INDEPENDENT EVALUATION UNIT
OFFICE OF EVALUATION AND INTERNAL OVERSIGHT

INDEPENDENT TERMINAL EVALUATION

Malaysia Energy Efficiency and Solar Thermal Application Project (MAEESTA)

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Evaluation team:

Mr. Roland Wong, Team Leader and International Evaluation Consultant
Mr. Lim Chin Haw, National Evaluation Consultant

Abbreviations and acronyms

Acronyms	Definitions
4IR	Malaysia's 4th Industrial Revolution
9MP	Ninth Malaysia Plan 2006-2010
ADB	Asian Development Bank
AEE-INTEC	AEE Institute for Sustainable Technologies, Austria
APEC	Asia Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
AWP	Annual Work Plan
BIPV	Building Integrated Photovoltaic
CEO ER	CEO Endorsement Request form
CC	Climate change
CCO	Climate Change Office
CDP	Continuous Development Programme
CO_2	Carbon dioxide
DSM	Department of Standards Malaysia
ECO	Energy Conservation Officers
EE	Energy efficiency
EECA	Energy Efficiency Conservation Act
EnMS	Energy Management Standard (ISO)
EOP	End of Project
EPC	Energy performance contract
EPU	Economic Planning Unit (Energy Section)
ESM	Thermal energy saving measures
EU	European Union
ESCO	Energy service company
FiT	Feed-in tariff
FMM	Federation of Malaysian Manufacturers
FSP	GEF full-sized project
GW	Gigawatt, 1000 MW
GWh	Gigawatt-hours
GEF	Global Environment Facility
GEF CEO	GEF Chief Executive Officer
GTFS	Green Technology Financing Scheme
GHG	Greenhouse gas
GITA	Green Investment Tax Allowance
GITE	Green Investment Tax Exemption
GoM	Government of Malaysia
HQ	Headquarters
IPP	Independent Power Producer
ISO	International Organization for Standardization
HL	Highly Likely

Acronyms	Definitions
HS	Highly Satisfactory
HU	Highly Unsatisfactory
IEE	industrial energy efficiency
IEEMMS	Industrial Energy Efficiency for Malaysian Manufacturing Sector
KASA	Ministry of Environment and Water
KeTSA	Ministry of Energy and Natural Resources
KeTTHA	Ministry of Energy, Green Technology and Water
ktoe	kiloton of oil equivalent
kW	kilowatt
kWh	kilowatt-hour
MAEESTA	UNIDO-GEF Project "Malaysia Energy Efficiency and Solar Thermal Application"
MBIPV	Malaysian Building Integrated Photovoltaic
MDV	Malaysia Debt Ventures
M&E	Monitoring and Evaluation
MESTECC	Ministry of Energy, Science, Technology, Environment and Climate Change
MGTC	Malaysia Green Technology Corporation
MIDA	Malaysian Investment Development Authority
MIEEIP	Malaysian Industrial Energy Efficiency Improvement Project
MIGHT	Malaysian Industry Government Group for High Technology
MITI	Ministry of International Trade and Industry
ML	Moderately Likely
MNRE	Ministry of Natural Resources and Environment
MoSTI	Ministry of Science, Technology and Innovation
MPPK	National Education Advisory Council
MS	Moderately Satisfactory
Mtoe	million tons of oil equivalent
MTR	Mid-Term Review
MU	Moderately Unlikely
MU	Moderately Unsatisfactory
MW	megawatt (million Watt)
NDC	Nationally Determined Contribution
NEEAP	National Energy Efficiency Action Plan
NGO	Non-Government Organization
NOSS	National Occupational Skills Standard
NPC	National Project Coordinator
NPD	National Project Director
NPM	National Project Manager
NPSC	National Project Steering Committee
PIR	Project Implementation Review
PMU	Project Management Unit

Acronyms	Definitions
PPG	GEF project preparation grant
PRF	Project Results Framework
PSC	Project Steering Committee
PV	Solar photovoltaic
RBM	Results-based management
RCE	Request for CEO Endorsement
RE	Renewable energy
RM	Malaysian ringgit
RMK-12	12th Malaysia Plan
RoI	Return on invesment
ROtI	Review of Outcomes to Impacts
RToC	Re-constructed Theory of Change
SE4All	UN Sustainable Energy for All
SEC	Specific energy consumption
SEDA	Sustainable Energy Development Authority
SERI	Solar Energy Research Institute
SIRIM Berhad	Standard and Industrial Research Institute of Malaysia
SMART	Specific, Measurable, Achievable, Realistic and Time-Bound
SME	Small-to-Medium Enterprise
SO	System optimization
ST	Energy Commission (Suruhanjaya Tenaga)
STS	Solar Thermal System
tCO_2	tons of carbon dioxide (equivalent)
TC	Technical Committee
TE	Terminal Evaluation
ToC	Theory of Change
ToR	Terms of reference
TWG	Technical Working Group
UKM	University Kebangsaan Malaysia
UNIDO	United Nations Industrial Development Organization
USD	United States dollar

1 Glossary of Evaluation-related Terms

Term	Definition
Baseline	The situation, prior to an intervention, against which progress can be assessed.
Effect	Intended or unintended change directly or indirectly due to an intervention.
Effectiveness	The extent to which the development intervention's objectives were achieved or are expected to be achieved.
Efficiency	A measure of how economically resources/inputs (funds, expertise, time, etc.) are converted to results.
Impact	Positive & negative, intended & unintended, direct & indirect, long term effects that represent fundamental durable change in the condition of institutions, people & their environment brought about by the Project.
Indicator	Quantitative or qualitative factors that provide a means to measure the changes caused by an intervention.
Intermediate States	The transitional conditions between the Project's outcomes & impacts, which must be achieved in order to deliver the intended impacts.
Lessons learned	Generalizations based on evaluation experiences that abstract from the specific circumstances to broader situations.
Logframe (logical framework approach)	Management tool drawing on results-based management principles used to facilitate the planning, implementation and evaluation of an intervention. It involves identifying strategic elements (activities, outputs, outcomes, impacts) and their causal relationships, indicators, and assumptions that may affect project success or failure. The logframe is also referred to in the report as the Project Results Framework (PRF).
Outcomes	The likely or achieved short- to medium-term behavioural or systemic effects to which the Project contributes, which help to achieve its impacts.
Outputs	The products, capital goods, and services that an intervention must deliver to achieve its outcomes.
Relevance	The extent to which an intervention's objectives are consistent with beneficiaries' requirements, country needs, global priorities and partners' and donor's policies.
Risks	Factors, normally outside the scope of an intervention, which may affect the achievement of an intervention's objectives.
Sustainability	The continuation of benefits from an intervention, after the development assistance has been completed.
Target groups	Specific entities for whose benefit an intervention is undertaken.

2. Executive Summary

Evaluation Background and Methodology

An independent terminal evaluation (TE) of the UNIDO-GEF Project in Malaysia entitled "Malaysia Energy Efficiency and Solar Thermal Application Project (MAEESTA)" (hereafter, MAEESTA or the Project) was carried out during the period of June 2022 to February 2023. MAEESTA was launched in Kuala Lumpur on 23 March 2012 at an Inception Workshop by UNIDO with KeTTHA and SIRIM Berhad as executing partners as executing partners. The terminal date of MAEESTA was scheduled for 30 June 2019, a period of 5 years of implementation; this was extended to 30 June 2022. This TE follows UNIDO Evaluation Policy and GEF Monitoring & Evaluation Policy. To deliver an evidence-based evaluation, data and information was sourced from key project documentation, desk studies, meetings with individuals and focus groups, and direct observations. The evaluation employed a participatory approach where key stakeholders were kept informed and consulted throughout the process.

This TE was conducted 8 months after the completion of the Project. The primary challenge of this TE was the International Consultant not being able to visit pilot project sites due to travel restriction, a limitation mitigated by the presence of a National Consultant who was able to visit pilot projects and interview many of the stakeholders (Para 11).

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The aim of this evaluation is was to assess the performance of the project in terms of relevance, effectiveness, efficiency, sustainability, and progress to impact while developing recommendations the could help UNIDO and GEF to improve the design and implementation of similar projects in the future.

Summary of the Main Evaluation Findings

Project results are summarized in Table A against intended outcomes of the Project Results Framework (PRF) and the Theory of Change (ToC) for the MAEESTA Project (see Figure 1). Project evaluation criteria are summarized in Table B.

Table A: Comparison of Intended Project Outcomes from the Inception Report to Actual Outcomes

Intended Outcomes in Project Results Framework of July 2014 and Re-Constructed Theory of Change (see Figure 2)	Actual Outcomes as of June 2022
Objective: To reduce Green House Gas (GHG) emissions by promoting and demonstrating sector-specific Energy Efficiency (EE) improvements and solar thermal technology utilization in industry.	**Actual impact toward objective**: MAEESTA was a significant contributor in catalysing interest in thermal energy saving measures (ESMs) and solar thermal in Malaysia resulting in policy papers being prepared and MAEESTA training activities being very popular. However, due to COVID-19 pandemic and low energy prices in Malaysia, the overall MAEESTA Project GHG emission reduction targets were not met (Paras 58-61 and Table 7).
Outcome 1: Policy papers and financial incentive schemes established and endorsed by stakeholders.	**Actual Outcome 1**: MAEESTA delivered substantial contributions to the policy arena and financial incentive schemes, that were endorsed by stakeholders at workshops and events to raise the profile of these policies and schemes (Paras 65 to 73 and Table 8)
Outcome 2: Awareness and capacity of equipment vendors, service providers, industry management,	**Actual Outcome 2**: Awareness-raising programs, including workshops and hands-on training sessions increased the awareness of industry management, plant engineers, equipment vendors, service providers, and

Intended Outcomes in Project Results Framework of July 2014 and Re-Constructed Theory of Change (see Figure 2)	Actual Outcomes as of June 2022
plant engineers, and financial institutions in 5 targeted industrial sub-sectors strengthened and utilized.	financial institutions;however, changes in the work force of solar thermal specialists did not breed public confidence and trust in solar thermal practices (Paras **Error! Reference source not found.**-83, 94, 109 - 4th bullet).
Outcome 3: Thermal energy efficiency and solar thermal technology demonstrated and deployed in 5 targeted industrial sub-sectors.	**Actual Outcome 3**: Thermal energy efficiency and solar thermal technology were demonstrated but not to a greater audience (Paras 0-96, 106, 107).

Table B: MAEESTA Project evaluation criteria

#	Evaluation criteria	Rating
A	**Progress to impact**	**Moderately Satisfactory.** Depending on the level of external and donor support for bridging SIRIM staffing and ESM and Solar Thermal System (STS) expert capacity gaps and the level of business compliance to the Energy Efficiency Conservation Act (EECA), the pace of EECA implementation towards the long-term impacts may be slower (Paras 116-117).
B	**Project design**	
1	Overall design	**Satisfactory**. The overall design of the MAEESTA is *satisfactory* due to its clarity of preparing policy papers on solar thermal energy, training and awareness raising of solar thermal, and demonstration investments in energy saving and solar thermal practices (Para 51).
2	Logframe	**Satisfactory**. The general quality of the Project Results Framework (PRF) in the context of best practices for its preparation is *satisfactory* with outcome, output and indicator descriptions generally meeting most SMART criteria, and, most importantly, assisting MAEESTA implementers in managing the Project (Paras 44-45).
C	**Project performance**	
1	Relevance	**Highly Satisfactory.** Strong relevance to GoM's Energy Efficiency Conservation Act, the National Climate Change Policy and other plans and acts (Paras 52-54)
2	Effectiveness	**Moderately Satisfactory.** Most targets met. Exception was Outcome 3 where only 15 factories implemented ESMs (out of a target of 30) and 7 STS investments were implemented with 13 projects cancelled for various reasons (Paras 60-96).
3	Coherence	**Satisfactory**. MAEESTA was implemented in a logical manner starting with policy papers followed by capacity building of ESM and STS experts, designers, suppliers and installers, and the deployment of ESMs and STSs. The deployment of ESMs and STSs became problematic due to the COVID-19 pandemic and associated difficult investment scenario across the country (Para 97).
4	Efficiency	**Moderately satisfactory**. MAEESTA exceeded its planned timespan from 5 to 8 years and only spent US$3.58 million out of the total GEF grant of US$4.00 million (Paras 98-100).
5	Sustainability of benefits	**Moderately likely.** With the EECA being promulgated by 2023 or 2024, there are sufficient funds from various grants that can be utilized to finance STS and address the long Return on Investment (RoI) for some of the investments (Para 101).
D	**Cross-cutting performance criteria**	
1	Gender mainstreaming	**Moderately satisfactory.** Gender mainstreaming actions were integrated into all stages of the Project cycles. However, with 10-13% female participation in training and skills enhancement activities and limited female participation in the

#	Evaluation criteria	Rating
		majority of solar investments, gender mainstreaming was an additional challenge. Notwithstanding, MAEESTA has made sustained efforts to utilize gender disaggregated indicators and targets to measure impact, and further encourage female participation (Paras 150-151).
2	M&E: ✓ M&E design ✓ M&E implementation	**Satisfactory.** M&E design makes reference to the Logical Framework Matrix in providing performance and impact indicators for Project implementation along with their corresponding means of verification (Paras 118-120). **Satisfactory**. Project implementation Reports **(**PIRs) were prepared on an annual basis, using an Excel or Word format from 2015 up to 2021. There were challenges to monitoring due to the reluctance of many establishments to fully reveal their energy efficiency activities, primarily for proprietary reasons (Paras 121-123).
3	Results-based Management (RBM)	**Satisfactory.** Results-based management was required to adjust the MAEESTA implementation approach to improve the prospects of meeting targets in the PRF, notably the GHG emission reduction target. With the assumption that policy papers and building capacity itself would be sufficient to catalyze interest and investment in ESMs and STSs, many of these entities could not implement thermal ESM and STS investments for various reasons as laid out in Para 103. This required more adaptive management efforts by the PMU to convince industries and entities to implement thermal ESMs and STS investments, which were ultimately unsuccessful, primarily due to COVID-19 (Para 144-145).
E	**Performance of partners**	
1	UNIDO	**Highly Satisfactory**. UNIDO's performance in these responsibilities was conducted in a manner that was responsive to the requests and needs of the PMU, GoM and stakeholders from the industrial, health and hospitality sectors. All stakeholder participants overwhelmingly expressed their support for UNIDO's continued involvement in this sector (Paras 137-138).
2	National counterparts	**Satisfactory**. SIRIM Berhad provided solid support for coordination of policy papers and the organization of training. Despite their best efforts, SIRIM Berhad's involvement did not result in achieving the target number of ESM and STS demo primarily due to COVID-19 and resulting difficult investment conditions for industries (Para 139).
3	Donor	**Satisfactory**. Despite the shortfall in the target for ESM and STS demos, there were no issues with funding from the donor (Para 140).
F	**Overall assessment**	**Moderately satisfactory.** The MAEESTA Project significantly contributed to catalysing interest in thermal energy saving measures (ESMs) and solar thermal systems (STSs) in Malaysia resulting in policy papers being prepared and MAEESTA training activities being very popular. However, the overall MAEESTA Project GHG emission reduction targets were not met, primarily due to the EECA bill not being cleared in Parliament in 2020 (due to the COVID-19 pandemic and the collapse of the Malaysian government in February 2020), and prevailing low energy prices in Malaysia. There were other reasons that include many entities being reluctant to invest in STS activities until there was more familiarity with these technologies, and many of the ESM and STS installations being installed by uncertified foreign installers leading to substantial risks of STSs not functioning properly. Notwithstanding, the legislation and anticipated mandatory enforcement in 2023 or 2024 of the EECA is a positive development for the deployment of more ESMs and STSs in the industrial, health and hospitality sectors as well as others . GoM agencies will face challenges with current levels of ESM and STS expertise, slowing the pace of EECA implementation, likely 2 to 4 years depending on the level of donor support for bridging staffing and capacity gaps and the level of business compliance with the EECA (Paras 153-155).

#	Evaluation criteria	Rating

Recommendations

Recommendation #1: Create an STS association in order to regulate the quality of STS installations (Para 160).

Recommendation #2: Start mandating real time metering and monitoring of actual energy savings at the company level (Para **Error! Reference source not found.**).

Recommendation #3: Conduct additional ESM and STS showcases and more training to create long term demand for ESMs and STSs (Para **Error! Reference source not found.**).

Lessons Learned

Lesson #1: STS is seen as an attractive technology only by those companies with plenty of resources and a rather long planning horizon (Para 156).

Lesson #2: The awareness of the low efficiency of existing energy supply systems is often lacking, thus leading to little knowledge on higher efficiency of ESM or off-grid STS solutions (Para 157).

Lesson #3: The timeline to establish an STS association that can work with companies and entities to understand the benefits of STS and implement STS installations requires a longer gestation period (Para 158).

Lesson #4: Expert training sessions that come with Continuous Development Programme (CDP) points are more attractive to professionals and consultants to participate in (Para 159).

1. Evaluation Objectives, Methodology, Process

1.1. Introduction and Background on the Terminal Evaluation

1. An independent terminal evaluation of the UNIDO Project entitled "Malaysia Energy Efficiency and Solar Thermal Application Project" (hereafter, "MAEESTA" or the "Project") was included as a part of the Project design of 2014. Following UNIDO Evaluation Policy and GEF Monitoring & Evaluation Policy, this report has been prepared as the Terminal Evaluation (TE) for MAEESTA, carried out during the period of June 2022 to February 2023 by an independent team including an international consultant (Mr. Roland Wong), who also acted as the team leader, and a national consultant (Dr. Lim Chin Haw).

2. MAEESTA was launched in Malaysia on 18 July 2014 by UNIDO, and executed by the Ministry of Energy, Green Technology and Water (KeTTHA), the Standard and Industrial Research Institute of Malaysia (SIRIM Berhad), with Ministry of Science, Technology and Innovation (MoSTI), Malaysian Industry Government Group for High Technology (MIGHT), University Kebangsaan Malaysia (UKM), Federation of Malaysian Manufacturers (FMM), and the Ministry of Natural Resources and Environment (MNRE) as executing partners. The MAEESTA Project was completed on 30 June 2022 over a period of just under 8 years.

1.2. Objectives and Scope of the Terminal Evaluation

3. Guided by Terms of Reference given provided by UNIDO's Independent Evaluation Division (as provided in Annex 1), this TE had 3 objectives:

   - assess Project performance in terms of relevance, effectiveness, efficiency, sustainability of benefits, and progress to impact;
   - drawing lessons and developing recommendations for UNIDO and the GEF that may help for improving the selection, enhancing the design and implementation of similar future projects and activities in the country and on a global scale upon Project completion;
   - develop findings, lessons, and recommendations that could be used to enhance the design of new projects and implementation of ongoing projects of UNIDO.

4. This TE covers the Project's duration from its start on 14 July 2014 until 30 June 2022, which included several no-cost extensions.

5. In terms of scope, the TE assessed the extent to which the Project achieved its objective of "reducing GHG emissions by promoting and demonstrating sector-specific EE improvements and solar thermal technology utilization in industry". In this context, this TE considered the extent to which the technical assistance of MAEESTA was effective and assessed the likelihood of sustainability of Project results in achieving 6 intended outcomes: i) policy papers and financial incentive schemes established and endorsed by stakeholders; ii) awareness and capacity of equipment vendors, service providers, industry management, plant engineers, and financial institutions in 5 targeted industrial sub-sectors strengthened and utilized; iii) thermal energy efficiency and solar thermal technology demonstrated and deployed in 5 targeted industrial sub-sectors; and iv) adequate monitoring and evaluation mechanisms are in place, facilitating smooth and successful project implementation and sound impact.

1.3. Evaluation Methodology

6. The TE was carried out by an independent team in accordance with the required guidance[1] following criteria elaborated in the evaluation's ToR, which were rated using UNIDO's 6-point scale, with justifications elaborated through the Report's main body and findings.

7. This TE employed a participatory approach where key stakeholders were kept informed and consulted throughout the process. The TE team liaised with UNIDO's Independent Evaluation Division regarding methodological issues and the conduct of the evaluation. A full list of persons interviewed during the Evaluation mission is provided in Annex 3.

8. To deliver evidence-based qualitative and quantitative information, the collection of data and information was sourced from key project documentation, desk studies, literature reviews, meetings with individuals and focus groups, surveys and direct observations. Documentation was provided by the UNIDO Project Manager based in Vienna, and the Project Management Unit (PMU) housed within SIRIM in Kuala Lumpur that included information from owners and managers who implemented the ESM and STS measures.

9. The evaluation methodology consisted of:

   - a review of project documents;
   - a re-examination of the Project Results Framework (PRF) through a Theory of Change (ToC) analysis and a Review of Outcomes to Impacts (ROtI), the indicators and targets of which Project performance is evaluated;
   - Zoom discussions in early June 2022 with MAEESTA personnel located in UNIDO HQ in Vienna prior to interviews and mission travel by the National Consultant throughout Malaysia;
   - interviews with the PMU in Kuala Lumpur, country focal points from key ministries of the GoM, national experts, and industrial personnel during field visits to various industrial facilities that were beneficiaries of training, all done during the June-July 2022 period;
   - debriefing with UNIDO HQ in Vienna on preliminary mission findings on 27 March 2023;
   - follow-up phone conversations, emails and reporting writing from home bases during August and September 2022; and
   - a period of additional information gathering, validation of findings and editing of draft report to reflect factual accuracy of the findings.

10. Steps were undertaken to enhance stakeholder engagement and the quality of consultation: i) interviewees were informed about the TE's aims and guided in their input through a semi-structured protocol; ii) well-formulated, open-ended questions and further probes were used to promote balanced reflection, generate new insights, and yield higher quality information (as opposed to yes/no questions or an "audit" approach), as it was considered that input to this TE required contextualisation, complex description, and explanation; iii) interviewees were assured of the anonymity and confidentiality of their input whenever deemed appropriate, notably industrial entities, many of who considered that any information disclosed was considered proprietary or sensitive.

[1] UNIDO's 2015 Evaluation Policy, UNIDO's 2006 Guidelines for the Technical Cooperation Project and Project Cycle, GEF Guidelines for GEF Agencies in Conducting Terminal Evaluations, GEF Monitoring and Evaluation Policy, and GEF Minimum Fiduciary Standards for GEF Implementing and Executing Agencies.

1.4. Challenges and Limitations

11. At the time of this Evaluation, MAEESTA was scheduled for completion on 30 June 2022. The National Consultant of the Evaluation Team spent a total of 20 calendar days traveling throughout Malaysia, making efforts to see as many industrial stakeholders and government partners as possible. Most of the industrial stakeholders were located in the vicinity of Kuala Lumpur with a few located in secondary cities throughout Malaysia located in Johore and Sarawak. Unfortunately, the National Consultant was unable to visit some of these cities due to travel restrictions to these areas. Fortunately, many of the institutional partners and government agencies were located within the Greater Kuala Lumpur area (which has its own challenges related to urban mobility limiting the number of stakeholders that could be visited within one day). Notwithstanding, the limitations to this evaluation were somewhat mitigated by the presence of the National Consultant considering the industrial and institutional stakeholders met during the TE mission who provided a reasonable indicator of the interest catalyzed by MAEESTA on financial incentive schemes, training on energy savings based on process heating and solar thermal technologies, and demonstration projects to raise awareness and investments in solar thermal.

2. Country and Project Background

2.1. Country Background

12. After years of pursuing renewable energy (RE) in its previous plans, the Government of Malaysia (GoM) incorporated renewable energy (RE) in the 9th Malaysia Plan (9MP) between 2006-2010. To facilitate the implementation of RE projects, the GoM introduced several programs such as Small Renewable Energy Programme where all types of RE were promoted and implemented including biomass, biogas, municipal waste, solar, mini-hydro and wind. Since its implementation until 2010, a total of 43 projects with target capacity of 286.15 MW were approved by the government with most of the RE came from biomass and mini hydro.

13. The GoM also launched the Malaysian Building Integrated Photovoltaic (MBIPV) in 2005, a 5-year program targeted to reduce BIPV system costs in the Malaysian market and to generate widespread use of BIPV applications by creating a sustainable BIPV market in Malaysia. This program was supported and funded by GEF, implemented by UNDP and GoM as well as the private sector. The MBIPV program also saw an increase of 203% of PV installed capacity from 468 kWp in 2005 to 1,416 kWp in 2010, reducing 65,100 tonnes of CO_2 emissions.

14. After the completion of MBIPV program, Malaysia has seen multiple new RE policies that have been introduced by GoM including the establishment of the National Green Technology Policy (2009), Malaysia's National Climate Change Policy (2009), the Tenth Malaysia Plan 2011-2015 (10MP), the National Renewable Energy Policy and Action Plan (2010), Renewable Energy Act (2011), National Energy Efficiency Action Plan (2014), the Eleventh Malaysia Plan (2016-2020), and the Twelfth Malaysia Plan (2021-2025). Though many RE policies in Malaysia were related to solar energy, most of these policies were solely focused on solar PV for electricity generation rather than on solar thermal technology for heating applications in Malaysia.

15. Based on the Malaysia's National Energy Balance 2019, the total final energy demand in 2019 was 66,483 kilotonne of oil equivalent (ktoe)[2]. From this demand, 26% was consumed by industry where heating requirement account for 67% of the total energy use and the balance for electricity. This 67% for heating requirements demonstrates the great potential for solar thermal in Malaysian

[2] NEB_2019.pdf (st.gov.my)

industry. Moreover, various studies have shown that 30% of the total industrial process heat demand requires temperatures below 100°C that can be easily met by existing commercially available solar thermal technology.

16. The 2018 Malaysian elections resulted in the formation of the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) which had an even stronger focus on renewables; the minister, Miss Yeo Bee Yin raised the target of RE from 5% to 20%.

17. The 2015 National Energy Efficiency Act was adopted to further foster the efforts by industry and other sectors to reduce energy consumption, not only of electricity but also thermal energy use. As a further evaluation of the 2015 Act, an Energy Efficiency Conservation Act (EECA) was approved under this Ministry and by Cabinet in 2019 with the intention to cover both electrical and thermal energy consumption for sustainable growth for the nation. The Ministry plans to finalize the EECA with an appointed consultant and table it to Parliament by 2023 or 2024. The EECA was set to be mandatory to achieve minimum energy savings and compliance to building energy codes in industrial, commercial, and residential sectors with the aim of achieving Carbon Neutrality by 2040.

18. As of September 2018, there were still barriers to more widespread use of solar thermal technologies:

- The enabling policy framework and support programmes for renewable energy focuses on power generation (grid and IPPs), not thermal applications. Since energy efficiency efforts have often concentrated on electricity savings, there is a subsequent lack of adequate financing, investment, and policy instruments for thermal energy applications;
- Lack of awareness and capacity on industrial solar thermal applications, and thermal energy saving measures (ESMs) in industry. Industry and financial institutions are not aware of the high potential for thermal EE and solar thermal energy;
- Lack of demonstrations on thermal energy savings and commercially viable solar thermal systems in selected subsector industries.

19. The MAEESTA Project was designed to address these barriers in an integrated and holistic approach by combining demonstration projects (with a high replication potential) with training and awareness raising activities to establish a market environment conducive to investments in clean solar thermal energy practices and technologies in industry. A ToC for the MAEESTA Project was provided during the MTR on Figure 1.

2.2. Sector-specific issues of concern to the Project

20. Malaysia is a coastal equatorial economy spread across two main landmasses and endowed with abundant agricultural and energy resources. The industrial and transport sectors dominate Malaysia's energy demand (30% and 40% of final energy demand in 2018, respectively). Natural gas and petroleum products constitute the principal fuels, and oil remains dominant in final energy demand (69% in 2021) despite growth in the use of both electricity and natural gas. From 1990 to 2021, the share of natural gas in final energy demand grew rapidly from 29% to 35%, while oil's share fell from 56% to 34% amid concerted efforts to replace oil-fired power with domestically produced gas-fired power[3].

21. Malaysia's rate of industrialization is reflected in the growth of the manufacturing sector and increased energy consumption. Malaysia has been recording a substantial real GDP growth rate, 3.1% in 2021 (while stagnating between 2017 and 2020), with manufacturing's share accounting for 23.5% of GDP in 2021. Final energy demand by the industrial sector is expected to stagnate and

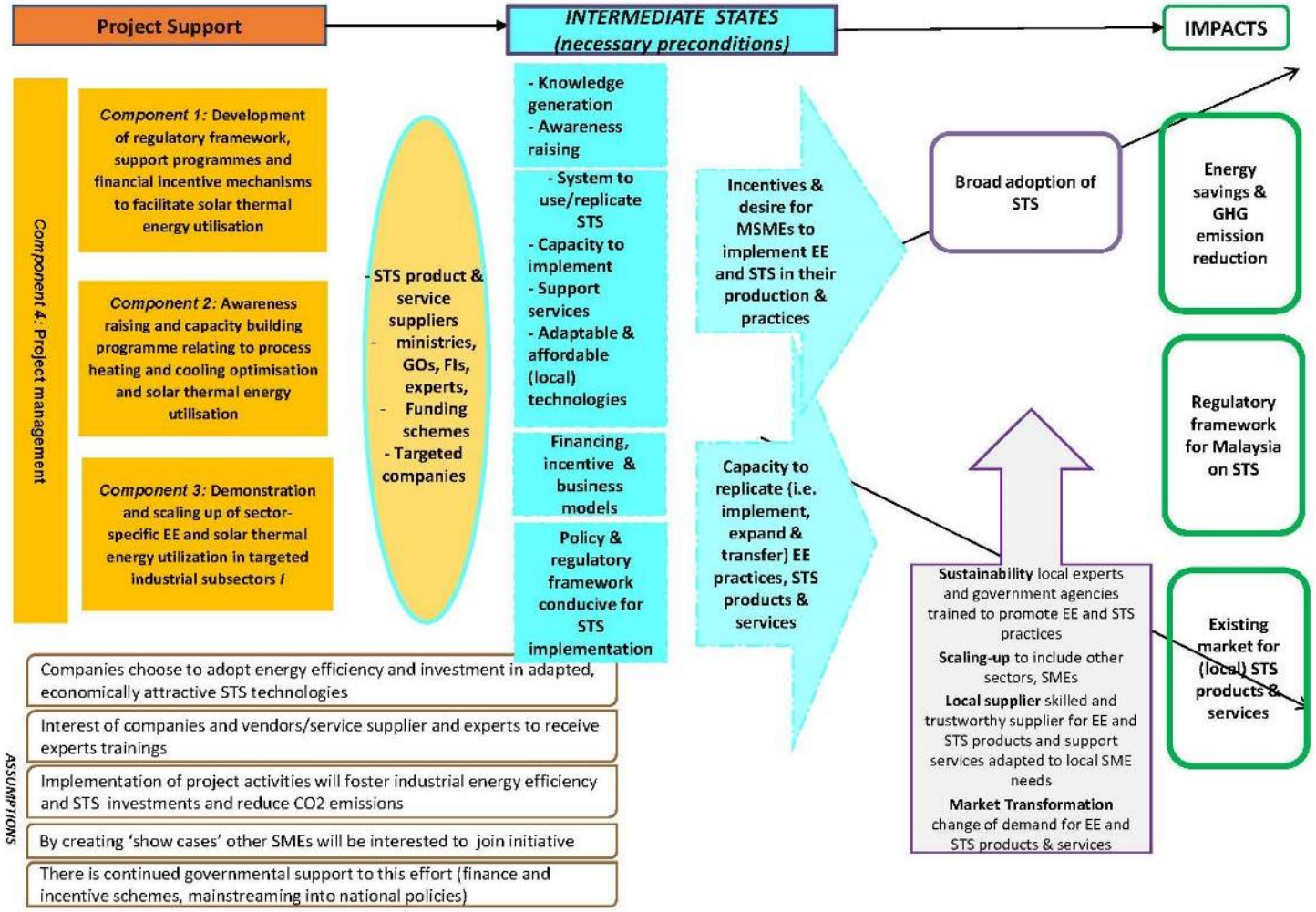
[3] https://ourworldindata.org/energy/country/malaysia

grow at an average rate of 3.4% per year and reach about 35.9 mtoe (million tons of oil equivalent) by 2030[4]. Under this scenario, industry remains the largest energy-consuming sector (about 47% in 2030).

22. Malaysia's industrial output (ranked 34th in the world as of 2018) consists of rubber and palm oil processing and manufacturing, light manufacturing, pharmaceuticals, medical technology, electronics, tin mining and smelting, wood and timber processing (Peninsular Malaysia), wood industries (Sarawak), oil production (Sabah) and agricultural processing, and petroleum production and refining. The major energy-intensive segments of the manufacturing sector are iron and steel, cement, wood, food, glass, pulp and paper, and the ceramics, rubber, chemical, plastics and textiles industries.

[4] https://www.adb.org/sites/default/files/publication/29782/energy-outlook.pdf

Figure 1: Theory of Change for the MAEESTA Project[5]



[5] From MAEESTA MTR, September 2018

23. The National Energy Efficiency Action Plan (NEEAP) was initiated by KeTTHA in 2016. NEEAP was initiated to encourage the adoption of energy efficiency in the public and private sectors through reducing electricity demand growth by 8% over a 10-year period with a total GHG reduction of 38 million tCO_{2eq}. In July 2021, Malaysia's 4th Industrial Revolution (4IR) made reference to disruptive transformation of industries through the application of emerging technology; this translates into advanced technologies to also improve the competitive edge of a country's manufacturing sector, by reducing its reliance on foreign input. This includes opportunities in reducing fossil fuel energy consumption, such as power grid support market, renewable energy and energy efficiency.

24. Supportive policy and regulatory frameworks for thermal energy were not in place prior to the MAEESTA Project. A lack of thermal energy data at the demand level has caused difficulty for the government to develop policies, action plans and set targets for thermal energy. The enabling policy framework and support programmes in Malaysia for renewable energy were focused on grid electricity power generation over thermal applications. This is taking place despite a large portion of the energy being expended to meet heating requirements in the industrial sector. Many programmes, incentives and R&D activities related to solar energy in Malaysia have mainly emphasized solar photovoltaic (PV) for electricity generation, and far fewer heating applications. Apart from domestic solar water heaters, there were no available standards or guidelines in Malaysia that specifically aim for larger-scale solar thermal applications in commercial buildings and industries.

25. However, the drafting of the EECA will be key to enable thermal energy policies and frameworks in Malaysia. The EECA is expected to be tabled in Parliament in 2023 or 2024.

2.3. Project Summary

2.3.1 Project Goal, Objective and General Information

26. The objective of the MAEESTA Project was to "reduce GHG emissions by promoting and demonstrating sector-specific EE improvements and solar thermal technology utilization in industry." The conservation of thermal energy includes:

- improved insulation of heating equipment, ducts, tanks and pipes;
- installation of waste heat recovery systems;
- increased efficiency in combustion, water heating or drying processes;
- efficient air compression and water pumping: good boiler operating practices
- proper cleaning, operation and maintenance of systems;
- optimization of system operations; and
- application of heat pumps and good maintenance (boiler and furnace maintenance, repairing leaks).

27. Many industrial heating processes use heat to process materials, processes that use fuel combustion to produce heat. A portion of this heat is wasted in the form of exhaust gases that need to be discharged from the heating system. These and other losses due to inadequate insulation, improper control of combustion processes can be reduced through proper design, operation and maintenance of the heating system. For lower temperature processes, primary losses are related to the combustion process, heat losses from hot surfaces and hot exhaust gases that contain the heat of water vapour. Recent developments can be used to improve system efficiency such as electronic and computer or

smart controls, better insulation, and condensing heat exchangers or economizers. These can be integrated with solar thermal heating to improve 24/7 application of solar heat without using large accumulators or the need to have a large solar system.

28. To achieve this objective, the Project was structured into 3 components, each of which were designed to deliver outputs, supported by monitoring and evaluation. The MAEESTA design is captured in PRF, which can be found in Annex 6.

29. The 3 components of MAEESTA are as follows:

- *Component 1: Development of a regulatory framework and financial incentive schemes to facilitate solar thermal energy utilization and thermal energy efficiency*. The purpose of this component was to provide an enabling environment by preparing 3 policy papers on solar thermal energy and two financial incentive schemes focusing on solar thermal applications;
- *Component 2: Awareness raising and capacity building programme relating to process heating and cooling optimization and solar thermal energy utilization*. The purpose of this component was to provide training on energy savings based on process heating and cooling and on solar thermal technology, and awareness raising for industrial management and financial institutions on solar thermal investments;
- *Component 3: Demonstration and scaling up of sector- specific energy efficiency and solar thermal energy utilization in targeted industrial subsectors*. The purpose of this component was to implement energy saving measures and solar thermal demonstration projects.

30. General information of the MAEESTA Project is presented in Table 1. Key dates of MAEESTA are provided on Table 2. Project expenditures broken down into Project components and co-financing are provided on Table 3. A listing of stakeholders is provided on Table 4.

Table 1: General Information on the MAEESTA Project

Project title	Malaysia Energy Efficiency and Solar Thermal Application Project
GEF ID number	4878
UNIDO ID (SAP Number)	120264
Region	EAP
Country(ies)	Malaysia
GEF Focal area and operational program:	GEF-5 CCM 2: Promote market transformation for energy efficiency in industry and building sector – c) GHG emissions avoided; GEF-5 CCM 3: Promote investment in renewable energy technologies – a) Appropriate policy, legal and regulatory frameworks adopted and enforced; and b) Sustainable financing and delivery mechanisms established and operational
Co-implementing agency(ies)	n/a
GEF agencies (implementing agency)	UNIDO
Project executing partners	SIRIM Berhad, Ministry of Energy and Natural Resources (KeTSA), Ministry of Science, Technology and Innovation (MoSTI), Ministry of Environment and Water (KASA), Malaysian Green Technology and Climate Change Centre (MGTC)
Project Size (FSP, MSP, EA)	FSP
Project CEO endorsement/ Approval date	28 April 2014
Project implementation start date	11 July 2014
Original expected implementation end	1 July 2019

date (indicated in CEO endorsement document)	
Revised expected implementation end date	30 June 2022
Actual project duration (months)	96 months (against the planned 60 months)
GEF grant (USD)	US$ 4,000,000
GEF PPG (USD) (if any)	US$ 75,000
Co-financing (USD) **at CEO endorsement**	US$ 20,000,000
Total project cost (USD) (GEF grant + co-financing at CEO endorsement)	US$ 24,000,000
Agency fee (USD)	US$ 400,000

Table 2: Key dates for the MAEESTA Project

Milestone	Expected date	Actual date
Project CEO endorsement / Approval date	25 March 2011	28 April 2014
PMU establishment		August 2014
Project implementation start date (PAD Issuance Date)		11 July 2014
Original expected implementation end date (indicated in CEO endorsement/ approval document)	1 July 2019	30 June 2022
Revised expected implementation end date (if any)		30 June 2022
Terminal evaluation completion	30 June 2019	30 November 2022
Planned tracking tool date	30 April 2017	30 November 2022

Table 3: Summary of MAEESTA Logical Framework and budget

Project Component	Activity Type[6]	GEF financing (in USD)		Co-financing (in USD)	
		Approved	Actual[7]	Promised	Actual
1. Regulatory framework and financial incentives	a,b	120,000	946,393	525,000	n/a
2. Awareness raising and capacity building	a,b	886,000	1,391,304	2,175,000	n/a
3. Demonstration projects	a, b, c	2,740,000	1,219,613	16,200,000	n/a
Project management	a	64,000	90,542	100,000	n/a
Monitoring and evaluation	a	190,000	352,178	1,000,000	n/a
Total		**4,000,000**	**3,590,594**	**20,000,000**	**14,182,201**

[6] Activity types are:
a) Experts, researches hired
b) Technical assistance, workshop, meetings or experts consultation scientific and technical analysis
c) Promised co-financing refers to the amount indicated on endorsement/approval.

[7] To 14 April 2022

Table 4: Stakeholders identified at MAEESTA design stage

Stakeholder and Mandate	Role in MAEESTA
SIRIM Berhad The Department of Standards Malaysia (DSM) has appointed the Standards and Industrial Research Institute of Malaysia (SIRIM Berhad) as the sole 'national standards development agency.' SIRIM Berhad is a wholly owned company of the Government (incorporated in 1996) under the Ministry of Finance Incorporated. While Standards Malaysia is responsible at the policy level, SIRIM is responsible at the technical level for the development of standards, as well as R&D development, engineering and design services, technology commercialization, training and consulting services and (through SIRIM QAS Int. Sdn. Bhd.) providing certification, inspection and testing services.	SIRIM Berhad was to be the national executing agency of the project, responsible for hosting the Project Management Unit (PMU) and appoint the National Project Director (NPD). Surveys conducted by SIRIM were to serve as input for the creation of an enabling policy environment under Component 1, and SIRIM was also to assist in the organization and coordination of trainings under Component 2. In addition, SIRIM was also to be involved in the implementation of energy saving measures and solar thermal demo projects. SIRIM Berhad was to be a member of the PSC.
Ministry of Energy, Green Technology and Water (KeTTHA; *Kementerian Tenaga, Teknologi Hijau dan Air Malaysia*) The role of KeTTHA is to facilitate and regulate the electricity sectors in the country, to ensure affordable energy is available to consumers throughout the country (by reviewing tariffs imposed by the utilities and monitoring standards of the utilities), to monitor energy programmes and to promote energy efficiency and renewable energy. The Ministry, in coordination with the Economic Planning Unit (of the Prime Minister's Office), provides the general direction, and strategies in the energy sector. KeTTHA is also responsible for the promotion, innovation in and application of green technologies and for the water sector.	KeTTHA will be the Co-chair of the PSC.
Ministry of Science, Technology and Innovation (MoSTI) MoSTI seeks to increase productivity and competitiveness in agriculture, manufacturing and service sectors, generate new sources of wealth in technology and knowledge-intensive sectors (such as biotechnology, ICT, sea and space technology as well as industrial technology) and to raise the country's capacity for knowledge, creativity and innovation.	MoSTI will be a member of the PSC.
Ministry of International Trade and Industry (MITI) MITI has the function of planning, formulating and implementing policies on industrial development, international trade and investment; encouraging foreign and domestic investment; promoting Malaysia's exports of manufacturing products and services by strengthening bilateral, multilateral and regional trade relations and cooperation as well as enhancing national productivity and competitiveness in the manufacturing sector.	MITI will be a member of the PSC.
Ministry of Natural Resources and Environment (MNRE) MNRE is the GEF Focal point in Malaysia and its major areas of focus include: (i) Natural resource management; (ii) Conservation and management of environment and shelters; and (iii) Management of land survey and mapping administration.	MNRE will be a member of the PSC.
Energy Commission (ST; *Suruhanjaya Tenaga*) ST has been the regulatory agency for the electricity and piped gas supply industries in Malaysia since 2001. The Commission's main tasks are to provide technical and performance regulation for the electricity and piped gas supply industries, safety regulations for electricity and piped gas, to advise the Minister on all matters relating to electricity and piped gas supply and to ensure consumer protection. Another function of the Commission is to promote the use of renewable energy and the conservation of non-renewable energy. Several initiatives have been started, mostly related to efficient electricity production and use	The Energy Commission will be a member of the PSC and will participate in the capacity building activities under Component 1
Sustainable Energy Development Authority (SEDA) SEDA has recently been established and assigned to administering the FiT (feed-in tariff mechanism) and promoting renewable energy technology in Malaysia.	SEDA was to serve as a member of the PSC and participate in the capacity building activities under Component 1.

Stakeholder and Mandate	Role in MAEESTA
Federation of Malaysian Manufacturers (FMM) FMM was established in 1968 and is Malaysia's largest private sector economic organization in Malaysia, representing over 2,000 manufacturing and industrial service companies of varying sizes. FMM is officially recognized and acknowledged as the voice of industry in Malaysia, and its institute offers training courses to upgrade the skills and knowledge of manufacturing sector employees.	FMM was to coordinate the organization of training courses, and participate in the selection of plants for EE improvements and the installation of solar thermal systems (STSs) and awareness raising activities for its members. FMM was to be a member of the PSC and assist in the development of the database under Component 3
Malaysia Green Technology Corporation (MGTC) MGTC, or more commonly known as GreenTech Malaysia, was established on 12 May 1998 as the Malaysian Energy Centre or *Pusat Tenaga Malaysia* (PTM). As a national energy research centre, PTM focuses on the development of the energy sector, especially technological research and demonstration of RE and EE. In August 2009, the Government launched the National Green Technology Policy with the aim to provide direction toward the management of sustainable environment. To pursue it further, PTM was restructured as GreenTech Malaysia on 7 April 2010, to act as the implementing arm of KeTTHA. MGTC is the focal point to drive and facilitate the implementation of the development and promotion of green technology in Malaysia.	MGTC was to be a member of the PSC and participate in the capacity building activities under Component 1. In addition, the Green Technology Funding Scheme, under the auspice of GreenTech Malaysia, was to contribute to the project in the form of potential investment in the projects conducted under Component 1 and 3.
Economic Planning Unit (EPU, Energy Section) The EPU is the principal government agency in Malaysia that was set up in 1961 to "focus on development planning, on high problems in plan execution, and on all forms of foreign aid" for the nation. It has been made responsible for the formulation, implementation, progress evaluation and revision of development plans.	EPU will be a member of the PSC and will participate in the capacity building activities under Component 1
Malaysian Investment Development Authority (MIDA) Under MITI, the MIDA is the government's principal agency for the promotion of the manufacturing and services sectors in Malaysia. MIDA assists companies that intend to invest in these sectors, as well as facilitates the implementation of their projects. MIDA also evaluates applications for projects in the manufacturing and related services sectors, such as manufacturing licenses, tax incentives, expatriate posts, duty exemptions on raw materials, components, machinery and equipment.	MIDA will be a member of the PSC.

2.3.2 Key Events in Project Design and Implementation

31. Table 5 documents the key milestones related to project design and implementation.

Table 5: Key events in MAEESTA Project design and implementation

Key project event	Date
Project preparations for MAEESTA undertaken	2012-2013
CEO endorsement approval	28 April 2014
Setup of PMU for MAEESTA	August 2014
Designation of a National Coordinator for MAEESTA commenced work	March 2015
Sectoral scope of MAEESTA expanded beyond 4 sectors	Commencing mid-2015
Approval of 20 solar thermal demonstrations	2017-2021
Approval of 15 entities for thermal energy savings measures	2017-2022
Sign off on new Energy Efficiency and Conservation Act (EECA)	January 2019
Green Technology Financing Scheme (GTFS) extended to GTFS 3.0 to end of 2022	November 2020
12th Malaysia Plan (RMK-12) with "Solar thermal potential for Malaysia's industrial sectors" approved in Parliament	27 September 2021

Key project event	Date
Terminal date of MAEESTA	**30 une 2022**

2.3.3 Implementation Arrangements and Project Partners

32. As the GEF Implementing Agency, UNIDO had responsibility for the delivery of planned MAEESTA outputs and the achievement of intended outcomes. As agreed with the Government of Malaysia (GoM), UNIDO was also expected to directly execute MAEESTA with its execution partner SIRIM Berhad whose profile is provided in Table 4. UNIDO's responsibilities to MAEESTA included overall management and monitoring, Project performance reporting to GEF, procurement of international expertise to deliver outputs planned under the 3 MAEESTA components, and providing supplemental technical expertise to ensure technically sound deliverables consistent with Project requirements.

33. A Project Management Unit (PMU) was to be established with contributions from SIRIM Berhad as the host. The PMU was to be staffed with a National Project Manager, Assistant National Project Manager, Technical Experts and Project Assistants. PMU responsibilities to MAEESTA included day-to-day management, monitoring and evaluation of Project activities as per approved work plans, and coordination of all Project activities carried out by national experts and partners in close collaboration with SIRIM Berhad. UNIDO was to provide the PMU with GEF funds as required to execute work plans and support necessary management and monitoring of MAEESTA. Execution arrangements for the MAEESTA are illustrated on Figure 2.

34. The Project management arrangements also included a Project Steering Committee (PSC) that was to be established with representatives from the key government institutions participating on MAEESTA, namely SIRIM Berhad, KeTTHA, MoSTI, MITI, SEDA, ST, MGTC, EPU, MIDA and the GEF Focal Point in Malaysia (under MNRE) as well as FMM and UNIDO. The PSC was tasked to review and evaluate progress and provide broad policy guidelines for implementation of the three project components.

35. Detailed working plans for the entire MAEESTA implementation period were to be developed by UNIDO in collaboration with the SIRIM Berhad and KeTTHA. The work plans were to clearly define roles and responsibilities for execution of Project activities, as well as M&E, and to set milestones for deliverables and outputs. The working plan would be used as a basis for advancing funds to the PMU, and as a management and monitoring tool by UNIDO and the PMU to be reviewed and updated as appropriate on a biannual basis.

2.3.4 Positioning of the UNIDO Project

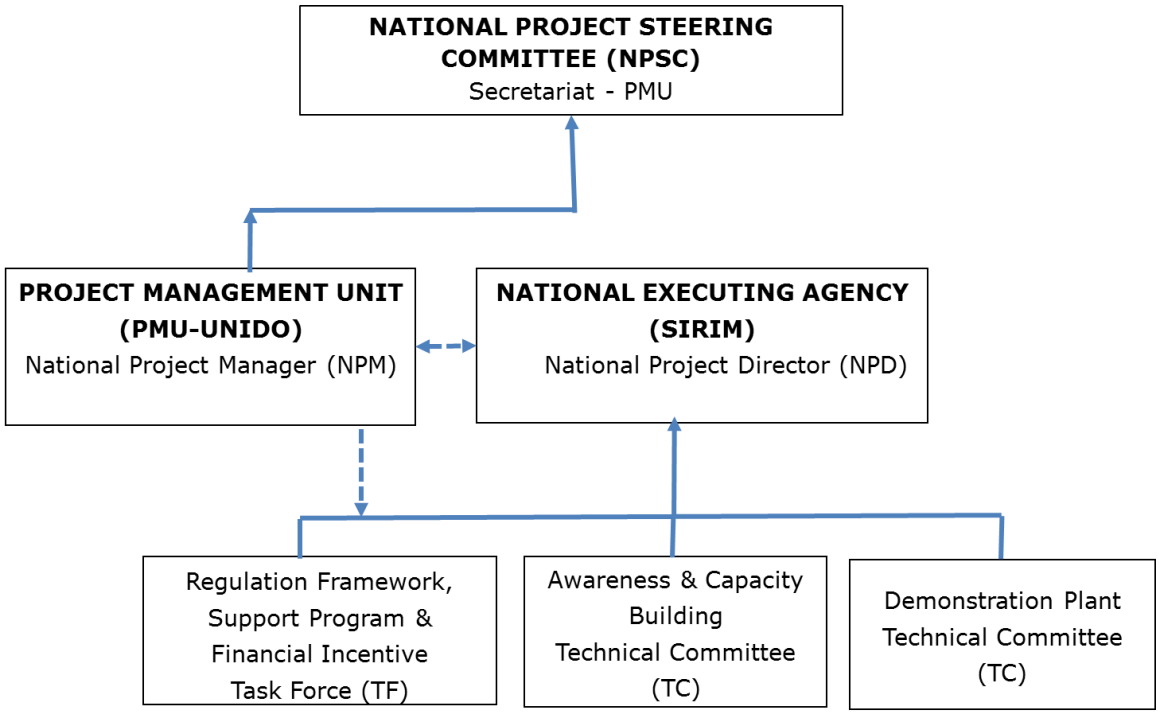
36. The MAEESTA Project was positioned at the time of its design in 2012-2013 to support the reduction of fossil CO_2 emissions in Malaysia's industry, and in particular, with select industrial sub-sectors, by improving energy efficiency in industrial heating processes and process optimization, and the utilization of solar thermal energy whenever applicable and feasible. As a result of MAEESTA, Malaysia was to have improved regulations and financial incentive mechanisms (grant and non-grant instruments) and strengthened technical and institutional capabilities for the development, financing and implementation of ESMs and STSs in industry on a sustainable basis. MAEESTA was positioned to support the GoM in contributing towards:

- The **National Energy Efficiency Act** that was to foster public and private sector efforts to reduce electricity consumption, not thermal energy use. This Act instituted a legal and regulatory framework for EE and conservation, establishment of a centralized agency for EE[8] and development of a funding mechanism including establishment of a revolving EE fund. MAEESTA

[8] Energy Efficiency and Conservation Agency (EECAM) possibly with SEDA.

introduced thermal energy as a part of this Act with a new version of the Act called the **Energy Efficiency Conservation Act** (EECA) in 2019. The Ministry plans to finalize the EECA and table it to Parliament by 2023 or 2024. The EECA was set to be mandatory to achieve minimum energy savings and compliance to building energy codes in industrial, commercial and residential sectors with the aim of achieving Carbon Neutrality by 2040;

Figure 2: MAEESTA Execution Arrangement



- The **National Climate Change Policy** was formulated in 2009 under the **Ninth Malaysia Plan 2006-2010 (9MP)** and updated in 2019. Malaysia was to adopt a dual strategy in addressing climate change impacts: firstly, adaptation strategies to protect economic growth and development factors from the impact of climate change; and secondly, mitigation strategies to reduce emissions of greenhouse gases (GHGs). The Policy aims to mainstream climate change into national policies, plans and programmes and to strengthen the institutional and implementation capacity to better harness climate change adaptation and mitigation opportunities;

- The **National Green Technology Policy** was formulated in July 2009, built on four pillars: energy (seeking to attain energy independence and promote efficient use); environment (to conserve and minimize the impact on the environment); economy (to enhance economic development through the use of technology); and society (to improve the quality of life for all). KeTTHA has been assigned to oversee the Green Technology Policy that will, inter-alia, support the government in achieving its target of carbon neutrality by the year of 2040;

- The **National Renewable Energy Policy and Action Plan** seeks to achieve a 20% renewable energy capacity mix by 2025, and carbon neutrality by 2040;

- The **Renewable Energy Act** was formulated in December 2011 with the GoM supporting feed-in-

tariffs (FiT) for power generated from RE resources. The Sustainable Energy Development Authority (SEDA), a special agency under the KeTTHA, has been established to administer the FiT fund as well as to support the development of RE in the economy;

37. MAEESTA was also positioned amongst other baseline projects related to the GoM's drive to become more energy independent. A sampling of some of these projects included:

- The **Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP)** was implemented from 2000 to 2009 to improve the rational use of energy in the industrial sector. Support and funding was provided by GEF and UNDP, and the former Ministry of Energy, Water and Communications (MEWC) as the project's executing agency and GreenTech Malaysia (now MGTC) as the implementing partner. MIEEIP contributed to creating higher awareness of energy efficiency, establishing an energy benchmarking facility for industry, and supporting quick surveys and energy audits in over 60 companies to identify the potential for thermal and electric energy efficiency, while focusing on 8 sub-sectors (cement, ceramic, iron & steel, food, glass, wood, pulp & paper and rubber);

- The **Industrial Energy Efficiency for Malaysian Manufacturing Sector** (IEEMMS) was implemented from 2011 to 2018. Support and funding were provided by GEF and UNIDO to further improve the policy and regulatory framework, and incentives schemes for energy efficiency in industry. This project focused on energy systems optimization and energy system management; the new ISO 50001 requires an organization to establish, implement, maintain, and improve an energy management system, enabling systematic achievement of continual improvements in energy performance, energy efficiency, and energy conservation. The IEEMMS project did not cover process heating and cooling optimization and solar thermal utilization, a gap that MAEESTA attempted to close;

- The **TECHNOFUND** was created during the 9MP by MoSTI for "pre-commercialization-based projects" resulting in 2 solar thermal related projects with large-scale solar hot water heating systems at the Universiti Kebangsaan Malaysia Medical Centre (PPUKM) in Cheras[9] and solar drying of agricultural and marine products by SIRIM Berhad;

- An STS has been designed, manufactured, and installed by Zamatel, a local company, with technical support from the Solar Energy Research Institute (SERI). In operation since May 2011, the STS has helped to reduce LPG consumption by 69,350 m^3 and CO_2 emissions by 718 tonnes annually. The existence of such large systems encourages local solar energy companies, SERI and related government authorities to pioneer and invest resources into the design, manufacturing and installation of STSs in the potential industrial sub-sectors.

38. Based on the size (in terms of number of companies) of the different industrial sub-sectors of Malaysia, the potential to use solar thermal energy in Malaysia's industry is quite high, particularly in the food and beverage, chemical and pharmaceutical industries, machinery and rubber industries. Sectors with the highest number of companies coincide with those industrial subsectors that utilize low-temperature processes. MAEESTA solar thermal technology was to focus on low-temperature processes.

[9] The Universiti Kebangsaan Malaysia Medical Centre (PPUKM) in Cheras is the first green hospital in Malaysia with the installation of the country's first large-scale hot water system using solar energy. The solar energy system is made up of 2,304 evacuated tubes with a net absorber area of 186 m^2 to supply hot water to 1,000 beds at PPUKM.

3. Project Assessment

3.1. Project Design

3.1.1. Overall Design

39. The MAEESTA design was assessed against the 2013 baseline scenario and barriers to widespread adoption of energy efficiency in the industrial sector in Malaysia as described in Para 37. The MAEESTA design was aimed at supporting the reduction of fossil CO_2 emissions in Malaysia's industry by improving energy efficiency in industrial heating processes and process optimization, and the utilization of solar thermal energy whenever applicable and feasible. MAEESTA did include pilot project investments, relying on the quality of training and follow-up by trained national experts to generate direct energy savings and GHG emission reductions. A number of PPG activities were undertaken by UNIDO between 2012 and 2013 to determine the baseline and barriers to more widespread adoption of solar thermal technologies and other thermal energy efficiency measures including:

- close collaboration with the SIRIM Berhad on the collection and analysis of information on the industrial sector including energy management issues, capacity needs of relevant national institutions, and baseline policy, all of which serve as a basis for incremental assistance from GEF project;
- surveys and consultations with selected industrial stakeholders managing industrial entities, having sufficient fiscal resources and the willingness to make solar thermal investments;
- two workshops to consult with all relevant stakeholders on a proposed project design, designed to solicit feedback and improve the design to meet the needs of specific industrial sub-sectors; and
- preparations of the Request for CEO Endorsement (RCE) document for submission to GEF for funding.

40. The MAEESTA design incorporated an approach to support the preparation of the most suitable projects having the highest potential for solar thermal process heat in Malaysia. This includes the pharmaceutical, textile, pulp and paper, food and beverage processing, metal surface treatment, rubber and the petrochemical and chemical industrial sub-sectors, where hot water and steam are extensively used. The MAEESTA Project was to focus on solar thermal applications that use conventional, non-concentrating, collectors in the low-temperature range up to 100-150°C. Using experiences built with the GEF-funded MIEEIP and IEEMMS projects, new approaches to the optimization of the production process heating and cooling were expected to be formulated.

41. Complementing this aim, specific awareness raising campaigns were to target decision-makers for industries most suitable for solar thermal process heat in the selected subsectors. Several demonstration projects were proposed to gain more experience and to increase confidence in solar thermal technologies. Furthermore, expertise was needed to promote thermal energy savings and applications of solar thermal technology in combination with overall system optimization. Training courses for professionals were required to raise awareness and to overcome the current lack of specific expertise among planners and installers. Finally, MAEESTA was to advise the government on the provision of policy guidelines and instruments to companies for the installation of solar thermal systems to drive their industrial processes.

42. MAEESTA was to utilize the experience of SIRIM, SERI-UKM and CETREE-USM in Malaysia, as well as build on the accumulated knowledge and experience of the AEE Institute for Sustainable Technologies

(AEE-INTEC), Austria. Experience from other industrialized countries using solar thermal, such as the USA, Germany, and Japan, and emerging economies, such as China, India, and Brazil, in the field of process optimization, optimization of process heating and cooling, and solar thermal integration was also to be utilized. MAEESTA was also to introduce software for use as solar simulation tools.

43. With regards to GHG emission targets, the Evaluation Team appreciates the uncertainties of estimating *MAEESTA's global environmental benefits.* The indicators and targets for energy savings and GHG emission reductions generally meet SMART criteria although the "achievability" is questionable considering the difficulties in forecasting what solar thermal measures may be financed and undertaken for each factory.

The rating for overall design is "satisfactory"

3.1.2 Logframe and Reconstructed Theory of Change

44. The Project Results Framework (PRF) for MAEESTA was assessed to obtain a comprehensive understanding of intended outcomes in comparison with the actual outcomes achieved. In addition, the quality of SMART indicators and targets in the PRF has been assessed for its effectiveness in the monitoring of progress. The full MAEESTA PRF is provided in Annex 5. Table 6 is a condensed version of the PRF with suggested amendments to the description of outputs in the PRF as described on pages 29-33 of the RCE Document.

45. While the overall design of MAEESTA appears responsive to the needs of the Malaysian stakeholders in 2013, the general quality of the PRF in the context of best practices for its preparation is *satisfactory* with outcome, output and indicator descriptions generally meeting most SMART criteria, and, most importantly, assisting MAEESTA implementers in managing the Project. Some minor comments on the quality of the PRF in comparison with best practices for preparing PRFs includes:

- Objective (impact) level indicators and targets generally meet SMART criteria;
- Output descriptions are generally prepared according to UNIDO guidance (including the 2011 UNDG RBM handbook). Outputs can be better distinguished from outcomes or actions by simply dropping the verb from the wording of an output. Output descriptions on pages 34-39 of the RCE document are described with verbs whereas the "Revised Outputs" on Table 6 are revised without the verbs. For example, the following indicators were re-worded:
    - Output 1.1 was reworded to "Supported national counterparts for developing 3 policy papers on solar thermal energy:
    - Output 3.1 was reworded to "30 investment projects in 30 factories with energy saving measures";
    - Output 3.2 was reworded to "10 solar thermal demonstration projects";
    - Output 3.3 was reworded to "Case studies prepared and presented to raise more investment in EE and STS integration using the trained capacity and various financial incentive schemes created".

46. The MAEESTA PRF was re-examined on the basis of the ToC in Figure 1. The ToC essentially describes the Project as a roadmap of pathways driven by regulatory or market drivers in combination with Project activities to reach intended outcomes and long-term outcomes; this would enable a more effective assessment of MAEESTA sustainability. A re-constructed ToC (RToC) was prepared for this TE as shown on Figure 3 that is closely linked to the revised MAEESTA PRF in Annex 5, and using UNIDO's "Generic Theory of Change for UNIDO Energy Efficiency Programs" with slight changes to

reflect conditions in Malaysia.

47. The logic of the ToC diagram in Figure 3 flows in a horizontal direction (left to right) from component activities and outputs (brown boxes) to long term Project impacts (dark blue boxes) of the MAEESTA. The ToC includes Project pathways (light pink ovals), direct outcomes (green boxes), and an intermediate state that leads to the intended long-term impact of the MAEESTA of "reduced GHG emissions by promoting and demonstrating sector-specific thermal EE improvements and solar thermal technology utilization in industry". The initial assessment of the MAEESTA PRF led to some adjustments to the language of the outputs in the ToC (as described in Para 45 and in Table 6) which led to re-constructing the Project's ToC.

48. The ToC analysis re-confirms the intended outcomes of the MAEESTA would generate long-term impacts after the EOP that would need to be driven by:

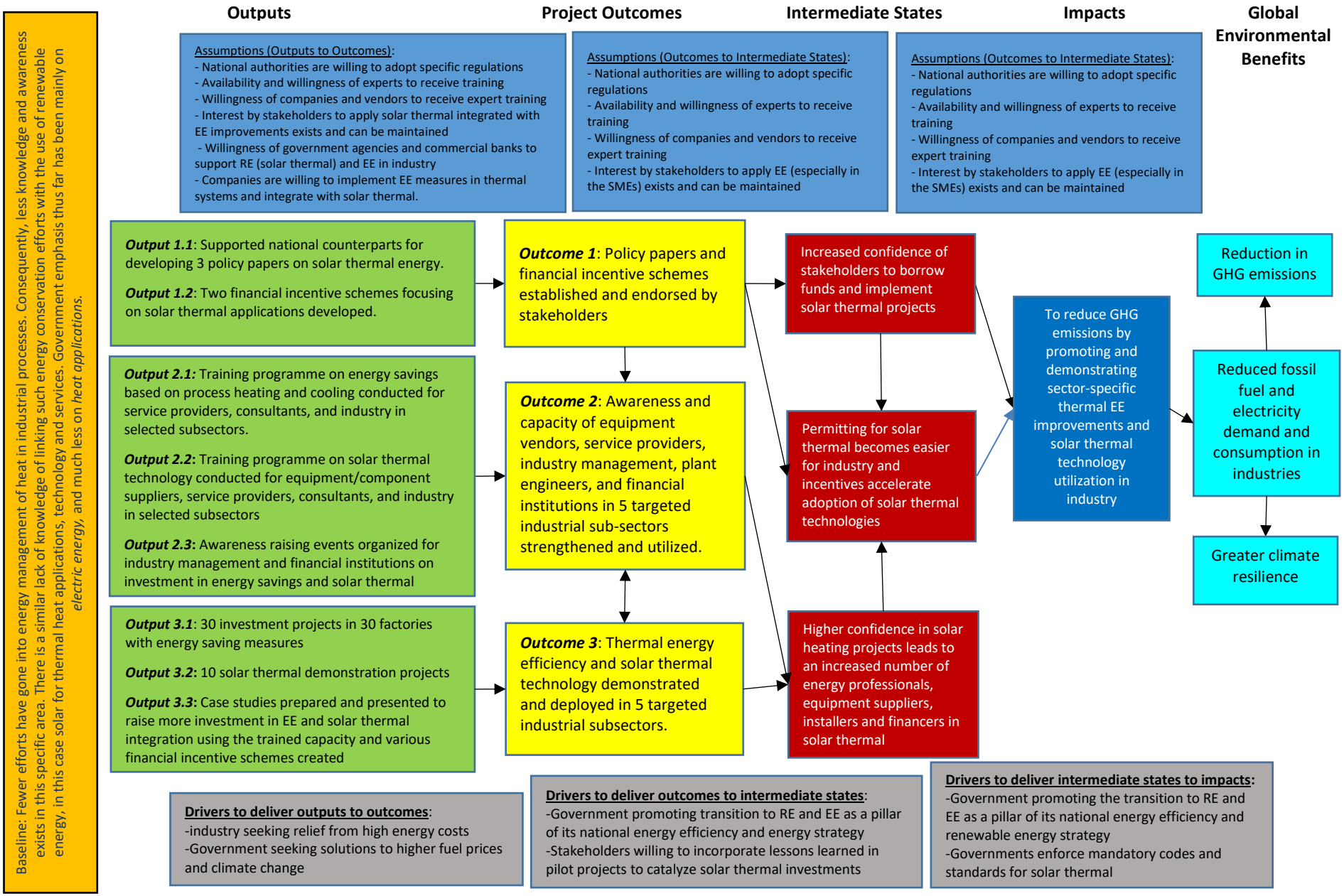
- Government promoting transition to RE and EE as a pillar of its national energy efficiency and energy strategy;
- stakeholders willing to incorporate lessons learned in pilot projects to catalyze solar thermal investments; and
- Governments enforce mandatory codes and standards for solar thermal.

Table 6: MAEESTA Project Results Framework (edited text in red font)

Components	Outcomes	Outputs (in 2014 PRF)	Revised Outputs (for ToC analysis)
Project Objective	Reduce GHG emissions by promoting and demonstrating sector-specific thermal EE improvements and solar thermal technology utilization in industry		
C1: Regulatory framework and financial incentives	**P**olicy papers and financial incentive schemes established and endorsed by stakeholders	O1.1: National counterparts supported to develop three policy papers on solar thermal energy O1.2: Two financial incentive schemes focusing on solar thermal applications developed	O1.1: National counterparts for developing 3 policy papers on solar thermal energy O1.2: Two financial incentive schemes focusing on solar thermal applications
C2: Awareness raising and capacity building programme	Awareness and capacity of equipment vendors, service providers, industry management, plant engineers, and financial institutions in 5 targeted industrial sub-sectors strengthened and utilized	O2.1: Training programme on energy savings based on process heating and cooling conducted for service providers, consultants and industry in selected sub-sectors. O2.2: Training programme on solar thermal technology conducted for equipment/ component suppliers, service providers, consultants and industry in selected sub-sectors O2.3: Awareness raising events organized for industry management and financial institutions on investment in energy savings and solar thermal	O2.1: Training programme on energy savings based on process heating and cooling conducted for service providers, consultants and industry in selected sub-sectors O2.2: Training programme on solar thermal technology for equipment/ component suppliers, service providers, consultants and industry in selected sub-sectors O2.3: Awareness raising events organized for industry management and financial institutions on investment in energy savings and solar thermal

		application	application
C3: Demonstration projects	Thermal energy efficiency and solar thermal technology demonstrated and deployed in 5 targeted industrial sub-sectors	O3.1: Energy saving measures and investment projects implemented in about 40 factories O3.2: Of the above 40 factories, around 10 implemented solar thermal demonstration projects O3.3: Case studies prepared and presented under output 2.3 to raise more investment in EE and solar thermal integration using the trained capacity and various financial incentive schemes created	O3.1: 30 investment projects in 30 factories with energy saving measures O3.2: 10 solar thermal demonstration projects O3.3: Case studies prepared and presented to raise more investment in EE and solar thermal integration using the trained capacity and various financial incentive schemes created

Figure 3: RToC Diagram for the MAEESTA Project



49. In this ToC visualisation, success of the MAEESTA to achieve its intended direct outcomes was predicated on the following assumptions (some of which are mentioned in the PRF) that are somewhat beyond the control of the MAEESTA:

- national authorities are willing to adopt specific regulations;
- availability and willingness of experts to receive training;
- willingness of companies and vendors to receive expert training;
- interest by stakeholders to apply solar thermal integrated with EE improvements exists and can be maintained;
- willingness of government agencies and banks to support RE (solar thermal) and EE in industry;
- grant incentives overcome the issue of relatively low energy prices and longer payback periods; and
- companies are willing to implement EE measures in thermal systems and integrate with solar thermal.

50. In a Review of Outcomes to Impacts (ROtI), pathways from direct outcomes to achieve IEE Project (long term) impacts include intermediate states of "increased confidence of stakeholders to borrow funds and implement solar thermal projects", "permitting for solar thermal becomes easier for industry and incentives accelerate adoption of solar thermal technologies" and "higher confidence in solar heating projects leads to an increased number of energy professionals, equipment suppliers, installers and financers in solar thermal". Assumptions that will increase the likelihood of achieving long term impacts includes "National authorities are willing to adopt specific regulations", "availability and willingness of experts to receive training", "willingness of companies and vendors to receive expert training" and "interest by stakeholders to apply EE (especially in the SMEs) exists and can be maintained".

51. In summary, the overall design of the MAEESTA is *satisfactory* due to its clarity of preparing policy papers on solar thermal energy, training and awareness raising of solar thermal, and demonstration investments in energy saving and solar thermal, notwithstanding the aforementioned issues mentioned in Para 45 on the shortcomings of the SMART indicators in the MAEESTA PRF.

The rating for the log frame is "satisfactory"

3.2. Project Performance

3.2.1 Relevance

52. MAEESTA is highly relevant to the Malaysian government strategy on sustainable energy development. As mentioned in Paras 25 and 36, the GoM has been intent on addressing the issues related to the lack of policies related to solar thermal energy, which has prompted the formulation of the EECA. The EECA indirectly promotes the solar thermal energy application for both industrial and domestic sectors. The target of the EECA is to reduce 8% electricity consumption and GHG emission reduction.

53. Furthermore, the EECA basically institutes a legal and regulatory framework for EE and conservation, the establishment of a centralized agency for EE and the development of a funding mechanism including the establishment of a revolving EE fund. MAEESTA was to introduce thermal energy as a part of the EECA.

54. MAEESTA is also relevant to:

- the National Climate Change Policy formulated in 2009 to mainstream climate change into national policies, plans and programmes and to strengthen the institutional and implementation capacity to better harness climate change adaptation and mitigation opportunities;
- the National Green Technology Policy formulated in July 2009 to support the government in achieving its target of carbon neutrality by the year of 2040;
- the National Renewable Energy Policy and Action Plan that seeks to achieve a 20% renewable energy capacity mix by 2025, and carbon neutrality by 2040; and
- the Renewable Energy Act formulated in December 2011 with SEDA, a special agency under the KeTTHA, established to support the development of RE in the economy;
- the RMK-12 where there was a write-up on "Solar thermal potential for Malaysia's industrial sectors" that was tabled and approved in Parliament on 27 September 2021.

55. MAEESTA also supports GEF-5 CCM 2: "Promote market transformation for energy efficiency in industry and building sector – c) GHG emissions avoided" by addressing key existing barriers on information, technical capacity and market barriers for solar thermal energy and energy savings in Malaysia, as well as GEF-5 CCM 3: "Promote investment in renewable energy technologies – a) Appropriate policy, legal and regulatory frameworks adopted and enforced; and b) Sustainable financing and delivery mechanisms established and operational". MAEESTA implementation included improvement of policy and regulatory frameworks; awareness raising and capacity building on process heating and solar thermal technology, and the demonstration of the application of energy efficient process heating and solar thermal technologies.

56. MAEESTA is also fully in line with UNIDO's mandate, core competences and benefits that were provided from UNIDO's comparative advantage as a GEF implementing agency in the sustainable energy and climate change domain. The organization's mandate is to support inclusive and sustainable industrial development, having strong core competences in the field of green industry, cleaner production and sustainable energy. UNIDO has made significant contributions and is well placed to implement MAEESTA due to its expertise in dealing with industry in Malaysia and building on the experience obtained in the projects "Industrial Energy Efficiency for the Malaysian Manufacturing Sector (IEEMMS)," GEF Id. 3908 and "GEF UNIDO Cleantech Programme for SMEs in Malaysia," GEF Id. 5146. The GEF Council document GEF/C.31/rev.1 also gives UNIDO comparative advantage for this Strategic Program under the Intervention Type Capacity Building/Technical Assistance with MAEESTA having a strong focus on promoting RE and EE in industry. Combining the provision of policy and normative development support services and capacity building for all market players, UNIDO aims to remove key barriers to the continuous improvement of energy efficiency in industries and the increased adoption of renewable energy for productive uses.

57. The UNIDO Energy Programme is structured around four core thematic areas: (1) Industrial Energy Efficiency; (2) Renewable Energy for Productive Uses; (3) Low-carbon technologies; and (4) Benchmarking, Monitoring and Verification. In particular, MAEESTA is a part of the parent programme/umbrella project: "Reducing industry's carbon footprint in South East Asia through compliance with an energy management system (ISO 50001)". The programme is composed of national projects to be implemented in Indonesia, Malaysia, Myanmar, the Philippines, Thailand and Vietnam; each designed to facilitate introduction of ISO 50001 through training and capacity building, including a technical focus on systems optimization.

The rating for relevance is "highly satisfactory"

3.2.2 Effectiveness

58. The effectiveness of the MAEESTA was assessed by examining the extent to which targets against the outcomes and outputs in the PRF and RToC were achieved, or are expected to be achieved in the near future. Accordingly, the results of these analyses are provided in Tables 7 to 10.

59. Table 7 provides a summary of the status of achieving objective-level targets. MAEESTA was a significant contributor in catalysing interest in thermal energy saving measures (ESMs) and solar thermal systems (STSs) in Malaysia resulting in policy papers being prepared and MAEESTA training activities being very popular. However, the overall MAEESTA Project GHG emission reduction targets were not met. Prevailing low energy prices in Malaysia was one of the key factors for low adoption of solar thermal systems by the industry in addition to delays in the clearance of the EECA bill by the Parliament. The EECA was supposed to be tabled in the Parliament in 2020; however, the collapse of the Malaysian government in February 2020 followed by the COVID-19 pandemic pushed further the clearance of the EECA into uncertainty.

Table 7: Summary of the Project's Success in Achievement of Objective

Objective: To reduce GHG emissions by promoting and demonstrating sector-specific thermal EE improvements and solar thermal technology utilization in industry	
Target/Indicators	*Status as at June 2022*
1. **Direct energy savings and substitution:** Solar thermal: 360,000 GJ; Thermal energy efficiency: 40,603,583 GJ	*Solar thermal: 76,788 GJ* *Thermal energy efficiency: 16,915,373 GJ*
2. **Lifetime GHG emission reduction:** Solar thermal: 24 $ktCO_2$; Thermal energy efficiency: 2,735 $ktCO_2$	*Solar thermal: 16 $ktCO_2$* *Thermal energy efficiency: 980 $ktCO_2$*
3. Post-project replication (investment in RE/EE opportunities in industry) will lead to indirect emission reduction of between 5,518 and 17,197 $ktCO_2$	*Unable to monitor*

60. The MAEESTA Project implemented ESMs in industries, hotels and hospitals. The ESMs were identified through expert training programmes and walk-through audits in factories, hotels and hospitals. Since no dedicated GEF funds were allocated for ESMs investment, the implementation was based on company self-awareness and willingness to do energy savings within their sites. Even though many of the companies and entities were not aware of their own low efficiency energy supply systems, the PMU kept following up and encouraging companies to implement ESM and STS investments which was to provide benefits to companies and reduce national GHG emissions. To date, 15 companies have implemented ESM with most companies closely evaluating their economic situation to ensure rates of return on investment against low energy prices[10].

61. The MAEESTA Project also had 20 solar thermal demonstrations approved by the PSC in 2017-2021 though the Project target was only 10. However, out of 20 approved projects, only 5 projects completed the STS installation with 15 projects cancelled due to various reasons, such as businesses being impacted by the COVID-19 pandemic, change in management, difficult investment scenarios, low energy prices and energy performance contracts not attractive due to constraints on the concession period resulting in long payback period. More details are provided in Paras 88-96, and Tables 11 and 12.

Component 1: Development of a regulatory framework and financial incentive schemes to facilitate

[10] This includes Guocera Tile Industries Sdn Bhd., Perusahaan Perkayuan Wan Feng Sdn Bhd, Top Glove Sdn Bhd, Sanwa (M) Sdn Bhd, Toyo Tyre Sdn Bhd, Spirit AeroSystems Malaysia Sdn Bhd, JB Cocoa Sdn Bhd, Perodua Manufacturing Sdn Bhd, Mycron Steel Sdn Bhd, Penfibre Sdn Bhd, Mewah Oleo Sdn Bhd, IOI Pan Century Edible Oils Sdn Bhd, Ampang Hospital, Pusat Jantung Sarawak, and NS BlueScope Malaysia Sdn Bhd.

solar thermal energy utilization and thermal energy efficiency

62. Component 1 was designed to provide technical assistance to prepare thermal energy policies and frameworks in Malaysia. The drafting of the EECA is the key to enable thermal energy policies and frameworks in Malaysia. This Act is expected to be tabled in Parliament with the next government possibly in 2023 or 2024.

63. To reach this point, Malaysia needed to have specific policy papers and frameworks on solar thermal developed prior to any thermal energy act, regulations, or policies to be in place. Prior to the drafting of the EECA, many programmes, incentives and R&D activities related to solar energy in Malaysia have mainly emphasized solar PV for electricity generation with fewer heating applications. Apart from domestic solar water heaters, there were no available standards or guidelines in Malaysia that specifically aim for larger-scale solar thermal applications in commercial buildings and industries. A lack of thermal energy data at the demand level also caused difficulties for GoM to develop policies, action plans and set targets for thermal energy.

64. To address these aforementioned issues, Component 1 was set up to deliver the following outputs (mirroring the output wording of Component 1 in the RToC in Figure 3 and Table 8):

- *Output 1.1: Supported national counterparts for developing 3 policy papers on solar thermal energy*. This was designed to strengthen the capacity of policy makers to introduce an energy management standard by familiarizing them with policy instruments in developed economies to catalyze adoption of energy efficiency;

- *Output 1.2: Two financial incentive schemes focusing on solar thermal applications developed*. This was designed to increase the understanding of industry personnel of the importance of EnMS and energy management planning including energy performance reporting.

Table 8 provides a summary of the status of delivery of these outputs and outcomes.

65. With regards to the delivery of Output 1.1, 6 policy input documents were developed to support the EECA, 3 of which are detailed below:

- Solar Thermal Market Analysis for Malaysian Industries in 2019: This study was conducted on the market potential of solar thermal technology for industries, hotels and hospitals applications. With industry being the main contributors to GHG emissions through their heavy reliance on conventional fuel options (28% in 2016), the study includes target capacity for solar thermal application for 2020-2025 with key recommendations by focus areas and best practices examples. This would lead to yearly emission reductions of 763 ktonnes CO_{2eq}, which would fill in a significant portion of the national CO_2 reduction targets and 0.19% of COP21 target;

- Policy Brief on Solar Thermal Deployment Strategy for Malaysian Industries in 2019: This policy brief document provides deployment strategies to implement key recommendations extracted from the Solar Thermal Market Analysis document for a Phase 1 (2020-2022);

- RMK-12: MAEESTA submitted to MESTECC (now KeTSA) and MEA (now EPU) a write-up on "Solar thermal potential for Malaysia's industrial sectors", for solar thermal technology to be considered in the 12th Malaysia Plan. The RMK-12 document was tabled and approved in Parliament on 27 September 2021 where solar thermal was explicitly mentioned as one of the solar technology solutions to reduce GHG in industry.

66. Four additional documents were developed and endorsed by the stakeholders for solar water heating systems including design specifications, installation guidance, testing and commissioning, and operation and maintenance. The 4 National Occupational Skills Standard (NOSS) documents outlines the path to achieve the minimum competencies required by skilled workers working in Malaysia in the solar thermal field. The topics covered under the NOSS documents include thermal energy audit measurement, solar thermal system installation, solar thermal system engineering

(Level 4), and solar thermal system engineering (Level 5).

Table 8: Summary of the MAEESTA Progress in delivering outputs under Component 1

Expected Outcome 1: Policy papers and financial incentives schemes established and endorsed by stakeholders		
Programmed Outputs	*Target/Indicators*	*Status as at June 2022*
1.1 Supported national counterparts for developing 3 policy papers on solar thermal energy	*At least 3 policy papers on solar thermal energy developed;* *At least 70% of counterparts taking part in the development of policy papers report having benefitted from built capacity*	Six policy input documents supporting the EECA were developed: i) Solar Thermal Market Analysis for Malaysian Industries ii) Policy Brief on Solar Thermal Deployment Strategy for Malaysian Industries iii) Inclusion of the statement in the 12th Malaysia Plan (RMK-12) iv) Guidelines on Energy Management System (EMS) v) Guidelines on Energy Audit Report (EAR) vi) Guidelines on Submission of Energy Efficiency and Conservation Report (EECR) Additional eight documents developed including 4 NOSS documents and 4 solar thermal industry standards: i) Thermal Energy Audit Measurement (Level 3) ii) Thermal Energy System Engineering – Coordination (Level 4) iii) Thermal Energy System Engineering – Management (Level 5) iv) Solar Thermal System Installation (Level 3) v) Solar Thermal Heating System - Design Specifications vi) Solar Thermal Heating System - Installation Guidance vii) Solar Thermal Heating System -Testing and Commissioning viii) Solar Thermal Heating System - Operation and Maintenance
1.2 Training materials and tools on energy management	At least 2 financial incentive schemes developed. At least 5 workshops and seminars/events to present and discuss proposals organized	5 financial incentives schemes for green technology were developed: i) Green Technology Financing Scheme (GTFS) ii) Energy Performance Contracting (EPC) Fund iii) Green Sukuk Issuance iv) Green Investment Tax Allowance (GITA)/Green Investment Tax Exemption (GITE) v) ECO-Labelling MyHIJAU Mark. 5 workshops and events were organized to discuss financial incentive schemes: i) Roadmap Deployment Plan Workshop 1 (Financial group); ii) Seminar on the thermal energy efficiency and solar thermal technologies to financial institutions; iii) Roadmap Deployment Plan Workshop 2 (Financial group); iv) Meeting with financial providers and AEE INTEC; v) Awareness seminar on investment opportunities and incentives in green technology, partnership with: • Invest Selangor, • Iskandar Regional Development Authority (IRDA), • Sarawak Economic Development Corporation (SEDC), and • Economic Planning Unit (EPU) Terengganu

67. Four consultative workshops were conducted in support of the Solar Thermal Market Analysis for Malaysian Industries with SIRIM Berhad, the Task Force (SERI-UKM, MITI, ST, FMM and UNIDO), stakeholders and industry. Four consultative workshops were conducted in support of the Policy Brief on Solar Thermal Deployment Strategy for Malaysian Industries with Malaysian industries,

SEDA Malaysia, MGTC and MESTECC (Energy).

68. With regards to the delivery of Output 1.2, financial incentives and schemes to promote thermal energy efficiency and solar thermal technology investment was promoted together with the possibility of matching with the MAEESTA fund for the solar thermal project investment. Through meeting and engagement sessions, MAEESTA managed to provide awareness to related agencies on the applicability of solar thermal projects and on the existing green technology financial incentives and schemes. Some of the applicable green technology financial incentives schemes from the government for solar thermal technology are:

- the GTFS is a soft loan-based financial mechanism for local companies who are green technology producers and users from building, energy, transport, water, and waste sectors. In November 2020, the scheme has been extended to GTFS 3.0 until the end of 2022;
- the EPC Fund is managed by Malaysia Debt Ventures (MDV providing Energy service company (ESCOs) with a credit financing for EE and energy saving-based projects in a building;
- GITA and GITE incentives are managed by MIDA, and are used by green technology users and service providers.

These schemes are listed on Table 8.

69. On 25 April 2019, MAEESTA collaborated with MGTC to promote and create awareness to the financial institutions, including 35 participants from 16 financial institutions and government departments commercial banks, Islamic banks, development banks and venture capitals, on the thermal energy efficiency and solar thermal technologies. A total of 8 workshops and events between March and November 2019 were organized to discuss financial incentives and schemes[11].

70. Apart from government incentives and schemes, MAEESTA also reached out to private entities to promote and possibility finance solar thermal investment projects. There were a few identified EPC providers (such as Edgenta Energy Services, Private Equity) and banks (such as Hong Leong Bank, AmBank Islamic and HSBC) in search of green financing opportunities. One barrier is that the banks needed guarantees from GoM to secure return on investment and mitigate investment risks related to green projects. Though all financial institutions and banks are always eager to finance viable projects, the challenge with the banks is that they are likely to support projects where they have familiarity and have proven to be successful. The success of GTFS in supporting solar PV projects is a good example of how the financial institutions slowly became familiar with the technology, eventually getting comfortable to work with technology and service providers and ESCOs to offer scaled-up versions of financial packages for solar PV installation.

71. Financing challenges are experienced mostly by service providers or ESCOs, especially when they are to finance an EPC, whereby ESCOs need to raise money to install a project at a host owner's facility and look to recover the money from the energy savings. Although financial institutions are now familiar with the concept of EPCs, the financial costs as well as term and conditions to do such projects can be prohibitive for ESCOs. The MDV's EPC Fund is available to support all ESCOs, though most still find the cost of financing EPCs expensive where terms and conditions are more favorable for larger projects. The other factor affecting most ESCOs is that once they are able to secure financing for one or two projects, they have limited financial capacity to develop more projects as

[11] This included the Roadmap Deployment Plan Workshop 1 (Financial group) on 12 March 2019, the Seminar on Thermal Energy Efficiency & Solar Thermal Application for Financial Institutions in Malaysia on 25 April 2019, the Roadmap Deployment Plan Workshop 2 (Financial group) on 29 April 2019, meeting with financial providers and AEE INTEC on 27 June 2019, Awareness Seminar on Investment Opportunities and Incentives in Green Technology, partner with Invest Selangor on 1 October 2019, Awareness Seminar on Investment Opportunities and Incentives in Green Technology, partner with the Sarawak Economic Development Corporation (SEDC) on 8 October 2019, Awareness Seminar on Investment Opportunities and Incentives in Green Technology, partner with the Iskandar Regional Development Authority (IRDA) on 24 October 2019, and Awareness Seminar on Investment Opportunities and Incentives in Green Technology, partner with the Economic Planning Unit (EPU) Terengganu on 6 November 2019.

the bank is reluctant to loan beyond the credit worthiness of the ESCO's financial position. This is where a collaboration between interested financial institutions and ESCOs should be developed to provide specific solutions.

72. However, most facilities owners seek fast ROI, with the main driver to implement a project being other benefits that they can derive from the project. Hence, incentives like GITA/GITE are of interest to them. Typically, if it is not a priority project, facilities owners will only consider projects that have fast payback within two years.

73. In summary, MAEESTA activities delivered the intended outputs of this component that includes substantial contributions to the policy arena and financial incentive schemes, and workshops and events to raise the profile of these knowledge products. As such, Component 1 is assessed as *satisfactory*.

Component 2: Awareness raising and capacity building

74. Component 2 was designed to provide technical assistance to raise awareness and capacities of solar thermal. This is to overcome the misperceptions at the industrial level of solar thermal to solar PV technologies. The limited use of solar thermal applications is due to a lack of consumer awareness on the technology and inadequately trained solar thermal installers and system integrators in the market. The lack of exposure to solar thermal technology, know-how and limited media coverage are the main reasons for the low take-up rate for the technology to be used in industry. Moreover, the industrial sector was unaware that solar thermal technology can replace natural gas, diesel and biomass for processes that require thermal energy. As a result, they tend to mistakenly associate solar thermal with solar PV.

75. To address these aforementioned issues, Component 2 was set up to deliver the outcome of "awareness and capacity of equipment vendors, service providers, industry management, plant engineers, and financial institutions in 5 targeted industrial sub-sectors strengthened and utilized" and 3 outputs (mirroring the output wording of Component 2 in the RToC in Figure 3 and Table 9:

- Output 2.1: Training programme on energy savings based on process heating and cooling conducted for service providers, consultants and industries in selected sub-sectors. This was designed to improve the skills and competency for service providers, consultants and industry in the implementation of process heating and cooling projects;
- Output 2.2: Training programme on solar thermal technology conducted for equipment/ component suppliers, service providers, consultants and industries in selected sub-sectors. This was designed to improve the competency of equipment suppliers, service providers, consultants and industry in the implementation of solar thermal projects;
- Output 2.3: Awareness raising events organized for industry management and financial institutions on investment in energy savings and solar thermal. This output was intended to enhance awareness among industry management and financial institutions to make decisions on investments on energy saving and solar thermal application, including using case study results of Component 3.

Table 9 provides a summary of the status of delivery of these outputs and outcomes.

76. With regards to delivery of Outputs 2.1, the training programme was structured as follows:

- Half-a-day awareness seminar for companies' top management between 2014-and 2019;
- Two-day users training as basic training on Energy Efficiency and integration of solar thermal in 2022 and between 2016 and 2019;
- Two 4-day trainings as an advanced expert training between 2016 and 2020 consisting of:

- Four-day training on energy efficiency, audit methodology, and basics on renewables integration;
- Accompanied project work of six months supported by project experts linked to assessments and following implementation of energy efficiency measures (target 40) and solar thermal (target 10);

Table 9: Summary of the MAEESTA Progress in delivering outputs under Component 2

Outcome 2: Awareness and capacity of equipment vendors, service providers, industry management, plant engineers, and financial institutions in 5 targeted industrial sub-sectors strengthened and utilized		
Programmed Outputs	*Target/Indicators*	*Status as at March 2019*
2.1 Training programme on energy savings based on process heating and cooling conducted for service providers, consultants and industries in selected sub-sectors	50 equipment vendors, 100 users, and 50 experts trained	Organized 15 trainings throughout the regions. Number of joined participants is 29 equipment vendors, 495 users and 220 experts. From 220 participants, 127 are trained EE experts.
2.2 Training programme on solar thermal technology conducted for equipment/ component suppliers, service providers, consultants and industries in selected sub-sectors	30 equipment vendors, 80 users, and 40 experts trained	Organized 15 trainings throughout the regions. Number of joined participants is 17 equipment vendors, 509 users and 135 experts. From 135 participants, 49 are trained experts.
2.3: Awareness raising events organized for industry management and financial institutions on investment in energy savings and solar thermal	At least 20 awareness-raising events for the target group (industry managers, financial institutions) organized, including experience with the demonstration projects. 20 publications, posters, etc. issued; project website operational	27 awareness seminars organized throughout the regions with 1,118 attending participants. Various project promotional materials developed including: ● Project profiles (2) ● Advertising banners (2) ● Newsletter (1) ● Article (1) ● Technical paper (1) ● Magazines (2) ● SIRIM's Annual Reports (5) – 2016, 2017, 2018, 2019, 2020 ● Website (1) ● Social media, i.e. Facebook (1) ● Newspaper 2015, 2018 (2) ● Posters (7) ● Video (1)

- Four-day training on integrating solar thermal on an advanced level including a presentation of project work and a final evaluation;
- At the end of the training, the participants were assessed on their knowledge and understanding on the expert courses, completion of an audit report and a final examination for certification.

77. The experts training was intensive training that provided more in-depth technical information on application, operations, troubleshooting and improvements to waste heat recovery systems and solar thermal systems. This training also introduced basic principles for designing energy efficient heating systems, waste heat recovery systems and STSs. The participants were trained through classroom and on-the-job trainings, webinars and coaching sessions with international experts. Expert participants were trained in assessing and evaluating identified measures, while demonstration host companies are directly involved in the whole process.

78. Out of 355 participants who attended the expert training, 36% are from manufacturing industries while 39% are from ESCOs, out of which 13% of participants were women. Four expert batches took Course 1 on "Thermal energy efficiency and energy audit" for 4 days culminating with a short

examination and the start of on-the-job-training at the host companies. The batches would work together for 4-6 months to carry out the energy audit and prepare the group audit report. During this period, PMU and the international consultant supported the participants through progress reports updates and site visits.

79. After submitting a draft report for Course 1, the expert batch would start on Course 2 on "Solar thermal system concept design and analysis" with energy audit report presentations. Throughout the course, participants were taught to design the solar thermal integration concept using tools provided by an international consultant. At the end of the course, participants took a short assessment examination, and completed an audit report on solar thermal design. The number of trained experts for Course 1 was 127. Out of the 49 shortlisted participants for Course 2, 25 participants passed and qualified as experts.

80. With regards to delivery of Output 2.2, one-day users training was conducted for equipment vendors to expose the key market players to solar and heating system application optimization techniques and service offerings, and also to enable the trainees to identify the important things on their market offerings and system service approaches. The market for solar thermal system players in Malaysia is small with about 16 companies, some of who joined the MAEESTA training programme and who took part as vendors for solar thermal demonstration projects under MAEESTA. It is noteworthy that none of the targets for equipment vendors was achieved (Output 2.1: 29 equipment vendors versus a target of 50, and Output 2.2: 17 equipment vendors versus a target of 30).

81. Financial training on "Aspects of financial and engineering economics" was held on 18 December 2017 with the objective to assist participants in developing the financial proposals to top management of the companies interested to invest in solar thermal system. The training was attended by 33 participants from energy consulting companies, manufacturing industries, institutes of higher learning, research institutes and government agencies who had participated in the earlier capacity building programmes under the MAEESTA. The training was delivered by a member of FMM's Energy Management Committee.

82. With regards to delivery of Output 2.3, 27 awareness seminars and webinars were conducted between 2014 and 2022 to create and promote awareness for industries, academia and other stakeholders on MAEESTA on process heating energy efficiency and solar thermal technology applications. The seminars and webinars covered an introduction to the MAEESTA Project, thermal energy efficiency measures, solar thermal process heating and cooling applications and integration, existing incentives and grants as well as best practices examples (national and international projects). The seminars were organised across Malaysia in collaboration with industry organisations and associations such as FMM, the Malaysia Rubber Products Manufacturers' Association, the Malaysia Association of Energy Service Companies and government agencies such as SIRIM Berhad, MGTC, Iskandar Regional Development Authority, Invest Selangor, Sarawak Economic Development Corporation and the EPU Terengganu.

83. In summary, the delivery of outputs of Component 2 is assessed as ***satisfactory***. To this end, MAEESTA has made a substantial contribution to the training of engineers, service providers, consultants and industries on energy savings based on process heating and cooling and solar thermal technologies. MAEESTA has made significant progress by conducting awareness programmes, workshops and hands-on training sessions supervised by industry experts, sessions that have been attended by a diverse group of people from industrial sub-sectors, consultants and higher learning institution. However, there is not yet a critical mass of expertise for thermal ESM and STS to sustain efforts to mainstream these technologies; more awareness raising and training is needed.

Component 3: Investment demonstration projects

84. Component 3 was designed to achieve the outcome of "demonstrating thermal energy efficiency

and solar thermal technology deployed in 5 targeted industrial subsectors". To achieve this outcome, the delivery of 3 outputs was proposed:

- *Output 3.1: 30 investment projects in 30 factories with energy saving measures*. This output was designed to implement thermal ESMs in industries, hotels and hospitals. The ESMs were identified through expert training programmes and walk-through audits in factories, hotels and hospitals. Potential ESMs were recorded, and PMU did follow-up with companies on implementation measures;

- *Output 3.2: 10 solar thermal demonstration projects*. This output was designed to develop solar thermal demonstrations based on the commitment and motivation of the company from both technical and financial readiness. Major project costs are covered by the company (65% - 80%) with MAEESTA funds covering 20-35% of the cost after the project is completed;

- Output 3.3: Case studies prepared and presented to raise more investment in EE and solar thermal integration using the trained capacity and various financial incentive schemes created. This output was designed to build the capacity of local financial institutions on IEE evaluation criteria, and of factory managers and national experts on EnMS and developing IEE projects. Training would be delivered by international finance experts.

Table 10 provides a summary of the status of delivery of these outputs.

Table 10: Summary of the MAEESTA Progress in delivering outputs under Component 3

Outcome 3: Demonstrating thermal energy efficiency and solar thermal technology deployed in 5 targeted industrial subsectors		
Outputs	*Target/Indicators*	*Status as at June 2022*
3.1: 30 investment projects in 30 factories with energy saving measures	30 companies with EE improvements in process heating and cooling	**16 factories** with EE improvements in process heating and cooling
3.2: 10 solar thermal demonstration projects	10 facilities with integrated solar thermal systems.	Installed STSs: **5 projects** Collector area**: 1066.5m² (aperture)** Lifetime energy generation**: 76,788 GJ (21%)**
3.3: Case studies prepared and presented to raise more investment in EE and solar thermal integration using the trained capacity and various financial incentive schemes created	10 case studies prepared and presented at seminars/ workshops (total of 20 event days, held at workshops at various places throughout Malaysia)	Number of case studies**: 5**

85. With regards to the delivery of Output 3.1, MAEESTA implemented ESMs in 15 industries, hotels and hospitals[12]. Since no Project funds were allocated for ESM investments, implementation in 2018-2022 was based on company willingness to generate energy savings on their sites. Nonetheless, PMU kept following up and encouraging companies to implement ESMs to provide benefits to companies and reduce national GHG emissions. In the end, the Project did not reach its target for this indicator; only 16,915,373 GJ of lifetime energy savings were generated compared to the target of 40,603,583 GJ. This amounted to a lifetime emission reduction of 980,000 tonnes CO_{2eq} compared to the lifetime target of 2,735,000 tonnes CO_{2eq}.

[12] This included Guocera Tile Industries Sdn Bhd, Perusahaan Perkayuan Wan Feng Sdn Bhd, Top Glove Sdn Bhd, Sanwa (M) Sdn Bhd, Toyo Tyre Sdn Bhd, Spirit AeroSystems Malaysia Sdn Bhd, JB Cocoa Sdn Bhd, Perodua Manufacturing Sdn Bhd, Mycron Steel Sdn Bhd, Penfibre Sdn Bhd, Mewah Oleo Sdn Bhd, IOI Pan Century Edible Oils Sdn Bhd, Ampang Hospital, Pusat Jantung Sarawak and NS BlueScope Malaysia Sdn Bhd.

86. Overall, the willingness to implement identified ESMs was very dependent on how each company manages its energy use. The type of companies implementing ESMs during the Project can be categorized as a large energy user, a multinational company, a company having existing energy sustainability management in place, or a company having existing requirements and regulations to comply with. While all participating companies were quick to implement low to no cost measures (such as fixing leaks), most were very slow at implementing measures that require some form of investment. Reasons mentioned by participating companies for not implementing ESM-related investments were:

- long payback where investment periods longer than 2 years was not worthy of investment consideration;
- not a priority investment as the system is still functioning and production not affected;
- the cost of energy is 3% of the total operating cost, and not a significant portion of the company's overall operating cost.

87. With regards to the delivery of Output 3.2, STS demonstrations were selected based on both technical and financial readiness with the main drivers for the demonstration being the commitment and motivation of the company. Total lifetime thermal energy savings of 76,788 GJ and lifetime GHG emission reductions of 16 ktonnes CO_{2eq} were generated compared to the targets of 360,000 GJ and 16 ktonnes CO_{2eq} respectively.

88. With 20 STS demonstrations approved by the NPSC through PSC meetings in 2017-2021, there were 5 STS demonstrations implemented with Table 11 depicting these STS investments that included 2 significant investments made in hospitals in the health sector. There were 15 STS demonstrations that were cancelled due to various reasons, such as change in management, business impacted by COVID-19, difficult investment scenarios, long payback period resulting from relatively lower energy prices, and EPC contract not attractive due to constraints in the concession period available by facility management. Cancelled STS demonstrations are shown on Table 12.

89. A site visit was made to the MIWA Manufacturing Sdn Bhd in Selangor who installed an STS with a 4,000 litre calorifier tank that had an overflow problem. The project commenced in 2017 when SIRIM approached the company via the Fraunhofer grant scheme, and progressed in 2018 with SIRIM involved with UNIDO for co-financing of the investment. Proposal was seen by the UNIDO team, but no further input was provided. In 2019, the STS was commissioned with all procurement via SIRIM only. The STS was initially designed to cater for single line but now it has 2 lines in operation. With the factory previously using gas-fired boilers, the STS changed daily electricity consumption from RM 2,500 for 5 batches per day to RM 4,000 for 18 batches per day. Though the system has an automatic controller, there was no real-time monitoring system to allow the PMU side to monitor the performance of the system, and no dedicated technical person on site to monitor the daily operation of the STS. This site was used as a case study for SIRIM program (see Para 95). The calorifier tank has an overflowing problem due to the malfunction of the floatation system. The owner has the intention to use cloud monitoring with more sensors installed in the system. Currently, there is no trained technician to monitor the operation of the solar thermal system. Only the management that has some knowledge about the operational system. The owner intends to expand the production and find a new and bigger place.

90. There was no site visit to the IOI Pan-Century Oleochemicals Sdn Bhd plant or the NB Poultry Factory in Pontian, Johor. NB Poultry installed an STS with 2-12,500 litre calorifier units that was commissioned in 2020. The system has been in operation for 2 years now without any major problem with total chicken production at full capacity of 40,000 to 60,000 chicken per day to COVID-19 pandemic production of 30,000 to 40,000 chickens per day. The factory owner has saved 50% of the diesel cost for heating, using 160 litres of diesel per day compared to 320 litres. The factory requires around 60^{o}C of hot water to processing the chicken. On a sunny day, the system has the capacity to provide 90 to 100% hot water to the factory without for the auxiliary heater.

Chicken processing only starts at night because during the daytime, the lorries will go out to collect the chicken from farms. The factory owners is pleased with the solar thermal system, and has the intention to install a solar PV system to cater for the electricity consumption in the factory.

Table 11: Solar thermal demonstration projects implemented

Company	Sub-sector	Investment Cost (MYR)	MAEESTA Contribution (MYR)	Remarks
MIWA Manufacturing Sdn Bhd	Food	150,864	37,716	Completed
IOI Pan-Century Oleochemicals Sdn Bhd	Food	286,147	122,634	Completed
NB Poultry Processing Industries Sdn Bhd	Agriculture (Poultry)	870,100	269,000	Completed
Ampang Hospital	Healthcare	1,411,200	481,800	Completed
Pusat Jantung Sarawak	Healthcare	1,374,500	317,500	Completed
Totals:		**4,092,811**	**1,288,650**	

Table 12: Solar thermal demonstration projects not approved

Company	Sub-sector	Investment Cost (MYR)	MAEESTA Contribution (MYR)	Remarks
Perusahaan Perkayuan Wan Feng Sdn Bhd	Timber	220,000	44,000	Long payback
Advanced Kitchen Processing Sdn Bhd	Food			Change in management
Tuanku Ja'afar Hospital	Healthcare	350,000	105,000	EPC not attractive due to constraint concession period
Farm's Best Food Industries Sdn Bhd	Food	1,945,000	225,000	EPC not attractive
FIMA Bulking Services Sdn Bhd	Storage	763,338	341,973	Disagreement between FIMA Technology and FIMA Bulking Services on the integration design for the solar thermal project
Encompass Industries Sdn Bhd	Rubber	357,263	107,179	Business impacted by COVID-19
Damai Beach Resort	Hospitality	419,000	125,700	Business impacted by COVID-19
KPFB Bersepadu Sdn Bhd	Animal Food	644,898	193,469	Business impacted by COVID-19-change in management
FPG Oleochemicals Sdn Bhd	Oleochemicals	759, 096	265,684	Business impacted by COVID-19
UiTM Private Specialist Centre	Healthcare	633,000	186,550	Prioritized changed, the institute is focusing on preparing to be National Heart Centre for Selangor
Slim River Hospital	Healthcare	456,600	129,810	EPC contract not attractive due to constraint concession period
Hospital Raja Permaisuri Bainun (Ipoh)	Healthcare	1,080,000	278,000	
Hospital Teluk Intan	Healthcare	580,000	203,000	
Sg. Buluh Hospital	Healthcare	n/a	0	Not approved due to long payback period
PPNJ Poultry	Food	n/a	0	Not approved due to long payback period
Totals:		**8,208,195**	**2,205,365**	

91. A site visit was made to the Ampang Hospital in Kuala Lumpur who installed an STS with 4-10,000 litre calorifier tanks along with retrofitting with LED tubes through an EPC. The STS investment was able to save 95% of LPG consumption amounting to annual savings of RM 282,142. The STS is also connected to 4 heat pump units to assist the STS during nights and rainy days. While only one of the 4 calorifier tank units is operational, Ampang Hospital management is pleased with the solar thermal installation. UNIDO covered 30% of the solar collector cost.

92. A site visit was made to the Pusat Jantung Hospital in Kuching, Sarawak who installed an STS with 2 calorifier tanks along with replacement of florescent lighting with LED tubes. With the investment of the solar thermal and LED tubes being RM 4,185,660, annual energy savings amounted to RM 1,315,269, and annual GHG reduction of 4,249 tonnes. Daily hot water usage for the hospital is 7,299.26 litres. Average supply hot water supply temperature is 81^0C with the solar thermal system connected to 4 heat pump units to augment the solar thermal system during rain and nights. Based on site visit observation, the evacuated tubes were infected by fungus. UNIDO covered 30% of the solar collector cost.

93. Though there was no approval for GEF-UNIDO funds to cover 30% of the solar collector cost for the Sg. Buluh Hospital (Kuching), an STS installation was performed by Zamatel, a contractor who also installed the STS for Hospital UKM. There are reportedly still many defects in the solar thermal systems at both Sg. Buluh Hospital and Hospital UKM. However, the STS at Sg. Buluh Hospital is still operational.

94. Many of the STS installations were installed by uncertified foreign installers (mostly Bangladeshi or Indonesian) leading to substantial risks of STSs not functioning properly. For example, over 80% of STSs in Malaysia experience overheating with heat dissipators needing to be installed to protect the STSs from overheating, and several installations have problems with leaking pipes. Reportedly, training for STS installations has been done through You Tube channels and cursory inspections. To date, there have been no inputs to these issues given by NOSS local installers, and no supervision provided by the management of the installation company. This is a severe risk for ESCOs and installation companies in general, in that additional costs could be incurred repairing STSs, affecting the profitability and sustainability of ESCOs. With no regulations over the quality of STS installations and the EECA (with solar thermal) becoming mandatory in the near-future (2023 or 2024), installation companies have attempted to form an STS installation association, approaching the Energy Commission and MoSTI to assist these companies in regulating all aspects of their installations. Discussions are ongoing to establish a timeline to form an STS association who can work with companies and entities to understand the benefits of STS, and implement STS installations; this will likely require a 2–3-year gestation period.

95. With regards to the delivery of Output 3.3, MAEESTA has developed 5 case studies for MIWA Manufacturing Sdn Bhd, IOI Pan Century Oleochemicals Sdn Bhd, NB Poultry Processing Industries Sdn Bhd, Ampang Hospital and Pusat Jantung Sarwak. Data for MIWA was facilitated by SIRIM and data for IOI was provided by a service provider for presentation purposes in organized seminars and trainings. In addition, SEDA has been developing and managing an online monitoring system dashboard for the solar thermal projects registered under MAEESTA project for use after the MAEESTA Project ends

96. In summary, the delivery of outputs within Component 3 is assessed as *moderately satisfactory* due to the fact that there were not as many thermal ESMs and solar thermal demonstrations implemented as targeted.

The rating for project effectiveness is "moderately satisfactory"

3.2.3 Coherence

97. MAEESTA was implemented in a logical manner starting with policy papers followed by capacity building of ESM and STS experts, designers, suppliers and installers, and the deployment and

implementation of ESMs and STSs. The deployment of ESMs and STSs became problematic due to the COVID-19 pandemic, low energy prices, and associated difficult investment scenarios across the country.

The rating for project coherence is "satisfactory"

3.2.4 Efficiency

98. Up to the TE date of 30 June 2022, nearly 90% of the MAEESTA-GEF resources or US$ 3,590,594 was expended over an 8-year period for undertaking MAEESTA activities. While the original MAEESTA duration was 60 months, it was completed in just under 96 months with its terminal date of 30 June 2022. Table 13 provides an overview of UNIDO-GEF budget expenditures up to 30 June 2022.

99. With MAEESTA having exceeded its planned timespan from 5 to 8 years, the efficiency of the expended US$3,590,594 of the total GEF grant of US$4,000,000 has been assessed as ***moderately satisfactory*** considering delivery of most outputs accompanied by:

- significant investment in the preparation of policy papers for ESMs and solar thermal systems, awareness raising, and training for financial institutions, equipment suppliers, service providers, consultants and industries in selected sub-sectors throughout the Project implementation period;
- investments in solar thermal technology by the Project;
- challenges of engaging industrial establishments to implement ESMs and STSs under the Project;
- the time and effort required to convince some entities to implement the STS investments despite long payback periods which are offset by 20-35% grant support from UNIDO. Many projects had simple payback periods of 4 to 6 years, leaving many of the entities to debate whether or not to implement the STS investment;
- overcoming delays caused by the COVID-19 pandemic.

This resulted in Outcome 3 being underspent by US$ 1.5 million with additional resources poured into the other Outcomes as well as Project management;

100. Table 14 shows that almost 90% of the budget was expended mostly on contractual services for installation of EE and STS equipment, followed by experts and local subcontractors for technical assistance provided to design and deliver training programs for heating EE, solar thermal and financing.

The rating for project efficiency is "moderately satisfactory"

3.2.5 Sustainability of Benefits

101. Sustainability of MAEESTA has been assessed as *moderately likely (ML)* due to:

- there are sufficient funds from various grants that can be utilized to finance STS and address the long RoIs for some of the investments (Paras 102-104);
- the Project has only implemented a low number of locally viable successful demonstrations tailored for specific industries with ESMs not disseminated to a greater audience. It appears that only multi-national companies are more responsive towards STSs and green technology in general (Paras 105-110);
- EECA that will be in tabled in Parliament by 2023 or 2024 with the expectation that by 2023 or

2024, it will be implemented and enforced including solar thermal that is mentioned explicitly in the EECA (Paras 111-114).

Table 13: MAEESTA Project Disbursements

MAEESTA Outcomes	Budget (from CEO End. Doc)	2014*	2015	2016	2017	2018	2019	2020	2021	2022**	Total disbursed	Total remaining
Outcome 1: Policy papers and financial incentives schemes established and endorsed by stakeholders	120,000	38,852	40,943	140,175	155,092	78,938	82,715	20,709	192,274	155,349	905,046	-785,046
Outcome 2: Awareness and capacity of equipment vendors, service providers, industry management, plant engineers, and financial institutions in 5 targeted industrial sub-sectors strengthened and utilized	886,000		70,021	93,829	44,211	262,514	221,142	457,274	129,004	50,790	1,328,785	-442,785
Outcome 3: Demonstrating thermal energy efficiency and solar thermal technology deployed in 5 targeted industrial subsectors	2,740,000		68,526	69,601	91,498	76,580	152,326	112,363	322,905	83,263	977,062	1,762,938
Monitoring and evaluation	64,000		-	-	-	24,062	112	-	-	21,049	45,223	18,777
Project Management	190,000	867	39,480	66,279	88,088	61,487	31,457	21,551	20,544	4,727	334,479	-144,479
Total (Actual)	4,000,000	39,719	218,969	369,884	378,889	503,580	487,752	611,897	664,727	315,178	3,590,594	409,406
Total (Cumulative Actual)		**39,719**	**258,688**	**628,572**	**1,007,461**	**1,511,041**	**1,998,793**	**2,610,689**	**3,275,416**	**3,590,594**		

Table 14: MAEESTA Project Resource use breakdown up to 30 June 2022

UNIDO Cost Code	Amount (US$)
1100-Staff & Intern Consultants	205,030
1500-Local travel	271,096
1700-Nat.Consult./Staff	972,791
2100-Contractual Services	1,730,023
3000-Train/Fellowship/Study	38,675
4300-Premises	89,133
3500-International Meetings	14,224
4500-Equipment	83,108
5100-Other Direct Costs	186,451
Total	**3,590,531**[13]

[13] US$409,469 still to be cost coded.

Financial Risks

102. In the early years of MAEESTA, financial risks to solar thermal were mitigated by exemption of duties on specialized equipment to make solar thermal and participating SMEs more competitive. This included the cost of collectors in the solar thermal system which comprise as much as 40-60% of the total system cost. This exemption was added to grants from MoSTI (SIRIM SME Development Programme) grants that also factored into the financing puzzle for solar thermal. There were also privately financed initiatives.

103. By September 2020, 10 project were approved by UNIDO out of which 2 were being completed at that time. However, it was also at this time that STS investments were delayed or even cancelled due to:

- the COVID-19 pandemic adversely affecting and changing the business outlook and motivation for several companies to do solar thermal (for example, some of the hotels were not expecting high occupancy rates). Some project proponents requested scaled down versions of their STS investments;
- ESCO and company budget constraints making solar thermal EPCs more than a 5-year RoI, not attractive to the project proponents despite a 20-35% UNIDO grant funding for solar collectors;
- design changes resulting in an unattractive RoI of more than 5 years;
- incorrect installation of STSs that add to installation costs. This happened at the Miwa Manufacturing that had a problem with an overflowing 4,000 litre calorifier tank with no dedicated technical person on site to monitor the daily operation of the solar thermal system. Some installation errors with the STSs were made at UKM Hospital (under Ministry of Higher Education) and Sungai Buluh Hospital by an ESCO. There is a cost associated with these errors;
- the 30% buy-down by UNIDO for solar collectors being insufficient according to MoH. With concessionaires managing all hospitals under MoH, each concessionaire is responsible for maintaining and ensuring the operation of the solar thermal system. The solar thermal contractor will only liaise with the concessionaire and not directly with the Ministry of Health.

104. From a financial perspective, the sustainability of the MAEESTA outcomes is *moderately likely (ML)* considering that there are sufficient funds from MGTC, MoSTI (SIRIM SME Development Programme), LKIM and MITI (BPU) grants that can be utilized to finance STS and address the long RoIs for some of the investments.

The rating for financial risks is "moderately likely"

Socio-political Risks

105. Energy audit services paid out of the Project budget were appreciated by companies; however, they were unwilling to pay for these services indicating a major risk for sustainability. Without adequate financial support and payment for energy audits, it is unlikely that companies will continue with EE on heat energy.

106. There is improved capacity to identify and work towards thermal ESMs and STSs in companies. However, the main focus for EE implementations is still on electricity. The Project has only implemented a low number of locally viable successful demonstrations tailored for specific industries.

107. The demonstrations for thermal ESMs and STSs are not disseminated to a greater audience. It appears that only multi-national companies are more responsive towards solar thermal and green technology in general. This has an impact on sustainability.

108. The enforcement of the lockdown throughout Malaysia due to the COVID-19 pandemic and the enforcement of the Control Movement Order resulted in the travelling restrictions and imposed quarantines for site visits which impacted the demo project progress. Demonstration projects started in early 2020 needed until 30 September 2022 to complete.

109. There were also technical issues with the STSs delaying the completion of demonstration projects that raise the socio-political risks of MAEESTA:

- Over 80% STSs experience overheating issues needing a heat dissipator to provide an overheating protection system (see Para 94);
- Some experience overflow problems due to the malfunction of the floatation system. The solar thermal system has an automatic controller (see Para **Error! Reference source not found.**);
- Based on interviews with industries, many companies seem to be risk averse to STS, therefore leading to a reluctance to invest in STS technologies unless there was more proof that STS technologies work as designed;
- Expertise in STS installations is still in its infancy but improving. The importance solar thermal expertise has only been recognized lately by industry. However, the work force of solar thermal specialists was not stable[14]. To start with, there were not many graduates from the MAEESTA training programmes, and not many were able to get solar thermal assignments. Marketing skills are required to sustain their consultancy business and ESCOs as well as a good relationship with the public to breed trust and confidence, being more important than technical knowledge and team work required to launch a solar thermal practice. In a classic chicken-and-egg scenario, if the industries are not using available expertise, sooner or later, they will change profession;
- The absence of a solar thermal association that would regulate the installations with the building code. This would ensure sustainability of STS in industry with safety and performance requirements for an STS being an important issue that needs to be addressed;
- The looming EECA legislation that is set to be mandatory in 2023 or 2024 should force industrial, health and hospitality sector entities to consider ESMs and solar thermal systems. ESCOs and expertise in ESM and STS installations should continue its steady trend of improving, leading to the formation of a solar thermal association to regulate STS installations with the building code, and companies becoming less risk averse to ESM and STS investments. This only bodes well for the sustainability of the Project.

110. The socio-political risks to sustainability of the MAEESTA is assessed as ***moderately likely (ML)*** in consideration that expertise in ESM and STS installations is improving, the likely formation of a solar thermal association, and companies becoming less risk averse to ESM and STS investments.

The rating for socio-political risks is "moderately likely".

Institutional Framework and Government Risks

111. By July 2021, the 12th Malaysia Plan highlights the new energy options and its potential including solar thermal. By September 2022, policy documents were developed by the Project to include 4 solar thermal industry standards that were upgraded to national standards, 3 solar thermal guidelines for EECA (final draft accepted by the Energy Commission), and 4 solar NOSS documents

[14] Currently, there are only 3 vendors in the market for solar thermal systems. Market awareness done by UNIDO program quite good. NB Poultry, MIWA Manufacturing and the Seremban Hospital are using Kingspan solar thermal collectors with installation by Alpha Entity. The Solar Key Mark ISO is the European certification scheme used to ensure the quality of solar thermal collectors.

(approved by the National Education Advisory Council or MPPK on 24 June 2021). Inclusion of solar thermal agenda in the new EECA will indirectly regulate the equipment for solar thermal such as pumps. Currently, there is not yet a regulation on solar thermal collectors. This is due to a small number of users.

112. EECA will be in tabled in Parliament by 2023 or 2024 with the expectation it will be implemented and enforced including solar thermal that is mentioned explicitly in the EECA. The new act is known as Registered Energy Manager which covers all thermal energy sectors. Suruhanjaya Tenaga will be the agency that enforces the EECA which is the driver for solar thermal.

113. SIRIM is now under MIT). MESTECC has been split into 3 ministries namely MoSTI, Ministry of Environment and Water (KASA) and Ministry of Energy and Natural Resources (KeTSA). SIRIM, which was a part of the Ministry of Energy, Science, Technology, Environment and Climate Change, played a significant role on the MAEESTA Project. As such, lessons from the Project were directly absorbed and influence and inform SIRIM activities, resulting in a better chance for lessons to be absorbed into national policies and plans, and creating long-term sustainability of Project outcomes. However, an agency is required to promote STS after EOP since SIRIM, the Energy Commission or SEDA has a mandate or a budget to promote STS.

114. Institutional and governance risks to sustainability of MAEESTA is assessed as *moderately likely (ML)*.

The rating for institutional framework and government risks is "moderately likely".

Environmental Risks

115. MAEESTA is aimed at achieving an impact of positive global environmental benefits, including improvements in heat energy efficiency, and the deployment of STSs to reduce primary fuel consumption that would lead to substantial GHG emission reductions. The general perception within the industrial, health and hospitality sectors in Malaysia is that efficiency of consumption of resources and the deployment of STSs should lead to decreased operational costs of production and increased profitability provided that good economic conditions persist in the country that would lead to long-term sustainability of the industrial enterprise, reduced operational costs for hospitals and the hotel sectors and improved environmental conditions. As such, the environmental risks of MAEESTA are low. The environmental risk to sustainability of MAEESTA is assessed as *highly likely (HL)*.

The rating for environmental risks is "highly likely"

The rating for sustainability of MAEESTA benefits is "moderately likely"

Impact

116. In reference to the Reconstructed Theory of Change for MAEESTA as illustrated in Figure 3, the TE can conclude that 1 out of the 3 intended outcomes of MAEESTA was fully achieved including Outcome 1 (Policy papers and financial incentive scheme established and endorsed by stakeholders). However, Outcome 2 (Awareness and capacity of equipment vendors, service providers, industry management, plant engineers, and financial institutions in 5 targeted industrial sub-sectors strengthened and utilized) and Outcome 3 (Thermal energy efficiency and solar thermal technology demonstrated), was only partially achieved and not reaching targets.

117. With MAEESTA achieving one of these outcomes, there will be mandatory legislation in the form of the EECA which will drive demand for services for technologies in heat energy efficiency and solar thermal in the industrial sector, health and hospitality sectors. However, transforming the market for ESMs and STSs will require a critical mass of expertise which has not yet been developed (see Para 109, 4th bullet). SIRIM and other GoM agencies will face challenges with current levels of solar thermal expertise, and its own current level of staffing and capacities to implement and enforce the

EECA. Depending on the level of external and donor support for bridging these staffing and capacity gaps and the level of business compliance to the EECA, the pace of EECA implementation towards the long term MAEESTA impacts as illustrated on Figure 3 may take longer (2 to 4 years)[15]. As such, the likelihood of impact of MAEESTA in achieving long-term impacts in heating energy efficiency and solar thermal can be assessed as ***moderately likely***.

The rating for likelihood of impact is "moderately likely"

3.4 M&E System

M & E Design

118. M&E design is rated as *satisfactory*. This was based on an M&E system plan as specified in Annex H of the RCE document, stating the importance of the M&E plan to ensure successful implementation of MAEESTA through tracking and reviewing project activities execution and accomplishments, identifying issues to allow the PMU to take early corrective action if performance deviates significantly from original plans, and adaptively managing the Project through adjustments and updating of the Project strategy and implementation plan in tandem with changes on the ground and actual results achieved.

119. The M&E design makes reference to the Logical Framework Matrix in Annex 5 in providing performance and impact indicators for Project implementation along with their corresponding means of verification. This was to the basis of the M&E Plan to use the impact and performance indicators in Annex 5 to track, report and review Project activities and accomplishments in relation to:

- establishment and adoption of policy papers and financial incentive schemes;
- capacity building and awareness raising; and
- demonstration projects.

120. With the discussion in Para 45 on the issue SMART quality of MAEESTA indicators, the M&E design can be regarded as reasonably effective for the purposes of monitoring progress of MAEESTA.

The rating for M&E design is "satisfactory"

M & E Implementation

121. M&E implementation for MAEESTA was assessed as *satisfactory*. PIRs for MAEESTA were prepared on an annual basis, using an Excel or Word format from 2015 up to 2021. In addition, progress reports were prepared by UNIDO HQ at year's end from the end of 2015 to the end of 2021. PIRs and progress reports were:

- formulated by PMU and UNIDO HQ with weekly project meetings for Project updates and issues discussions. PMU also had constant communications with UNIDO HQ through emails;
- drafting of the PIRs and progress reports by the PMU and National Project Steering Committee (NPSC) with at least 2 annual meetings scheduled to update project progress and demonstration projects for MAEESTA fund approval;
- reviewed at regular meetings with the President Office where a presentation is made on MAEESTA activities implemented for the SIRIM annual report publication;
- project progress updates were held through Technical Working Group (TWG) meetings chaired by

[15] Includes "reducing GHG emissions by promoting and demonstrating sector-specific thermal EE improvements and solar thermal technology utilization in industry".

MNRE to provide status updates and mitigation plans for all climate change projects overviewed by the Ministry up to 2019. These meetings were discontinued in 2019 with MNRE receiving progress updates through the NPSC meetings;

- met with PMU challenges to monitoring of Outcome 3 targets given the number of industrial establishments that have received MAEESTA training in ESMs and STS technologies, and the reluctance of many of those establishments to fully reveal their energy efficiency activities, primarily for proprietary reasons. As a result, the monitoring of direct energy savings and emission reductions over the Project duration is likely to have been underreported, partially causing the GHG emission reductions to be short of its targets;
- cleared by the UNIDO Regional Office in Bangkok;
- cleared by the UNIDO HQ in Vienna, Austria.

122. MAEESTA and SEDA developed an online monitoring dashboard system for the solar thermal demo projects. SEDA owns and extend the usage to the other projects after MAEESTA project ends.

123. In addition, an MTR was conducted for MAEESTA in July 2018. While the Project appears to have received a moderately satisfactory assessment in its MTR[16], there were several conclusions made to characterize MAEESTA:

- STS for industries was a new topic for Malaysia;
- Project goals and time plan were very ambitious, especially with low energy prices and policies which make the demonstration projects difficult to be implemented;
- it was found that most companies seem to have a low risk-taking appetite, and therefore they are reluctant to invest in STS activities;
- lack of showcases is a barrier towards Project success. Creating a sustainable marketing demand is essential to ensuring long term uptake of ESMs and STSs after the EOP. Therefore, multiple "locally created" showcases are required for that purpose;
- most of the companies who are likely to be the first to adopt and take the benefit from Project activities are larger enterprises with more manpower to devote to activities and funds to utilize for STS activities or to those companies with a rather long planning horizon that includes CSR strategies.

The rating for M&E plan implementation is "satisfactory"

<u>Budgeting and Funding for M&E Activities</u>

124. Budgeting and funding of M&E activities has been rated as <u>*satisfactory*</u>. The M&E budget in the RCE Document was estimated at an indicative amount of US$64,000, with UNIDO co-financing of M&E budgeted at US$60,000. The total amount of US$124,000 is considered a normal amount for a project of this size. However, this amount only included the cost of the measurement of GEF Tracking Tool specific indicators, monitoring of Project impact indicators as per PRF, preparation of the mid-term review and terminal evaluation. The budget did not include the PMU cost of monitoring and tracking progress and preparing the PIRs, a key documentation tool for reporting progress and proposing adaptive management measures as well as the Project terminal report.

125. The Evaluation Team has viewed annual MAEESTA work plans since 2016 that provide the basis for fund requests from the field office to UNIDO HQ for funds for specific field activities. None of these fund requests included M&E activities under Component 4 such as tracking and reviewing

[16] A rating was not provided but assumed to be MS based on the commentary.

Project activities and implementation progress, preparing detailed monitoring plans, and outsourcing services to monitor specific Project activities. This may possibly be due to the staffing of the PMU which only included 2 full-time staff, the NPM and a Project Assistant, and co-financing of the M&E activities by UNIDO.

The rating for budgeting and funding for M&E activities is "satisfactory"

3.5. Monitoring Long Term Changes

126. MAEESTA was primarily designed to support the legislation and capacity building of engineers, installers and vendors to design, supply and install thermal ESMs and STSs by industrial, health and hospitality sectors throughout Malaysia. A significant proportion of MAEESTA resources were utilized to monitor adoption of best practices for installing thermal ESMs and STSs by participating entities. The monitoring of these entities was undertaken mainly by the PMU who were recruited towards the end of MAEESTA to undertake a survey to monitor energy savings and GHG emission reduction impacts of the Project. Unfortunately, this has not led to MAEESTA facilitating a set up for monitoring long term changes:

- SIRIM has built some capacity to monitor several entities in the industrial, health and hospitality sectors on their adoption of thermal ESMs and solar thermal technologies. However, SIRIM is not yet setup to monitor ESM and STS investments when the EECA is implemented and enforced;
- Given the difficulty of obtaining energy savings information from most industrial enterprises, SIRIM may have difficulty obtaining accurate energy savings information in future.

3.6. Processes affecting achievement of project results

3.6.1 Preparation and readiness/quality at entry

127. The PPG phase of MAEESTA was undertaken between 2013 and 2014, led by a Project Manager from UNIDO HQ with strong support from SIRIM. Information collected from UNIDO management suggests that PPG activities included an inception workshop conducted in 2014 to commence Project activities and disseminate information on the Project for industries with the Project Manager travelling to Kuala Lumpur for the workshop. Preparation for the inception workshop was organized by SIRIM Berhad.

The rating for quality at entry/preparation and readiness is "satisfactory"

3.6.2 Country Ownership

128. Country ownership of MAEESTA is reflected in the GoM's extremely proactive stance in developing renewable energy, notably its Nationally Determined Contribution (NDC) pledge of 45% by 2030 relative to emissions intensity of 2005. Further to this, a write-up on "Solar thermal potential for Malaysia's industrial sectors" was submitted by the Project to MESTECC (now KeTSA) and MEA (now EPU) for solar thermal technology to be considered in the 12th Malaysia Plan (RMK-12). The result was the RMK-12 document was tabled and approved in Parliament on 27 September 2021 where solar thermal has been explicitly mentioned as one of the solar technology solutions to reduce GHG in industry. The inclusion of solar thermal technology in RMK-12 is significant since it is neglected in existing renewable energy policies and acts.

129. In July 2021, Malaysia's 4IR made reference to disruptive transformation of industries through the application of emerging technology; this translates into advanced technologies such as power grid support market, renewable energy and energy efficiency to improve the competitive edge of a country's manufacturing sector and reducing its reliance on foreign input.

3.6.1. Stakeholder Involvement

130. Stakeholder engagement on MAEESTA activities was highly effective. During the PPG phase of the Project of 2013-14, UNIDO was able to consult with different relevant government agencies, industry associations, local experts, service providers and selected industries referred by the industry associations. SIRIM provided support to interact with multiple agencies, organizations, and associations for a timely conclusion of the PPG phase.

131. During implementation of the Project, stakeholder engagement by the PMU was through SIRIM Berhad, a wholly-owned company of the GoM under the Ministry of Finance Incorporated with experience and expertise in industrial research and technology development. With SIRIM hosting the PMU, this facilitated effective stakeholder engagement with a number of stakeholders key to the policy papers for heating EE and solar thermal including KeTTHA, KeTSA, MITI, EPU, MoSTI, MNRE, MIDA, SEDA, ST and MGTC.

132. Stakeholders for the awareness-raising and capacity building programmes of MAEESTA were also effectively engaged; the SME Corporation Malaysia and the FMM were engaged to attract engineers and other professionals to capacity building sessions for heating EE and solar thermal technologies. SERI, UKM and the University Technology MARA provided the technical assistance to disseminate the knowledge.

133. The outcome of the Project's stakeholder engagement strategy was *satisfactory* in consideration of the strong interest that MAEESTA has generated from a wide section of stakeholders, creating considerable interest in heating EE and solar thermal technologies at the EOP.

3.6.4 Financial Planning

134. MAEESTA AWPs were to provide the estimated required funding for the upcoming year, the flow of funds of which were triggered by requests from PMU, and approved by HQ on a continuous basis through UNIDO's ERP/SAP system. Typically, low value procurement was approved by the HQ's PM in SAP with higher value procurement (>$40,000) requiring the involvement of UNIDO's Procurement Department. The operational cash advances for the operations of the MAEESTA-PMU were released on an "as-needed basis", released in €2000 tranches. All other expenditures such as procurement and travel, first obtain approval from the HQ Project Manager. Financial planning of MAEESTA was based primarily on AWPs prepared by the PMU in close collaboration with UNIDO HQ.

135. With the delivery of funds to the PMU in Kuala Lumpur, a total of 18 missions from UNIDO HQ were made to Malaysia between 2014 and 2022 to attend PSC meetings, conduct due diligence on the expenditure of the Project funds, to monitor the progress on the preparation of policy papers, awareness raising campaigns, capacity building programmes, and investments into heating EE and solar thermal systems within the industrial, health and hospitality sector enterprises.

136. However, severe COVID-19 pandemic impacts did not result in a positive investment environment with most private enterprises just waiting for return of normality. After restrictions were removed in the 1Q 2022, the PMU tried to initiate some action on commencement of approved projects. By then time was not sufficient to support execution of investment projects with the Project ending June 2022. With US$14 million in co-financing, co-financing targets of MAEESTA of US$20 million were not met (see Paras 141-142 and Table 3). However, in comparison to similar UNIDO solar thermal projects in India and Egypt, there was a higher success rate in terms of completed STS investment projects notwithstanding lower energy prices in Malaysia. As such, co-financing was deemed to be moderately satisfactory

3.6.5 Support of UNIDO, national counterparts and donor

137. As GEF's implementing agency, UNIDO had responsibility for timely implementation of the Project, delivery of planned outputs, technical backstopping, and monitoring achievement of expected

outcomes. UNIDO was also accountable to the GEF grant and other funding resources provided by the Malaysian government and the financial institutions in Malaysia. UNIDO's performance in undertaking these responsibilities was conducted in a manner that was responsive to the requests and needs of the PMU, Government of Malaysia, and stakeholders from the industrial, health and hospitality sectors. The end result of UNIDO's support for MAEESTA was that it significantly contributed towards the preparation of policy paper for heating EE and solar thermal, and to capacity building of engineering experts, users of these systems and vendors in an effort to reduce fossil fuel consumption. However, UNIDO support did not result in a sufficient number of thermal ESM and STS investments, mainly due to many of the businesses being greatly impacted by the COVID-19 pandemic resulting in them having to withdraw from their plans to implement STS installation.

138. All stakeholders interviewed during the Terminal Evaluation mission highly valued the participation of UNIDO. They expressed confidence in the technical assistance provided by international consultants of UNIDO, all experts and vendors mentioning the great potential of heating EE and solar thermal, and users mentioning the energy savings benefits to their businesses. All stakeholder participants overwhelmingly expressed their support for UNIDO's continuation of these trainings. Similarly, MAEESTA's institutional partner, SIRIM Berhad, mentioned the excellent relationship with the PMU and MAEESTA's responsiveness to ensuring appropriate progress.

139. Impact at the national level, to inform policy and ensure coordination with stakeholders, has been possible through housing the PMU in SIRIM. PMU engagement with stakeholders facilitated regular interactions around issues of EE and STS with SIRIM officials as well as other ministries, institutes, experts and associations members. In this regard, SIRIM Berhad provided solid support for knowledge management, energy efficiency expertise, coordination of policy papers and the organization of training. SIRIM is also running projects on solar thermal, where learnings from these efforts were used to inform national government plans and policies. Despite their best efforts, SIRIM Berhad's involvement did not result in achieving the target number of ESM and STS demo primarily due to COVID-19 and resulting difficult investment conditions for industries

140. Despite the shortfall in the target achievement for ESM and STS demos, there were no issues with funding from GEF. The agency mostly stayed away from the operations of the MAEESTA Project.

The rating for UNIDO's support is "highly satisfactory", donor counterpart support is "satisfactory", and donor support is "satisfactory".

3.6.6 Co-Financing on Project Outcomes and Sustainability

141. Overall MAEESTA co-financing reached US$14 million, short of its target of US$20 million, mainly due to EPC conditions not being attractive for STS investments and many of the businesses being greatly impacted by the COVID-19 pandemic resulting in them having to withdraw from their plans for STS installation. Co-financing is shown on Table 3 and in Annex 4.

142. Co-financing from the large industrial establishments on this Project is likely to be sustained in Malaysia due to resources being readily available for thermal ESM and STS investments. However, co-financing from smaller entities was not successful during MAEESTA and financing institutes were not involved during MAEESTA implementation. There have been issues tied to the familiarity with the ESM and STS technology, the quality of ESM and STS installations and the functionality of STS technology, affecting the demand for financing ESM and STS installations. Co-financing challenges are most felt by ESCOs when they finance EPCs, requiring ESCOs to raise money to conduct an installation at a host owner's facility and recovering the money from the resultant savings. For these reasons, the financial costs under certain terms and conditions can be prohibitive for ESCOs. Though some financial institutions are now familiar with the EPC concept to the point where ESCOs are able to secure financing for one or two projects, most ESCOs still find the cost of EPC financing expensive and can only consider larger projects and investments. The other factor affecting most ESCOs is their limited financial capacity to develop more projects as the bank is

reluctant to loan beyond the credit worthiness of the ESCO's financial position.

3.6.7 Delays of Project Outcomes and Sustainability

143. By early 2021, the COVID-19 pandemic had affected solar thermal investments. This was mainly due to many of the businesses being adversely impacted by the pandemic resulting in them having to withdraw their plans to implement STS installation. This affects the sustainability of demonstration solar thermal investments.

3.6.8 Results-based management (implementation) approach

144. The key approach of the MAEESTA implementation was to focus on policy papers for promoting ESM and STS investments and raising awareness and training of engineers, experts, vendors and installers on ESMs and STSs. This was deemed to be sufficient to convince a critical number of enterprises to adopt ESMs and STSs in their operations given the potential for cost savings and additional profitability. To improve the adoption of ESMs and STSs by a greater proportion of industrial, health and hospitality establishments, the MAEESTA implementation approach also included assistance to financing sector personnel to improve their capacities to more efficiently approve loan finance for STSs.

145. Results-based management was required to adjust the implementation approach of MAEESTA to improve the prospects of meeting targets in the MAEESTA PRF, notably the GHG emission reduction target. While the assumption that policy papers and building capacity itself would be sufficient to catalyze interest and investment into ESMs and STSs, many of these entities could not implement thermal ESM and STS investments for various reasons as laid out in Para 103. This required more adaptive management efforts by the PMU to convince industries and entities to implement thermal ESMs and STS investments, which were ultimately unsuccessful, primarily due to COVID-19. There were also the entities participating on MAEESTA STS financial assistance who have financed or have arranged financing through their own budgets, leaving capacities of Project trained financing personnel underutilized. The promulgation of the EECA in 2023 or 2024 will create more demand for ESM and STS financing and position financial sector personnel to strengthen their capacity to appraise and more efficiently approve solar thermal financing.

The rating for implementation approach is "satisfactory"

3.7. Project coordination and management

146. Day-to-day management and coordination of MAEESTA in Kuala Lumpur was undertaken by the PMU whose office premises were hosted by SIRIM Berhad. This facilitated close collaboration between the PMU and the SIRIM to maximize the opportunities of GoM and stakeholder cooperation. Informal PMU meetings with SIRIM was possible under this arrangement that led to AWPs containing considerable inputs from SIRIM, sharing its network of industrial, health and hospitality stakeholder contacts for follow-up by the PMU, and subsequent relationships with several entities, and other institutional partners. One of the primary reasons, however, for the completion of MAEESTA over an 8-year period instead of the designed 5-year period was related to MAEESTA's difficulties during the COVID-19 pandemic and businesses dropping out of the MAEESTA program.

147. The MAEESTA Project was managed by:

- The NPSC that was established to provide strategic planning, guidance, and coordination between various ministries and other stakeholders. The first NPSC meeting was held on 4 August 2015, chaired by the Deputy Secretary General of KeTTHA. In 2018, the Chairmanship was passed to the Deputy Secretary General of MoSTI. NPSC meetings were well attended with regular reporting to HQ and to the NPSC and main stakeholders;

- SIRIM Berhad serving as the national executing agency for MAEESTA, responsible for hosting the PMU and appointing one of its senior managers to be the NPD who acts as the government representative to work closely with the PMU;

- the PMU responsible for the daily management of project activities or execution, and to act as the NPSC Secretariat. The PMU provided advice on the execution of each Project component in accordance with the Project document and fully in line with government priorities, rules and regulations and that all local inputs and participation in Project implementation are timely and adequate. The PMU was led by an NPM with assistance from an Assistant Project Manager, Training Coordinator and Project Administrator. By 2019, the team had 5 technical experts (2 full-time and 3 part-time experts);

- a Technical Committee (TC) that was established in December 2016 to provide technical advice for the Project implementation. The TC was chaired by SIRIM senior officer and was comprised of personnel from KeTTHA, SERI UKM, FMM, SIRIM, ST, MIDA, MGTC, Department of Safety and Health, Ministry of Health and Department of Skills Development, to review solar thermal project proposals before its presentation to NPSC for approval;

- a Solar Thermal Roadmap Task Force that was established in December 2016 to provide advice and monitor development of the national solar thermal roadmap for the industry. The TF was chaired by a Senior Professor from SERI-UKM and was comprised of personnel from MoSTI, KeTTHA, EC, MIDA, SIRIM, MGTC and FMM. In July 2018, the Task Force finalized the Roadmap.

148. With the COVID-19 pandemic, solar thermal projects were delayed. With UNIDO and the GoM wanting MAEESTA to be a successful project, a 24-month no-cost extension was requested in May 2019 with another request in August 2021 to extend the Project for another 6 months from January to June 2022. The extensions were granted.

149. In conclusion, the management and coordination of MAEESTA h3.as led to the Project partially achieving its intended outcomes, and its GHG emission reduction target. These results are a reflection of the good management of the Project. Unfortunately for this Project, there were difficulties related to the COVID-19 pandemic which adversely affected the achievement of the GHG emission reduction targets. More technical assistance from UNIDO in the form of international inputs and financial support to Malaysia-based activities is in need. Balancing the aforementioned comments, the overall assessment of the Project coordination and management can be assessed as *satisfactory*.

The rating for Project coordination and management is "satisfactory"

3.8. Gender Mainstreaming

150. The UN has a mandate to address human rights and gender equality in all interventions to promote social justice and equality[17]. Since MAEESTA was designed as a GEF-5 project at its design stage in 2013-14, explicit recommendations or requirements for gender mainstreaming were required. This included a gender analysis to be carried out as part of the capacity assessment of Output 1.1 at the outset of the Project, and gender mainstreaming in the training and skills strengthening activities of Outputs 2.1 and 2.2. Female experts were to be encouraged to participate in the training and other project activities. At entry, the project was assigned Gender Marker 2A, meaning that its expected contribution to gender equality was significant[18].

[17] Guidance Document: Integrating Human Rights and Gender Equality in Evaluations, UN Evaluation Group, Aug 2014, pg 19

[18] Since 2015 all UNIDO technical assistance projects have been assigned a gender marker and their design are screened based on a gender mainstreaming check-list before approval. UNIDO's gender marker is in line with UN System-wide action plan (SWAP) requirements, with four categories: 0 — no attention to gender, 1 — some/limited attention to gender, 2a — significant attention to

151. Gender mainstreaming actions were integrated into all stages of the Project cycles, particularly for the training and skills enhancement activities. For seminars and trainings, about 87-90% male and 10-13% female participated. As is typical for the industrial sector (which is where the majority of solar investments were made), there is limited female participation, thus making this focus of activity an additional challenge. However, MAEESTA has made sustained efforts to utilize gender disaggregated indicators and targets to measure impact, and further encourage female participation. The Evaluation has not reviewed any documentation that follows up on monitoring gender disaggregated indicators with the exception of monitoring the increase in female participation in training workshops and implementing energy efficiency on behalf of participating industrial, health and hospitality sector establishments.

The rating for gender mainstreaming is "moderately satisfactory"

3.9. Overall Rating of the MAEESTA Project

152. Overall performance of MAEESTA is rated as *moderately satisfactory*. An overall summary of these evaluation ratings[19] and findings is provided in Table 14.

Table 14: Summary of Findings and Ratings by Evaluation Criteria for the MAEESTA Project

Criterion	Summarized Assessment of the Findings	Rating
Attainment of project objectives and results (overall rating)	MAEESTA was a significant contributor in catalysing interest in thermal energy saving measures (ESMs) and solar thermal in Malaysia resulting in policy papers being prepared and MAEESTA training activities being very popular. However, due to COVID-19 pandemic and other reasons, the overall MAEESTA Project GHG emission reduction targets were not met (Paras 58-61)	MS
Relevance	Strong relevance to GoM's Energy Efficiency Conservation Act, the National Climate Change Policy and other plans and acts (Paras 52-54)	HS
Effectiveness	Most targets met. Exception was Outcome 3 where only 15 factories implemented ESMs (out of a target of 30) and 7 STS investments were implemented with 13 projects cancelled for various reasons (Paras 60-96).	MS
Coherence	MAEESTA was implemented in a logical manner starting with policy papers followed by capacity building of ESM and STS experts, designers, suppliers and installers, and the deployment of ESMs and STSs. The deployment of ESMs and STSs became problematic due to the COVID-19 pandemic and other reasons (Para 97).	S
Efficiency	MAEESTA exceeded its planned timespan from 5 to 8 years and only expended US$3.58 million out of the total GEF grant of US$4.00 million (Paras 98-88).	MS
Impact	Depending on the level of external and donor support for bridging SIRIM staffing and ESM and STS expert capacity gaps and the level of business compliance to the EECA, the pace of EECA implementation towards the long-term impacts may be slower (Paras 116-117).	MS
Sustainability of project outcomes (overall rating)	With the EECA being promulgated by 2023 or 2024, there are sufficient funds from various grants that can be utilized to finance STS and address the long RoIs for some of the investments (Para 101).	ML
Financial Risks	There are sufficient funds from MGTC, MoSTI (SIRIM SME Development Programme), LKIM and MITI (BPU) grants that can be utilized to finance STS	ML

gender, 2b — gender is the principal objective (https://www.unido.org/sites/default/files/files/2019-11/UNIDO%20Gender%20Strategy%20ebook.pdf)

[19] Highly Satisfactory (HS); Satisfactory (S); Moderately Satisfactory (MS); Moderately Unsatisfactory (MU); Unsatisfactory (U); Highly Unsatisfactory (HU). Impact and Sustainability is rated from Highly Likely (HL) to Highly Unlikely (HU)

Criterion	Summarized Assessment of the Findings	Rating
	and address the long RoIs for some of the investments (Paras 102-104)	
Socio-political Risks	Expertise in STS installations is still in its infancy but improving and that only multi-national companies are more responsive towards ESMs, STSs and green technology in general (Paras 105-110)	MU
Institutional framework and governance risks	EECA will be in tabled in Parliament by 2023 or 2024 with the expectation that it will be implemented and enforced including STS that is mentioned explicitly in the EECA (Paras 111-114).	ML
Environmental risks	Project is aimed at achieving positive global environmental benefits, including improvements in ESMs, and the deployment of STSs to reduce primary fuel consumption that would lead to substantial GHG emission reductions (Para 115).	HL
Monitoring and evaluation		
M&E design	M&E design makes reference to the Logical Framework Matrix in providing performance and impact indicators for Project implementation along with their corresponding means of verification (Paras 118-120).	S
M&E plan implementation	PIRs were prepared on an annual basis, using an Excel or Word format from 2015 up to 2021. There were challenges to monitoring due to the reluctance of many establishments to fully reveal their energy efficiency activities, primarily for proprietary reasons (Paras 121-123)	S
Budgeting and funding for M&E activities	The M&E budget in the RCE Document was estimated at an indicative amount of US$64,000, with UNIDO co-financing of M&E budgeted at US$60,000. The total amount of US$124,000 is considered a normal amount for a project of this size (Paras 124-125)	S
UNIDO specific ratings		
Gender mainstreaming	Gender mainstreaming actions were integrated into all stages of the Project cycles. However, with 10-13% female participation in training and skills enhancement activities and limited female participation on the majority of solar investments, gender mainstreaming was an additional challenge. Notwithstanding, MAEESTA has made sustained efforts to utilize gender disaggregated indicators and targets to measure impact, and further encourage female participation	MS
Quality at entry/Preparation and Readiness	An inception workshop was conducted at the commencement of the Project after set up of the PMU. Preparatory activities were carried out in close consultations with the SIRIM and Project-related detailed information was disseminated to industries (Para 127).	S
Results-based management Approach	Key approach of MAEESTA implementation was to focus on policy papers for promoting ESMs and STSs and raising awareness and training of engineers, experts, vendors and installers on ESMs and STSs, which would be sufficient in convincing these enterprises to adopt ESMs and STSs in their operations given the potential for cost savings and additional profitability (Para 144-145).	S
UNIDO Supervision and Backstopping	UNIDO's performance in these responsibilities was conducted in a manner that was responsive to the requests and needs of the PMU, GoM and stakeholders from the industrial, health and hospitality sectors. All stakeholder participants overwhelmingly expressed their support for UNIDO's continued involvement in this sector (Paras 137-138).	HS
Overall rating		**MS**

4. Conclusions, Lessons Learned, Recommendations

4.1. Conclusions

153. The MAEESTA Project was a significant contributor in catalysing interest in thermal energy saving measures (ESMs) and solar thermal systems (STSs) in Malaysia resulting in policy papers being prepared and MAEESTA training activities being very popular. The location of the PMU within SIRIM was beneficial for the Project, resulting in a higher probability of national policies and plans being adopted. However, the overall MAEESTA Project GHG emission reduction targets were not met, primarily due to the COVID-19 pandemic.

154. The issues with ESMs and STSs in Malaysia can be summarized as follows:

- ESMs and STS for the industrial, health and hospitality sectors was a new topic, hence leading to many of these entities being reluctant to invest in STS activities until there was more familiarity with these technologies (Paras 123 and 142);
- There was insufficient awareness within the industrial, health and hospitality sectors and the general public to create a market for ESMs and STSs (Para 126, 3rd bullet);
- Larger enterprises are likely to be the first to adopt ESMs and STSs who can devote more resources to the investments (Para 123, 5th bullet);
- Many of the ESM and STS installations are installed by uncertified foreign installers leading to substantial risks of STSs not functioning properly with no regulations over the quality of STS installations (Para 94);
- The legislation and anticipated mandatory enforcement in 2023 or 2024 of the EECA is definitely a positive development for the deployment of more ESMs and STSs in the industrial, health and hospitality sectors as well as other sectors (Paras 19, 25, 36, 62, 63, 101, 109, 111 and 112)
- Despite the anticipation that the EECA (including STSs) to become mandatory in 2023, there is significant capacity building required to provide more STS expertise, vendors and installers to meet the expected demand for ESMs and STSs once they become mandatory (Para 109);
- ESCOs represent a promising way forward for ESMs and STS installations. However, the capacities of these ESCOs needs to be built to provide more confidence in STS installations such that loan financing secured by ESCOs does not become too costly (Paras 103, 109 and 142).

155. Looking forward towards mainstreaming thermal ESM and STS investments, SIRIM and other GoM agencies will face challenges with current levels of ESM and solar thermal expertise, and its own current level of staffing and capacities to implement and enforce the EECA. The pace of EECA implementation towards mainstreaming ESM and STS installations is anticipated to be slower, likely 2 to 4 years depending on the level of donor support for bridging staffing and capacity gaps and the level of business compliance to the EECA (Para 117).

4.2 Lessons Learned

156. Lesson #1: STS is seen as an attractive technology only by those companies with plenty of resources and a rather long planning horizon (Para 123, 5th bullet). This would include companies and entities with CSR strategies who have funds and staff to manage these strategies. However, the majority of entities are smaller in size and likely cannot undertake the risks of a poorly designed EPC contract or a faulty STS or ESM installation.

157. Lesson #2: The awareness of the low efficiency of existing energy supply systems is often lacking, thus leading to little knowledge on higher efficiency of ESM or off-grid STS solutions (Para 60).

158. Lesson #3: The timeline to establish an STS association who can work with companies and entities to understand the benefits of STS, and implement STS installations requires a longer gestation period. There is not yet a critical mass of national experts and installation personnel to implement STS projects at a pace to meet Carbon Neutrality goals by 2040. This will likely require 2 to 3 years of time and effort to transfer knowledge to multiple potential product suppliers, service providers and experts (Para 94).

159. Lesson #4: Expert training sessions that come with Continuous Development Programme (CDP) points will be seen as more attractive to professionals and consultants to participate. Expert training was also to include hands-on or practical sessions so that the participants will have a better understanding of STS.

4.3. Recommendations

160. Recommendation #1 (to SIRIM Berhad): Facilitate the formation of an STS association who can be regulated over the quality of STS installations. With the EECA being made mandatory for 2023 or 2024, the formation of this association is very important to regulate the installations and minimize substandard installations. Preparation and discussions should:

- revolve around the DSM personnel to do research and development with the association on STS installations to ensure regulations are applicable;
- compile a listing of companies that can benefit from ESMs and STSs with RoIs over 5 years for the purposes of approaching these entities for ESM and STS investment with existing or revised financial incentive schemes. It is highly likely there will be outreach from the entities to SIRIM Berhad on ESM and STS installations;
- in 1 to 2 years, training sessions for guidelines and standards for procurement and installing of STSs can be conducted. Training session discussions should revolve around the potential savings from STSs and ESMs, RoIs and the means of reducing the RoIs with the various grants and financing schemes available from the GoM and participating banks (see Recommendation 3, Para 162).

161. Recommendation #2 (SIRIM Berhad): Start mandating real time metering and monitoring of actual energy savings at the company level. This should start with entities selected for donor assistance who agree to a clause allowing online real time data on the performance of STS on their energy savings for uploading on a website (Para 160, Recommendation #1). This will lead to more visibility of the investments and create confidence in energy savings generated by ESM and STS investments that can lead to a lower payback periods.

162. Recommendation #3 (to SIRIM Berhad): Conduct additional ESM and STS showcases and more training to create long term demand for ESMs and STSs. This is to make up for time lost due to delays caused by the COVID-19 pandemic, and the fact that ESMs and STS installations with specific industries were not disseminated to a greater audience, likely due to the reluctance of many establishments to fully reveal their energy efficiency activities, primarily for proprietary reasons (Paras 101 and 121). Entities selected for donor assistance should agree to a clause whereby online real time data on the performance of STS on their energy savings can be uploaded on the website for public visibility, promotion, and awareness. Faster implementation of these showcase projects needs to also be considered as this will further increase interest with broader audience in the Project by other sectors. In addition, the provision of more training programmes will strengthen STS knowledge experts, vendors and installers as well as financing entities to establish an STS community or association who can work with companies and entities to regulate STS and ESM installations. Training can include:

- experts and installers: Thermal energy efficiency and energy audit, solar thermal system concept design and analysis, and solar thermal system performance and verification;

- vendors: solar heating system application optimization techniques and service offerings;
- financing stakeholders (banks and ESCOs): Aspects of financial and engineering economics especially as it pertains to solar thermal;
- organizing a technical tour specifically to see best practices on STS in countries like Austria or Germany for local companies and government agencies to expose themselves to actual operational STS projects. The country chosen should have operational STS projects.

Annex 1. Evaluation Terms of Referenc:

https://www.unido.org/sites/default/files/files/2022-07/GFMAL-120264_220317.pdf

Annex 2. List of Documents Reviewed

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Annex 3. List of stakeholders consulted

Related to UN Agencies

Name	Organisation	Position	Role in MAEESTA	Location
Sanjaya SHRESHTA	UNIDO	Industrial Development Officer, Renewable and Rural Energy Division, Energy Department	MAEESTA Project Manager	Vienna, Austria
Mohd Iskandar MAJIDI	UNIDO	PMU, MAEESTA	Expert batch 2	Kuala Lumpur
Hasimah HASAN	UNIDO	Assistant National Project Manager, MAEESTA		Kuala Lumpur
Ahmad ZAKUAN	UNIDO	Project Analyst		Kuala Lumpur
Dr Azmi IDRIS	UNIDO	Senior Technical Advisor		Kuala Lumpur
Ir Luk Chau BENG	UNIDO	Consultant, Expert Trainee Batch 1 and Certified Expert	PMU (Part time) Technical Committee member	Kuala Lumpur

Related to National Agencies

Name	Organisation	Position	Role in MAEESTA	Location

Mohd Fauzi ISMAIL	SIRIM	National Project Director, MAEESTA	National Project Director	Kuala Lumpur
Dr. Amir RAZAK	Universiti Malaysia Pahang (UMP)	Local expert/industry standard/NOSS Solar Thermal/Micro-credential	Advisor	Kuala Lumpur
Zulkiflee UMAR	Energy Commission	Deputy Director of Energy Efficiency & Conservation,	Project Steering Committee, Task Force & Technical Committee member.	Kuala Lumpur
Sabar bin Md HASHIM	Economic Planning Unit (EPU)		NPSC (National Project Steering Committee)	Kuala Lumpur
Prof HASLENDA	Universiti Teknologi Malaysia (UTM)		Appointed to develop training courses	Kuala Lumpur
Steve Anthony LOJUNTIN	SEDA	Director of Energy Demand Management (Energy Efficiency) Division of SEDA	Gazetting solar thermal within the EECA	Kuala Lumpur
Datuk Ts. Dr. Mohd Nor Azman HASSAN	Ministry of Science, Technology and Innovation (MOSTI) Malaysia	Deputy Secretary General (Technology Development)		Kuala Lumpur

Related to Project beneficiaries

Name	Organisation	Position	Role in MAEESTA	Location
Ir. Dr. Philip Tan Chee Lin	FMM	Advisor	Advisor	Kuala Lumpur
Ms. FARAH	MIWA Manufacturing (Food & Beverage)	Managing Director	Recipient of Kingspan solar thermal system	Kuala Lumpur
Dr Chua Soon Hung	Kingspan		Installation of solar thermal collectors	Kuala Lumpur
Dr Mohd Asri bin RIFFIN	Pusat Jantung Hospital	Director of Hospital	Recipient of solar thermal system	Kuching
Miss FATIN (MOH),	Ministry of Health, Ampang Hospital		Recipient of solar thermal system	Kuala Lumpur
Mr. NABIL	Radicare (M) Sdn. Bhd.		Recipient of solar thermal system	Kuala Lumpur

Annex 4. Summary of Project Identification and Financial Data

Project Factsheet

Milestone	Expected date	Actual date
Project CEO endorsement/approval date	25 March 2011	28 April 2014
Project implementation start date (PAD issuance date)		11 July 2014
Original expected implementation end date (indicated in CEO endorsement/ approval document)	1 July 2019	30 June 2022
Revised expected implementation end date	30 June 2021	30 June 2022
Terminal evaluation completion	30 June 2019	31 March 2023

Project budget

Financing plan summary

	Project Preparation	Project	Total ($)
Financing (GEF / others)	75,000	4,000,000	4,075,000
Co-financing (cash and in-kind)	75,000	20,000,000	20,075,000
Total (USD $)	**150,000**	**24,000,000**	**24,150,000**

Financing plan summary - Component breakdown

Project components	Donor (GEF) ($)	Co-Financing ($)	Total ($)
1. Regulatory framework and financial incentive schemes	120,000	525,000	645,000
2. Awareness raising and capacity building	886,000	2,175,000	3,061,000
3. Demonstration projects	2,740,000	16,200,000	18,940,000
Project management	64,000	100,000	164,000
Monitoring and Evaluation	190,000	1,000,000	1,190,000
Total	**4,000,000**	**20,000,000**	**24,000,000**

Co-Financing sources, breakdown and actual co-financing realized

Name of Co-financier (source)	Classification	Type	Amount committed at design ($)	Actual amount realized ($)
UNIDO	Partner agency	Grant	60,000	65,000
UNIDO	Partner agency		140,000	140,000
SERI-UKM	Government		800,000	21,112
MoSTI, MIGHT	Government		250,000	10,548
SIRIM	Government		900,000	613,810
Industry	Private sector		7,150,000	1,937,455
Industry	Private sector	Cash	2,000,000	10,781,871
Industry	Private sector	Loan	8,450,000	
FMM	Government		250,000	8,965
Others	Government	In-kind		340,140
Others	Institute of higher learning	In-kind		303,300
Total Co-Financing ($)			**20,000,000**	**14,182,201**

Annex 5. GEF Tracking Tool

Results: Energy Savings, GHG Emissions Reduction and Investment on EE and Solar Thermal Systems

Quantity of energy saved annually (MWh)**: 348,049**

Volume of investment on energy efficiency/solar thermal technologies: **$10,781,871**

Direct energy savings and substitution	
Target at the CEO endorsement	***At the closure of the project***
Solar thermal: 360,000 GJ	Solar thermal: 76,788 GJ
Thermal energy efficiency: 40,603,583 GJ	Thermal energy efficiency: 16,915,373 GJ
Lifetime GHG emissions reduction over 15 years	
Target at the CEO endorsement	***At the closure of the project***
Solar thermal: 24 $ktCO_2$	Solar thermal: 16 $ktCO_2$
Thermal energy efficiency: 2,735 $ktCO_2$	Thermal energy efficiency: 980 $ktCO_2$
Post project replication	
Target at the CEO endorsement	**At the closure of the project**
(Investment in RE/EE opportunities in industry) will lead to indirect emission reduction of between 5,518 and 17,197 $ktCO_2$	Based on the achieved CO_2 reduction, the estimated indirect emissions reduction is 1,936 $ktCO_2$. With the low carbon commitment under RMK12 and industry motivation towards low-carbon operation, contributing to higher post-project replication.

Annex 6. Project Results Framework

Project Result	Indicator	Baseline	Targets	Source of verification	Risks and Assumptions
Project Objective					
To reduce GHG emissions by promoting and demonstrating sector-specific thermal EE improvements and solar thermal technology utilization in industry.			**Direct energy savings and substitution:** Solar thermal: 360,000 GJ; Thermal energy efficiency: 40,603,583 GJ **Lifetime GHG emission reduction:** Solar thermal: 24 $ktCO_2$; Thermal energy efficiency: 2,735 $ktCO_2$. **Post-project replication** (investment in RE/EE opportunities in industry) will lead to indirect emission reduction of between 5,518 and 17,197 $ktCO_2$	Project progress report Demonstration projects validation reports End-of-project impact report Project website	
Component 1: Development of a regulatory framework and financial incentive schemes to facilitate solar thermal energy utilization and thermal energy efficiency					
Outcome 1: Policy papers and financial incentive schemes established and endorsed by stakeholders.	Number of policy papers on solar thermal energy endorsed by stakeholders; Number of financial incentive schemes (e.g. tax breaks, certification schemes) established and endorsed by stakeholders.	No specific policy papers or financial incentive schemes for the promotion of industrial solar thermal energy utilization have been endorsed by the Malaysian institutions.	3 policy papers on solar thermal energy endorsed by stakeholders (score 4 from the GEF's 0 to 5 score range); 2 financial incentive schemes endorsed and established by stakeholders (score 4 from the GEF's 0 to 5 score range).	Official documents Websites of organizations Publicity given in media	National authorities are willing to adopt specific regulations; Interest by stakeholders to apply EE (especially in the SMEs) exists and can be maintained.

Project Result	Indicator	Baseline	Targets	Source of verification	Risks and Assumptions
Output 1.1: ~~National counterparts supported to develop three policy papers on solar thermal energy.~~ Supported national counterparts for developing 3 policy papers on solar thermal energy	Number of policy papers developed; % of counterparts taking part in the development of policy papers report having benefitted from built capacity; Number of workshops and seminars organized	There are currently no policy papers on solar thermal energy under development.	At least 3 policy papers on solar thermal energy developed; At least 70% of counterparts taking part in the development of policy papers report having benefitted from built capacity; At least 5 workshops and seminars organized.	Technical reports Project progress reports Workshop proceedings	
Output 1.2: Two financial incentive schemes focusing on solar thermal applications developed.	Number of financial incentive schemes (e.g. tax breaks, certification schemes) developed; Number of seminars/ events to present and discuss proposals organized.	No financial incentive schemes for the specific purpose of promoting the utilization of solar thermal energy in industry are available.	At least 2 financial incentive schemes developed. At least 5 workshops and seminars/events to present and discuss proposals organized	Technical reports Workshop proceedings Publicity in media Project progress reports	National authorities are willing to adopt specific regulations.
Component 2: Awareness raising and capacity building programme relating to process heating and cooling optimization and solar thermal energy utilization					

Project Result	Indicator	Baseline	Targets	Source of verification	Risks and Assumptions
Outcome 2: Awareness and capacity of equipment vendors, service providers, industry management, plant engineers, and financial institutions in 5 targeted industrial sub-sectors strengthened and utilized.	% of participants reporting that they feel capable of successfully applying the knowledge/ skills acquired in their workplace;	Currently only one institution and one company offer services, albeit limited, on solar thermal utilization, and there are very few consultants for boiler and furnace efficiency improvements.	90% of participants report that they feel capable of successfully applying the knowledge/ skills acquired in their workplace; (score 5 from the GEF's 0 to 5 score range);	Evaluation reports Website of organizations and companies Project progress reports	Availability and willingness of experts to receive training; Willingness of companies and vendors to receive expert training.
Output 2.1: Training programme on energy savings based on process heating and cooling conducted for service providers, consultants and industry in selected sub-sectors.	Number of trainees at various levels, users, experts, etc. trained in process heating optimization and waste heat recovery.	No comprehensive trainings on process heating and cooling are available in the selected sub-sectors.	50 equipment vendors, 100 users and 50 experts trained.	Training reports Project progress reports Company information	Availability and willingness of experts to receive training. Willingness of companies and vendors to receive expert training.
Output 2.2: Training programme on solar thermal technology conducted for equipment/ component suppliers, service providers, consultants and industry in selected sub-sectors.	Number of trainees trained at various levels on solar thermal systems and integration in industrial processes.	No comprehensive trainings on solar thermal technology are available in the selected sub-sectors.	30 equipment vendors, 80 users and 40 experts trained	Training reports Company info and plant visits	Interest by stakeholders to apply solar thermal integrated with EE improvements exists and can be maintained.
Output 2.3: Awareness raising events organized for industry management and financial institutions on investment in energy	Number of awareness raising events organised;	No comprehensive awareness programme on solar thermal energy utilization or on thermal EE in	At least 20 awareness raising events for the target group (industry managers, financial institutions) organized, including experience with the demonstration projects;	Technical reports Company info and plant visits	Willingness of government agencies and commercial banks to support RE (solar

Project Result	Indicator	Baseline	Targets	Source of verification	Risks and Assumptions
savings and solar thermal application.	Number of publications issued; project website developed.	industry exists.	20 publications, posters etc. issued; project website operational.		thermal) and EE in industry.
Component 3 - Demonstration and scaling up of sector-specific EE and solar thermal energy utilization in targeted industrial subsectors					
Outcome 3: Thermal energy efficiency and solar thermal technology demonstrated and deployed in 5 targeted industrial sub-sectors.	% of plants reporting that they will continue to use and maintain the technology transferred by the project in their plants.	The selected sub-sectors do not currently have ongoing demonstration projects for thermal EE and solar thermal technology.	90% of plants report that they will continue to use and maintain the technology transferred by the project in their plants.	Evaluation reports Website of organizations and companies Project progress and technical reports Monitoring and case study reports	Interest by stakeholders to apply EE (especially in the SMEs) exists and can be maintained.
Output 3.1: ~~Energy saving measures and investment projects implemented in about 40 factories~~ 30 investment projects in 30 factories with energy saving measures.	Number of facilities in which EE in thermal processes have been implemented.	No such demonstration projects are currently available in the selected sub-sectors.	~~40~~ 30 companies with EE improvements in process heating and cooling;	Project progress and technical reports; Monitoring and case study reports; Company information	Interest by companies to apply EE and systems optimization exists and can be maintained.
Output 3.2: ~~Of the above 40 factories, around 10 implemented solar thermal demonstration projects~~ 10 solar thermal demonstration projects.	Number of facilities in which solar thermal energy utilized.	No such demonstration projects are currently available in the selected sub-sectors.	10 facilities with integrated solar thermal systems.	Project progress and technical reports; Monitoring and case study reports; Company info and plant visits	Companies are willing to implement EE measures in thermal systems and integrate with solar thermal.
Output 3.3: ~~Case~~	Number of case studies	Due to the lack of	10 case studies prepared and	Progress reports	

Project Result	Indicator	Baseline	Targets	Source of verification	Risks and Assumptions
~~studies prepared and presented under output 2.3 to raise more investment in EE and solar thermal integration using the trained capacity and various financial incentive schemes created~~ Case studies prepared and presented to raise more investment in EE and solar thermal integration using the trained capacity and various financial incentive schemes created.	prepared and presented at awareness raising events; Number of future investment opportunities identified.	demonstration projects and investment in solar thermal technologies in industry, case studies are non-existent.	presented at seminars/ workshops (total of 20 event days, held at workshops at various places throughout Malaysia)	Presentations and training materials	