus it was conceptually appropriate to give no special consideration to the conflict in the project design.

With the objective of reliably covering the rapidly rising demand for electricity in the greater Colombo area from the national grid, the project drew on an important development bottleneck to support economic growth in the dynamic centre of Sri Lanka. The project did not target generation capacity, which, at the time of the project appraisal (PA) in 1997, appeared appropriate as generation capacity seemed to be guaranteed in the medium-term: the power plant capacity of 1,697 MW in 1997 was offset by a peak load of 1,037 MW. With support from other donors, new capacity with a total output of 363 MW was installed between 1997 and 2002. Consequently, the project was rightfully geared to ensuring an efficient and more reliable supply to the target group in Colombo by addressing the still inadequate transformer and transmission capacities and completing the 132 kV ring to increase the stability of the power supply. Together, secure power generation and the project's goal of eliminating the bottleneck at an important interface between transmission and distribution had the potential to reliably cover the rising demand for electricity (outcome) and thus contribute to economic development through ensuring an efficient electricity supply (impact). The prerequisite for a **cost-covering** electricity supply - that had also been required as part of the overarching objective and which is important for providing incentives for allocation-efficient power consumption - cannot be directly influenced by the project; rather, the target achievement depends on sector policy. Overall, the intervention logic is coherent.

The installed capacity of the power station increased by around 130 % from 1,697 MW at the PA to around 3,900 MW (2016); electricity sales actually increased 220 % in the same period, from 4,039 GWh to around 13,000 GWh. The reasons for these changes were the strong economic dynamism of the country and the increase in the electrification rate from 48 % to a remarkable 99 % in 2015. In fact, the demand for electricity in Colombo has actually increased by around 300 % since 1997. The relevance of the project has thus remained high over time.

The project was well integrated into the country's national planning as well as contributions from other donors. It has targeted a very important part of the electricity sector and has already been supplemented by the CEB from its own funds in recent years through further investment in additional 31.5 MVA transformers and corresponding feeders at three out of four locations. This last point highlights the alignment of the project with the partner's priorities.

At the time of the appraisal, the energy sector was the focus of German-Sri Lankan cooperation and was thus in line with the development priorities of German Development Cooperation (DC) and of the Sri Lankan government. The project remains coherent with Sri Lankan development plans. Overall its relevance can be considered good.

Relevance rating: 2

Effectiveness

The project objective (outcome) was to cover the rising demand for electricity from the national grid in the greater Colombo area from 2001 and 2002 onwards respectively. The target achievement was measured by the evaluation using the following indicators:

Indicator	Status PA	Ex post evaluation
(i) Transmission peak power (MW) and output (GWh p.a.) in the project substations	PA: at the time of the PA, steadily increasing target values were defined for the years following connection of the system. (see table below)	Taken together, the actual and target figures for the indicators were very similar. Deviations (up and down) of the individual substations are equaled out over all of the substations. The indicator is considered largely fulfilled. (see table below)
(ii) Transmission losses	17.7 % (2004) Indicator added ex-post	The indicator is fulfilled: 9.6 % (2016)

Development of peak load and output of financed substations

	Forecast for peak load in MW for 5 / 9 / 10 (2016) years after start of operation	Actual value for peak load in MW for 5 / 9 / 10 (2016) years after start of operation	Forecast for electrical work in GWh for 5 / 9 / 10 (2016) years after start of operation	Actual value for electrical work in GWh for 5 / 9 / 10 (2016) years after start of operation
Sri Jayawardenapura	47 / 61 / 63	43 / 46 / 56	247 / 321 / 331	262 / 118 / 342
Dehiwala	57 / 60 / 62	41 / 49 / 50	300 / 305 / 315	193 / 217 / 220
Maradana	33 / 39 / 40	29 / 57 / 61	160 / 186 / 194	122 / 181 / 191
Havelock Town	27 / 34 / 40	43 / 54 / 56	132 / 164 / 191	178 / 238 / 241
TOTAL	164 / 194 / 205	156 / 206 / 223	839 / 976 / 1031	755 / 754 / 994

(i) With an operating period of more than 10 years (commissioning in 2006) without significant disturbances or failures and with a strong increase in electricity demand in Colombo, it can be seen from the table that the output from the substations has steadily increased. This was verified based on the documents available in the substations. Due to problems with the SCADA system (Supervisory Control and Data Acquisition), the data have only been presented to the evaluators in excerpts. At the final review in 2013, the actual capacity utilisation of the financed substations was still below the target values set at the PA. At that time, however, the evaluation did not take into account the four to five year delay in commissioning. In the interim, consumers from the original supply area of the FC-financed substations were expediently connected to other substations, which initially reduced the utilisation of the financed stations. Taking into account the delays in completion and in the forecast values, and adding up the values of all substations, the peak load indicator is 9 % above target, while the output indicator fell just short of the target at 3.6 %. The two smaller substations in Maradana and Havelock Town are significantly above the target levels (30–40 % above plan), while the two larger substations in Sri Jayawardenapura and Dehiwala are still lagging behind the targets due to the connection of major customers elsewhere following the delays. In

our opinion, the CEB investments in new 31.5 MVA transformers at three out of four substations provide solid confirmation that the utilisation of the substations is appropriate.

(ii) Despite the significant expansion of the supply network, transmission losses were reduced from 17.7 % in 2004 to 9.6 % in 2016. The project has contributed to this by means of (i) the efficient transmission lines into the city at the 132 kV level and (ii) at the medium and low voltage levels. This, in turn, has contributed to the efficient and cost-effective supply of electricity as well as to a tangible reduction of greenhouse gas emissions.

The project measures have significantly improved the quantity supplied to households, public bodies and companies in Colombo (network expansion, increase in connection rate, increase in demand) and the quality (security of supply). Supply shortages that occurred shortly before the evaluation show how important the respective components of the project were for supply in past years; they also demonstrate that, in view of the strong increase in demand, there is a need for additional investment and potentially for further study (protection coordination, network optimisation and modelling).

In summary, we continue to rate the effectiveness of the project as good.

Effectiveness rating: 2

Efficiency

The substations and the ring cable (stable power networks are laid out in circuits so that the supply is guaranteed via the other direction even if there is a cable defect) were put into operation in 2006, with delays of 4 and 5 years, respectively, compared to the original planning. The main reasons for the delays were the delayed signing of the loan- and project contract (1.5-year delay), an increased complexity of the planning for the work on the underground cables and the appeal of one supplier relating to the tender (that was ultimately rejected). Due to bad weather conditions at the start of the project, problems integrating various delivery lots and right of way issues, the project was delayed in the construction phase by a further year. Nevertheless, the costs of the project are well below the estimates: foreign exchange costs (FC-financed) are 15 % lower than planned due to unexpectedly low tender prices, while local costs (counterpart contribution) are actually around 75 % lower (in euros) due to a retroactive tax exemption and a favourable exchange rate. Residual funds from the German side were used for the aforementioned supplementary measure in the Kotugoda substation. It was possible to cushion the delays in the implementation by diverting planned connections to other existing substations.

Although the executing agency recognised the problem of incompatible data protocols between the new stations and the overall system (SCADA) at an early stage, issues such as supplier staff shortages in particular prevented a timely solution. This problem was resolved during the rehabilitation of the network control room in 2017. In short, particularly given the very low costs - and despite the aforementioned delays and compatibility issues - the production efficiency is assessed as satisfactory.

From a macroeconomic point of view, it should be highlighted that the project contributed to (i) reducing nationwide transmission losses from 17.7 % in 2004 to a very good 9.6 % in 2016 and (ii) a nationwide doubling of the electrification rate from 48 % at the project appraisal to a very high 99 % in 2016. In addition, by creating a cable ring at the 132 kV transmission voltage level in Colombo, the project significantly increased the security of supply (n-1 criterion [1] at the high voltage level) in the project region and throughout Colombo. What is more, the project-executing agency also exhibits exceptionally good efficiency figures and, according to its own calculations, a collection rate of almost 100% with only minor payment delays. The CEB achieves these good results by consistently cutting off customers in default and thanks to the high reliability of its staff, as we also observed. By using twisted cables for power distribution and close monitoring, non-technical losses have fallen to such a low level that separate recording is no longer necessary and this data is instead included in total losses. The staff of the executing agency appear to be

[1] The “n-1 criterion” is an evaluation criterion for the probability of default of the power grid on the basis of additionally available capacity (redundancy). In line with the (n-1) rule, if n objects (e.g. lines) are required or available for a task, the other n-1 objects can be used to reliably ensure functionality in the event of failure of an object. The n-1 criterion is important from a climate adaptation perspective. If a line section fails, e.g. due to an extreme weather event, the n-1 criterion ensures that the corresponding delivery point is supplied by another grid section.

well qualified and committed at all levels. Given the high level of power supply overall, the allocation efficiency can be assessed as good. Consistent application of the “least cost” approach will reduce the costs of electricity generation, but this is accompanied by an increasing share of coal-fired electricity (35.7 % in 2016, 0 % in 2012) and should be viewed critically with regard to overarching climate protection considerations.

Restrictions arise given that the cost recovery ratio of the CEB is only just sufficient. The relatively stable, annually adjusted average tariffs equivalent to around 0.12 EUR/kWh stand in stark contrast to the strongly fluctuating costs of electricity generation, which essentially depend on the availability of hydropower stations (hydrology) and coal-fired power stations (technical difficulties) as well as the world market prices of the thermal energy sources coal and oil: the cost recovery ratio of the CEB is therefore subject to average fluctuations at around 100 % (105.8 % in 2013 / 92.6 % in 2014 / 115.5 % in 2015 / 99.6 % in 2016). Given the rising prices for fossil fuels and the relatively weak hydrology, the CEB anticipates declining cost recovery ratios for 2017 and 2018. With fluctuations in the energy mix of between 37 % and 46 % in hydropower, hydrology continues to be crucial to the success of recovering costs. An operating cash flow that is positive every year reliably covers operating costs and, in some cases, new and replacement investments too.

Altogether we assess the efficiency of the project as satisfactory.

Efficiency rating: 3

Impact

The overarching development objective (impact) of the project was to contribute to the economic development of Sri Lanka through an economically efficient and cost-covering supply of electricity. The following indicators were used in the evaluation to verify the achievement of objectives at the impact level:

Indicator	Status PA	Ex post evaluation
(I) Rate of electrification	PA: 48 % (national) Target value: increasing Indicator added ex post	The indicator is fulfilled: 99 % (2016)
(II) Reliability of power supply	PA: unplanned power outages are not uncommon. Indicator added ex post	The indicator is fulfilled. Only 3 unplanned power outages in 2 years (2015–2016).
(III) Share of productive power use and economic growth in Colombo	Status PA: 51% Target value: >60 %	The indicator is fulfilled: productive electricity use: > 63 % Economic growth in Colombo: the greater Colombo area’s share of national economic output increased disproportionately from 45 % in 2008 to 48 % in 2016.
(IV) Economic cost recovery ratio	Target value: > 100 %	The indicator is fulfilled (see below).

(I) The electrification rate in Colombo is now 100 % (data not available at the PA); nationwide, the rate has more than doubled since 1997, from 48 % to 99 %. The project contributed to this by preparing additional connections in Colombo.

(II) The electricity supply in Sri Lanka can be considered reliable by regional comparison. The national supply has been ensured around the clock to date - with the exception of three unplanned power outages in 2015 and 2016 related to system overloads (see Efficiency). By creating a ring and introducing the n-1 criterion (ring network instead of a radial network), the project has contributed to reliable supply of the connected districts. Particularly at the high voltage level and when connecting voltage levels, larger additional investments in network infrastructure are necessary in the medium term to prepare the grid for a higher share of renewable energies and to withstand the continued strong growth in demand for electricity.

(III) The productive use of electricity in Sri Lanka in 2014 was 63 % (as a share of total electricity used). According to the project-executing agency, private use is dominant in rural areas and in medium-sized towns, while the greater Colombo area - the economic, commercial and political centre of the country - sees a higher level of productive use. The indicator can be considered fulfilled. Nevertheless, from today's perspective, the indicator has rather low significance in terms of development policy, especially since the consumption figures of small businesses and of the informal sector are not generally recorded as "commercial". Regardless of the type of use, the establishment of productive users will be promoted above all through a reliable and cost-effective power supply. The above-average economic growth of the greater Colombo area, which would not have been possible without grid expansion, can also be used as a proxy for the contribution of the power grid to economic growth.

(IV) Given the complexity of the causal impact chain, the indicator regarding the macroeconomic cost recovery ratio can only be estimated roughly. In Sri Lanka, the electricity supplier CEB operates with a balanced or slightly negative result, which corresponds to a cost recovery ratio of the CEB of just under 100 %. The investments in the greater Colombo area are subject to particularly intensive use, however, suggesting a higher level of cost recovery in microeconomic terms. This is also evidenced by the high utilisation of the substations (see above) and the related expansion investments by the CEB - both those already carried out and those planned. Experience has shown that macroeconomic cost recovery for energy projects is well above the figure for microeconomic cost coverage. The World Bank expects benefits from the supply and use of electricity of at least USD 1 per KWh in poor countries; for Sri Lanka, this would represent an increase in economic benefit by a factor of eight compared to the generation, transmission and distribution costs at the level of the CEB (although the positive externalities - per kWh - of access to electricity in a richer economy such as Sri Lanka are likely to be lower). In any event, we know that stability of access - which is the primary objective of the project - is important for the development of these positive effects.[2]

In particular, the dynamic economic development in the project region and throughout Colombo would not have been possible without the project: many new and still-under-construction housing complexes, administrative buildings, commercial and industrial operations as well as the increased demand from existing consumers could not have been supplied without the project. Unfortunately, more detailed data on the area supplied is not available. In addition, had it not been for the project, supply security at times of system overloads would be significantly lower than it is today. Consequently, the project has been an important prerequisite for economic development in Sri Lanka in recent years. Based on an average nationwide increase in economic output of 6 % p.a. since the end of the civil war, the greater Colombo area has become even more attractive, increasing its share of national economic output through disproportionate growth from an already high output level of 45 % in 2008 to 48 % in 2016, representing a growth rate equivalent to almost 7 % p.a. The extent to which the investment could have been made from the region's own resources cannot be stated conclusively: from today's perspective, however, it seems certain that the huge successes in the sector (doubling the network and halving losses, etc.) would not have been possible without external financial support.

Overall, the project has a good developmental impact.

Impact rating: 2

[2] "Samad, Hussain; Zhang, Fan. 2016. Benefits of Electrification and the Role of Reliability: Evidence from India. Policy Research Working Paper; No. 7889. World Bank, Washington, DC. © World Bank.

Sustainability

The CEB has technically well-qualified and - as far as could be seen during the mission - motivated staff at all levels, which is also reflected in the low rate of staff turnover (< 5 % p.a.) and very good operational performance indicators, among other things. This also explains the good condition of the substations visited as well as of the reference station visited not financed under the program. All the necessary replacement investments, maintenance work, technical adjustments and even additional investments to increase transformer capacities have been expertly carried out by the CEB. The systems operate with a high degree of reliability, and a largely standardised design across the entire power grid allows for components to be exchanged with one another where necessary. For some system components, however, it would be desirable to maintain larger stocks of spare parts in order to respond more quickly to outages without having to factor in delivery times and in order to maintain a high level of supply security. According to the executing agency, the repair of a cable fault that occurred in April 2016 was completed within three months. The alignment of the protocols for automatic communication between the substation and the network control room took place as part of the network control room modernisation in 2017.

The three nationwide power outages in 2015 and 2016 were related to unfavourable hydrological conditions, cooling problems at the only coal-fired power plant and bottlenecks in the high-voltage grid of the CEB. In the medium term, insufficient capacity, particularly in the transmission network, is jeopardising the successes achieved. Without forward-looking investment, this may lead to further system overloads at bottlenecks. The associated damage for households, businesses and public utilities that have become accustomed to a reliable supply at the level of quality of that of an industrialised country would be high - if, for example, cooling chains or industrial processes are disrupted or if there is a reduction in the efficiency of administrative work due to a lack of computer access. The efforts by the CEB to date have thus far led to no new substantial failures being reported in 2017. From a medium-term perspective the current investments are not yet sufficient, particularly when it comes to aligning the high-voltage grid of the CEB with the expected growth rates and guaranteeing the high reliability of supply in the future. In this context, a comprehensive and long-term grid expansion planning study would be beneficial in order to maximise the impact of planned investments. This would, however, require an updated network modelling and protection coordination study in order to define the expansion planning precisely.

The current practice, whereby donors provide concessionary loans for specific investments, makes integrated long-term investment planning difficult. This, along with the fact that many donors have focused only on renewable energies, has led to certain bottlenecks in the Sri Lankan network infrastructure (particularly at the high voltage level) which limit supply reliability and have even contributed to the nationwide blackouts mentioned above. To be able to maintain the high level of supply security - not least as an important location factor for industry and economic growth - coordinated planning as well as rapid and comprehensive investment in the areas of power plant connection, high-voltage transmission and network infrastructure are required. The competent public administration and the equally competent CEB have recognised the problems and are developing a concrete investment program to remedy them. The speed with which investments are implemented may depend on the financial markets. In this context, a strengthening of the CEB’s financial situation would be desirable to be able to reliably carry out the investments in the transmission network and in the area of electricity generation which are required for further growth - irrespective of donor preferences or political orientation - thus giving the CEB greater flexibility in the selection and implementation of projects.

Overall, Sri Lanka has set very high targets for itself with regard to the electricity sector, corresponding to the level of supply in industrialised countries. We rate the sustainability of the project as good despite the criticisms mentioned above.

Sustainability rating: 2

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).