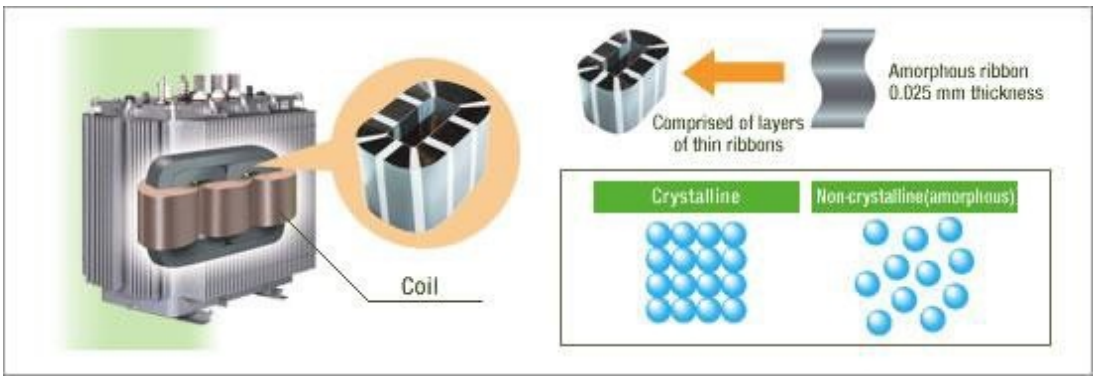
Additional information for the proposed methodology
"Installation of energy efficient transformers in a power distribution grid"

1. Overview of the technology applied

This proposed methodology focuses on energy efficient transformers in a power distribution grid which have amorphous metal core. There are two sources of power loss in transformers: load losses and no-load losses. Load losses are losses of electricity due to resistance in the electrical winding of the transformer. These losses include eddy current loss in the primary and secondary conductors of the transformer. These losses occur when the electricity flows through the transformer.

No-load losses are losses of electricity due to transformer core magnetizing or energizing. These losses occur whenever a transformer is energized and remain constant regardless of the amount of electricity flowing through it.

Amorphous metal core reduces the no-load losses and improves energy efficiency of transformers with its crystal architecture. Compared with the conventional steel type (i.e. silicon steel) with a regularly arrayed structure, amorphous metal has a random arrangement of crystals. When amorphous metal is used for transformer core, it reduces hysteresis loss and eddy current loss and realises energy efficiency improvement.



2. Market share of transformers in Lao PDR

Although there is no official market data of transformers installed in Lao PDR, based on the interview with one of the world largest producers and suppliers of amorphous metal, the market of transformers has been dominated by the transformers with silicon steel

3. Standards for load losses and no-load losses set by the power companies

The EDL who is a power company in Lao PDR has the own standard for load losses and no-load losses for transformer procurement. The suppliers of transformers are required to meet the standard set by EDL. It is expected that the specification values for load losses and no-load losses are in

decreasing trend (i.e. efficiency of the transformers are improving). The specification values are set for different capacities and numbers of phase of the transformer. Following table 1 and table 2 are the examples of NLL (no-load loss rate) and LL (load loss rate) for the standard set by EDL in Lao PDR.

Table 1 No-load loss rate for the transformers

[Three-phase]

Capacity [kVA]	No-Load loss rate [W]	
	Silicon steel core	Amorphous metal core
50	210	56
100	340	75
160	480	95
250	670	125
315	750	145
400	900	165
500	1,000	220
630	1,200	270

Table 2 Load loss rate for the transformers

[Three-phase]

Capacity [kVA]	Load loss rate [W]	
	Silicon steel core	Amorphous metal core
50	1,320	650
100	2,100	1,258
160	2,350	1,940
250	3,250	2,600
315	3,900	3,330
400	4,600	3,818
500	5,500	4,810
630	6,500	5,570

4. Blackout rate in Lao PDR

The System Average Interruption Duration Index (SAIDI) of EDL was analyzed based on available data of 2016 and 2017. The blackout rate on yearly basis can be calculated as SAIDI divided by the total minutes of the year. It is, however, difficult to calculate the blackout rate on monthly or daily basis, considering that the transformers are often introduced in the midstream of the year. As shown

in the table below, the average blackout rate is improving year by year from 2016 to 2017and it is expected that the average blackout rate will continue to improve year by year in the future. Therefore, selecting the worst (the highest) blackout rate during 2016 amongst all areas, which is 1.55%, would ensure the conservativeness, and reduce the burden to identify the blackout rate for individual transformers, considering that transformers are generally introduced in large numbers and in different regions.

No.	Area	2016		2017	
		SAIDI [min]	%	SAIDI [min]	%
1	North	8,142	1.55	926	0.18
2	Vientiane Capital	3,094	0.59	1,161	0.22
3	South	2,872	0.55	1,976	0.38
		Average	0.89	Average	0.26