Research Article

Development Of Measurement, Reporting And Verification (MRV) Indicators To Track The Progress Towards Climate Change Mitigation Targets In Viet Nam's Updated Nationally Determined Contribution

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Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 23 May 2021

ABSTRACT
In the updated NDC, Vietnam has allocated mitigation targets to energy, agriculture, industrial processes and product use (IPPU), land use, land use and forestry change (LULUCF) and waste in the period of 2021-2030. The establishment of a measurement, reporting and verification system (MRV) at national and sectoral levels is necessary to track the progress towards national and sectoral mitigation targets. However, at present very few studies on MRV indicators and remain fragmented. To meet that urgent need, this study was implemented to develop MRV indicators for mitigation actions to support the policy makers in tracking the NDC implementation. In this paper, a set of 85 MRV indicators divided into two categories: (i) 12 outcome indicators to track the national and sectoral mitigation targets, (ii) 72 progress indicators to track the implementation of mitigation options (including 40 for energy, 14 for agriculture, 7 for LULUCF, 4 for IPPU and 7 for waste) were developed based on relevant studies and expert consultation. The paper also tested the application of progress indicators in several mitigation options in the energy sector. The result showed that in energy sector, in 2014 the two mitigation options that have highest progress include: High efficiency residential refrigerators (0.85) and Introduction of CNG buses (0.75). Freight transport shift from road to railway and Cleaner cooking fuels had average values of progress indicators, 0.53 and 0.6, with respectively. The indicator values of the other tested mitigation options were all below 0.4 and hence greater efforts is needed to reach the mitigation targets.

Keywords: MRV, outcome indicators, progress indicators, Greenhouse gases emissions, NDC

1. INTRODUCTION

In December 2015, at the 21st Conference (COP21), the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) approved the Paris Agreement on Climate Change. This is the first global agreement binding legal responsibility for all Parties to mitigate greenhouse gas emissions, adapt to climate change for sustainable development [1]. The long-term goal of the Paris Agreement is to keep global average temperatures by the end of the century rising below 2°C from pre-industrial levels, to work to limit increases below 1.5°C and to achieve balance between greenhouse gas emissions and removals (zero emissions) in the second half of the century. Following the entry into force of the Paris Agreement, the Intended Nationally Determined Contribution (INDC) becomes a mandatory commitment (NDC, without the term intended), and the Parties to the Paris Agreement are responsible for compliance. Although the Paris Agreement came into effect on November 4, 2016, detailed guidance on the implementation of the Paris Agreement is only basically adopted at the Katowice Climate Package in December 2018 at COP24.

Although countries have submitted NDCs by the end of 2015, however, even if all NDCs are fully implemented, the global average temperature may still increase by about 2.9°C to 3.4°C. Achieving a target of 1.5°C will require zero global GHG emissions between 2060-2080 and around 2080-2090 for the 2°C target. Therefore, Decision No.1/CP21 of the Paris Agreement on Climate Change requires all Parties to review and update their NDCs at least every five years with the expectation of increasing their ambition to contribute to mitigating GHG emissions. The UNFCCC requires the parties to submit a revised NDC for the first time by 2020 [2].

On July 24, 2020, the Prime Minister approved Vietnam's updated NDC which sets the mitigation target of reducing the national GHG emissions by 9% compared to the Business-As-Usual scenario

(BAU) by domestic resources [3], and that unconditional contribution can increase up to 27% if Viet Nam receives international support. In the updated NDC, Vietnam has allocated mitigation targets to five sectors, particularly energy, agriculture, industrial processes and product use (IPPU), land use, land use and forestry change (LULUCF) and waste in the period of 2021-2030.

At COP13, UNFCCC requires all Nationally Appropriate Mitigation Actions (NAMAs), whether domestically or internationally supported, are subject to MRV [4-5]. According to UNFCCC, MRV aims at increasing the "transparency of mitigation efforts made by the developing countries as well as build mutual confidence among all countries". The Paris Agreement stipulates the development of MRV requirements, including for NDCs as part of a transparency framework "building upon and eventually superseding the measurement, reporting and verification system established by the decision 1/CP.16". Article 13 of the Paris Agreement on Climate Change requires states to develop a transparent framework that requires Parties to regularly submit GHG inventory reports and provide information on the NDC implementation process, information on support as well as adaptation efforts [2].

In order to effectively track and improve the implementation of mitigation targets committed by countries' NDCs, it is necessary to develop a strong measurement, reporting and verification (MRV) system. Trust and confidence among parties in achieving their NDCs can also be gained through a transparent MRV framework [6]. MRV for the implementation provides key information to assess the success of the activity, at the same time, generates confidence among actors, especially financiers that their resources are being used effectively to achieve the promised targets. In a broader extend, MRV supports the national development and mitigation agenda by producing relevant information for policy makers, the public and the international sources of finance [7-8].

According to [9], "measurement" (M) means collecting relevant information on mitigation progress and impact. "Reporting" (R) presents the measured information in a transparent and standardized manner. Verification (V) implies assessment of completeness, consistency, and reliability of the reported information through an independent process. When developing a MRV framework, the issues of measurement, reporting and verification issues should be considered separately as some non-supported actions may be subject to reporting but not verification [10]. GHG inventories and national communication will play an important role in measurement and reporting, with respectively [11].

In the MRV handbook [12], it is guided that at the international level, the MRV framework for non-Annex I Parties includes: guidance on reporting through national communications and BURs; guidance on setting up domestic MRV frameworks; a process for consideration of information submitted by non-Annex I Parties in their BURs through International Consultation Analysis (ICA) and international guidance on MRV for REDD-plus activities applies. Regarding national level, it is expected that developing countries need follow the international guidelines for domestic MRV frame-works and prepare and report information according to the guidance on reporting through national communications and BURs, including information on GHG emissions and removals, mitigation actions and their effects, and needed and received financial assistance [12].

Carbon Market Watch proposed a broader approach to MRV for NAMA that addresses the needs for accountability and supports assessment of the NAMA impact and contribution to sustainable development [13]:

- "Action" and "Progress" metrics can prove that NAMAs are being implemented and producing results. Metrics for "action" may include approval of a renewable energy feed-in tariff, installation of a specific climate-friendly industrial technology, or construction of a bus rapid transit (BRT) line. Progress metrics could include penetration rates, such as percentage of electricity generated from renewable sources, percentage of steel plants with dry gas quenching technology, or the share of trips taken on public transit. Progress metrics should ideally be compared to historic data and trends to evaluate overall effectiveness and avoid uncertainties associated with BAU forecasts.

- GHG metrics used for MRV includes the calculation of the aggregate GHG emissions, the reference levels, and the reductions. GHG intensity metrics are particularly useful in the context of growing economies, including economy-wide (GHG/GDP) and sectoral metrics: electricity (GHG/MWh) steel (GHG/ton), transportation (GHG for transport/capita).

- Sustainable development metrics may include per capita income, total leveraged public and private investment (e.g., wind turbines or public transport converting), household travel time and cost savings, expanded access to clean energy, better air quality, and health improvements.

The latest requirement was under Decision 18/CMA.1 (2018) required that developing countries like Viet Nam will submit the National Inventory Report (NIR) in accordance with IPCC 2006 [14] Guidelines for National GHG Inventories (GL 2006) and Global Warming Potentials (GWPs) in the first Biennial Transparency Reports (BTRs) at the latest by December 2024. Accordingly, the work steps related to the MRV system should ensure possible alignment with these reporting requirements and the corresponding national regulations, as far as existing, for the implementation of these requirements. This is specifically important as any mechanism under Article 6 of the Paris Agreement (PA) will also have an impact on NDC accounting. With regarding to reporting on emission reductions at national and sectoral levels, the Meeting of the Parties to the Paris Agreement (CMA) has not adopted detailed guidance for Article 6 implementation, reporting and accounting.

Establishment of an effective and well-functioning national MRV system is a crucial element for Viet Nam to implement the Paris Agreement and fulfil the country's commitments under its NDC. So far, Vietnam has not yet had specific, unified guidelines and legal basis for the implementation of MRV of GHG emission reduction activities. MRV for mitigation actions should be developed based on the existing institutional arrangement as laid out under BUR preparation to avoid duplication of efforts and to streamline the process. One advantage is that Vietnam has a supportive legal framework for the implementation of NDC mitigation targets with many relevant laws, climate strategies, and action plans at national and sectoral levels [3], [15-16]. At national level, a number of law documents which are important to mitigation can be mentioned: Law on Energy Efficiency [17]; Amended Law on Environmental Protection [18] and Law on Forestry [19].

Compared to the number of climate policies, fewer legal documents in Viet Nam specifically mentioned about MRV for mitigation activities. With the Prime Minister Decision No. 2359/QD-TTg issued on December 2015, a framework policy was established for creating and implementing the national GHG inventory system in Viet Nam but concrete and detailed guidance need to be developed to facilitate the data collection and sharing also to implement the GHG inventory at national and sector levels in a systematic manner [20]. In 2016, the Plan to implement the Paris Agreement on Climate Change approved by the Prime Minister has five pillars, including: (i) Mitigation of greenhouse gas emissions; (ii) Adaptation to climate change; (iii) Preparation of resources; (iv) Establishment of a transparency system (MRV); and (v) Development and revision of policies and institutions [15]. The plan for a MRV system for mitigation of GHG emissions was exhibited from Task 52 to Task 57 in the PIPA, including setting up a MRV system at the national level (Task 52) and at sectoral levels, particularly: industrial sector (Task 53), LULUCF sector (Task 54), agricultural sector (Task 55), construction sector (Task 56), and transportation sector (Task 57) [21].

It can be seen that at present very few studies on MRV were conducted in Viet Nam, and on MRV indicators are even fewer. The current studies focus more on synthesizing current knowledge on MRV and with the focus on NAMAs [22]. Since so far there is no study on MRV indicators developed with the specific aim to track the implementation of mitigation options in Viet Nam's NDC, this paper was implemented in order to fulfill that gap.

2. MATERIALS AND METHODS

2.1 Materials

This research is implemented based on reviewing and synthesizing the literature related to MRV process and indicators to assess the effectiveness of mitigation actions. The MRV indicators was developed specifically to track the implementation of the mitigation targets of the updated NDC so the proposal of MRV indicators was conducted based on mitigation targets and options at national and sectoral levels as set in Viet Nam's updated NDC. The approach of this study is illustrated in Figure 1.

Viet Nam's updated NDC is the key basis for the development of the MRV indicators. Based on the national and sectoral mitigation targets set by the updated NDC, the paper has proposed outcome indicators to track the national and sector mitigation targets, with respectively, in both case of unconditional and conditional contribution.

In each sector, the NDC technical group has identified mitigation options and their mitigation potentials. From that perspective, progress indicators were developed to track the progress of each mitigation option were proposed by this paper.

Information from desk study and other comments from expert consultation will be important input for the development and improvement and of the MRV indicators.

The approach for conducting this study includes 3 steps:

Step 1: Review the national and sectoral mitigation targets and mitigation options in 5 sectors (energy, IPPU, agriculture, LULUCF and waste) prescribed in the Viet Nam's NDC update technical report. In addition, the paper also reviews other relevant studies and existing legal documents related to mitigation actions of five sectors.

Step 2: Develop outcome indicators based on national and sectoral mitigation targets in the updated NDC. In each sector, progress metrics will be developed based on the assumption of mitigation options in 5 sectors. One important factor for a good monitoring and evaluation system is to have quantifiable indicators that are SMART (Specific, Measurable, Achievable, Realistic and Timely) [23]. In this paper, based on international and national experience, the set of indicators will be developed based on SMART criteria, particularly:

- Specific: Is the indicator specific enough to measure the progress to achieve the mitigation target?
- Measurable: Is the indicator reliable and evident enough to measure the mitigation target?
- Achievable: is the indicator realistic?
- Relevant: is the indicator relevant to mitigation targets?
- Time-phased: are data to measure the indicator available at reasonable cost and with moderate effort?

Step 3: Using the Delphi method to get consensus of the experts in the proposed set of indicators. The experts include: indicator experts and consultants involved in the development and update of BAU and mitigation scenario of five sectors in Viet Nam's NDC [24]. The paper applied the Delphi Technique with the analysis process divided into three phases: before, during and after consultation. The consultation process is carried out in rounds. Usually in round 1, a series of open-ended questions relevant to the indicators to track the progress of mitigation options were developed and sent to experts for their answers to find out the criteria that can be used to develop the MRV indicators.

2.2 Methods

2.2.1 Methods and data to develop the indicators

Data used for the development of the indicator set were collected from the Viet Nam's NDC update technical report, including: (1) Mitigation actions: Energy (39 options); IPPU (4 options); Agriculture (15 options); LULUCF (12 options); and, Waste (5 options) [3].

As the targeted year for all mitigation options in Vietnam's updated NDC is 2030, currently, few mitigation options are in the process of implementation. Therefore, the database for calculation of outcome and progress indicators for all mitigation options is inadequate at the moment. However, based on available data of several mitigation options which have been already implemented in Vietnam, the paper tested the application of the progress indicators for those mitigation options, particularly: E1, E2, E3, E4, E5, E10, E22, E29, E6s and E25s (Table 3). Year 2014 was chosen for calculation as that is the base year to develop the BAU scenario in the updated NDC. The source for the value of progress indicators in 2014 were taken from the report on Vietnam's updated NDC in the energy sector.

During the development of MRV indicators, two research methods were applied, including desk study and consultation with indicator experts and experts involved in the development and update of Viet Nam's sectoral reports.

Desk study: This activity was mainly conducted by reviewing relevant studies on MRV indicators on tracking the progress of mitigation activities.

The Delphi method: Based on desk study and close consultation with sectoral experts, this paper has proposed a set of 85 indicators for tracking the outcome and progress of mitigation targets in the updated NDC. The 08 steps of the Delphi process for pre-consultation, consultation and post-consultation phases from January to September 2020 are as follow:

- Pre-Consultation phase

+ Step 1. Select the experts to be involved in the Delphi process;
+ Step 2. Develop the draft set of indicators to track the mitigation outcomes and progress;
+ Step 3. Set up the questionnaire, which were open for discussion.

- Consultation phase

+ Step 4. Conduct First Round of the Delphi process.

Using open-ended questionnaires, a meeting with the 9 experts were conducted in Ha Noi. The 9 experts were requested to rate their degree of agreement to the indicator. The level of agreement is ranked from 1 to 5 as follow: (1) means highly irrelevant; (2) means likely irrelevant; (3) means more or less relevant; (4) means likely relevant; (5) means highly relevant.

+ Step 5. Analyse of data for first round

After collecting data using Delphi Technique, the level of consensus is scored according to the thresholds 0.0-0.1; > 0.1-0.3; > 0.3-0.5; > 0.5-0.7; > 0.7-1.0 is equivalent to a very weak consensus level; weak; medium; strong; very strong).

Based on the evaluation results, the median values (Md); Quartile deviation (Q); Mean Value (qi) and Variance (%) according to KAMET rule are calculated in Table 1.

+ Step 6. Conduct Second Round of the Delphi process

- Post-consultation phase

+ Step 7. Analyse of data for second round

+ Step 8. Reporting the result to the expert panel

2.2.2 Methods and data to develop the indicators

The calculation of the indicator set was based on the assumption that the main indicators were of equal weight. In the future, if necessary, these weights can be changed based on expert consultation. Applying the method [26], the formula for calculating the value of Tier III-indicators depends on the relationship of the Tier III-indicators to the GHG outcome and progress indicators (Tier I indicators).

As each tier-III indicator is calculated in different units, it is necessary to calibrate each of these indicators to the same standard system [27]. If the value of the tier-III indicators is proportional to the GHG outcome and progress indicators, then the normalized value is calculated according to the following equation:

$$s = \frac{s - s_{min}}{s_{max} - s_{min}} \quad (1)$$

where s is the value of tier-III indicator; s_{min} is the minimum value of tier-III indicators; s_{max} is the maximum value of tier-II I indicators.

In contrast, if the value of the tier-III indicators is inversely proportional to the GHG outcome and progress indicators, then the normalized value is calculated according to the following equation:

$$s = \frac{s_{max} - s}{s_{max} - s_{min}} \quad (2)$$

where s is the value of tier-III indicator; s_{min} is the minimum value of tier-III indicators; smax is the maximum value of tier-III indicators.

After standardization, the values of tier-III indicators are used to calculate the value of GHG outcome and progress indicators according to Equation (3):

$$M = \frac{\sum_{i=1}^{n} indicator_{si}}{n} \quad (3)$$

Based on the value of the tier-II indicators, the values of the tier-I indicators are calculated according to the following equation:

$$CF = \frac{\sum_{i=1}^{n} w_{M1} M_i}{\sum_{i=1}^{n} w_{M1}} \quad (4)$$

where CF is the contributing factors of climate-resilience of natural environment; M_i is the tier-II indicators that constitute CF; w_{Mi} is the weight of the tier-II indicators; n is the number of tier-II indicators that constitute tier-I indicators. The value of the GHG outcome and progress indicators is from 0 to 1. If the value ranges from 0 to 0.4, it means the progress of mitigation implementation is low. If the value ranges from 0.4 to 0.7, it means the progress of mitigation implementation is average. If the value ranges from 0.7 to 1, it means the progress of mitigation implementation is fast and able to reach the mitigation targets.

3. RESULTS AND DISCUSSION

Based on the SMART criteria and expert consultation through the Delphi Technique, this paper has developed a set of 85 MRV indicators divided into two categories: (i) 12 outcome indicators to track the national and sectoral mitigation targets, (ii) 72 progress indicators to track the implementation of

mitigation options in five sectors (including 40 for energy, 15 for agriculture, 7 for LULUCF, 4 for IPPU and 7 for waste sector. According to expert opinion, all these indicators achieve SMART criteria. The targeted year to track all indicators is 2030.

3.1 Outcome indicators

Outcome indicators were proposed track the national and sectoral mitigation targets and outcome and progress indicators to track the implementation of mitigation options in 5 sectors in case of unconditional and conditional contribution (Table 2). At the national level, two indicators were proposed, namely "percentage of national GHG emission reduction compared to national BAU by 2030 in case of unconditional contribution" and "percentage of national GHG emission reduction compared to national BAU by 2030 in case of conditional contribution". It is proposed by the paper that Ministry of Natural Resources and Environment (MONRE) will be the leading agency in cooperation with other line Ministries in measurement of the outcome indicators and the National Committee on Climate Change (NCCC) will report the result of the outcome indicators to the Prime Minister.

At sectoral level, although Viet Nam's updated NDC allocated national mitigation targets to 5 sectors, particularly energy, IPPU, agriculture, LULUCF and waste sectors. However, in Viet Nam, the sub-sector of transportation and construction under the energy sector are under the management of Ministry of Transport (MOT) and Ministry of Construction (MOC). In order to facilitate the measurement and reporting at ministerial level in future, this paper proposed to separate transportation and construction out of energy sector. However, the three ministries, Ministry of Industry and Trade (MOIT), MOT and MOC will cooperate in measurement and reporting of the indicator on "Percentage of GHG emission reduction in energy sector compared to BAU by 2030 in case of unconditional and conditional contribution".

Regarding other sectors, other similar indicators to track the sectoral mitigation targets were proposed, namely "Percentage of GHG emission reduction in agriculture/IPPU/LULUCF/waste sector compared to BAU by 2030 in case of unconditional and conditional contribution". In case of IPPU, since it is both managed by MOIT and MOC, these two ministries need cooperation during the measurement and reporting of those indicators. Similarly, as the waste sector is both under the management of MONRE and MOC, the measurement of the outcome indicators requires the collaboration of those two ministries. Ministry of Agricultural and Rural Development (MARD) will be the single ministry that takes responsibility for the measurement and reporting for the outcome indicators in agriculture and LULUCF sectors.

3.2 Progress indicators

In addition to outcome indicators to track the quantitative mitigation targets, this paper also proposed progress indicators to evaluate the progress towards the sectoral targets. These progress indicators were proposed based on the assumption of mitigation actions in Viet Nam's updated NDC technical report. The indicators which are already available in existing legal documents will be selected in order to facilitate the measurement and reporting by ministries in future. Therefore, the application of these indicators will be more feasible. In the energy sector, 40 progress indicators were proposed based on the assumptions for 39 mitigation options of the energy sector, particularly:

In case of unconditional contribution, 27 progress indicators were proposed, including: The average fuel consumption standards are applied for motorbikes, small cars and large cars (l/km); Percentage of the use of high efficiency lighting (or LED lighting) of the total lamp stock in the residential sector (%); Percentage of traditional brick production apply brick-making technology improvements (%); Percentage of freight transport by inland water (%); Percentage of electricity demand reduction compared to BAU (%); Percentage of households in rural areas will use biogas to replace coal for residential cooking (%); Percentage of individual road transport reduction compared to BAU (%); The percentage of annual new motorbikes sales compared to the total number of new motorcycles (%); The percentage of households using standard air-conditioning in urban and rural areas (%); The percentage of households using refrigerators in urban and rural areas (%); Percentage of clinker production that applied the method of kiln shell heat loss reduction (%); Percentage of steel production that applied the method of scrap preheating (%); Percentage of total steel production made by EAF technologies (%); Percentage of total iron production that applies pulverized coal injection in blast furnace (%); Percentage of clinker production that applies the method of waste heat recovery from cement (%); Percentage of clinker production that applies the method of combustion optimization (%); Percentage

of total steel production made by BOF technologies (%); Total capacity of small hydro power plants (MW); Percentage of households using solar water-heating devices (%); Total capacity of solar PV and wind power projects (MW); The amount of ethanol consumed (tons); The number of CNG buses; Percentage of cement production that applies vertical roller mill (%); and the power capacity of municipal solid waste-fired power plants (MW).

Regarding conditional contribution, 13 progress indicators were proposed for the energy sector, including: Percentage of energy demand of other industrial sub-sectors (%); Percentage of households in rural areas using LPG (%); Percentage of rail freight traffic in the total freight traffic (%); The percentage of annual new motorbikes sales compared to the total number of new motorcycles (%); The percentage of average truck loading factor (%); The total capacity of solar PV plants (MW); The biomass power capacity for grid connection (MW); The power capacity of landfill gas, biogas, LNG power plants, ultra-supercritical coal plants and wind power plants (MW); Percentage of ethanol in gasolines sales in Viet Nam (%); and Percentage of electric car in the annual new car sales (%).

In the agriculture sector, 14 progress indicators were proposed. In case of unconditional contribution, 4 progress indicators were developed, namely: Area for improved rice cultivation (ha); The area that applies the midseason drainage method (ha); The rice-specialized area with low efficiency that has been concerted to the rice-shrimp system (ha); and The area specialized in rice with unstable yield and poor efficiency has been converted to upland crops (ha). Regarding conditional contribution, 10 progress indicators were proposed, including: Number of dairy cows with improved diets; Number of beef cattle with improved diets; Number of buffalos with improved diets; Rice cultivation area that is collected straw by-products; Integrated crop management area for rice; Integrated crop management area for upland crops; Planted area that urea is replaced by slow-soluble nitrogen fertilizer; Rice areas with average infrastructure that applied AWD and SRI methods, given received international supports; Rice areas with weak infrastructure that applied AWD and SRI methods, given received international supports.; The coffee areas that applied an integrated drip irrigation system, given received international supports; and number of cattles of which waste are used to produce organic fertilizer, given received international supports.

In the IPPU sector, four progress indicators were proposed, including: Percentage of GBFS replacing clinker in cement component (%); Percentage of fly ash replacing clinker in cement component (%); Percentage of Pozzolana replacing clinker in cement component (%) and Percentage of Pozzolana replacing clinker in cement component (%).

In the LULUCF sector, seven progress indicators were proposed, including (i) Area of existing natural forest are conserved and protected (ha); Area of existing coastal protection forests are conserved and protected (ha); Area of protection and special use forests are restored (ha); Area of poor natural forest are enhanced the quality and carbon stock (ha); Areas of forest of which productivity and carbon stock of plantations for saw logs supply are enhanced (ha); Area that apply agro-forestry practices and Areas that have sustainable forest management and forest certification (ha).

In the waste sector, seven progress indicators were proposed, including: Percentage of municipal solid waste (MSW) are used to recover gas for electricity generation (%); Percentage of MSW are disposed at semi-aerobic landfills (%); Percentage of food waste of garden and wood waste will be treated by composting (%); Percentage of garden and wood waste are treated by composting (%); Percentage of textiles, paper, nappy waste is incinerated for electricity generation (%); Percentage of wood and garden waste is incinerated for electricity generation (%) and Percentage of textiles, paper and nappy waste is treated for RDF production (%).

3.3 Testing several progress indicators in the energy sector

All the progress indications in the pilot calculation are proportional to the GHG emissions reduction; therefore, Equation 1 was applied. The results of the progress indicators for each mitigation option in the energy sector were shown in Table 2 and Figure 2.

From Figure 2, it can be seen that the two mitigation options in the energy sector that have highest progress include: Option E2. High efficiencty residential refrigerators (0.85) and option E22. Introduction of CNG buses (0.75). This is owing to the implementation of the National Energy Efficiency Program (VNEEP) by MOIT from 2006 to present which has obtained many positive results.

Option E25s. Freight transport shift from road to railway and option E6s. Cleaner cooking fuels have average values of progress indicators, 0.53 and 0.6, with respectively. The other mitigation options need

being imposed greater efforts to reach the mitigation targets as their progress indicator values are all below 0.4.

4. CONCLUSIONS

In order to fulfill Vietnam's international commitment to GHG emission reduction, the MRV system plays a very important role. However, in Vietnam, currently there is not any specific regulation or guidance for the management and implementation of MRV of GHG emissions. The development of a set of MRV indicators at the national and sectoral level is critical to ensuring the realization of national and sectoral GHG emission reduction targets as set out in Viet Nam's updated NDC. From that perspective, this paper has proposed a set of 85 MRV indicators divided into two categories: (i) 12 outcome indicators to track the national and sectoral mitigation targets, (ii) 72 progress indicators to track the implementation of mitigation options in five sectors. Those indicators will be important basis for measurement and reporting of line Ministries on mitigation efforts. Further studies are needed in pilot application of the proposed indicators in selected sectors and development of indicators to track the impacts of those mitigation activities on the sustainable development in Viet Nam.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support from the National Science and Technology Program to respond to climate change, manage natural resources and the environment in the period 2016-2020. The national-level project title "The study and establishment of Measurement - Reporting - Verification (MRV) system for climate change response activities in Vietnam", grant number: BDKH.32/16-20.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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Table 1. Kamet rules analyzing reviews from experts using the Delphi method **ERROR! REFERENCE SOURCE NOT FOUND.**.

Round t	Round t + 1	Round t + 2
Rating mean (qi) ≥ 3.5	If rating mean (qi) ≥ 3.5, Q ≤ 0.5 and rating variance (qi) < 15%, then qi is accepted, and no further discussion concerning qi is needed.	
Rating mean (qi) < 3.5	If Rating mean (qi) <3.5 and Q ≤ 0.5 and rating variance (qi) ≤ 15% then qi is rejected, and no further discussion concerning qi, is needed.	If rating mean (qi) ≥ 3.5, Q ≤ 0.5 and rating variance (qi) ≤ 15% then qi is accepted, and no further discussion concerning qi, is needed.

Table 2. Outcome indicators to track the national and sectoral mitigation targets of the updated NDC.

Tier III-indicators	Unit	Mitigation targets (s_{max})	Targeted year	Responsible agency for measurement and reporting
National level (Tier I-indicator)				
- Percentage of national GHG emission reduction compared to national BAU by 2030 in case of unconditional contribution - Percentage of national GHG emission reduction compared to national BAU by 2030 in case of conditional contribution	%	9 27	2030	MONRE, NCCC
Sectoral level (Tier I-indicator)				
Energy (Tier II-indicators)				
- Percentage of GHG emission reduction in energy sector compared to BAU by 2030 in case of unconditional contribution. - Percentage of GHG emission reduction in energy sector compared to BAU by 2030 in case of conditional contribution.	%	5.5 11.2	2030	MOIT, MOT, MOC
Agriculture (Tier II-indicators)				
- Percentage of GHG emission reduction in agriculture sector compared to BAU by 2030 in case of unconditional contribution. - Percentage of GHG emission reduction in agriculture sector compared to BAU by 2030 in case of conditional contribution.	%	0.7 2.8	2030	MARD
IPPU (Tier II-indicators)				
	%	0.8	2030	MOIT, MOC

- Percentage of GHG emission reduction in the IPPU sector compared to BAU by 2030 in case of unconditional contribution.		0.1		
- Percentage of GHG emission reduction in IPPU sector compared to BAU by 2030 in case of conditional contribution.				
LULUCF (Tier II-indicators)				
- Percentage of GHG emission reduction in the LULUCF sector compared to BAU by 2030 in case of unconditional contribution.	%	9	2030	MARD
- Percentage of GHG emission reduction in LULUCF sector compared to BAU by 2030 in case of conditional contribution.		27		
Waste (Tier II-indicators)				
- Percentage of GHG emission reduction in the waste sector compared to BAU by 2030 in case of unconditional contribution.	%	1.0	2030	MONRE, MOC
- Percentage of GHG emission reduction in waste sector compared to BAU by 2030 in case of conditional contribution.		2.6		

Table 3. Progress indicators to track mitigation activ ities in the energy sector (Tier I-indicator).

Mitigation option	Tier III-Indicators	Unit	NDC targets (s_{max})	s_{min}	s_{2014}	Indicator value
Unconditional contribution (UC) (Tier II-indicators)						
E1. High efficiency residential air conditioning	The percentage of households using standard air-conditioning in urban areas	%	80	0	32.7	0.40
	The percentage of households using standard air-conditioning in rural areas		50	0	4.5	0.09
E2. High efficiency residential refrigerators	The percentage of households using refrigerators in urban areas	%	95	0	81.1	0.85
	The percentage of households using refrigerators in rural areas		80	0	50.2	0.62
E3. High efficiency residential lighting	Percentage of the use of high efficiency lighting (or LED lighting) of the total lamp stock in the residential sector	%	70	0	17	0.24
E4. Solar water heaters	Percentage of households using solar water-heating devices	%	26	0	1	0.0003
E5. Biogas replacing coal for residential	Percentage of households in rural areas will use biogas to replace coal for residential cooking	%	5	0	0.8	0.16

Mitigation option	Tier III-Indicators	Unit	NDC targets (s_{max})	s_{min}	s_{2014}	Indicator value
cooking in rural areas						
E10. Vertical roller mill	Percentage of cement production that applies vertical roller mill	%	50	0	19.1	0.38
E22. Introduction of CNG buses	The number of CNG buses	units	623	0	473	0.75
E29. Small hydropower plants	Total capacity of small hydro power plants	MW	5,000	0	1836	0.36
Conditional contribution (CC) (Tier II-indicators)						
E6s. Cleaner cooking fuels	Percentage of households in rural areas using LPG	%	50	0	30	0.6
E25s. Freight transport shift from road to railway	Percentage of rail freight traffic in the total freight traffic	%	2.6	0	1.4	0.53

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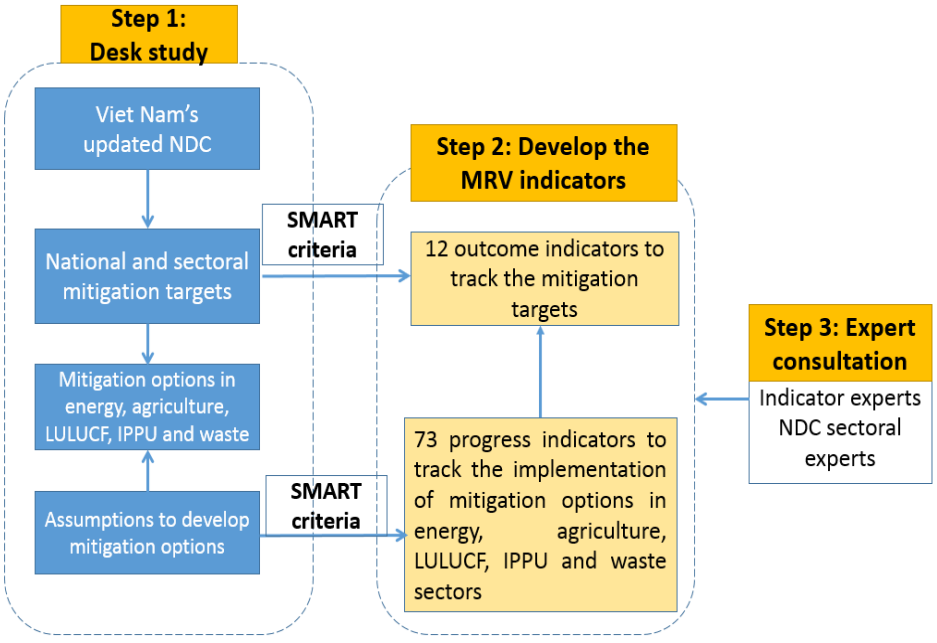

Figure 1. Approach for the development of the MRV indicators.

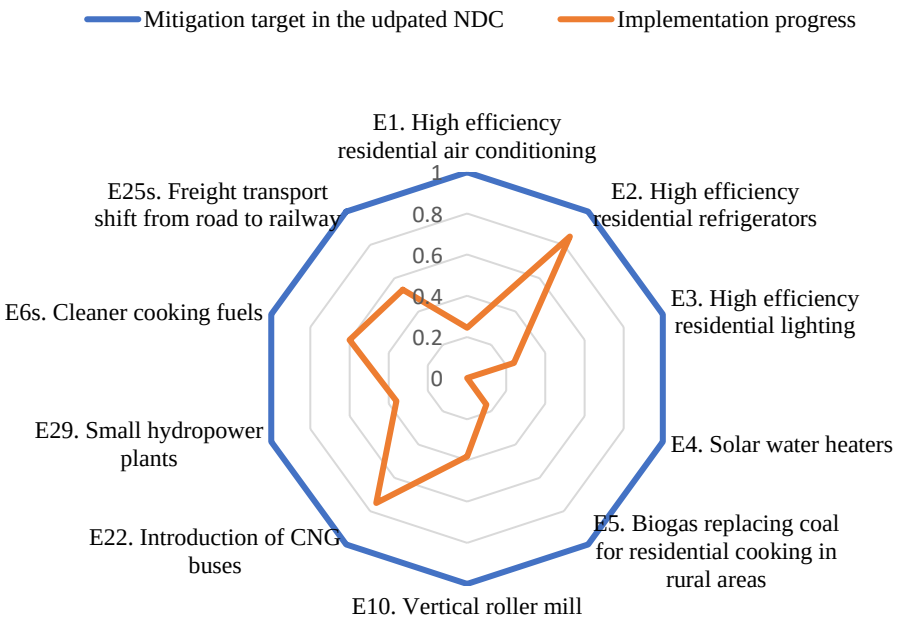

Figure 2. Implementation status of tested mitigation options in the energy sector in 2014.