

# Thailand Refrigeration & Air-conditioning (RAC) NAMA Support Project

## End-of-Project Report – Findings and Learnings

NAMA Support Project

Technical Cooperation (TC) Component

## The NAMA Facility

The NAMA Facility seeks to play a leading international role in funding truly transformational sector-based approaches to tackling climate change. Jointly established by the UK and Germany in 2012, and later joined in 2015 by Denmark and the European Union and the Children’s Investment Fund Foundation (CIFF) in 2021 as additional donors, the NAMA Facility inspires ambitious climate action and helps developing countries and emerging economies deliver on their nationally determined contributions (NDCs). These NDCs comprise countries’ commitments laid out under the Paris Agreement to keep temperature rises to well below two degrees Celsius.

Nationally appropriate mitigation actions (NAMAs) act as building blocks of NDC implementation, and the NAMA Facility supports partner countries in NAMA development and implementation. To date, the NAMA Facility has launched eight Calls for the submission of NAMA Support Project (NSP) Outlines – or project concepts for delivering this ambitious climate mitigation action.

More information is available at [www.nama-facility.org](http://www.nama-facility.org).

## About the End-of-Project Report

The End-of-Project Report serves to gather each NAMA Support Project’s (NSP) overall results and lessons learnt for the broader public. NSPs are tasked with drawing out lessons and demonstrating good practice for knowledge sharing, scaling up and replication to contribute to transformational change. This report also references the technical Evaluation and learning Exercise (ELE), which are conducted separately by external consultants, focus more narrowly on NSP results and occur as part of the end-of-project evaluation.

### Disclaimer

Please note that the results and lessons learnt included in the report represent the opinions of the NAMA Support Projects and do not necessarily represent the position of the NAMA Facility.

## Abbreviations

<b>BAU</b>	Business-as-usual
<b>BMU</b>	German Ministry for Environment, Nature Protection and Nuclear Safety
<b>BUR</b>	Biennial Update Report
<b>CFCs</b>	Chlorofluorocarbons
<b>DEDE</b>	Department of Alternative Energy Development and Efficiency
<b>DIW</b>	Department of Industrial Works
<b>DPT</b>	Department of Public Works and Town & Country Planning
<b>DSD</b>	Department of Skill Development
<b>EEL</b>	Electrics and Electronics Institute
<b>EERF</b>	Energy Efficiency Revolving Fund
<b>EESL</b>	Energy Efficiency Standards and Labelling
<b>EGAT</b>	Electricity Generating Authority of Thailand
<b>ENCON Fund</b>	Thailand’s Energy Conservation Fund
<b>GIZ</b>	Deutsche Gesellschaft für Internationale Zusammenarbeit
<b>GWP</b>	Global warming potentials
<b>HCFCs</b>	Hydrochlorofluorocarbons
<b>HFCs</b>	Hydrofluorocarbons
<b>HPMPs</b>	HCFC Phaseout Management Plans
<b>KMUTNB</b>	King Mongkut’s University of Technology North Bangkok
<b>M&amp;E</b>	Monitoring & Evaluation
<b>MRV</b>	Measurement, Reporting and Verification
<b>NAMAs</b>	Nationally Appropriate Mitigation Actions
<b>NDCs</b>	Nationally Determined Contributions
<b>NOU</b>	National Ozone Unit
<b>NSO</b>	NAMA Support Organisation
<b>NSP</b>	NAMA Support Project
<b>ODS</b>	Ozone-depleting substances
<b>ONEP</b>	Office of Natural Resources and Environmental Policy Planning
<b>OVEC</b>	Office of the Vocational Education Commission
<b>RAC</b>	Refrigeration and air-conditioning
<b>TISI</b>	Thailand’s Industrial Standard Institute
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change

Cooling in Southeast Asia is as important as heating in Northern Europe. It provides not only for human comfort, but also ensures healthy work environments and food security. From any perspective, it is a remarkable technological, economic and social achievement that an increasing number of people have access to affordable cooling technologies.

But where there is light, there are shadows too. Today, more than half of Thailand's electricity is produced just to respond to the energy demands of air-conditioners and refrigerators. Despite all the energy efficiency gains Thailand has made in the past, electricity consumption in the country is on the rise, mostly due to the soaring demand for all kinds of cooling. This not only puts Thailand's energy security at risk, but also contributes largely to climate change in a country where electricity production from fossil fuels is still the norm. On top of that, there are large emissions of synthetic refrigerants, chemicals that circulate within the refrigeration system and that are greenhouse gases much more harmful than carbon dioxide.

The scale of this problem, which stretches beyond Thailand across all Southeast Asia and many other tropical countries, is so huge that analysts from the International Energy Agency have named it the Cooling Crisis.

Amidst the Cooling Crisis, Thailand offers a special opportunity. Thailand is not only amongst the largest users of cooling technologies, but also one of the largest production hubs. One out of ten air-conditioners and refrigerators sold globally is "Made in Thailand", either by local brands or by international companies. And while it is important that these air-conditioners and refrigerators remain affordable, it is even more important that cooling is as clean and energy efficient as current technologies allow, and that the boundaries of green cooling technologies are constantly pushed.

Over the past five years, RAC NAMA has worked towards making green cooling technologies a reality in Thailand, building upon an alliance of ministries, agencies,

universities and the private sector. Ten manufacturers in Thailand have introduced green cooling technologies, recent international standards have been adopted, and technicians are being trained. And it was not private households that were the first adopters, but businesses, which now benefit from a clean technology that is paying off thanks to the immense energy savings. Today, we see a growing demand for green cooling technologies in Thailand, thanks to the work of many organisations and people involved in RAC NAMA.

In this report, GIZ would like to share the lessons learnt from more than five years of project implementation.

## 1 Project overview

The RAC NAMA Support Project (NSP) aims to initiate a transformation of Thailand's refrigeration and air-conditioning sector towards the production and use of green cooling technologies: climate-friendly and energy efficient cooling technologies based on natural refrigerants.

The use of refrigeration and air-conditioning (RAC) technologies already today contributes approximately 60% to Thailand's electricity consumption, with electricity being carbon intensive and mostly produced through fossil fuels. Until 2030, the electricity demand for cooling is projected to double, while an energy transition towards renewables that would decarbonise the electricity consumption of cooling equipment is not foreseeable.

The RAC industry is also responsible for the wide use of halogenated refrigerants – chemicals used in each cooling system – that are strong greenhouse gases eventually released into the atmosphere. One ton of these refrigerants emitted is as damaging as hundreds or thousands of tons of carbon dioxide emissions. Together, greenhouse gas emissions from electricity consumption and refrigerant use make the RAC sector one of the country's largest greenhouse gases emitters, accounting for approximately 20% of Thailand's overall greenhouse gas emissions. Thailand will need to reduce its emissions from the RAC sector to achieve its

targets and obligations in energy and climate policy.

Ultimately, the RAC sector in Thailand is also of greater strategic importance for the global efforts against climate change, as Thailand is an important manufacturing hub for the global RAC industry. If production in Thailand is changed towards green cooling technologies, this will also affect the sector globally, and will give Thailand's RAC industry a competitive edge in those markets that already demand climate-friendly and energy efficient cooling technologies.

## 1.1 International and national climate policy

The United Nations Framework Convention on Climate Change (UNFCCC) is a global response to climate change and its irreversible consequences. This multilateral treaty entered into force in 1994; today, it has a near-universal membership with 197 countries that have ratified the convention with the intention "to stabilise greenhouse gas concentrations at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system." Since the adoption of the convention and with increasing urgency of the issue, responsibilities of the parties have evolved both for developed and developing countries.

In this context, developing countries have been invited to put forward mitigation measures of their own, for example Nationally Appropriate Mitigation Actions (NAMAs). NAMAs are actions to reduce emissions in developing countries under the umbrella of national governmental initiatives; NAMAs can be policies directed at specific economic sectors or the entire economy. In 2014, Thailand pledged to mitigate 7 to 20% of CO<sub>2</sub> emissions against a business-as-usual (BAU) scenario by 2020. It is intended that 7% of the reduction is achieved through domestic NAMAs that are funded by the country's own budget; reductions beyond 7% would be achieved through NAMAs supported by international funding. As of the third Biennial Update Report (BUR) submitted by Thailand to the UNFCCC in December 2020, the measures under Thailand's NAMA Roadmap have already achieved about 57.8 Mt CO<sub>2</sub>

equivalent greenhouse gas emission reduction in 2018, accounting to a 15.8% reduction from the BAU level.

During the climate negotiations under the UNFCCC in 2015, the parties went beyond NAMAs and strengthened actions to combat climate change through the adoption of the Paris Agreement. The Paris Agreement aims to keep global temperature rise "well below 2 degrees Celsius above pre-industrial levels and (to) pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius." For the first time, it required all parties to formulate their commitments in combating climate change in the form of "Nationally Determined Contributions" (or "Intended Nationally Determined Contributions" before the ratification of the Paris Agreement). These NDCs are the fundament of the Paris Agreement, along with appropriate mobilisation and provision of financial resources and an enhanced transparency framework for the reporting of climate action. In October 2015, Thailand submitted its first intended NDCs, which formally became Thailand NDCs after ratification of the Paris Agreement in November 2016, setting out a greenhouse gas mitigation target of 20 to 25% until 2030 compared to its projected BAU emissions scenario. The unconditional target will be achieved through national resources, while the conditional target would be subject to enhanced access to technology, financial resources, and capacity building support.

The RAC sector is one of Thailand's largest emitters of greenhouse gases. While RAC NAMA was initiated under Thailand's NAMA pledge, it also serves Thailand's NDCs and is closely entangled with Thailand's Energy Efficiency Plan. Most importantly, Thailand has included RAC NAMA into its NDC Roadmap, which was endorsed by the cabinet in 2017 and puts the responsibility of implementing in total 15 mitigation measures on the shoulders of the responsible sector ministries. For RAC NAMA, these are the Ministry of Energy and the Ministry of Industry, as well as the Ministry of Natural Resources and the Environment.

## 1.2 Montreal Protocol, the Kigali Amendment and national RAC sector policy

The Montreal Protocol on Substances that Deplete the Ozone Layer was the first treaty to achieve universal ratification with all 197 member states of the UN; it was signed in 1987 and entered into force in 1989. It aims to protect the stratospheric ozone layer by setting mandatory phase-out schedules for the production and consumption of ozone-depleting substances (ODS) such as Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs), which are widely used as refrigerants in RAC equipment and foam production.

The Montreal Protocol foresees different phase-out schedules for developed and developing countries. In developing countries, the most harmful substances, CFCs, have been phased out in 2010, though the Protocol only controls bulk consumption and does not prohibit use of existing or recycled substances beyond their phase out dates, so remaining CFCs may still be in use. While phasing out CFCs, HCFCs were introduced as a transitional substitute. Currently, developing countries are required to phase out HCFCs by 2030, carried out through their HCFC Phaseout Management Plans (HPMPs) with technical and financial support provided by the Multilateral Fund of the Montreal Protocol. In this current phase, Hydrofluorocarbons (HFCs) are being widely introduced as the next substitute. While HFCs do not deplete the ozone layer, HFCs are strong greenhouse gases with global warming potentials (GWP) of several hundreds or thousands, measuring the climate damage in comparison to CO<sub>2</sub>.

As a response to the climate damage posed by the introduction of HFCs, the Kigali Amendment to the Montreal Protocol was agreed during the 28th Meeting of the Parties to the Montreal Protocol in Kigali in October 2016. The Kigali Amendment stipulates the gradual reduction of the consumption and production of HFCs, though not aiming for a total phase-out. Developing countries should freeze consumption in 2024, achieve the first reduction of 10% in 2029 and a total reduction of 80% by 2045. The Kigali Amendment entered into force in January 2019. As of April

2021, the amendment has been ratified by 110 member states and the European Union. It is estimated that the promised HFC reductions from the Kigali Amendment could result to avoiding 0.5 degrees Celsius of global warming by the end of the century. The Kigali Amendment thereby implicitly links the Montreal Protocol to the goals of the Paris Agreement.

Thailand ratified the Montreal Protocol in 1989. The National Ozone Unit (NOU) was established within the Department of Industrial Works (DIW) to implement Thailand's obligations under the Montreal Protocol. Thailand has fulfilled all obligations of the Montreal Protocol so far and currently implements its HPMP to phase out HCFCs in different stages. HPMP Stage I was completed in December 2018, having eliminated the consumption of HCFC refrigerant R22 in the manufacturing of residential air-conditioners and introduced HFC refrigerant R32 as a substitute. In the ongoing HPMP Stage II, Thailand will eliminate the remaining HCFC consumption in the foam sector until 2023. Thailand has not yet ratified the Kigali Amendment – its ratification could have significant implications for the industry that has already widely introduced R32.

As countries are still widely introducing HFCs to substitute HCFCs, it is imperative to look to more sustainable and climate-friendly solutions so that HFCs can be phased down more quickly or leapfrogged entirely. As an early action, the Thailand RAC NAMA provides financial and technical assistance for the reduction of HFCs and for the adoption of natural refrigerants. Through the NAMA, Thailand would already achieve significant HFC reduction ahead of the phase-down schedules of the Kigali Amendment, and would prepare its industry for the future demand for HFC-free technologies in Thailand and international export markets.

## 1.3 State of the RAC industry and green cooling technologies

The global RAC industry is comprised of equipment manufacturers, technology suppliers (manufacturers of key components such as compressors, valves, heat exchangers, fans, electronics), refrigerant suppliers and



service providers. The industry serves various subsectors and market segments, such as residential air-conditioners, household refrigerators, commercial refrigeration appliances, chillers for air-conditioning and process cooling, as well as automotive air-conditioning and transport refrigeration. Thailand's RAC industry, which is mostly comprised of equipment manufacturers and technology suppliers, has surpassed a business volume of EUR 3 Billion in Thailand's domestic market alone.

The RAC industry has undergone several transformations in the past and faces further transformations in the future due to technological advancement and policy pressure. Under the Kigali Amendment to the Montreal Protocol, most of the industry will need to shift towards refrigerants with low global warming potential, either novel classes of halogenated refrigerants or natural refrigerants. RAC NAMA supports the introduction of natural refrigerants, such as hydrocarbons, carbon-dioxide, or ammonia, which are the most sustainable choice with very low global warming potential and without the environmental side-effects – like pollution of aquatic systems – that halogenated refrigerants with low global warming potential would still exhibit.

The challenge in introducing natural refrigerants is safety: hydrocarbons such as propane, which is the natural refrigerant of choice for cooling appliances, are more flammable than widely used HFCs. This requires manufacturers to consider flammability in their product design – for example using explosion-proof components – and technicians to work with diligence. Internationally, governments have created safety frameworks for flammable refrigerants, comprised of qualification standards, product safety standards and building regulations. Thailand bans flammable refrigerants from large buildings almost entirely through its strict building code as national product safety standards and qualification standards do not reflect technical knowledge and international best practices for the safe handling of flammable refrigerants yet. This ban narrows down the market potential for green cooling technologies.

The project was conceptualised during a time of promising trends for natural refrigerants in the air-conditioning manufacturing sector. Unfortunately, the industry has not moved at the anticipated pace and in the anticipated direction. Today, only Godrej, a manufacturer in India, has proven successful in introducing natural refrigerants for air-conditioning in its domestic market with approximately one million units sold. Despite the large absolute number, this only corresponds to a marginal market share in a country such as India. In China, several manufacturers (Midea, GREE, TCL, Haier) have established production capacities for air-conditioners using natural refrigerants. It was expected that products would launch into the Chinese and international markets in 2016, but companies delayed market introduction until 2020 and only serve public procurement in China so far. In international markets, air-conditioners using natural refrigerants are practically not available, as halogenated refrigerants with high and moderate global warming potentials are still being used and even introduced in major manufacturing countries: China and Thailand. This has posed a significant challenge for the project, which expected to build on increased response from other manufacturers, suppliers, end-users and the servicing industry, but has been in the position of a first mover since the beginning.

In the refrigeration sector, the market situation is different – especially for sealed equipment that requires smaller refrigerant filling and that would pose a smaller flammability risk. Here, regulatory pressure in Europe as well as other markets is further pushing the industry to rethink the use of halogenated refrigerants and to increase the use of climate-friendly alternatives across the entire refrigeration sector. This trend also affects companies in Thailand, which actively serve these export markets.

## 1.4 Project design

RAC NAMA was developed under the leadership of Thailand's Ministry of Natural Resources and Environment and Ministry of Energy, also involving other ministries, agencies and local expertise. In its design, the project recognised that a transformation of the RAC sector would only be possible in

cooperation with the private sector, including the RAC industry as well as large end-use sectors. Within the industry, the project targets three market segments: **residential air-conditioners, commercial refrigeration appliances and chillers.**

As the project started in 2016, the manufacturing industry was in the process of adopting R32 in residential air-conditioners, an HFC refrigerant replacing the HCFC R22. Only one year later, R32 would be the dominant refrigerant in the air-conditioning sector. Green cooling technologies were nearly invisible in Thailand. There was no demand and supply, and international markets for green cooling technologies were just picking up pace, mostly in the refrigeration sector. For many industry players, there were large concerns against the use of natural refrigerants, which are flammable and may impose a safety risk if not handled appropriately during production, use and servicing. This risk perception was also underpinned by the country's strict building regulation and outdated product safety standards that largely restricted the use of natural refrigerants in many applications. Within this difficult environment, the project was designed to build a supply and demand for green cooling technologies, create a safety framework through standards and qualification, and to shape a conducive political and regulatory environment:

- **In its overall project management,** the project would establish a joint Oversight Board under the authority of the political partner, would ensure that the project remains embedded into national policies and would create a monitoring and evaluation system that would allow both GIZ and the political partners to track and report the progress of the project (Output 1).
- **In its policy dialogues,** the project would work towards enhanced energy efficiency regulation and environmental standards for the RAC sector, which would create a significant advantage for green cooling technologies. The project would also try to overcome existing

regulatory barriers, for example the current building code and outdated product safety standards (Output 2).

- **On technology transfer,** the project would establish cooperation with manufacturers in Thailand, both domestic and international companies, and support them on product development, production engineering and safety compliance. The project would provide **financial assistance** to those companies that want to establish production capacities and build a supply for green cooling technologies (Output 3).
- **For technical safety,** the project would establish trainings and qualification standards for the safe handling of natural refrigerants, which would enhance the safety of the labour force through better working practices and would increase their overall competency. The project would provide **financial assistance** for the establishment of training centres throughout the country, and for the establishment of testing laboratories for product certification (Output 4).
- **For market introduction,** the project would establish a revolving fund to provide **financial assistance** in the form of incentives that would create a demand for green cooling technologies, embedded into a communication strategy directed towards potential first movers (Output 5).

Under a joint project management, these activities were bundled in **three project components: policy, technology and financial assistance;** market introduction and communication were organised in a cross-cutting manner to integrate the results and successes of the project components. Overall, the NAMA Support Project had a budget of EUR 14.7 million, of which EUR 8.3 million were foreseen for financial assistance.



## 2 Project progress and achievement

The Thailand RAC NAMA Support Project aims to initiate a transformation of Thailand's refrigeration and air-conditioning sector towards the production and use of green cooling technologies: climate-friendly and energy efficient cooling technologies based on natural refrigerants. The project was commissioned to the Office of Natural Resources and Environmental Policy Planning (ONEP), which is shaping Thailand's climate policies, and the Department of Alternative Energy Development and Efficiency (DEDE), implementing Thailand's energy policies. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH was nominated as the NAMA Support Organisation (NSO) responsible for the delivery of technical and financial assistance.

### 2.1. General information

After its commissioning in April 2016, the project established its management structures to start with the provision of technical assistance; the financial assistance – the RAC NAMA Fund – could not start as anticipated due to delays in the diplomatic processes that would formalise the cooperation on RAC NAMA between Thailand and Germany, the lead commissioning party of NAMA Facility.

Without the diplomatic process completed, the original concept of anchoring the project's financial assistance with Thailand's Energy Conservation Fund (ENCON Fund) was legally impossible. In 2017, the project started to evaluate other options (politically, financially and legally), and agreed with its political partners to establish the RAC NAMA Fund under the leadership of the Electricity Generating Authority of Thailand (EGAT), Thailand's major utility, that could integrate the RAC NAMA Fund into its energy efficiency programme. It was agreed that EGAT would manage the financial assistance entirely, which would include grants for producers and training and testing centres, and loans for market introduction. The RAC NAMA Fund was established through a grant agreement between EGAT and GIZ in December 2017 and

put into operation in early 2018, almost two years after the start of the project.

#### 2.1.1 Technology component

In the first two years of implementation, the project decided to advance technical assistance despite the unclear perspective for the RAC NAMA Fund. Most importantly, the project reached out to potential cooperating manufacturers and approached them for first consultations, assessing with them their existing product portfolio and market opportunities for green cooling technologies. While the project was able to access manufacturers in the commercial refrigeration sector quickly, it faced difficulties to reach dependable working relationships with manufacturers of air-conditioners given their previous transition and commitment to R32 as well as prevailing safety concerns and a dim market outlook for green cooling technologies for air-conditioning.

The delay in financial assistance lessened the ability of the project to make financial commitments and to initiate technology transfer. With technical and financial assistance in place, the project established cooperation with a total ten manufacturing companies. In 2018 and 2019, the RAC NAMA Fund launched two grant programmes for the production of green cooling technologies and successfully contracted eight companies to receive partial grants for investing into production capacities for green cooling technologies; two companies have joined the project without financial support for their production lines. All companies have received extensive technical support through the project on product development, production engineering and safety compliance. Due to the initial delays in the deployment of financial assistance and due to the COVID pandemic, which hit the project in the last year of implementation, three producers finished the establishment of production just a few months before the end of the project, two of them in the critical air-conditioning sector.

With the onset of production, the project and the RAC NAMA Fund provided further support for market development. Multiple companies

have received concessional loans from the RAC NAMA Fund, which they passed on to their clients in the form of credit card financings, extended payment terms, and one-time discounts. Further, the project and EGAT have directly approached large end-users to spur their interest for green cooling technologies, with multiple large supermarket chains and food & beverage companies now in concrete dialogues with participating manufacturers.

To address valid safety concerns, the project has invested significantly into training, qualification standards and product certification, which form the necessary safety framework for a wider adoption of green cooling technologies. However, the project has largely underestimated the investment needs and the structural complexity of Thailand's training and qualification system (involving two ministries, multiple agencies as well as mostly independent training institutes). With consent of the NAMA Facility, the project mobilised the RAC NAMA Fund to provide support for the establishment of training and testing centres and forged a cooperation with King Mongkut's University of Technology North Bangkok (KMUTNB) to implement trainings in cooperation with other training institutes. KMUTNB would serve as the grant agent to the RAC NAMA Fund, handle the procurement of equipment (for all training centres, including those operated by other agencies) and serve as main training hub for training-of-trainer programmes.

In 2019 and 2020, the project and KMUTNB have equipped eight training centres for the safe handling of natural refrigerants and have concluded a series of training-of-trainer programmes; manufacturers of green cooling technologies have provided in-house trainings to their company staff. To ensure that trainings on green cooling technologies become a standard in Thailand in the future, the project has worked with the Department of Skill Development (DSD) and the Office of the Vocational Education Commission (OVEC) to carry out trainings in their associated training centres. DSD aims to integrate these trainings into their training curriculum; a draft of the revised curriculum has been developed by DSD and KMUTNB and formally submitted to the responsible working group.

For product certification, the project supported the Electrics and Electronics Institute (EEI) to extend its testing services towards green cooling technologies. EEI is associated with the Ministry of Industry and Thailand's industry and provides product testing and certification against national and international standards. In addition to technical trainings for EEI's engineers, the RAC NAMA Fund provided financial support to upgrade EEI's existing testing facilities. The project also built on this cooperation to further policy dialogues on strengthening Thailand's product safety standards.

### 2.1.2 Policy component

The policy component worked closely with the technical component and focused on regulatory aspects and policy instruments that could benefit the advancement of green cooling technologies, be it on the level of safety standards, energy efficiency regulation or overarching climate policy.

Thailand's Industrial Standard Institute (TISI) regularly adopts international product safety standards, mostly by literal translation for the national standard without any technical changes. While apparently straightforward, the adoption and updating of national standards tends to be a resource-intensive political process. As TISI usually does not actively engage in international standardisation processes, the project supported TISI with frequent updates on international standards developments to set priorities for their adoption. As a result, Thailand has adopted a recent international standard for the product safety of air-conditioners and prioritised the adoption of a recently changed standard for the product safety of commercial refrigeration equipment.

As a major barrier, Thailand's building code restricts use of flammable refrigerants in large buildings. The project consulted with the Department of Public Works and Town & Country Planning (DPT) to allow use of natural refrigerants, given that the newly established product safety standards would form a sufficient safety framework. Unfortunately, the project could not build upon any political momentum to amend the building code solely for the purpose of green cooling technologies,

given the complexity of the legislative process. The project hopes that DPT will consider the recommendations of the project in the next larger amendment of the building code, which is not imminent yet. This heavily affected the projects attempt to unlock the air-conditioning sector, as a wide uptake of green cooling ACs would require that legal barriers were removed.

A strong focus of the policy component were Energy Efficiency Standards and Labelling (EESL), which set minimum requirements for energy efficiency (for products to enter the market) and inform consumers and users about electricity demand and electricity cost of electrical equipment (in the market). Given the inherent energy efficiency advantage of green cooling technologies, the project sees EESL as one of the best policy instruments for their promotion. EGAT, the implementing partner of the RAC NAMA Fund, is also responsible for Thailand's energy efficiency label, known as "Label No. 5", which was undergoing a revision just as the project started. Through the policy component, the project conducted a series of workshops including EGAT, other ministries as well as private sector representative and worked towards a significant advancement of the labelling system and underlying energy performance standards. Today, Thailand has an energy efficiency label on the same or better level than many developed countries. Efforts are made to extend the labelling system to also include larger equipment beyond cooling appliances. EGAT also considers to embed environmental aspects into the criteria of the energy efficiency label, such as the carbon footprint of electrical equipment or the global warming potential of refrigerants.

Finally, the project supported ONEP to integrate RAC NAMA into Thailand's climate policy. When the project started, the ratification of the Paris Agreement and NDC process was still in its onset, giving the project the opportunity to integrate RAC NAMA into Thailand's NDC Roadmap. Further the project supported Thailand to establish the necessary Measurement, Reporting and Verification (MRV) methodology to formally report the emission reductions that RAC NAMA would achieve.

### 2.1.3 Financial component

The financial assistance provided through the RAC NAMA Fund has been an important pillar throughout the implementation of the project. In establishing the RAC NAMA Fund, the project aimed to provide as much authority and autonomy to EGAT with a system of checks and balances that would ensure that financial assistance would be aligned with the overall strategy of the project. After signing the grant agreement in December 2017, EGAT set up a separate unit for the operational management of the RAC NAMA Fund, and an investment committee (formally called Financial Working Group) that would have to approve all major funding decisions and in which GIZ and the political partners were represented. Until the end of the project, EGAT has rolled out multiple funding lines, including grants for the establishment of production capacities, grants for training and testing facilities, and loan-based revolving instruments for market introduction of green cooling technologies.

A major success of the project is its sustainable impact: The manufacturers of cooling equipment will further scale up their production, having reached a sales volume of more than 140,000 units per year in the commercial refrigeration sector already. Businesses start to embrace green cooling technologies, being it for energy cost savings or as part of their sustainability strategies. EGAT will continue to support green cooling technologies through the Cooling Innovation Fund, a spin-off from the returns of the RAC NAMA Fund. The Cooling Innovation Fund will not only support the commercial refrigeration sector, but also those sectors that need more time for development: for example, air-conditioning and large commercial cooling equipment. KMUTNB has announced to extend its training efforts in the future and will seek further collaboration with other training institutes. ONEP will continue to provide their political backing for a transition to green cooling technologies and monitor the sector and the long-term impact of the project. Finally, the German Ministry of Environment, Nature Protection and Nuclear Safety (BMU) and GIZ will continue to support green cooling technologies – in the country and the region – through the Green Cooling Initiative.

## 2.2. Achievements: Mandatory core indicators

The NAMA Facility reports to its donors based on a set of mandatory core indicators that apply to all NAMA Support Projects such as the RAC NAMA. These include the mitigation of greenhouse gases, the number of beneficiaries, the degree of transformation achieved, as well as the commitment of public and private partners in terms of tangible financial contributions. These core indicators reflect the overall outcome of the project – achievements as a result of successfully delivered project activities.

### 2.2.1 Mitigation

Indicator	Baseline (Start of NSP)	Achievement (end of NSP)	Target (end of NSP)	Status
Direct emission reductions	0 Mt	0.52 Mt	0.76 Mt	Progressing
Indirect emission reductions	0 Mt	0.53 Mt	0.88 Mt	Progressing
<b>Total emission reductions</b>	0 Mt	1.05 Mt	1.64 Mt	Progressing

In 2017, the project conducted a bottom-up inventory and market assessment for the refrigeration and air-conditioning sector in Thailand based on primary data collected from manufacturers and importers, as well as secondary data from official statistics. The assessment looked at the different refrigeration and air-conditioning applications on the level of individual appliances, including equipment specifications, refrigerant and energy use as well as sales and import data. In a second step, leakage rates during maintenance and at the end of the product lifetime were assessed from servicing companies and end-users. The result of the inventory captured both emissions from energy consumption and refrigerant use, broken down by different market segments, and thereby provided grounding information for setting sectoral priorities and for the monitoring of the project.

The project distinguishes between direct and indirect mitigation of greenhouse gases: Directly, mitigation is achieved by the

investments of the project, in this case through the cooperation with manufacturers, the investments in their production capacity and ultimately through the **RAC equipment with green cooling technologies produced**. Indirectly, the project could contribute to the mitigation of greenhouse gases through policy recommendations – if implemented – such as more **stringent energy efficiency regulation and promotion**.

#### Direct emission reductions

Green cooling technologies mitigate by the use of natural refrigerants and enhanced energy efficiency. Through its MRV system, the project monitored the number of units that have been produced by partner manufacturers and which have been technically or financially supported by the NSP and the RAC NAMA Fund, respectively. The mitigation impact is calculated based on energy savings of newly sold units with natural refrigerants and high energy efficiency in comparison to conventional units currently sold on the market with synthetic refrigerants and low energy efficiency. Until the end of the NSP, **about 0.52 Mt of CO<sub>2</sub>eq emissions were reduced by the project** – mostly through more than 200,000 commercial refrigerators that were released in the market until the end of the project. In the air-conditioning sector, the scale-up of production lags well behind the schedule of the manufacturers and the project.

Overall, the project maintains its substantial long-term emission reduction potential. The units already sold will continue to mitigate after the end of the project until the end of their lifetime, which is 10 to 15 years. At the same time, manufacturers will sell increasing numbers of green cooling equipment year by year – in 2021 already 140,000 units estimated conservatively – which would contribute to further mitigate emissions from the RAC sector.

#### Indirect emission reductions

The most remarkable contribution in Thailand was made by EGAT in the revision of the energy efficiency label, which the project supported through a series of workshops. EGAT followed international best practices



and introduced stringent requirements for the highest energy efficiency rating: “three stars”. In the run-up, the cooling industry pushed the energy efficiency of their products substantially to reach the prestigious rating. Until the end of the project, the energy efficiency race **reduced about 0.53 Mt of CO<sub>2</sub>eq emission reductions** attributed to the project.

### 2.2.1. Beneficiaries

Indicator	Baseline (Start of NSP)	Achievement (end of NSP)	Target (end of NSP)	Status
Number of beneficiaries	0	270,900	1.3m	Progressing

Through its technical and financial assistance, the project creates social and economic benefits for people and businesses in its target groups. For example, it increases the skills of the people trained or the competitiveness of partner manufacturers. The largest group of beneficiaries are the users of green cooling technologies, which directly benefit from energy cost savings.

The number of beneficiaries is difficult to assess. For example, the energy cost savings of a single household refrigerator may benefit all members of the household, or a business may pass on energy cost savings to multiple owners, employees or to its customers. For simplification, the project has decided to equate the number of beneficiaries to the **units of equipment with green cooling technology sold: 270,900 units until the end of the project.**

### 2.2.2. Transformation

Indicator	Baseline (Start of NSP)	Achievement (end of NSP)	Target (end of NSP)	Rating
Market share	0	see explanation	20 %	Early signs of transformation
Active producers	0	10	3	

To evaluate the progress of market transformation, the project defined two indicators: the market share of green cooling technologies, and the number of producers in the relevant applications. In total, the project

attracted **10 manufacturers of residential air-conditioners, commercial refrigeration appliances and chillers**, an alliance much broader than anticipated.

The commercial refrigeration companies have in total a current market share of more than 20% in Thailand. With support from the RAC NAMA Fund, the most dominant companies are aiming to switch their entire product portfolio to green cooling technologies, providing a significant potential for market transformation; however, getting there requires the redesign of more than 100 models of cooling equipment and will not be concluded within the project period. Once these manufacturers will have completed the switch – probably in 2022 – **green cooling technologies will exceed the targeted 20% market share and dominate the commercial refrigeration sector.**

The situation in the air-conditioning sector remains adverse due to the dominance of the refrigerant R32. Many manufacturers in Thailand produce for international companies, which dictate their technology roadmaps. Even though the project has successfully attracted three independent local companies to introduce a first series of air-conditioners and air-conditioning chillers with green cooling technology, these manufacturers will not be able to initiate a market transformation in this important sector against the majority of the industry.

What these indicators do not reflect is the positive **overall sentiment for green cooling technologies**. At the beginning of the project, green cooling technologies were highly disputed and opposed by most of the industry. Today, discussions on green cooling technologies can be held in an open and factual manner, with increasing advocacy from manufacturers and early adopters in end-user sectors. Given the growth of the green cooling market during the project period, the project is confident that market transformation will continue.

### 2.2.3. Public contributions

Indicator	Baseline (Start of NSP)	Achievement (end of NSP)	Target (end of NSP)	Status
Public finance mobilised	EUR 0 m	See explanation	EUR 10.4m	See explanation

In the first place, NAMAs are national projects, and NSPs serve as a vehicle for additional technical and financial assistance. The projects are conceptualised to draw from both national and international funding. The major sources of funding for RAC NAMA are **the ENCON Fund, the Energy Efficiency Revolving Fund (EERF) and the ESCO Fund**, which are controlled by Ministry of Energy and provide financial support for energy efficiency projects.

The sixth phase of the EERF was implemented from 2015 to 2019 and was completed with a total disbursed budget of 96 million Euro. According to official data, about EUR 13 million were invested in machine changes in factories, including cooling plants. EUR 2.6 million were provided specifically for cooling technologies, including air-conditioners and chillers. In addition, Ministry of Energy reactivated the ESCO Fund with an annual budget of EUR 16 million and a bidding programme for energy efficiency projects with EUR 32 million.

In addition, the Ministry of Energy has implemented several sector-specific support programmes for energy efficiency in public buildings, e.g., hospitals, schools, municipalities, as well as in the commercial and industry sector, including a programme for energy efficient air-conditioners in public buildings with a total budget of EUR 74 million, a programme for energy efficient chillers for commercial buildings with a total budget of EUR 1.5 million, and a programme for energy efficiency in public hospitals with a total budget of EUR 19 million, focused on air-conditioning. All these funds contribute to the objectives of the project as part of Thailand's commitment to support energy efficiency in the cooling sector.

However, the project cannot assess how much

of the funding was used to promote green cooling technologies that would meet the strict criteria of the project: based on energy efficient technologies and natural refrigerants. At the present stage, it must be assumed that most government funding – except in industrial cooling – was used for technologies using synthetic refrigerants, given that the market for green cooling technologies has just started to develop within the past two years.

### 2.2.4. Private contributions

Indicator	Baseline (Start of NSP)	Achievement (end of NSP)	Target (end of NSP)	Status
Private finance mobilised	EUR 0	EUR 142.7 m	EUR 300 m	Progressing
by participating producers	EUR 0	EUR 2.5 m	EUR 1 m	
By purchasers/end-users	EUR 0	EUR 129.2 m	EUR 300 m	

Public funding – be it donor funding or public contributions from the partner country – cannot address a sector of the size of the RAC industry in Thailand. To be successful, NAMAs must stimulate contributions from the private sector.

RAC NAMA mobilises private funding in three ways: When providing financial assistance to manufacturers, RAC NAMA demands own contributions in the form of own investments. Users purchase green cooling equipment using own funds. And when providing credits for market introduction through financial institutions, RAC NAMA leverages contributions in the form of blended capital.

As all these private contributions are directly or indirectly mobilised by the financial assistance of the project. Jointly with EGAT, the project has monitored the use of financial assistance, for example through regular reporting of the recipients, and collected data on the private contributions provided. Until the end of the project, in **total EUR 143 million of private contributions** were leveraged



mostly through purchases of climate-friendly and energy efficient cooling equipment.

## 2.3. Achievements: Project-specific indicators and outputs

The outcome of the project – be it mitigation or funds leveraged – is not directly created by the project but is the result of the project’s outputs being taken up by the partners, specifically by the RAC industry. This is reflected in a set of outputs and output indicators, that serve to monitor the progress of project implementation.

### 2.3.1. Project management

Embeddedness and accountability are two of the fundamental requirements for setting up a successful international cooperation project. The NSP responded to that by defining a dedicated project management output, under which it established its Oversight Board and a MRV system.

Indicator	Baseline (Start of NSP)	Achievement (end of NSP)	Target (end of NSP)	Status
Oversight Board meetings	none	5	10	behind target
MRV/M&E system established	no	yes	yes	completed

The Oversight Board was set to meet at least twice a year to coordinate the involvement of the project partners in the implementation of the NSP, which encompassed ministries and agencies involved as well as private sector stakeholders. The Oversight Board was established as a formal government committee under the chairmanship of ONEP. Due to the complex setting of such official meetings, bilateral consultations soon turned out to be much more effective in coordinating with the project partners and carrying out comprehensive and trustful discussions. **The Oversight Board was used by the project’s main partner ONEP as a political management instrument** through which it could ensure alignment with other ministries and agencies on governmental level, for example on the topic of MRV. In practice, the

political management was delegated to more specific working groups, like the MRV Working Group or the Financial Working Group of the RAC NAMA Fund, so that less meetings of the Oversight Board were held.

In its work on the MRV system, the project distinguishes between the Monitoring & Evaluation (M&E) system of the project and the MRV system for Thailand’s mitigation reporting. The M&E system serves the monitoring of project implementation, including the core indicators and the delivery of outputs. It adheres to NAMA Facility’s M&E Framework. The MRV system serves Thailand’s reporting of greenhouse gas emission reduction to the UNFCCC. It allows Thailand to report the success of RAC NAMA for its NDC targets.

The concept of the MRV system was already completed in 2017 and was handed over to the partners in the form of an MRV tool in 2018. With technical support from GIZ, EGAT implemented the MRV system in line with its monitoring of the RAC NAMA Fund; recipients of the RAC NAMA Fund are obliged to report back activity data that would allow the calculation of emission reduction. In 2019, EGAT has presented the first results generated from the MRV tool for discussion in the project’s MRV Working Group, where a major concern was the quality of activity data reported to EGAT. Since then, the project has worked on integrating verification steps into the MRV tool, including for example plausibility checks. In 2021, the project used data from the **MRV tool to verify its M&E to NAMA Facility**.

The establishment of a MRV system is much more than a technical matter, but a complex political process among many agencies to connect data sources and to ensure that reporting obligations are enforced. A major success of the project is the creation of a roadmap for establishing a national MRV system for refrigerant-related emissions in coordination with ONEP and the DIW as the responsible line agency.

### 2.3.2. Policy advancement

In its policy advisory, the project focused on three major fields: incentivising green cooling technologies, building a regulatory safety framework, and embedding the project into Thailand’s climate policy (as reflected in the NDC Roadmap and the project’s work towards Thailand’s MRV system).

Indicator	Baseline (Start of NSP)	Achievement (end of NSP)	Target (end of NSP)	Status
Policy recommendations on incentives for green cooling	none	5	5	completed
Policy recommendations on safety framework	none	5	2	completed

On product safety standards, RAC NAMA established a demand-oriented working relationship with TISI, the national standardisation body, provided technical analyses to identify gaps between the existing and international standard, and gave recommendations for their adoption. One notable product from this cooperation is the **adoption of the latest international product safety standard for air-conditioners** (IEC 60335-2-40) as a national standard. The national standard TIS 1529-2561 (2018) was officially announced and published in Thailand’s Royal Gazette in October 2020 and awaits announcement of the corresponding ministerial regulation, which would make it mandatory for manufacturers. According to TISI, even at this stage the adopted TIS standard can already serve as a safety guidance, and certification against the TIS standard can already be provided by accredited testing bodies, such as EEI. With increased interest from manufacturers in the **2019 update of the international product safety standard for commercial refrigerators** (IEC 60335-2-89), which lowers restrictions on flammable refrigerants, discussions for updating the corresponding national standard were taken up, but the adoption process will certainly take multiple years. For the time being, manufacturers would adhere to the IEC standard.

Despite product safety standards in place, both nationally and internationally, the building code in Thailand still restricts the use of flammable refrigerants in high-rise buildings, posing a very prominent barrier for the potential market uptake of air-conditioners using natural refrigerants such as propane, a hydrocarbon. The restriction in the building code also increases the perception of natural refrigerants as a potentially dangerous technology, a psychological barrier that is difficult to overcome. To initiate discussions on a potential amendment of the building code, the project communicated several proposals to the responsible agency DPT indicating how the building code could refer to existing product safety standards for flammable refrigerants instead of banning them entirely. For example, the project assessed the applicability of product safety standards in a risk assessment together with Chulalongkorn University in 2018 and conducted a series of safety demonstrations in cooperation with KMUTNB in 2020. Unfortunately, the project could **not create the necessary political momentum for an amendment of the building code** solely for the case of natural refrigerants.

In the field of energy efficiency, policy makers have successfully established a system of promotional instruments to pull appliances towards higher energy efficiency. In cooperation with DEDE, one of its main partners, the project chose to enhance EESL – Energy Efficiency Standards that ban the most inefficient units, and Energy Efficiency Labelling that create awareness for the most efficient products.

Together with DEDE, the project developed an “EESL Roadmap for the RAC sector” for strengthening the implementation of current energy efficiency policies within the legislative framework of the Energy Conservation Promotion Act. Smaller cooling appliances are already covered by the highly recognised labelling scheme “Label No. 5” under the authority of EGAT, which EGAT substantially tightened in 2018 after a series of workshops and stakeholder consultations moderated by the project. Larger cooling equipment, such as chillers, are not under a similarly stringent energy efficiency regime, as the necessary compliance testing would be technically

challenging and expensive given the size of the equipment. **The EESL Roadmap points out a way towards a more comprehensive energy efficiency regulation and promotion.**

The project also aimed to embed green cooling technologies into Thailand’s “Green Label” – an environmental label for various products, from paper to electric appliances. For air-conditioners and refrigerators, the Green Label goes beyond energy efficiency by including criteria for the environmental impact of materials and refrigerants used. Unfortunately, the Green Label is not widely recognised by consumers or in larger procurement, an awareness problem the project is unable to solve. Therefore, the project focused its efforts on the more impactful energy efficiency regulation.

### 2.3.3. Technology transfer

Indicator	Baseline (Start of NSP)	Achievement (end of NSP)	Target (end of NSP)	Status
No. of cooperating manufacturers	none	10	3	completed

In 2016 and 2017, the project built extensive working relationships with manufacturers in the RAC sector and has grown a **large network of cooperation partners, meanwhile comprising 10 companies.** The project supported the scouting of business opportunities, the development of first prototypes, and the planning of the production line. After establishment of the RAC NAMA Fund, eight of ten companies also received financial support for the establishment of production capacities for green cooling equipment, under the condition that they would contribute own financial resources. Further financial support was provided in the form of concessional loans, through which the manufacturers created financial benefits for their end-users, e.g., in the form of credit card financings, extended payment terms or one-time discounts.

Today, the market situation for green cooling technologies is mixed, with a very bright outlook in the commercial refrigeration sector, and difficult market conditions in the air-conditioning sector. Further, the economic

fallout of the COVID pandemic has taken its toll in the RAC sector and among the partner manufacturers:

- Five major manufacturers of refrigeration equipment have stable business and their portfolio in green cooling technologies is continuously growing; financial support for market introduction has helped these companies to grow their business during the COVID pandemic.
- Three manufacturers of air-conditioners have finished the establishment of production lines and have developed production-ready prototypes, with a delay of almost one year due to restrictions related to the COVID pandemic. The affected manufacturers are now introducing their products into the market, unfortunately without support of the project.
- One company has cancelled its contract with the RAC NAMA Fund and withdrawn from the establishment of additional production in response to their overall business situation; as the producer has established small production capacities for climate-friendly and energy efficient cooling technologies already, withdrawal only affects the overall production capacity.
- One company will transfer parts of the production to Vietnam. Currently, it is not clear how that will affect the production line established with the support of the RAC NAMA Fund. If production equipment is uninstalled and sold, EGAT will take appropriate action to reclaim the support from the RAC NAMA Fund to be credited to the future Cooling Innovation Fund.

The project’s commercial refrigeration companies have a total market share of far more than 20% in Thailand – an important tipping point. With support from the RAC NAMA Fund, major companies are aiming for a full conversion of their production towards

green cooling technologies, providing a significant potential for market transformation; full conversion requires the redesign of more than 100 models of cooling equipment, which has not been concluded within the project period.

The situation in the air-conditioning sector remains adverse due to the recent switch to the refrigerant R32. The project has successfully convinced and supported three companies to introduce a first series of climate-friendly and energy efficient air-conditioners and chillers, but these producers will not be able to initiate a market transformation in this important sector against the majority of the industry.

A remaining issue is the fragmented supply chain for critical components, such as compressors for natural refrigerants; while Thailand is host to many manufacturers of RAC equipment, compressors are mostly imported. While the supply of compressors for commercial refrigeration equipment has much improved at a remarkable pace, now with several suppliers active in Thailand, the selection of compressors for air-conditioners remains scarce.

#### 2.3.4. Training and qualification

Indicator	Baseline (Start of NSP)	Achievement (end of NSP)	Target (end of NSP)	Status
Number of training centres	none	8	8	completed
Number of trainers trained	none	222	200	completed
Number of technicians trained	none	2000	159	behind target

Training, qualification and product testing form the necessary safety framework for a wider use of natural refrigerants. Enhancing training and qualification does not only need the right training programmes for building the competency among technical trainers, but also the establishment of training centres with specialised training equipment.

The project underestimated the complexity of cooperating with existing training institutes, most of them independently organised under various skill development organizations. The project therefore joined forces with KMUTNB, a leading technical university in Thailand, to act as an implementing partner for training activities, build a network of participating training centres and deliver a training-of-trainer programme.

Over the project period, the project and the RAC NAMA Fund established **eight training centres throughout the country** to provide technicians with easy and inexpensive access to specific training programmes on the safe use of natural refrigerants. To support the necessary investments in existing training institutes, EUR 0.5 million have been made available through the RAC NAMA Fund and implemented by KMUTNB. Together with the project, KMUTNB selected training centres based on location and area coverage, existing classes and curricula on refrigeration and air-conditioning, quality of existing facilities and previous qualification of training staff. They are located on the campuses of King Mongkut's University of Technology North Bangkok and Rajamangala University of Technology Isan, as well as in six training institutes under the authority of the DSD and the OVEC.

Together with the new training centres, the project and KMUTNB have implemented an **extensive training-of-trainer programme** for the safe handling of flammable refrigerants. More than 200 senior technicians, technical trainers, and engineers participated in the five-day courses. Companies that participated in the training-of-trainer programme have started to develop in-house trainings for their own service staff, reaching about 160 technicians so far. Currently, KMUTNB is further condensing the curriculum to **serve the needs of service technicians**, who often do not have the time and resources to participate in longer courses. DSD will include the new training programme into their existing skill standards and curricula (which would indirectly also affect OVEC's curriculum as well as the licensing for technicians), while KMUTNB aims to offer paid trainings to larger companies in the future.

### 2.3.5. RAC NAMA Fund

Indicator	Baseline (Start of NSP)	Achievement (end of NSP)	Target (end of NSP)	Status
Donor funds provided for loan-based instruments	EUR 0 m	EUR 5.3 m	EUR 5.3 m	completed

The RAC NAMA Fund was established under a Grant Agreement between EGAT and GIZ in December 2017, following a long and thorough process of due diligence assessments and contract negotiations. After that, EGAT established the management structure of the RAC NAMA Fund, including an operational fund management and an investment committee, that would safeguard the fund and ensure close coordination with GIZ and the political partners of RAC NAMA.

Within three years of implementation, EGAT has rolled out several funding lines including grants (for the establishment of production, training centers and testing capacities) and concessional loans (for the establishment of production and market introduction):

- **Grants and concessional loans for the establishment of production** were awarded in two open calls to eight manufacturers that aimed to step into the market for green cooling technologies. EGAT made the funding decision based on investment proposals and negotiations with the applicants. Prior to final disbursement, all investments have undergone a technical and financial verification process by EGAT and GIZ, ensuring that only functional production lines would be supported by the RAC NAMA Fund.
- **Concessional loans for market introduction** were awarded in multiple open calls to two groups of manufacturers. Successful applicants were obliged to extend the concessional nature of the loans to their end-users, e.g., in the form of concessional credit card financings,

concessional payment terms, and one-time discounts. The concessional loans were provided during the COVID pandemic, which also helped companies to sustain their business during the slowdown of the economy and within a difficult market environment.

- **Grants for training and testing centres** were awarded directly to the partner institutions upon consultations and negotiations with the RAC NAMA Fund. The investments in training centers were implemented by KMUTNB as an intermediary to DSD and OVEC, which procured the equipment for all training centers after a needs-assessment, installed the equipment on-site, and handed over ownership of the equipment to the training institutes of DSD and OVEC. The investments in testing centers were implemented by EEI.

Despite the complexity of handling multiple different funding lines with different technical, contractual and legal requirements, EGAT has settled all contracts of the RAC NAMA Fund successfully and has met all technical and financial reporting requirements. The project also commissioned an independent auditor to review EGAT's internal fund management – and has achieved an excellent rating on EGAT's management conduct. With the conclusion of the audit, the Grant Agreement for the establishment of the RAC NAMA Fund has been formally settled after more than three years of successful implementation and cooperation between technical and financial assistance.



Funding lines	Expenses in EUR
<b>Grants</b>	<b>2,761,139</b>
Grants for the establishment of production	(2,280,630)
Grants for the establishment of training centres	(404,056)
Grants for the establishment of testing centres	(76,453)
<b>Revolving fund</b>	<b>5,827,078</b>
Loans for the establishment of production	(1,370,540)
Loans for market introduction	(4,189,357)
Financing cost for market introduction	(266,383)
Other cost	(798)
<b>Total</b>	<b>8,588,217</b>

Funding lines	Income / outflows in EUR
<b>Funds provided by NAMA Facility</b>	<b>8,300,000</b>
Grants	-2,761,139
Revolving fund	-5,827,078
Reflowed fund	5,509,897
<b>Remaining Funds for Cooling Innovation Fund</b>	<b>5,221,680</b>

In a Concluding Agreement, **EGAT and GIZ have agreed to transform the RAC NAMA Fund into the Cooling Innovation Fund**, which will feed from the reflows of the loans provided by the RAC NAMA Fund. The Cooling Innovation Fund will share the goals with the original RAC NAMA Fund – a market transformation towards green cooling technologies using natural refrigerants, and the scope and instruments will be extended to reflect the current stage of market development. EGAT has defined three main funding windows of the Cooling Innovation Fund, including demonstration projects for air-conditioning and large cooling equipment, support to enhance safety research and testing facilities, and further investments into the training efforts initiated by RAC NAMA. In addition, EGAT aims to establish a knowledge management platform to share the results and experiences gathered by the projects under the RAC NAMA Fund and Cooling Innovation Fund.

### 3 Lessons learnt

RAC NAMA was one of the first NAMA support projects commissioned by the NAMA Facility as well as one of the first larger sectoral projects aiming for transformation through combined technical and financial assistance – naturally, the project had to tackle many new frontiers. Against all odds, RAC NAMA proved not only to be a successful project, but has also created many experiences from which NAMA Facility, the partners in Thailand, and GIZ as an implementing organization can draw.

- Market obstructions by transitional technologies:** The widespread introduction of R32 under the Montreal Protocol proved to be a major barrier to the introduction of less climate-damaging natural refrigerants. It created a situation in which industry had just invested into the transition to R32 and was unwilling to invest into greener alternatives, despite the foreseeable phase-down of R32 under the Kigali Amendment. Especially for a producing country such as Thailand, the decision to promote a transitional technology has become a long-lasting obstruction for a sector transformation. In future project designs – also in other sectors – NAMA Facility projects should carefully assess the potential for a sector transformation as well as the short- and long-term obstructions that could arise before or during implementation.
- Market transformation strategy:** The RAC industry serves very different market segments, with different technological and commercial challenges. Despite vastly different starting situations, the original project was designed to tackle the most important market segments at the same time: residential air-conditioners, commercial refrigeration appliances and chillers. Given prevailing safety concerns and the successful transition to R32, manufacturers of air-conditioners



would not embrace natural refrigerants if there was not even a business case and evident use for natural refrigerants in less safety-sensitive market segments. The project therefore changed its strategy and introduced commercial refrigeration appliances and chillers before establishing cooperation with manufacturers of air-conditioners. Consequently, the air-conditioning sector has just started market introduction at the end of the project only.

RAC NAMA would have failed if it had focused on air-conditioning only. It was the commercial refrigeration sector that eventually created the largest impact and paved the way to enter collaboration with manufacturers of air-conditioners. However, the project would have needed more time to lead this strategy to an end.

- **Technology development:** The strength of RAC NAMA is that the project does not attempt to promote best available technologies in Thailand – e.g., air-conditioners using R32 – but that it tries to introduce green cooling technologies as new best available technology. In this approach, the project needed to shortcut a process that would normally take 5 to 10 years: technology transfer, advance development, product development, production engineering, market introduction and commercialisation. Overall, the duration of five years was too short to successfully shortcut the introduction of green cooling technologies in three relevant market segments: residential air-conditioners, commercial refrigeration appliances and chillers.
- **Training strategy:** The project aimed not only to provide ad-hoc trainings for technicians of participating producers, but to generally improve the training structures for the more than 10,000 RAC technicians in Thailand. The project overlooked the complex structure of Thailand's education and qualification system, and underestimated the time and resources needed to roll out a training programme for 2,000 technicians. Instead of sacrificing training quality and sustainability to force this indicator, the project revised its strategy and decided to gradually build up training centres and training-of-trainer programmes, on which the training-of-technicians could be set up. The project mobilised additional funding for training centres and engaged with a strong implementing partner – KMUTNB – for the training-of-trainer programme, which both was successfully concluded. The training-of-technicians has started, involving technicians from partner manufacturers and large end-users. A further expansion is expected after the end of the project. Overall, leading the training strategy to completion would have needed more time.
- **Legal changes:** Given the long timeframes and complexities of national legislative processes, NAMA Support Projects should not rely on legal changes in setting their strategies, unless the legislative process is already underway and could be supported by the project. For example, while the project was able to positively support the ongoing revision of Thailand's energy efficiency label, it was unable to initiate the legislative process required to change the building code, on which it relied for the market introduction of green cooling technologies in the air-conditioning sector.
- **Local consultancies:** The project employed multiple international consultancies, for example for technology transfer, market development or policy advisory. However, it turned out that international consultants, coming to the country every few weeks or months only, would have difficulties in establishing trustful and dependable working relationships and in transferring their knowledge into the

context of Thailand's culture, politics and economy. Thailand has a very vivid consulting industry, with some outstanding consultancies in the fields of energy, climate change, and sustainability. While local consultancies may sometimes lack the independent view that an international consultancy would have, the project decided to strengthen the role of local consultants, utilise their expertise and relationships, and to build their knowledge where international experience might be missing. Ultimately, these consultancies will still be working in the country when the project has long ended. Strengthening them with international support is a worthy, sustainable investment.

- **State enterprise as implementing partner:** In its design, the project aimed to implement the RAC NAMA Fund alongside the EERF of the Ministry of Energy. The cooperation with EGAT, which was decided in the beginning of the project, has been a major success factor. The RAC NAMA Fund was strategically embedded in EGAT's greenhouse gas management division and would operationally rely on EGAT's finance, accounting and legal departments. While ministries and agencies are often slowed down by strict government protocols, EGAT could establish the RAC NAMA Fund upon existing business management structures.
- **Contractual design of the financial component:** In negotiating the grant agreement for RAC NAMA Fund, the project had to balance contractual safeguards with strategic and operational flexibility. The project agreed with EGAT to establish a management structure to include a system of checks and balances by separating the operational fund management from the investment decision making; in turn, GIZ and political partners would only hold observer positions in the investment committee and would not intervene

with the day-to-day operations of the RAC NAMA Fund. The grant agreement also formulates minimum standards for financial instruments (in terms of fund award procedures, fund allocation, safeguards to be employed by EGAT), but does not stipulate the concrete contractual or financial design. This combination of safeguards, flexibility and trustful cooperation has created the ownership of EGAT for the success of the RAC NAMA Fund and for its successor, the Cooling Innovation Fund.

- **Cooperation with the financial sector:** The financial sector is often seen as the ideal intermediary for financial cooperation, despite its business interest. Originally, the project aimed to provide concessional loans for green cooling technologies together with commercial banks, which would receive a concessional refinancing from the RAC NAMA Fund. However, in times of low interest rates, most banks do not face any constraints in refinancing their lending business and are not keen to accept concessional refinancing without need, given the cost associated with the management of donor funds and the reporting obligations attached. Most banks are also reluctant to provide concessional loans that would undermine their usual lending conditions, or to develop specific lending products for green cooling technologies, a niche market. The project therefore decided not to cooperate directly with the financial sector, but to support manufacturers of cooling equipment to cooperate with commercial banks for the promotion of their green cooling products, and to provide concessional payment conditions for their products on their own.
- **Strategic grant investments:** Donors often give a strong preference to market-based instruments, such as loans or guarantees, which they deem more effective than grants or subsidies. RAC NAMA has proven that

strategic grant investments – here: the change of production – can be more transformational than loan-based instruments – here: loans for individual products.

The remaining funds of the RAC NAMA Fund still serve a sustainable purpose: They will feed into the Cooling Innovation Fund, through which EGAT will support green cooling technologies beyond the duration of the project.

Throughout its implementation, the project was able to translate lessons learnt into strategic adjustments. This ability to adapt is reflected in the success of the project, the partnerships built, and in the outlook the project has created for Thailand's cooling sector.

## 4 Outlook

The RAC NAMA project has stimulated a substantial change in Thailand's cooling industry. At the beginning of the project, there was no supply and demand for green cooling technologies. Today we observe a growing market for green cooling technologies, mostly in commercial refrigeration, and the entire supply chain for green cooling technologies, including compressors, has constantly improved. At the beginning of the project, the policy framework for green cooling technologies was weak. Today, relevant safety standards have been adopted and Thailand has one of the more advanced energy efficiency labelling systems. At the beginning of the project, there was no technical and financial support for green cooling technologies. After the end of the project, EGAT will continue to provide financial support for the sector through the Cooling Innovation Fund, and KMUTNB will expand its technical support in the form of trainings for technicians and academic seminars for engineers and decision makers. At the beginning of the project, green cooling technologies were highly disputed and opposed by most of the industry. Today, discussions on green cooling technologies can be held in an open and factual manner, with increasing advocacy from manufacturers and early adopters.

Contrary to one-time investments into mitigation technologies, here: refrigerators or air-conditioners, the RAC NAMA project chose to change the production of cooling technologies in Thailand entirely, so that even after the end of the project the market for green cooling technologies could keep growing. In the commercial refrigeration sector, partner manufacturers aim to scale up production of green cooling technology to 200,000 units per year in 2022, which is about 50% of the production in Thailand. This is also reflected in an intact mitigation potential, as not only the cooling equipment produced so far will continue to reduce emissions in the future, but more and more cooling equipment will be produced to mitigate. While the equipment sold so far has mitigated about 0.52 Mt CO<sub>2</sub> equivalent greenhouse gases, this and future equipment together will reduce emissions by about 16 Mt until 2030, even under pessimistic assumptions for the air-conditioning sector.

Unfortunately, Thailand's direction in the air-conditioning sector remains unclear. Thailand is yet to ratify the Kigali Amendment to the Montreal Protocol, and Thailand's NDCs do not exert the same pressure as the Montreal Protocol with its mandatory targets and sanction mechanisms. There is a caveat though: As the commercial refrigeration sector will be mostly transformed to natural refrigerants soon and the baseline for the phase-down of HFCs is yet to be set, Thailand would need to take action in other sectors. The project hopes that the responsible Ministry of Industry will build on the knowledge and infrastructure created by RAC NAMA to consider natural refrigerants for the air-conditioning sector, although international industry pushes more towards a continuous use of halogenated refrigerants.

With EGAT and KMUTNB now promoting natural refrigerants for the benefit of the industry, natural refrigerants have certainly gained some weight in the discussion on Thailand's future refrigerant policy. The future commitment of these two partners also means that there will be support for green cooling technologies in the form of technical and financial assistance. KMUTNB, together with Thailand's skill development organisations, aims to scale the training for

technicians by embedding aspects of green cooling technologies into national skill standards and curricula, or by supporting companies in building in-house trainings. As a reputable university, KMUTNB is also producing Thailand's future engineers, which will certainly learn to embrace green cooling technologies. EGAT has decided to transfer the RAC NAMA Fund into the Cooling Innovation Fund. While the instruments of the RAC NAMA Fund were well justified during project implementation – aiming to establish demand and supply – the Cooling Innovation

Given the changes achieved and the support for green cooling technologies built, the project has successfully initiated a transformation of the cooling sector towards the use of green cooling technologies, and Thailand has the knowledge and means to carry on this journey.

Fund will now focus on the adoption of technically more challenging applications, for example residential air-conditioning and large commercial cooling equipment, and involve public and private capital from the beginning to ensure that successful innovation projects could be scaled up. EGAT will also support KMUTNB's training efforts and provide funding for safety research and compliance testing, tackling the safety challenges of natural refrigerants and the safety concerns still in the heads and minds.

### 3 Annex

#### 5.1. Overview table for all project indicators and outputs

During implementation of the NSP, some indicators were amended to comply with updates of NAMA Facility's Monitoring & Evaluation Framework. Target dates for some indicators were pushed by one year to reflect the late commissioning of the NSP. This table shows the indicators as reported to NAMA Facility according to the most recent Monitoring & Evaluation Framework.

Indicator	Baseline (start of NSP)	2016	2017	2018	2019	2020	07/2021 (end of NSP)	Proposed target (end of NSP)	Status
<b>Outcome:</b> A sector wide transition towards the use of climate friendly and energy efficient cooling technologies has been initiated.									
Direct emission reductions	0 Mt	0	0	0.04	0.15	0.35	0.52 Mt	0.76 Mt	progressing
Indirect emission reductions	0 Mt	0	0	0	0.12	0.35	0.53 Mt	0.88 Mt	progressing
Total emission reductions	0 Mt	0	0	0.04	0.27	0.07	1.05 Mt	1.64 Mt	progressing
Number of beneficiaries	none	0	0	50,800	105,900	189,000	270,900	1,300,000	progressing
Market share	0 %	N/A	N/A	N/A	N/A	N/A	see page 10	20 %	early signs of transformation
Active producers	none	0	0	4	10	10	10	3	
Public finance mobilised	EUR 0 m	N/A	N/A	N/A	N/A	N/A	see page 11	EUR 10.4 m	see page 11
Private finance mobilised	EUR 0 m	EUR 0 m	EUR 0 m	EUR 26.3 m	EUR 55.4 m	EUR 103.6 m	EUR 142.7 m	EUR. 300 m	progressing
<b>Output 1</b>									

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Oversight Board meetings	none	0	1	3	4	4	5	10	behind target
MRV/M&E system established	no	no	Yes	yes	yes	yes	yes	yes	completed
<b>Output 2</b>									
Policy recommendations on incentives for green cooling	none	0	2	4	5	5	5	5	completed
Policy recommendations on safety framework	none	0	2	3	4	5	5	2	completed
<b>Output 3</b>									
Number of cooperating manufacturers	none	0	0	4	10	10	10	3	completed
<b>Output 4</b>									
Number of training centres	none	0	0	1	3	8	8	8	completed
Number of trainers trained	none	0	0	2	139	222	222	200	completed
Number of technicians trained	none	0	0	0	0	159	159	2000	behind target
<b>Output 5</b>									
Donor funds provided for loan-based instruments	EUR 0 m	EUR 0 m	EUR 0 m	EUR 2.02 m	EUR 5.25 m	EUR 5.25 m	EUR 5.3 m	EUR 5.3 m	completed
Outreach to individuals	none	4,350	6,240	47,240	56,410	91,500	91,500	10,000	completed
Outreach to businesses	none	37	240	1,140	1,760	2,380	2,380	500	completed



NAMA Facility Indicators									
Number of institutions that received technical assistance	none	7	9	10	11	11	11	no target	no target
Number of low-carbon policies, regulations or standards adopted or amended	none	0	1	1	2	3	3	no target	no target
Number and type of co-benefits reported	None	Economic (improved competitiveness of the RAC industry); social (improved qualification of technicians and engineers)						no target	no target

## 5.2. Logframe of the RAC NAMA Support Project

During implementation of the NSP, some indicators were amended to comply with updates of NAMA Facility’s Monitoring & Evaluation Framework. Target dates for some indicators were pushed by one year to reflect the late commissioning of the NSP. This table shows the indicators as reported to NAMA Facility according to the most recent Monitoring & Evaluation Framework.

Summary	Indicators	Sources of Verification	Assumptions / Risks
<b>Outcome</b>			
A sector wide transition towards the use of climate friendly and energy efficient cooling technologies has been initiated.	<b>Indicator M1:</b> By the end of the NSP, at least 1.64 Mt CO <sub>2</sub> eq emissions are reduced through the use of climate friendly and energy efficient cooling technologies. <b>Baseline:</b> Baseline cooling appliances and system use high GWP refrigerants and the energy efficiency is low (no inverter technology, MEPS and HEPS at current levels i.e. HEPS 5 Stars) <b>Target:</b> At least 1.64 Mt CO <sub>2</sub> eq	<b>Source:</b> Monitoring system, inventory (2010) and updated inventory during 2016	
	<b>Indicator M2:</b> By the end of the NSP, over 1,300,000 users benefit	<b>Source:</b> Market assessment at the end of the project; Number of appliances	

	<p>from the reduction of costs through increased energy efficiency of the cooling devices supported by the project.</p> <p><b>Baseline:</b> Users use appliance and systems with high GWP refrigerants and low energy efficiencies.</p> <p><b>Target Value:</b> Over 1,300,000 users</p>	<p>and systems sold through cooperating producers and resellers</p>	
	<p><b>Indicator M3 (1):</b> By the end of the NSP, at least one producer in each of the subsectors is not only selling and producing climate friendly and energy efficient appliances for the domestic market but also for the regional export market.</p> <p><b>Baseline:</b> Will be established in 2016 by updating the market assessment.</p> <p><b>Target:</b> At least one producer in each of the subsectors</p>	<p><b>Source:</b> Market assessment at the end of the project</p>	
	<p><b>Indicator M3 (2):</b> By the end of the NSP, in each subsector (AC, domestic fridges, commercial refrigeration and chillers) at least 20% of the devices sold in Thailand by the end of the project are climate friendly and energy efficient.</p> <p><b>Baseline:</b> Will be established in 2016 by updating the market assessment.</p> <p><b>Target:</b> At least 20% of the devices sold in Thailand in each subsector</p>	<p><b>Source:</b> Market assessment at the end of the project</p>	
	<p><b>Indicator M4:</b> By the end of the NSP, EUR 10.4 million of public</p>	<p><b>Source:</b> Market assessment at the end of the project</p>	

	<p>finance has been mobilised for climate friendly and energy efficient cooling technologies.</p> <p><b>Baseline:</b> There is no specific financing available for climate friendly and energy efficient cooling appliances and systems.</p> <p><b>Target:</b> Over EUR 10.4 million</p>		
	<p><b>Indicator M5:</b> By the end of the NSP, over EUR 300 million of public and private finance have been mobilised for climate friendly and energy efficient cooling technologies.</p> <p><b>Baseline:</b> There is no specific financing available for climate friendly and energy efficient cooling appliances and systems.</p> <p><b>Target:</b> Over EUR 300 million</p>	<p><b>Source:</b> Market assessment at the end of the project, monitoring tool of the RAC NAMA Revolving Fund</p>	
<b>Output</b>			
<p><b>Output 1:</b> An advisory structure as well as monitoring system are set up.</p>	<p><b>Indicator 1.1:</b> The RAC NAMA Committee meets at least twice a year in its function as advisory board.</p> <p><b>Baseline:</b> No meetings of the RAC NAMA Committee are planned for 2016 and beyond.</p> <p><b>Target:</b> Meeting at least twice a year</p>	<p><b>Source:</b> Minutes of meeting, list of participants</p>	<p>There is a market for energy efficient and climate friendly cooling technologies in Thailand.</p> <p>Consumers can be convinced of the advantages of energy efficient and climate friendly cooling technologies and accept the flammability of hydrocarbon refrigerants.</p> <p>Even if governments change during the implementation period, the political and financial support for energy efficiency in the cooling sector will stay unchanged.</p>
	<p><b>Indicator 1.2:</b> An MRV system is developed, implemented throughout the project implementation phase and transferred to partners.</p> <p><b>Baseline:</b> No MRV system is set up.</p>	<p><b>Source:</b> Annual reports to NAMA Facility, MRV reports</p>	

<p><b>Output 2:</b> The Thai government has the knowledge required to shape the political and regulatory framework in a way that it supports the introduction of climate friendly and energy efficient cooling technologies in Thailand.</p>	<p><b>Target:</b> MRV system established</p> <p><b>Indicator 2.1:</b> By the end of 2017 the Thai government has received proposals or technical analysis required for shaping the building code (at least 1) as well as for shaping safety standards (at least 1) in a way that it allows for the introduction of climate friendly and energy efficient cooling technologies.</p> <p><b>Baseline:</b> No recommendations are available for safety standards or building code are available in Thailand.</p> <p><b>Target:</b> At least 1 proposal or technical analysis for building code and at least 1 for safety standards</p>	<p><b>Source:</b> Documentation of the recommendations and the transfer to partners via email and/or presentation</p>	
	<p><b>Indicator 2.2:</b> By the end of 2018 the Thai government has received at least 5 proposals or technical analysis required for creating incentives for the introduction of climate friendly and energy efficient technologies.</p> <p><b>Baseline:</b> No recommendations on creating incentives for climate friendly and energy efficient cooling technologies exist in Thailand.</p> <p><b>Target:</b> At least 5 proposals or technical analysis</p>	<p><b>Source:</b> Documentation of the recommendations and the transfer to partners via email, minutes of meeting or presentation</p>	
<p><b>Output 3:</b> Producers and assemblers have the technical and financial capability to produce and assemble climate</p>	<p><b>Indicator 3.1:</b> By the end of 2018, at least three manufacturers or assemblers have received trainings and financial support of (in total)</p>	<p><b>Source:</b> Grant Agreement, prove of disbursement, documentation of technical support</p>	

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<p>friendly and energy efficient cooling technologies.</p>	<p>up to EUR 3 million to change their production lines to produce climate friendly and energy efficient cooling technologies in Thailand.</p> <p><b>Baseline:</b> No support is provided to change production lines for devices using natural refrigerants.</p> <p><b>Target:</b> At least 3 manufacturers have received support</p>		
<p><b>Output 4:</b> The service sector in Thailand is prepared to service cooling technologies based on natural refrigerants.</p>	<p><b>Indicator 4.1.1:</b> By the end of the NSP, at least 2000 technicians have been trained on servicing RAC equipment using natural refrigerant.</p> <p><b>Baseline:</b> No training for servicing staff on handling natural refrigerants exists in Thailand.</p> <p><b>Target:</b> At least 2000 technicians</p>	<p><b>Source:</b> Participation lists, training material, agendas, reports</p>	
	<p><b>Indicator 4.1.2:</b> By the end of the NSP, at least 200 trainers have been trained on servicing RAC equipment using natural refrigerant.</p> <p><b>Baseline:</b> No training for servicing staff on handling natural refrigerants exists in Thailand.</p> <p><b>Target:</b> At least 200 trainers</p>	<p><b>Source:</b> Participation lists, training material, agendas, reports</p>	
	<p><b>Indicator 4.2:</b> By the end of the NSP, at least 8 training centres have been established to train technicians, trainers and engineers on handling natural refrigerants with technical and/or financial support from the project.</p> <p><b>Baseline:</b> No training centres for</p>	<p><b>Source:</b> Documentation of training materials and equipment provided</p>	

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	servicing staff on handling natural refrigerants exist in Thailand. <b>Target:</b> At least 8 training centres		
<b>Output 5:</b> The market introduction of climate friendly and energy efficient cooling technologies is supported.	<b>Indicator 5.1:</b> By the end of 2018, at least EUR 5.3 million have been disbursed by the project into the RAC NAMA Revolving Fund loan scheme for climate friendly and energy efficient cooling. <b>Baseline:</b> No corporate credit line targeted at climate friendly and energy efficient RAC equipment exists in Thailand. <b>Target:</b> EUR 5.3 million disbursed	<b>Source:</b> Prove of fund disbursement	
	<b>Indicator 5.2:</b> By the end of 2018, the knowledge centre set up by the project has provided at least 10,000 consumers and 500 companies with information about the benefits of RAC technologies based on natural refrigerants. <b>Baseline:</b> No information about the benefits of RAC technologies based on natural refrigerants is distributed in Thailand. <b>Target:</b> 10 000 consumers and 500 companies.	<b>Source:</b> Clicks on homepage, articles in newspapers and magazines, visitors of public presentation, estimations of recipients of PR products, individual talks with and targeted information for companies	
<b>Main activities</b>			
<b>Output 1:</b> Set up of Project Management Structure Develop MRV System and monitor project implementation Set up a system of financial controlling of expenditures			The project will be able to find suitable staff and subcontractors within in the first three month of the implementation period. Producers see the opportunities and are willing to take the risks connected to changing production lines. The servicing sector sees the market development and is interested in trainings



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<p>Update market assessment Identify synergies and initiate cooperation with related projects Develop and implement of PR strategy for knowledge center Disseminate the project results in national and international conferences.</p>			<p>to service RAC equipment using natural refrigerants. Energy efficient and climate friendly cooling technology is available and can be transferred to Thailand. Once a production line is changed, the producer will strongly support the market introduction of the product.</p>
<p><b>Output 2:</b> Advice on Cooling System Safety Standards Advice on Building Code Advice on MEPS Advice on HEPS and labels Advice on political framework documents</p>			<p>The project will be able to provide more attractive conditions for consumer loans to provide incentives to buy energy efficient and climate friendly ACs and domestic fridges than those provided by producers of ACs and domestic fridges with higher energy demand and higher GWP.</p>
<p><b>Output 3:</b> Identification and Evaluation of producers Entering into Cooperation Agreement Implementation of Product Development and Production Line Conversion Dissemination</p>			<p>The knowledge centre is able to compete with expected campaigns of companies supporting the R32 introduction. Large end users are interested in saving money through energy efficiency as well as in the marketing possibilities connected to green technologies.</p>
<p><b>Output 4:</b> Identification of relevant Groups in Servicing Sector Develop and implement trainings Development and Implementation of Demonstration projects Develop case studies for dissemination from both demonstration projects and</p>			

training programs			
<p><b>Output 5:</b>                  Technical Support                  Awareness Raising of the General Public                  Awareness Raising of Key Users                  Extend Green Public Procurement Scheme                  Financial Support                  Establishment of RAC NAMA Revolving Fund                  Establishment of the Fund’s Investment Committee                  Drafting and Approval of Revolving Fund Lending Guidelines                  Selection of Bank Account holder                  Identification of interested FIs                  Disbursement of Funds                  Monitoring of FI credit line role out by RAC NAMA Revolving Fund                  Training of political partner staff                  Training of FI staff</p>			

### 5.3 Budget /expenditures

Budget lines	Planned budget in EUR	Actual spending in EUR	Difference
<b>Personnel cost</b>	3.913.100	4.259.600	+ 9 %
Project staff	(1.974.100)	(2.075.300)	+ 5 %
National consultancies	(330.000)	(788.800)	+ 140 %
International consultancies	(1.310.000)	(1.076.900)	- 18 %
Administrative and other staff	(299.000)	(318.600)	+ 7 %
<b>Travel and relocation cost</b>	260.000	187.500	- 28 %
<b>Procurement cost</b>	158.000	53.200	- 66 %
<b>Operational cost</b>	858.500	627.600	- 27 %
<b>Financial assistance</b>	8.300.000	8.300.000	0 %
<b>Overheads and taxes</b>	1.232.400	1.194.500	- 3 %
<b><u>Total</u></b>	<b>14.722.000</b>	<b>14.622.400</b>	<b>- 1 %</b>

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