

FY 2008 CDM/JI Feasibility Study (FS) Programme Report

CDM Feasibility Study for the Introduction of High-Efficiency Electric Transformers in the Electric
Transmission & Distribution Grid of Ho Chi Minh City

Executive Summary

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Mitsubishi UFJ Securities, Co. Ltd.

Summary of CDM Feasibility Study for the Introduction of High-Efficiency Electric Transformers in the Electric Transmission & Distribution Grid of Ho Chi Minh City

1. Basic Elements for the implementation of the Project

(1) Location of Project Activity

Ho Chi Minh City, Vietnam

(2) Summary of the proposed project and background of the project proposal

The purpose of the project activity is to improve energy efficiency of electric transformers installed in electric transmission and distribution grid of Ho Chi Minh City by cooperating with Ho Chi Minh Power Company (HCMPC). The project activity shall contribute to the reduction of greenhouse gas emissions by reducing the amount of atmospheric emissions from thermal fossil fuel-fired power stations, to optimization of the use of energy resources as well as to the improvement of thermal environment and safety in metropolitan area. The Project yields an average yearly emission reduction of 3,213 tonnes CO₂ equivalent (tCO₂e). This Study also examined that the effect of potential reduction is expected to reach the dozens of times the project level when it is developed into comprehensive framework by Vietnam Electricity (EVN).

The Project is recognized as a co-benefiting project that achieves both the aspects of environmental and safety improvement as well as greenhouse gas reduction by promoting the rehabilitation of existing power distribution grid. In addition, it contributes to a substantial increase in the power supply by efficiency improvement with neither the increase nor the repair of the power generation facilities and it is an effective project to prevent environmental deterioration caused by constructing new power plant as well as increase of fossil fuel consumption.

2. Study Contents

(1) Study Subjects

There are four primary study subjects that should be clarified for implementing the Project under the CDM procedure as follows.

- Confirming the intention of Ho Chi Minh Electric Power Company (HCMPC)
The power distribution grid in Ho Chi Minh City has been expanded since HCMPC

was established more than thirty years ago. The power transmission loss reaches as much as 50% in aging part of the grid. The load loss and no-load rates of existing transformers, which are key devices in power distribution system, are significantly higher than the present Vietnamese standard and are required to improve their efficiency.

The current economical growth has, however, resulted in 10% increase of power demand every year, leading to investments in installation of new facilities rather than in replacing aging equipment. One of the most important subjects was, therefore, to provide incentives for HCMPC to promote the project.

- The production structure of amorphous transformers in Vietnam
The amorphous transformers which are considered for installation in the project activity have yet to be produced and sold in Vietnam. In adopting this new technology, instead of relying on imported products, domestic production is envisaged as a necessity in order to for Vietnam to continuously develop, create employment and strengthen price competitiveness. To enable technology transfer, it was necessary in the Study to clarify the outstanding uncertainties and issues, such as acceptance mechanism by Vietnamese manufacturers and securing import routes with the cooperation of Hitachi Metals Ltd. which has the world's largest share in amorphous metal supply.

- Identifying the baseline scenario
The identification of the baseline scenario is important when determining the CDM potential and the presence of an incentive. Although the fact that the distribution loss caused by the ageing existing facilities is problematic had already been grasped at the time of starting the Study, the methodology stipulates that the baseline in case the project plan includes new equipment or modification shall be the performance based on the relevant law or standards. For this reason, the possibility of being unable to obtain specific data had been feared.

- Formulating the project plan (scenario)
Implementation of the Project in relatively large scale is necessary in order to secure an incentive as a CDM project as well as to build a new production system of transformers. The number of new transformers installed on yearly basis was already known before the conception of the Study, however, consideration of emission reduction and financial

feasibility had been conducted based on assumptions made on uncertain aspects and therefore, clarification of such uncertainties was the issue.

(2) Study Implementation Framework

Energy Conservation Center of Ho Chi Minh City (ECC):

- Coordination with Ho Chi Minh City Power Company (HCMPC), another collaborator for technology transfer and Electrical Equipment Manufacturing Company (EEMC)
- Collection of information including current situation in Vietnam and standards.
- Analysis of impacts and financial feasibility of the installation of amorphous transformers.

Hitachi Metals, Ltd.

- Providing information on characteristics and performance of amorphous metal.
- Providing technical training to transformer manufacturers in Vietnam on transformer production using amorphous metal core.
- Cooperation on analysis and consideration required in the Study in the areas of technology, profitability and efficiency, taking advantage of the existing production and sales system of amorphous core products that meet the demands of Southeast Asian countries.

(3) Study Contents

The Study was conducted based on relevant literature, information available on websites as well as analysis and consideration of data provided by counterparts both in Japan and overseas in addition to two field works. The findings from the Study are summarized below.

- Technology transfer
The Hitachi Metals' presentation was given during the first field work to numerous stakeholders of the Project including over 20 staff members of ECC, three electricity suppliers, two equipment manufacturers, two electricity equipment designing companies and two media. In the presentation, the amorphous transformer technology, its impact, production, cost, marketing and material procurement were comprehensively discussed and positive feedback on the installation of such transformers has been received.

Also, during the visit to Thibidi Corporation, the transformer manufacturer's plant, detailed technical training was provided on methods to establish an amorphous transformer production line within the existing production line, designing of the transformers, manufacturing and testing methods. As a result, the initial stage of technology transfer was smoothly conducted as Thibidi carried out the basic designing and cost estimation within the period of this Study.

➤ Energy efficiency improvement measures

Ministry of Commerce and Industry expressed strong interest in the Project at the meetings held during two field works. The Ministry, in conjunction with ECCs set up in 7 main regions of Vietnam, is promoting model projects in energy efficiency improvement. Based on the Ministry's idea that the Project could qualify as a model project, the Ministry recommended coordination with EVN and ECC of Hanoi. Discussion on the coordination will be continued after the Study completion.

➤ Development of the Project

It was discovered that the specifications demanded on transformers by the HCMPC greatly exceed Vietnamese standard. As a result, based on HCMPC's new transformer installation plan, the greenhouse gas reduction has been estimated as 3,213 tCO₂/year, lower than the 4,251 tCO₂/year estimated before the Study. Only two companies among the 11 electricity providers under EVN, HCMPC and PC2 apply such high efficiency standard and others have their own rules based on the Vietnamese standard.

When applying the standard value of PC3 to the above estimation based on the new equipment installation plan of HCMPC, the greenhouse gas emission reduction can be estimated as 7,354 tCO₂/year, raising expectation for potential impact that can be brought by further development of the Project. The Study also revealed that by adding the distribution grid owned by PC2 and PC3 to the project, the Project can be enlarged to the level of annual CO₂ reduction of 20,000 tCO₂. The possibility of project deployment throughout Vietnam will be pursued in future discussion with EVN.

➤ Programmatic CDM

The Project aims to introduce high efficiency transformers in the distribution grid owned by HCMPC, however, the Study also pursued the possibility of implementing the Project on wider scale by extending the area to distribution grid owned by other

companies. The impact of implementing the Project as programmatic CDM has been investigated in order to facilitate the Project as CDM and effective certification of carbon credits.

The potential of programmatic CDM was considered in two scenarios. The first scenario assumes that the Project is deployed all over Vietnam or in multiple regions. In this case, the CDM project activity will be implemented by EVN and projects implemented by each one of 11 power companies under EVN will be individual CPA. In the second scenario, credits are claimed within the current HCMPC's project. The Project will install a certain number of transformers every year over the first crediting period of 7 years. For smooth credit certification, transformer installation of each year can be an individual CPA to implement the project as programmatic CDM. On the other hand, cost cannot be ignored when implementing the CDM project, therefore, the cost benefit analysis has been conducted.

➤ **Summary**

Through the Study, many stakeholders in Vietnam have come to realize that the implementation of the high efficiency transformer installation project will lead to decrease of continuous electricity loss caused by transformation of distribution grids over many years and contribute to greenhouse gas emissions reduction as well as improvement of urban environment and safety.

➤ **Outline of fieldwork**

The first fieldwork was highly productive. In addition to the technical workshop provided by Hitachi Metals Ltd. to 40 participants from 6 companies, meetings with the total of 10 companies were held and visit to the manufacturing plant as well as inspection of the state of distribution grid maintenance were covered.

The second fieldwork conducted from 16th to 24th of December 2008 centered around discussions with ECC, HCMPC, Thibidi, the transformer manufacturer on issues e identified during the first fieldwork. Interviews were also conducted on wider scale to obtain grid data that is likely to become the biggest obstacle when promoting the CDM project in Vietnam, to survey the trend of energy efficiency projects as well as to establish cooperative relationship for starting the actual project.

3. Project Development

(1) Determination of project boundary and baseline scenario

For projects involving energy efficiency improvement on the supply side, there are two applicable methodologies already approved by the United Nations. They are “AM0067 : *Methodology for installing of energy efficiency transformers in a power distribution grid*” and “AMS II.A: *Supply side energy efficiency improvements – transmission and distribution*”. In the Study, AM0067 is selected and used for the PDD taking into account the future expansion of the Project.

AM0067 is applicable to the following.

- (1) Replacement of existing lower-efficiency transformers with higher efficiency transformers in an existing distribution grid; or
- (2) Install new high efficiency transformers in the new areas covered by expansion of the distribution grid where in the absence of the project, lower efficiency transformers would have been installed.

The Project involves switching from inefficient transformers to highly efficient ones in the existing electricity distribution grid and is located in the new area covered by the distribution grid’s expansion. The Project introduces new super high efficiency transformers to the distribution grid where less efficient transformers would be introduced in the absence of the project activity. As such, the Project meets both applicability conditions mentioned above.

Whether the Project meets the applicability conditions of the methodology is explained in detail in Table 1. More work is needed to ascertain the applicability, however, it is deemed the methodology, in essence, is applicable to the Project.

Table 1: Applicability conditions of the methodology

	Conditions	Applicability
(a)	Emission reductions due to the reduction in no-load losses alone are claimed	Yes
(b)	Installation of transformers within the distribution grid is governed by performance levels established by local or national regulations, which define maximum permissible load losses and no-load losses.	Yes
(c)	Load losses, at rated load, of the transformers implemented under the project activity are demonstrated to be equal or lower than the load losses in transformers that would have been installed in the absence of the project	Needs modification

	activity.	
(d)	The transformers installed in the project activity comply with national/international QA/QC standards. This shall be demonstrated through certification based on tests conducted using relevant national/international testing standards from an accredited entity/government recognised entity. The certification report shall include information on the measured performance levels for load losses and no-load losses in various operational conditions and in addition, the associated uncertainty.	Yes
(e)	Project proponent implements a system to ensure that the replaced transformers are not used in other parts of the distribution grid or in another distribution grid.	Needs modification
(f)	A complete list of co-ordinates uniquely identifying each transformer installed under the project activity is provided.	Needs modification
(g)	Data on total number and type of transformers installed over the last three years previous to the project implementation is available.	Needs confirmation

As per AM0067, Version 2, the project boundary is the HCMPC's power distribution grid where amorphous transformers are installed in the Project Activity.

The baseline scenario is identified as the following in accordance with the newest version of "Combined tool to identify baseline scenario and demonstrate additionality".

- Continuation of current practice. Replacement or installation of transformers with the most commonly used transformers in the geographical region where the project activity is implemented
- Replacement or installation of transformers as per new performance levels enforced by regulation;

The baseline emissions are calculated according to the following equation.

$$BE_y = \sum_{k=1} (NLL_{BL,k} * n_{k,y}) * MP * (1 - Br) * EF_{CO2,grid,y} * 10^{-6}$$

BE_y :	Baseline emissions in year 'y' (tCO ₂ e/yr)
k :	Index 'k' represents the type of transformers installed in the Project Activity
NLL_{BL,k} :	No-load loss rate of the transformer type 'k' that would have been installed by the end of the year 'y-1' in the baseline scenario
MP :	No-load loss rate of the transformer type 'k' that would have been installed by the end of the year 'y-1' in the baseline scenario
Br :	Black out rate of each monitoring period (%)
EF_{CO₂,grid,y} :	CO ₂ emission factor of the grid for the year 'y' when the project activity is implemented (tCO ₂ /MWh). EF is calculated using the combined margin as outlined in the methodological "Tool to calculate the emission factor of an electricity system".
n_{k,y} :	Cumulative number of type 'k' transformers installed by the Project Activity at the end of year 'y-1'.

The equation to estimate project emissions is as follows.

$$PE_y = \sum_{k=1}^n [(1 + UNC) * NLL_{PR,k,y} * n_k] * MP * (1 - Br) * EF_{CO_2,grid,y} * 10^{-6}$$

PE_y :	Project emissions in year 'y' (tCO ₂ e/yr)
k :	Index 'k' represents the type of transformers installed in the Project Activity
NLL_{PR,k,y} :	No-load loss rate of the transformer type 'k' that would have been installed by the end of the year 'y-1' in the Project Activity (W)
MP :	Duration of each monitoring period (hours)
Br :	Black out rate of each monitoring period (%)
EF_{CO₂,grid,y} :	CO ₂ emission factor of the grid for the year 'y' when the project activity is implemented (tCO ₂ /MWh). EF is calculated using the combined margin as outlined in the methodological "Tool to calculate the emission factor of an electricity system"
UNC	Maximum allowable uncertainty for the no-load losses stated in the certification report provided by an accredited entity
n_{k,y} :	Cumulative number of type 'k' transformers installed by the Project Activity at the end of year 'y-1'

Leakage is not envisaged in the methodology, however, it is necessary to establish a system in which ensures that the transformers used before the project activity will not be used elsewhere. To verify, it is necessary to put in place some measures such as requiring written evidence for scrapping removed transformers.

(2) Monitoring Plan

The methodology requires the following two items to be monitored to confirm applicability.

- Type of transformer, capacity, transformation rate and load-loss rate (W) of high efficiency transformers installed in the Project.

- Record of transformer installation by type in the 5 recent years.

The methodology also requires the following four items to be monitored to calculate project emissions.

- Load loss rate and No-load loss rate of high efficiency transformers installed in the Project.
- Details (date of installation, location, technical data) of high efficiency transformers installed in the Project.
- Annual blackout rate
- Number of transformer units installed in the Project.

Other monitoring parameters are summarized in Table 2.

In Vietnam, grid data required for the calculation of the grid emission factor are not made publicly available by power companies. The lack of grid data has been a major obstacle for registering CDM projects located in Vietnam. As previously mentioned, it is clear from interviews conducted during the Study that the Vietnamese government has acknowledged this problem and intends to make the data available as official data. In the Project, the emissions factor is monitored annually.

On the other hand, the actual operating hours (MP) and black out rate (Br) are made publicly available on yearly basis by HCMCPC and can be monitored continuously. The transformer type (k) and number of units (n) will be obtained and summarized from supplier's terms of reference at the time of delivery. No-load loss (NLL) and load loss (LL) will be sourced from manufacturer's test results at the point of shipment. Transformer manufacturers in Vietnam conduct quality control of their manufactured good according to ISO9001 and test results based on the standard will be used as data. Collected transformers will be disposed. Data will be collected and summarized annually from contracts with waste disposal company.

Monitoring will be carried out under the responsibility of HCMPC. ECC will support the recording and reporting tasks.

Table 2: Monitoring Data and Parameters

Parameter	Unit	Calculated?	Data source	Frequency
$EF_{CO_2,grid,y}$	tCO ₂ /MWh	Calculated	Official data from power company	Annually
MP	Hours	-	Official data from power company	-
Br	%	-	Official data from power company	-
k	-	Report	Record	-
$n_{k,y}$	Unit	Report	Record	Annually
$NLL_{PR,k,y}$	W	-	Manufacturer's test result	-
$LL_{PR,i}$	W	-	Manufacturer's test result	-
Number of replaced transformers	-	-	Record	Annually

(3) Greenhouse gas emissions reduction

In accordance with the formula previously described, the emissions reduction is calculated as follows.

Table 3: Emissions Reduction

Year	Baseline emissions (tonnes of CO ₂)	Project emissions (tonnes of CO ₂)	Leakage (tonnes of CO ₂)	Emission reductions (tonnes of CO ₂)
1	1,249	446	0	803
2	2,498	892	0	1,606
3	3,747	1,338	0	2,410
4	4,996	1,783	0	3,213
5	6,246	2,229	0	4,016
6	7,495	2,675	0	4,819
7	8,744	3,121	0	5,623
Total	34,975	12,484	0	22,491
Average	4,996	1,783	0	3,213

Through the Study, it is clear that the standard concerning no-load loss of HCMPC is significantly higher than the national standard. It also greatly exceeds the standards of other electricity suppliers under EVN.

Table 4 describes parameters and estimated emissions reduction based on the no-load loss standard of PC3, electric power company that provides services to the agricultural area of central Vietnam. The table reveals that the amount of emissions reduction is 2.3 times the value of HCMPC (7,151 tCO₂/year). Also, in case the Project continues into second and third crediting periods, credits incurred during the last year of the first crediting period will be continuously issued and annual average emission reduction during the subsequent crediting periods will reach 1.75 times the first crediting period (12,514 tCO₂/year).

As there are 11 electric power companies including HCMCPC, the potential impact of the CDM project with EVN as the project proponent is immense.

Table 4: Emissions Reduction Based on Standard Specifications of PC3

Year	Baseline emissions (tonnes of CO₂)	Project emissions (tonnes of CO₂)	Leakage (tonnes of CO₂)	Emission reductions (tonnes of CO₂)
1	2,222	434	0	1,788
2	4,444	869	0	3,575
3	6,667	1,303	0	5,363
4	8,889	1,738	0	7,151
5	11,111	2,172	0	8,939
6	13,333	2,607	0	10,726
7	15,556	3,041	0	12,514
Total	62,222	12,165	0	50,057
Average	8,889	1,738	0	7,151

(4) Project operation period and crediting period

The Project is planned to start in spring 2010. The technology transfer issue has been cleared during the Study and the basic designing of amorphous transformers by equipment producer is completed. The remaining tasks are collection of detailed data using actual equipment and improvement of the bidding system of the electricity supplier that emphasizes initial cost. Further coordination is required after the completion of the Study.

The crediting period of the Project is established as 7 years with the option for two renewals based on the CDM rules that extend the maximum total crediting period to 21 years. The methodology requires the baseline scenario to be reviewed at the onset of second and third crediting periods.

The Study confirmed that the life of a transformer is 25 to 30 years and will not interfere with the crediting period.

(5) Environmental impact and other indirect impacts

The National Resources and Environment Research Programmed (NRERP) introduced the Environmental Impact Assessment (EIA) system in 1984 which requires the submission of an EIA for development projects in need of a license. The Project does not require development license and therefore is not subject to EIA requirements.

The law that affects the Project is The Law on Environmental Protection (LEP) and was established in 1994 under the control of MOSTE (Ministry of Science, Technology, and Environmental). In 2002, MOSTE was separated into MOST (Ministry of Science and Technology) and MONRE (Ministry of Natural Resources and Environment) is currently in charge of the Law. The Law's objective is to contribute to regional and global environmental protection for the purpose of protecting people's health while maintaining sustainable development. The Law must be adhered to while producing amorphous transformers.

(6) Stakeholder Comments

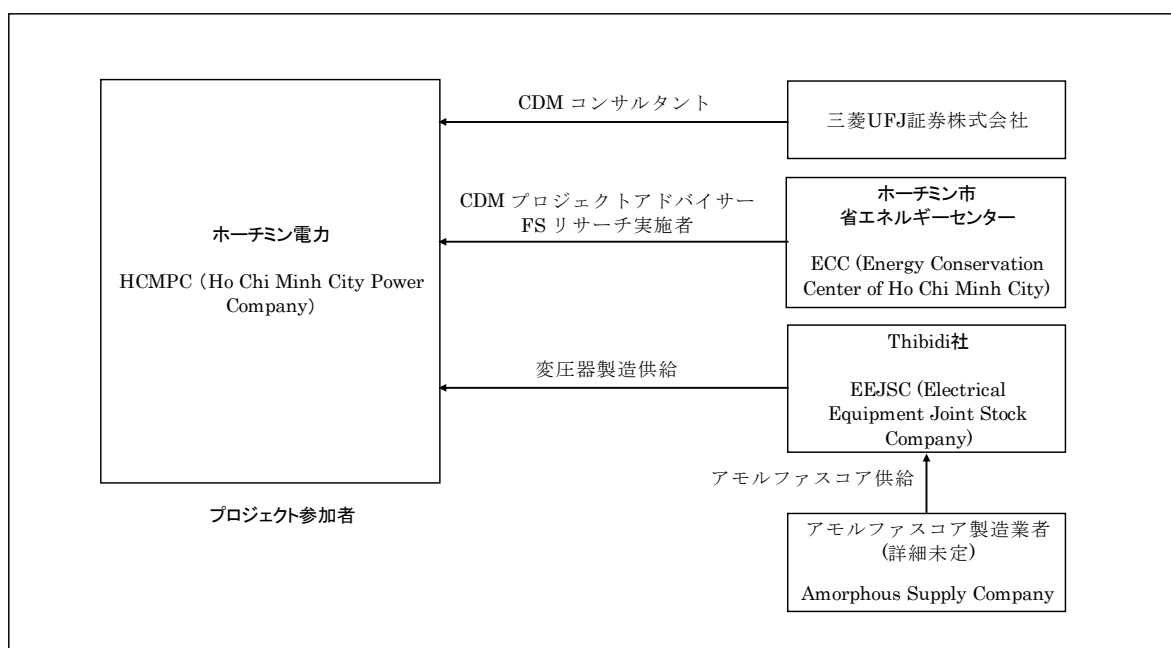
Main comments and questions raised at the stakeholder meeting during the Study are summarized in Table 5. Another meeting will be held prior to the implementation of the Project.

Table 5: Questions and Answers

Questions/Comments	Commentator	Answer/Response
Where is it possible to install amorphous transformers?	Electrical Equipment Joint Stock Company	In the Project, amorphous transformers will be installed in the power grid, however, they can be used in many places, such as office buildings, schools and flats, etc.
How many amorphous transformers are in use in Japan?	Power Company of HCM City	About 10% of all transformers in use are amorphous
10% is not a high value. What are the reasons?	Power Company of HCM City	In Japan, many cases adopt a business strategy in which high performance silicon transformers are sold at low price. Therefore, they are not so wide-spread, however their performance has received high evaluation and is believed to increase their share.
How can we produce and distribute amorphous transformers in Vietnam?	The Voice of HCM City People	You can import the amorphous core and product amorphous transformers in Vietnam. Hitachi Metal Ltd. will support Vietnamese company on technology.
Isn't the cost high?	Power Company 2	Amorphous transformers cannot categorically be described as high cost. The final cost is decided by manufacturer's business judgment. In other countries, however, they are 15-20% higher in some cases.
Have understood the high performance and effectiveness of amorphous transformers. Further consideration will be given by the	Mr. Nguyen Duy Hoang - Power Company of HCM City Mr. Huynh Van Hau -	

company.	Power Company 2	
Highly interesting. Hope for future technical support.	Mr. Luong Van Truong - Electrical Equipment Joint Stock Company	
Have further understanding of the technology. It also complies with the Vietnamese government policy and has recognized its effectiveness.	Mr. Ngo Van Trai - Energy Conservation Center of HCM City	

(7) Project implementation structure



In the project implementation structure described in the above figure, each entity will have the following role in supporting HCMPC.

Mitsubishi UFJ Securities Co., Ltd., as a CDM consultant, will advise on the CDM aspect of the Project. ECC will continue to support HCMPC as Mitsubishi UFJ Securities' counterpart in CDM consulting.

The amorphous transformers which are the technology involved in the CDM project activity will be produced and supplied by a Vietnamese manufacturer. The technology transfer concerning transformer production is being discussed between Hitachi Metals and Thibidi Corporation whose majority of shares is owned by the Vietnamese government. The transformer producer will, for the time being, receive the core from overseas amorphous producers, however, domestic production by Thibidi is foreseen in the future

(8) Financial plan

The Project will be financed by through annual budget of HCMPC, a subsidiary of ENV. HCMPC has already adopted a transformer standard that is significantly more efficient than the national standard and has set further reduction of transmission loss as the future task.

The cost analysis of the installation of amorphous transformers has been conducted, however, the Project differs from ordinary projects in a way that whether or not the investment effect is positive does not have direct correlation with investment decision for the Project. In order to make the decision on project implementation, HCMPC will take into account the cost analysis conducted in the Study as well as the analysis of the effect of amorphous transformers. Once the decision is made, the cost will be incorporated into the annual budget.

(9) Analysis of financial feasibility

The result of cost estimation carried out by Thibidi Corporation has revealed that the cost of amorphous transformers will be 15% higher compared to the conventional silicon-made transformers. The initial investment cost amounts to additional 824,517 US Dollars on yearly basis.

Based on the simple calculation of electricity tariff reduced by the Project, the pay-back period is 10 years. The pay-back period can be shortened to 8.7 and 8.4 years respectively when revenues from CER sales is estimated at 15 USD/t CO₂ and 20 USD/ t CO₂.

As explained above, the Project does not generate any incentive for the project proponent in terms of investment effect. An investment decision with consideration of other benefits such as environmental improvement, stable supply of electricity as well as safety improvement is desired.

(10) Justification of additionality

[Technological barrier]

The amorphous transformers used in the project activity are super high efficiency transformers designated as the top-runner product in Japan. The amorphous transformers are known for their big effect at low-load and is effective towards lowering the loss rate of transformers when they are operated 24 hours/day 365 days/year. Such performance is realized by using amorphous metal as the material for the core part of the transformer.

However, Vietnam has yet to supply or produce amorphous core or amorphous metal raw materials. There is no market including imports for amorphous transformers. In all, the project activity will be the first case of installing amorphous transformers in Vietnam.

The Project will involve importation of amorphous core and production by domestic producers. Technology transfer from abroad is essential in equipment design, production and testing process. As the first stage, technical training by Hitachi Metals was provided through the Study and as a result, the basic designing and cost estimation have been completed by Thibidi Corporation, a transformer producer in Vietnam. Further technology transfer from various countries will be required for the subsequent stages of project implementation. As explained, numerous technological barriers exist for the implementation of the project activity.

[Investment barrier]

As previously explained, there is no domestic production of amorphous transformers at the time of the Study. Also, as establishing a new production line for amorphous metals and amorphous core involves significant initial cost, it is not realistic. Therefore, it is necessary to import amorphous core from abroad at the start of the project activity, which is more costly compared to the conventional silicon core. Under these circumstances, Thibidi Corporation estimates that the cost of the amorphous transformers will be 15 % higher than the conventional transformers currently used by HCMPC.

On the other hand, the Project will generate revenue from electricity loss savings and CER sales. Market price of electricity tariff has been used in this analysis, however, HCMPC will not gain any actual revenue by reducing electricity loss, therefore, the investment decision will not be affected by the IRR estimated in this Section. Having said that, the analysis clearly shows that there is an investment barrier in implementing the Project.

The IRR without CER revenues is calculated at 6.84%. The IRR will rise to 7.73%, 8.16% and 8.59% when the CER price is set at 10 USD, 15 USD and 20 USD respectively. The payback period is estimated as 16 years.

According to the investment sensitivity analysis, the IRR rises to 8.01% when the initial cost decreases by 10% and to 7.75% when the electricity tariff increases by 10%. It should be noted that the maintenance cost is not taken into account in the calculation as it is considered unchanged from prior to project implementation. When 5% increase in maintenance cost is considered, IRR drops to 1.58%.

As previously explained, these analyses assume that the revenue from electricity usage reduction at market price is brought to HCMPC. When wholesale electricity tariff by EVN is considered, profitability exacerbates. For this reason, it is not possible for HCMPC, in their current situation, to seek financial incentives for project implementation.

[Barrier due to prevailing practice]

Transformer producers in Vietnam design and manufacture standard transformers according to each client's specification. Although the quality of the core material varies according to the level of client's request, almost all are silicon steel plates. Production lines using silicon steel plates have been installed at production plants. For this reason, rearrangement of the lines is required for the introduction of the new core.

Silicon steel transformers meet the current regulations as well as the standard requirements of each power distribution company. It is not an accepted practice in Vietnam to produce and sell amorphous transformer that require even higher standards.

As stated, the Project will not be implemented without the CDM status as there are technological, investment barriers as well as barriers due to prevailing practice. Justification of additionality as a CDM project is possible.

(11) Future prospects of the project development and remaining issues

As previously explained, remaining issues towards project implementation include the collection of detailed data using actual equipment and the problem with regards to the bidding system of the electricity supplier that emphasizes initial cost. Further coordination is required after the completion of the Study.

Also, the initial stage of technology transfer has been completed during the Study and the rough designing of the equipment and rough cost estimation have been carried out by the transformer producer. However, in order to bring the Project to the next stage, it is necessary to build up the technology and know-how through (1) production of test machine and testing/analysis, (2) production of the standard machine and testing/analysis and (3) installation on the transmission line and testing/analysis. The sales channel of amorphous core in Asia has already been established and the core supplier in place of Hitachi Metals will provide technical support when Project is implemented in the future. The cores supplier already provides similar technical support to other developing countries, such as China and Thailand and there seems to be no significant barrier in technology transfer.

4. Validation (pre-validation)

TBD

5. Realization of Co-benefit in Host Country

(1) Evaluation of pollution prevention in host country

As previously stated, the purpose of the project activity is to reduce electricity loss wasted 24 hours/day for 365 days/year caused by transformation and to reduce greenhouse gas emissions. All transformation is changed to heat and emitted into the atmosphere. The prevention of such exhaust heat will improve the working environment at the time of equipment maintenance and is expected to secure safety. It will also contribute to improvement of serious environmental problem in people's daily lives, such as the urban heat island. Moreover, by promoting rehabilitation of existing transmission and distribution grid, improvement of the safety aspect, such as fire caused by a short circuit and therefore, the Project is deemed to offer co-benefit in terms of the improvement of urban living environment.

Regarding the temperature around core, while it stays between 30-34 degrees for amorphous core, it goes up to 45 degrees or higher for silicon-steel core. In order to control such temperature rise and to effectively exhaust the heat into the atmosphere, the outer area of the transformer is equipped with a fin.

The electricity loss reduced by the Project is 183,111(W) and when converted into heat value, it is as follows.

Heat value (kcal/h) = 0.862 x 183,111 (W) = 157,841 (kcal/h)

Annual amount of heat exhausted into the atmosphere= 157,841 (kcal/h) x 24 (h) x 365 (d) = 1,382,693,134 (kcal/year)

$$\begin{aligned} &= 1,382,693,134 * 4.1868 \\ &= 5,789,693,134 \text{ (kJ)} / 1.0545 \\ &= 5,489,862,129 \text{ (BTU}_{\text{ISO}}) \end{aligned}$$

It must be noted that transformer installed in the Project will be used only in a small portion of HCMPC's distribution grid and the above estimation is based on the current HCMPC's own standard for electricity loss. As previously explained, this standard is significantly higher than the standards adopted in other places of Vietnam and when compared to existing equipment currently used, electricity loss can be reduced by 70%. Under such circumstances, the dissemination of high efficiency transformer project can contribute to easing of urban heat island.

Also, as the transmission and distribution grid becomes efficient by the Project dissemination, actual electricity supply will increase without the need to build new power stations or rehabilitation. The prevention of increase of fossil fuel consumption and environmental problems associated with the construction of new power stations can be expected.

(2) Proposal of co-benefit indices

By and large, the amount of greenhouse gas emission reduced by an energy efficiency project is limited and for this reason, it is difficult to produce adequate incentives for project developers only with CDM benefits. However, it is apparent that the dissemination of highly efficient equipment like this project activity holds huge potential as global warming counter-measure.

Although the Study described the effect of high efficiency transformers on urban heat island prevention by quantifying the effect in terms of reduction of heat exhaust into the atmosphere, the quantification of the prevention effect is difficult. When the exhaust heat is converted into petroleum, it becomes a large value of 218,032 tons. It is necessary to consider replacing the index of co-benefit type project effect with such a quantified index.