DCC
Department of Climate Change

DEPARTMENT OF AGRICULTURE AND ENVIRONMENT OF CAN THO CITY

# Action Plan Report on Urban Cooling for Can Tho city

Supported by

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# List of Abbreviations

| | |
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| AMC: | Ahmedabad Municipal Corporation |
| CADIF: | Can Tho City Development Investment Fund |
| CHMFs: | Centres of Hydro-Meteorological Forecasting |
| DAE: | Department of Agriculture and Environment |
| DCC: | Department of Climate Change |
| DoC: | Department of Construction |
| DoIT: | Department of Industry & Trade |
| GGGI: | Global Green Growth Institute |
| GHG: | Greenhouse Gas Emissions |
| GRDP: | Gross Regional Domestic Product |
| GWP: | Global Warming Potential |
| HAP: | Heat Action Plan |
| HDB: | Housing & Development Board |
| ICAP: | India Cooling Action Plan |
| KCEP: | Kigali Cooling Efficiency Programme |
| LST: | Land Surface Temperature |
| LUSH: | Landscaping for Urban Spaces & High-Rises |
| MAE: | Ministry of Agriculture and Environment |
| NCAP: | National Cooling Action Plan |
| NDC: | Nationally Determined Contributions |
| NDVI: | Normalised Difference Vegetation Index |
| NDBI: | Normalised Difference Building Index |
| MNDWI/NDWI: | (Modified) Normalised Difference Water Index |
| ODA: | Official Development Assistance |
| ODS: | Ozone Depleting Substances |

| | |
|---|---|
| OTC: | Outdoor Thermal Comfort |
| PET: | Physiological Equivalent Temperature |
| RAC: | Refrigeration & Air Conditioning |
| RCM: | Regional Climate Model |
| SHGC: | Solar Heat Gain Coefficient |
| UCAP: | Urban Cooling Action Plan |
| UHIE: | Urban Heat Island Effect |
| UNEP: | United Nations Environment Programme |
| VEPF: | Viet Nam Environmental Protection Fund |
| WHO: | World Health Organisation |
| WMO: | World Meteorological Organisation |

Photo: View of Ninh Kieu wharf Can Tho from above
Credit: Istock

# Foreword

Sustainable urban cooling is at the heart of our collective efforts to build more sustainable and resilient cities in the face of intensifying heatwaves. As temperatures rise alongside rapid urbanisation, economic expansion, and population growth, cities are confronted with both urgent challenges and valuable opportunities. Now more than ever, we need innovative and integrated approaches to urban planning that mitigate the urban heat island effect, safeguard public health, maintain economic stability, and ensure sustainable and affordable access to cooling for all.

In response to this pressing need, the Department of Climate Change (DCC), Ministry of Agriculture and Environment (formerly the Ministry of Natural Resources and Environment), in collaboration with the United Nations Environment Programme (UNEP) and the Global Green Growth Institute (GGGI), has implemented the cooperative initiative "Sustainable Urban Cooling for Vietnamese Cities" under the framework of the Cool Coalition. Can Tho has been identified as one of two pilot cities for the implementation of sustainable urban cooling interventions. In this context, the UCAP Can Tho is developed to advance sustainable urban cooling and to provide strategic recommendations for scaling up the adoption of cooling solutions across the city, aiming to enhance climate resilience and support a heat-resilient urban future, in alignment with Viet Nam's national commitments to climate change adaptation and sustainable cooling.

The report has been developed with the contributions of the technical support team, including Ms. Lily Riahi, Mr. Benjamin Hickman, Mr. Manjeet Singh, Dr. Zhuolun Chen, Dr. Clara Camarsa, Ms. Trupti Yargattimath, Ms. Leyla Prezelin, Dr. Dung Ngo Hoang Ngoc, Dr. Quoc Dung Trinh, and Mr. Tung Le (UNEP); as well as Ms. Huong Ta, Mr. Manh Do, and Ms. Duong Thanh Van, Coordinator in Can Tho (GGGI).

The UCAP has been refined based on guidance from the leadership of the Department of Climate Change (DCC), as well as valuable contributions from key stakeholders, including Ms. Nguyen Dang Thu Cuc and Mr. Nguyen Ba Tu (DCC); representatives from the Mr. Pham Nam Huan and Ms. Chau Thi Kim Thoa (Department of Agriculture and Environment of Can Tho City); the Department of Industry and Trade; the Department of Construction; other relevant departments and agencies; the Can Tho Development Investment Fund; research institutes; and local enterprises in Can Tho City. Furthermore, the report has benefited from technical feedback provided by both national and international experts, including Mr. Tran Thanh Vu (EDEEC), Assoc. Prof. Dr. Pham Thi Hai Ha (Hanoi University of Civil Engineering), Assoc. Prof. Dr. Phan Kieu Diem (Can Tho University), Dr. Nguyen Thuy (University of Hamburg), Prof. Dr. Alexander Baklanov (University of Copenhagen), Prof. Rajan Rawal (CEPT University), as well as UNEP experts: Ms. Minni Sastry, Ms. Aarti Nain, Mr. Gennai Kamata, Ms. Marisofi Giannouli, and Ms. Alexandra Mutungi.

As we move forward, we call on local authorities, urban planners, the private sector and civil society organisations to embrace and implement this action plan. Collaboration and shared commitment will be key to ensuring its success and impact on the ground. The Department of Climate Change of the Ministry of Agriculture and Environment also supports and encourages other Vietnamese cities to draw inspiration from the UCAP's evidence, methodology, and analysis, adapting its recommendations to implement sustainable cooling initiatives tailored to each city's unique geography, climate, and socio-economic context. By doing so, cities can develop locally relevant solutions that enhance resilience to extreme heat and contribute to a more sustainable urban future.

**Department of Climate Change**

**Ministry of Agriculture and Environment**

August 2025

# Executive Summary

Viet Nam's rapid urbanisation and economic growth have significantly escalated cooling demand in cities. However, business-as-usual cooling leads to greenhouse gas (GHG) emissions due to higher energy consumption, increased energy costs, and intensified urban heat island effects (UHIE). Preliminary analysis from the National Cooling Action Plan projects a 34% increase in cooling demand by 2030 compared to 2020 levels. At the same time, Viet Nam's cities are facing rising temperatures and more frequent and intense heatwaves due to climate change, exacerbated by the UHIE. The severity of UHIE is influenced by various factors, including climate, geography, urban geometry, material properties, green space availability, and heat emissions from human activities. Within cities, localised "hot spots" emerge due to the uneven distribution of built and green environments, adversely impacting the health and well-being of residents, particularly vulnerable groups such as the elderly, young children, outdoor workers, individuals with health issues, and low-income populations.

In Can Tho, a city heavily reliant on agriculture, extreme heat severely affects heavy labourers, including farmers. Increasing the exposure to severe heat leads to health issues and productivity losses. For the city, **projections indicate that by the mid-term (2041-2070) and long-term (2071-2100), almost all days in a year will be classified as "unsafe" for heavy labour, with productivity loss peaking in May, reaching 47% in the long-term. The rate of hospitalisation is also estimated to rise by 14% in the long-term adding to the strain on the healthcare system.**

Meeting these challenges necessitates targeted, sustainable urban cooling strategies tailored to Viet Nam's unique urban context. Urban cooling strategies aim to reduce urban temperatures, mitigate UHIE, improve thermal comfort, and decrease energy and refrigerant consumption associated with cooling.

*Can Tho city is experiencing rapid economic growth with a 12.64% increase in gross regional domestic product (GRDP) in 2022—the highest in the Mekong Delta region—and significant foreign direct investment. The city faces a substantial rise in energy demand for cooling due to its tropical climate and low air conditioner penetration.*

The Urban Cooling Action Plan (UCAP) report has been developed to address the aforementioned challenges by assessing the factors influencing cooling demand and the Urban Heat Island Effect (UHIE) in Can Tho City. It also provides recommendations for sustainably managing and reducing cooling demand, thereby supporting the achievement of national climate goals. The report was developed under the "Sustainable Urban Cooling in Viet Nam's Cities" project, co-led by the United Nations Environment Programme (UNEP) and the Global Green Growth Institute (GGGI), in collaboration with the Department of Climate Change (DCC) under the Ministry of Agriculture and Environment (formerly the Ministry of Natural Resources and Environment). This project aims to identify solutions to manage the rapidly rising cooling demand and its environmental and economic impacts, serving as a roadmap for pilot cities to deliver sustainable cooling solutions and reduce heat island effects. The initiative prioritises two pilot cities, Can Tho and Tam Ky, Quang Nam Province (now Da Nang City), to spearhead sustainable urban cooling efforts, with Dong Hoi, Quang Binh province (now Quang Tri province) serving as a learning city.

**Can Tho city is experiencing rapid economic growth with a 12.64% increase in gross regional domestic product (GRDP) in 2022—the highest in the Mekong Delta region—and significant**

**foreign direct investment. The city faces a substantial rise in energy demand for cooling due to its tropical climate and low air conditioner penetration**. Existing urban planning in Can Tho falls short in addressing critical cooling challenges and urban heat island effects, or UHIE, necessitating comprehensive analysis and actionable steps to manage cooling demand and align with national climate targets.

This Urban Cooling Action Plan (UCAP) evaluates the factors influencing cooling demand and UHIE at city and neighbourhood levels, alongside calculating cooling loads for individual buildings in Can Tho. These evaluations form the basis for tailored recommendations for city planners and policymakers at all three levels: city, neighbourhood, and building. Additionally, a list of targeted projects has been identified, ranging from neighbourhood-wide initiatives to specific building and equipment solutions. These projects provide a practical starting point for the city government to prioritise and expand its efforts in identifying additional potential cooling projects. The recommendations also outline various instruments and strategies to finance these listed initiatives, ensuring their feasibility and implementation.

As part of the analysis, a policy mapping of existing regulatory frameworks at both national and city levels was conducted. **Despite Viet Nam's national commitments to climate change and the COP28 Presidency's Global Cooling Pledge, direct policies addressing cooling and urban heat remain limited in scope**. Indirectly, cooling is influenced by broader strategies addressing construction planning, housing, energy efficiency, climate change, and green growth. At the city level, Can Tho's development plans for 2021-2030, its green growth plan, and environmental protection efforts, including the commitment to plant over 6 million trees, indirectly support the cooling agenda but lack targeted regulations for cooling.

Policies specifically targeting cooling are essential. **The analysis of UHIE reveals that urbanised areas like Ninh Kieu, Binh Thuy, Cai Rang, and O Mon experience the highest land surface temperatures.** These central districts are also facing significant green space loss due to urbanisation. In 2018, green space coverage in the central areas was only 31.6%, compared to 82.4% in the peri-urban and suburban areas. The Normalised Difference Vegetation Index (NDVI) and the Normalised Building Difference Index (NDBI) highlight this issue. NDVI values, which indicate the amount of green space, are as low as 0.3 in urban areas compared to 0.6 in rural areas. Meanwhile, the NDBI values, indicating built-up density, are -0.1 in Ninh Kieu, significantly higher than the -0.35 in surrounding parts. **This confirms that increased vegetation cover is associated with lower land surface temperatures, while more paved surfaces lead to higher temperatures.**

The analysis also includes an analysis of outdoor microclimate and thermal comfort in Can Tho City based on in-situ measurement of near-surface air temperature and survey of green spaces and urbanisation. One in a hotspot area and one in the rural area to draw comparisons. Two measurement points located in the 91B neighbourhood, representing the hotspot area of the downtown, and in the rural ward of Nhon Ai, a typical location for the rural area, were selected**. On-site measurements which were performed in June 2023 showed that the urban neighbourhood of 91B experienced higher ambient temperatures compared to the rural ward of Nhon Ai, with daytime temperature differences peaking significantly. The maximum temperature difference during the daytime were recognised at 6°C, while diurnal temperature deviation was around 4°C.**

*The analysis of UHIE reveals that urbanised areas like Ninh Kieu, Binh Thuy, Cai Rang, and O Mon experience the highest land surface temperatures*

Using ENVI-Met, a simulation software for urban microclimates, the thermal parameters under various urban contexts were estimated. Climate inputs for the simulation were obtained from measurement data collected on June 13th, 2023. 91B residential area was selected to evaluate thermal conditions and comfort levels using the Physiological Equivalent Temperature (PET) index. This index considers factors such as air temperature, humidity, wind speed, and mean radiant temperature. **The simulation results revealed that urbanisation in the 91B area increases PET by 2°C compared to its original state, which featured large grass covers and small canals. Nighttime effects of urbanisation were even more pronounced, with PET values exceeding 54°C in built-up areas, compared to a maximum of 32°C in the original landscape with canals and grasslands.**

Additionally, a high-level heatwave and extreme heat event analysis at the city level points towards an intensifying heatwave trend over the long-term future (2081-2100) along with elevated daily temperatures. **The most intense scenario projects a rise in maximum mean temperature to approximately 36°C, an increase of more than 2°C from historical levels. Additionally, the duration of heatwaves is expected to increase sixfold, resulting in about 120-280 heatwave days over the long-term, compared to 20 days currently.**

The building simulation results on the other hand show that due to high temperatures, especially in the summer season, a combination of active and passive cooling strategies is needed. These strategies should include exterior shading of windows, enhanced natural ventilation and fans, direct evaporative cooling, and mechanical air conditioning with cooling and dehumidification.

Incorporating various macro, mild, and hotspot microclimate conditions of Can Tho city, eQUEST was used to simulate the building cooling loads in Watt/square-meter for five distinct typologies: residential, offices, malls, hotels, and schools. Among these structures, malls and offices exhibit the highest cooling loads. A discernible trend emerges, illustrating an increase in cooling load from macro to mild to hotspot conditions. This indicates that buildings situated in hotspot conditions (C3 scenario) require higher cooling loads compared to similar structures located in zones with milder (C2 scenario) or macro (C1 scenario) conditions. According to the projections of cooling demands till 2050, the proposed scenario can reduce 45% (59.2GWh per year) of cooling electricity consumption, 25% (38.6MW) of peak cooling load and 47.5% (34 thousand tons) of GHG emission, comparing to BAU scenario.

**The main findings of the building simulations indicate that exterior environments can account for over 20% of cooling loads in different building types.** Design strategies that improve exterior environment parameters, such as lower air temperature, higher wind speed, and reasonable humidity, should be considered by architects and landscaping designers. Additionally, window systems with low Solar Heat Gain Coefficient (SHGC) and effective external shading can account for as much as 25% to 40% of peak cooling load.

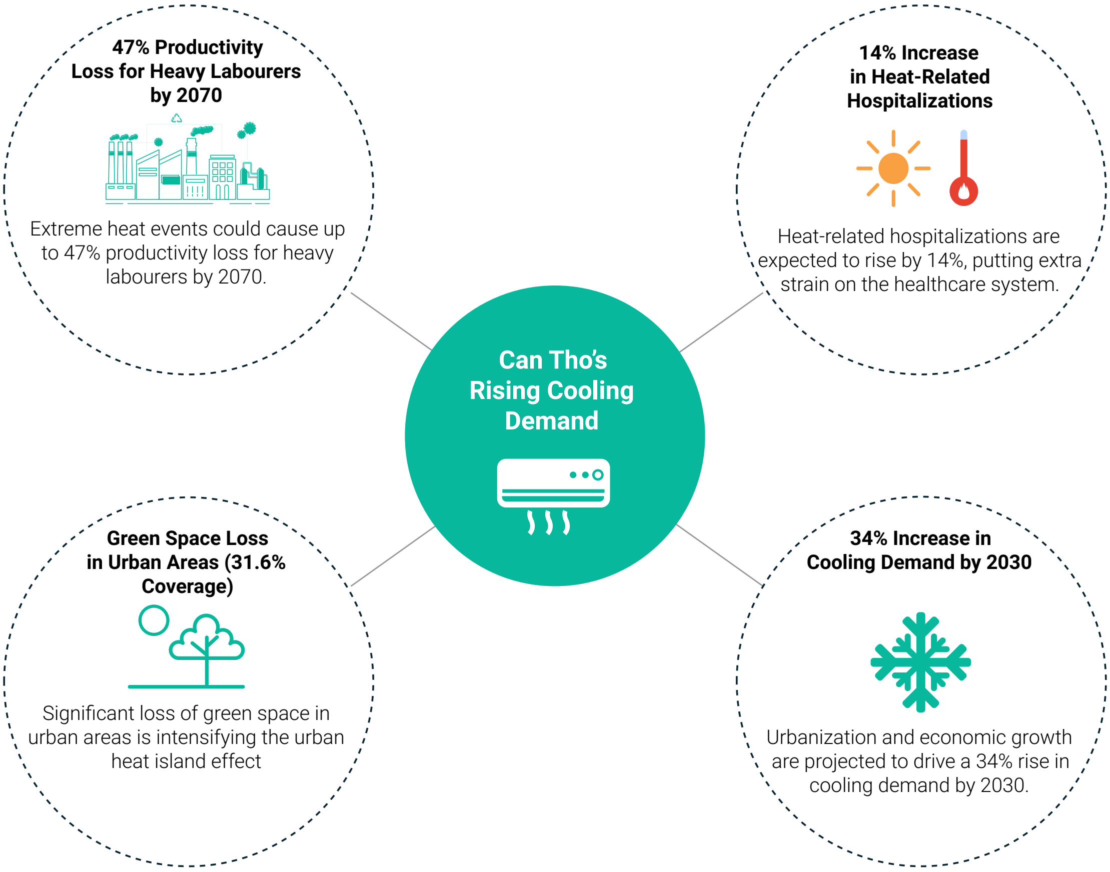
These findings highlight the urgent need for targeted urban cooling strategies. The Urban Cooling Action Plan (UCAP) offers detailed recommendations to manage and reduce cooling demand sustainably, supporting Can Tho's growth while aligning with national climate goals.

*The main findings of the building simulations indicate that exterior environments can account for over*

**20%**

*of cooling loads in different building typ*

**Figure 1: Can Tho's Rising Cooling Demand Key Facts**




The recommendations to address the cooling challenge in Can Tho City are categorised into short, medium, and long-term actions and further divided into groups including nature-based solutions, passive cooling strategies, urban planning and design, and governance strategies, building design and equipment strategies, financial resources and other related strategies some of which are detailed below.

**Nature-Based Solutions and Passive Cooling Strategies:**

- Follow WHO recommendations for 9m² of green space per person and implement regulations for green roofs and cool roofs.
- Increase high-canopy (at least 10m) and dense tree coverage for shading streets, parks, and mini-parks.
- Ensure that at least 40% of public spaces in hotspot areas are shaded.
- Plan urban green spaces with a ratio of 70:30:70 for high trees vs. bushes vs. grass.
- Considering green walls as extra greenery measures for buildings, with ideally watering system from reused source (grey water) and pest-prevention methods

**Urban Planning and Design:**

- Require early integration of heat-resilience studies during the development of neighbourhood plans, with the support of high-accuracy simulation analysis of design scenarios on urban heat.

- For new neighbourhoods, ensure adequate positioning of buildings and streets to maintain a height-to-width ratio of 2-3 for improved urban shading.

- Orient major structures parallel or slightly oblique (no more than 15 degrees) to prevailing favourable winds for better urban ventilation.

- Promote vegetated and less-absorbed (permeable) materials e.g. porous concrete, grass paver blocks with minimum percentage of 70% in city's open spaces.

- Promote void decks in hi-rise buildings, especially the ones located by or close to the river banks for better cool air flows into the city's inner parts.

**Building Design and Equipment:**

- Arrange building clusters in a linear ('一') layout, which is more effective than 'U' or '口' layouts for the purpose of enabling natural ventilation from external environment with lower temperature to reduce indoor space cooling needs from air-conditioning.

- Maintain a window-to-wall ratio of over 0.5 for residential buildings and over 0.3 for commercial buildings on the south façade, and over 0.35 for residential and over 0.25 for commercial buildings on the east/west façades.

- Ensure that over 50% of windows in residential buildings and over 30% in commercial buildings are operable. These measurements of operable part in windows can enable the natural ventilation from external environment to indoor so as to reduce the space cooling needs, especially in the swing seasons and nighttime in summer season when outdoor temperature is low.

- Design for natural ventilation with an air change rate (ACH) of over 1.3, and ensure that over 45% of main residential areas have wind speeds exceeding 0.5 m/s.

- Adhere strictly to the Viet Nam's National Technical Regulation of Energy Efficiency Buildings (QCVN 09:2017/BXD), ensuring sufficient shading and appropriate Solar Heat Gain Coefficient (SHGC) of glass corresponding to the window-to-wall ratio.

**Financial Resources:**

- Develop a compelling business case for the energy efficiency market (ESCO), thereby building a robust pipeline of bankable projects for the green finance market.

- Encourage public - private cooperation mechanisms to adequately allocate risks, which facilitates the climate fund mobilisation from multilateral organisations on infrastructure development.

- Amplify the utilisation of green bonds/loans, sustainability-linked bonds/loans, and transition finance instruments such as tax rebates or subsidies to fund green buildings and innovative business models such as FAR/height bonus for developers pertaining to energy efficiency and sustainable cooling.

Along with the recommendations, the report highlights policies that can be revised, amended or introduced to implement these strategies. It also identifies key stakeholders who can spearhead the implementation activities. These comprehensive recommendations in this report are designed to reduce cooling loads, improve thermal comfort, and enhance energy efficiency in Can Tho, aligning with both local development goals and national targets of climate change response.

Photo: Aerial panoramic view of Can Tho
Credit: Shutterstock

# 01 INTRODUCTION

This report addresses Viet Nam's growing cooling challenges in the context of rapid urbanisation, climate change, and rising energy demands. It highlights the socio-economic and environmental impacts of extreme heat and urban heat islands (UHIs) while presenting sustainable urban cooling strategies as a solution. Cities play a critical role in addressing these challenges as they are the epicentres of urbanisation and the primary drivers of cooling demand. By implementing localised strategies, cities can lead the way in reducing emissions, improving thermal comfort, and building resilience to climate change impacts. The report serves as a guide to help cities develop Urban Cooling Action Plans (UCAPs) in pilot locations like Can Tho, enabling Viet Nam to achieve its national and global climate commitments, including its net-zero goal by 2050, and actionable insights.

Viet Nam's rapid urbanisation and economic growth are significantly increasing cooling needs in cities, leading to a surge in power consumption and refrigerant use. This trend is expected to increase cooling demand by 34% by 2030 compared to 2020 levels, as per preliminary National Cooling Action Plan analysis[1]. As cities grow, the urban heat island effect (UHIE) is increasing as natural landscapes are replaced by heat-absorbing infrastructure like roads, pavements, and rooftops. This replacement escalates cooling needs by absorbing and re-emitting more solar radiation than forests and other natural landscapes.

The severity of heat islands depends on factors such as weather, geography, urban geometry, material properties, green space availability, and heat emissions from human activities. Within cities, temperatures can vary, creating localised "hot spots" due to the distribution of built and green environments. Heat islands severely affect residents' health and well-being, particularly among vulnerable populations such as children, the elderly, and outdoor workers. Additionally, Viet Nam's geographic location makes it prone to extreme heat events, which are becoming more frequent due to climate change[2].

The socio-economic impacts of extreme heat are already evident in tropical countries. Heatstroke can lead to permanent organ damage and sometimes even death[3]. Long periods of extreme heat can worsen major health problems like heart and lung diseases, kidney issues, and diabetes. Extreme heat can also lead to more hospital visits[4]. During heatwaves, the risk of being hospitalised for cardio-vascular issues went up by 2.2%[5]. For every 1°C increase during hot weather, the mortality for people aged 65 and older increased by 2-5%[6]. Additionally, the spread of diseases like dengue fever has increased by about 9.4% since 1950 due to rising temperatures[7]. The World Health Organisation predicts that between 2030 and 2050, heat

1 Consultations with MAE on the draft National Cooling Action Plan for Viet Nam

2 World Bank Climate Risk Country Profile: Vietnam

3 Nutong, R et al., (2018). Personal risk factors associated with heat related illness among new conscripts undergoing basic training in Thailand.

4 Cheng, J et al., (2019) Impacts of exposure to ambient temperature on burden of disease: a systematic review of epidemiological evidence. International journal of biometeorology.

5 Phung, D et al., (2016). High temperature and risk of hospitalisations, and effect modifying potential of socio-economic conditions: A multi-province study in the tropical Mekong Delta Region.

6 Yu, W et al., (2012). Daily average temperature and mortality among the elderly: a meta-analysis and systematic review of epidemiological evidence. International journal of biometeorology.

7 Watts, N et al., (2018). The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health

exposure could cause approximately 38,000 additional deaths per year among elderly people. Heat stress can also impact the productivity of workers and consequently decrease the GDP. Labour productivity during peak months has already dropped by 10%, and that a decline of up to 20% might be expected by 2050 under the highest emissions pathway (RCP8.5)[8].

Urban cooling refers to a joined-up set of strategies and interventions designed to accelerate uptake of sustainable, resilient and affordable cooling while reducing temperatures in urban areas. These strategies aim to mitigate the urban heat island effect (UHIE), improve thermal comfort for residents, and reduce energy consumption associated with cooling. Key urban cooling strategies include:

- Increasing green spaces: Planting trees, creating parks, as well as establishing green roofs and walls.

- Improving urban design: Using reflective materials for pavements and buildings and optimising urban geometry to enhance natural ventilation.

- Implementing passive cooling strategies in buildings: Designing buildings to maximise natural cooling through external and window shading, insulation, glazing and ventilation, complemented where needed by super-efficient fans to reduce use of AC.

- Nature-based solutions: Restoring natural water bodies, wetlands, and creating urban forests.

- District Cooling Systems (DCS): Centralising cooling production and distribution to improve efficiency and reduce emissions.

- Super-efficient appliances and equipment: Super-efficient fans and air conditioners with low Global Warming Potential (GWP) refrigerants sized and operated correctly and used minimally with emphasis on passive cooling.

- Citizen awareness: City-led awareness and education campaigns on extreme heat risks and alternatives to air conditioning

## National and global commitments

Early action to curb cooling emissions and adapt populations and infrastructure to climate change is a priority for Viet Nam, as reflected in its updated Nationally Determined Contribution (NDC) targeting a net-zero economy by 2050. Viet Nam is also a signatory to the Kigali Amendment, committing to reduce the production and consumption of hydrofluorocarbons (HFC) refrigerants by 80% in the next 30 years. Further reinforcing its commitment, in 2023 Viet Nam signed the Global Cooling Pledge, aiming for 68% reduction in cooling emissions globally by 2050 compared to 2022 levels and with specific commitments across the cooling sector.

To deliver on these commitments, comprehensive cooling and heat mitigation policy and finance measures need to be developed at multiple levels of government. In cities, the urban cooling strategies listed above need to be supported, promoted and enforced.

## Project overview

In response to the aforementioned challenges, the Department of Climate Change under the Ministry of Natural Resources and Environment (currently the Ministry of Agriculture and Environment), in collaboration with the United Nations Environment Programme (UNEP) and the Global Green Growth Institute (GGGI), is spearheading the implementation of the project "Sustainable Urban Cooling in Viet Nam". This initiative is undertaken within the framework of the Cool Coalition. The project is designed to formulate strategic recommendations and catalyse investment in sustainable cooling solutions to address the rapidly escalating

8 International Labour Organization., (2019) Working on a warmer planet, the impact of heat stress on labour productivity and decent work.

demand for cooling services. It seeks to minimise the environmental and economic impacts associated with cooling while advancing climate resilience. The overarching objective is to develop a comprehensive roadmap that enables pilot cities to adopt and scale sustainable urban cooling strategies—ensuring equitable access to thermal comfort at an affordable cost, while concurrently mitigating the urban heat island effect (UHIE).

The project is providing support to two pilot cities, Can Tho and Tam Ky, Quang Nam province (now Da Nang city), in developing Urban Cooling Action Plans (UCAPs). These plans aim to serve as roadmaps for integrating comprehensive measures to reduce energy-related emissions from cooling systems. The UCAPs include spatial analysis of cooling, drivers of extreme heat, and recommendations for local policies, planning and financial instruments. Proposed interventions will include improved urban design, nature-based solutions, passive cooling measures, municipal incentives, district cooling based on best practices as outlined in the UNEP's Beat the Heat- Sustainable Cooling Handbook for Cities in 2021.

Apart from developing the UCAPs, the project will support the design of a new national cooling fund as part of MAE's Environmental Protection Fund, capacity building for replication of urban cooling strategies and NDC implementation through integrated policy approach.

## Focus on Can Tho

Can Tho is experiencing rapid economic growth, with a 12.64% increase in gross regional domestic product (GRDP) in 2022—the highest in the Mekong Delta region[9]. In 2023, the city registered 85 foreign direct investment projects with a total capital of approximately 2 billion USD[10]. This growth, coupled with increasing urbanisation and population expansion, is expected to drive a significant rise in energy demand, predominantly for cooling due to the city's tropical climate and increasing air conditioner penetration[11]. Current urban design and planning practices do not adequately address cooling challenges or UHIE, necessitating a comprehensive analysis and actionable steps to manage cooling demand and align with national targets.

This UCAP explores factors influencing cooling demand in Can Tho, offering recommendations to manage and reduce this demand sustainably while supporting national climate goals. Based on the analysis of cooling demand and the Urban Heat Island Effect (UHIE), a list of potential projects for sustainable urban cooling in Can Tho City has been developed. This portfolio includes both passive and active cooling solutions. The proposed measures have been formally reviewed and endorsed by the city government, with the draft proposals finalized in consultation with the Department of Natural Resources and Environment (now the Department of Agriculture and Environment) of Can Tho City - the coordinating agency assigned by the People's Committee of Can Tho City for the implementation of the project..

9 Municipal Statistics Office, 2022

10 Viet Nam investment promotional portal (https://investvietnam.vn/can-tho-lo55.html)

11 Statista, Air conditioners – Vietnam

Photo: Residential area of Can Tho
Credit: Alamy

# 02 METHODOLOGY

The methodology for the analysis includes a systematic approach of urban cooling and includes the following steps:

1. Policy mapping and analysis of existing regulation framework of urban cooling.
2. Analysis of Urban heat island effect (UHIE) and Outdoor thermal comfort (OTC).
3. Building level space cooling impact analysis.
4. Identification of interventions and recommendations for urban cooling.

**Figure 2: Methodology for developing the UCAP for Can Tho**

| Step 1 | Step 2 | Step 3 | Step 4 |
| --- | --- | --- | --- |
| **Policy Mapping** | **City Level UHI Analysis** | **Building Level Analysis** | **Recommendations** |
| 1. Compile international best practices on cooling<br>2. Identify relevant existing policy & regulations of urban cooling at national level<br>3. Identify relevant existing policy & regulations of urban cooling at city level<br>4. Financial resources for urban cooling implementation | 1. Pan-city UHI profile assessment<br>2. On site measurement for evaluating outdoor thermal comfort<br>3. Evaluation of heat stress mitigation measures<br>4. Analysis of heatwaves & socio-economic impacts<br>5. Neighbourhood level cooling demand analysis<br>6. Projections of cooling demand & emissions | 1. Summarize climate adaptive architectural design strategies<br>2. Cooling demand modelling under macro/microclimate conditions<br>3. Performance attribution analysis on architectural design factors of space cooling | 1. Short- & medium-term recommendations encompassing city, neighborhood & building level strategies |

**Step 1: Policy mapping and analysis of existing policy & regulation framework of urban cooling**

This step involved a comprehensive examination of laws, policies, standards, and guidelines spanning different governance levels, aimed at discerning the current policy and regulatory framework pertaining to urban heat and cooling. Special attention was given to clauses or sections offering avenues for mitigating the impacts of increasing urban temperatures and fostering urban cooling initiatives.

**Activity 1.1:** Compile international best practices on cooling.

Various countries and cities that share a tropical/subtropical climate similar to Viet Nam and have developed strategies to address urban heat issues were selected. Apart from these cities, other best-case practices regarding urban geometry, nature-based solutions, materials, clean transport, district cooling, energy codes have also been compiled.

**Activity 1.2:** Identify relevant existing policy & regulation framework of urban cooling at the national level.

Various national frameworks directly or indirectly addressing UHIs and urban cooling initiatives were reviewed in terms of objectives, targets and actions suggested.

Frameworks with indirect implication for urban cooling were divided into four categories:

- Construction Planning and Housing Policies
- Energy Efficiency Policies
- Climate Change Policies
- Green Growth Policies

**Activity 1.3:** Identify relevant existing policy & regulation framework of urban cooling at the city level.

While city-level frameworks directly addressing cooling challenges are limited, existing plans on green growth and climate adaptation offer entry points for action.

Other city level sustainable initiatives such as goals and targets were identified.

**Activity 1.4:** Financial resources for urban cooling implementation.

Available published studies on the financial resources for urban cooling solutions in Viet Nam were looked up which included private, public and blended financing. Urban cooling solutions which are currently being implemented individually, based on various funding sources were also analysed and recommendations were developed to access funding for urban cooling implementation.

**Step 2: Analysis of Urban heat island effect (UHIE) and Outdoor thermal comfort (OTC) on city and neighbourhood levels**

In this step, the UHIE and OTC are evaluated through satellite imagery on city level, in-situ measurements and simulation of urban microclimate and outdoor thermal comfort on neighbourhood level.

**The UHIE** is a phenomenon where the significant temperature disparities between urban and rural areas is captured. This temperature difference is caused by the concentration of buildings, roads, and other infrastructure that absorb and re-emit heat more in the urbanised areas than natural landscapes, along with reduced vegetation and increased heat generated by vehicles, factories, and air conditioning systems.

**Outdoor thermal comfort (OTC)** refers to the condition in which people feel comfortable with the temperature, humidity, wind speed, and solar radiation levels when they are outside, as defined by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). It is a state where the outdoor environment is perceived as neither too hot nor too cold, allowing individuals to engage in outdoor activities without experiencing thermal stress.

The objectives of this step are (1) to identify areas in the city frequently exposed to high UHI intensity by mapping the city-level UHIE and correlating with relevant factors including urbanisation, vegetation and water elements; (2) to quantify the actual thermal perception reflected by outdoor thermal comfort level across the city; (3) to predict the evolution of heatwaves on mid-term and long-term basis; and (4) evaluate potential of heat stress mitigation measures through urban design at neighbourhood level.

**Activity 2.1:** Pan-city UHI profile assessment

This activity involves an in-depth analysis of the spatial dynamics of the surface urban heat island phenomenon across the entire city of Can Tho. It assesses spatial variations in Land Surface Temperature (LST) and examines the correlations between the UHIE and key indices including the Normalised Difference Building Index (NDBI), Normalised Difference Vegetation Index (NDVI), and (modified) Normalised Difference Water Index (mNDWI).:

1. 100-m resolution satellite images captured at ~10:30 AM*, focuses on typical months* of the recent years (2020, 2021, 2022, 2023), 2010 and 2015

2. 30-m resolution satellite images captured at ~10:30 AM of the recent years (2020, 2021, 2022, 2023), 2010 and 2015

The images cover a 15x15-m wide area. The retrieved images are of LANDSAT 8, 9, however, older LANDSAT (5) versions can be exploited in case images are affected by clouds.

The inputs (1) are used to estimate and visualise the spatial variation of LST at ~10.30. It will help to gain insights into daytime UHI pattern and detection of typical hot spots, i.e. locations exposed to high heat level. Meanwhile, inputs (2) are used for the calculation and visualisation of specific factors related to vegetation (Normalised Difference Vegetation Index or NDVI for quantifying the health and density of vegetation), built surfaces (Normalised Difference Building Index or NDBI for mapping building densities and distinguish between built-up and non-built areas), and water ((Modified) Normalised Difference Water Index or (M)NDWI for assessing and monitoring water content and availability).

The results of LST, NDVI, NDBI and (M)NDWI are combined with collected land-use and land-cover data as well as field surveys to detect most typical areas for on-site monitoring of microclimate. Due to the unavailability of LANDSAT images captured in the afternoon and nighttime, the analysis of nocturnal UHI and OTC will be performed with monitoring and simulation.

**Activity 2.2:** On-site measurement of outdoor microclimate and thermal comfort

This activity aims to select the most representative locations for investigation of intra-urban microclimate and outdoor thermal comfort. Basis for the selection will be the UHI profile images as developed in Activity 2.1 (considering the indices of LST, NDVI, NDBI, NDWI) and detection of neighbourhood typologies. Since UHI profile can only estimate the spatial variation of LST, on-site stationary observation of OTC and microclimate is required to evaluate more parameters at pedestrian level (1.5-m) which is helpful to the study of heat mitigation and OTC.

In Can Tho, the measurement plan was developed at the near-surface level for the air temperature, relative humidity, wind speed, and Wet-bulb globe temperature / Globe temperature referring to the Guidance on Measuring, Modelling and Monitoring the Canopy Layer Urban Heat Island (CL-UHI)[12] and being adapted to the local context and availability of resources. In this study, the land surface temperature is observed by remote sensing,

12 https://library.wmo.int/viewer/58410/download?file=1292_en.pdf&type=pdf&navigator=1

thus the emissivity and albedo of materials will be referred to a relevant predefined material database and excluded in the measurement campaign. The monitoring was conducted in two major neighbourhood typologies: (1) in an urban historical neighbourhood with densely built structures that is exposed to strong UHI, and (2) in a rural neighbourhood experiencing less intensified UHI with sparse built structures but in the process of urbanisation. Due to the limited equipment and human resources, the number of measurement points in the city is 2. Thus, in each neighbourhood typology, one location representing the spatial morphology will be selected for monitoring of microclimate. The sampling point is in the centre of a homogeneous morphology where the radius varies from 200 to 500 m. Additionally, for an individual sampling location, sensors are placed in shaded and unshaded areas to evaluate the effects of sun-shading measures on OTC.

**Activity 2.3:** Evaluation of heat mitigation and cooling measures through urban planning and design

The analysis of heat mitigation measures is performed with ENVI-Met, a 3D modelling software for simulating complex urban environments with a focus on urban cooling and climate adaptive urban planning.

The ENVI-Met model is first validated for reliability, followed by an analysis on impacts of urban geometry, nature-based elements, materials and combined measures on thermal condition and outdoor thermal comfort.

**2.3.1.** Validation of ENVI-Met model

The validation of the ENVI-Met model is highly important before further computational analysis is performed. To carry out the validation, simulation of current OTC and microclimate is done. The size of simulated domains is limited to 300x300-m as optimal choice with the ENVI-Met model. Grid resolution is defined at 3x3-m, while vertical resolution is 1.5-m.

**2.3.2.** Study of impacts by urban geometry

Considered aspects of urban geometry are street aspect ratio, street orientation, building height and spacing. Analysis is performed with these individual factors to quantify their effects on OTC. Combined influences of these elements are also evaluated to determine the optimal interventions with the urban geometry.

**2.3.3.** Study of nature-based solutions (landscape elements)

Vegetation and water are two natural elements considered in this study. In particular, the following factors are included in the analysis of the nature-based solutions:

- Choice of vegetation: grass, high trees (15m)
- Coverage of grass and high trees at public open spaces
- Tree placement on streets
- Coverage of water
- Coverage of green roof

**2.3.4.** Study of urban materials

The effects of albedo strategies through material selection are analysed for ground surfaces and building roofs.

At first, individual computational analysis of OTC for different albedo values of ground surfaces, i.e. pavement and open spaces is performed. Best-performing scenario of ground surface's albedo may be found from this analysis.

Following the best choice of ground surface's albedo, the evaluation of building roofs' influence is performed, which eventually leads to the optimal combination of materials on ground surfaces, building facades and building roofs.

**2.3.5.** Study of combined measures

In this sub-activity, the combination of optimal urban geometry, nature-based solutions and materials is assessed, in comparison to individual measures.

**Activity 2.4:** Analysis of heatwaves and socio-economic impacts

This activity projects the evolution of heat hazards under future climate scenarios, providing essential insights for mitigation planning.

The data gathered for this step includes:

- Historical weather data at hourly intervals (10 years of observation between 2011 to 2020) from the local Centre of Hydro-Meteorological Forecasting (CHMF) of Can Tho City
- Regional climate model (RCM) simulation results of historical and prospective multi-year periods (i.e. CORDEX project) – rcm 8.5 is exploited.

From these inputs, statistical and bias-correction analysis is performed for historical and future data of heatwave duration and intensity.

Results of this activity include historical (2020s) and future (2050s) heatwave data, in forms of typical meteorological years data (TMYs), heat stress level in terms of intensity (temperature), severity (aggregated temperature by duration) and duration (number of heat stress days).

Additionally, socio-economic indicators such as loss in productivity and unsafe workdays due to extreme heat were estimated for Can Tho.

**Activity 2.5:** Neighbourhood level cooling demand analysis

Cooling demand (kWh per square metre) was estimated for buildings of various typologies. The energy simulation tool eQuest was used for this purpose. Detailed neighbourhood plans were procured from the local government. The height of the buildings was estimated from Google Maps Street View. The cooling loads of selected individual buildings in a neighbourhood were analysed to determine the cooling loads at neighbourhood level. Neighbourhoods with a mix of buildings typologies (e.g. residential buildings, offices, hotels, shopping malls, restaurants and schools) were selected for this calculation. The results were presented in terms of peak cooling load per square metre and annual cooling electricity consumption per square metre.

**Activity 2.6:** Projection of cooling demand and emissions

The cooling demand of main building typologies in the city (e.g. residential buildings, offices, hotels, shopping malls, restaurants and schools) was simulated and estimated.

The building cooling load per square metre was estimated in activity 2.5 while the total built-up area for buildings and population was retrieved from land use planning documents. Projections for the future were made assuming an increase in population as estimated in the full report of the approved master plan of Can Tho City.

**Step 3: Impact analysis on space cooling of buildings**

The objective of this step is to assess various factors of architectural, landscaping and minimum energy performance standard in buildings or building clusters for the potential benefits of reducing energy consumption, minimising environmental impact, reducing operation cost of buildings, and enhancing occupant indoor thermal comfort and satisfaction.

The results can facilitate architects and designers to better understand climate-adaptive design strategies, including passive cooling technologies in buildings (e.g. building envelopes, green roof, shading facilities etc.), and hybrid measurements of passive and active cooling.

In addition, this step integrates data on the urban heat island effect and local microclimatic conditions in identified hotspot areas to perform cooling energy simulations across various building typologies. The objective is to provide a more detailed assessment of the effectiveness of both passive and active cooling solutions in reducing peak cooling loads, while also considering improvements of indoor summer comfort.

**Activity 3.1:** Summarise climate adaptive architectural design strategies in Can Tho

Climate adaptive architectural design strategies aim to enhance thermal comfort and sustainability. Through consideration of climatic conditions (e.g. 10 -year meteorological data in Can Tho, microclimate measurement or simulations in different parts of Can Tho with hot or mild spots) of temperature, humidity and wind patterns, these design strategies aim to create bioclimatic design principles to inform design decisions and optimise building performances.

**Activity 3.2:** Cooling demand modelling under macro/microclimate conditions

On the basis of results from urban heat island assessment throughout the city of Can Tho, different sets of climate data are developed, including the macro climate of Typical Meteorological Year (TMY) from Can Tho International Airport and hotspot microclimatic TMY as of urban regions in Can Tho. As a result, the various climate conditions on hourly basis reflect the various levels of impacts by urban island in different locations of the city of Can Tho. Six different building types, such as multi-family residential buildings, office buildings, shopping malls, comfort hotels, restaurants and schools, are selected to be simulated for hourly cooling load. The peak cooling loads of each building typologies in the three regions are then further analysed to evaluate the thermal performances and compositions of following building components:

- Window or glazing system (U-value and Solar Heat Gain Coefficient (SHGC) as required by the National Technical Regulation of Energy Efficiency Buildings QCVN 09:2017/BXD for window-wall ratio of 0.30)
- Walls (U-value as required by the QCVN 09:2017/BXD)
- Roof (U-value as required by the QCVN 09:2017/BXD)
- Exterior shading
- Natural ventilation
- Exterior environment, e.g. tree shading

**Activity 3.3:** Performance attribution analysis on UHIE and building envelope factors of space cooling.

By analysing these factors and their contributions to indoor thermal comfort and energy savings, stakeholders can assess the effectiveness of passive cooling strategies and identify opportunities for optimisation and improvement.

**Step 4: Identification of interventions and recommendations for urban cooling**

Based on the city level urban heat island assessment, building cooling demand assessment, stakeholder consultations and policy mapping appropriate recommendations are identified. They are divided into short, medium and long-term recommendations targeting heat issues at the city level as well as the building level. The city level recommendations encompass areas of urban planning, nature-based solutions, materials and anthropogenic heat. A governance structure is also proposed identifying key stakeholders that can drive the desired change.

## 2.1 Limitations of the study

Despite careful planning for data collection and on-the-ground monitoring of climatic data, several barriers such as lack of data availability and weather conditions impacted the analysis.

- During the on-site measurement of climate (Activity 2.2). Additionally, nighttime observations in certain public spaces (such as squares and parks) were not conducted due to security concerns.
- The study of anthropogenic heat from traffic and buildings was not included in the Urban Cooling Action Plan (UCAP). The current analysis used typical meteorological year (TMY) data for wind speed and direction.
- Due to the unavailability of building information data in the city level cooling demand for both current years and the future, GIS data for main zones and buildings in the city, and audited energy consumption of electricity and cooling for buildings etc., the cooling demand projections are limited to specific building typologies.

Photo: Can Tho Bridge
Credit: Istock

# 03 CITY BASELINE ASSESSMENT

## 3.1 City overview

Can Tho is the largest city and the administrative centre of the Mekong Delta region in southern Viet Nam. It plays a strategic role in the region's transportation, commerce, agriculture, and education sectors. As the city undergoes rapid urbanisation - accompanied by rising population and building density - the demand for cooling has become increasingly urgent. This underscores the necessity for research and implementation of appropriate, sustainable cooling solutions. A detailed analysis of the current conditions is presented in the sections below.

### 3.1.1 Location and demography

Can Tho City (10.0452°N, 105.7469°E) is located in the Mekong Delta region of southern Viet Nam. Covering an area of 1,440.4 square kilometers - approximately 3.5% of the region's total area[13] —the city lies along the Hau River and is surrounded by an extensive network of rivers, canals, and rice fields. Thanks to its advantageous location at the crossroads of major waterways such as the Mekong River and the Can Tho – Phong Dien – Cai Rang – Cai Lay routes, Can Tho serves as a vital commercial and transportation hub for the region.

As of 2020, Can Tho had a population of approximately 1.24 million, accounting for 7.1% of the Mekong Delta region's total population and ranking second in the region for population growth that year[14]. Between 2010 and 2020, the city's population grew at an average annual rate of 0.4%, increasing from 1.19 million to 1.24 million—placing it fourth in the region in terms of overall population size. The city has undergone rapid urbanisation, with urban expansion reaching approximately 24% within just five years, from 2002 to 2007[15].

The administrative area of Can Tho City consists of five urban districts, namely, Ninh Kieu, O Mon, Binh Thuy, Cai Rang, and Thot Not; and four rural districts, namely Vinh Thanh, Co Do, Phong Dien, and Thoi Lai. These districts are composed of 44 wards (in urban districts) and 41 communes (in rural districts). The current status of typical urban and building design is detailed in Annex 1.

**Table 1: Overview of Can Tho's demography**

| Area of the city | 1440.4 sq.km |
|---|---|
| Districts | 9 (5 urban & 4 rural) |
| Population (2010) | 1.19 million |
| Population (2020) | 1.24 million |
| Population density (2020) | 862 people per sq.km |

13 https://www.asean-mayors.eu/2022/01/member-profile-can-tho-vietnam/
14 Economist Intelligence Unit
15 https://www.jstage.jst.go.jp/article/geoinformatics/21/3/21_3_147/_pdf

## 3.1.2 Economy

Can Tho holds a pivotal position as an economic powerhouse in Viet Nam, showcasing consistent growth over the last decade. It provides the logistical hubs for aquaculture and agricultural products and is the economic, commercial, educational, and health centre for 12 other provinces of the Mekong Delta. Between 2010 and 2019 the GRDP experienced an annual increase of 6.6%. The city recorded an 8.04% growth in GRDP in the first six months of 2022, the highest in recent three years[16].

**Table 2: Economic indicators for Can Tho City (2017-2019)[17]**

| Economic Indicators | 2017 | 2018 | 2019 |
|---|---|---|---|
| **GRDP (USD millions)** | **3,228** | **3,609** | **3,856** |
| **Share per sector (%)** | | | |
| Agriculture | 10.41 | 10.24 | 9.62 |
| Industry | 31.82 | 33.40 | 33.17 |
| Services | 50.33 | 49.08 | 50.03 |
| **GDP per capita (USD thousands)** | **2.64** | **2.94** | **3.12** |
| **GDP growth rate** | **6.28** | **8.15** | **5.38** |

The city is known for its fertile land and is a major producer of rice, fruits, and vegetables and the city is home to several large-scale agricultural processing facilities. In recent years, the service sector has had the strongest growth rate, with an average of 7.3% per year, followed by construction industry (6.4%) and agriculture industry (2.1%). It is a key hub for transportation and trade, with several major waterways and roads passing through the city. This makes Can Tho an important centre for the distribution of goods between the Mekong Delta region and other parts of Viet Nam.

## 3.1.3 Climate

Can Tho is mainly subject to tropical monsoon climate and experiences a long rainy season from May to November and dry season from December to April.

The average annual temperature is high, varying from 17.7 to 36.7 °C (average is 26.8 °C). The average monthly temperature varies from 25.5 to 28.1°C. April is the hottest month with an average temperature of 28.1 °C. January is the coldest, with an average temperature of 17.7 °C. The outdoor temperature distribution in the TMY data from 2007-2021 also shows that the unmet hours (represented by red colour in Figure 4) for thermal comfort under the macro climate condition in Can Tho are around 5606h, accounting for 64% of time across the year.

16 https://en.vietnamplus.vn/can-tho-posts-threeyear-high-economic-growth/231733.vnp

17 Sub-national public expenditure & financial accountability assessment Can Tho

**Figure 3: Average monthly temperatures in Can Tho**

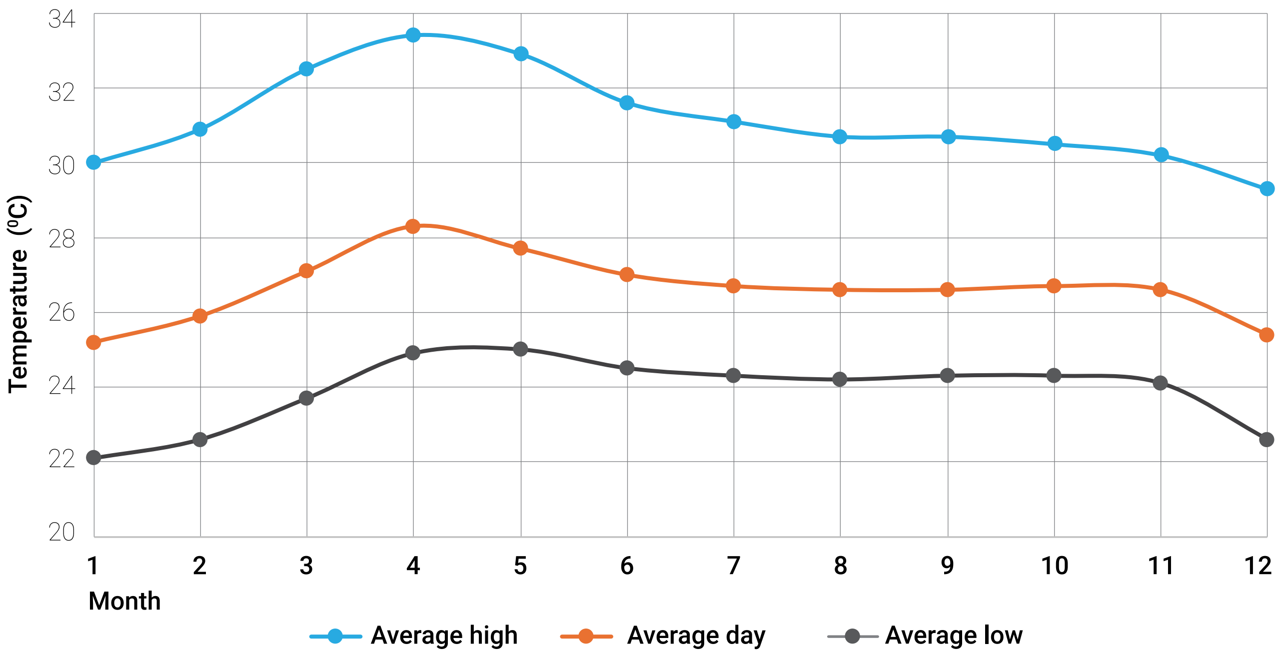
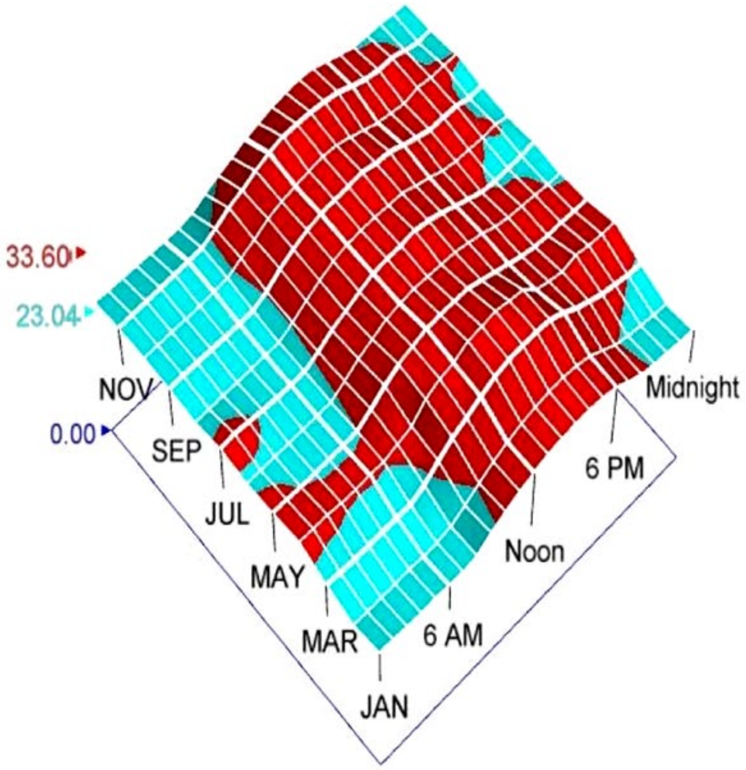


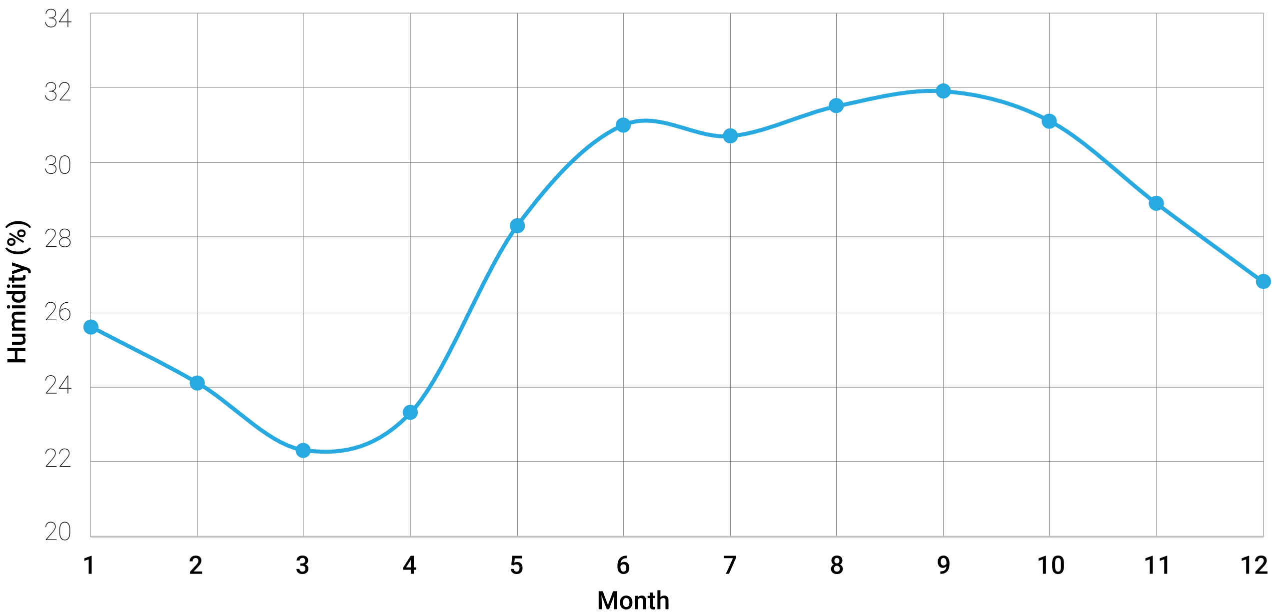

**Figure 4: Unmet hours for thermal comfort under macro climate condition**



High relative humidity, averaging 80–89%, further exacerbates discomfort, particularly during the peak months of September and October when humidity reaches 88–89%. In February and March, the lowest average relative humidity is 79 - 80% (up to 270 mm in October), the climate drives a strong reliance on air conditioning (AC) as a means of maintaining indoor comfort. These factors underline the necessity of cooling systems in Can Tho, with AC being the most likely and widely adopted solution.

Additionally, the changing climate is expected to intensify these challenges. According to the Intergovernmental Panel on Climate Change (IPCC), rising global temperatures will lead to more frequent, severe, and prolonged heatwaves, exacerbating health risks and increasing the need for cooling solutions. Although specific projections for heatwaves in Can Tho are limited, general trends indicate that Southeast Asia is particularly vulnerable to these effects. This climate profile highlights the critical importance of addressing Can Tho's cooling needs through targeted interventions that consider both current climate conditions and future projections.

**Figure 5: Average monthly humidity levels in Can Tho**

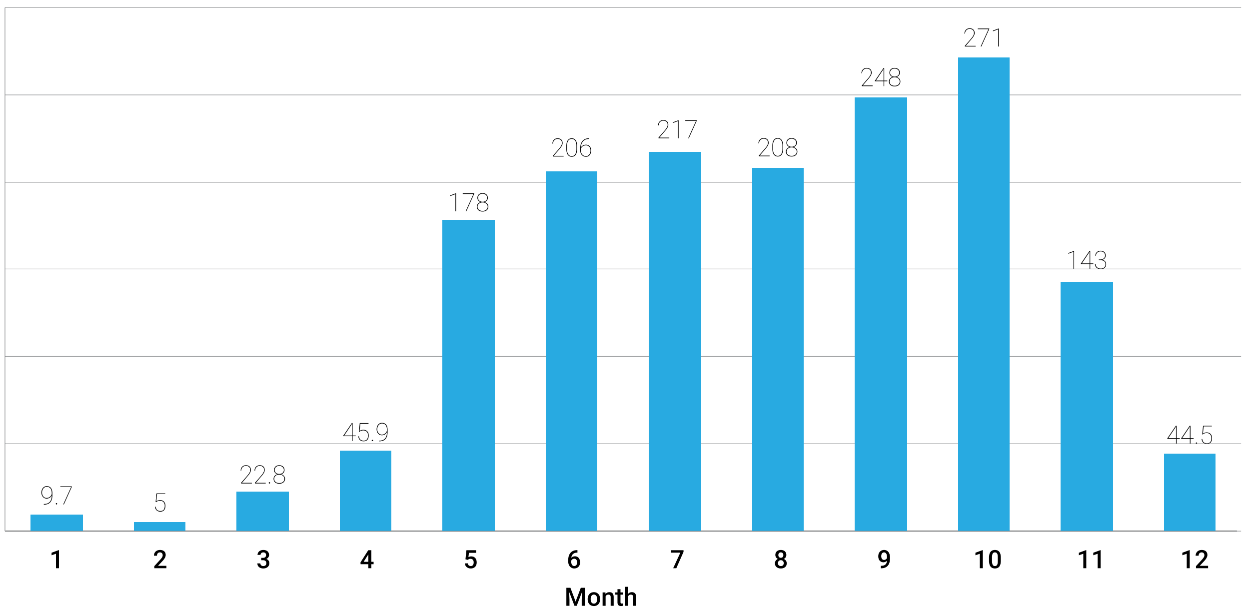


The average number of hours of sunlight is high, the average for the whole year is 2556 hours which is 7.2 hours per day. February to April has the highest number of sunny hours (8-10 hours per day on average) while August to October has the lowest average number of sunshine hours around 5 to 6 hours per day.

Can Tho city is influenced by the monsoons and experiences winds from the Northeast (from November to April) coinciding with the dry season and the Southwest (from May to October), coinciding with the rainy season. The northeast monsoon has the highest monthly average wind speed of 1.6 m/s (February) and the highest instantaneous wind speed being 21.0m/s. The southwest monsoon maximum monthly average wind speed is 1.8 m/s, the maximum instantaneous wind speed being 24.0 m/s.

The average rainfall is relatively high in Can Tho city which receives approximately 1,599 mm of precipitation annually. The average number of rainy days is approximately 124 days a year as measured at the Can Tho weather station. There is a big difference in rainfall between the rainy season (May-November) and the dry season (December-April). The rainiest month is October, with an average rainfall of 270 mm. The least rainy month is February, with an average of 2 mm. The region is also prone to thunderstorms and flooding.

**Figure 6: Average monthly rainfall (mm) in Can Tho from 1980 to 2020**

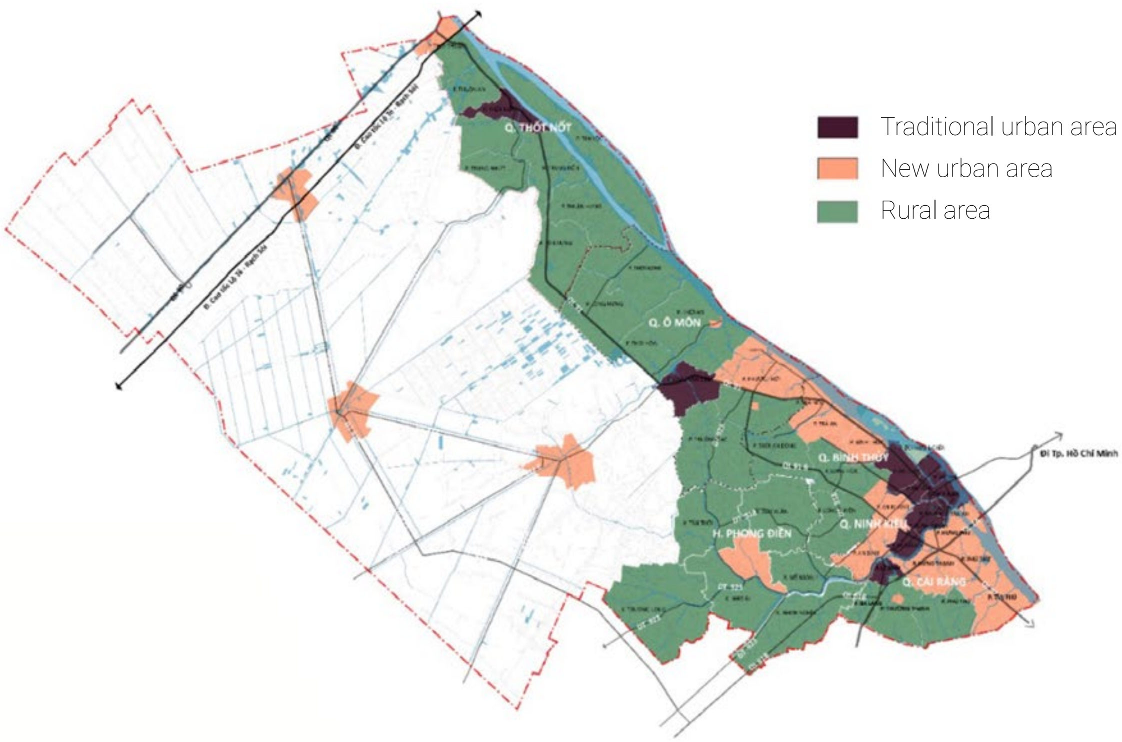


## 3.1.4 Land use

Historically, the city's land use has been and continues to be primarily agricultural, with large areas dedicated to rice cultivation, fruit and vegetable farming. The city is also home to several large-scale agricultural processing facilities, which provide significant local economic opportunities. In recent years, the city has observed a growing number of residential areas, commercial centres, and industrial zones due to rising population particularly in the districts of Cai rang, Binh Thuy and Ninh Kieu. Urbanisation in Can Tho is increasing rapidly, and this is leading to the conversion of agricultural land into urban land. Urban and rural residential areas have seen on average 37% growth in 2020 from 2010.

Anticipating the future landscape beyond 2030, Can Tho aspires to evolve into a smart city within the Mekong Delta. For agricultural land, the city plans to zone off the area of land specialised in high-yield rice cultivation for strict protection in order to ensure food security, applying highly intensive farming methods, and increasing productivity and quality. A portion of agricultural lands will undergo conversion, paving the way for industrial, commercial, and service sector development. During this transformative period, the city's industrial clusters, namely Binh Thuy, Thoi Lai, Co Do, and Vinh Thanh, are planned for expansion, by approximately 75 hectares (ha). An additional aviation industry cluster (30ha) near the airport area in Binh Thuy district is also planned.

**Figure 7: Map of land use status in 2020, Can Tho[18]**




18 Can Tho City Planning for 2021 to 2030, Vision to 2050

**Table 3: Overview of land use in Can Tho**

| Land Use Type | Area in 2020 (ha) | Planned area by 2030 (ha) | Percentage increase |
|---|---|---|---|
| Agriculture | 114,256 | 104,807 | -8% ↓ |
| Urban residential | 5,206 | 8,082 | 55% ↑ |
| Rural residential | 3,441 | 3,974 | 15% ↑ |
| Offices | 216 | 318 | 47% ↑ |
| Commercial & service | 449 | 875 | 95% ↑ |
| Industry | 1,344 | 3,910 | 190% ↑ |
| Transport | 3,661 | 5,651 | 54% ↑ |
| Medical facilities | 88 | 145 | 65% ↑ |
| Educational facilities | 571 | 1,299 | 127% ↑ |
| Culture & sports facilities | 422 | 556 | 32% ↑ |
| Landfill & waste treatment | 60 | 176 | 193% ↑ |
| Defence & security | 910 | 920 | 1% ↑ |

### 3.1.5 Green Cover

Can Tho historically boasted significant green cover, but urban expansion has led to its consistent decline, especially in central districts. This was determined by a remote sensing approach which monitored the spatial distribution of green areas from 1990 to 2018. Based on the analysis, green space in Can Tho city has reduced by 19.2% from 1990 and currently is estimated to cover 105,000 hectares. Central districts such as Ninh Kieu, Binh Thuy, and Cai Rang showed higher levels of green cover loss due to urbanisation. Thus, green space coverage in the central area was lower (31.6%) than that in the peri-urban areas and the suburbs of the city (82.4%) in 2018. Changing the purpose of the land use has been dramatically decreasing the green cover in the city.

**Figure 8:** **Map of green cover in Can Tho (Part of 2014 masterplan)**

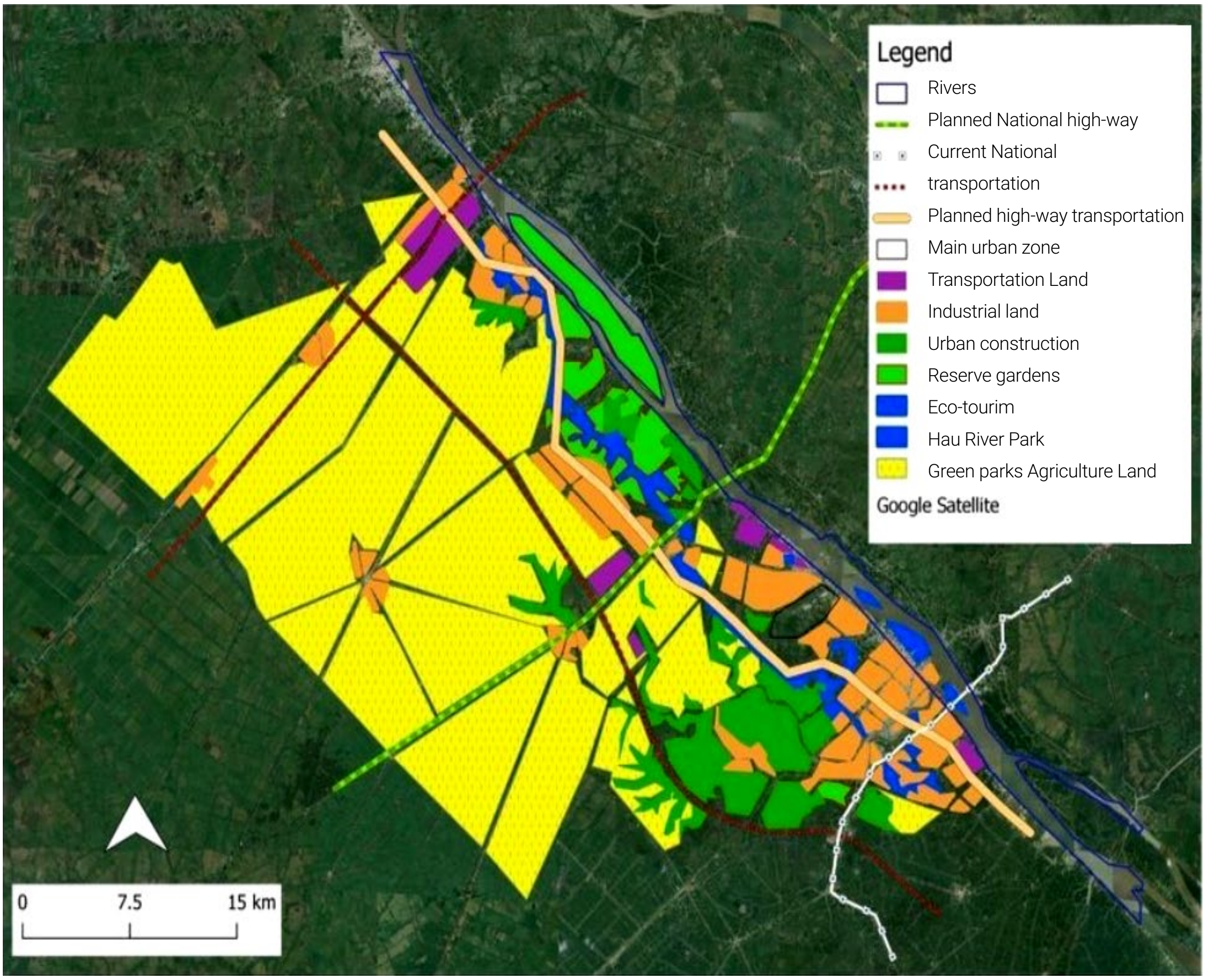
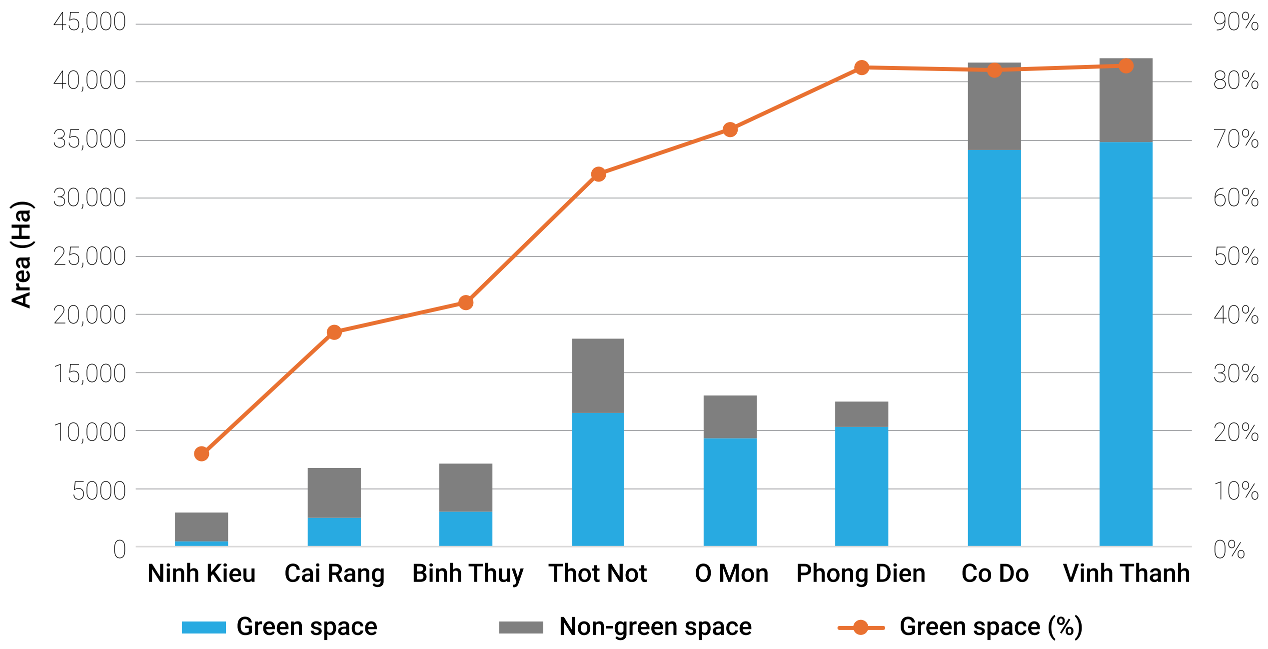



**Table 4:** **Variation in green space in Can Tho from 1990 to 2018**

| Year | 1990 | 2010 | 2018 |
|---|---|---|---|
| Area (ha) | 130,000 | 119,000 | 105,000 |

**Figure 9: District wise distribution of greenspace in Can Tho**[19]




### 3.1.6 Air quality

Air quality in Can Tho, like many cities in Viet Nam and other developing countries, can be a concern. The city's rapid industrialisation and urbanisation, as well as an increase in the number of vehicles on the roads, have contributed to air pollution in the city.

**Table 5: Air quality conditions in Can Tho**[20]

| Year | Total suspended particles (µg/m³) | $SO_2$ (µg/m³) | $NO_2$ (µg/m³) |
|---|---|---|---|
| QCVN 05:2023/BTNMT | 300 | 350 | 200 |
| Densely populated areas | | | |
| Average 2005-2012 | 276 | 158 | 103 |
| 2020 (estimation made before 2020) | 294.8 | 176.8 | 121.8 |
| 2030 (prediction made before 2020) | 302.2 | 184.2 | 129.2 |
| Industrial zones & clusters | | | |
| Average 2005-2012 | 321 | 116 | 67 |
| 2020 (estimate) | 385 | 139 | 80 |
| 2030 (estimate) | 751 | 271 | 157 |

19 An assessment of green space, blue space & green infrastructure using remote sensing approach

20 Can Tho City Planning for 2021 to 2030, Vision to 2050

A joint study conducted by the World Health Organisation (WHO) and the Ho Chi Minh City Institute of Public Health showed that the air quality of the city between 2011 and 2018 was within the WHO limits however average annual concentrations of PM2.5 is at 50.2-51.5 μg/m$^3$, exceeding the WHO air quality standard of 50 μg/m$^3$, by a small margin.

Transportation and industrial activities are said to be the two main emission sources responsible for 80% of total nitric oxide ($NO_x$), 90% of total sulphur dioxide ($SO_2$), 75% of carbon monoxide (CO), 60% of total suspended particles, and 60% of non-methane volatile organic compounds. In addition, the agricultural activities still include burning straw, which releases a large amount of fine dust and smoke into the air[21].

Table 5 provides the average concentrations of total suspended particles, SOx and NOx with fine suspended particles exceeding the upper limit set by QCVN 05:2023/BTNMT regulation and estimated to progressively get worse by 2030.

### 3.1.7 Energy consumption

Can Tho is a rapidly developing city, and with such development comes an increase in energy consumption. The city's main source of energy is fossil fuels, such as coal and natural gas, which are primarily used for power generation and transportation. The city has a handful of electricity generation stations, and their specifics are provided in Annex 2.

**Figure 10: Electricity consumption by different sectors in Can Tho (2020)[22]**

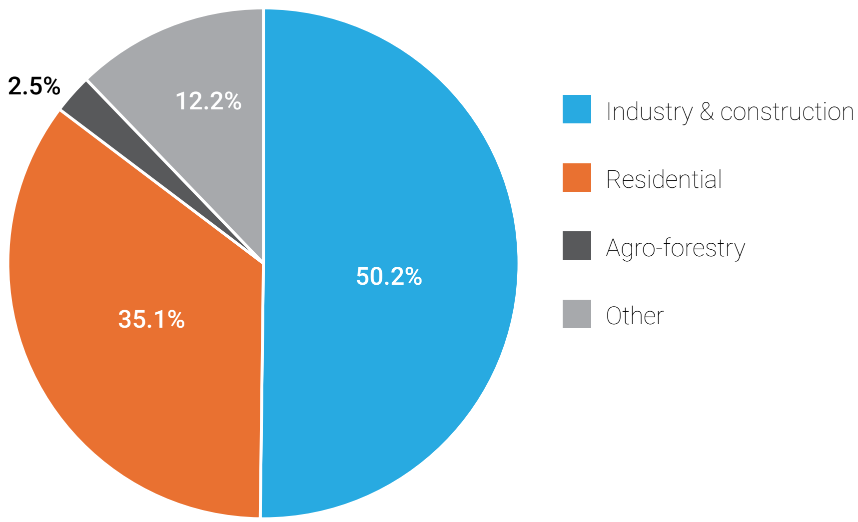



Figure 10 provides the data for electricity consumption by various sectors in 2020 in Can Tho City. According to data, the construction industry in the city accounts for over 50% of total electricity consumption and management and daily life accounts for more than 30%. These are the two groups with the highest percentage of electricity consumption in the whole city. Based on the economic development rate in the period 2021-2025, GRDP growth is estimated to reach 7.5-8%/year, leading to an increase in the energy demand for economic sectors of the city. Details on contribution of other sectors to this energy demand is also provided in Annex B.

The average growth rate of commercial electricity in the period 2021-2030 is projected to be around 10.7%/year due to the high rate of urbanisation. The city has prioritised diversifying its energy mix, with a particular focus on integrating renewable energy sources such as solar and biomass. Solar energy is the most popular form of renewable energy in the city, followed by biomass and wind energy in recent years. The city has also implemented several projects to increase the use of renewable energy in the transportation sector, such as electric buses and

21 https://www.iqair.com/vietnam/thanh-pho-can-tho/can-tho

22 Can Tho electricity company

electric motorbike taxi services.

The people's committee has also set ambitious targets such as reduction in the consumption of primary energy by 1-1.5%/year in the period 2021 to 2030 and to increase the proportion of renewable energy in the total primary energy supply up to 15-20% in the same period.

### 3.1.8 GHG emissions

The main sources of GHG emissions in the city are transportation, industrial processes, and power generation. On the basis of current activities of the main economic sectors and their trends, the land use planning document for Can Tho (2021-2030) determined the $CO_2$ and NOx emissions in 2021 for the Transport and Industry sector and estimated the emissions for 2025.

Can Tho faces significant greenhouse gas (GHG) emissions from its growing number of vehicles. Based on the number of vehicles, the number of kilometres transported and the emission factor for each type of vehicle a 55% increase (Table 6) in transport related emissions can be expected by 2025[23]. Efforts to mitigate this include promoting public and non-motorised transportation, as well as enforcing stricter vehicle emission regulations. These efforts will also contribute in reducing anthropogenic heat and UHIE from the transport sector.

**Table 6: Transport sector emissions**

| | 2021 | 2025 |
|---|---|---|
| NOx (tons/year) | 5,218.5 | 8,089.0 |
| CO2 (tons/year) | 14,490.0 | 22,460.0 |

The city's industrial sector also contributes to GHG emissions, primarily from the burning of fossil fuels for power generation. Based on the land utilised by the industrial sector and related factors a 68% increase (Table 7) in emissions can be expected by 2025. The city has been working to reduce GHG emissions from industry by promoting cleaner energy, such as renewable energy, and by implementing stricter regulations for industrial emissions.

**Table 7: Industry sector emissions[24]**

| | 2021 | 2025 |
|---|---|---|
| NOx (tons/year) | 2.66 | 4.49 |
| CO2 (tons/year) | 26.80 | 45.26 |

The agriculture sector, which is the primary source of methane emissions is projected to decrease between 2021-2025 due to factors such as, the reduction of livestock and wet rice cultivation area and the conversion of agricultural production land, aquaculture area to other purposes. In addition, CO2 emissions are also reduced due to reduced burning of post-harvest agricultural biomass.

Overall, based on the land-use planning document the CO2 emissions are estimated to increase from 631,208 tons/year in 2021 to 5,507,675 tons/year in 2025. The city has set ambitious targets to combat rising emissions. By 2030, the goal is to reduce the intensity of greenhouse gas emissions per GRDP by at least 15% compared to 2014. Looking ahead to 2050, the aim is to achieve a minimum 30% reduction in the intensity of greenhouse gas emissions per GRDP compared to 2014.

## 3.2 Stakeholder mapping

23 Can Tho City Planning for 2021 to 2030, Vision to 2050

24 Can Tho City Planning for 2021 to 2030, Vision to 2050

### 3.2.1 Identification and description

Key stakeholders, spanning government, academic, private, and community sectors, were identified for their roles in advancing urban cooling solutions in Can Tho., which includes decision making authorities, developers, financing organisations among others and have been listed in Table 8 and their specific roles and responsibilities are provided in Annex 3.

Throughout the project, stakeholders have been actively engaged to discuss urban cooling challenges and co-develop actionable solutions.

**Table 8: Stakeholders related to urban cooling**

| Institute type | Institute |
|---|---|
| National Government | 1) Ministry of Agriculture & Environment (MAE)<br>2) Ministry of Finance (MoF)<br>3) Ministry of Industry & Trade (MoIT)<br>4) Ministry of Construction (MoC)<br>5) Ministry of Science & Technology (MoST)<br>6) Department of Climate Change (DCC)<br>7) Viet Nam Environment Protection Fund (VEPF) |
| City Government | 8) Can Tho City People's Committee<br>9) Department of Agriculture & Environment (DAE)<br>10) Department of Construction (DoC)<br>11) Department of Finance (DoF)<br>12) Department of Science & Technology (DoST)<br>13) Department of Industry & Trade (DoIT)<br>14) Can Tho Development Investment Fund (CADIF)<br>15) Can Tho Electricity Company<br>16) Centre of Industry Promotion & Energy Efficiency<br>17) Centre for Resource & Environmental Monitoring<br>18) Investment Construction Project Management Board<br>19) Management Board of Export Processing & Industrial Zones |
| Academic | 20) Can Tho University<br>21) Mekong Delta Research & Global Observation Network<br>22) Institute of Economics & Science |
| Private | 23) Hoan My Cuu Long Hospital<br>24) Saigon Can Tho Trading Co., Ltd<br>25) Victoria Can Tho Company Ltd.<br>26) Hoang Quan Can Tho Investment Real Estate Joint Stock Company<br>27) Dai Thuan Thien Clean Agricultural Products Co., Ltd<br>28) Management Board of Cai Khe Open Market |
| Unions | 29) Women's Union of Can Tho<br>30) Can Tho City Youth Union's<br>31) Union of Science & Technology Associations<br>32) Cooperative Alliance |

## 3.2.2 Categorisation of stakeholders

The stakeholders are prioritised based on their interest and influence over sustainable urban cooling implementation. An interest vs power matrix is generated to classify stakeholders into four categories based on their level of interest and power mentioned below:

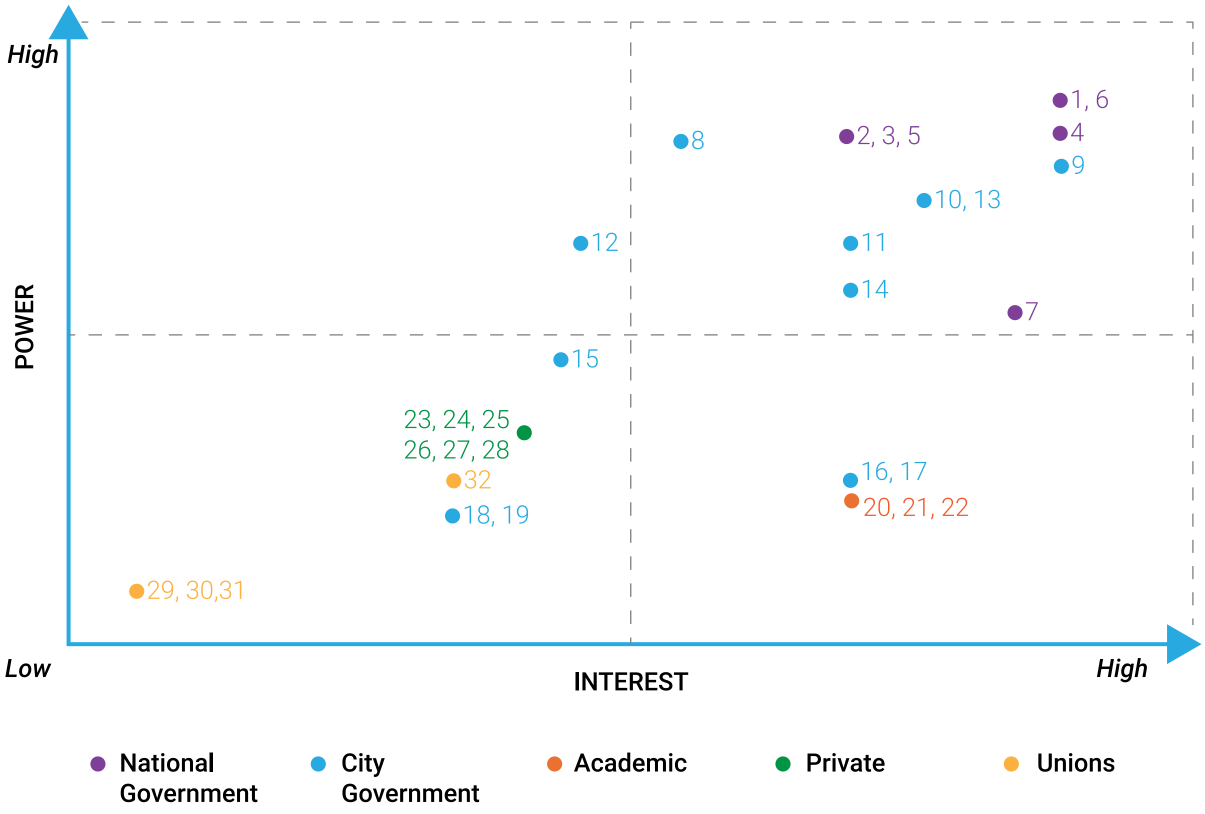
High power & high interest (key players): Stakeholders with high power and high interest are the most critical to the success of the project, as they hold significant influence over its outcomes. It is essential to engage with them regularly and actively consider their feedback throughout the project's implementation.

High power & low interest: Stakeholders with high power but low interest should also be engaged and their perspectives taken into account, as they possess the capacity to influence the project's direction or outcomes, even if they are not actively involved..

Low power & high interest: Stakeholders with low power may not be decisive in shaping project outcomes, but it is important to keep them informed and aware of the project's developments. Their support can contribute to broader acceptance and long-term sustainability.

Low power & low interest: Stakeholders in this group may not be among the most critical, but efforts should be focused on raising their awareness and building their capacity. This can enhance their ability to contribute meaningfully and foster broader stakeholder engagement in the long term.

**Figure 11: Stakeholder mapping in power vs interest graph**



## 3.3 Drivers for the UHIE in the city

The main causes of urban heat in Can Tho City were identified based on-site visits, data analysis and stakeholder consultations and are listed below.

**i) Increasing rates of urbanisation:**

Can Tho City is experiencing record levels of population growth and subsequent urban expansion, earning the distinction of being the second-fastest-growing city between 2015 and 2020. This surge in population has fuelled a heightened demand for housing and other essential built infrastructure. The approved master plan, extending to 2030, forecasts a significant reduction in agricultural land by nearly 8%, in contrast with a staggering 390% increase in industrial areas. As urbanisation progresses, vast areas of natural land are transformed into impervious surfaces such as asphalt roads, concrete buildings, and pavements, which absorb and retain heat. This shift, combined with the loss of biodiversity and ecosystems that typically mitigate temperature fluctuations, such as trees shading roads and sidewalks, drives temperatures in urban areas significantly higher than in their rural surroundings. Detailed analysis on impact of urbanisation on temperatures is presented in section 5.

**ii) Increase in industrial activities:**

Can Tho City stands as a major commercial hub within the Mekong Delta, serving as a pivotal centre for economic, financial, and service-related activities throughout the region. This economic prominence manifests in the industrial and trade activities within numerous industrial areas. Notably, the highest magnitude of heat island effect is perceptible within these industrial areas. The presence of thermal power stations in the vicinity further exacerbates this phenomenon. Remote-sensing analysis of land surface temperatures spanning from 2014 to 2020 reveals a maximum land surface temperature within these specific areas (e.g. Binh Thuy and O Mon districts) up to 5°C higher in comparison with rural districts of Co Do and Thoi Lai. The city is planning to further enhance these economic activities as indicated by the 2030 master plan document which could lead to significant population migration, resource requirements and urbanisation that impacts the heat island effect.

**iii) Increase in transport activities:**

Can Tho City being strategically located in the Mekong Delta, handles a lot of freight being trafficked through the city which has been steadily rising. The river system that connects to major ports in the east Viet Nam Sea and the network of roads comprising six national highways mean that Can Tho City acts as a logistics hub in the delta. As the economy grows, freight transport activities surge to meet the demands and vehicular emissions become a significant contributor to the accumulation of heat-trapping pollutants in the atmosphere. Consequently, Can Tho City could experience heightened temperatures, particularly in densely trafficked zones that can lead to an increase in emissions as seen in table 6 which could further exacerbate the urban heat island effect.

## 3.4 Barriers to urban cooling in the city

i) Lack of awareness among key stakeholders

There exists a significant lack of awareness regarding the urban heat island effect, its underlying causes, and the intricate linkages it shares with various contributing factors. City-level decision-makers lack familiarity with urban cooling solutions, including their costs, potential energy savings, performance metrics, and overall benefits. Moreover, stakeholders remain uncertain about the tangible and intangible advantages associated with implementing such solutions. Compounding these challenges is the insufficient technical know-how, capacity and human resources available to develop, integrate, and execute urban cooling strategies particularly within relevant provincial departments, such as: Department of Construction, Department of Agriculture and Environment, etc. Targeted efforts are also needed to address lack of awareness and technical capacity of the construction industry, architects, contractors, utility and service providers on adoption of sustainable cooling solutions in buildings and urban infrastructure. Additionally, the proposed intervention could serve as an opportunity to enhance gender inclusivity by supporting the upskilling and participation of women in these roles.

ii) Lack of technical expertise studies to address UHI effect

In recent years, Can Tho has experienced notable growth in its commercial, logistical, and industrial sectors, which has substantially amplified the Urban Heat Island (UHI) effects in the area. Despite this trend, there is an absence of baseline assessments dedicated to studying and quantifying the UHI effect, as well as identifying potential mitigation strategies both on the city level as well as neighbourhood level. The scarcity of information on effective cooling solutions or applicable tools further exacerbates the challenge for the local government to implement suitable mitigation actions. There is no dedicated department/staff, at either the national or local level, to coordinate with other departments and stakeholders, prepare guidelines, implement urban cooling solutions and monitor the executed projects to track their impacts related to urban heat. Compounded by limited awareness and cooperation mechanisms among key stakeholders, this presents a significant barrier to addressing the issue effectively.

iii) Lack of dedicated policy framework for urban cooling

Policies related to climate change, green growth, infrastructure improvement, energy efficiency do exist, as summarised in Section 4.1 of the report, however they do not address the UHI effect in a holistic manner. The policy challenge lies in the absence of an official document issued specifically for urban cooling solutions. This lack of clear policies can create uncertainty, making it difficult for individuals, businesses, and organisations to plan for the future. Currently, these solutions are scattered across documents in different sectors. For e.g. Decision No. 3184/QD-UBND (2018) by the People's Committee of Can Tho City, approves the overall planning of the green tree system in Can Tho City until 2030. However, no specific guidelines exist for selecting a location of such green spaces in order to effectively address urban heat. Generally, such green spaces are placed in a scattered manner based on availability of reserved land, which may not be in line with potential heat island pockets, existing ones as well as ones resulting from the said development.

However, to effectively invest in and implement measures to combat the urban heat island phenomenon, synchronous and systematic solutions are necessary. A lack of policies can lead to inefficiencies in resource allocation, as there are no guidelines for prioritising or optimising the use of resources, time, and effort. In the context of urban cooling, this can result in regulatory gaps that put people and the environment at risk. Additionally, women often lack access to financial and technical resources, while men dominate decision-making. Ensuring gender-responsive resource allocation in policy development is essential to address diverse needs. Future policy efforts should incorporate gender-sensitive assessments to identify and integrate the specific requirements of different groups, ensuring equitable access to cooling solutions and related resources.

iv) Institutional arrangement

Section 3.2 and Annex C list the governmental/provincial authorities and stakeholders involved in urban cooling, along with their specific roles and functions. From this, it can be seen that the current institutional arrangement is somewhat ambiguous. There's no legal basis to designate which ministry is the focal point and lead agency for urban cooling issues, even though it involves multiple ministries in Viet Nam. This makes data management challenging, especially when the data are dispersed across different locations in the management system. Furthermore, without clear institutional arrangements, coordination among different ministries, departments, and agencies can become difficult. This can lead to inefficiencies, overlaps, and inconsistencies in decision-making and actions.

However, the absence of central institutions can also foster an environment where local initiatives and grassroots movements thrive. This allows communities to take control of their own solutions and facilitates swift responses to evolving situations or crises. It encourages adaptability, innovation in decision-making and problem-solving processes. Women, key in household energy use and community initiatives, should be empowered through leadership training, policy inclusion, and entrepreneurship support to drive innovative, inclusive cooling solutions.

Nonetheless, it's important to note that establishing a well-structured system is crucial. Such a system can clearly define the roles of relevant stakeholders, serving as the cornerstone for successful governance and development.

v) Financial resources

Urban cooling with a sustainable approach may not yield immediate economic value. This financial challenge is common in developing countries, including Viet Nam, where cost-benefit analysis is a crucial factor in investment decisions. Building level cooling strategies such as green building certification (e.g. LOTUS) are currently implemented on a voluntary basis. There is a lack of financial incentives to promote green buildings which hinder the uptake since there are additional capital costs incurred by developers to follow green building guidelines.

However, from a strategic and long-term perspective, investing in urban cooling solutions can help save cooling costs, improve the living environment, and ensure human health. The trend of investing for sustainable development is on the rise, and accessing green capital and preferential capital has become easier. Yet, it's important to have clear criteria for green projects, risk assessment criteria for green investments, and a transparent and attractive financial mechanism for both borrowers and lenders to unlock this capital. In the current context, this presents a great opportunity for urban cooling projects in Viet Nam that require substantial investments.

Moreover, the need for investment capital for urban cooling solutions also promotes the development of new financial mechanisms to channel international capital into Viet Nam and mobilise capital from both public and private sectors.

Photo: Aerial panoramic view of Luu Huu Phuoc park, Can Tho
Credit: Shutterstock

# 04 POLICY MAPPING AND ANALYSIS OF EXISTING REGULATION FRAMEWORK OF URBAN COOLING

## 4.1 Existing policy and regulation framework of urban cooling at national level

Viet Nam has formulated various laws, policies and guidelines at different levels of governance, focusing on sustainable planning and environmental protection. There are limited policies that directly address the UHI challenge and their effects. However, focus areas of the policies do offer entry points and support strategies to mitigate the effects of rising urban temperatures and promote sustainable urban cooling initiatives. Relevant national level legislations and policies are mapped in Table 9, with linkages to UHI effect noted.

**Table 9: Existing frameworks that address urban cooling at national level**

| Framework | Description |
|---|---|
| **National Government's commitments, strategies and plans that facilitate Urban Cooling** | |
| **Global Cooling Pledge** | Viet Nam is among the initial 63 nations to participate in the Global Cooling Pledge under the auspices of COP28. As part of this commitment, Viet Nam pledges to release a national cooling action plan, incorporate cooling considerations into its national action plan, or promulgate an equivalent regulation by 2026. |
| **Nationally Determined Contributions (NDC)** | Viet Nam submitted its updated Nationally Determined Contribution (NDC) in 2022, in which cooling-related content was notably enhanced. Key updates related to cooling include:<br>• In Viet Nam's latest NDC (2022), emissions from refrigeration and air conditioning systems are identified as a solution for mitigating greenhouse gas emissions. This includes a focus on transforming the management of HCFCs and HFCs through their conversion, use, recovery, recycling, reclamation, and destruction, all aimed at achieving net-zero emissions by 2050.<br>• The emission reduction measures detailed in the emission reduction scenarios in the Technical Report include various actions such as adopting high-efficiency room air conditioners, using energy-efficient refrigerators, deploying high-performance electrical equipment in service, both in commercial applications and cooling and refrigeration within the energy sector.<br>• This approach also involves using environmentally friendly refrigerants, which includes transitioning from high Global Warming Potential (GWP) HFCs to low GWP alternatives in refrigeration and air conditioning systems, as well as promoting the recovery, recycling, and reuse of refrigerants within the industrial process and product use sector. |

| Framework | Description |
| --- | --- |
| **Decision No. 896/ QD-TTg** (National Strategy on Climate Change in period of 2050) | The Prime Minister of Viet Nam issued the National Climate Change Strategy to 2050 under Decision No. 896/QĐ-TTg dated July 26, 2022. This strategy explicitly addresses key concepts such as "Urban Heat Island Effect (UHIE)," "sustainable cooling," and "green cooling." It outlines specific measures and directions, including:<br>• Section IV.2.a outlines the broad goal of cutting GHG emissions by 2030. It emphasises the commitment of government agencies, socio-political organisations, and businesses to put into action measures that aim to reduce emissions. It highlights the importance of sustainable cooling as an effective strategy for reducing greenhouse gas emissions.<br>• In Section IV.2.b, for energy-efficient buildings, the Decision mandates the construction of buildings with a focus on heat resistance and the use of eco-friendly cooling solutions. It advocates for the use of natural elements to mitigate urban heat islands and materials that emit minimal greenhouse gases, while also promoting the use of recycled materials. The Decision further encourages the adoption of energy-efficient technologies and innovative business models for cooling and air conditioning equipment, projection systems, and smart lighting. In terms of improving equipment efficiency, it calls for an enhancement in the energy efficiency of various equipment and cold chain systems; and promotes the use of renewable energy sources in cold storage and supply systems.<br>• Section IV.2.b, for industrial processes, stipulates a progressive discontinuation of HCFC and HFC refrigerants in cold chain, refrigeration, and air conditioning systems in buildings. It further insists on an increase in cooling efficiency and a decrease in the need for cooling and refrigerant usage, achieved through innovative building designs and passive cooling solutions. Moreover, it promotes the responsible handling of refrigerants through recovery, reuse, destruction, and recycling, while advocating a shift towards refrigerants with a diminished GWP. |
| **Prime Minister's Decision No. 496/ QĐ-TTg** (National Action Plan for the Management and Elimination of Substances that Deplete the Ozone Layer and Greenhouse Gases) | On June 11, 2024, the Prime Minister of Viet Nam issued the National Plan for the Management and Phase-out of Ozone-Depleting Substances and Controlled Greenhouse Gases. Section III.4 of the Plan outlines a phased roadmap for the implementation of sustainable cooling solutions, with specific measures and timelines as follows:<br>• 2024 - 2028: Implement training programmes, enhance capacity; Integrate sustainable cooling requirements into national and provincial development policies/programmes; Develop legal documents and technical guidelines for energy efficiency, carbon emissions reduction, gradually meet the criteria for green building certification.<br>• 2029 - 2034: Develop regulations on energy use standards for different types of buildings; Pilot the application of technical guidelines for energy-efficient buildings; Deploy models of sustainable cooling applying passive cooling solutions in office buildings, commercial or public works.<br>• 2035 - 2039: Apply energy use standards for different types of buildings for construction projects; Popularise and expand models of sustainable cooling.<br>• 2040 - 2044: Special urban areas, type I and II cities build and apply comprehensive solutions to reduce urban heat island effect and cope with extreme heat; 100% of new buildings achieve green building certification. |

| Framework | Description |
|---|---|
| **Construction Planning and Housing/Building Policies that Facilitate Urban Cooling** | |
| **Circular No. 01/2021/TT-BXD** National Technical Regulation on Construction Planning (QCVN 01:2021/BXD) | On May 19, 2021, the Minister of Construction issued Circular No. 01/2021/TT-BXD, promulgating the National Technical Regulation on Construction Planning (QCVN 01:2021/BXD)<br>• Sets out requirements on green land, including the minimum area of green space for public use in each type of urban area, for example:<br>– A special urban area must have a minimum area of green land for public use in the urban area (excluding green land for public use in residential units) of 7 m2/person.<br>– Class-1 and class-2 urban areas, class-3 and class-4 urban areas, and class-5 urban areas will have lower standards, respectively 6.5, 5, 4 m2/person.<br>• This Circular also stipulates that the minimum distance between buildings must be specified in the detailed planning and urban design project, arrangement of works, determining the height of the works must ensure to minimise the negative impacts of natural conditions (sun, wind...), creating advantages for microclimate conditions in the works. These requirements will apply to buildings with a height of ≥ 46m and <46m.<br>• The Circular sets standards for the minimum percentage of green land in land lots for construction of works, with at least 20% for apartment buildings and factories and at least 30% for educational, medical, and cultural buildings. |
| **Decision No. 143/QD-BXD** Action Plan for planning, construction, management, and sustainable development of urban areas in Viet Nam until 2030, with a vision toward 2045) | On March 8, 2023, the Ministry of Construction issued Decision No. 143/QĐ-BXD, approving the Ministry's Action Plan to implement Resolution No. 06-NQ/TW dated January 24, 2022, of the Politburo on Urban Planning, Construction, Management, and Sustainable Urban Development in Viet Nam to 2030, with a Vision to 2045, and Resolution No. 148/NQ-CP dated November 11, 2022, of the Government on the issuance of the Government's Action Program for implementing the Politburo's Resolution.<br>Sets a goal of achieving an average green space per urban resident of approximately 6 - 8 square metres by 2025 and around 8 - 10 square metres by 2030. |
| **Decision 2161/QD-TTg** (National strategy on housing development 2021 – 2030, with a vision toward 2045) | On December 22, 2021, the Prime Minister approved the National Housing Development Strategy for the 2021–2030 period, with a vision to 2045, under Decision No. 2161/QĐ-TTg.<br>• Approves The National Housing Development Strategy for 2021-2030, with a vision towards 2045. This Decision sets a goal for green housing projects, specifically as follows:<br>– For new resident houses, it is required to design to expand the functional living space of the house towards the development of green, sustainable, low-emission spaces.<br>– During the renovation and reconstruction of existing apartment buildings and apartment complexes, the developer must be directed towards green and sustainable urban development.<br>• This Decision also sets the task of issuing housing standards for new designs, techniques, and construction technologies aimed at improving living quality, in line with the trend of developing green housing. It supplements mechanisms and policies to encourage and prefer organisations and individuals to participate in developing green, energy-saving, and low-emission housing. |
| **Decision 385/QD-BXD** (Action plan of the Construction industry to promote climate change adaptation for the period 2022-2030, with a vision to 2050) | On May 12, 2022, the Ministry of Construction issued Decision No. 385/QĐ-BXD, approving the Construction Sector Action Plan for Climate Change Adaptation for the 2022–2030 period, with a vision to 2050, in response to Viet Nam's commitments made at COP26.<br>• Develop and implement the sector's roadmap to fulfill Viet Nam's commitment at COP26 to achieve net-zero emissions by 2050.<br>• Develop urban technical infrastructure that adapts to climate change and reduces greenhouse gas emissions. By 2025, complete the development of criteria and evaluation processes for recognising green buildings and low-carbon buildings; green urban areas and low-carbon urban areas. By 2030, at least 25% of new urban areas will apply green urban and low-carbon criteria. |

| Framework | Description |
|---|---|
| **National Technical Standard QCVN 09:2017/BXD on Energy Efficiency Buildings** | On December 28, 2017, the Minister of Construction issued Circular No. 15/2017/TT-BXD, promulgating the National Technical Regulation on Energy Efficiency for Buildings (QCVN 09:2017/BXD).<br><br>The National Technical Standards for energy-efficient buildings specify mandatory technical requirements that must be followed when designing, constructing new buildings, or renovating buildings with a total floor area of 2,500 square meters or more. These standards apply to the following types or combinations of buildings: Offices; Hotels; Hospitals; Schools; Commercial and service buildings; and Residential buildings. |
| **Decree 15/2021/ND-CP** (Elaborating certain regulations on management of construction projects) | On March 3, 2021, the Government of Viet Nam issued Decree No. 15/2021/ND-CP, detailing several provisions on the management of construction investment projects.<br><br>Article 7 of Decree 15/2021/ND-CP specifies that the State encourages the construction, development, evaluation, and certification of energy efficient buildings, resource saving buildings, and green buildings. It emphasises for the first time the meaning of Green Building as the construction project designed, constructed and operated to meet the criteria and standards of energy efficiency and resource saving, and to ensure indoor comfort and air quality and outdoor environment protection. |
| **Energy Efficiency Policies that Facilitate Urban Cooling** | |
| **Decree No. 21/2011/ND-CP** (Detailing the EE law for its implementation) | **Issuing agency**: Government (2011)<br>• Introduced to provide specific guidelines for effectively implementing the Law on Economical and Efficient Use of Energy.<br>• Article 6 of this decree stipulates that buildings with a total annual energy consumption equivalent to five hundred tons of oil (500 TOE) or more will be included in the list of heavy energy-using facilities. Accordingly, these buildings will be required to apply an energy management model that includes implementing annual and five-year plans for economical and efficient energy use; conducting energy audits; and other requirements.<br>• The Decree also introduced requirements for energy labelling to provide consumers with information about the energy efficiency of various products and equipment. These labels empower consumers to make informed decisions when purchasing energy-consuming items. |
| **Decision 280/QD-TTg** (National programme for energy efficiency for the period of 2019 - 2030) | **Issuing agency**: Prime Minister (2019)<br>• Approving the national programme on economical and efficient use of energy for the period 2019 – 2030.<br>• This decision sets a goal of achieving certification for 80 green, energy-saving, and efficient buildings by 2025, and increasing this number to 150 in the period from 2025 – 2030.<br>• To achieve these goals, the Ministry of Construction is tasked with carrying out technical support activities, promoting new construction investment projects, and renovation projects to install or replace equipment in buildings for economical and efficient energy use. |
| **Decision No. 04/2017/QD-TTg** (List of equipment and appliances to which the mandatory energy labelling and minimum energy efficiency standards are applied, and the roadmap to their implementation) | **Issuing agency**: Prime Minister (2017)<br>● Established a list of vehicles and equipment that are required to bear energy labels and meet minimum energy efficiency standards. This Decision reinforces the government's commitment to promoting energy-efficient practices and cultivating responsible energy consumption in Viet Nam. |

| Framework | Description |
| --- | --- |
| **Climate Change Policies that Facilitate Urban Cooling** | |
| **Law on Environmental Protection No. 72/2020/QH14** | **Issuing agency**: National Assembly (2020)<br>Although it does not explicitly mention urban cooling, this law provides an important legal foundation for implementing sustainable cooling solutions through regulations on green infrastructure development, integration of climate change adaptation into urban planning, promotion of energy-saving technologies, and the development of green buildings. The law also requires strategic environmental assessment for urban planning and the formulation of local climate adaptation plans. |
| **Decree No. 06/2022/ND-CP** (Mitigation of greenhouse gas emissions and protection of ozone layer) | **Issuing agency**: Government (2022)<br>• Clarified the provisions of the 2020 Environmental Protection Law regarding the mitigation of greenhouse gas emissions and protection of the ozone layer.<br>• Commercial buildings consuming an annual energy equivalent to or exceeding 1,000 TOE are required to perform a biennial assessment of their greenhouse gas emissions.<br>• Measurement, Reporting, and Verification (MRV) system: Applied to emission reduction activities in sectors related to cooling, such as refrigeration, air conditioning, buildings, and urban transportation<br>Ozone Layer Protection: Management and control of refrigerants (ODS and HFCs) used in air conditioning and urban cooling equipment in accordance with the phasedown roadmap, while promoting the transition to environmentally friendly cooling technologies |
| **Decision No. 910/QD-BXD** (Implementation Plan for the Development of Urban Areas in Viet Nam with Climate Change Adaptation for the 2021-2030) | **Issuing agency**: Ministry of Construction (2022)<br>• Outlined tasks such as developing guidelines for urban planning, urban design, green building design, and energy-saving works during the 2021-2025 period.<br>• In addition, research and pilot projects for urban planning are initiated with priority given to programmes in urban development, green growth, and implementation of smart, climate-friendly architectural practices aimed at climate change adaptation. |
| **Green Growth Policies that Facilitate Urban Cooling** | |
| **Decision 1658/QD-TTg** (National Green Growth Strategy for 2021-2030, with a vision to 2050) | **Issuing agency:** Prime Minister (2022)<br>• The National Green Growth Strategy complements the National Action Plan on Green Growth which was approved on July 22, 2022. Both documents introduced new targets for reducing greenhouse gas emissions and emphasised green growth urban development.<br>• The Strategy set a goal for 2030 to have at least 10 cities implement Master Plans dedicated to green growth urban development, aiming to establish sustainable, smart cities. By 2050, the goal is to have at least 45 such cities. |
| **Circular No. 01/2018/TT-BXD** (Urban green growth indicators) | **Issuing agency**: Ministry of Construction (2018)<br>• The Ministry of Construction launched an Action Plan for green growth in the construction sector, aiming to achieve the goals outlined in the National Strategy on Green Growth and the National Green Growth Action Plan.<br>• Subsequently, Circular No. 01/2018/TT-BXD was issued to establish norms for green growth urban construction.<br>• Decision No. 84/QD -TTg approved the Green Growth Urban Development Plan for Viet Nam until 2030, detailing the objectives, activities, and a list of 23 pilot cities implementing green growth urban development. |
| **Decision No. 84/QD -TTg** (Action Plan for developing green growth cities in Viet Nam until 2030) | **Issuing agency**: Prime Minister (2018)<br>• Decision No. 84/QD -TTg approved the Green Growth Urban Development Plan for Viet Nam until 2030, detailing the objectives, activities, and a list of 23 pilot cities implementing green growth urban development. |

**Box 1: International best practices**

While preparing the policy analysis an examination of best practices in urban heat and cooling from various countries and cities were compiled to derive lessons relevant for Viet Nam's context. Countries such as India, Cambodia and Singapore were selected due to their climate similarities and advanced policy framework around urban heating. Similarly, cities like Ahmedabad and Western Australia were also examined along with other technical and non-technical best practice cases, the details of which have been provided in Appendix D. These lessons learnt for Viet Nam were compiled to support recommendations and divided into four categories and summarised below. Complete details are provided in Appendix E.

**a) Development & implementation of urban cooling policy:**

The frameworks from India and Cambodia clearly indicate the need for national level and local level Cooling Action Plans emphasising on the involvement of a diverse set of stakeholders. A clear implementation framework is crucial for the successful execution of specific programmes and actions, as it helps stakeholders understand their roles and responsibilities.

**b) Effective technical solutions:**

Enhancing urban cooling through technical practices involves several key elements. These encompass strategic city planning and design considerations, including optimising street orientation to maximise natural ventilation and airflow patterns, strategically configuring wind corridors, and integrating abundant green and blue spaces to foster biodiversity and enhance urban resilience. Moreover, employing materials like high albedo surfaces and permeable pavements aids in reducing heat absorption and managing stormwater runoff effectively. Solutions such as cool roof and cool wall technologies further contribute to minimising heat retention within urban areas, thus mitigating temperature extremes. Additionally, promoting clean mobility solutions and implementing district cooling systems play pivotal roles in curbing emissions and reducing energy consumption, thereby fostering sustainable urban development.

**c) Effective non-technical solutions**

Effective non-technical strategies encompass a multifaceted approach, starting with raising public awareness about the impact of extreme heat and the benefits of urban cooling initiatives. This includes implementing early warning systems to alert communities and individuals to impending heat-related risks, fostering proactive preparedness. Equally crucial is the provision of comprehensive training and capacity-building programmes for local officials, empowering them with the knowledge and skills to effectively manage and adapt to extreme heat phenomena. Furthermore, promoting energy efficiency represents a key avenue for mitigating heat-related stressors. Cities can explore innovative measures such as implementing an energy-efficiency grading system for buildings or incentivising environmentally and climatically responsible architectural designs through awards and recognition.

Women and low-income individuals often lack access to cooling solutions, increasing their risk of heat-related illnesses and reducing productivity. It is crucial to include the most vulnerable communities when designing awareness campaigns, ensuring they are not only informed about the risks associated with extreme heat but also have access to practical, affordable, and sustainable cooling solutions. This approach helps bridge gaps in information and resource access, empowering these communities to protect their health and well-being.

**d) Financial mobilisation for urban cooling**

Various funding sources have been examined that could support the implementation of urban cooling strategies and interventions, ranging from municipal funds derived from taxes and national budgets which play a pivotal role in financing urban cooling programmes. Moreover, Official Development Assistance (ODA) and Dedicated Climate Funds emerge as prominent financial mechanisms for executing national-level initiatives. Other funds encompass grants and loans from institutions such as the Global Environment Facility, Green Climate Fund, and Climate Investment Funds, as well as country-specific funds or participation in carbon markets. Government-issued debt instruments present another avenue for financing urban cooling projects, encompassing general obligation bonds, special-purpose bonds, and specialised green or climate bonds designed explicitly for environmental initiatives. These financial instruments provide a means for governments to mobilise capital for climate resilience efforts while aligning with sustainable development objectives. Additionally, public-private partnerships represent a valuable strategy for implementing urban cooling projects, leveraging the expertise and resources of private contractors in collaboration with local administrations.

## 4.2 City's existing sustainable initiatives, goals and targets

Can Tho City has implemented action on a range of sustainability issues, particularly advocating for reduced energy consumption and green growth to address climate change at the local level.

**Table 10: Existing initiatives, goals and targets that address urban cooling at city level**

| Framework | Description |
|---|---|
| **Development plan for Can Tho City** for the period 2021 – 2030, with a vision to 2050 | • Develop Can Tho City towards an ecological, cultured, and modern city; with a synchronised infrastructure system adaptable to climate change.<br>• The average growth rate of the total product in the area (GRDP) ranges from 7.5% to 8%; the per capita GRDP (at current prices) exceeds 220 million VND.<br>• Regarding infrastructure development: The urbanisation rate is about 80%. |
| **Plan No. 200/ KH-UBND** (Green growth for the period 2021 - 2030, vision 2050) | • Reduce greenhouse gas emission intensity on GRDP: reduce at least 15% by 2030 and 30% by 2050 (compared to 2014).<br>• Primary energy consumption on GRDP: for the period 2021 - 2030 reduce from 1.0 - 1.5%/year; by 2050 on average each period (10 years) reduces 1.0%/year. |
| **Plan No. 66/ KH-UBND** (Implementing the national programme on energy-saving and efficient use in Can Tho City for the period 2021 – 2030) | • 2021 - 2025 period: Achieve a minimum saving of 4.50 - 6.0% of total energy consumption compared to the forecasted energy demand and reduce the power loss in the whole city to less than 3.0% (about 3.12% in 2020).<br>• 2026 - 2030 period: Achieve a minimum saving of about 6.0 - 7.0% of total energy consumption compared to the forecasted energy demand and reduce power loss to 2.5% of the whole city. |
| **Plan No. 183/KH-UBND** | Can Tho City aims to plant 6.838 million trees of all kinds in both urban and rural areas during this period. |
| **Decision No. 1160/ QĐ-UBND** (Action plan to respond to climate change for the period 2021 – 2030, with a vision to 2050) | **Objectives**:<br>• Enhance the ability to respond to climate change of the entire city government system, with the target of at least 80% of communes, wards, and towns in areas prone to the impact of climate change having sufficient capacity and physical facilities to respond effectively to natural disasters and extreme weather conditions.<br>• Gradually orient the market for industrial - agricultural production and services under the condition of climate change.<br>• Reduce greenhouse gas emissions in the fields of transportation, industry, agriculture, construction, and solid waste to contribute to the implementation of "Viet Nam's Nationally Determined Contribution" (updated in 2020).<br>• Encourage and attract the participation of domestic and foreign investors, the private sector in responding to climate change, preventing natural disasters, riverbank erosion. |

| Framework | Description |
|---|---|
| **Programme No. 27-CTr/TU** (Environmental protection "Can Tho is green and clean") | **Objectives**:<br>• Urban Planning: The programme aims to develop ecologically conscious, river-centric, and climate-adaptive urban areas while preserving green spaces and natural water bodies.<br>• Green Infrastructure: The strategy involves increasing the proportion of trees and water surfaces and dedicating more land for public welfare facilities that enhance community life.<br>• Urban Design: The programme envisions a contemporary urban landscape that blends seamlessly with the natural environment, emphasising the potential of river ecosystems.<br>• Integrated Pollution Prevention and Greening: The programme commits to integrating strategies for pollution prevention and urban greening in a rational and achievable manner.<br>• Green Economy and Industry: The programme is dedicated to executing projects that promote a green economy and industry. |
| **Plan No. 04/ KH-UBND** (Implementing the Project "Developing Vietnamese urban areas to respond to climate change in the period 2021-2030") | **Objectives**:<br>This plan outlines research content and pilot implementation of several planning projects and key priority programmes for developing green, smart urban growth. |

### 4.2.1 Institutional arrangement

Since Viet Nam doesn't have a dedicated urban cooling programme or plan, the implementation of relevant policies is dependent on the sector to which the policy is related, rather than being based on a fixed structure.

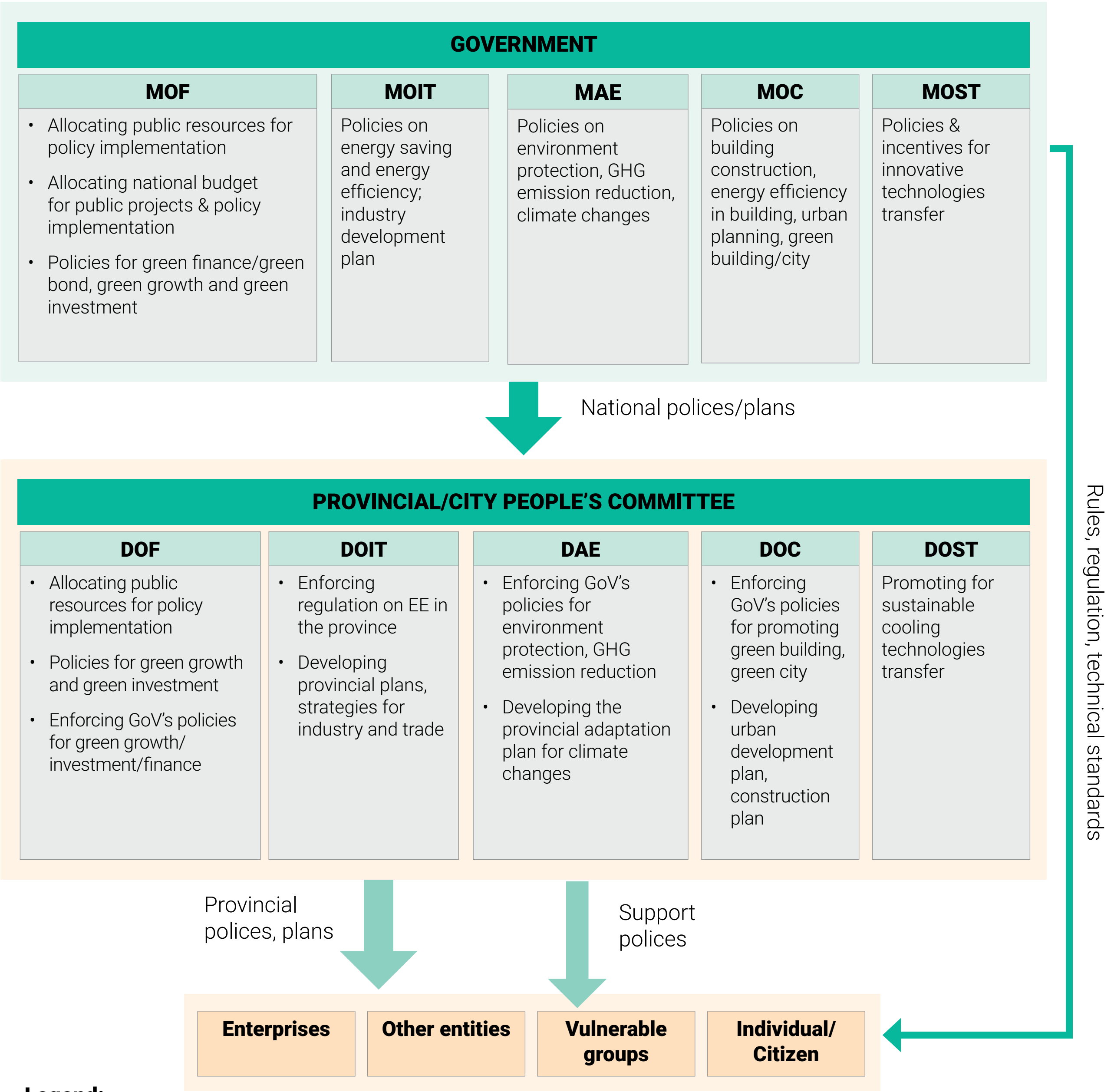
a) At national level

The aforementioned documents consistently specify an "implementing organisation," which clearly delineates the roles and responsibilities of the parties involved. The choice of the leading organisation varies depending on the specific sector or focused area. For example, the Ministry of Agriculture and Environment spearheads the development and implementation of national programmes, strategies, and plans related to climate change. The Ministry of Finance oversees the creation of the national strategy for green growth, while the Ministry of Industry and Trade takes the lead in formulating the national strategy and plan for the energy sector. The Ministry of Construction leads in devising programmes and projects related to urban development, technical infrastructure, and housing. Other ministries and relevant entities participate in accordance with their designated functions and assigned tasks.

b) At provincial level

At the local level, sectoral management is always intricately intertwined with local management. This involves coordination between the vertical management of ministries and the horizontal management of local government, based on the distribution of responsibilities and decentralisation of management across sectors and levels. Provincial departments are tasked with implementing vertical tasks (requirements of line ministries) while also carrying out assigned responsibilities and reporting to the provincial People's Committee. The organisation and execution of programmes and plans at the provincial level mirror those at the national level.

**Figure 12: Existing Governance and Support Framework for Sustainable Urban Cooling in Viet Nam at a National and Provincial/City Level.**




**Legend:**

| | | | | | |
|---|---|---|---|---|---|
| MOF: | Ministry of Finance | MOST: | Ministry of Science and Technology | DOIT: | Department of Industry and Trade |
| MAE: | Ministry of Agriculture and Environment | DOF: | Department of Finance | DOC: | Department of Construction |
| MOIT: | Ministry of Industry and Trade | DAE: | Department of Agriculture and Environment | DOST: | Department of Science and Technology |
| MOC: | Ministry of Construction | | | | |

## 4.3 Financial resources

At present, there are no published studies on the financial resources for urban cooling solutions in Viet Nam. Several urban cooling solutions are currently being implemented individually, based on various funding sources.

Official Development Assistance (ODA) funds from development partners are often used to sponsor research, policy evaluation and improvement, and the implementation of pilot projects. For instance, GIZ has sponsored a pilot project for green wall & green roof solutions at the Public Service Management Building in Dong Hoi City, Quang Binh province. In relation to urban cooling indirectly, ODA funds are also used by provinces to develop the environment and urban infrastructure to cope with climate change; for example, the ADB has provided a loan of 83,299 billion VND to Quang Binh province for the aforementioned purpose.

State budget resources are used to invest in public projects, which contribute to overall green growth, such as urban tree planting, public awareness raising, capacity building, etc.

Private capital is primarily invested in private buildings (such as hotels, hospitals, commercial buildings, etc.) that integrate energy efficiency solutions and construct some green buildings.

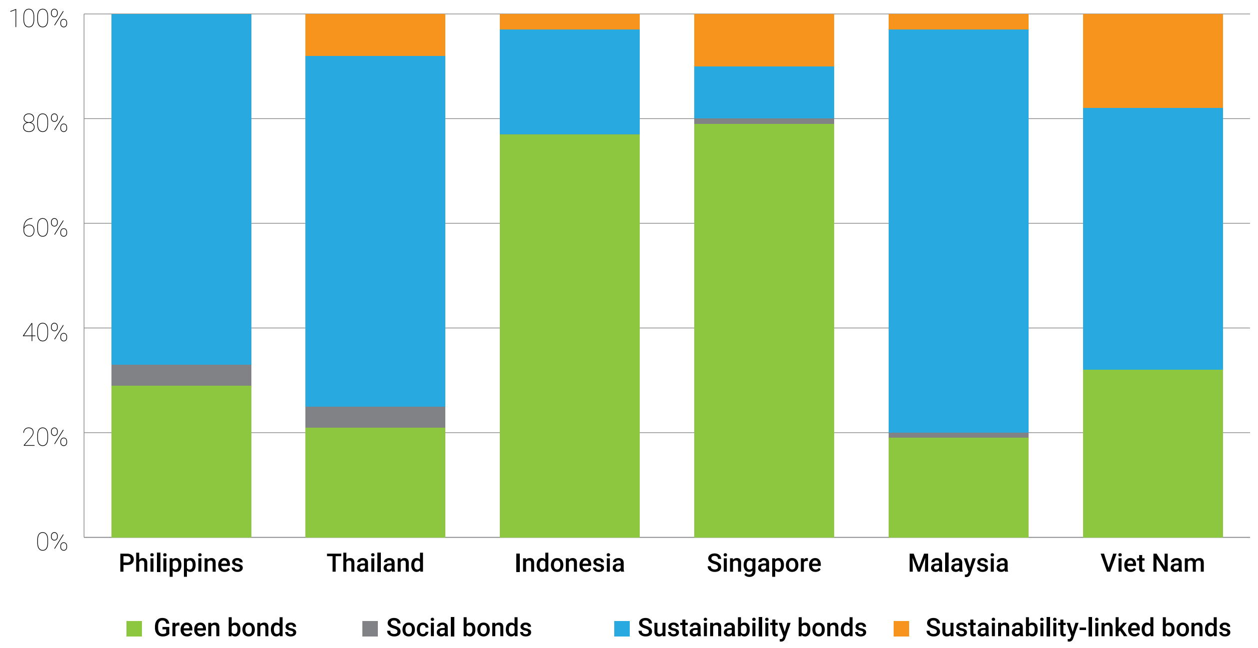
- In the realm of capital mobilisation for green/energy efficiency projects, various options are available both in Viet Nam and globally:
- Traditional Loans: Typically constrained by limited availability and high interest rates, attributed to banks' unfamiliarity and inadequate assessment of cooling projects. Projects often remain small and fragmented, incurring high evaluation costs.
- Energy Saving Revolving Fund: As exemplified in Thailand, this fund, backed by the government, extends 0% interest loans to commercial banks for energy-saving endeavours.
- ESCO Model: ESCOs invest in energy-efficient systems and share benefits with property owners.
- Carbon Finance: Presents economic prospects through the sale of carbon credits in energy efficiency ventures.
- Blended Finance: Combining risk mitigation mechanisms and credit enhancements to allure investments from both banks and private sectors.
- Green/Sustainable Bonds: Offering prolonged loan terms and potentially favourable interest rates, specifically tailored for green and sustainable initiatives.

The Risk Sharing Facility (RSF) mechanism, implemented through The Viet Nam Sustainable Energy Efficiency Industry Project (VSUEE), facilitated by the Green Climate Fund via the World Bank and managed by the Ministry of Industry and Trade, holds significant promise. With a budget totalling USD 11.3 million, its objective is to foster Viet Nam's industrial energy-saving market by providing credit guarantees. RSF, encompassing a total of USD 75 million, extends guarantees for loans dedicated to energy efficiency projects by industrial enterprises or ESCOs.

In the domain of Green Bonds, the Ministry of Finance, working with the Ministry of Agriculture and Environment and related ministries and agencies, developed the legal framework including the Laws and Decrees (Environmental Protection Law, Decree No. 08/2022/ND-CP detailing a number of Articles of Environmental Protection Law and other Decrees on bond issuance), facilitating the green bond market development. The Ministry of Finance also issued Circular No. 101/2021/TT-BTC on November 17th, 2021, promulgating service fees in the securities sector to be applicable at the Stock Exchanges (SEs) and VSDC, including incentives for green bonds (50 percent reduction of service fees for listing registration, trading, securities registration, and partial cancellation of securities and securities depository). EVN Finance issued green bonds valued over VND 1.7 trillion in 2022, primarily to bolster green energy in Viet Nam. Similarly, BIDV's successful issuance of VND 2.5 trillion in green bonds in 2023 aims to finance various green, energy-efficient, emission reduction, and environmentally friendly initiatives. At the beginning of December 2024, Vietcombank successfully issued VND 2,000 billion in green bonds to finance projects in the environmental protection sector and projects that provide environmental benefits. Among these, energy efficiency projects are also included in the list of eligible projects for funding.

**Figure 13: Composition of GSS bonds in select ASEAN members**

*(Source: AsianBondsOnline)*




Despite the potential, the ESCO market remains underdeveloped, due to barriers such as limited financial capacity, inadequate understanding and trust in energy efficiency benefits, and a dearth of supportive financial policies.

***The Viet Nam Environment Protection Fund (VEPF)*** operates as a national environmental protection fund and a state financial organisation under the Ministry of Agriculture and Environment. The VEPF's primary functions include providing preferential loans, financing, and interest support for projects related to environmental protection and climate change adaptation that are not covered by the state budget. The charter capital of the VEPF is allocated from the state budget. Projects eligible for preferential loans from the VEPF encompass a range of environmental initiatives, including energy efficiency projects. However, it is noteworthy that, to date, no energy efficiency projects have been included in the actual list of projects supported by the VEPF.

### 4.3.1 Demonstration and pilot projects

Demonstration and pilot projects are valuable tools for addressing these barriers, attracting funding, and building market confidence in sustainable urban cooling solutions. City governments, independently or in partnership with businesses and non-profit organisations, can model and test specific cooling technologies and extreme heat mitigation strategies. These projects can evaluate the effectiveness of cooling approaches in local microclimates and gather public feedback. Pilot projects also provide measurable cooling benefits, and effectively communicate findings can enhance public awareness, convey lessons learned, and make replication more feasible.

By showcasing the energy performance and benefits of efficient buildings and technologies, demonstration projects help instil market confidence, send strong demand signals, and catalyse broader adoption of sustainable urban cooling solutions. These projects not only highlight the feasibility and advantages of sustainable cooling practices but also inspire policy and private sector action, influencing wider adoption of sustainable cooling practices.

Considering this, a list of potential pilot zonal and standalone building projects has been identified for the city of Can Tho, encompassing scales ranging from zonal and neighbourhood levels to individual buildings. These projects include both greenfield developments, where planning is still in progress, and brownfield sites, involving existing communities or buildings.

The identified projects target areas with significant heat hotspots, including residential neighbourhoods, commercial districts, industrial zones, and public buildings across the city. Each pilot project is accompanied by a detailed description, highlighting its scope and objectives. Additionally, potential technologies such as landscaping, passive cooling, and active cooling solutions are outlined alongside business models for further in-depth analysis and implementation planning.

### 4.3.2 Zonal pilot projects

Based on the initial analysis of the urban planning in Can Tho city till 2030, there are several neighbourhoods across the city with either high population density or building/construction density. Following potential demonstration sites are outlined for further analysis:

1) Ninh Kieu: traditional CBD with some new development till 2030
2) Cai Rang and Tra Noc: mix-use residential zones
3) O Mon: new development for residential zone

**a) Focused areas for climate resilience to improve outdoor thermal comfort**

On the basis of remote sensing analysis on 10-year surface temperature data, there are several hotspots with higher surface temperature compared to nearby zones across in Can Tho, including:

1) Cai Son – Hang Bang – Hong Phat neighbourhood
2) 91B neighbourhood
3) Cai Khe – Can Do – Mien Tay neighbourhood
4) Cai Khe – Thuy Duong Commercial – Service – Residential Complex
5) Van Hoa Tay Do neighbourhood
6) Hong Loan neighbourhood
7) Nam Long neighbourhood

Most of these residential areas have low-rise housing with height of less than 15m, high-rise housing or social housing, and normally contain schools and other mix-used facilities.

**b) Focused areas for district energy systems in industrial parks**

Through desk-top investigation, local stakeholders' consultation and on-site investigations, there are several existing and/or newly established industrial parks (IPs) which are identified to implement district cooling systems for higher energy efficiency and cost-effectiveness in cooling. These industrial parks include:

1) Thot Not IP
2) Mon IP
3) Bac O Mon IP
4) Hung Phu 1 IP
5) Vinh Thanh IP or Viet Nam-Singapore IP

However, because of the diversified industrial types (e.g. milk processing, cold storage for fruits and food etc.) in these parks, the cooling needs may be different in terms of temperature, press, time and type.

### 4.3.3 Standalone-building pilot projects

For all the recommended pilot projects, analysed or estimated results on both financial and non-financial benefits are presented. The detailed pilot project list is provided in Annex 8. The city government has taken a significant step toward implementing sustainable cooling practices by selecting one project from this list for an in-depth pre-feasibility analysis and another project as a duplicating project. This initiative marks the first step in translating plans into actionable solutions. A letter of endorsement from the Department of Agriculture and Environment of Can Tho City, confirming this commitment, can be found in Annex 9.


Photo: A typical street of Can Tho
Credit: Istock

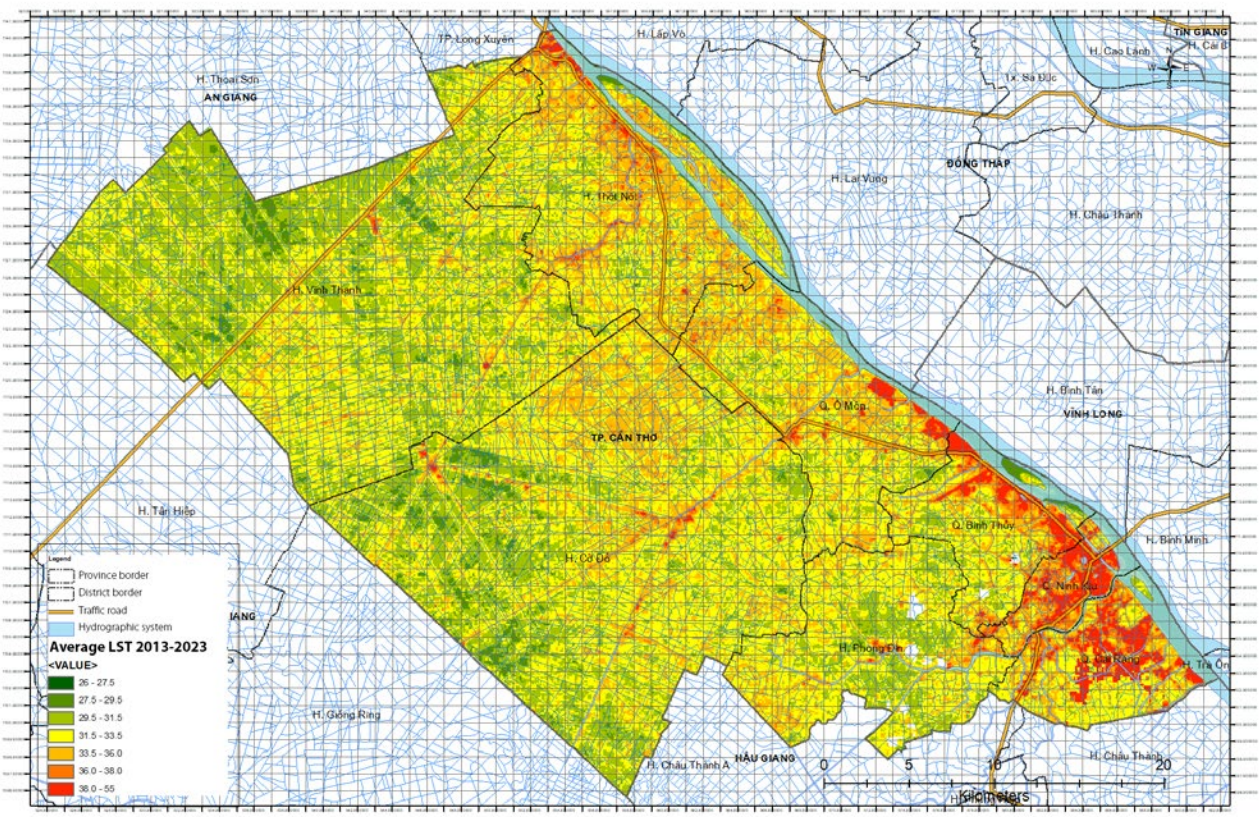
# 05 URBAN HEAT ISLAND AND OUTDOOR THERMAL COMFORT EVOLUTION AT URBAN AND NEIGHBOURHOOD LEVEL

## 5.1 Pan-city UHI profile assessment

The UHI pattern observed with mean land-surface temperature distribution was captured for a dry season (March to May) in the ten-year period of 2013 - 2022. Figure 14 shows the spatial distribution of surface temperature during the daytime (at around 10.00 a.m. as the operation time of NASA satellites) over the entire city of Can Tho. The results indicate a considerable deviation of surface heat between city downtown or urbanised parts and rural districts, where more intense heat was observed in the urban parts while much lower exposure to heat was seen in the rural areas.

It is clear from the surface temperature map that the strong intensity of UHI with higher surface temperature was found in Ninh Kieu district and strongly urbanised parts of other districts (Cai Rang, Binh Thuy) with dense built-up areas as well as highly paved surfaces. The maximum average surface temperature was recorded exceeding 38°C. In contrast, the outskirt with a higher amount of vegetation and water, and lower built density experiences more pleasant surface temperatures varying from 29 to 33°C.

**Figure 14: Spatial distribution of average land-surface temperatures over the city of Can Tho for the period of 2013-2023, captured at 10.00 am during the dry season (March to May)**



Further analysis of land-surface temperature distribution in the central districts as hot spots were shown in Figure 14. The intensified UHI at the urban districts can be explained by a higher number of built-up areas with reduced vegetation cover, which leads to higher surface temperature over these areas compared to rural parts.

In addition to the analysis of land-surface temperature distribution, the distribution of vegetation and building cover was studied in order to identify the correlation between these factors and land-surface temperature. Accordingly, visualisation of Normalised Vegetation Difference Index (NVDI), Normalised Building Difference Index (NDBI) were developed. The analysis showed that considerably low NVDI falling below 0.3 was observed in the city downtown (Ninh Kieu), and this index was elevated by moving further away to the outskirts where vegetation index may go up to 0.5. In fact, a higher percentage of green spaces was also observed in the rural districts (70%) in comparison with less than 10% as observed in the urban districts. On the contrary to the spatial variation of NVDI, the NDBI pattern was highlighted with a city-ward increase trend, where the index which stayed around -0.1, was significantly higher in urban high-density district of Ninh Kieu while it was lowered to -0.35 in the surrounded parts, even in the urban districts including Cai Rang, Binh Thuy, O Mon and Thot Not. Figure 15 and Figure 16 show the contrasting influences of increased vegetation and built-up areas on LST. Enhanced vegetation cover is associated with lowered LST while higher amount of built-up space will lead to higher LST. The distribution of NDBI may be attributed to the huge difference of built density among the districts of Can Tho, where only Ninh Kieu as a central business district experienced a strong spatial densification while the evolution of urban growth in other parts was still going.

**Figure 15: Spatial Distribution of Average Land Surface Temperature in Can Tho City for 2015, 2020, and 2023, and an 11-year period of 2013 -2023 captured at 10:00 AM during the dry season (March-May)**

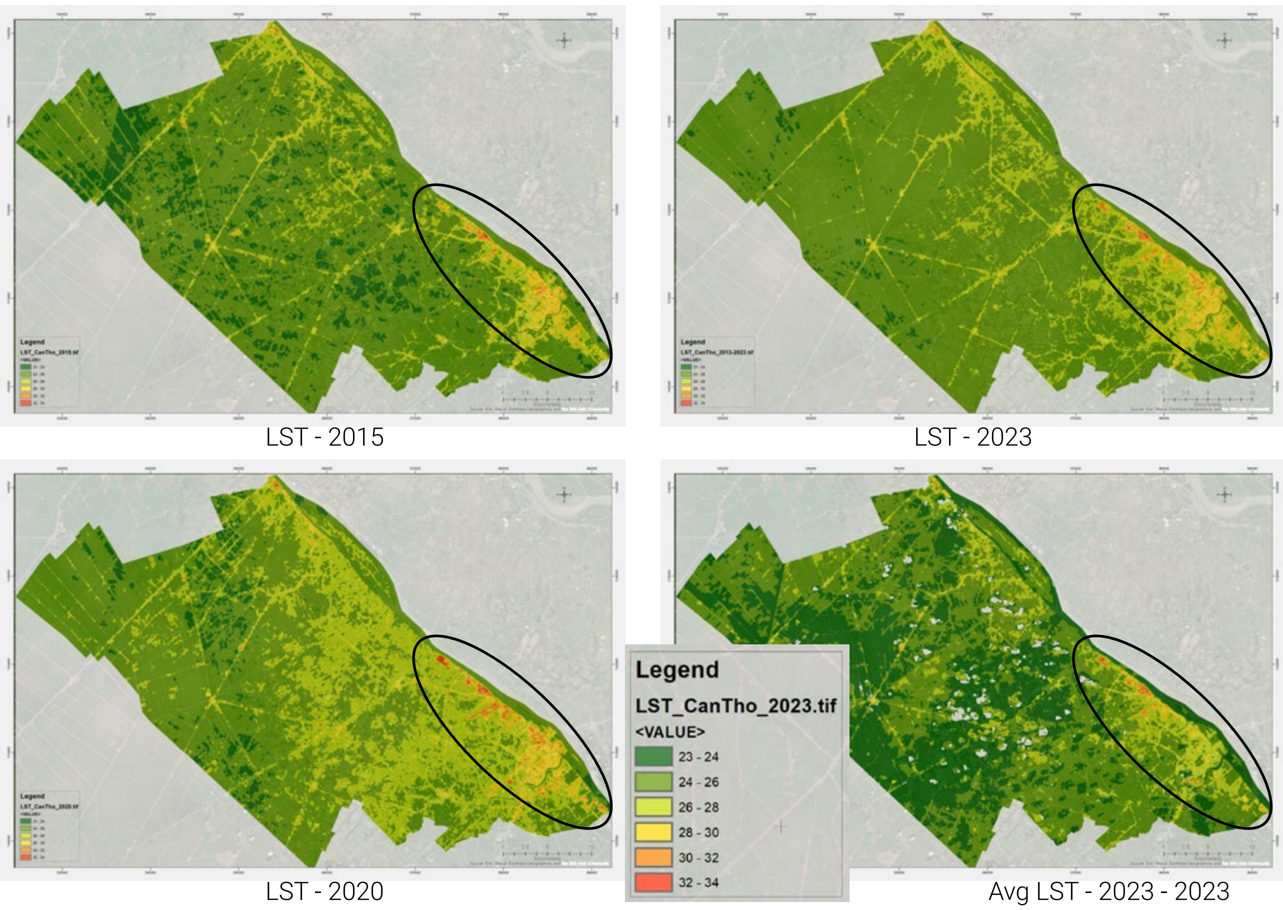
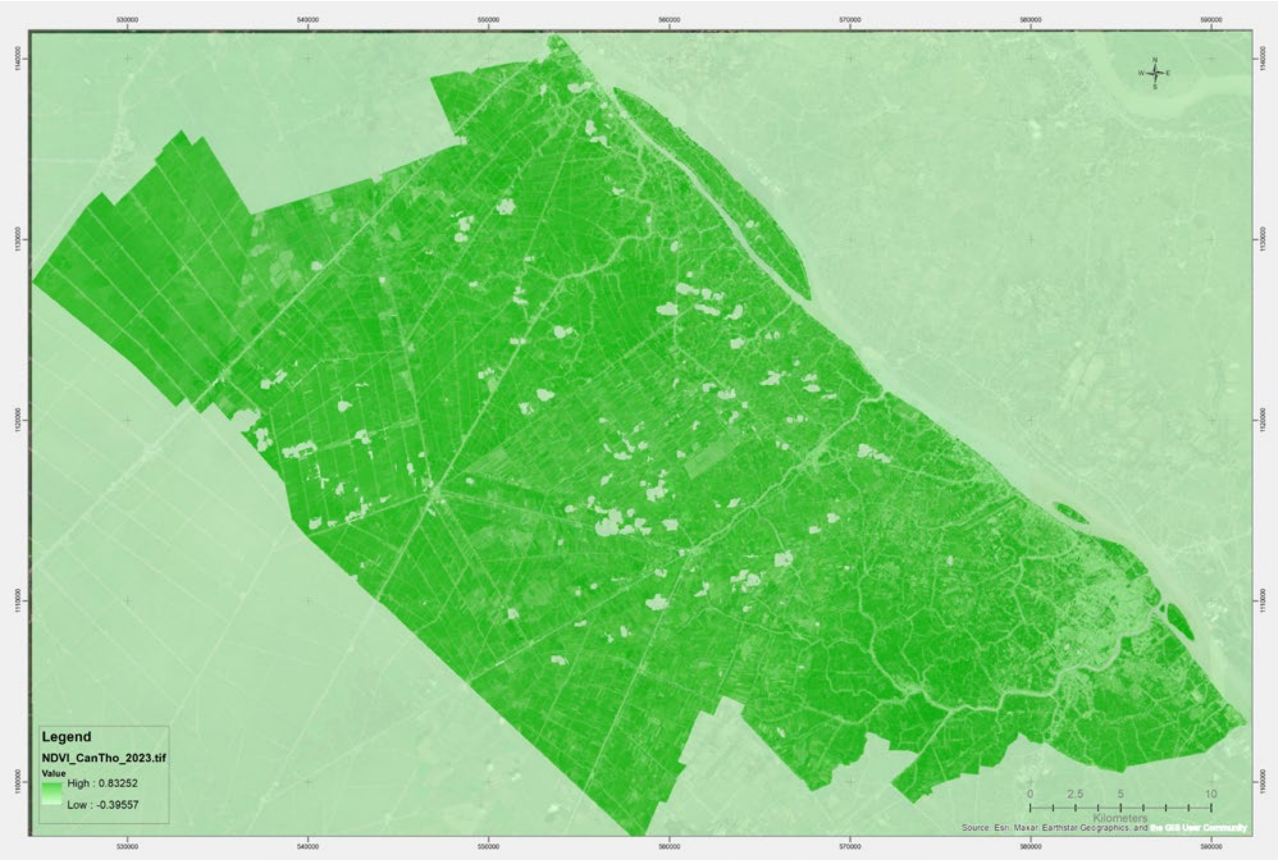


**Figure 16: Distribution of Normalised Vegetation Difference Index (NVDI) over the entire city of Can Tho in 2023 captured at 10.00 a.m. during the dry season (March-May)**




However, a particularly higher NDBI was still captured in the central parts of Binh Thuy and Cai Rang, where the mean NDBI was estimated at over -0.2 due to highly paved surfaces in the administrative and residential neighbourhoods as well as industrial zones, in reference to those staying around -0.3 in other rural parts thanks to vegetated and agricultural surfaces. A comparative summary of mean NDBI and NVDI during a 11-year period of 2013-2023 among urban and rural districts is shown in Table 11.

**Figure 17:** **Distribution of Normalised Building Difference Index (NDBI) over the entire city of Can Tho in 2023 captured at 10.00 AM during the dry season (March-May)**

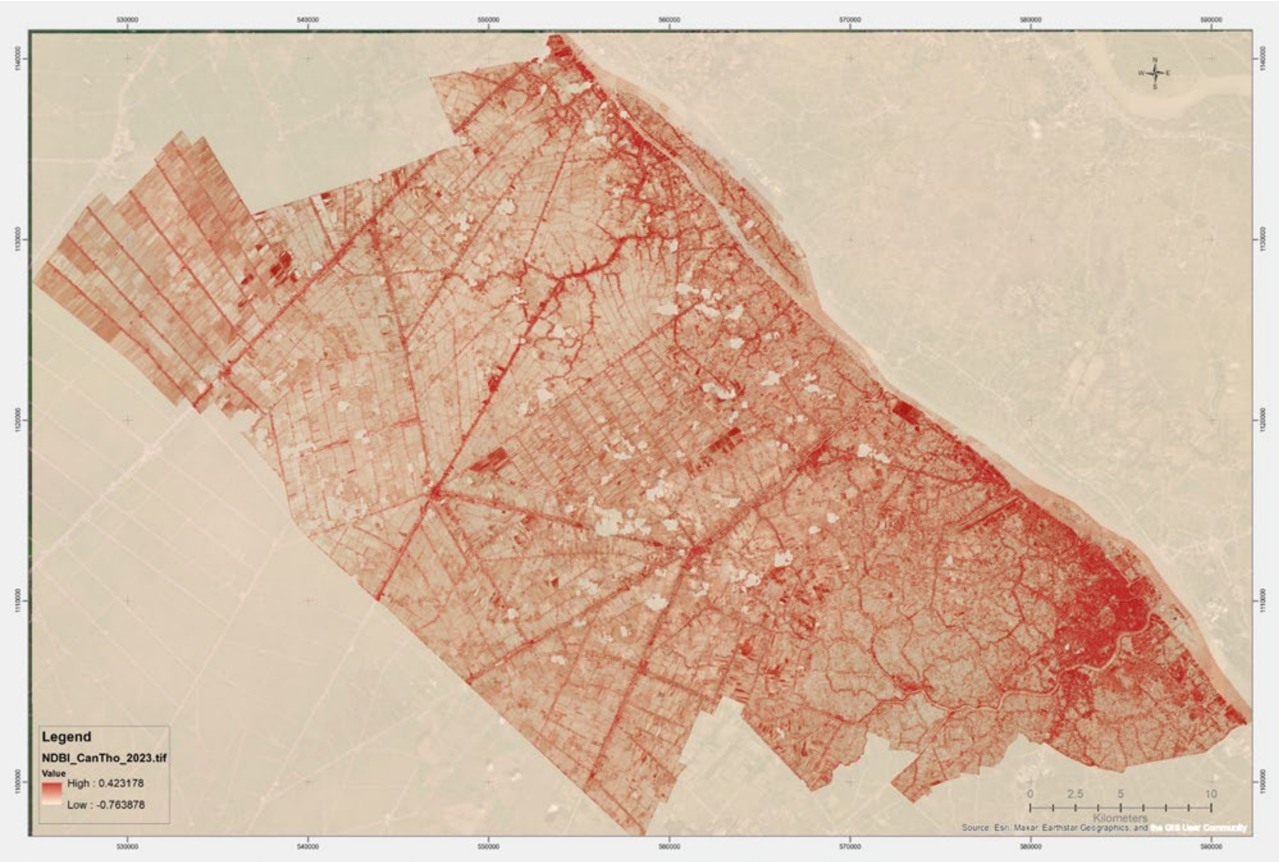



**Table 11:** **Comparison of NDBI index observed in urban and rural districts of Can Tho during the period of 2013-2023**

| District | Mean NDVI | Mean NDBI |
|---|---|---|
| Ninh Kieu (Urban) | 0.247904 | -0.121502 |
| O Mon (Urban) | 0.453203 | -0.269494 |
| Binh Thuy (Urban) | 0.377431 | -0.239443 |
| Cai Rang (Urban) | 0.395746 | -0.247231 |
| Thot Not (Urban) | 0.383394 | -0.271598 |
| Vinh Thanh (Rural) | 0.567513 | -0.343725 |
| Co Do (Rural) | 0.530069 | -0.334185 |
| Phong Đien (Rural) | 0.555058 | -0.307537 |
| Thoi Lai (Rural) | 0.537347 | -0.328272 |

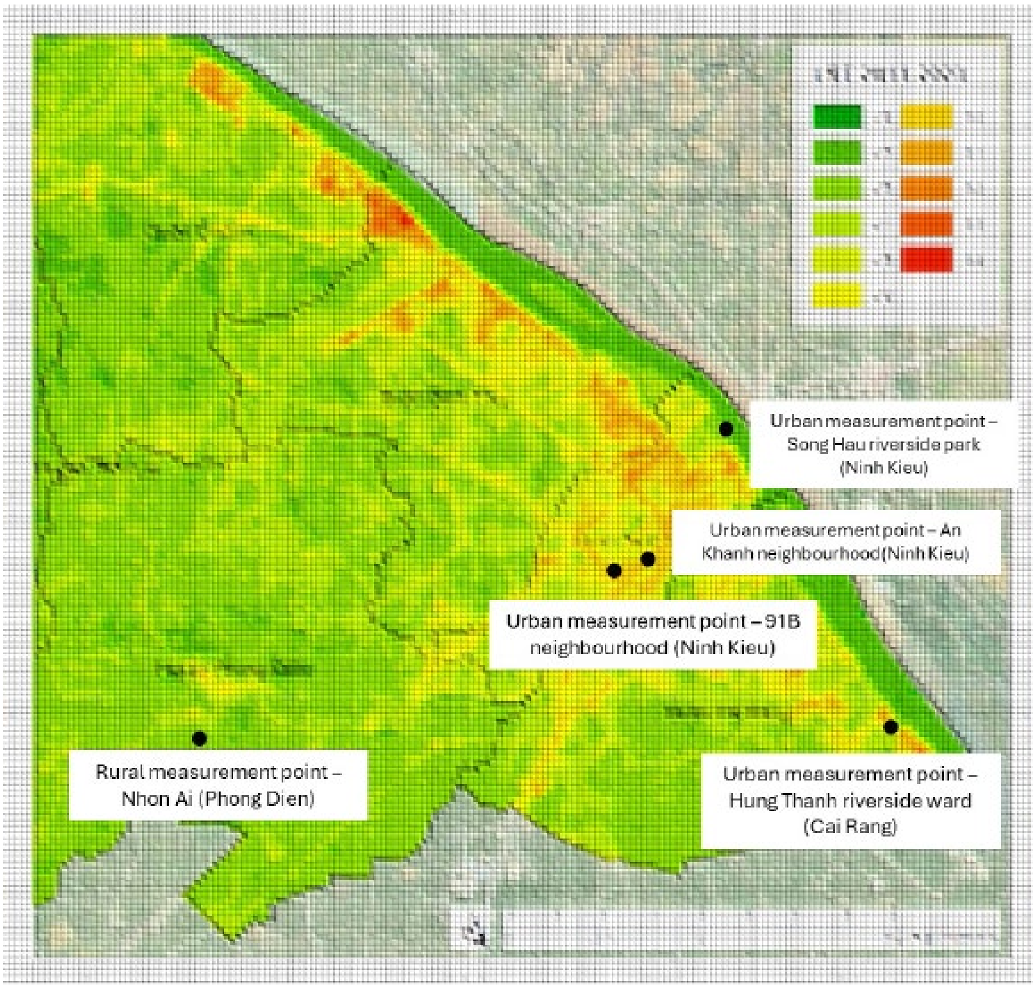
It implies the strong correlation between high surface temperature with density of hard unshaded surfaces (concrete, brick, asphalt, stone), and urbanisation results in the expansion of heat-exposed areas. The sub-urban parts have been and may still be less prone to higher land-surface temperature unless urban expansion is carried out. Detailed relation between mean land surface temperature and NVDI as well as relation between mean land surface temperature and NDBI is provided in Annex 5.

The analysis of pan-city UHI profile was a concrete basis for further study with monitoring and simulation of heat level over the city. From the city-level UHI study, typical hotspots are located in the downtown of Ninh Kieu, and rural districts e.g. Phong Dien and are considered as a potential location for evaluation of UHI intensity as well as intra-urban thermal comfort.

## 5.2 On-site measurement of Microclimate and Outdoor thermal comfort

This section describes the main results from the measurement campaign and highlights the UHI intensity deviation among urban and rural areas of Can Tho. More details of the sampling points selection, and the measurement campaign including the used devices, the observation periods can be found in the Annex. Location of measurement points were pinned on a map shown in Figure 18.

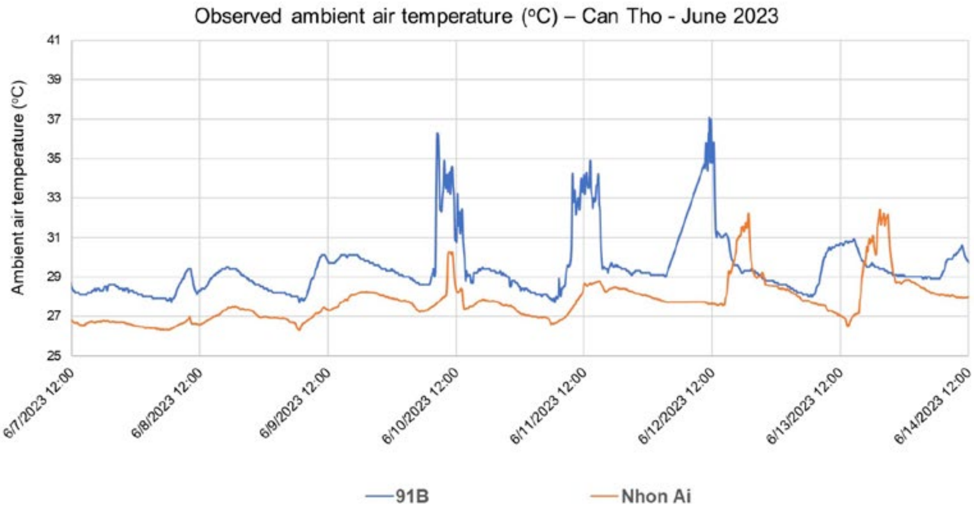
**Figure 18: Locations of sampling points for the measurement campaign in June 2023 in Can Tho**



The two most typical areas that were observed during the measurement campaign were (1) 91B residential area and (2) Nhon Ai rural ward of Phong Dien rural district. These locations represent the strongly urbanised hot spot and low built density respectively. The measurement campaign was designed for a 7-day summer and dry-season period that lasted from June 7th to 14th 2023.

Used sensors were KESTREL 5500 (for measurement of wind velocity and direction), HOBO MX1203 (for measurement of air temperature and relative humidity), and WBGT 2010SD (for measurement of globe temperature).

**Figure 19: Temporal variation of ambient temperature at the two selected measurement points: 91B neighbourhood and Nhon Ai rural ward, observed from June 7th to 14th 2023**




**91B – Urban site**

**Nhon Ai – Rural site**

Figure 19 reveals the temporal variation of ambient air temperature observed at the selected sites from June 7th to 14th 2023. It is clear that the urban area experienced a considerably higher all-day temperature compared to the rural site. The maximum temperature difference during the daytime was recognised at 6°C, while diurnal temperature deviation fell around 4°C. Highest temperature was normally observed at noon and early afternoon at both locations. The monitoring results indicate a real heat impact by urbanisation with densified built density and increased building height that prevent nocturnal heat escape and trigger diurnal heat absorption. Lowered temperature in the rural area highlighted great benefits of tree shades and large running water body that characterise the sub-urban neighbourhood typology.

The on-site monitoring was in high agreement with the pan-city UHI profile, where strongly urbanised areas experienced higher temperatures. With the on-site measurement, a clear nighttime UHI effect was also found in Can Tho, highlighting the necessity to improve development plan especially for the periphery and rural parts to avoid the deterioration of thermal condition.

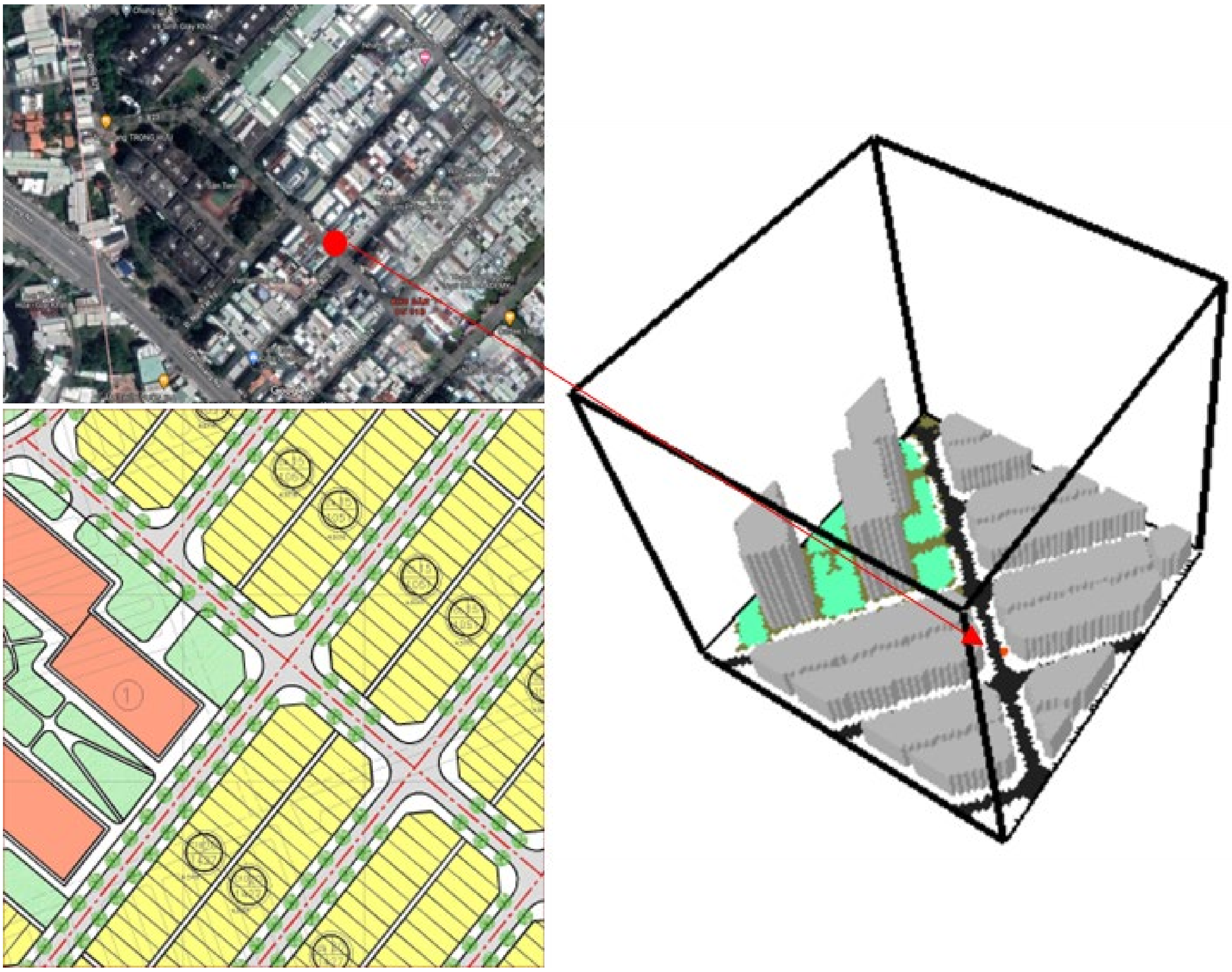
The monitoring was helpful to evaluate the ground-level thermal condition at the representative locations and will be useful to depict the intra-urban thermal comfort level over the city. However, due to limited human and equipment resources, it is still needed to further study the spatial variation of thermal parameters in order to examine the effect of urban design. Therefore, a computational approach with ENVI-Met models was exploited for this analysis.

### 5.2.1 Prediction of UHI trends due to urbanisation

This section describes a simulation study about the effect of urbanisation on thermal conditions. In this analysis, ENVI-Met, a 3D simulation software on urban microclimate was used to estimate the thermal parameters under effects of different urban contexts. The climate inputs for simulation were obtained from the measurement data on June 13th, 2023, around the studied area.

At first, a domain as a part of 91B residential area (Khu dan cu 91B) was selected for this study as shown in Figure 18. The domain covered a 150x150-m area, and its spatial condition was reproduced in an ENVI-Met model configured with 3x3-m spatial resolution. Figure 18 (right) illustrates the ENVI-Met model of the studied domain. The simulation was planned for 24-hours, starting from 5.00 a.m. of June 13th to 5.00 a.m. of June 14th, 2023. Through this simulation, it was found that the estimated air temperature and relative humidity were reasonably deviated from the observed one, which implies that ENVI-Met model is a reliable one for coming study on the impacts of urban development on thermal conditions in Can Tho.

**Figure 20: Description of the simulated domain**



To evaluate the thermal condition and comfort level, Physiological Equivalent Temperature (PET) was used as an indicator. In the hot-humid climate as of one recognised in Can Tho, the scale that links the thermal sensations to the values of PET is as follows: slightly cool for 20 – 24oC, neutral for 24 – 30oC, slightly warm for 30 – 34oC, warm for 34 – 38oC, hot for 38 – 42oC, and very hot for PET above 42oC.

Figure 21 gives diurnal spatial variation of PET of two urban contexts: before and after the implementation of plan of 91B residence. The analysis reveals PET is elevated by 2°C in the planned scenario (right side) due to the presence of low-rise residential buildings, if compared to the original context (left side) that was highlighted with a large cover of grass and small canals.

**Figure 21:** **Spatial variation of diurnal PET, captured at 15.00 on June 13th, 2023**

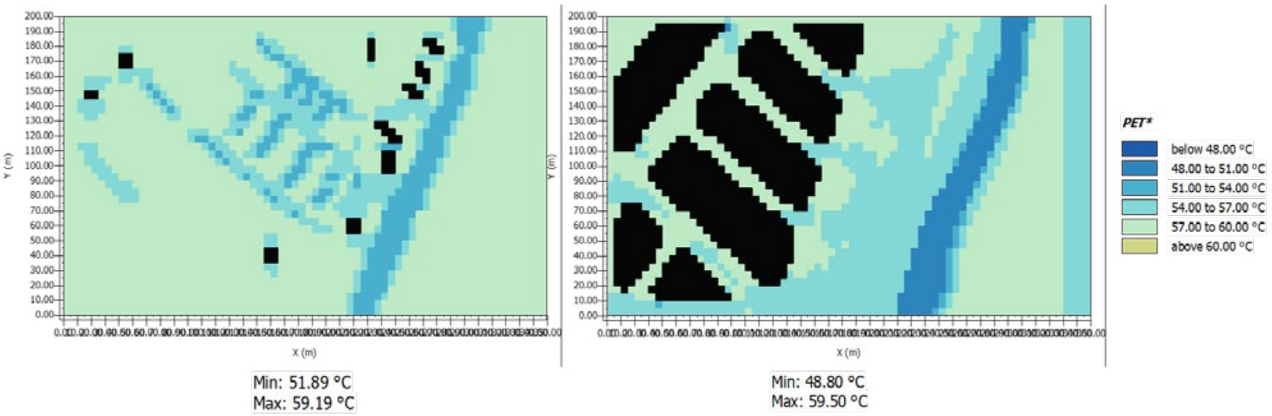
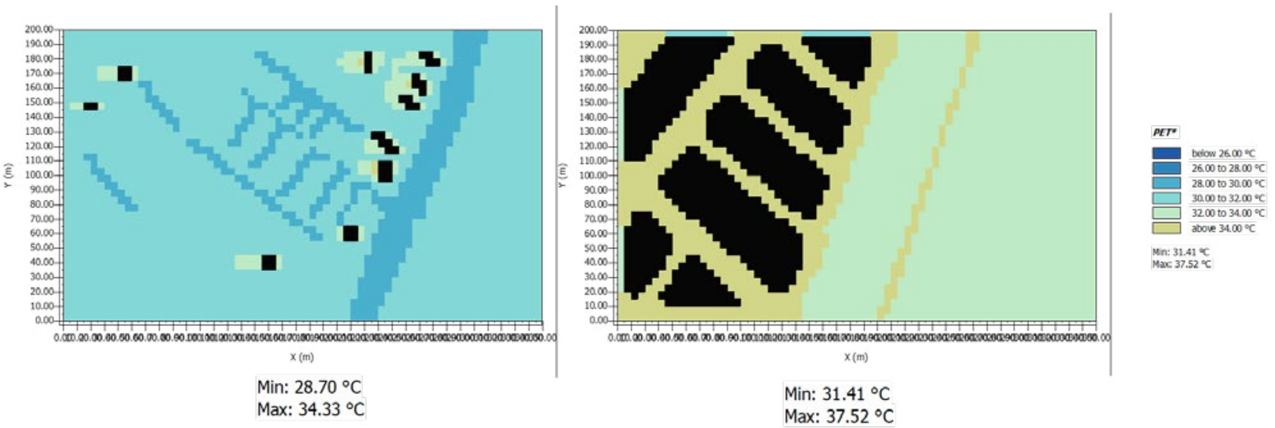



Figure 22 presents nocturnal spatial variation of PET estimated in these two urban contexts. The nighttime effect of urbanisation was further elevated, where PET values of above 54°C were observed in the built-up areas, while only maximum PET of 32°C was observed in the canal and grassland in the original landscape.

**Figure 22:** **Spatial variation of nocturnal PET, captured at 20.00 on June 13th, 2023**



## 5.3 Evaluation of heat stress mitigation measures

The studied area spans a 300x300-m surface in the considered neighbourhood in Can Tho that contains several rows of buildings of various heights. The ENVI-Met model reproduces the spatial development scheme following the original master plan of the selected neighbourhood. A grid resolution of 3x3-m relevant to the simulation of OTC was applied for this area. This considered quarter represents a typical morphology of new urban blocks that are formed with parallel rows of single-family attached houses. All buildings were assumed as 12-m height, an equivalent height of four stories, with an aspect ratio (H/W) varying between 0.25 and 1. The main street orientation as planned is in the NE-SW axis. To completely remove the boundary effects at the edge of the considered area, only computational results falling within the frame shown in Figure 23 (on the right) are considered.

In addition to the base proposal, several other scenarios are introduced by adjusting the orientation, aspect ratio and vegetation in the area of interest. Similar ground and building materials are applied in all the considered cases. All the proposed scenarios, from 1 to 3 and excluding the base case, are vegetated with higher tree density and higher plants. The proposition of urban trees' height and plan interval was completely in compliance with the city's regulation on the management of urban park and trees, issued in the Decision 15/2012/QĐ-UBND dated June 28, 2012. The high trees on the studied streets were also placed at least 5 meters from the edges of all street-crosses to ensure mobility safety[25]. Furthermore, the selected values for tree's height and planting interval are 15 and 12 meters respectively. Furthermore, the height of 15 meters is a relevant and common value for urban trees and does not cause obstruction and danger for the traffic operations, which is allowed in the National instruction into the development and management of urban tree system issued in the Circular 20/2009/TT-BXD by Ministry of Construction dated in June 30th 2009[26].

Considering the official category of trees that should be prohibited and restricted in urban areas of Can Tho city as stated in the Decision 3263/QĐ-UBND dated October 25, 2016[27], the recommended trees are Dipterocarpus crinitus (*in Latin: crinitus*), Mango (*in Latin: Mangifera indica*), Golden oak (*in Latin: Hopea odorata*) that well suit the tropical climate and urban landscape. Recommended suitable urban trees for improving thermal comfort in Can Tho can be found in Annex 10.

The impact of street vegetation will be analysed in-depth by comparing non-vegetated and vegetated cases of low-rise attached buildings and high-rise apartments which are both located in NE-SW orientation. In this study, vertical green surfaces along buildings' facades were not considered.

25 Thông tư 20/2009/TT-BXD sửa đổi 20/2005/TT-BXD quản lý cây xanh đô thị mới nhất

26 Thông tư 20/2009/TT-BXD sửa đổi 20/2005/TT-BXD quản lý cây xanh đô thị mới nhất

27 Quyết định 3263/QĐ-Danh mục cây cấm trồng, cây trồng hạn chế trong các đô thị Cần Thơ 2016

**Figure 23: Visualised description of studied scenarios**

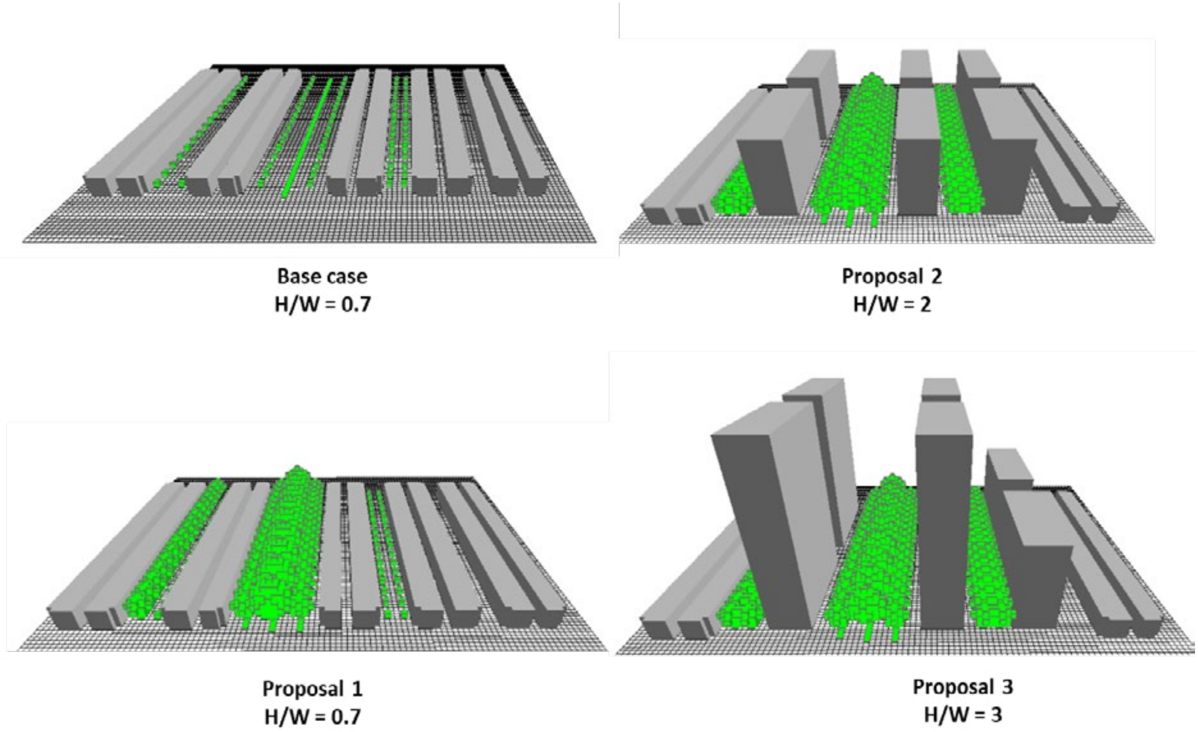



Figure 24 shows the spatial variation of PET at 15.00 on June 13th, 2023, over the simulation domain. In these graphs, three aspect-ratio scenarios named as Proposal 1 (P1), proposal 2 (P2) and proposal 3 (P3) are compared. A general conclusion is that variation of the aspect ratio has a real impact on the spatial distribution of PET values. The results indicate the close relation of PET variation to building shadow geometries: the higher buildings in P2 and P3 generate expanded shadows for sufficient sheltering, but P1 fails to provide shades to pedestrians.

**Figure 24: Spatial distribution of PET in the examined scenarios captured at 15.00 of June 13th, 2023**

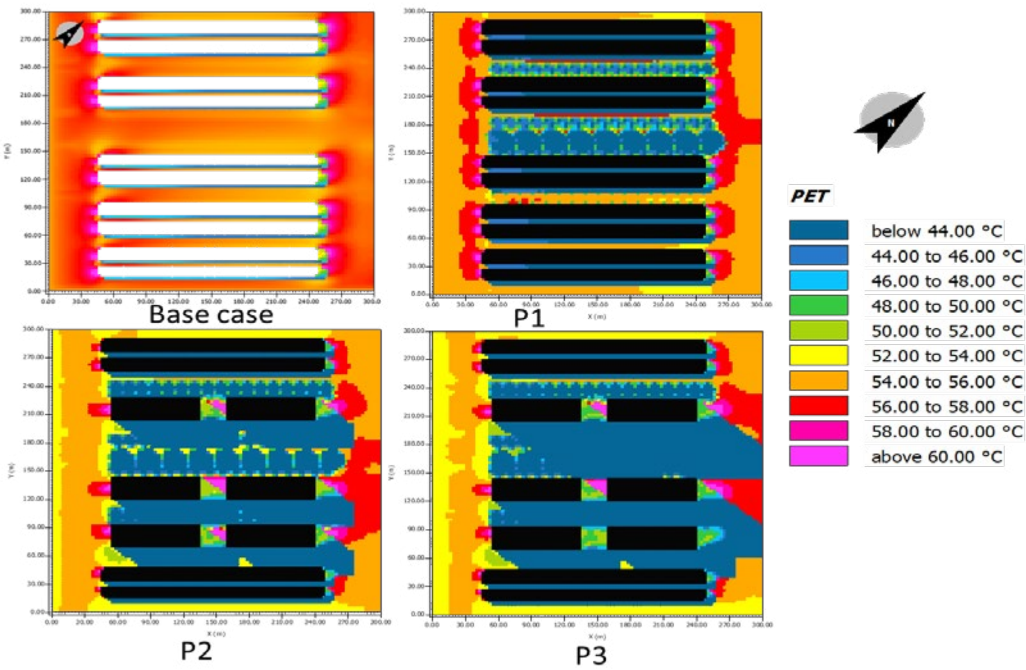
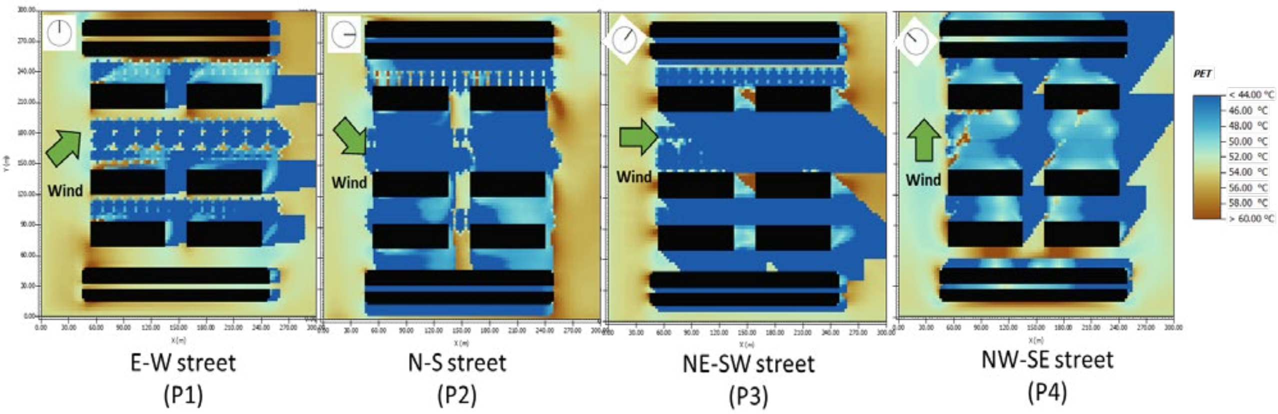


**Figure 25: Spatial distribution of PET in the examined street orientations captured at 15.00 of June 13th, 2023**




The influence of street orientation on OTC is assessed through the variation of median hourly PET values for the same aspect ratio as shown in Figure 25 for the P2 and P3 scenarios. In general, street orientation considerably affects PET during the daytime period, between 8.00 until 17.00 due to the increase of solar altitude angle and the difference of building shadow generated by differently directed streets, whereas nocturnal OTC is less sensitive to the directional factor. The street orientation clearly deviates PET values of all studied cases during the period 8.00 - 17.00 when strong solar radiation is present. In early morning hours i.e. before 8.00 and during the evening and at night-time, the difference of PET among scenarios is less noticeable.

Findings from the study of potential measures indicate that the most effective strategy for heat mitigation is enhancing shades from high trees and buildings, especially at pedestrian level. Modifying the street aspect ratio and increased placement of street high trees are effective solutions to trigger the reduction of PET or improve the thermal comfort.

The other effective strategy is to increase but maintain the wind speed at the limit of 2.5 m/s. This can be realised by a proper plan of street orientation that facilitates wind movement and avoids block effects at wind-lee buildings' sides. The preferred orientation is expected to be parallel or slightly obliqued (up to 15°C) to the prevailing cool wind direction.

## 5.4 Prediction of future heatwaves and socio-economic impacts

This section describes the analysis of current and future heatwaves based on the historical meteorological data (2011-2020) and CORDEX-based downscale weather files of the Southeast Asian region. The analysis considers mid-term (2041-2060) and long-term (2081-2100) for predicting heat events.

**In this analysis, the heatwave was characterised with the following criteria:**

- **Max Temperature (in °C):** It is the maximum daily mean temperature of the heatwave
- **Severity (in °C days):** It is a cumulative temperature above the 97.5 threshold (97.5 quantile of the temperature distribution during the historical period)
- **Intensity (in °C)**: Maximum daily mean temperature °C reached during the heatwave.
- **Duration (in days):** The number of days a heatwave persists

Figure 26 shows the evolution of maximum mean daily temperature from historical to long-term future periods. From the analysis, it can be drawn that the heatwave is increasingly intensified with elevated daily mean temperature. The highest impact was observed in the future long-term in the most intense scenario. The maximum mean temperature may approach 36°C, rising by more than 2°C in reference to the historical period while for the mid-term, it is approximately 34.2°C.

Figure 27 shows the evolution of estimated heatwave duration from historical to long-term future periods. In a similar trend with the mean temperature, the heatwave is expected to be elongated by almost 6 times, which increases the number of heatwave days to approximately 120 if compared with 20 days in the present time considering only severity (most severe heatwave), and it will be increased if severity with duration and intensity is considered, which may come up to ~280 days.

**Figure 26: Evolution of historical and future heatwave in terms of maximum daily mean temperature**

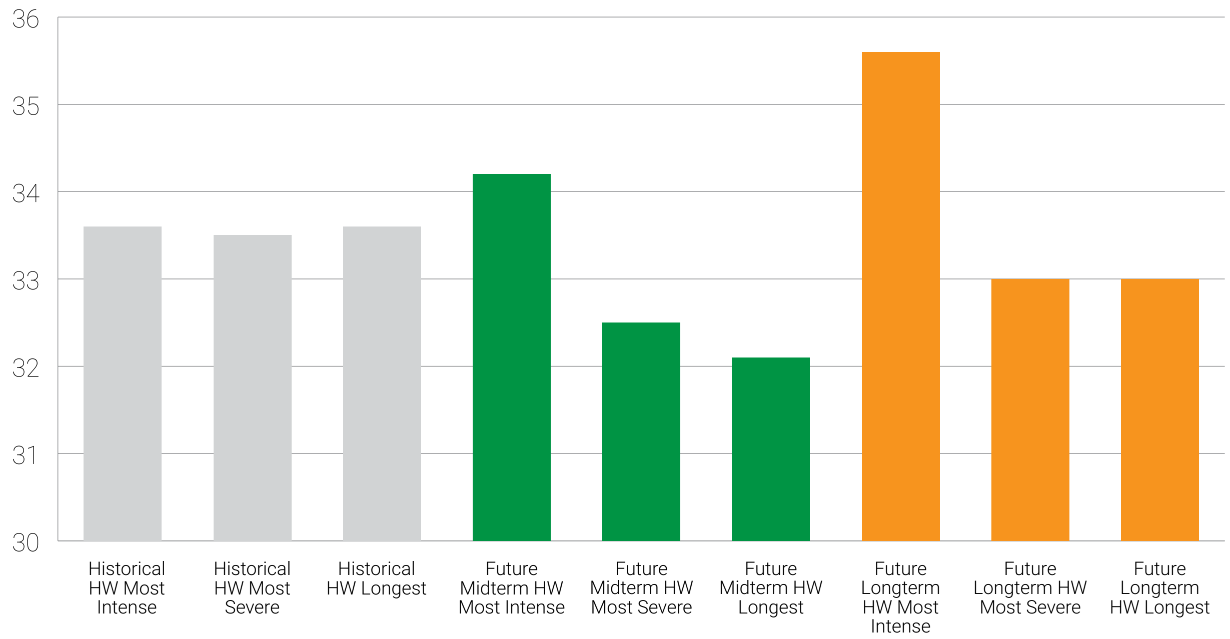
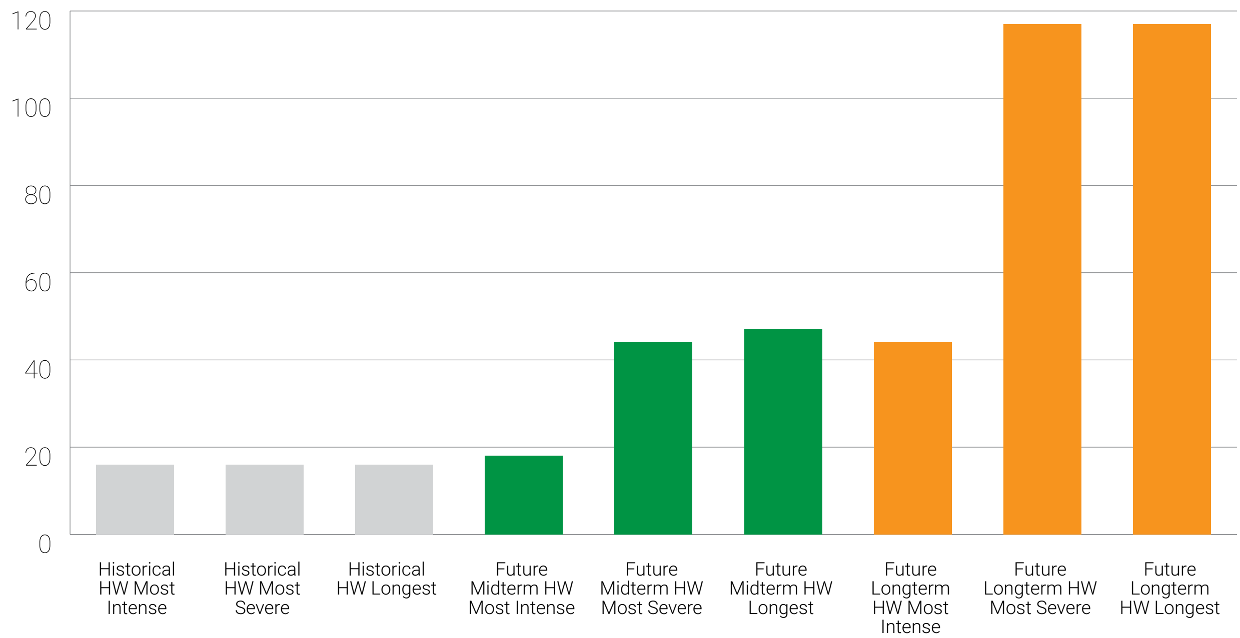



**Figure 27: Evolution of historical and future heatwave in terms of maximum daily mean temperature**



Such events will strain the residents, impacting the socio-economic landscape. A recent study by the German Red Cross highlighted several impacts of heat events on the socio-economic condition in Viet Nam as follows.[28] More than 35% loss in productivity among outdoor workers was observed in Da Nang leading to significant economic and labour efficiency repercussions. Similarly, a 20% increase in hospitalisations in Hanoi points to the strain on healthcare systems and the broader public health implications. With less than 01% of outdoor workers having sufficient knowledge on heat stress, there is a clear need for education and preventive measures to protect vulnerable populations. A 15% increase in hospital admissions for people with mental disorders during a 3-day heatwave highlights the broader psychological and social impacts of extreme heat events. Specifically in Can Tho the health and well-being of the residents will be compromised as daily average hospitalisation rate in Can Tho is estimated to rise from 30 per day from the period 2003-2013 to 34.24 per day in the future long-term period (2081-2100), a rise of nearly 14% adding to strain on the healthcare system.

Such heat events will impact the work environment and consequently the productivity in the city. Figure 28 and Figure 29 depict estimations of unsafe workdays and productivity loss respectively[29]. Unsafe workdays are the monthly number of days hot enough to require heat prevention actions and the likely productivity loss if work is carried out in heat. These indicators are categorised into light and heavy activities based on their intensity (ISO standard), affecting people in these categories to varying degrees. For example, light work includes office tasks, while heavy work encompasses agriculture or construction labour.

As seen from the figures, heavy physical intensity labourers (metabolic rate of 400W)[30][31] are more impacted by heat events than light workers (metabolic rate of 200W). Since Can Tho relies significantly on agriculture, classified under the heavy category, these heat events will increase the exposure of farmers to unsafe workdays leading to health issues and loss in productivity. In general, for the heavy category, in the mid-term and long-term, almost all days in a year will be classified as "unsafe" for work. Additionally, we observe that productivity loss in the long term (2071-2100) is greater than in the mid-term (2041-2070) as heat events become more severe. Peak productivity loss is projected to occur in the month of May, reaching values of 47% for the heavy category in the long-term prediction.

28 Forecast based financing, German Red Cross in Vietnam

29 Workplace Heat Effects Assessment Tool by Climate CHIP: https://climatechip.org/heat-effects-assessment-tool/01

30 https://climatechip.org/heat-effects-assessment-tool/01

31 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2799237/

**Figure 28:** **Number of unsafe workdays per month for heavy and light work intensities for mid-term and long- term**

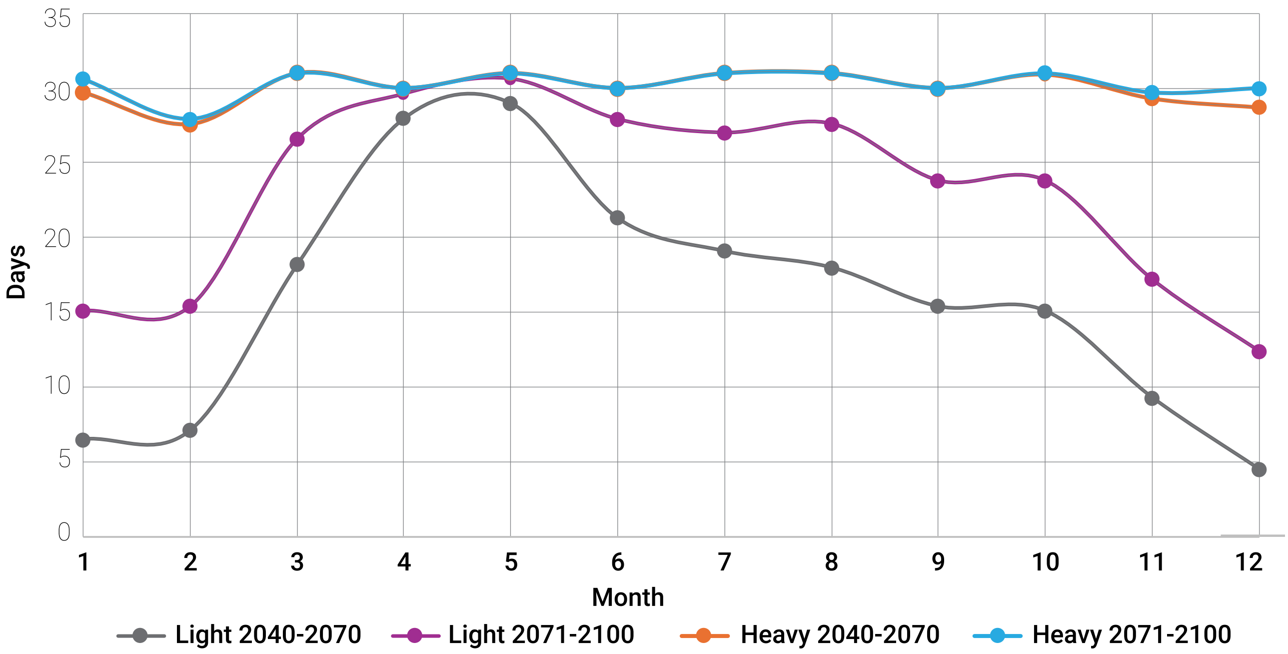
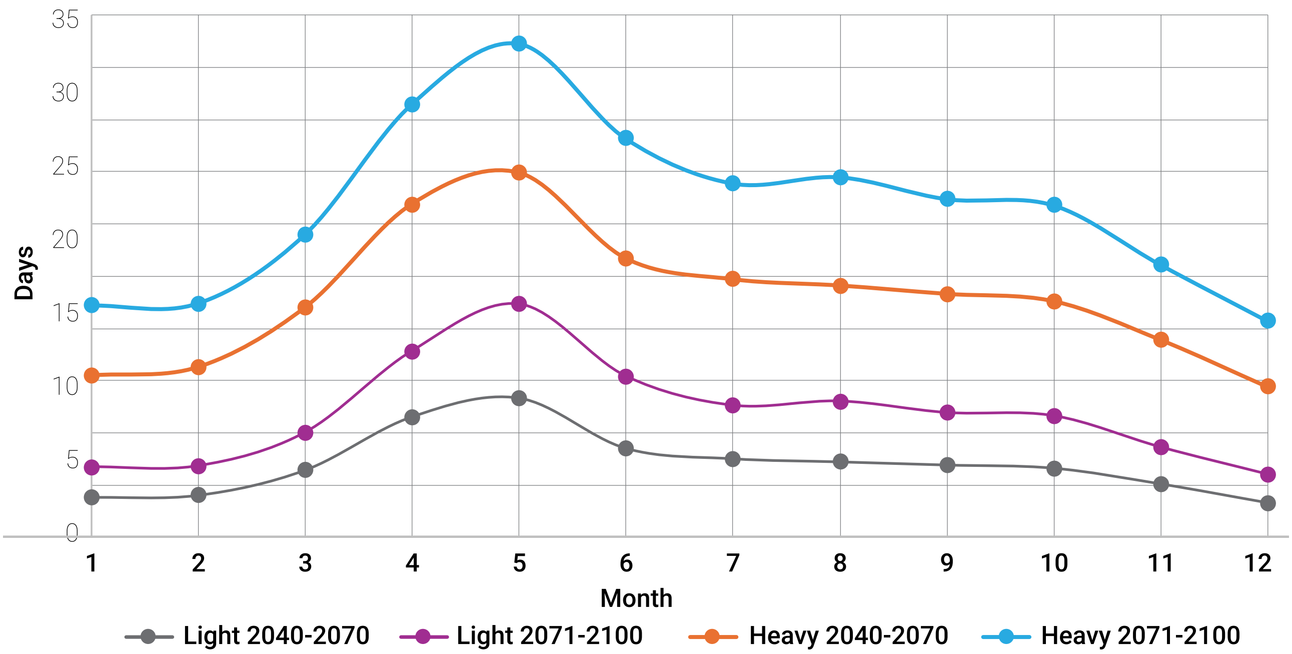



**Figure 29:** **Productivity loss for heavy and light work intensities for mid-term and long- term**



## 5.5 Neighbourhood level cooling demand analysis

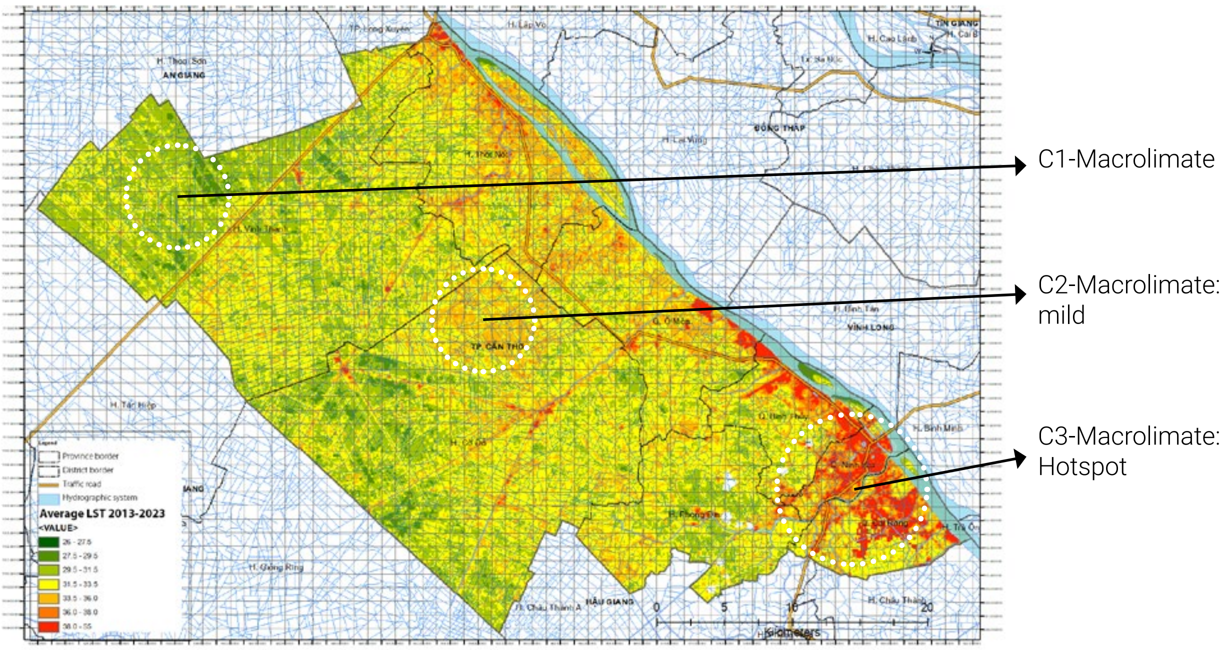
Extreme heat events, coupled with urban heat island effects, can significantly strain public healthcare systems and energy infrastructure as cooling needs surge. To adapt to rising temperatures and provide adequate cooling, cities must be able to estimate and monitor energy consumption related to cooling. This is a critical indicator for identifying areas of high demand, anticipating future needs, and designing targeted interventions that improve energy efficiency, promote sustainable cooling technologies, and mitigate the effects of urban heat islands.

By integrating cooling demand into urban planning, cities can optimise resource allocation, prioritise vulnerable populations, and ensure that cooling solutions are both equitable and accessible, ultimately enhancing long-term urban resilience. To achieve this, it is essential to assess cooling demand across different building types—such as residential, commercial, and industrial spaces—since each has unique characteristics and cooling requirements.

For example, high-density residential areas may require specific cooling strategies that differ from those in industrial zones, where heat emissions from machinery significantly elevate local temperatures. Understanding these differences allows cities to implement more effective, tailored cooling solutions that address the specific needs of each building type.

On the basis of different micro-climatic conditions as defined in sections of 5.1,5.2 and 5.3 in Can Tho city (defined as macro (C1), mild (C2), and hotspot (C3), as shown in Fig.30), which reflect different impact from heat island effects due to urbanisation for the future scenarios. The energy simulation software of eQUEST is used to simulate main building types of residential buildings, offices, hotels, shopping malls, restaurants and schools/campus buildings in Can Tho city. However, due to limitation in data, several assumptions are made and summarised in Annex 6.

**Figure 30: Macro and micro climatic conditions for Can Tho city**



Both the peak cooling load per square meter (W/m²) and the annual cooling electricity consumption per square meter (kWh/ m²) under current development status are simulated in eQUEST and calibrated with some of the data available in the public domain. The simulation results are presented in Fig. 31 and Fig. 32 respectively.

As per the figures, it is shown that the different impacts from the exterior micro climatic conditions on both peak cooling load from the building envelope and the annual cooling electricity consumption from mainly the air-conditioning equipment, considering maintaining the suitable indoor thermal comfort in buildings. However, the heat island effect can bring in different impacts on cooling demand as well as electricity consumption. Comparing the macro and hot spot conditions, it is seen the residential buildings have the largest percentages of differences as of 35% and 22% among other building types in terms of annual cooling electricity consumption and peak cooling demand respectively. It is because residential buildings are considered to use more passive cooling technologies for cooling purposes on the basis of traditional best practices and lessons learnt for the hot and humid climate, e.g. enhanced building envelope performances, exterior shading facilities and natural ventilation. As a result, improving the outdoor environment quality as of lower outdoor temperature and suitable wind speed etc. in the neighbourhood areas can lead to reduce the cooling demand and consumption of buildings and building clusters as the same indoor thermal comfort level.

More details of the simulation results are presented in Annex 6.

**Figure 31: Annual cooling electricity consumption of building typologies in Can Tho**

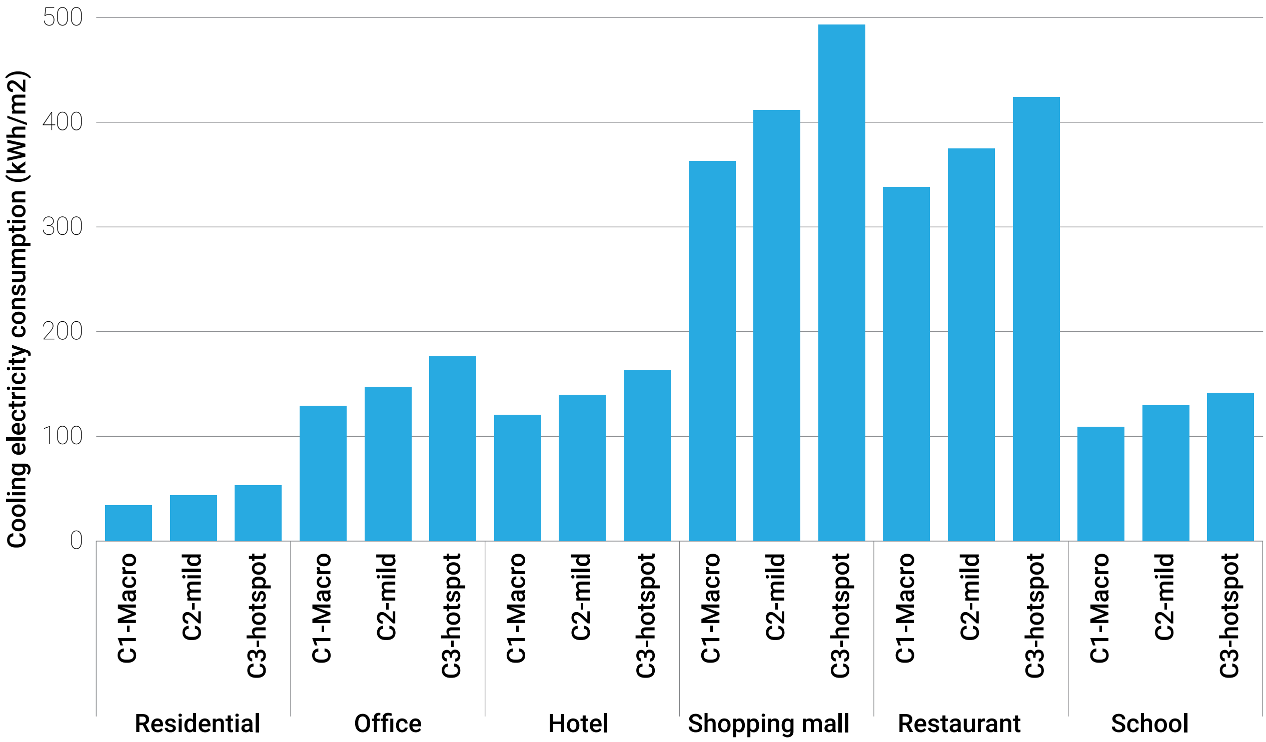
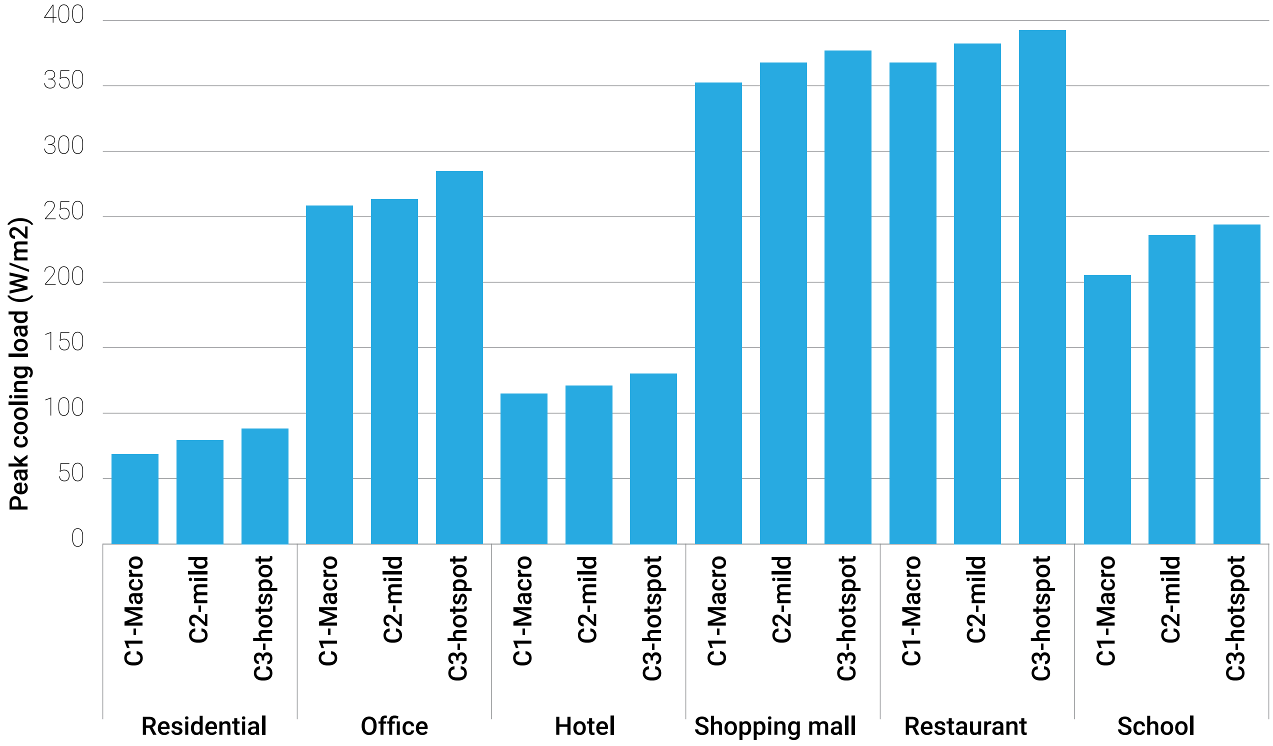


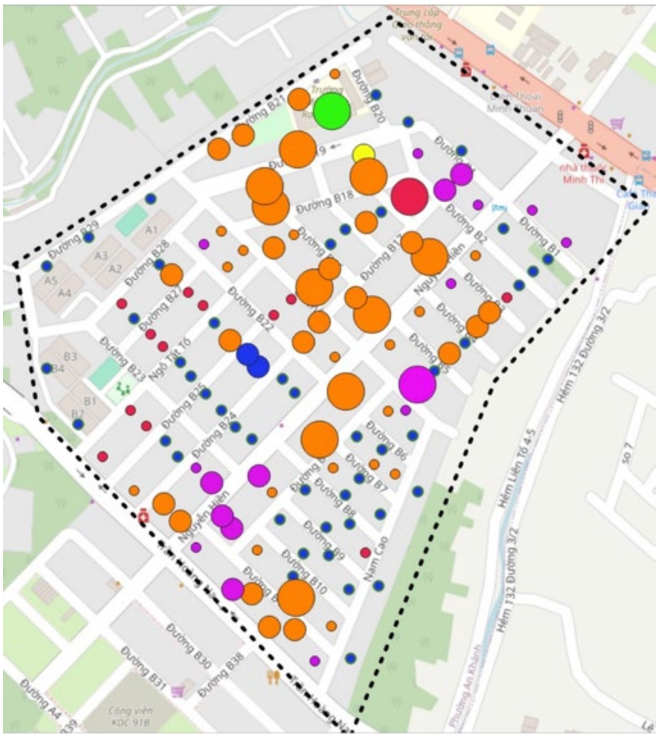
**Figure 32: Peak cooling load of building typologies in Can Tho**




Meanwhile, in order to better understand the location of different space cooling demand and consumption, several zones are selected to map out the cooling through the platform of Geographic Information System (GIS) with a combination of existing buildings, green space, different under-lay materials and other configurations at the neighbourhood level. These regions are identified as hotspots with high impacts from heat island effect, which are also considered in the annual cooling electricity consumptions. Due to the limitation of basic building information, there are totally 5 neighbourhoods selected for mapping the cooling demand in Can Tho based on available master plans. Figure 33 shows the mapping result in GIS as of the 91B region. Other mapping results of space cooling consumption in buildings are presented in Annex 7. The area is predominantly composed of three-story residential buildings, with ground floors often utilised as cafés, restaurants, small offices, or shops. The cooling demand, represented by circles, accounts for both the residential cooling needs on the first and second floors, as well as the mixed-use demands on the ground floor. For example, an orange circle indicating Range 3 signifies that the buildings within that parcel are primarily three-story residential structures with shops on the ground floor, and their cooling electricity consumption ranges between 870,001 and 3,236,770 kWh/year. The use of ground floor areas was determined using Google Maps by identifying the marked establishments. The accuracy of the analysis is limited by the reliance on Google Maps to identify ground floor establishments. To enhance the accuracy of the findings, conducting site visits to the neighbourhoods would allow the city to directly observe and document the establishments, thereby refining the analysis.

On the basis of cooling simulation analysis in the report, several potential pilot projects, including existing or new buildings with different functions in various areas of the Can Tho city, are identified. The technologies for both active and passive cooling in standalone buildings as well as bigger scale of neighbourhoods are analysed for cost-effective, economic, social and environmental benefits. The potential project list for Can Tho City has been developed, finalised, and reviewed with the consensus of the Can Tho Department of Agriculture and Environment—the agency designated by the Can Tho City People's Committee as the focal point for the Partnership Programme.

**Figure 33: Annual cooling electricity consumption in the neighbourhood of 91B, Can Tho**



| | Range | Cooling el consumption (kWh/yr) |
|---|---|---|
| ○ | Range 1 | 80,000 – 475,538 |
| ○ | Range 2 | 475,539 – 870,000 |
| ◯ | Range 3 | 870,001 – 3,236,770 |

- Neighborhood 91B
- Restaurant
- Residential
- Office
- School
- Shops
- Hotel

## 5.6 Projection of space cooling demand and related GHG emissions in specific building typologies

As mentioned in the previous chapters, Can Tho, as a major city in the Mekong Delta of Viet Nam, is expected to experience a significant increase in cooling demand due to several factors:

- Urbanisation and Economic Growth: Can Tho is growing rapidly, with increasing urbanisation and economic development. This growth is likely to lead to higher living standards, which in turn will increase the demand for air conditioning and other cooling technologies.

- Population Growth: The population in Can Tho is projected to grow, which will contribute to a higher number of households and commercial spaces requiring cooling.

- Rising Temperatures: Due to climate change and heat island effects, outdoor temperatures in Can Tho are expected to rise, leading to higher cooling needs to maintain comfortable indoor environments.

- Increased Building Development: The expansion of residential, commercial, and industrial buildings will also drive up the demand for cooling systems.

The increase in space cooling demand is directly linked to a rise in GHG emissions, primarily due to electricity consumption on operation and refrigerants in equipment, e.g. air conditioners. The majority of cooling systems in buildings (e.g. room ACs, VRF and chillers, etc.) are powered by electricity. As cooling demand rises, so will electricity consumption, leading to higher emissions. In summary, the projected increase in cooling demand in Can Tho is due to a combination of environmental, socio-economic, technological, and policy-related factors, all of which contribute to a growing reliance on cooling systems to maintain comfort and support economic activities in the face of rising temperatures and urbanisation.

These projections include short-term till 2030 and medium-to-long term till 2050. And two scenarios are considered which can be defined as following:

The **'Business-As-Usual' (BAU) Scenario** refers to the condition of the rising cooling demand without efficiency gains and no major shift to energy-efficiency technologies. Cooling demand continues to rise as a result of increasing urbanisation, population growth, and rising incomes. Households and businesses continue to install more air conditioning units, leading to a significant increase in electricity consumption. The adoption of more energy-efficient air conditioning systems, such as those using inverter technology, remains limited. Most new installations are conventional units with lower energy efficiency, which require more electricity to provide the same cooling output. Meanwhile, under this scenario, there are limited urban planning interventions to mitigate urban heating island effects, and a lack of passive cooling adoption (e.g. shading, natural ventilation or thermal insulation etc.) in building design, leading to greater reliance on air conditioning. This scenario highlights the risks of inaction, where the city becomes increasingly vulnerable to the impacts of climate change, faces higher energy costs, and contributes more significantly to global GHG emissions.

The **UCAP Scenario** refers to a proposed solution to implement the long-term national target of carbon neutrality in Viet Nam. It is a strategic framework designed to manage and reduce the cooling demand in urban areas of Can Tho, while minimising associated GHG emissions and addressing the urban heat island effect. This scenario involves proactive interventions across various sectors, aimed at achieving sustainable cooling solutions and enhancing climate resilience in buildings and neighbourhoods. It includes to enhance energy efficiency in both air-conditioning equipment and building envelopes (assuming 5% increase of efficiency in both every 2.5 years) and adopt passive cooling strategies to reduce the impact of heat island impact in neighbourhood level (e.g. increase green density and shading devices in public areas, implement cool/green roof, improve natural ventilation in open spaces etc.) as highlighted in the previous chapters (assuming 5% improvement every 5 years). All the settings of building envelope and cooling equipment efficiency are summarised in Annex 6.

Due to the limitation of data, the report only considers space cooling electricity consumptions in specific building typologies (as stated before, including residential buildings, offices, hotels, shopping malls, restaurants and schools). And some assumptions are made for the projections of future built-up areas as listed in Annex 6.

As per Fig. 34 to Fig. 36, the results are summarised for all the building typologies that are analysed for annual cooling electricity consumption, peak cooling demand and GHG emissions from 2025 to 2050 respectively. According to the projections in 2050, the proposed scenario can reduce 45% (787GWh per year) of cooling electricity consumption, 36% (426MW) of peak cooling load and 53% (564 thousand tons) of GHG emission, comparing to the BAU scenario.

More detailed projection results based on the simulation are presented in Annex 6.

**Figure 34: Projections on annual cooling electricity consumptions for specific building types in Can Tho**

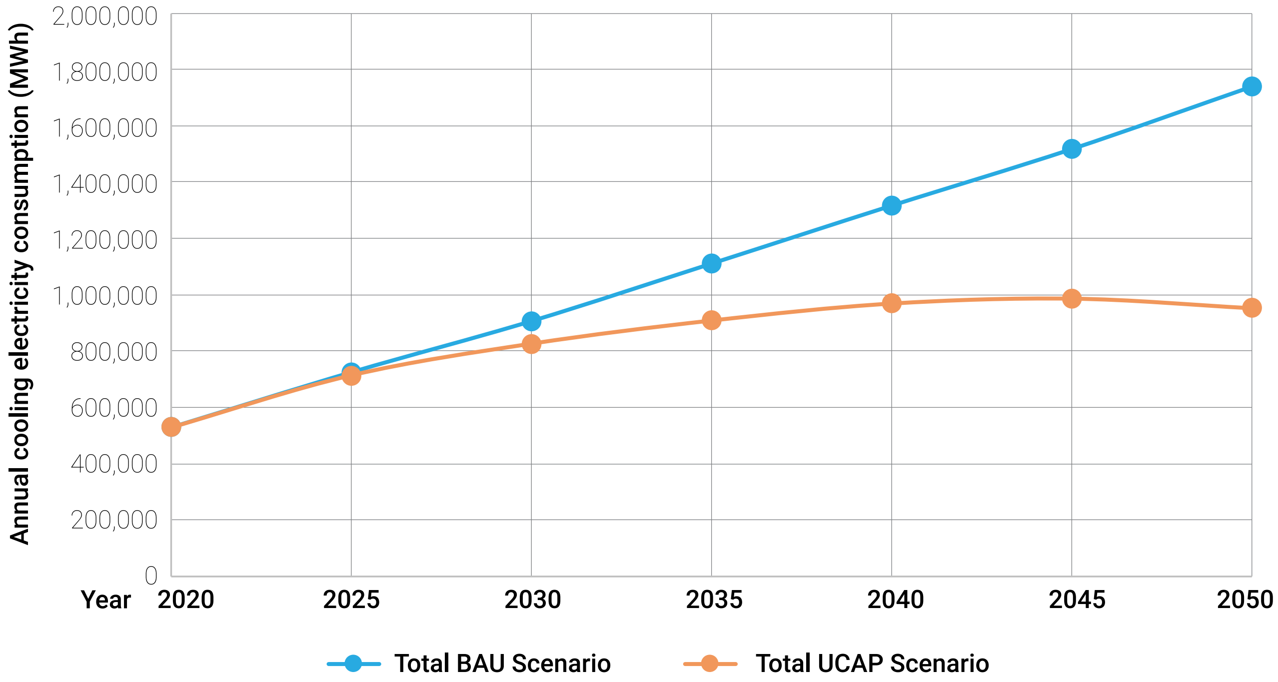



**Figure 35: Projections on peak cooling demand for specific building types in Can Tho**

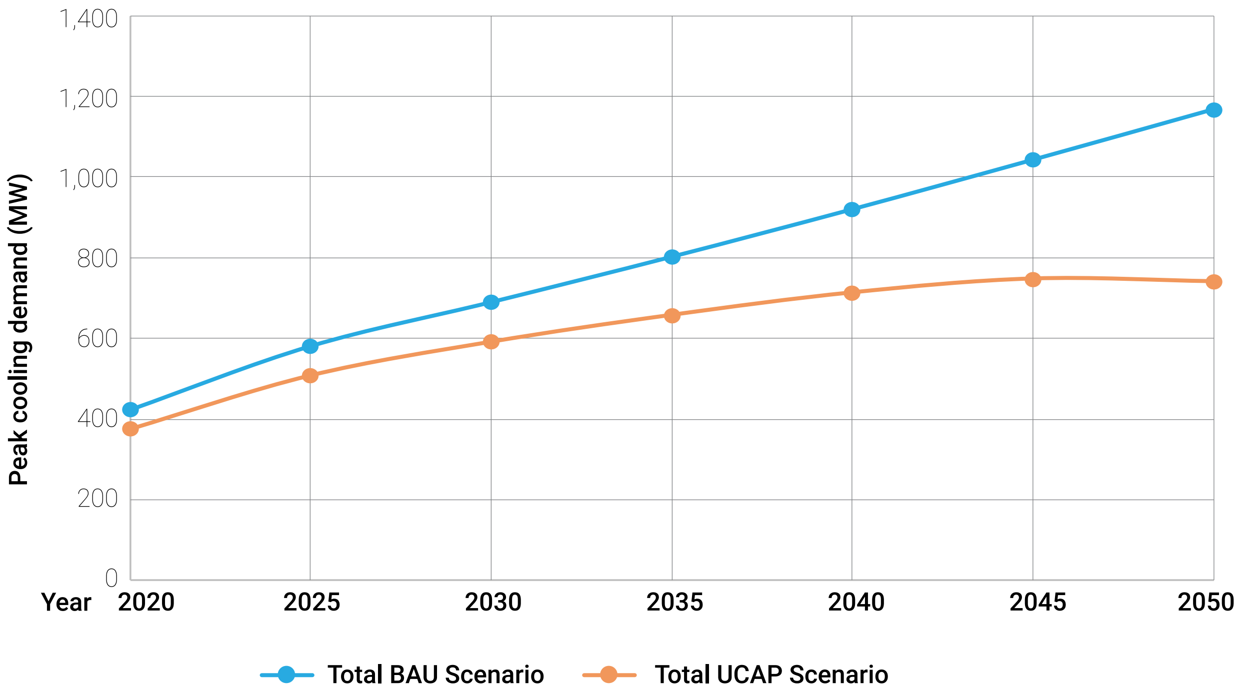


**Figure 36:** **Projects on GHG emissions of cooling electricity consumption for specific building types in Can Tho**

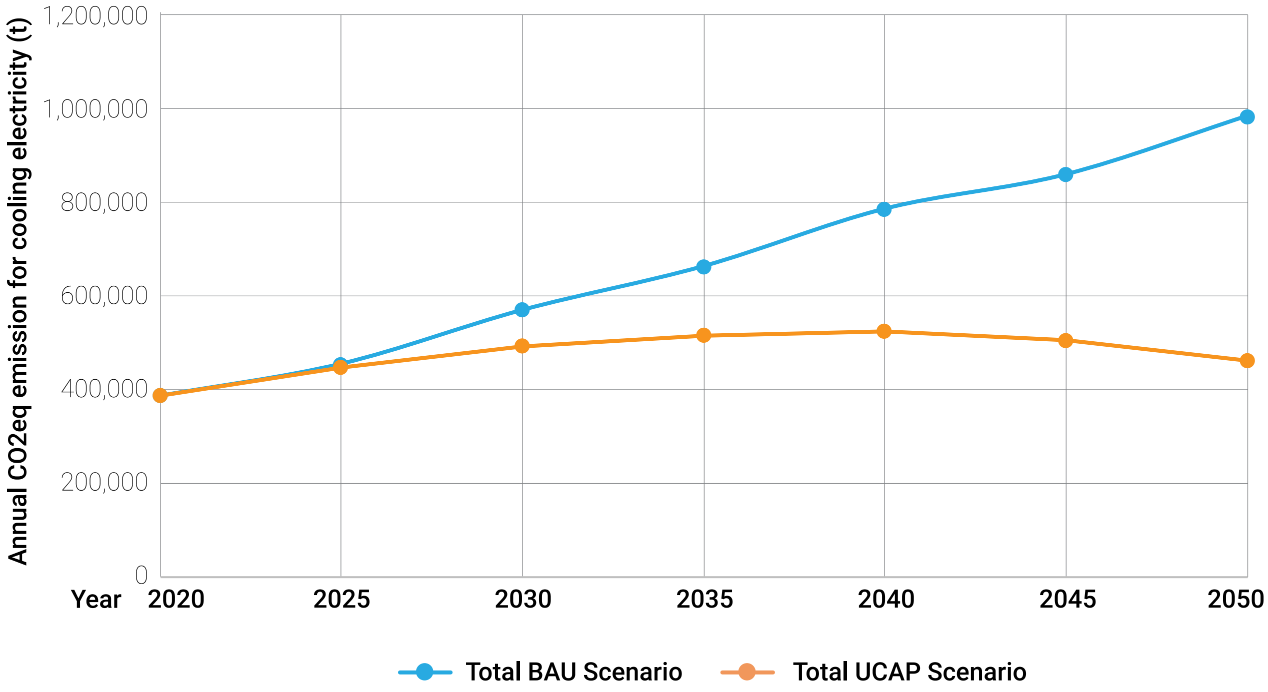


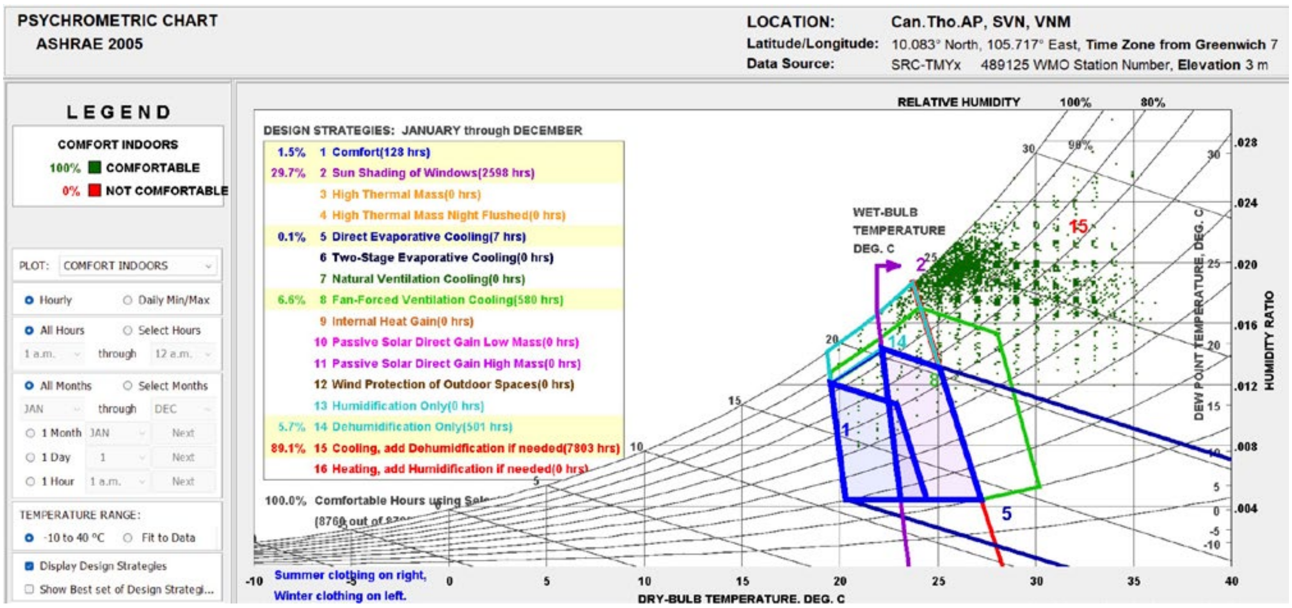

Photo: Aerial panoramic view of Can Tho
Credit: Istock

# 06 IMPACTS ANALYSIS ON SPACE COOLING OF BUILDINGS

## 6.1 Climate adaptive architectural design strategies

To understand the potential applications of different climate adaptive architectural design strategies to reduce cooling demand in the context of Can Tho, a positive screening of these strategies via Typical Meteorological Year (TMY) on the psychrometric chart based on the indoor thermal comfort standard of ASHRAE 55-2005 is conducted. The results show that due to high temperature especially in the summer season, a combination of active cooling and passive cooling design strategies is needed, including exterior shading of windows, enhanced natural ventilation and fans, direct evaporative cooling and mechanical air conditioning with cooling and dehumidification. Design related measures such as external shading should be integrated as a mandatory regulation to reduce cooling energy demand.

**Figure 37:** **Can Tho psychrometric chart**




## 6.1.1 Peak cooling loads of building typologies

Incorporating various macro (C1), mild (C2), and hotspot (C3) microclimate conditions (defined in section 5.5) as shown in Fig. 26, eQUEST was utilised to simulate the building cooling loads in Watt/sq.m for five distinct typologies: residential (multi-family), offices, malls, hotels, restaurants and schools. The fluctuation in Wet bulb and Dry bulb temperatures across C1, C2, and C3 cases is influenced by the land surface temperature. It should be noted that solar radiation and wind speeds remain consistent across C1, C2, and C3 conditions in this simulation, but ideally, the wind speeds should vary as well. Due to limited information, an assumption of uniform wind speeds across these conditions was made.

**Table 12: The building models considered for simulation**

| Building type | Storey | Area (total sq.m) |
|---|---|---|
| Hotel | 15 | 7500 |
| Office | 15 | 7500 |
| Retail | 4 | 4000 |
| School | 5 | 2500 |
| Residential (multi-family) | 15 | 7500 |

Among these structures, malls and offices exhibit the highest cooling loads. A discernible trend emerges, illustrating an increase in cooling load from macro (C1) to mild (C2) to hotspot (C3) conditions. This indicates that buildings situated in hotspot conditions necessitate higher cooling loads compared to similar structures located in zones with milder or macro conditions.

## 6.2 Cooling demand modelling under macro/ mild/ microclimate conditions

Figure 38, Figure 39 and Figure 40 provide a visual representation of the factors influencing the cooling load under macro, mild and hotspot conditions for all building typologies, offering insights into the differential impacts of these factors across different building types. Upon closer examination of each building, the factors that contribute to their respective cooling loads can be discerned. Envelope elements, including roofs, walls, windows, and exterior shading, were assessed alongside external weather parameters and internal heat gain to understand their impact on cooling load.

In the case of offices and shopping malls, internal heat gain and windows emerged as the primary contributors to the cooling load. Conversely, for schools, the exterior environment and windows played a predominant role. Hotels and residential buildings exhibited a more balanced distribution of cooling load contributions across various components.

**Figure 38: Building cooling load compositions under C1 macro condition**

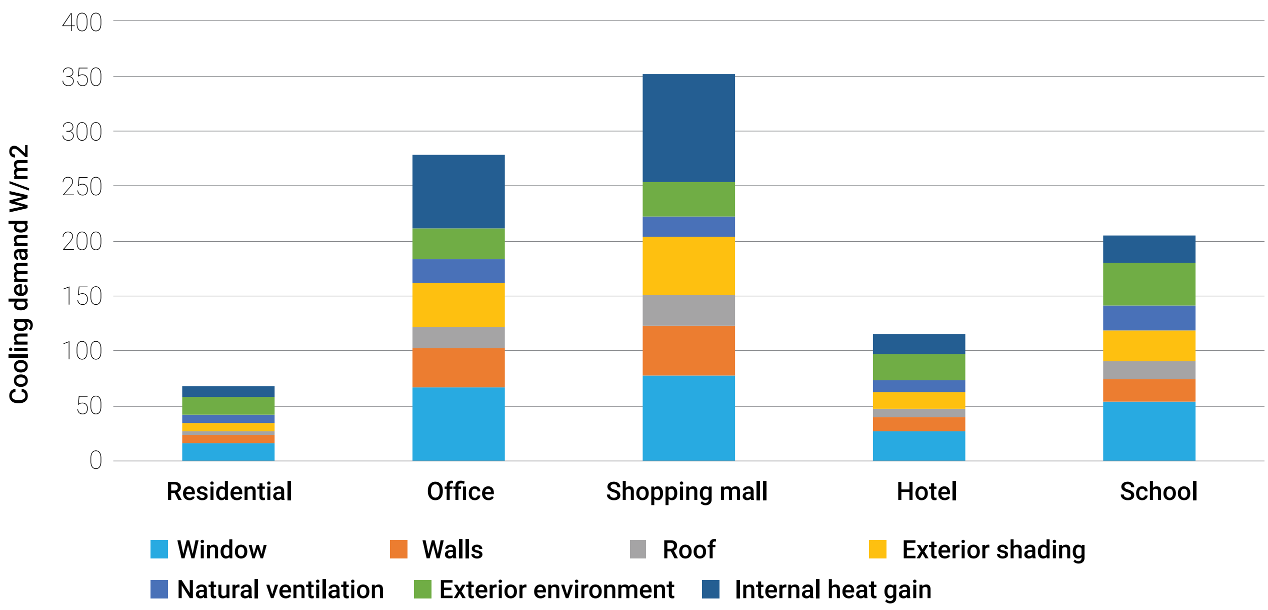


**Figure 39: Building cooling load compositions under C2 mild condition**

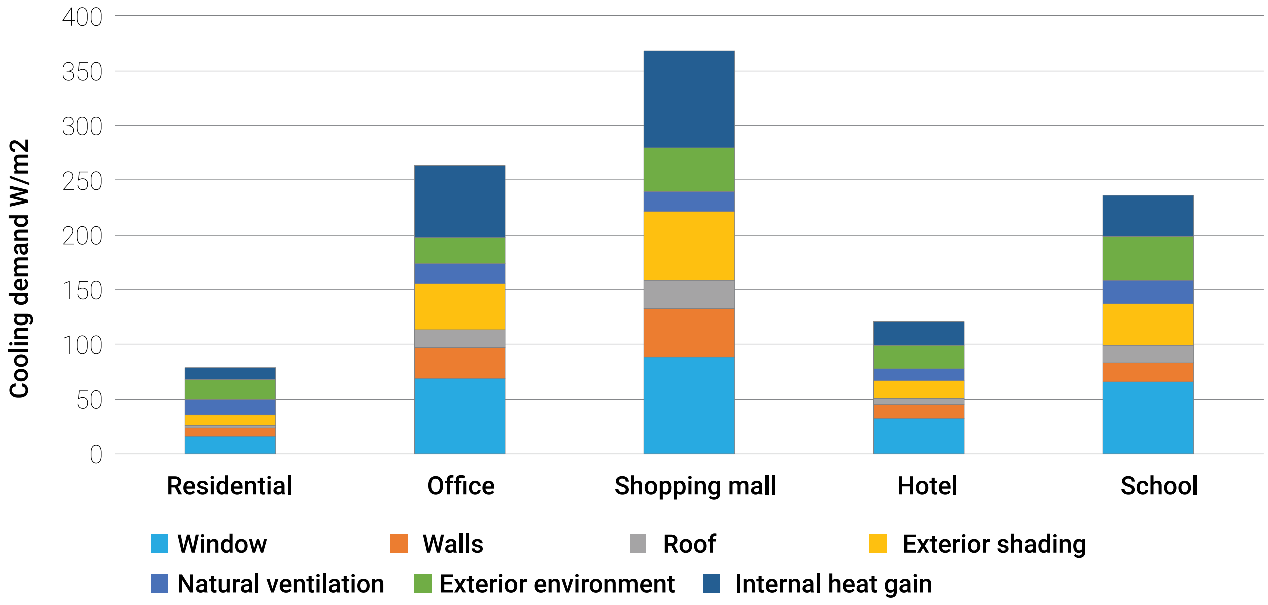
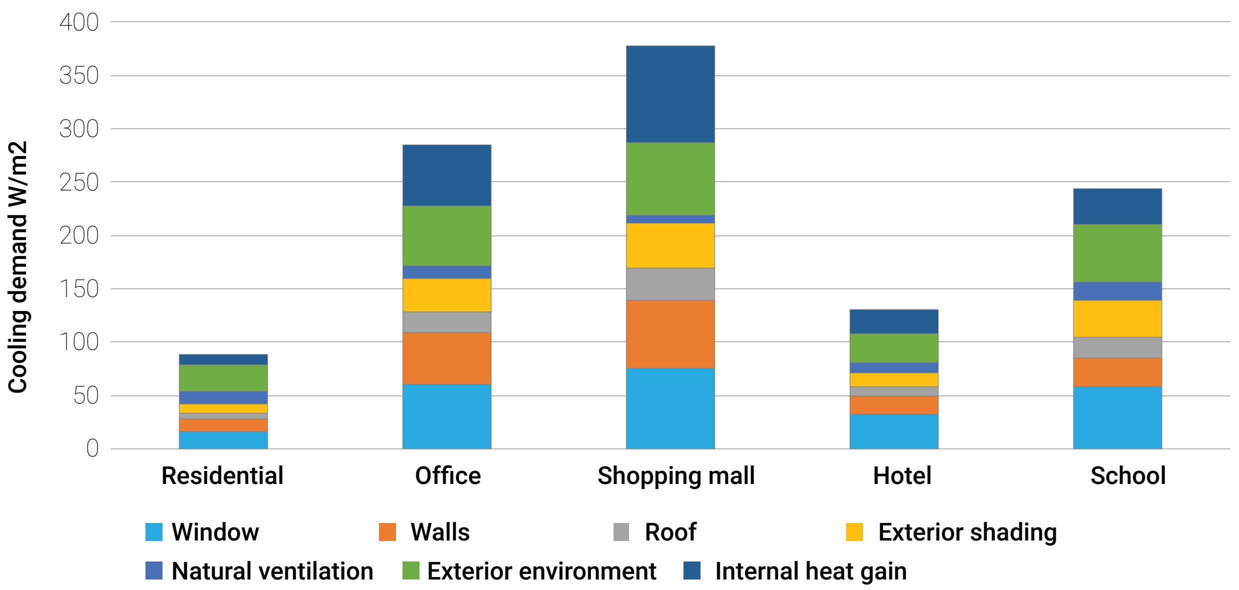



**Figure 40: Building cooling load compositions under C3 hotspot condition**




**The simulation results indicate following conclusions:**

Exterior environments can account for over 20% of cooling loads in different building types. The design strategies that can improve the exterior environment parameters such as lower air temperature, higher wind speed and more reasonable humidity, should be considered by architects and landscaping designers. These strategies may include (but not limit to): trees planting in terms of position and types, public parks, water bodies (e.g. lakes or rivers), buildings and community orientations, outdoor wind environment to maximise natural ventilation, sponge communities with on-site abatement (urban planning model that emphasises flood management via strengthening green infrastructures instead of purely relying on drainage systems), high performance facades (e.g. cool roof, green roof/facade) and exterior shading from plants, buildings and other artificial constructions.

The thermal performance parameters of Solar Heat Gain Coefficient (SHGC) in glazing systems and external shading facilities of windows can account for as much as 25% to 40% of peak cooling load. Additionally, if the operable part of window systems is designed suitably, the indoor natural ventilation can also be enhanced, with additional reduction of 5% to 11% of peak cooling load. Thus, it is advised to emphasise selection of glazing units and ensure the operable parts are well designed no matter the nature of the building (residential or commercial).

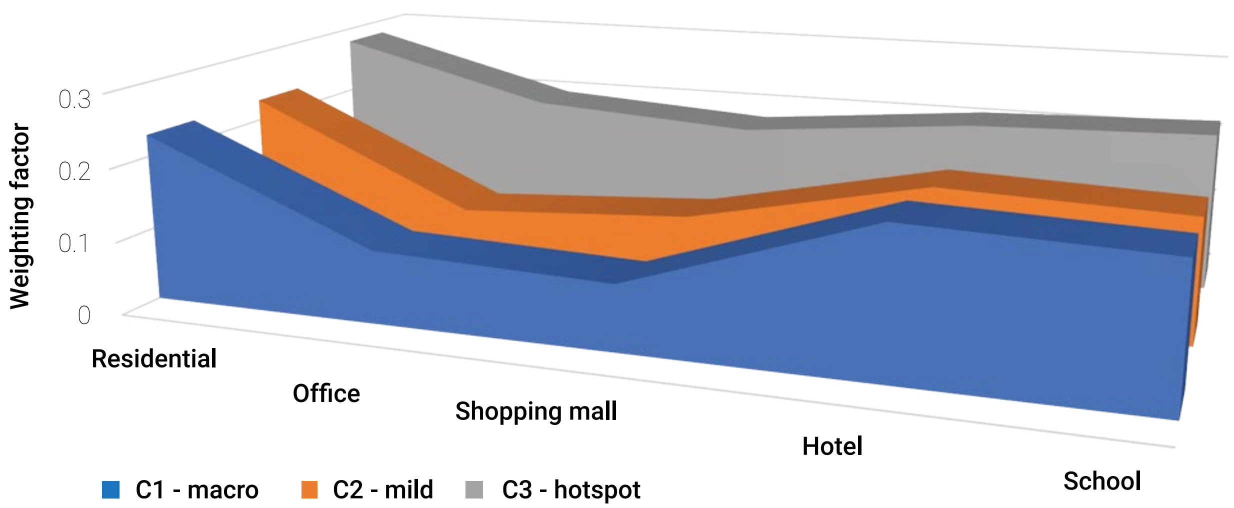
Due to the limited data available for clarification and validation of simulation results in residential buildings, only the high-rise multi-family buildings are in consideration. The potential contributions of roof structure to space cooling demand may be underestimated, as if it is in low-rise single-family buildings, e.g. 3-floor ones.

## 6.3 Performance attribution analysis on heat island and building envelope factors of space cooling

Figure 41 and Figure 42 represent the impact of heat island effects, as well as roof and wall properties, on the cooling loads of buildings. This analysis mirrors a sensitivity study wherein various factors within the simulation model are systematically altered and compared against a baseline scenario, enabling a clear understanding of their respective contributions to cooling loads.

Figure 41 represents the weighting factor of heat island effects on the space cooling loads of different building typologies across macro, mild, and hotspot conditions. Notably, hotspot conditions exhibit markedly higher weighting factors compared to macro and mild conditions. Among the building types, residential areas, hotels, and schools demonstrate greater sensitivity to changes in cooling loads induced by heat island effects, contrasting with offices and shopping malls. Heat island effect has higher impacts on space cooling in the building types of residential, hotel and school, which have the higher potential to enable natural ventilation in the mornings and evenings with suitable design of window systems. Especially for schools and residential buildings, these two building types normally have bigger windows due to the requirement for sunlight.

**Figure 41: Performance weighting factors of heat island on space cooling**



Meanwhile, Figure 42 illustrates the weighting factor of walls and roofs on space cooling loads across various building typologies under different climate conditions. While minimal disparities exist between the weighting factors in macro and mild conditions, a substantial increase is evident in hotspot conditions. In general, the impacts of wall and roof for different building types are almost similar at around 15% to 20%, which means that the thermal performance of U-value of these building envelopes can only have a relatively limited impact in the overall space cooling. One observation is that better or lower U-values may not always bring in lower cooling consumption, unlike the case of heating. At night, during certain seasons in Can Tho, low outdoor temperature with suitable wind speed is observed which can enable the indoor heat to expand to outdoor through walls by natural procedure of heat transfer instead of enforced by cooling machines. In this case, the walls with higher U-value can benefit from fast heat transfer compared to the ones with lower U-value. Thus, it requires a more detailed comparison and balance before determining which levels of U-value should be used.

**Figure 42: Performance weighting factors of wall and roof on space cooling**

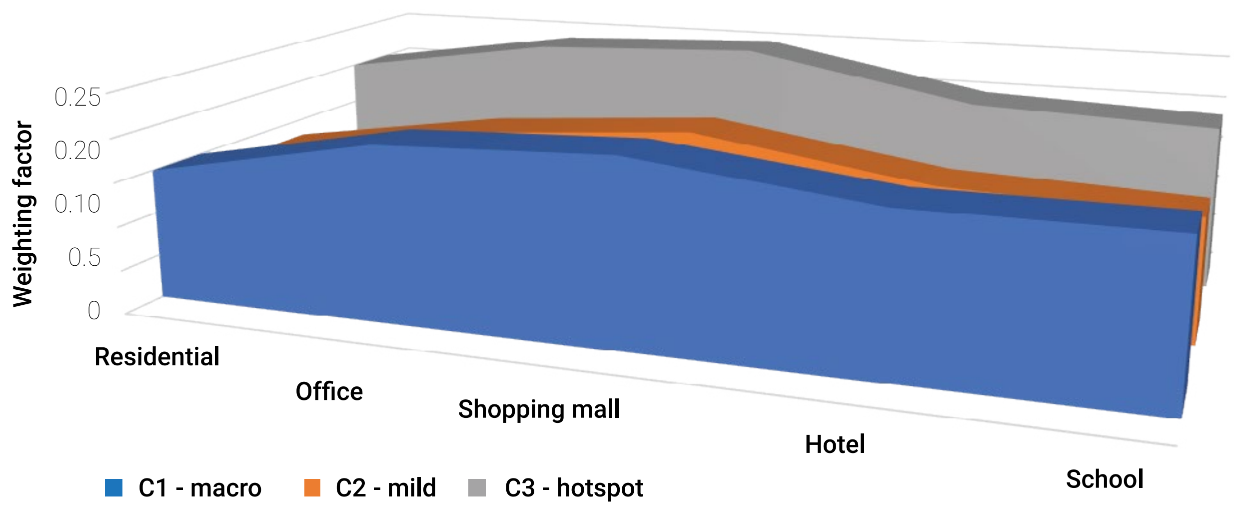


Photo: Aerial panoramic view of Ninh Kieu wharf, Can Tho
Credit: Wikipedia

# 07 RECOMMENDATIONS: IMPLEMENTATION STRATEGIES & INTERVENTIONS FOR URBAN COOLING

<table>
<tr><th colspan="3">Recommendations #1 - Integrate nature-based solutions and passive cooling in urban areas</th></tr>
<tr><th>Short term (<5 years)</th><th>Medium term (5-10 years)</th><th>Long term (>10 years)</th></tr>
<tr><th colspan="3">Action/Activities</th></tr>
<tr>
<td>For city, zonal (i.e. ward / rural ward) and neighbourhood level: maintaining/preserving and strengthening existing green factors:<br>• Increasing the high-canopy (at least 10m) and dense trees for shading on streets (refer to Annex 10 for tree categories selection) (median strip, pavement), parks/mini-parks.<br>• Increasing shaded surfaces on public spaces at the hotspots, no less than 40% within a certain space.<br>• Strictly preserving the existing blue network, particularly the flowing-water surfaces (river, canal).<br>• Integrate local communities perspectives and knowledge of natural resources in designing nature-based solutions<br>• Consult various stakeholders including most vulnerable women and men in the communities throughout the interventions. (short-to-long term)<br>• Promote gender parity in decision-making participation on passive cooling and nature-based solutions initiatives/projects. (short-to-long term)<br>• Encourage women-led initiatives in implementing Nature-based Solutions and passive cooling strategies (PCS), while also expanding training programmes to enhance the skills of women in the workforce on PCS. (short-to-medium-term)<br>For building level:<br>• Integrate cool roof and / or green roof as a regulation in the building byelaws.<br>• Integrate high performance facade, including green facade as a regulation in the building byelaws.</td>
<td>For city, zonal (i.e. ward / rural ward) and neighbourhood level: optimising cooling performance and the accessibility to green elements/ areas:<br>• Maximising the accessibility from residence to urban green area in new planned neighbourhoods by reducing distance between residential buildings to the nearest green space to ~100m.<br>• Diversifying forms and level of urban green spaces to include: city, district, and pocket parks in the revised land-used master plan of city and district, particularly in hot spots identified in the UHIE analysis.<br><br>For neighbourhood level<br>• Ensure green space no less than 9 m2/person as mentioned in WHO guidelines.<br>• Increasing tree shades in the waterfront to ensure no less than 50% of the area is covered with high trees.<br>• Planning a breakdown of high trees vs. bushes vs. grass within an urban green space's surface: 70:30:70.<br>• Increasing ventilation through void decks of hi-rise buildings and adequate street orientation<br>• Equipping water sprays on the water surfaces.<br>• Greening the open spaces of public-used facilities (governmental buildings, schools / universities, companies, hospitals, malls).</td>
<td>For city and zonal level (i.e. ward, rural ward):<br>• Re-considering the placement of buildings on the river and canal banks, increasing gaps to facilitate the river wind flow.<br>• Integrating heat-resilience with biodiversity and urban flood-resistance by introducing sponge community design principles.<br>• Procurement guidelines on urban plan and design that includes urban geometry, materials and vegetation<br>• Procurement a guideline for selection and implementation of nature-based solutions, including inventory of technical specifications.<br><br>For all levels:<br>• Requiring clean/green mobility (bike, electric bike) within neighbourhoods framed by green areas.<br>• Requiring minimum amount of asphalt roads within a neighbourhood (5%).<br>• Transforming conventional neighbourhood asphalt-surfaced roads into vegetated corridors.</td>
</tr>
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| Recommendations #1 - Integrate nature-based solutions and passive cooling in urban areas | | |
|---|---|---|
| **Short term (<5 years)** | **Medium term (5-10 years)** | **Long term (>10 years)** |
| **Policy support** | | |
| **Continuing the implementation of the government's current policies related to green space in Can Tho City, including:**<br>• National-level policies: (i) Decision No. 524/QD-TTg dated April 1, 2021, by the Prime Minister approving the Project 'Plant one billion scattered green trees in the 2021-2025 period'; (ii) Greenery planning for public utilities in urban areas - Design standards (TCVN 9257:2012); (iii) Decision No. 326/ QĐ-TTg dated March 9, 2022, by the Prime Minister allocating national land use planning targets for the period 2021 - 2030, vision to 2050, national land use plan for 5 years 2021-2025; (iv) Decision No. 1519/ QĐ-TTg dated December 2, 2023, by the Prime Minister approving the city planning of Can Tho for the period 2021 - 2030, vision to 2050; and other related documents.<br>• City-level policies, including: (i) Plan No. 183/KH-UBND of the People's Committee of Can Tho City implements Decision No. 524/ QD-TTg approving the Project 'Planting One Billion Trees for the period 2021-2025' in the jurisdiction of Can Tho City ; (ii) Decision No. 3184/QD-UBND dated December 5, 2018 approves the overall planning of the green tree system in Can Tho City until 2030; (iii) Decision No. 3184/QD-UBND dated December 5, 2018, by the People's Committee of Can Tho City, approves the overall planning of the green tree system in Can Tho City until 2030.<br>**Considering factors to enhance the area of green trees, water surface when developing new policies for mid-term, including:**<br>• Developing, adjusting urban planning, ensuring unity, synchronisation with the city planning for the period 2021 - 2030, vision to 2050.<br>• Executing Plan No. 183/KH-UBND of the People's Committee of Can Tho City implementing Decision No. 524/QD-TTg approving the Project 'Planting One Billion Trees for the period 2021-2025' by targeting hot spot areas with high UHI intensity.<br>• Developing and issuing annual land use plans in districts under Can Tho City. | **Continuing the implementation of the government's current policies related to green space in Can Tho City, including:**<br>• *Implementation of national-level policies*: ((i) Greenery planning for public utilities in urban areas - Design standards (TCVN 9257:2012); (ii) Decision No. 326/ QĐ-TTg dated March 9, 2022, by the Prime Minister allocating national land use planning targets for the period 2021 - 2030, vision to 2050, national land use plan for 5 years 2021-2025; (iii) Decision No. 1519/QĐ-TTg dated December 2, 2023, by the Prime Minister approving the city planning of Can Tho for the period 2021 - 2030, vision to 2050; and (iv) other related documents.<br>• *Implementation of city-level policies*, including: (i) Decision No. 3184/QD-UBND dated December 5, 2018, by the People's Committee of Can Tho City, approves the overall planning of the green tree system in Can Tho City until 2030; and (ii) Policies integrating the elements of green space have been proposed for implementation in the short-term phase.<br>**Considering factors to enhance nature-based solutions and passive cooling when developing long-policies, including:**<br>• National-level: Research and issue guidelines on integrating nature-based solutions and passive cooling into policies from the central to local levels. Study and supplement more detailed criteria and standards for green space in urban areas.<br>• City/Province-level: Develop and adjust urban planning in accordance with the new regulations of the government; implement the integration of factors related to green space, nature-based solutions, and passive cooling into the city's policies and action plans. | • Conduct evaluations and refine both national-level and provincial-level policies for ensuring the comprehensive and complete integration of nature-based solutions and passive cooling into the aforementioned policies.<br>• Consider making the implementation of nature-based solutions and passive cooling mandatory in the process of policy development and execution. |

| Recommendations #1 - Integrate nature-based solutions and passive cooling in urban areas | | |
|---|---|---|
| Short term (<5 years) | Medium term (5-10 years) | Long term (>10 years) |
| Key stakeholders (Implementation body) | | |
| **Policy development and enforcement:**<br>• At national level: MAE, MoF, MoC, MoIT<br>• At city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>**Key investors:**<br>• Private building owners in the city<br>• Can Tho city's ODA Project Management Unit<br>**Financiers:**<br>• Public/Commercial banks, FIs<br>• CADIF (Can Tho City Development Investment Fund)<br>**R&D & Awareness raising:**<br>• R&D centre, Institutes, Universities<br>• Can Tho Women's Union, Can Tho Youth Union<br>• Real estate associations & developers | **Policy development and enforcement:**<br>• At national level: MAE, MoF, MoC, MoIT<br>• At city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>**Key investors:**<br>• Private building owners in the city<br>• Can Tho city's ODA Project Management Unit<br>**Financiers:**<br>• Public/Commercial banks, FIs<br>• CADIF (Can Tho City Development Investment Fund)<br>**R&D & Awareness raising:**<br>• R&D centre, Institutes, Universities<br>• Can Tho Women's Union, Can Tho Youth Union<br>• Real estate associations & developers | **Policy development and enforcement:**<br>• At national level: MAE, MoF, MoC, MoIT<br>• At city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>**Key investors:**<br>• Private building owners in the city<br>• Can Tho city's ODA Project Management Unit<br>**Financiers:**<br>• Public/Commercial banks, FIs<br>• CADIF (Can Tho City Development Investment Fund)<br>**R&D & Awareness raising:**<br>• R&D centre, Institutes, Universities<br>• Can Tho Women's Union, Can Tho Youth Union<br>• Real estate associations & developers |

<table>
<tr><th colspan="3">Recommendations #2 - Urban design</th></tr>
<tr><th>Short term (<5 years)</th><th>Medium term (5-10 years)</th><th>Long term (>10 years)</th></tr>
<tr><th colspan="3">Action/Activities</th></tr>
<tr>
<td>• Requiring integration of heat-resilience study in neighbourhood development projects<br>• For new neighbourhood areas: requiring adequate position of buildings and streets to ensure H/W = 2 – 3<br>• Major orientation in parallel / slight oblique (no greater than 15 degrees) with prevailing favourable wind.<br>• Promoting active cooling measures for open public space including (1) water spray, (2) fountain, (3) wetting the hard and strongly absorbed surfaces during peak time of summer days.<br>• Considering the installation of cool roofs on public-used and residential buildings.<br>• Implement the pilot projects identified for the city of Can Tho, as outlined in Annex 8, specifically the project endorsed in Annex 9.</td>
<td>• Requiring heat-resilience study in all level development projects<br>• Considering the revision of height – width relation in older developed neighbourhoods: higher buildings on wider roads H/W = 2 – 3 for sufficient shades.<br>• Carefully locating high-rise buildings to facilitate wind corridors through urban streets and to prevent wind block.<br>• Considering the installation of cool and green roofs on public-used buildings.<br>• Expand the list of pilot projects to encompass other critical uses that have not been addressed in this study, such as social housing and/or other innovative solutions.</td>
<td>• Considering the installation of cool and green roofs on private residential buildings.<br>• Revision of Master Plans, integrating passive cooling in urban hot spots.</td>
</tr>
<tr><th colspan="3">Policy support</th></tr>
<tr>
<td>Implementing and executing in accordance with current legal regulations, including:<br>• Decision No. 326/QĐ-TTg dated March 9, 2022, by the Prime Minister allocating national land use planning targets for the period 2021 - 2030, vision to 2050, national land use plan for 5 years 2021-2025;<br>• Decision No. 1519/QĐ-TTg dated December 2, 2023, by the Prime Minister approving the city planning of Can Tho for the period 2021 - 2030<br>• Circular No. 06/2013/TT-BXD dated May 13, 2013, from the Ministry of Construction, provides guidance on urban design content.<br>• The National Technical Regulation QCVN 01:2021/BXD on construction planning.<br>Incentivising the integration of heat-resilience studies into neighbourhood development projects.<br>Researching criteria pertaining to green urban areas.<br>Developing regulations, or technical handbooks, that provide guidance on the incorporation of passive cooling solutions and nature-based cooling solutions into urban design highlighting multiple benefits.</td>
<td>At the National level:<br>• Enacting regulations that mandate the inclusion of heat-resilience studies in all development projects, regardless of their scale.<br>• Encourage city level cooling action plans including UHIE analysis<br>• Revising the existing/develop new criteria or standards to provide detailed technical specifications for nature-based and passive cooling solutions in urban design.<br>• Developing technical guidelines on the criteria of evaluating green urban areas, green cities.<br>• Studying to develop a green transition for cities integrating sustainable cooling solutions.<br>At the City level (for Can Tho city):<br>• Implement and apply the new regulations issued by the Government within the jurisdiction of Can Tho city</td>
<td>At the National level:<br>• Refining and implementing mandatory regulations for integrating sustainable cooling solutions in urban design.<br>• Issuing a roadmap for green transition for cities.<br>At the city level (for Can Tho city): developing plans to implement the aforementioned policies within the city's jurisdiction.</td>
</tr>
</table>

| Recommendations #2 - Urban design | | |
|---|---|---|
| **Short term (<5 years)** | **Medium term (5-10 years)** | **Long term (>10 years)** |
| **Key stakeholders (Implementation body)** | | |
| Policy development and enforcement:<br>• At national level: MAE, MoF, MoC, MoIT<br>• At city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>Key investors:<br>• Private building owners in the city<br>• Can Tho city's ODA Project Management Unit<br>Financiers:<br>• Public/Commercial banks, FIs<br>• CADIF (Can Tho City Development Investment Fund)<br>R&D & Awareness raising:<br>• R&D centre, Institutes, Universities<br>• Can Tho Women's Union, Can Tho Youth Union<br>• Real estate associations & developers | Policy development and enforcement:<br>• At national level: MAE, MoF, MoC, MoIT<br>• At city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>Key investors:<br>• Private building owners in the city<br>• Can Tho city's ODA Project Management Unit<br>Financiers:<br>• Public/Commercial banks, FIs<br>• CADIF (Can Tho City Development Investment Fund)<br>R&D & Awareness raising:<br>• R&D centre, Institutes, Universities<br>• Can Tho Women's Union, Can Tho Youth Union<br>• Real estate associations & developers | Policy development and enforcement:<br>• At national level: MAE, MoF, MoC, MoIT<br>• At city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>Key investors:<br>• Private building owners in the city<br>• Can Tho city's ODA Project Management Unit<br>Financiers:<br>• Public/Commercial banks, FIs<br>• CADIF (Can Tho City Development Investment Fund)<br>R&D & Awareness raising:<br>• R&D centre, Institutes, Universities<br>• Can Tho Women's Union, Can Tho Youth Union<br>• Real estate associations & developers |

| Recommendations #3 - Building design & equipment | | |
|---|---|---|
| **Short term (<5 years)** | **Medium term (5-10 years)** | **Long term (>10 years)** |
| **Action/Activities** | | |
| • Building cluster arrangement: '—' better than 'U' better than '□'<br>• Window-to-wall ratio:<br>– South façade: >0.5 (residential), >0.3 (commercial)<br>– East/west façade: >0.35 (residential), >0.25 (commercial)<br>• Operable window ration: >50% (residential), >0.3 (commercial)<br>• Natural ventilation architectural design: ACH> 1.3, >45% main resident areas with wind speed >0.5m/s<br>• Requiring the location of AC outdoor units at the roof-top level<br>• Building envelope design to follow strictly Viet Nam's building energy code (QCVN 09:2017/BXD): sufficient shading, adequate SHGC of glass in correspondence with WWR<br>• Buildings should either be integrated with cool roof or green roof. All surfaces exposed to sky (including roof and non-roof landscape pavements), should be either shaded or have high SRI or should be soft& pervious. | • Energy efficiency labelling of cooling equipment<br>• Optimised building envelope design to follow local green building certification (EDGE, Lotus)<br>• Incentivisation for green buildings: extra GFA, financial incentives<br>• Promoting the application of reflective roofs, and higher albedo material (> 0.7) for upper part of residential buildings in urban canyons | • Environment labelling of cooling equipment (Advanced requirement)<br>• Design Awards for developers who contribute towards implementation of urban heat adaptation and mitigation measures. |
| **Policy support** | | |
| At the National level:<br>• Enforcing the implementation of the National Technical Regulation on Energy Efficient Buildings (QCVN 09:2017/BXD), and other regulations related to energy efficiency for buildings in the whole country<br>• Researching and developing regulations on the following issues: Standard energy consumption of buildings; Criteria for recognising green buildings; Guidelines on GHG emission inventory and emission allowances for buildings.<br>At the City level (for Can Tho city):<br>• Enforcing the implementation of the National Technical Regulation on Energy Efficient Buildings (QCVN 09:2017/BXD), and other regulations related to energy efficiency for buildings, for all buildings within the city's jurisdiction.<br>• Implementing policy instruments including regulation, information and incentives to promote and encourage building investors to apply sustainable cooling solutions during the design, construction, and operation of buildings. | At the National level:<br>• Issuing and enforcing regulations on: Standard energy consumption of buildings; Criteria for green buildings; GHG emission inventory and emission allowances for buildings.<br>• Developing regulations for the carbon market and operating a pilot carbon market.<br>At the City level (for Can Tho city): Enforcing the implementation of the aforementioned policies issued by the Government. | At the National level:<br>• Issuing and enforcing regulations on environment labelling of cooling equipment<br>At the City level (for Can Tho city): Enforcing the implementation of the aforementioned policies issued by the Government. |

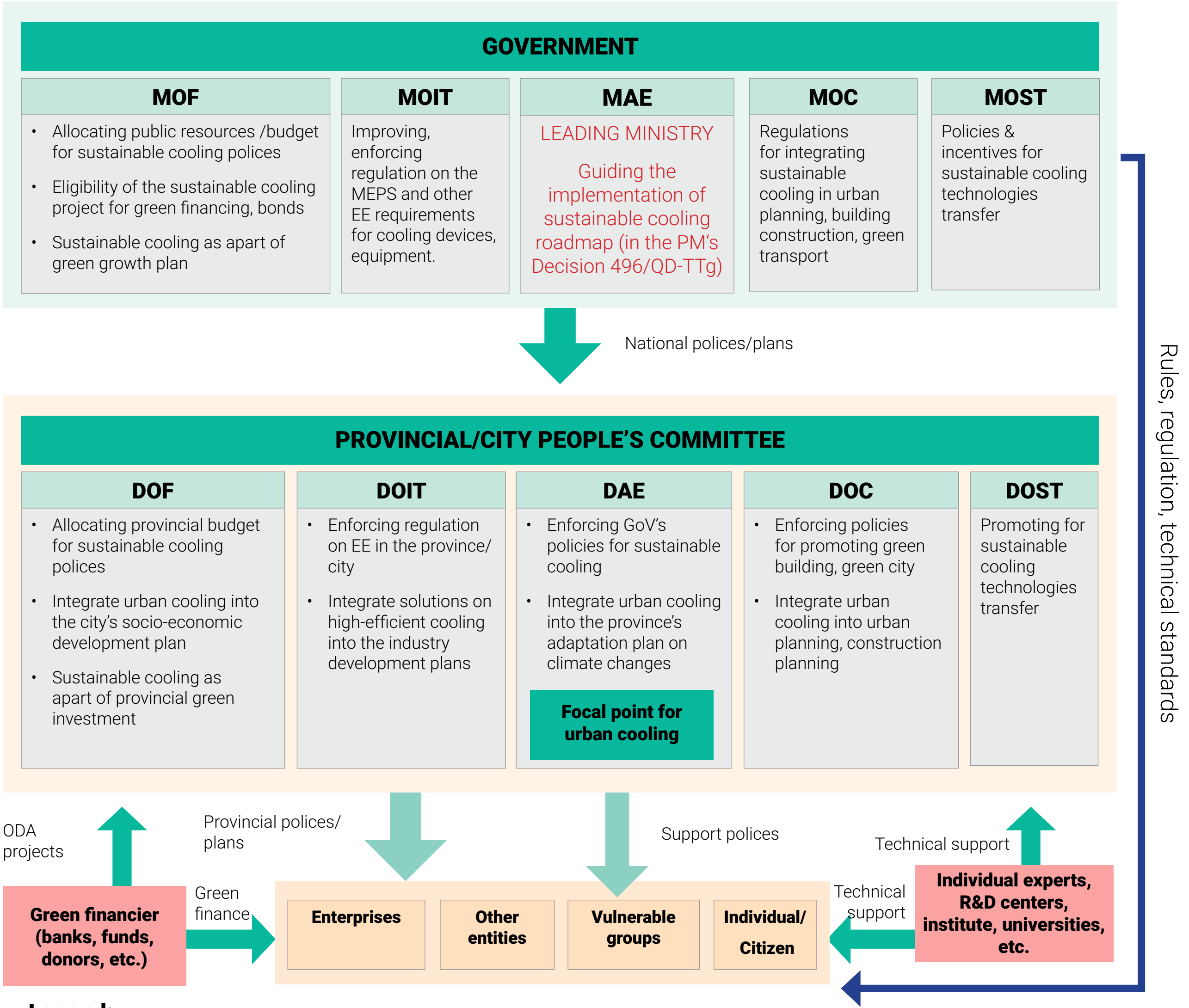
| Recommendations #3 - Building design & equipment | | |
|---|---|---|
| **Short term (<5 years)** | **Medium term (5-10 years)** | **Long term (>10 years)** |
| **Key stakeholders (Implementation body)** | | |
| • Policy makers at national level: MAE, MoF, MoC, MoIT<br>• Policy makers at city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>• Public/Commercial banks, FIs<br>• Building owners in the city<br>• Others: Associations (Can Tho Women's Union, Can Tho Youth Union), R&D centre, Institutes, Universities | • Policy makers at national level: MAE, MoF, MoC, MoIT<br>• Policy makers at city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>• Public/Commercial banks, FIs<br>• Building owners in the city<br>• Others: Associations (Can Tho Women's Union, Can Tho Youth Union) R&D centre, Institutes, Universities | • Policy makers at national level: MAE, MoF, MoC, MoIT<br>• Policy makers at city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>• Public/Commercial banks, FIs<br>• Building owners in the city<br>• Others: Associations (Can Tho Women's Union, Can Tho Youth Union) R&D centre, Institutes, Universities |

| Recommendations #4 - Financial | | |
|---|---|---|
| **Short term (<5 years)** | **Medium term (5-10 years)** | **Long term (>10 years)** |
| **Action/Activities** | | |
| • Leverage grants and technical support programmes to augment capacity and awareness regarding the advantages of energy efficiency, sustainable cooling<br>• Develop a compelling business case for the energy efficiency market (ESCO), thereby building a robust pipeline of bankable projects for the green finance market.<br>• Explore blended finance mechanisms to mitigate risk and engage institutional investors, employing multilateral development climate finance to alleviate infrastructure risks. | • Amplify the utilisation of green bonds/loans, sustainability-linked bonds/loans, and transition finance instruments to fund green buildings and innovative business models pertaining to energy efficiency and sustainable cooling. Additionally, issue orange bonds to finance gender-responsive cooling projects that prioritise women and marginalised groups, particularly in sectors such as healthcare, education, and economic participation.<br>• Explore mechanisms through dedicated trust fund vehicles to secure domestic and international grants or private sector investments for funding sustainable cooling projects, such as Central/local Environmental Protection Funds and local development and investment funds. | • Employ local green bond tools to stimulate investment by enabling cities to secure long-term debt at stable prices. |

| Recommendations #4 - Financial | | |
|---|---|---|
| **Short term (<5 years)** | **Medium term (5-10 years)** | **Long term (>10 years)** |
| **Policy support** | | |
| At the National level:<br>• Allocate grant resources according to Decree 20/2023/ND-CP and Decree 114/2021/ND-CP to implement projects that enhance capacity and awareness regarding the benefits of energy efficiency and sustainable cooling.<br>• Promote the process of amending the Law on Energy Efficiency and Conservation (currently led by MOIT) to enhance regulations related to the ESCO model.<br>• Promptly issue Viet Nam's green taxonomy to promote green finance.<br>• Implementation of the Prime Minister's Decision No. 496/QĐ-TTg dated June 11, 2024: (i) Strengthen cooperation with domestic and international organisations and financial funds to establish a sustainable financial arrangement for sustainable cooling; (ii) Enhance the capacity of the Viet Nam Environmental Protection Fund<br>At the City level (for Can Tho city):<br>• Implement the Prime Minister's Decision No. 496/QĐ-TTg dated June 11, 2024: Mobilise both domestic and international resources to assist businesses in accessing investment opportunities for technology transition towards sustainable cooling.<br>• Implement the pilot projects identified for the city of Can Tho, as outlined in Annex 8, specifically the project endorsed in Annex 9. | At the National level:<br>• Refine regulations on green bonds and green finance mechanisms in line with the green taxonomy regulations issued in the previous phase.<br>• Promote the implementation of regulations on the ESCO model that are amended in the Energy Efficiency Law in the previous phase.<br>• Continue to implement the Prime Minister's Decision No. 496/QĐ-TTg dated June 11, 2024, regarding strengthening cooperation with domestic and international organisations and financial funds to establish a sustainable financial arrangement for sustainable cooling.<br>At the City level (for Can Tho city):<br>• Implement and apply the new regulations issued by the Government within the jurisdiction of Can Tho city. | At the National level:<br>• Intensify the enforcement and refinement of regulations on green bonds and green taxonomy<br>At the City level (for Can Tho city):<br>• Implement and apply the new regulations issued by the Government within the jurisdiction of Can Tho city. |
| **Key stakeholders (Implementation body)** | | |
| • Policy makers at national level: MAE, MoF, MoC, MoIT<br>• Policy makers at city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>• Public/Commercial banks, FIs | • Policy makers at national level: MAE, MoF, MoC, MoIT<br>• Policy makers at city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>• Public/Commercial banks, FIs | • Policy makers at national level: MAE, MoF, MoC, MoIT<br>• Policy makers at city-level: Provincial People Committee, DAE, DoF, DoC, DoIT<br>• Public/Commercial banks, FIs |

| Recommendations #5 - Other | | |
|---|---|---|
| **Short term (<5 years)** | **Medium term (5-10 years)** | **Long term (>10 years)** |
| **Action/Activities** | | |
| • Development of warning systems to safeguard residents against extreme heat<br>• Establish data collection systems for gathering energy audit reports for buildings, equipment in use, associated efficiency and data on kWh/$m^2$ of cooling demand and total built-up area of various building typologies in $m^2$<br>• Further develop the pilot projects identified and endorsed by the Can Tho government to pre-/ feasibility studies and integrate the identified potential cooling technologies into urban planning, design and other stages of project development.<br>• Conduct a gender-disaggregated assessment of labour division and adaptive capacities to heat stress with the help of city-led surveys or leveraging existing data sources to better understand gender-specific vulnerabilities and inform more inclusive adaptation strategies. | • Reduction of anthropogenic heat by transforming transport system<br>• Collect annual data for kWh/$m^2$ and total built-up area by $m^2$<br>• Consult various stakeholders including most vulnerable women and men in the communities throughout the interventions. | • Develop a comprehensive and current database on reliable metrics related to urban cooling and land use planning.<br>• Establish Weather Stations for monitoring urban heat, environment parameters- across the city and also establish Early Warning Systems. |
| **Policy support** | | |
| • On April 1, 2022, the People's Committee of the city issued Decision No. 1160/ QĐ-UBND, approving the Action Plan for Climate Change Response for the period 2021 - 2030, with a vision to 2050 in the city of Can Tho. | • On a national level, the Minister of Transport approved the action programme for transitioning to green energy and mitigating $CO_2$ and $CH_4$ emissions from transportation, as per Decision No. 876/QD-TTg dated July 22, 2022.<br>• At the city level (Can Tho city), Plan 114/KH-UBND was implemented in 2023. This plan carries out the action programme for transitioning to green energy and reducing $CO_2$ and methane emissions from the transportation sector within the Can Tho city. | - |
| **Key stakeholders (Implementation body)** | | |
| • Policy makers at city-level: Provincial People Committee, DAE, DOF, DoC, DoIT<br>• Others: Associations (Can Tho Women's Union, Can Tho Youth Union) R&D centre, Institutes, Universities | • Policy makers at national level: MAE, MoC, MoIT.<br>• Policy makers at city-level: Provincial People Committee, DAE, DOF, DoC, DoIT<br>• Transport enterprises, citizens,<br>• Others: Associations (Can Tho Women's Union, Can Tho Youth Union) R&D centre, Institutes, Universities | |

**Figure 43: Suggested Governance and Support Framework for Sustainable Urban Cooling in Viet Nam at a National and Provincial/City Level.**




**Legend:**

MOF: Ministry of Finance
MOIT: Ministry of Industry and Trade
MAE: Ministry of Agriculture and Environment
MOC: Ministry of Construction
MOST: Ministry of Science and Technology
DOF: Department of Finance
DOIT: Department of Industry and Trade
DAE: Department of Agriculture and Environment
DOC: Department of Construction
DOST: Department of Science and Technology

Photo: Can Tho Bridge
Credit: Istock

# Annex 1. Current situation of urban and building design in Can Tho City

The evaluation of heat-considerate urban and building design was carried out based on desk research and field visits taken in 2023 throughout urban and rural districts of Can Tho. Major outdoor public spaces and building categories / typologies were scanned for currently applied heat mitigation and cooling measures. Practical situation of heat-considerate urban and building design is described below.

Figure below give actual perspectives of urban public spaces including a central square of Co Do rural district (a), a central mini park of O Mon urban district (b), a central square of Vinh Thanh rural district (c), and a riverside central park of Song Hau in Ninh Kieu central business district (d).

**Urban Public spaces in Can Tho**

A central square of Co Do rural district

A pergola at a public mini park in O Mon urban district (b)

A pergola at a public mini park in Vinh Thanh rural district (c)

Song Hau large park in the CBD of Ninh Kieu (d)

It is clear that plant- and water-based solutions are the most-frequently observed measures for mitigating urban heat in the city's public spaces. For a variety of historical places located in urban districts, a major shelter against heat is shades from high trees whose height is greater than 10m. The plantation of high and dense canopy trees is normally combined with grassed surfaces to reduce further heat absorption at ground level. Furthermore, urban parks are intentionally planned by and close to large-scale running water, which triggers cooling potential of vegetation.

The development of open squares is also observed in political and business neighbourhoods of rural districts where urbanisation plans were and have been realised. Since the development schemes of urbanised neighbourhoods in rural districts were initiated roughly a decade behind the ones of historical urban districts, fully grown high vegetation is hardly observed. In addition, few measures from public utilities that protect users from the heat are captured.

Although tree-related solutions were realised in the development of public spaces, the use of cool materials and active cooling equipment were not considered. In fact, open spaces were paved with conventional hard surfaces of e.g. bricks, concrete but not the permeable and low heat-absorbed materials. In addition, no outdoor cooling equipment e.g. water sprayer, fountain that provide further increase of cooling performance were found.

**Typical streets in Can Tho**

A central street as connector of Nam Long, new neighbourhood in Cai Rang

A neighbourhood-level street in 91B neighbourhood (Ninh Kieu)

A neighbourhood street in Tay Do cultural neighbourhood (Cai Rang)

A district-level street in Thot Not urban district

Beside public spaces, streets were also scanned for existing cooling elements and solutions. Vegetation is again the primary and only cooling element, while the provision of extra shading from buildings' gallery or canopy pedestrian streets are currently absent. However, the fully grown and healthy trees for shade were observed merely in historical neighbourhoods, while the majority of newly developed / renovated streets were barely exposed to strong solar radiation. Several urban streets were planned with less than 3-meter sidewalks as shown in figures below thus challenging the plantation of street trees. The urban districts are also characterised with densely populated neighbourhoods structured by narrow alleys. These neighbourhoods have been experiencing shortage of either heat mitigation or cooling measures.

## Residential spaces in Can Tho

A typical urban house in a small alley in the urban district of Ninh Kieu

A typical townhouse in the urban district of Ninh Kieu

A typical residential buildings in rural district of Phong Dien

Newly-built modern residential buildings in rural district of Phong Dien

**UHI pan-city profile**

In this study, LANDSAT 5, 8 and 9 satellite images for a 10 year-period from 2013 to 2023 were used to analyse the patterns and trends of urban surface temperature, cover of vegetation, water surfaces, and buildings. A domain framed by a 15x15-km square was selected for the analysis of LANDSAT images to completely cover the territory of Can Tho city.

Type 1: 100-m resolution satellite images captured at ~10:30 a.m during hot and dry months

Type 2: 30-m resolution satellite images captured at ~10:30 a.m during hot and dry months

The type-1 LANDSAT images were used to estimate and visualise the spatial variation of LST at ~10.30, which provides insights into daytime UHI pattern for the detection of typical hot spots, i.e. locations exposed to high heat level.

The type-2 LANDSAT images were exploited for the calculation and visualisation of correlation between LST and specific factors including buildings, vegetation and water. In respective order, these indices are considered: Normalised Difference Building Index (NDBI), Normalised Difference Vegetation Index (NDVI), (Modified) Normalised Difference Water Index or ((m) NDWI). Further details on fundamentals of these three indices can be found in the Annex …

**On-site measurement**

For the microclimate observation in Tam Ky, typical measurement points were conducted in typical areas: (1) urban historical neighbourhoods with densely built structures that are strongly exposed to high UHI intensity, and (2) rural / peri-urban neighbourhoods experiencing less intensified UHI with sparse built structures. Thus, in each neighbourhood typology, one location representing spatial morphology will be selected for monitoring of microclimate. The sampling point is in the centre of a homogeneous spatial condition where the radius varies from 200 to 500 m.

# Annex 2. In-operation power plants and electricity consumption by sectors in Can Tho city

**Table: Electricity generation units in Can Tho**

| Plant | Location | Type | Status | Capacity (MW) | Connection voltage level |
|---|---|---|---|---|---|
| Can Tho thermal power plant | Tra An | Thermal | In operation since 1999; using FO oil; expected to stop in 2025 | 188.16 | 110/220kV |
| O Mon thermal power plant #1 | Phuoc Thoi | Thermal | In operation since 2009, using FO oil, expected after 2024 using gas from block B | 330 | 110/220kV |
| O Mon Thermal power plant #2 | Phuoc Thoi | Thermal | In operation since 2015, using FO oil, expected after 2024 to use gas from block B | 330 | 110/220kV |
| Can Tho waste power plant | Changchun | Direct waste incineration technology | Active since 2018 | 7.5 | 22kV |
| Rooftop solar | | | Active since 2020 | 80 | 22kV |

The city's commercial electricity output in the 2016-2020 period for all economic sectors has increased gradually over the years. Specifically:

**Table: Electricity consumption by sectors**

*Unit: Million kWh*

| Sector | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| Agriculture, forestry & seafood | 31.71 | 38.05 | 44.84 | 58.86 | 63.98 |
| Construction industry | 1,058.31 | 1,078.27 | 1,163.44 | 1,246.61 | 1,269.50 |
| Commercial, hotels & restaurants | 150.19 | 171.30 | 188.21 | 197.79 | 179.72 |
| Management activities | 689.52 | 722.89 | 755.06 | 824.01 | 885.04 |
| Other | 99.14 | 102.26 | 106.60 | 119.40 | 127.94 |
| Total | 2,028.87 | 2,112.77 | 2,258.15 | 2,446.67 | 2,5626.18 |

# Annex 3. Stakeholders related to urban cooling and their roles

**Table: Stakeholders related to urban cooling and their roles**

| Institution type | Agency | Role and responsibility |
|---|---|---|
| National government | Ministry of Agriculture & Environment (MAE)<br><br>Ministry of Finance (MoF)<br><br>Ministry of Industry & Trade (MoIT)<br><br>Ministry of Construction (MoC)<br><br>Ministry of Science &Technology (MoST)<br><br>Department of Climate Change (DCC)<br><br>Viet Nam Environmental Protection Fund (VEPF) | **MAE** is a governmental agency performing the state management of the fields of land; water resources; mineral resources; geology; environment; hydrometeorology; climate change; survey and mapping; integrated management of natural resources and protection of the marine and island environment; and remote sensing; and state management of public services in the fields under its management.<br><br>**MoF** is responsible for the finances of Viet Nam, including managing the national budget, tax revenue, state assets, national financial reserves and the finances of state corporations. The Ministry manages the work of national accounting, state borrowing, the activities of stock markets, and the Department of Customs.<br><br>**MoIT** is the government ministry in Viet Nam responsible for the advancement, promotion, governance, regulation, management and growth of industry and trade.<br><br>**MoC** is a government ministry in Viet Nam responsible for state administration on construction, building materials, housing and office buildings, architecture, urban and rural construction planning, urban infrastructure, public services; and representing the owner of state capital in state-owned enterprises.<br><br>**MoST** is a government ministry in Viet Nam responsible for state administration of science and technology activities; development of science and technology potentials; intellectual property; standards, metrology and quality control; atomic energy, radiation and nuclear safety<br><br>**DCC,** under the MAE of Viet Nam, plays a pivotal role towards climate resilience and environmental protection, with a special emphasis on cooling and ozone layer preservation that is responsible for formulating policies, strategies, and action plans that align with both national priorities and international commitments, such as the Montreal Protocol, which aims to phase out substances that deplete the ozone layer.<br><br>**VEPF** is a state financial institution attached to MAE. It is responsible for receiving slate budget capital; fundings, contributions and entrusted capital from domestic and foreign organisations and individuals in order to finance environmental protection activities nationwide. |

| Institution type | Agency | Role and responsibility |
|---|---|---|
| City government | People's Committee<br><br>Department of Agriculture & Environment (DAE)<br><br>Department of Construction (DoC)<br><br>Department of Finance (DoF)<br><br>Department of Science & Technology (DoST)<br><br>Department of Industry & Trade (DoIT)<br><br>Department of Foreign Affairs (DoFA)<br><br>Department of Justice (DoJ)<br><br>Can Tho City Development Investment Fund (CADIF)<br><br>Can Tho Electricity company<br><br>Centre of Industry Promotion & Energy Efficiency of Can Tho<br><br>Centre for Resource & Environmental Monitoring<br><br>Investment Construction Project Management Board<br><br>Management Board of Export Processing & Industrial Zones | **Can Tho City People's Committee** is the executive body of People's Council, the administrative body of the State in localities, being responsible to People's Council at the same level and higher authorities.<br><br>**DAE** is a specialised agency under the People's Committee, tasked to provide and share information, data, natural resources and environmental products for organisations and individuals to exploit and use to serve state management of environmental protection and support socio-economic development.<br><br>**DoC** is a specialised agency under the People's Committee tasked to perform the function of advising and assisting the People's Committee of the province in the state management of: Construction planning; architecture; construction investment activities; urban development; infrastructure; houses; offices; real estate markets; building materials, etc.<br><br>**DoF** advises and assists Can Tho City People's Committees in state management of finance; state budget; taxes, charges, fees and other revenues of the state budget; the financial funds; state financial investment; corporate finance; accounting; independent auditing; pricing and financial services in the city and the department also performs a number of tasks and authorities authorised by Can Tho City People's Committee and in accordance with law.<br><br>**DoST** provides state management of scientific and technological activities; developing scientific and technological potentials; managing product quality metrological standards; managing intellectual property; managing radiation safety and nuclear in Can Tho City<br><br>**DoIT** is a specialised agency under the People's Committee tasked to perform management of all activities related to industry and trade, such as: mechanics, metallurgy, power, new power, recycled power, chemicals, industrial explosives, mining and minerals extraction, consumer production industry; food industry, other manufacturing industries; goods transportation within the province; imports and exports; market management, competition management; trade promotion; monopoly control; anti-dumping; anti-subsidise; consumer protection; e-commerce; commerce services; economic integration; management of industrial clusters and zones etc.<br><br>**DoFA** is a specialised agency under the People's Committee. Its function is to assist the People's Committee in State management in the field of local foreign affairs. It also carries out some duties, authorities according to the arrangement and the commission of People's Committee and current law.<br><br>**DoJ** is a specialised agency under the provincial People's Committee, functioning as an advisory body to the provincial People's Committee on state management in the following areas: legal drafting and implementation; monitoring law enforcement; reviewing, handling, and systematising legal documents; law dissemination and education; grassroots mediation; legal affairs; authentication; adoption; civil status; nationality; judicial records; state compensation; legal aid; lawyers, legal consultancy; notarisation; judicial expertise; asset auction; commercial arbitration; commercial mediation; bailiff services; asset management and liquidation enterprises; registration of security measures; enforcement of administrative sanctions; other legal affairs, and public service activities within the justice sector, as regulated by law.<br><br>**CADIF** is a state financial organisation responsible for receiving budget capital, mobilising capital from domestic & foreign organisations to invest in infrastructure & economic & social development of the city. |

| Institution type | Agency | Role and responsibility |
|---|---|---|
| | | **Can Tho Electricity Company** is a state-owned enterprise under the Southern Power Corporation (a dependent accounting enterprise) with the primary responsibilities of supplying electricity, managing operations, repairing, and constructing new power lines and electrical substations. The company also engages in business activities and develops the electrical system to serve residential, industrial, and commercial needs, as well as to support the socio-economic development and national defence and security throughout Can Tho City.<br><br>**Centre of Industry Promotion & Energy Efficiency of Can Tho** is a public non-business unit under the Department of Industry and Trade. Its functions are to support the state management of the Department of Industry and Trade in industry promotion activities, provide consultation on industrial development and energy efficiency, and offer public services in the fields of industry promotion, industrial development consultation, and energy efficiency in accordance with legal regulations.<br><br>Centre for Resource & Environmental Monitoring has the responsibilities in consulting and preparing reports on the current state of the environment; conducting Environmental Impact Assessments (EIA); developing Environmental Protection Plans; consulting, designing, constructing, and installing wastewater and exhaust gas treatment systems for production, business, and service facilities; providing information, training, and professional development consultancy services in resource and environmental management for organisations and individuals as needed.<br><br>· Investment Construction Project Management Board invests and gets authorised to invest in State-funded construction projects, monitors progress and quality of construction in the city.<br><br>· Management Board of Export Processing & Industrial Zones accelerates the construction progress of infrastructure while simultaneously promoting and calling for investment in Can Tho Industry Parks. |
| Academic | 0. Can Tho University (CTU)<br>1. Delta Research & global Observation Network (DRAGON) Mekong Institute<br>2. Institute of Economics & Science | CTU plays an important role in multi-disciplinary education and training, providing human resources for Can Tho city. It conducts training, scientific research, and supports transferring technology to serve the regional and national socio-economic development.<br><br>Dragon Mekong Institute aims to establish a global information network, enhance cooperation and share long-term experiences among global deltas in general, and between the Mississippi Delta and the Mekong Delta in particular.<br><br>Institute of Economics & Science is responsible for conducting research and providing professional advice to the Provincial People's Committee in the fields of development planning and policy, state management of socio-economic affairs, urbanisation and economic integration, and other issues at the request of the Provincial People's Committee |

<table>
<tr><th>Institution type</th><th>Agency</th><th>Role and responsibility</th></tr>
<tr><td>Private</td><td>3. Hoan My Cuu Long Hospital<br>4. Saigon Can Tho Trading Co., Ltd<br>5. Victoria Can Tho Company Ltd.<br>6. Can Tho Real Estate Company<br>7. Dai Thuan Thien Clean Agricultural Products Co., Ltd<br>8. Management Board of Cai Khe Trade Centre</td><td>Hoan My Cuu Long Hospital conducts clinical practices, education and research, provides high quality health care in the region.<br><br>Saigon Can Tho Trading Co., Ltd a joint-venture company between Saigon Co.op, SCID and C.T.C that constructed the Sense city trade centre in Can Tho with an area of 22,000 m2.<br><br>Victoria Can Tho Company Ltd. is a limited liability company that owns the Victoria resort in Can Tho<br><br>Hoang Quan Can Tho Investment Real Estate Joint Stock Company was founded in 2008, as one of the subsidiaries of Hoang Quan Group. According to the general orientation of the Group, Hoang Quan Can Tho Company operates in a closed model including: real estate, design, construction. To promote production and business activities, improve the efficiency and professionalism of services as well as contribute to improve the transparency in real estate transactions.<br><br>Dai Thuan Thien Clean Agricultural Products Co., Ltd founded in 2015, is a company that produces and distributes eco-friendly and safe fruit products using a unique ecological method with optimised production costs.<br><br>Management Board of Cai Khe Open Market is the management unit of Cai Khe Open Market that is bordered on one side by the river and on the other side by the street. Here they sell fresh products like fish, vegetables and other fresh foods. Across the street are some wholesalers for textiles and house wares.</td></tr>
<tr><td>Unions</td><td>9. Women's Union of Can Tho city<br>10. Can Tho City Youth Union<br>11. Union of Science & Technology Associations of Can Tho City<br>12. Cooperative Alliance</td><td>Women's Union of Can Tho is a socio – political organisation, widely gathering all classes of women in the city, having function of representation, protection of women's equality, democracy, legal and legitimate benefits, gather, propagate, educate, campaign, organise and guide women to implement Party's policies, State's law and policies.<br><br>Can Tho City Youth Union's strategic duty is to step up propagation, political and cultural education, the Party's directions and policies, the State's laws and it also helps raise political knowledge and spirits of Youth Union members.<br><br>Union of Science & Technology Associations brings together stakeholders in research and technological development, innovations, technical standards and qualifications, property rights protection, and other research and development operations.<br><br>Cooperative Alliance propagates, disseminates and organises the implementation of legal documents on collective economy, the core of which is the cooperatives and other related legal documents.</td></tr>
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# Annex 4. International best practice on sustainable cooling

**1. Country-level policies for urban cooling**

Numerous policies have been instituted globally at different levels to swiftly address episodes of extreme heat. Considering the climatic similarities between Cambodia, India, Australia, and Viet Nam, the following section will provide a detailed overview of their sustainable urban cooling initiatives.

***a) India***

In 2019, the Ministry of Environment, Forest and Climate Change of India (MoEF & CC) unveiled the India Cooling Action Plan (ICAP). The ICAP proposed a 20-year roadmap (from 2017 to 2037) to cater to the cooling requirements across various sectors. The primary aim of ICAP was to ensure universal access to sustainable cooling and thermal comfort while safeguarding the environment and promoting socio economic objectives for the community. The specific goals of ICAP included:

- Recognition of "cooling and related areas" as a thrust area of research under the national science and technology programme to support the development of technological solutions and encourage innovation;
- Reduction of cooling demand across sectors by 20% to 25% by 2037 - 2038;
- Reduction of refrigerant demand by 25% to 30% by 2037 - 2038;
- Reduction of cooling energy requirements by 25% to 40% by 2037 - 2038;
- In order to align energy efficiency with the HCFCs phase-out and high-GWP HFC phase-down timelines, the ICAP took into account interdependencies across policy measures. Reiterating the objectives of India's Country Programme for the phase-out of Ozone Depleting Substances (ODS), it also underlined the importance of minimising economic disruption and obsolescence costs while maximising indigenous manufacturing for both environmental and economic benefits.

By including both passive and active cooling techniques as well as the optimisation of cooling loads, the ICAP adopted a comprehensive and balanced methodology. The ICAP included, among other things:

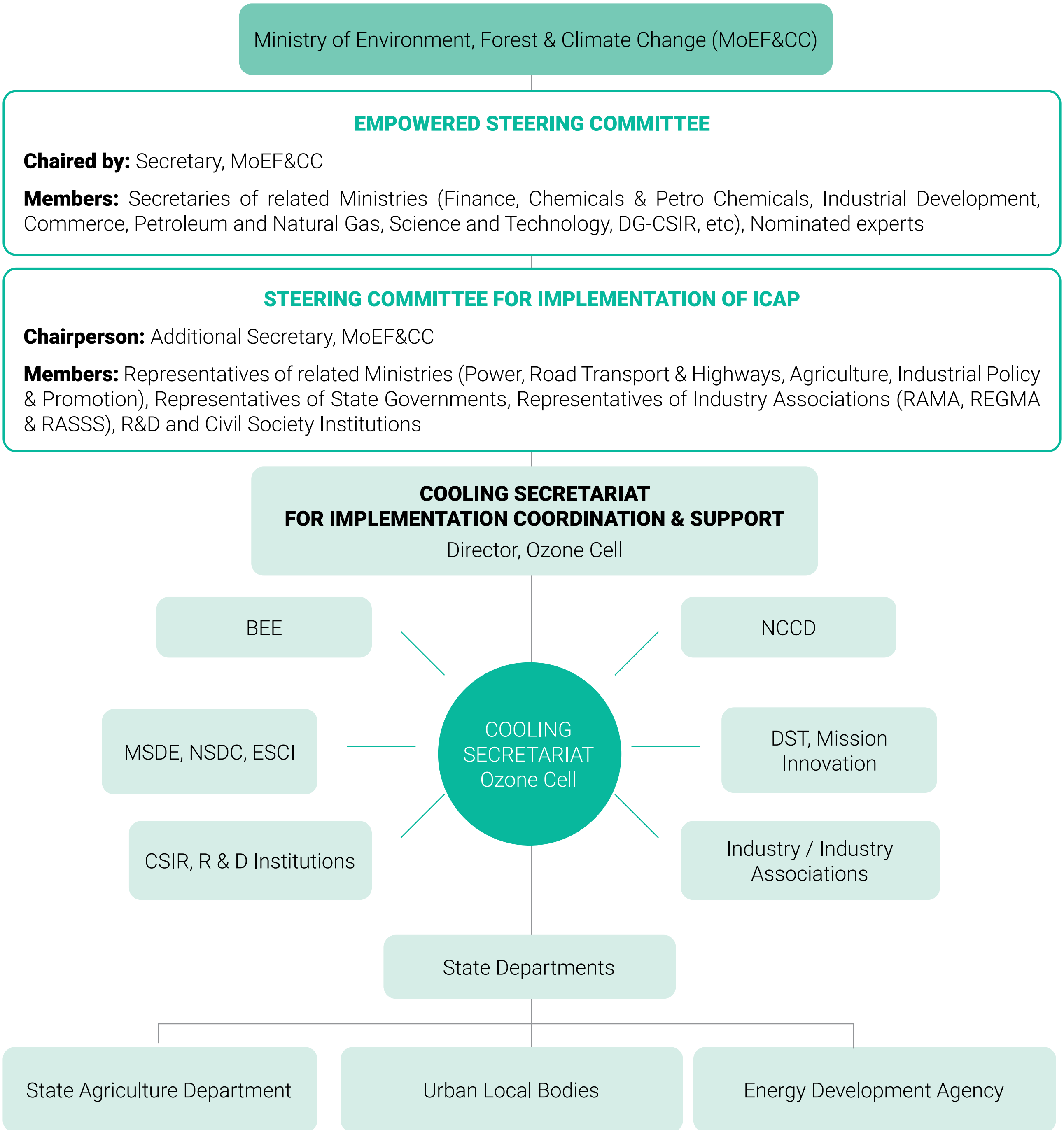
- Passively cooled building design that deployed natural and mechanical ventilation;
- Adoption of adaptive thermal comfort standards to specify pre-setting of temperatures of air conditioning equipment for commercial built spaces;
- Promoting the use of energy-efficient refrigerant-based appliances as well as not-in-kind technologies;
- Policy interventions for market transformation, including public procurement of energy-efficient refrigeration and air conditioning (RAC) appliances and equipment;
- Development of energy efficient and renewable energy-based cold chain;

- National skill development programme for training and certification for RAC service technicians to complement transition to energy efficient, low-GWP refrigerants;

- Focused R&D efforts to foster an innovative ecosystem to support the development and deployment of low-GWP refrigerant alternatives.

The ICAP emphasised the significance of continuing to develop and utilise a diverse range of cooling technologies, including the usage of energy-efficient appliances with appropriate environmentally friendly refrigerants, in order to fulfil the country's expanding cooling demand.

**Implementation Framework of India Cooling Action Plan**



As the solutions for cooling lie in the domain of multiple ministries, The India Cooling Action Plan was conceived as an inter-ministerial undertaking. A framework for the implementation of the plan showed the link between national and global cooling priorities, highlighting Government ministries and departments, as well as ongoing initiatives, interspersed with the cooling programme. ICAP implementation was supervised by the already established Inter-ministerial Empowered Steering Committee for the Montreal Protocol implementation, which was approved by the Union Cabinet. Other ministries were included in the Steering Committee depending on the actions that resulted from the ICAP recommendations. The MoEF&CC's Ozone Cell were strengthened and given the additional responsibility of serving as a cooling secretariat in order to support the Steering Committee and plan the activities that result from ICAP. ICAP determined that active cooperation between the necessary ministries and the businesses in the private sector would be to its best advantage. When necessary, the ICAP mandated the employment of relevant legislative, regulatory, and financial tools in addition to creating synergies with other government initiatives to carry out the essential steps. In order to expedite implementation, the related line ministries of the Government of India, the State Governments, and Urban Local Bodies might seek additional budgetary resources.

***b) Singapore***

According to the Centre for Climate Research Singapore, Singapore's highest daily temperature could reach 35 - 37 degrees Celsius by 2100 if the current pace of carbon emissions continues. The Urban Heat Island effect, which states that cities with high people densities and sophisticated infrastructure typically experience higher temperatures than rural areas, exacerbates this even further.

In response, in February 2021, the Singaporean government introduced the Singapore Green Plan 2030 (also known as the "Green Plan") as part of a nationwide initiative to support Singapore in fulfilling its commitments to sustainable development. The Green Plan prepared Singapore to meet its long-term goal of net-zero emissions as soon as it is practical and aims to mobilise strong, group action to combat climate change. The five main pillars of the Green Plan were: (i) City in nature; (ii) Sustainable living; (iii) Energy reset; (iv) Green economy; and (v) Resilient future.

The plan was led by five ministries - Education, National Development, Sustainability & The Environment, Trade & Industry and Transport. The government launched numerous initiatives and assistance programmes in the fields of research and development, energy, green finance, sustainable tourism, and land transportation to meet these goals.

Since then, the government started the "Keep Singapore Cool" campaign as part of the fifth pillar, "Resilient Future," to reduce urban heat increases by promoting greenery and testing cool paint on building exteriors. To mitigate the urban heat island effect, Singapore planned to:

- Improve understanding of the urban heat island effect by deploying a network of climate sensors across the island for data collection;
- Conduct research and modelling on urban heat island effect, such as through the Cooling Singapore 2.0 project;
- Collaborate with industry and public sectors to implement an urban heat island mitigation action plan, which includes pilot testing of cool materials and reducing human-generated heat.

According to Singapore's Green Plan 2030, a further 1000 hectares of green space would be set aside within 10 to 15 years, with every home being within a 10-minute walk of a park by 2030. Previously, more than 300 hectares of green space were added to new developments through the Landscaping for Urban Spaces and High-Rises (LUSH) programme. The use of vertical greenery on building facades is essential because it provides shade, lowers energy costs, and improves pedestrian comfort.

Furthermore, cool paint pilot programmes were introduced in public housing residential complexes, affecting about 80% of the population. According to preliminary research, cool paint coatings can lower surrounding building temperatures by up to 2°C.

A call to action to "Keep Singapore Cool" was also issued by Singapore's Ministry of Sustainability and the Environment. There were several ways that individuals can support this programme, such as:

- Raising the temperature settings on air conditioners can reduce both heat emissions into the environment and carbon emissions.
- Using air conditioners less frequently or opting for public transportation can also help reduce local urban heat island effects.
- The "Keep Singapore Cool" initiative required a collective effort from government bodies, academic institutions, private sectors, and individuals.

***c) Cambodia***

In 2022, Cambodia's Ministry of Environment published its "National Cooling Action Plan" (NCAP) to address rising urban cooling demand. The NCAP aims to create a national framework for sustainable, climate-friendly, and energy-efficient cooling, aligning with Cambodia's commitments under the Paris Agreement and the Kigali Amendment.

The NCAP is overseen by the Inter-sectoral Working Group for Environmental Protection, established in 2020, involving representatives from 13 ministries and other national bodies. The plan focuses on five key areas: Building Space Cooling, Food Cold Chain, Health-care Cold Chain, Mobile Air Conditioning, and Process Cooling.

By 2040, the NCAP aims to reduce emissions by 17% compared to 2020, with the building sector and food cold chain as major contributors. Proposed measures include improving urban planning and building design, promoting renewables-based cooling, enhancing cooling equipment efficiency, and protecting vulnerable populations from heat and cold chain failures.

**2. City-level policies for urban cooling**

***a) Western Sydney - Australia***

Western Sydney, already known for its warmer summer temperatures and heatwaves, is predicted to experience even more extreme weather. This could be exacerbated by an increasingly urbanised environment. The rate of heat-related deaths during heatwaves in Western Sydney is three times higher than on the city's east side. This is due to temperatures in the west reaching up to 6-10°C higher during extreme events. (Sydney Water Corporation, 2017).

As a result, the "Turn Down the Heat Strategy and Action Plan" was introduced and implemented in Western Sydney, Australia. This comprehensive action plan was developed by seven local city councils in Greater Western Sydney (UNEP, 2021). The critical concerns of urban heat in Western Sydney were the focus of this Action Plan, which attempted to raise awareness and encourage a larger and more coordinated response. Western Sydney's Action Plan was published in 2018 and was organised based on five strategic drivers. These drivers include: (i) Take action together; (ii) Design and plan to cool the built environment; (iii) Innovative and responsive infrastructure; (iv) Cool with green space and water; and (v) Build a community that is healthy and prepared.

As a response to the drivers mentioned earlier, the Action Plan for Western Sydney was a highly synergistic endeavour. It amalgamated the insights and recommendations of a diverse array of stakeholders, including local councils, state government, corporations, businesses, researchers, and key infrastructure and service providers. Leaders from various organisations and institutions joined forces in this Action Plan to amplify awareness about the issue of urban heat and catalyse action. Consequently, alterations to regulatory laws and other opportunities to mitigate the built environment's contribution to urban heat could potentially influence the planning and design outcomes of numerous ongoing development projects in Western Sydney. The action plan harnessed Western Sydney's parks, waterways, and green spaces to reduce temperatures in existing public and private areas. It also strived to enhance public cognisance of urban greening and water-sensitive urban design, ensuring that future spaces would be designed with urban heat considerations in mind.

***b) Ahmedabad Municipal Corporation, India***

At the local level, in 2013, the Ahmedabad Municipal Corporation (India) constructed the country's first Heat Action Plan and Warning System with four main areas: (i) An early warning system and interagency emergency response plan; (ii) Public awareness and community outreach; (iii) Capacity-building among medical professionals; and (iv) Reducing heat exposure and promoting adaptive measures (ESMAP, 2020).

This Heat Action Plan (HAP) aimed to raise awareness of the risks associated with heat-related illnesses and provide strategies to mitigate those risks. It involved community participation through training and capacity building, informational campaigns, and targeted assistance for vulnerable groups. The HAP identified at-risk groups, the factors that increase their risk, and methods and coordinated heat-related interventions. To support the HAP, the city, in collaboration with researchers and the Natural Resources Defence Council, published studies on household vulnerability, excess mortality related to the 2010 heatwave, evidence-based recommendations to address heat for residents of informal settlements, and outdoor workers, as well as recommendations for health professionals and government officials (UNEP, 2021). The HAP was reviewed and modified yearly, allowing the city to scale down its goals and improve on what has been discovered.

The early warning system that AMC utilised to determine the activation of its heat action plan formed the crux of the plan. Designated AMC Nodal Officers were tasked with coordinating parties and ensuring the implementation of the Heat Action Plan. As temperatures escalated, AMC collaborated with a telecommunications provider to alert the public, thereby fostering community awareness. Media entities and television networks also joined forces to issue public warnings. Moreover, HAP officers conducted educational sessions for children and organised weekly meetings with NGOs and slum leaders. The HAP also incorporated guidelines for healthcare professionals on identifying and managing heat-related ailments. The Heat Action Plan advocated for the provision of potable drinking water and air-conditioned spaces during periods of intense heat. The Heat Action Plan introduced a cool roof initiative to promote passive cooling roofs.

**3. City-level best practices: Technical Solutions**

This section provides an overview of technical solutions applied in cities/sites around the world with the goal of reducing the impact of urban heat islands. Main solutions include planning and redesigning urban areas; leveraging natural-based solutions; and applying modern technologies to help cool down buildings, offices, etc.

***a) Urban planning and design***

Good technical practices include urban planning and design, the exploitation of nature-based spaces, the application of highly reflective materials, the use of environmentally friendly vehicles, etc. Starting with urban planning, by situating various land uses to prevent the formation of heat islands, utilising prevailing winds, and designing neighbourhoods to minimise the need for driving, cities can lessen the effects of the built environment. It was proven that areas with buildings spaced farther apart are cooler than dense communities and the coolest parts are normally those with higher loads of green spaces and water bodies (Stewart, Oke and Krayenhoff, 2014; Geletič, Lehnert and Dobrovolný, 2016; Shih, 2017).

*(i) Urban geometry*: It has been proven that cities are hotter than surrounding areas since they have more sun-absorption surfaces than natural-based surfaces. Urban planning creates an urban canyon effect, causing cities to be surrounded by high-rise buildings, leading to heat

traps and reducing ventilation (UNEP, 2021). In addition, heat and emissions from vehicles and human activities also cause heat gain in urban areas. To counter these effects, cities can:

- Minimising solar gain, or the quantity of sunlight that is absorbed by constructed surfaces (e.g., by using green walls and roofs, trees, and man-made structures that shade these surfaces);
- Minimising the amount of heat generated in the city (e.g., by switching from using fuel-powered vehicles to electric vehicles, and by using less mechanical cooling);
- Dissipating heat by increasing ventilation through urban planning.

In terms of urban geometry, the amount of heat island intensity in a particular location is influenced by the size, density, form, and use of buildings. Because of the difference in building density and land cover, areas with mid-rise buildings spaced apart typically have a higher diurnal range (i.e., cool down more at night) than those with mid-rise buildings close together (UNEP, 2021). Due to waste heat generation and excessive energy use, industrial regions are frequently hotter than other areas. For this reason, it is thought that re-arranging the spaces inside an urban region is crucial to achieving sustainable cooling.

In urban areas, blocks of large and tall buildings create "urban canyons" that obstruct airflow and retain heat and pollutants. For pollutants and heat to escape and for thermal comfort to rise, improved ventilation is essential. However, the planning and arrangement of buildings is considered very complicated. Reducing the density and height of buildings may help reduce heat but does not improve wind flow (UNEP, 2021). Meanwhile, building a skyscraper between mid-rise buildings helps increase wind speed on the windward side but creates a "wind shadow" effect on its downside (UNEP, 2021).

Therefore, the application of planning models is thought to be a crucial tool for aiding planners in their understanding of local circumstances and factor interactions. In Singapore, a significant research project called Cooling Singapore aims to develop a decision-supporting system for lowering urban heat islands using historical and current region- and micro-scale modelling (UNEP, 2021). Since 2017, researchers have been combining computational models of the environment, land surface, industry, traffic, and building energy and customising them for regional circumstances.

To enhance ventilation, main streets might be placed parallel to the wind direction. In the Philippines, the government converted a military base into a new planned city while considering sun and wind patterns in various seasons to make outdoor spaces more livable and comfortable in the hot and humid climate (UNEP, 2021). One other example is in Hong Kong where major streets run perpendicular to the coast and extend to the coastline to take advantage of sea breezes (UNEP, 2021).

Orienting main streets parallel to the wind direction means that some streets will be placed perpendicular, creating urban canyons. In this instance, the ratio between the height and width of urban canyons will determine the wind characteristics. If this ratio is greater than 0.7 (meaning the height of the buildings is roughly equal to the width of a street) then air will frequently be trapped. Extending streets is thought to be a good way to improve air ventilation. The density of buildings is also decreased by widening the streets, although it should be emphasised that this will also increase vehicle heat emissions.

The urban canyon's "shape" affects ventilation as well. Wind speeds are reduced by relatively uniform urban canyon walls. A "step-up configuration" allows the wind to reach the leeward side of each structure and increases wind speeds at pedestrian height across a succession of buildings due to the fact that the upwind building is shorter (by one or two floors) than the downwind building.

One other strategy to increase ventilation is to create a void deck or cutout in the ground area to enhance pedestrian-level wind flow. In Singapore, void decks or cutouts have been created to enhance ventilation, instead of the ground level of a building. Unique to Singapore, the phrase “void deck”, describes the ground floor of the Housing and Development Board (HDB) buildings that have been left open as a protected area that locals can freely use to meet friends (National Heritage Board, 2013). To this day, void decks can also be an area for convenience shops or an early education centre. Void decks can increase pedestrian-level wind flow in urban canyons (UNEP, 2021). In terms of designing for thermal comfort, balancing shade and sun is an important decision. Technically speaking, the balance is between the aspect ratio and the sky view factor, which is the ratio of the visible sky to the hemisphere centred over a particular location from any given place (UNEP, 2021). High aspect ratios can result in less airflow, but they can produce more shade, which is beneficial in hot climates. Planners can help in shaping structures that are appropriate for their climates and that give surrounding buildings access to sunlight, shadow, and views of the sky.

*(ii) Nature-based solution:* As mentioned above, the most cost-effective solution to enhance outdoor thermal comfort is nature-based infrastructures (trees, vegetation, and water bodies). These nature-based infrastructures can reduce temperature, provide shade, enhance ventilation, and act as emission sinks. In the US, the value of the heat-reducing benefits provided by urban tree cover is estimated to be between $5.3 billion and $12.1 billion yearly. The maximum temperature that 77 million people would experience on hot days would drop by 1°C if $100 million was invested globally in street trees each year (UNEP, 2021). As mentioned by UNEP, parks and other large green areas can offer a number of advantages both inside and outside of their boundaries. Warm air rises above ground and cool air disperses as a result of convection currents caused by transpiration from the plants, which cools the area around it. Parks and urban forests can have a cooling impact that reaches up to 800 metres beyond the park (UNEP, 2021). Additionally, individual green areas can chill the area around them, and a city’s total air temperature can be lowered by the combined effect of all its green spaces. In Seoul (Korea), within 5 years, nearly 2000 urban forests and gardens of different sizes were added (Rim, R, 2018). However, urban parks or forests must be evenly distributed throughout a city to reap these advantages and guarantee that even residents of low-income areas can experience thermal comfort. In Chile, on average, the five wealthiest cities had access to over five times as much public green space as the five poorest municipalities (UNEP, 2021). According to UNDP, “An accessible park is one that is available to all, reachable and welcome to all”. Similar to vegetation, water bodies such as lakes, ponds, wetlands, etc, can bring about many benefits including evaporative cooling. The cooling effect increases as the area of water increases, enabling cooling from up to a kilometre away. Cooling is more effective when there is a buffer between the water and surrounding buildings or dense vegetation. By carefully planning their waterfront expansion and preserving existing areas, cities may optimise the advantages of blue spaces. In India, the traditional step wells offer various degrees of cooling as well as shaded areas for relaxation.

(iii) *Materials:* In addition, many cities have substituted high sun-light reflectivity materials for pavement, walls, and roofs, also known as cool surfaces. Cool surfaces are created by making the wall, pavement, or roof surface colour lighter to reflect more solar energy in the visible spectrum. Reduced peak energy load, reduced direct and indirect cooling energy use, and decreased energy costs are all benefits of cool surfaces. In some circumstances, the extended surface life of all cool surfaces as well as the advantages of lower urban heat on air quality and human health are positives. Between 20 and 65 percent of a city’s surfaces are made up of pavement, which presents a substantial potential to cool these heated surfaces (ESMAP, 2020). Albedo, or solar reflectivity, is initially as low as 0.05 in traditional asphalt pavement and can rise to 0.20 as it becomes lighter with use. The surface temperature of asphalt or concrete can be lowered by 3-5°C by increasing surface albedo by 0.1, according to multiple studies. Not only does it aid in cooling, but lowering pavement temperature can also greatly increase pavement longevity. Several cities, including Los Angeles, Phoenix, and Tokyo have piloted cool pavements on roads (UNEP, 2021). In order to speed up the availability and affordability of these solutions, these cities attempted to demonstrate demand for cool pavements. In the long run, they hope to set procurement specification standards that cities may utilise. However, it is recommended that green surfaces (using vegetation) are better than using reflective materials, due to the fact that highly reflective materials reflect solar radiation back to pedestrians, and poorer thermal performance (Nazanin et al., 2020). Therefore, careful evaluation and calculations are needed before applying reflective pavements.

Another material solution is permeable pavements. By using this solution in place of traditional materials, evaporative cooling, and stormwater management are made possible by runoff and stormwater passing through the pavement and its bed. Not only are permeable pavements used to manage runoff, but they also lower air temperature by evaporating the moisture they contain (UNEP, 2021). In low-traffic locations where stormwater management would be beneficial, permeable pavements are effective. It is crucial to ensure that permeable pavements are positioned to prevent them from absorbing large amounts of pollutants or spilling the water they collect into nearby natural bodies of water (UNEP, 2021). However, the expense of permeable pavements is higher, and they need to be maintained frequently.

In some countries, cool roof solutions have also been applied. Since rooftops often comprise up to 25 - 30% of a city's surface area, they offer a considerable opportunity for cities to lower the amount of heat they absorb (UNEP, 2021). Cool roofs can be applied to almost any form of building in the globe, and they are typically affordable. A large range of highly reflective roofing solutions are available for almost every type of roof surface utilised globally. Cool roofs are often a no-regrets decision (UNEP, 2021). While all cool roofs lessen the impact of the urban heat island, single-story buildings with a high roof-to-wall area ratio benefit the most from their increased indoor thermal comfort (UNEP, 2021). Cool roofs and cool walls have also been piloted in low-income housing in India and South Africa (UNEP, 2021). Through the Million Cool Roofs Challenge, additional pilot projects were carried out in Bangladesh, Côte d'Ivoire, Indonesia, Kenya, Mexico, Niger, the Philippines, Rwanda, Senegal, and South Africa. Each project aimed to deploy one million square metres of cool roofs by August 2021 (UNEP, 2021). The benefits and principles of cool walls are identical to those of cool roofs. Cool walls require careful consideration when applied to structures that are close together and receive significant sunlight (UNEP, 2021). In this case, cool walls may reflect sunlight onto nearby structures, which could result in heat gain if those nearby buildings have absorbent surfaces. Moreover, cool walls or light-colour surface performance can be reduced due to lack of cleaning/maintenance after 2-3 years of use.

Green walls and roofs are an additional option, although they are more costly and require more maintenance. By combining the advantages of cool walls and roofs with vegetation, green roofs, and walls can minimise runoff, prevent solar gain on structures, and cool the surrounding air through evapotranspiration. In cities with enough precipitation, green roofs are most suitable; they require buildings that can sustain their weight (ESMAP, 2020). They can range from extensive green roofs, which have a thin covering of vegetation, to intensive green roofs, which have trees and plants. Green roofs have certain special advantages despite their expense. In addition to extending the life of the underlying roof, properly sized and maintained green roofs can be extremely beneficial to communities that are having difficulty managing surface runoff (UNEP, 2021). Further, in dense urban areas with insufficient green space, green roofs provide additional space, with all the co-benefits that green cover brings.

(iv) *Clean transpor*t: In the process of urban planning, it's important to prioritise the shift from conventional vehicles to electric ones. Public transportation should be favoured over private vehicles. To make bus and tram systems easily accessible, they should be built throughout residential areas. Walking and cycling routes should be incorporated to reduce the reliance on cars and motorcycles. Furthermore, to minimise commuting, essential services like grocery stores, clinics, and schools should be located near residential areas. For instance, in Paris, the local government transformed schoolyards into spaces for sports and cultural events. These schoolyards also serve as cooling oases, providing shade and water retention for not just students, but the entire community (City of Paris, 2020; City of Paris, 2021a; City of Paris, 2021b). These efforts are primarily aimed at reducing citizens' need for travel These efforts were mainly to reduce the need of the citizens for travel. In 2007, Ljubljana (Slovenia) published its 2025 Vision, which focused on greenery and access to open areas. To encourage walking and cycling, the city renovated major roads to be more pedestrian-friendly, closed over 10 hectares of the city centre to motor vehicle traffic, planted trees, and offered free electric taxis to tourists and residents with mobility issues (UNEP, 2021). These initiatives decreased the temperature, noise, and air pollution in the downtown area, revealing important synergies between planning for green space and reducing transportation. One other example was in Barcelona (Spain), in 2016 when they created the "superblocks" to minimise cars in the most trafficked areas and renovated these areas into parks or public squares for the community. This programme's main goals were to lessen air pollution, improve public safety, and encourage people to use public transportation. One more example of natural-based planning was in Medellin (Colombia) when the city created 18 green corridors along major roads and 18 along waterways (UNEP, 2021). Green corridors were concentrated in locations that had the highest temperatures and the fewest green spaces. Temperature drops of up to 4°C have already been recorded in the areas with green corridors.

***b) District cooling***

District cooling systems are an effective active cooling solution adopted in many countries. These systems generate chilled water at a central plant and distribute it to buildings through pipe networks. They are efficient as they can utilise underground heat sinks or free cooling sources, reduce energy consumption, and lower installed cooling capacity. However, due to the complexity of the investment, installation, and operation process, district cooling systems are relatively new to developing countries.

For instance, in Paris, district cooling has been in operation since the early 90s and is used for offices, banks, stores, museums, hotels, etc. The system leverages the Seine River as a heat sink instead of using a traditional cooling tower. When the river's water temperature drops below 8°C, it is directly distributed to these sites as "free cooling" (UNEP, 2021). Additionally, this system benefits from off-peak electricity rates during the night to store thermal energy for chilled water.

In the Philippines, the Philippine DCS Development Corporation operates the country's largest district cooling system (UNEP, 2021). This system, which includes a 3.4-kilometer underground distribution network, connects an initial plant with a refrigeration capacity of 8,000 tons (28.2 MW of refrigeration) in Northgate Cyberzone to 16 buildings. The project uniquely converted already-existing, occupied Filinvest buildings to the district cooling network, reportedly resulting in a net 40% reduction in energy consumption and enhancing the aesthetics and environmental rating of the existing buildings. This replaced older, less efficient building-distributed cooling systems.

In Cyberjaya, a tech hub in Malaysia, a district cooling system has been in operation since 1999. This system, with an initial capacity of 1,500 tons of refrigeration (5.3 MW), is set to expand to 25,950 tons across two district cooling plants (UNEP, 2021). It currently serves 48 buildings via a 12-kilometre pre-insulated distribution pipe network. The Malaysian government has committed to expanding the use of district cooling systems in public buildings to enhance their energy efficiency.

**4. City-level best practices: Non-technical Solutions**

***a) Baseline assessment***

Assessing current urban temperatures, providing cooling solutions and initiatives to increase public and official awareness, are all crucial. For instance, in Western Sydney, city councils collaborated with other stakeholders to publish the "Turn Down the Heat Strategy and Action Plan". This plan includes an assessment of the current state of urban heat in the area, predictions for future urban heat in Western Sydney, impacts of urban heat on people, infrastructure, the economy, and the environment, and a synthesis of current resources to cope with urban heat.

***b) Building energy codes***

Building energy codes are a proven solution adopted globally to enhance energy efficiency in buildings. For instance, China could potentially reduce its building energy consumption by 13 to 22% by the end of the century through the implementation and adherence to building efficiency rules (Evans, Roshchanka and Graham, 2017). Similarly, India could decrease cooling requirements in its commercial building stock by 20% by 2037-2038 through strict compliance with the building energy code (Ministry of Environment, Forest and Climate Change, 2019). In addition to building energy codes, various national and international green building certification and rating systems have been implemented. These can be either voluntary or mandatory. Examples include the US Energy Star commercial buildings programme and the globally recognised Leadership in Energy and Environmental Design (UNEP, 2021). Australia's national rating system, NABERS, is a mandated programme that assesses the environmental performance of residences, buildings, and tenancies (UNEP, 2021). Building energy benchmarking is another effective solution that helps quantify the energy performance of buildings. It allows tracking and comparing the energy efficiency performance of a building over time and with other similar buildings (UNEP, 2021). Cities can use it to set benchmarks for different sectors of the building stock and identify areas for improvement and variance. For example, New York enacted three local laws to access building energy performance data, including: (i) Submitting benchmarking data on energy and water consumption; (ii) Conducting regular energy audits and retro-commissioning measures; and (iii) Installing electrical sub-meters for large non-residential tenant spaces and providing monthly energy statements.

***c) Capacity building***

Training city staff on the importance of sustainable cooling solutions is crucial, particularly for procurement officials/staff who make purchasing decisions for municipal governments. They need to understand the benefits of sustainable procurement, relevant laws and regulations, and available resources. Cities can provide these tools, training, and outreach, or utilise state or federal resources. For instance, the Green Purchasing Network in Japan supports sustainable purchasing policies, maintains an eco-products database, and trains local government employees. Capacity building activities on urban cooling and energy efficiency can be incorporated into learning programmes. This includes enhancing the academic and professional competence of university lecturers and researchers. It's also important to improve university curriculums to strengthen the professional competence of students and professionals such as urban planners, architects, and engineers.

***d) Warning system for heat events***

Non-structural solutions such as extreme weather warnings or hot weather health advice hotlines can effectively mitigate heat stress effects. For instance, in Boston, USA, the City of Boston's Keep Cool app provides alerts on extreme heat events and maps for nearby cooling centres (UNEP, 2021). In India, with the assistance of the Indian Meteorological Department, over 100 cities and districts have established heat alert systems to provide early heat warnings to the community. Similarly, in New York, USA, the local government initiated a "Be-A-Buddy" pilot programme in 2018. This programme trains home healthcare aides to recognise the early stages of heat stress in their clients and educates them on risk reduction strategies (ESMAP, 2020).

***e) Exploitation of technology advancements***

In addition to the solutions previously mentioned, it's crucial to leverage the advancements in information technology to support urban cooling initiatives. This could involve creating a "digital twin" of cities, which would allow for more efficient management and evaluation of heat stress. The deployment of an Internet of Things (IoT) system could also be beneficial. Such a system would utilise a mix of professional and private sensors to map and identify areas at risk of heat stress. Furthermore, integrating thermal data into the city's comprehensive data repository could prove advantageous. By applying artificial intelligence algorithms to this data, authorities could be assisted in making informed decisions.

**5. Financial mobilisation**

In Cambodia's National Cooling Action Plan (NCAP), it's stated that both public and private sectors can contribute to cooling solutions. This includes climate change mitigation funds, multilateral development banks, and national and private financial institutions. These entities support sustainable cooling initiatives, initiate programmes, boost investor confidence, and attract private investors. The government also seeks external funding from multilateral and bilateral funds, and encourages private sector participation.

In India's Cooling Action Plan (ICAP), the financial mobilisation mechanism isn't explicitly stated. However, the Ministry of Finance is mentioned in the Implementation Framework, indicating that the financial mechanism will adhere to India's applicable laws and policies. In Ahmedabad, India, the Ahmedabad Municipal Corporation (AMC) has partnered with local businesses that have donated materials for cool roof projects in low-income communities. These initiatives provide necessary financial and technological resources for urban cooling.

In Gothenburg, Sweden, the local government issued green bonds in 2013 to finance sustainable and innovative projects, including district cooling projects. This is part of their aim to become a climate-neutral city by 2030. Between 2018 and 2021, Gothenburg and Göteborg Energi constructed a thermal energy storage tank to store thermal energy for use during the summer when demand is lower (Helena Granstedt Löfman, 2022).

**6. Lessons learnt for Viet Nam**

***a) Development and implementation of urban cooling policies:***

The lessons from policy clearly underscore the necessity of developing an urban cooling action plan. This plan can be formulated and executed both nationally and locally. Like other countries, Viet Nam's urban cooling strategy should involve a diverse group of stakeholders committed to mitigating the city's heat impact on its inhabitants. Government bodies, NGOs, research institutions, and civic organisations representing the public can all contribute to the design and execution of this urban cooling action plan. A clear implementation framework is crucial for the successful execution of specific programmes and actions, as it helps stakeholders understand their roles and responsibilities. The proposed implementation strategies require research and discussion from these groups.

On a local scale, Urban Cooling Action Plans can either be published separately or incorporated into a province or city's development plans. While the content of the National Plan may mirror this one, the target audience can be customised to suit each province's or city's unique circumstances. If urban cooling content is included in the Master Plans, localities should consider the strategic organisation of residential areas, buildings, parks, lakes, and industrial zones to leverage wind direction, shade, and other natural cooling features. Prioritising activities that promote awareness and training is also essential.

***b) Best practices: effective technical solutions***

The following technical solutions have been applied and proven effective in practice, and can be implemented in the urban areas/cities of Viet Nam:

*(i) City planning and design for climate resilience:*

- Street orientation planning: Cities should plan key streets that are perpendicular to the coast and reach the shoreline. This will help coastal or riverside cities, such as Can Tho, Tam Ky, and Dong Hoi, to harness sea breezes and increase ventilation.

- Avoid urban canyons: Urban planners should use models to account for local topography, historical data, weather data, etc., before making decisions. They should also study the "step-up configuration" model to allow wind to flow through leeward areas and increase wind speed at pedestrian height. For example, Singapore's "void decks" approach can improve ground-level ventilation and wind speed in buildings, while also providing extra living space.

- Enhance green spaces and water bodies: Cities should increase green spaces and water bodies on the streets to take advantage of the shade, natural cooling, and dust and emission absorption. For instance, building parks, planting trees along roads, placing greenery on rooftops or bus stops are simple ways to improve green spaces. Utilising the river system as a waterfront corridor rather than highways with rows of residences on either side will also help lower the temperature. City planners should ensure that parks and lakes are evenly distributed so that everyone can benefit from the cooling effects. The government should ensure that even low-income communities have access to parks or lakes, as well as public green spaces around residential areas

*(ii) Use high-albedo materials:* Cities should consider using materials that have high albedo, such as reflective pavement. However, they should also be aware that reflective materials can cause visual discomfort to residents or surrounding buildings. Therefore, environmentally friendly materials, such as permeable pavements can be considered. Permeable pavements can also help with stormwater management, especially in Can Tho. However, the costs of installation and maintenance of this kind of material should also be considered.

(iii) Use cool roof and cool wall solutions: Cities should also consider using cool roof and cool wall solutions, especially in high-rise buildings. Cool roofs can help increase the thermal cooling efficiency of buildings and reduce thermal discomfort for residents. Along with using high-albedo materials, buildings can install solar panels to help absorb heat and increase energy efficiency. Solar panels can also prevent solar gain on the roof, even though they absorb light rather than reflect it. Solar panels can be used in combination with cool surfaces and/or green roofs. Buildings used for public administration can start by installing low-heat glazing and painting the walls and roofs with lighter colours. To improve thermal comfort, buildings can also add trees to their terraces and roofs.

*(iv) Mobility Transition:* The initial step is to experiment with and gradually transition from conventional fossil fuel-based vehicles to electric vehicles. Cities must establish the necessary infrastructure, particularly electric vehicle charging stations, to ensure a smooth transition. It's possible to plant more trees or install green roofs at battery charging stations to provide shade and improve thermal comfort.

*(v) District Cooling:* Cities can evaluate the pre-feasibility of district cooling systems. Although this is a new solution for developing countries, water chiller systems are being used in many large buildings or enterprises throughout Viet Nam, demonstrating the potential for expanding this system. District cooling can be tested in industrial parks and small residential areas before being widely implemented, similar to the models used in Malaysia and the Philippines.

*(vi) Others:* Other options include building cooling facilities within communities for those living in densely populated areas, those who have to work outside, or the homeless. To provide people with more cover and a chance to cool off, bus stations may potentially add extra air conditioning or fans. Cities can also set up public water or drinking tap water to aid residents in rehydrating and lowering heat stress.

***c) Best practices: effective non-technical solutions***

In addition to the technical solutions mentioned above, Viet Nam could consider implementing non-technical measures to help raise awareness and expand the implementation of urban cooling nationwide, extending to provinces and cities. These specific measures include:

(i) Raising public awareness on the impact of extreme heat and the benefit of urban cooling:

- City governments should undertake studies to understand how excessive heat events affect people's health and socio-economic activities. The findings from these studies can be used to develop adaptable solutions that align with their urban heat reduction goals. This includes raising awareness among the public and officials about the effects of extreme heat. Strategies to mitigate these effects can be integrated through public forums, classroom presentations, or media campaigns. Topics might include the use of highly reflective materials in the design and upkeep of green spaces in residential areas.

- Early warning system for extreme heat: Cities can alert people about extreme heat events through mass media, particularly text messages and social networks. With this information, people can take proactive measures, especially those working outdoors. Information sites can guide people to places where they can escape the heat, such as community cooling centres, cinemas, shopping centres, or hospitals when there are health issues due to high temperatures.

- Social networking sites, especially Facebook, are currently effective at disseminating weather information. Many weather-related websites are highly trafficked and provide accurate information. To update individuals as quickly as possible, these information sites could be linked with meteorology-related divisions. These websites can also offer advice on the best times to be outdoors or how to dress appropriately to prevent heat absorption.

*(ii) Training programmes and capacity building:* Training and capacity building programmes initiatives should be provided for local officials to equip them with the necessary skills to adapt to extreme heat phenomena. These officials should take the lead in implementing strategies to reduce heat. They should be knowledgeable about methods to increase green space, utilise energy-efficient devices, and use materials that strongly reflect sunlight, especially those responsible for managing administrative buildings. Awards should be given to residents or officials who take innovative steps to mitigate heat stress in urban areas. Additionally, residents can be trained to provide medical assistance to those suffering from heatstroke or who are vulnerable to extreme temperatures.

*(iii) Promoting energy efficiency:* Cities could consider introducing an energy-efficiency grading system for specific buildings or awarding prizes for environmentally and climatically responsible structures. The implementation of these strategies should be tailored to the size of the cities. However, collectively, they represent the most fundamental measures a city can adopt to eliminate urban heat islands and ensure thermal comfort for its citizens.

***d) Financial mobilisation for urban cooling***

While the financial mechanisms for implementing a national action plan are not fully addressed in the aforementioned good practices, the "Beating The Heat: A Sustainable Cooling Handbook For Cities" (UNEP, 2021) lists some financial mechanisms as lessons for implementing national and sub-national action plans.

Firstly, national budgets are often used at the national or subnational level for strategies and programmes. The central government redirects funds from taxes or other resources to assist municipalities in implementing programmes. Alongside national budgets, taxes can provide additional funds, including (i) general tax revenues (such as property, sales, and income tax), or (ii) targeted environmental or location-specific taxes or surcharges related to the use of infrastructure services or other amenities.

Additionally, Official Development Assistance (ODA) and Dedicated Climate Funds are two popular financial tools for executing national action programmes. ODA projects are typically grants or subsidies from multilateral and bilateral sources. They often have a framework agreement that outlines the objectives for resource usage and place a strong emphasis on social and environmental safeguards intended to protect and nurture people. These funds may or may not include discounted (concessional) rates to ensure affordability, depending on a country's level of development. In Viet Nam, the management and use of ODA capital still face many challenges due to complex and inconsistent processes and procedures for managing programmes and projects using Viet Nam's ODA capital. Furthermore, there is a lack of a legal system and policies related to state management of ODA capital, coordination between ministries, between central and local levels, and with donors due to the capacity of people involved in project management, especially in localities.

Dedicated climate funds may include (i) loans/grants from the Global Environment Facility, Green Climate Fund, Climate Investment Funds, or country- or region-specific funds or (ii) carbon markets or other market-based climate instruments.

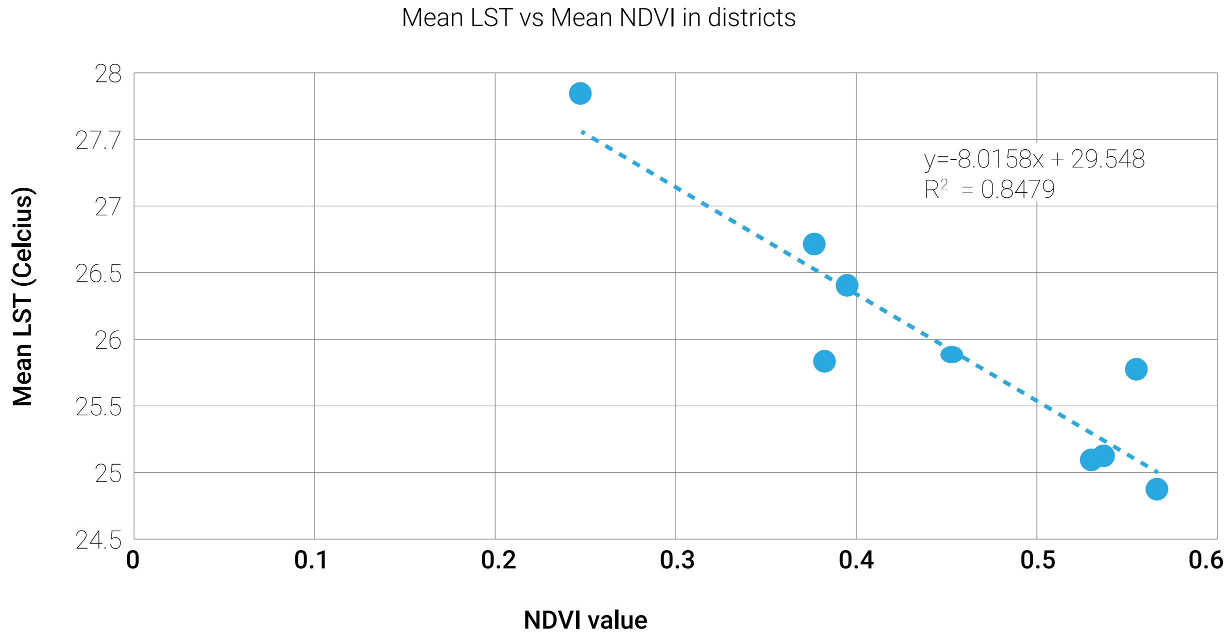
The dedicated climate funds could include an entitlement window with a resource flow that is guaranteed to each country based on predetermined criteria. Project-based submissions are also covered by some funding windows. For example, Athens' 2030 Resilience Strategy has been supported by a Natural Capital Finance Facility thanks to a €55 million ($65 million) loan approved by the European Investment Bank in 2018 (Climate Policy Initiative, 2021).

For practical structural solutions in an urban area, localities can take advantage of financial resources from dedicated climate funds (as above-mentioned) or government-issued debt. Government-issued debt may include: (i) general obligation bonds; (ii) special-purpose bonds; or (iii) green bonds or climate bonds (for dedicated environmental purposes). A city or system operator must have fundamental creditworthiness and an enabling environment to issue bonds for government-issued debt. Bonds are typically utilised to finance significant capital projects due to the high processing costs associated with bond issuance.

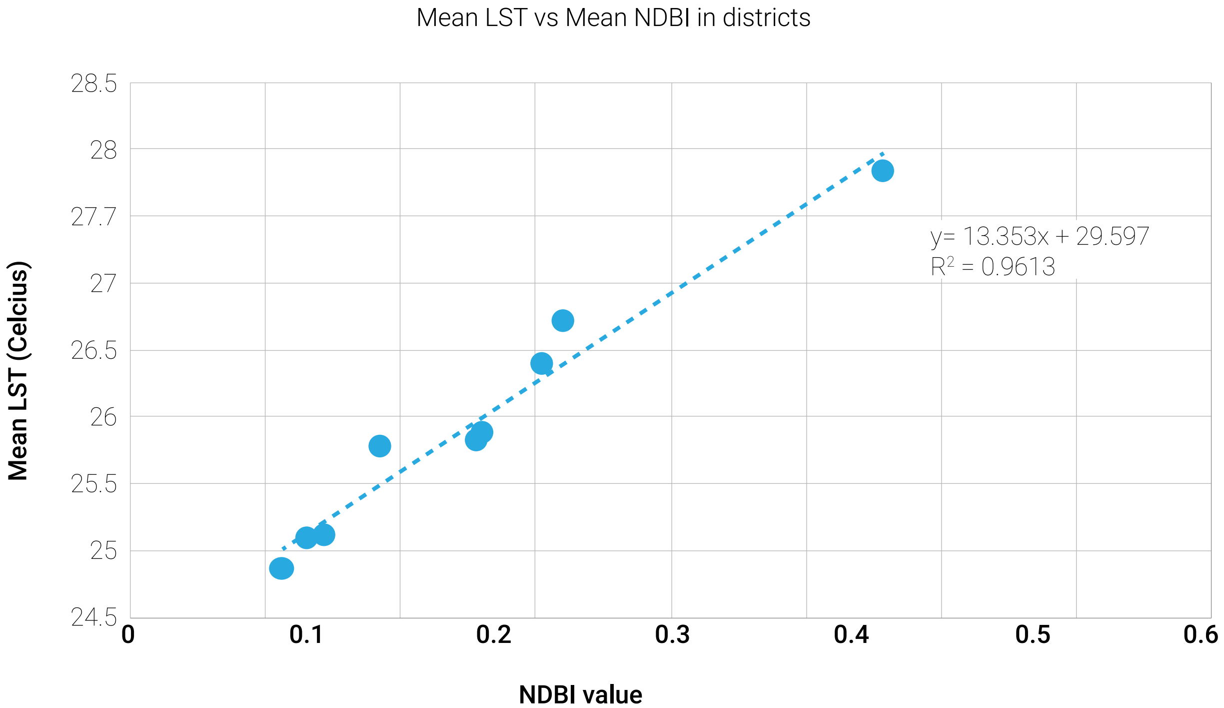
A public-private partnership between the locality's administration and a private contractor is another option for implementing the project. This concept is flexible and can take many different shapes, frequently focusing on how contracts can be set up to demand that the private contractor provide additional resources to upgrade or maintain the infrastructure system. A design-build-own-operate-maintain public-private partnership model might be used, for instance, to enable a district cooling infrastructure project when a city would like to maintain some level of control or is possibly the principal off-taker. In this situation, a private sector consortium will plan, design, construct, own, run, and maintain the project. This is sometimes done for a brief length of time under concessions, following which a transfer or extension will be discussed. By this concept, a local government would select the lowest levelised cost option, retain some degree of project control, and mobilise private sector funding.

# Annex 5. Correlation between Mean Land Surface Temperature and Mean NDVI and NDBI values

**Relation between Mean land surface temperature and Mean NDVI**




**Relation between Mean land surface temperature and Mean NDVI**



# Annex 6. Main assumptions for projection scenarios

Some of the main assumptions considered while developing the projections of cooling electricity consumption, peak cooling demand and GHG emissions and their results are presented in this Annex.

**Main assumptions for projections of scenarios**

1) Population in Can Tho

| Year | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|
| Thousand people | 1241 | 1304 | 1375 | 1431 | 1482 | 1530 | 1577 |
| % increase | 0.38% | 5.10% | 5.44% | 4.06% | 3.55% | 3.29% | 3.04% |

**Data are provided by Can Tho government document 'Can Tho Master Plan in the period of 2021-2030, vision to 2050'.*

2) Built-up area (m2) for different building typologies

| Year | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|
| Residential | 27710226 | 33015161 | 34812240 | 36227188 | 37513016 | 38748141 | 39924619 |
| Office | 299064 | 314319 | 331428 | 344899 | 357141 | 368900 | 380101 |
| Hotel | 129460 | 136063 | 143469 | 149301 | 154600 | 159690 | 164539 |
| Shopping mall | 62584 | 65776 | 69357 | 72176 | 74737 | 77198 | 79542 |
| Restaurant | 15646 | 16444 | 17339 | 18044 | 18684 | 19300 | 19886 |
| School | 65843 | 69202 | 72969 | 75934 | 78630 | 81218 | 83684 |

**Data for 2020 are provided by the Department of Construction Can Tho.*

***Data for residential buildings in 2020 and 2025 are provided by the urban planning document in Can Tho (Decision 1103/QĐ-UBND dated 25/3/2022).*

****Data for 2025-2050 are assumptions on the basis of an increased percentage of population.*

*****Restaurant built-up areas are estimated as 25% of shopping malls, on the basis of urban planning experiences.*

3) Emission factors (tCO2/MWh) of electricity grid in Can Tho

| Year | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|
| Scenario BAU | 0.7980 | 0.6766 | 0.6766 | 0.6428 | 0.6428 | 0.6106 | 0.6106 |
| Scenario UCAP | 0.7980 | 0.6766 | 0.6428 | 0.6106 | 0.5801 | 0.5511 | 0.5235 |

**Emission factors of 2022 are provided by document '327/BĐKH-PTCBT' from the Department of Climate Change. Assume the same value in both 2020 and 2025.*

**Assume 5% reduction in emission factors every 10 years from 2030 to 2050 in the BAU scenario.*

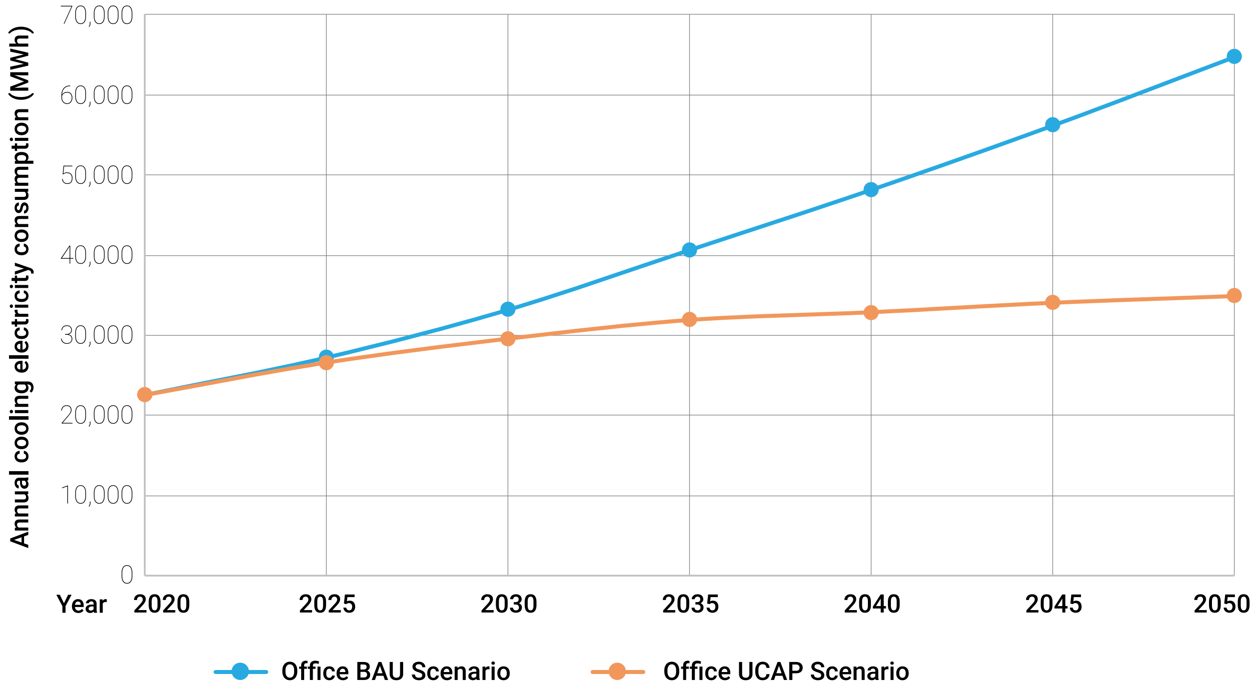
**Assume 5% reduction in emission factors every 5 years from 2030 to 2050 in the UCAP scenario.*

4) Percentage in specific building typologies with air conditioning

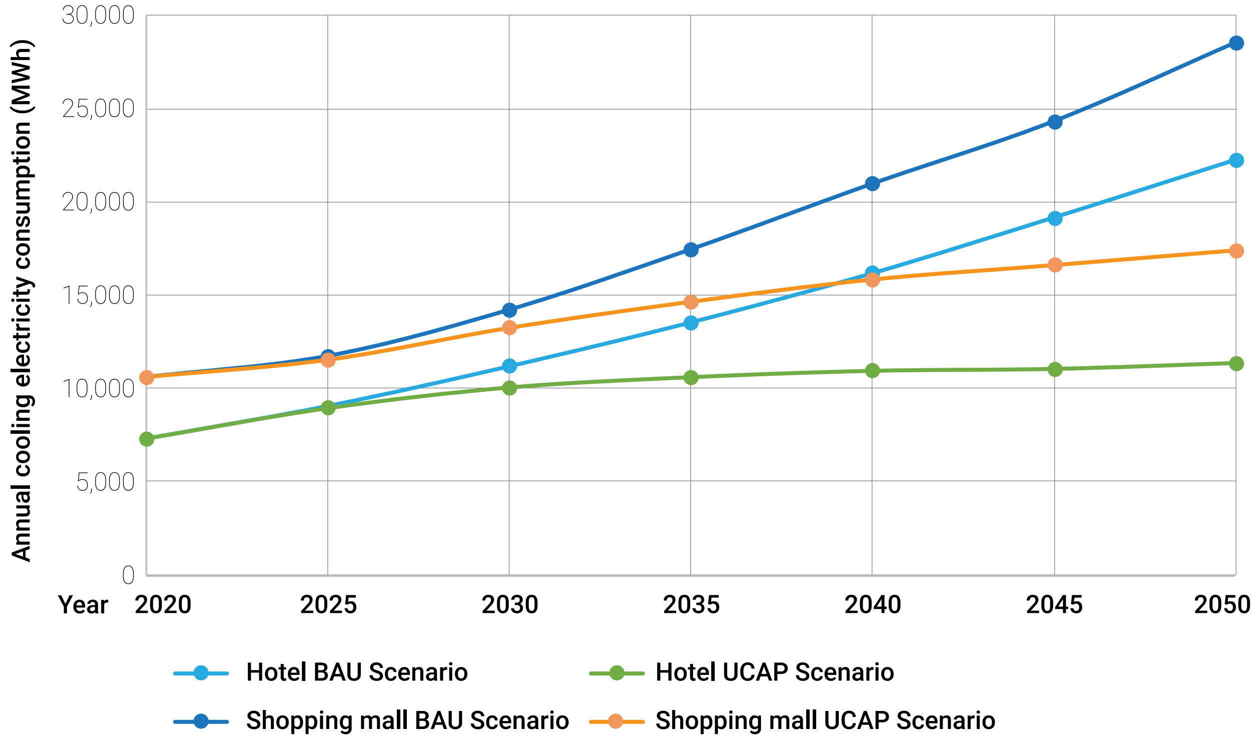
| Year | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|
| Residential | 40% | 45% | 50% | 55% | 60% | 65% | 70% |
| Office | 50% | 55% | 60% | 65% | 70% | 75% | 80% |
| Hotel | 60% | 65% | 70% | 75% | 80% | 85% | 90% |
| Shopping mall | 40% | 40% | 45% | 50% | 55% | 60% | 65% |
| Restaurant | 50% | 50% | 55% | 60% | 65% | 70% | 75% |
| School | 30% | 30% | 35% | 40% | 45% | 50% | 55% |

**Projections on cooling electricity consumption**

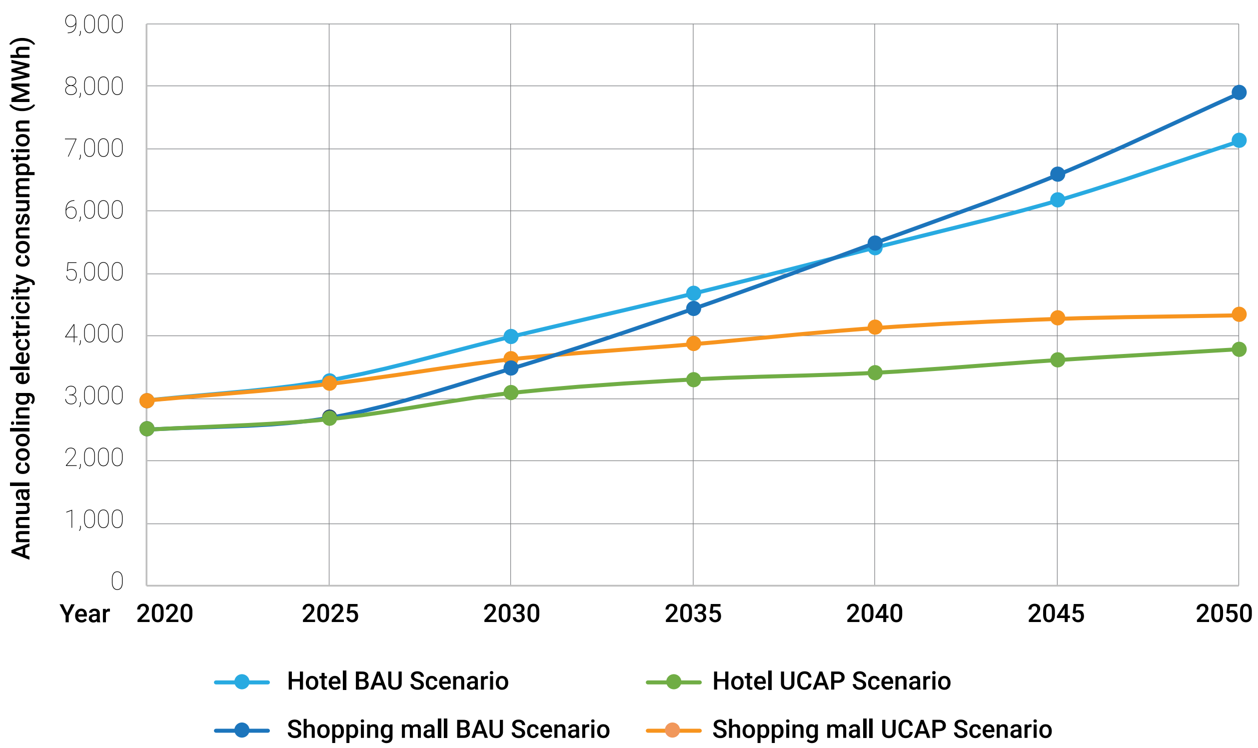
**Projections on Annual Cooling Electricity Consumption for Offices in Can Tho**



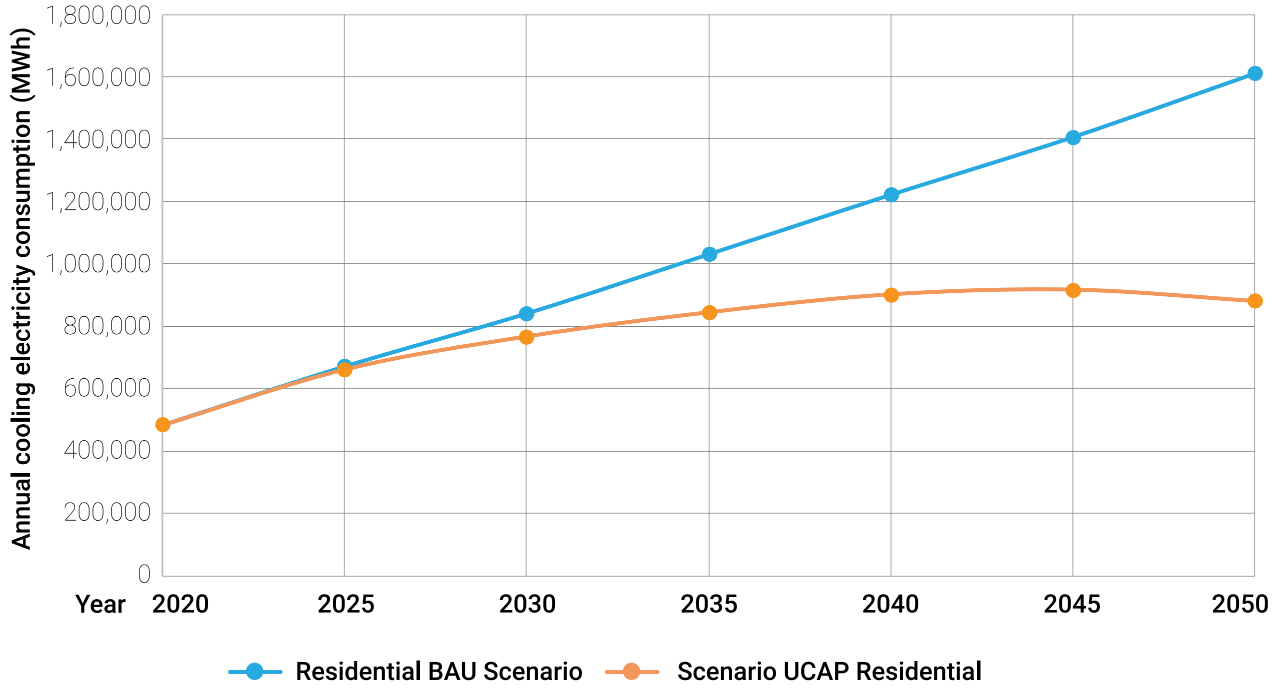
**Projections of Annual Cooling Electricity Consumption for Hotels & Shopping Malls in Can Tho**




**Projections on Annual Cooling Electricity Consumption for Restaurants & Schools in Can Tho.**

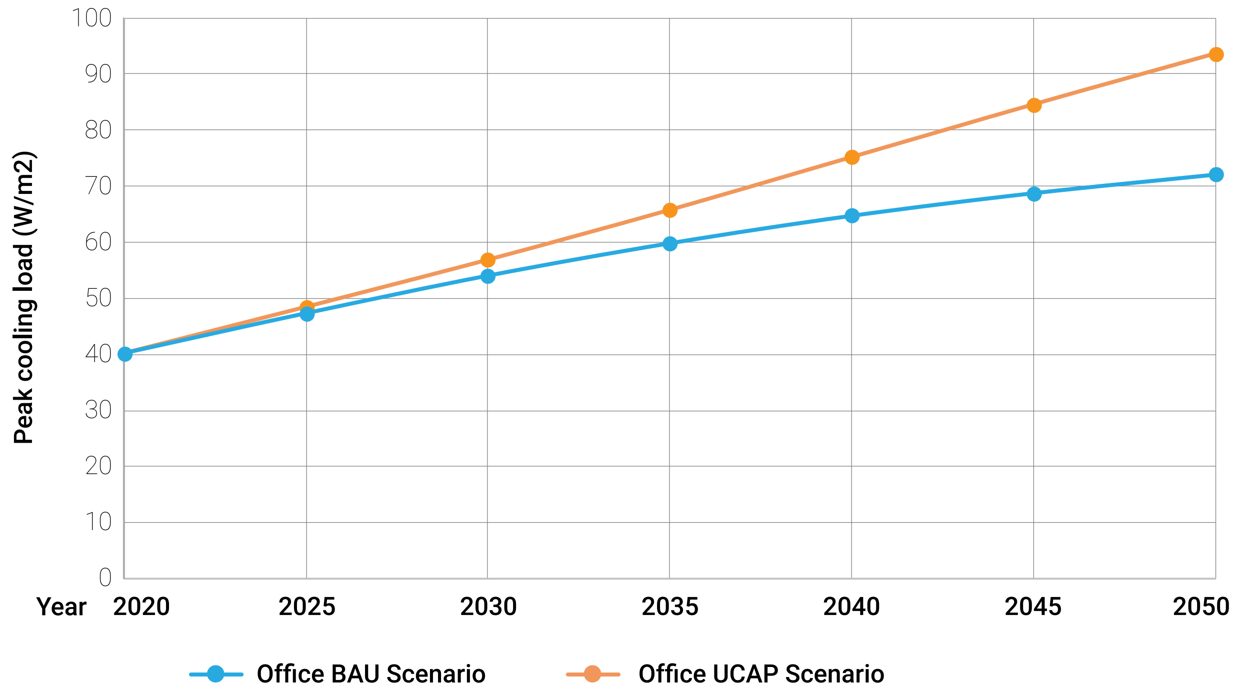


**Projections on Annual Cooling Electricity Consumption for Residential Buildings in Can Tho.**

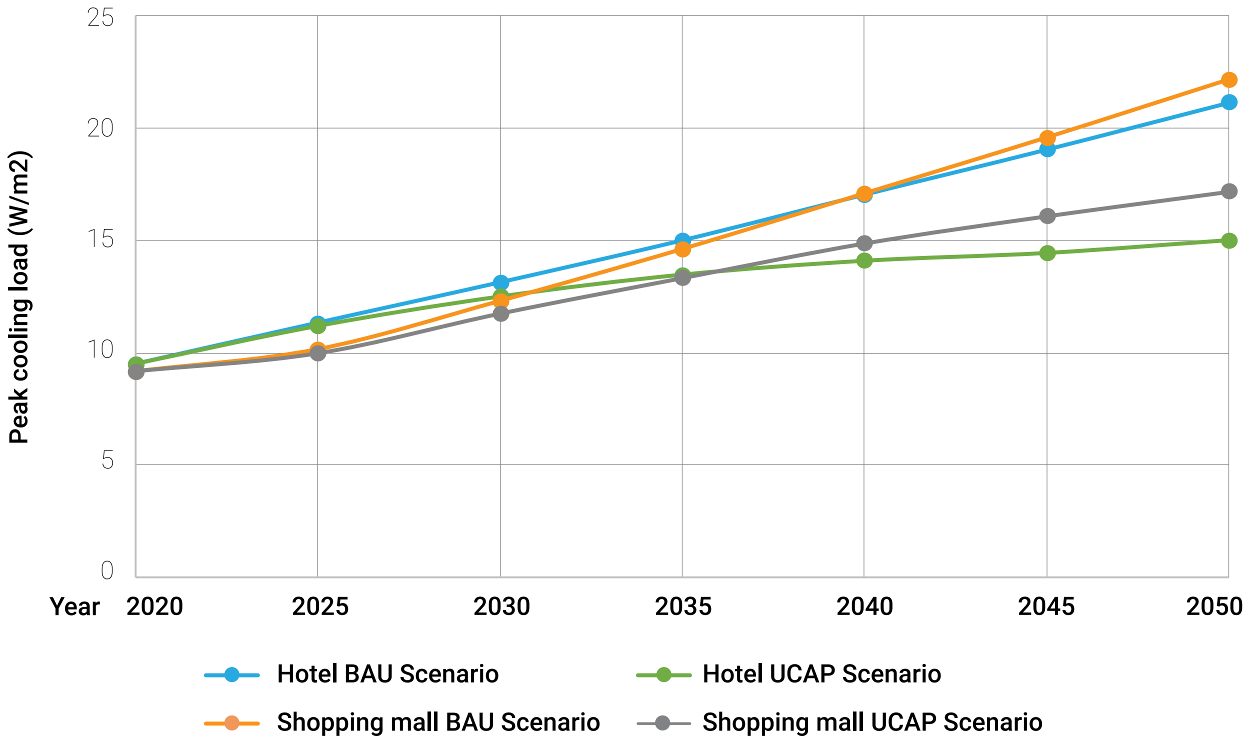



**Projections on peak cooling demand**

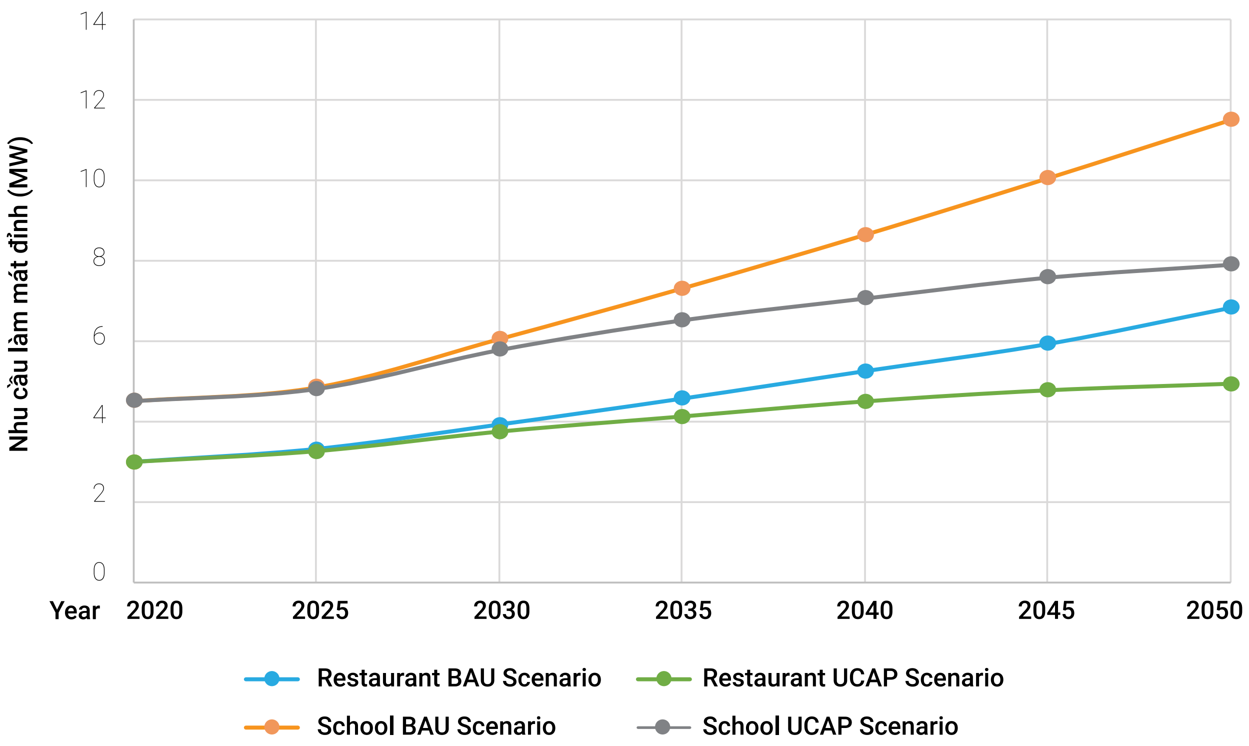
**Projections on Peak Cooling Demand for Offices in Can Tho.**



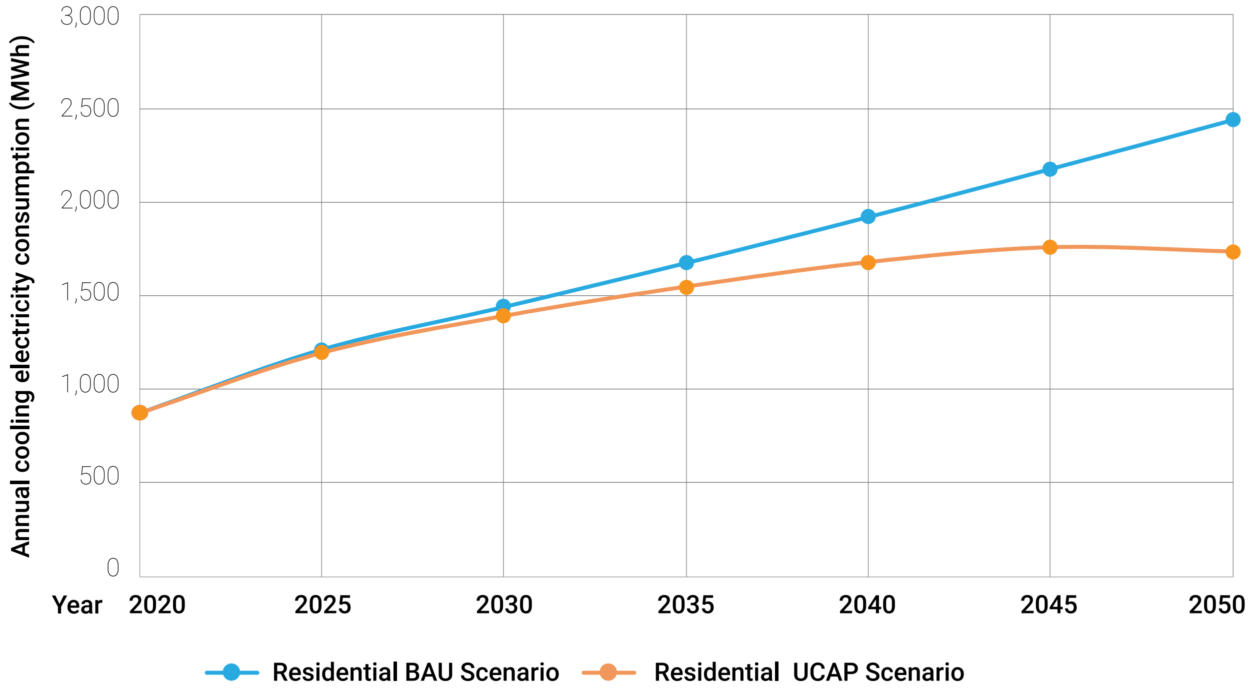
**Projections on Peak Cooling Demand for Hotels & Shopping Malls in Can Tho.**




**Projections on Peak Cooling Demand for Restaurants & Schools in Can Tho.**

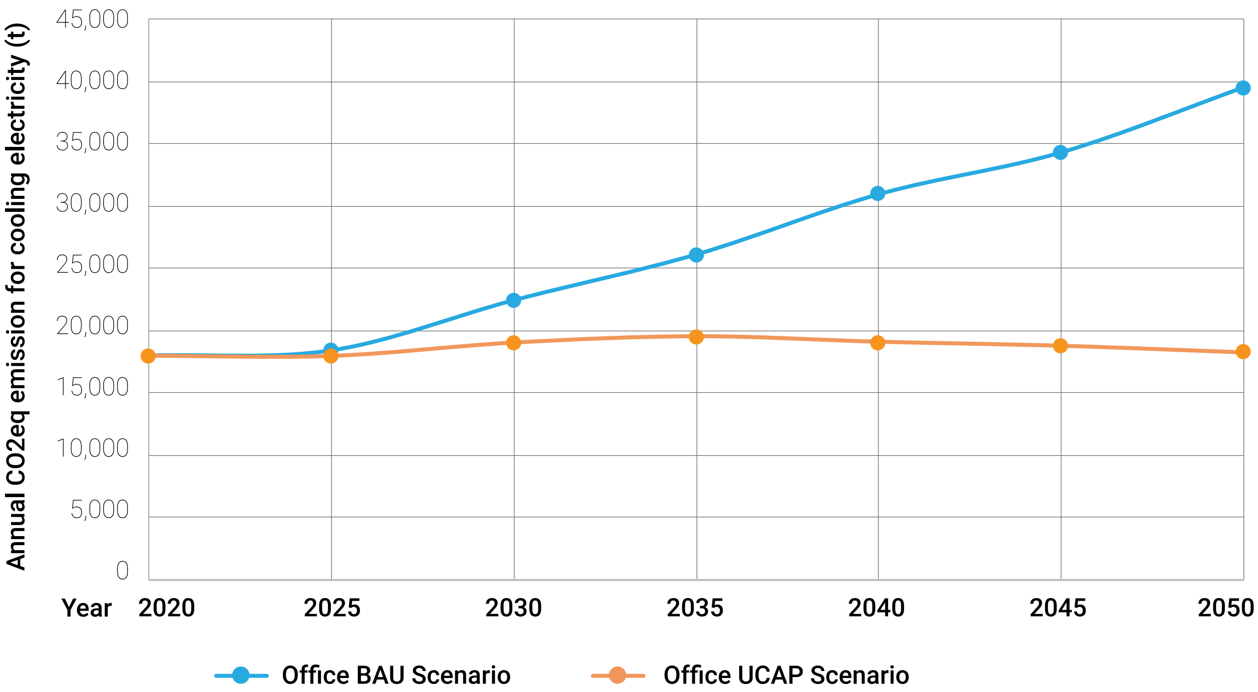


**Projections on Peak Cooling Demand for Residential Buildings in Can Tho.**

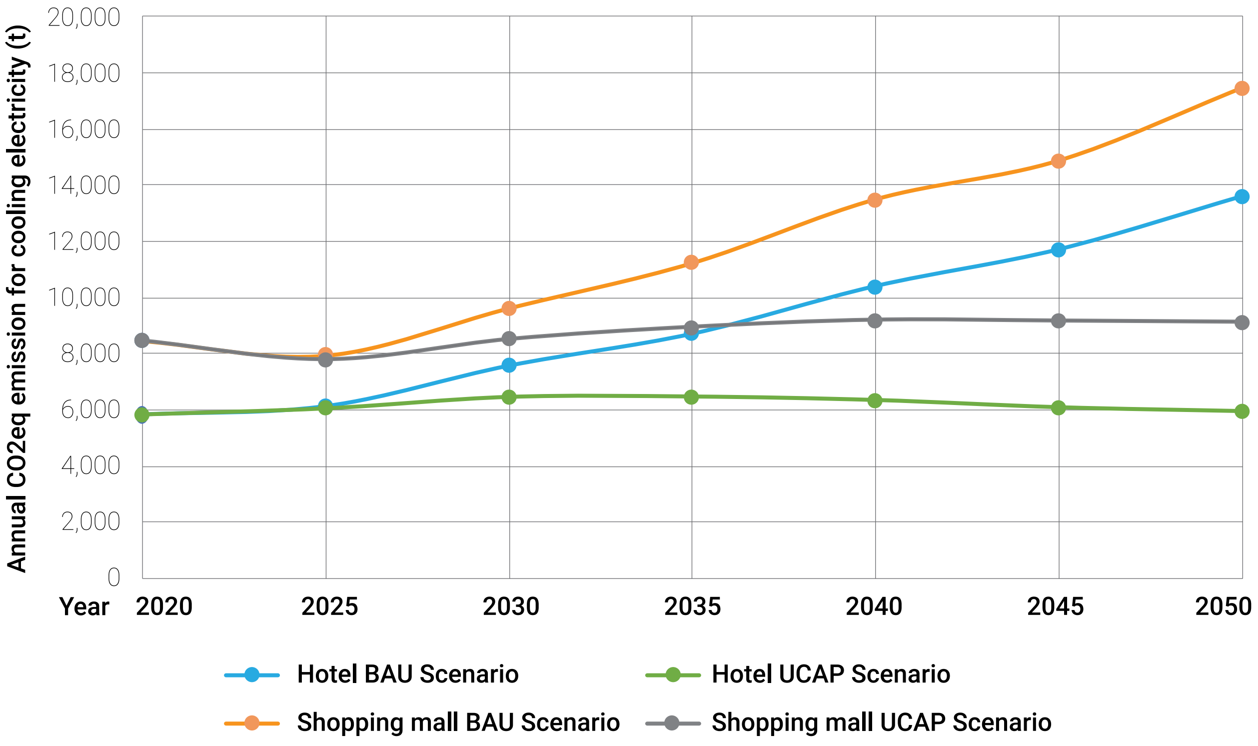



**Projections on GHG emissions for cooling electricity consumption**

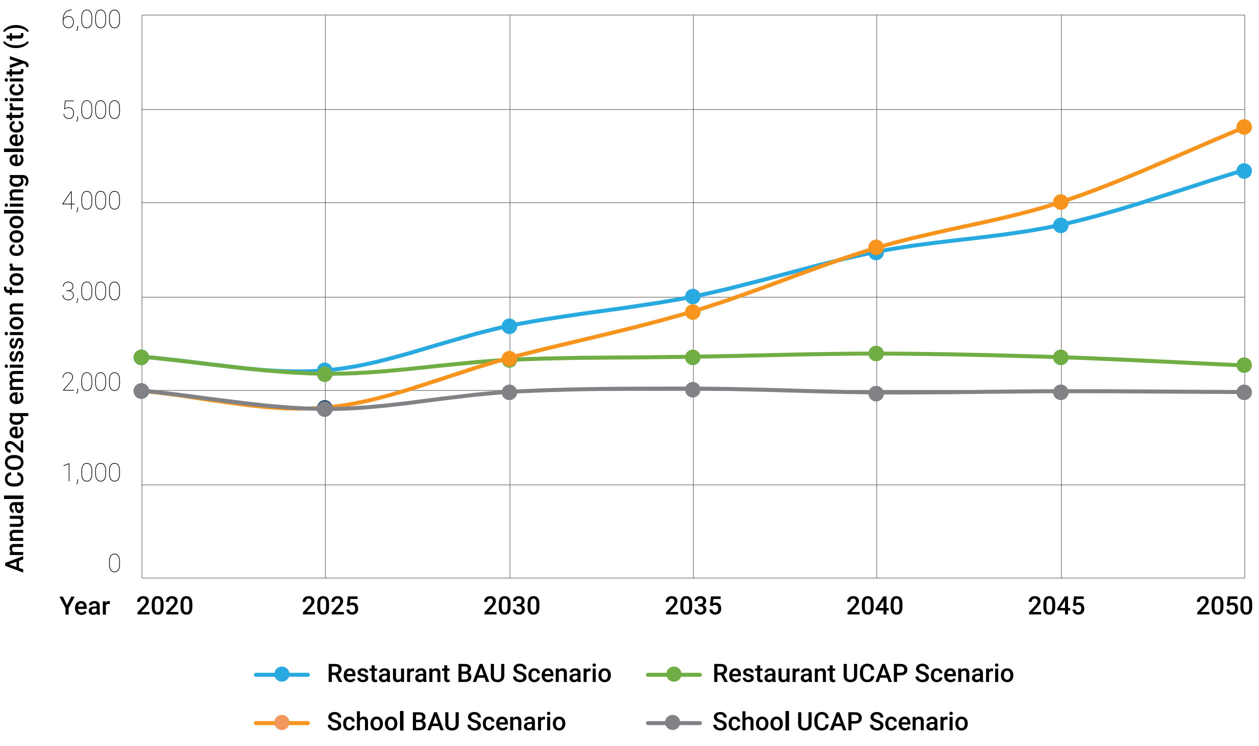
**GHG emissions for Cooling Electricity of Offices in Can Tho.**



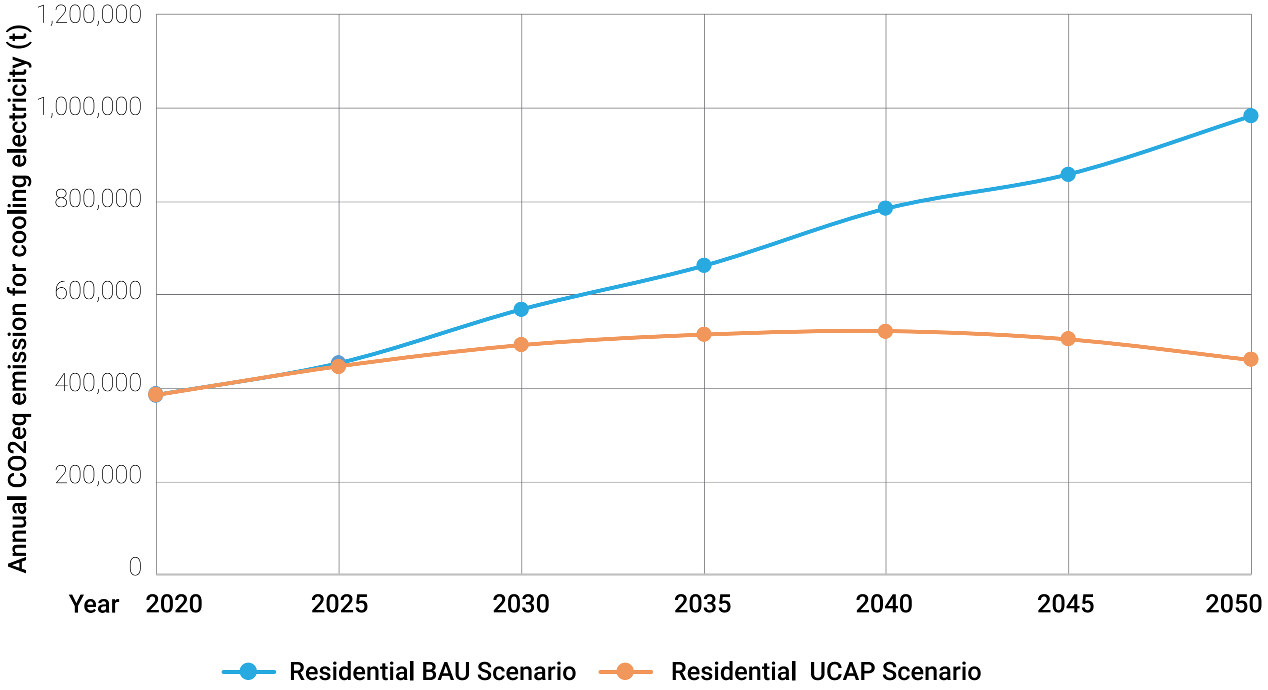
**GHG Emissions for Cooling Electricity of Hotels & Shopping Malls in Can Tho.**




**GHG Emissions for Cooling Electricity in Restaurants and Schools in Can Tho.**



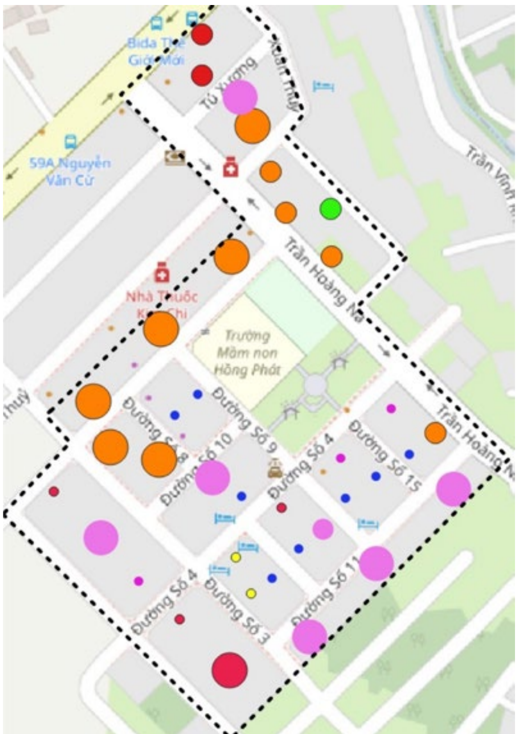
**GHG Emissions for Cooling Electricity in Residential Buildings in Can Tho.**



# Annex 7. Spatial distribution of cooling electricity consumption of the studied neighbourhoods in Can Tho City

Five neighbourhoods were selected for mapping the cooling demand in Can Tho based on available master plans. The neighbourhoods are predominantly composed of three-story residential buildings, with ground floors often utilised as cafés, restaurants, small offices, or shops. The cooling demand, represented by circles, accounts for both the residential cooling needs on the first and second floors, as well as the mixed-use demands on the ground floor. For example, an orange circle indicating Range 3 signifies that the buildings within that parcel are primarily three-story residential structures with shops on the ground floor, and their cooling electricity consumption ranges between the corresponding values mentioned in the legend in kWh/year. The use of ground floor areas was determined using Google Maps by identifying the marked establishments. The accuracy of the analysis is limited by the reliance on Google Maps to identify ground floor establishments. To enhance the accuracy of the findings, conducting site visits to the neighbourhoods would allow the city to directly observe and document the establishments, thereby refining the analysis. In some cases, the buildings are not yet constructed and are marked by light blue circles. It is assumed that these buildings will be established by the year 2045 and represent future residential cooling electricity consumption. GIS mapping of neighbourhoods in Can Tho is presented below:

**GIS mapping of cooling electricity consumption in neighbourhood Hong Phat**




| | Range | Cooling el consumption (kWh/yr) |
|---|---|---|
| ○ | Range 1 | 169,044 – 490,246 |
| ○ | Range 2 | 490,247 – 811,450 |
| ◯ | Range 3 | 811,451 – 1,453,854 |

- Neighborhood Hong Phat
- Restaurant
- Residential
- Office
- School
- Shops
- Hotel

### GIS mapping of cooling electricity consumption in neighbourhood Nam Long

| | Range | Cooling el consumption (kWh/yr) |
|---|---|---|
| ○ | Range 1 | 95,924 – 471,582 |
| ○ | Range 2 | 471,583 – 847,242 |
| ◯ | Range 3 | 847,243 – 1,598,558 |

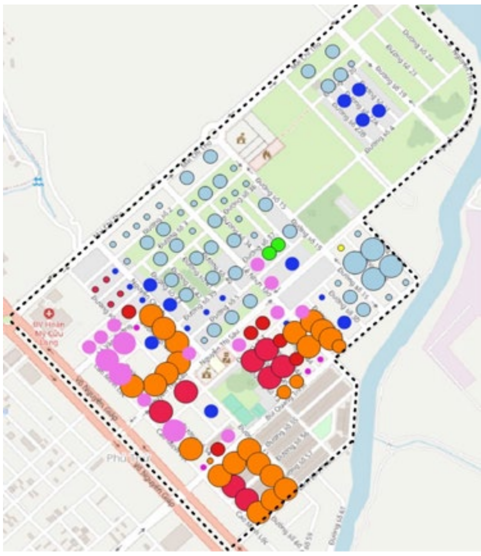
- Neighborhood Nam Long
- Restaurant
- Residential
- Office
- Shops
- Hotel

### GIS mapping of cooling electricity consumption in neighbourhood Hong Loan

| | Range | Cooling el consumption (kWh/yr) |
|---|---|---|
| ○ | Range 1 | 66,010 – 280,229 |
| ○ | Range 2 | 280,230 – 494,450 |
| ◯ | Range 3 | 494,451 – 922,887 |

- Neighborhood Hong Loan
- Future Residential (2045)
- Existing Residential
- Existing Office

### GIS mapping of cooling electricity consumption in neighbourhood 586



| | Range | Cooling el consumption (kWh/yr) |
|---|---|---|
| ○ | Range 1 | 138,786 – 599,468 |
| ○ | Range 2 | 599,469 – 1,060,150 |
| ◯ | Range 3 | 1,060,151 – 1,981,512 |

- Neighbourhood 586
- Future Residential (2045)
- Residential
- Office
- Restaurant
- Shops
- Hotel
- School

# Annex 8. Potential pilot project list of urban cooling in Can Tho

The potential project list for sustainable urban cooling in Can Tho City comprises a carefully evaluated and selected set of initiatives aimed at improving environmental quality, responding to climate change, and enhancing urban living conditions to meet the growing demand for sustainable cooling. The list is organised in descending order of priority, reflecting the relative suitability and effectiveness of each proposed project.

The list is based on high level information shared by interested parties, however the potential projects identified here needs feasibility assessments to identify effective cooling solutions and techno-economic analysis. The list is indicative and not exhaustive in itself, and there can be more potential investment opportunities in future brown field or green field projects to implement sustainable cooling solutions recommended in the UCAP report

**1. Pilot project 1 (New construction/Greenfield): IT park in Huang Thanh ward, Cai Rong District**

a) Project description

In 2021, Can Tho City approved the investment policy for the development of a New Urban Area and Centralised Information Technology Park. The project aims to concretize the detailed planning of the Southern Can Tho Urban Area (located in Cai Rang District), with the objective of building a modern new urban zone that will expand the city's housing stock and establish a dedicated area to accelerate the development of Can Tho's information technology sector. The project is being implemented by the Can Tho City Investment and Development Fund, an entity under the authority of the Can Tho City People's Committee. The project is expected to be completed by 2025. Land within the Centralised Information Technology Park will be leased for investment in sectors such as high technology, information technology, and other related fields, in accordance with applicable regulations.

The investor is currently undertaking land clearance for the construction of the Information Technology Park by relocating low-rise residential buildings to newly designated nearby areas. At the same time, the investor is progressing with the detailed design of several projects within the IT Park, such as social housing, landscaping, and public roads, among others. Several public infrastructure components have already been constructed, including main traffic roads, flood prevention canals or drainage channels, and electrical cabling. However, additional public infrastructure—particularly the primary power supply network—still needs to be constructed or upgraded to meet the anticipated demand, especially for the development of planned data centres.

- Asset Management (Investor): Can Tho Investment and Development Fund
- Construction Area: Approximately 72.06 hectares, including 20.02 hectares for the Centralized Information Technology Park and 52.04 hectares for the New Urban Area
- Location: Cai Rang Ward, Can Tho City
- Types of Buildings: Data centers, social housing, standalone apartments, high-rise buildings, and residential complexes

## The new urban area (ground for resettlement zone)

3D rendered perspective of the IT Park

Current situation of the project site

(a & b) Current situation of project site for the new residential area (an actual view of the ground for resettlement zone as a part of the new residential area)

b) Potential cooling technologies

On the basis of fast assessment, following cooling technologies are recommended to apply in the project. However, it needs to be highlighted that it is necessary to have in-depth analysis on the viability of these technologies through further assessment and pre-feasibility studies.

| Cooling Technology | | Description/Priority ranking |
|---|---|---|
| 1 | Exterior landscaping for urban cooling purpose | |
| 1.1 | Wind corridor for natural ventilation | High |
| 1.2 | Shading on pedestrian from trees | High |
| 1.3 | Sponge community design to restore rainwater | High |
| 1.4 | Natural waterbody for natural cooling in community | High. Suggest having at least 10% water body for every 8000 sq. m of land. |
| 1.5 | Landscaping with absorbent pavement materials | Medium to high |
| 1.6 | Outdoor spray cooling for main pedestrian streets | Medium |
| 1.7 | Higher green density ratio | High |

| Cooling Technology | | Description/Priority ranking |
|---|---|---|
| 1.8 | Multi-layer landscaping | High. Suggest planting high trees vs. low brush as 5:2 |
| 1.9 | Landscaping design | Hight. Suggest increasing public parks among building as of at least 7% every 10000 sq. m of land. |
| 2 | Passive cooling for standalone buildings | |
| 2.1 | Green roof | Medium to high |
| 2.2 | Shading facility (steady) on exterior windows | Medium to high |
| 2.3 | Shading facility (operable) on exterior windows | Low to medium |
| 2.4 | LOWE windows | High. Double pane LOWE windows or Single pane LOWE coating windows |
| 2.5 | Natural ventilation design | Very high. For social housing: at least WWR on south/ east should be larger than 0.35 with 50% window operable, require to have indoor/outdoor natural ventilation analysis (CFD based) in summer and swing season design days for architectural design. |
| 2.6 | High reflection material on façade and roof | Medium |
| 2.7 | Building envelope efficiency | Very high. Follow the requirement of building energy conservation codes/standards in VN/Can Tho |
| 3 | Active cooling for standalone buildings | |
| 3.1 | High efficient fans | High for residential buildings |
| 3.2 | High efficient split Acs | Medium for all service buildings except data centres |
| 3.3 | Environmental friendly refrigerants in cooling systems | High. Recommend refrigerants with GWP<50. |
| 3.4 | Cooling management system | High for data centres |
| 3.5 | Evaporative cooling system | Low to Medium. |

c) Potential benefits (estimated)

Some of the potential benefits on economic (e.g. cost, saving & pay-back periods), environmental and social perspectives are estimated below. It needs to be highlighted that due to limitation of data, some assumptions are applied in this procedure. It is necessary to verify and validate these in the later stages of rapid assessment, prefeasibility and feasibility studies. For data centres, due to high requirements for cooling and energy supply security, it is thus not included in the estimation of economic benefits.

** Economic benefits*

| Additional cost for cooling technologies (USD/sq. m) | Estimated electricity/water/primary energy savings for cooling (USD/ sq.m/yr.) | Simple pay-back year (year) |
|---|---|---|
| 22-45 | 3-11 | 2-16 |

**The above benefits are estimated on the basis of a combination of international experience and Can Tho local data.*

** Environmental benefits*

- Reduce heat island index 22.5 degree.hour per day for the design day
- Shift peak outdoor temperature by 0.9-1.4 degree
- Restore over 60% of rainwater in the community
- Reduce the use of refrigerants in split AC and centralised cooling systems by 20-25%
- Reduce the electricity consumption of cooling by 18-35%
- Reduce the flooding risks by 70-80%

** Social benefits*

- Reduce 15-36% unmet cooling hours by nature ventilation under PMV-PPD scale
- Reduce risks of heat stroke by 80% (Keep WBGT at an acceptable level)
- Increase outdoor thermal comfort hours by natural ventilation up to 55%
- Increase productivity due to higher indoor thermal comfort by 35%
- Reduce hospitality (due to heat-related diseases) by 55%

**2. Pilot project 2 (New construction/Greenfield): Logistics park near the Cai Cui Port**

***a) Project description***

Cai Cui port in Can Tho city is the 17th port facility in the system of Tan Cang Saigon Corporation. Cai Cui port is designated as a combined international container terminal for the Mekong Delta region, aimed at serving the transportation of containerised import and export goods from the region to national hub ports, Cambodia and other countries in the Mekong sub-region. As a deep-water port, Cai Cui is equipped with modern loading and unloading facilities for container and bulk cargo, featuring 6,048 $m^2$ of warehouse to meet the requirements of shipping lines and import-export enterprises.

- Asset Management (Land Leasing): Can Tho Investment and Development Fund
- Construction Area: Approximately 26 hectares
- Location: Cai Cui Port, Hung Phu Ward, Can Tho City
- Types of Buildings: Cold storage facilities for logistics, warehousing infrastructure, and port terminals

## Cai Cui Port


Actual perspective of Cai Cui Port

***b) Potential cooling technologies***

On the basis of fast assessment, following cooling technologies are recommended to apply in the project. However, it needs to be highlighted that it is necessary to have in-depth analysis on the viability of these technologies through further assessment and pre-feasibility studies.

| Cooling Technology | | Description/Priority ranking |
|---|---|---|
| 1 | Exterior landscaping for urban cooling purpose | |
| 1.1 | Wind corridor for natural ventilation | High |
| 1.2 | Shading on pedestrian from trees | Medium |
| 1.3 | Sponge community design to restore rainwater | Medium to low. |
| 1.4 | Landscaping with absorbent pavement materials | Medium |
| 1.5 | Higher green density ratio | Medium |
| 1.6 | Multi-layer landscaping | High to medium |
| 2 | Passive cooling for standalone buildings | |
| 2.1 | Green roof | High |
| 2.2 | Shading facility (steady) on exterior windows | Medium to high |
| 2.3 | LOWE windows | High. Double pane LOWE windows or Single pane LOWE coating windows |
| 2.4 | High reflection material on façade and roof | Medium |
| 2.5 | Building envelope efficiency | Very high. Follow the requirement of building energy conservation codes/standards in VN/CanTho |
| 3 | Active cooling for standalone buildings | |
| 3.1 | High efficient split Acs | Medium for all service buildings except data centers |
| 3.2 | Environmental friendly refrigerants in cooling systems | High. Recommend refrigerants with GWP<50, e.g. CO2 cooling systems for cargo and/or small-size cool rooms. |
| 3.4 | Cooling management system | High for medium/large size of cold storage and food processing factories |
| 3.5 | Evaporative cooling system | Low to Medium. |

***c) Potential benefits (estimated)***

Some of the potential benefits on environmental and social perspectives are estimated below. It needs to be highlighted that due to limitation of data, some assumptions are applied in this procedure. It is necessary to verify and validate these in the later stages of rapid assessment, prefeasibility and feasibility studies.

** Environmental benefits*

- Reduce the use of refrigerants in split AC and centralised cooling systems by 25-40%
- Reduce the electricity consumption of cooling by 10-30%

** Social benefits*

- Increase outdoor thermal comfort hours by natural ventilation up to 20%
- Increase productivity due to higher indoor thermal comfort by 15%
- Reduce hospitality (due to heat-related diseases) by 30%

**3. Victoria Can Tho Resort (retrofit/brownfield)**

a) Project description

Victoria Can Tho Resort (Ninh Kieu District) opened in October 1998 as the flagship of the Victoria Hotels & Resorts Chain in the Mekong Delta. The hotel is situated on the banks of the Hau River, one of the nine estuaries of the Mekong Delta.

The hotel is being operated and managed by a management team with professional experience in energy system operation. As per the observation during the on-site visit, hybrid ventilation of electric fans and natural ventilation on the ground floor, e.g. lobby area, café and restaurant, has been implemented to replace electric air conditioning. Exterior shading facilities are well installed through integration with architectural design for each hotel room. The hotel has created a comfortable exterior environment from a good location to the river with a combination of outdoor swimming pool and gardens with high green density.

Property management: Victoria Can Tho Company Ltd. (Private).

Built-up area: Approx. 15,510 m2.

Location: Cai Khe Ward, Can Tho City

Status of cooling application: Split air conditioners for rooms, Electrical heater for hot water production and dryers. The owner doesn't use any energy saving solutions for cooling and heating in the hotel.

## Victoria Can Tho Resort

Victoria Resort, Can Tho (website)

Example of a room (website)

Resort interior (On-site)


Installed condensing unit (On-site)

Potential cooling technologies

| Cooling Technology | | Description/Priority ranking |
|---|---|---|
| 1 | Passive cooling for standalone buildings | |
| 1.1 | Green roof with integration of solar thermal hot water system | Medium |
| 1.2 | LOWE coated windows | High. Upgrade the windows with coatings of LOWE |
| 2 | Active cooling for standalone buildings | |
| 2.1 | Energy audit | High |
| 2.2 | Solar domestic hot water system with air-sourced heat pumps | High |
| 2.3 | End-user control in each hotel room | Medium |
| 2.4 | Upgrade AC systems | Low. According to on-site visit, the hotel has just upgraded some of the Acs, and the existing Acs are well maintained. |
| 3 | Business models | |
| 3.1 | ESCO/Cooling as a Service (CaaS) | Medium |

c) Potential Benefits

The coordinated application of sustainable cooling solutions can yield potential economic benefits (in terms of cost, energy savings, payback period, etc.). Environmental and social benefits may include:

* Environmental Benefits:

- Reduction of the urban heat island (UHI) index;
- Mitigation of peak outdoor temperatures;
- Reduction of direct emissions from refrigerants used in air conditioning systems;
- Reduction of indirect emissions from electricity consumption by air conditioning systems.

* Social Benefits:

- Reduction of unmet cooling hours through natural ventilation, measured using the PMV-PPD index;
- Increased labor productivity due to improved indoor thermal comfort;
- Lower healthcare costs associated with heat-related illnesses;
- Enhanced community and neighborhood engagement.

**4. The open market of Cai Khe**

a) Project description

The open market is the largest one in Can Tho and is located in Tran Van Kheo Street (Ninh Kieu District). The market consists of 3 buildings (zones). The market is bordered on one side by the river and on the other side by the street. Here, fresh products like fish, vegetables and other fresh foods are sold. They are transported across the river to the market.  Market stalls can also be found in this building. Across the street, wholesalers for textiles and house wares are present. The locals do their shopping on both sides.

- Property management: People's committee of Can Tho (Government).
- Built-up area: Approx. 8,000 m2.
- Location: Cai Khe Ward, Can Tho City
- Cooling status: No AC systems or mechanical ventilation systems are installed. Standalone fans are installed by the stand owners.

**The open market of Cai Khe**

The entrance from Tran Van Kheo street


An actual view of stores in business

b) Potential cooling technologies

| Cooling Technology | | Description/Priority ranking |
|---|---|---|
| 1 | Passive cooling | |
| 1.1 | Green roof | Medium |
| 1.2 | Sponge measures, e.g. porous outdoor ground, rainwater gardens, multiple layers of landscaping for exterior spaces | Medium to high |
| 1.3 | Exterior shading pavement facilities from front gate or parking lots to main entrances with spray cooling | Low to medium |
| 1.4 | High reflection façades | Low to medium |
| 1.5 | LOWE coated windows | Medium to high. Upgrade the windows with coatings of LOWE |
| 2 | Active cooling | |
| 2.1 | Fans or mechanical ventilation for interior corridors | Medium |
| 2.2 | Spray cooling for exterior corridors | Medium |
| 2.3 | Standalone AC fans in stands | Medium |

c) Potential Benefits

The integrated application of sustainable cooling solutions can bring significant potential benefits in terms of economics (cost, energy savings, payback time, etc.). Some notable environmental and social benefits include:

* Environmental Benefits:

- Reduction of urban heat island (UHI) index;
- Mitigation of peak outdoor temperature;
- Reduction of direct emissions from the use of refrigerants in air conditioning systems;
- Reduction of indirect emissions from electricity consumption of air conditioning systems.

* Social Benefits:

- Reduction of unmet cooling hours through natural ventilation based on the PMV-PPD scale;
- Improved labor productivity due to enhanced indoor thermal comfort;
- Lower healthcare costs related to heat-induced illnesses;
- Strengthened community and neighborhood engagement.

**5. Sense City Commercial Centre (retrofit/brownfield)**

a) Project description

Sense City Can Tho commercial Centre opened on January 20, 2014, with a total area over 22,000 m2, including 4 shopping and entertainment floors and 1 parking basement with an area of 3,500 m2.  The centre has a mix of products and services in a modern shopping space. It's organised into sections for fashion, cosmetics, jewellery, accessories, family use, entertainment, and a food court.

- Property management: Saigon Can Tho Trading Co., Ltd (Private)
- Built-up area: Approx. 22,000 m2.
- Location: Ninh Kieu Ward, Can Tho City
- Status of cooling application: Centralised air conditioning (Water chiller). The share of cooling is about 50-60% energy consumption annually. The owner installed PV for electricity generation.

**Rooftop condensing unit of Sense City commercial centre**


Sense City, Can Tho

Rooftop condensing unit

Existing cooling system

b) Potential cooling technologies

| Cooling Technology | | Description/Priority ranking |
|---|---|---|
| 1 | Passive cooling for standalone buildings | |
| 1.1 | Green/Cool roof | Medium |
| 1.2 | LOWE windows | High. Upgrade the windows with coatings of LOWE |
| 1.3 | Exterior shading pavement facilities on pedestrian ways with spray cooling | Low to medium |
| 1.4 | Tree shading for pavements around the building | Low |
| 2 | Active cooling for standalone buildings | |
| 2.1 | Energy audit | High |
| 2.2 | Commission existing cooling systems | High |
| 2.3 | End-user control and sensor (eg. CO2) | Medium |
| 2.4 | Central control systems of cooling | Medium |
| 2.5 | Heat/cool recovery for exhausted and fresh air system in centralised AC systems | Medium |
| 2.6 | Mechanic ventilation systems in corridors | Low to medium |
| 2.7 | Spray cooling systems on exterior pedestrian areas | Medium |
| 3 | Business models | |
| 3.1 | ESCO/Cooling as a Service (CaaS) | High |

c) Potential benefits (estimated)

The integrated implementation of sustainable cooling solutions can potentially generate significant economic benefits, such as reduced costs, improved energy savings, and shorter payback periods. In addition, a range of environmental and social benefits may also be realized, including but not limited to the following:

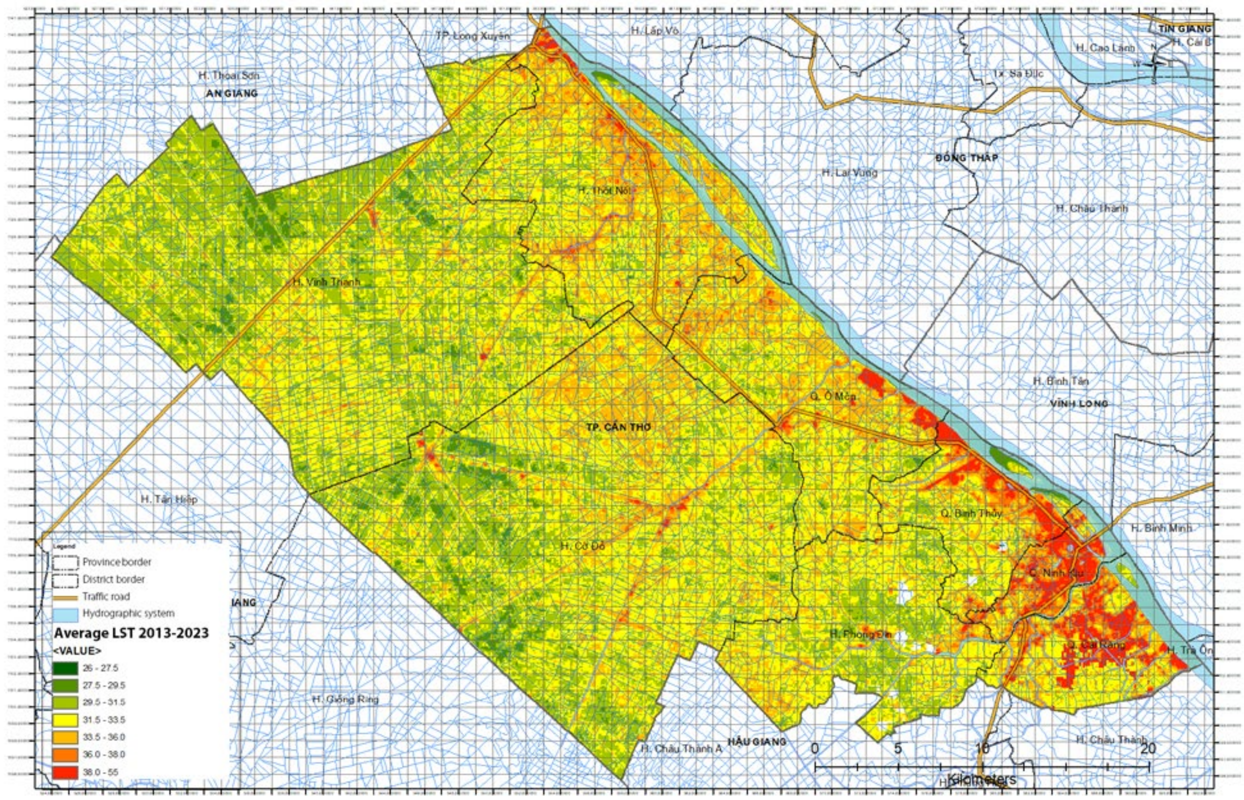
* Environmental benefits

- Reduction of Urban Heat Island (UHI) index;
- Mitigation of peak outdoor temperatures;
- Reduction of direct emissions from refrigerant use in air conditioning systems;
- Reduction of indirect emissions from electricity consumption for air conditioning

* Social benefits

- Reduction of unmet cooling hours through natural ventilation based on the PMV-PPD scale;
- Increased productivity due to improved indoor thermal comfort;
- Reduced healthcare costs related to heat-induced illnesses;
- Enhanced community and neighborhood engagement

**Potential pilot areas and hotspot areas(spatial variation of land surface temperature throughout 10 years) in Can Tho City**

Based on the initial analysis of Can Tho City's urban planning toward 2030, several areas within the city exhibit high population or building density. The following potential pilot locations have been identified for further in-depth analysis:

1) Ninh Kieu: A traditional commercial center with several new development projects planned by 2030.

2) Cai Rang and Tra Noc: Mixed-use residential areas.

3) O Mon: A newly developing residential area.

***6.1 Pilot Project Area 1: Climate Resilience for Outdoor Thermal Comfort***

Based on a ten-year remote sensing analysis of surface temperature data, several heat hotspots have been identified in Can Tho City where surface temperatures are higher than in surrounding areas. These include:

1) The Cai Son – Hang Bang – Hong Phat area;

2) The 91B area;

3) The Cai Khe residential area, Can Tho, Mekong Delta;

4) The Cai Khe – Thuy Duong commercial-service complex;

5) The Tay Do Cultural Center area;

6) The Hong Loan area;

7) The Nam Long area.

Most of these residential areas consist of low-rise buildings under 15 meters in height, along with high-rise housing or social housing projects, and typically include schools and other mixed-use facilities.

Potential Cooling Technologies:

Based on a preliminary assessment, the following passive cooling technologies and nature-based solutions are recommended to enhance outdoor thermal comfort for residents.

| Cooling Technologies | | Description / Rank of Priority |
|---|---|---|
| 1 | Outdoor landscape for cooling | |
| 1.1 | Wind corridor for natural ventilation | High |
| 1.2 | Shading on pedestrian from trees | High |
| 1.3 | Sponge community design to restore rainwater | High |
| 1.4 | Natural waterbody for natural cooling in community | Medium |
| 1.5 | Landscaping with absorbent pavement materials | Medium to high |
| 1.6 | Outdoor cooling for pedestrian streets | Medium |
| 1.7 | Higher green density ratio | High |
| 1.8 | Multi-layer landscaping | High |
| 1.9 | Landscape | High. Consider integrating a variety of trees, shrubs, and grasses; expanding urban park spaces and waterbody systems; optimizing building height-to-street width ratios; and ensuring a balanced proportion of greenery and building density |
| 2 | Passive cooling for pedestrian zone | |
| 2.1 | Artificial shades on pavement for pedestrians | Medium to high |
| 2.2 | Fixed shades from buildings along the streets for pedestrians on sidewalks | Medium to high |
| 2.3 | Operable shades from buildings along the streets for pedestrians on sidewalks | Medium to high |
| 2.4 | Fixed shades on sidewalks for pedestrians | High |

### *6.2 Pilot Project Area 2: Centralized Cooling Systems for Industrial Zones*

Based on desk research, stakeholder consultations, and on-site assessments, several existing and/or newly established industrial zones in Can Tho City have been identified as potential sites for the implementation of centralized cooling systems. These systems aim to enhance energy efficiency and reduce cooling-related costs. The identified industrial zones include:

1) Thot Not Industrial Zone;

2) O Mon Industrial Zone;

3) North O Mon Industrial Zone;

4) Hung Phu 1 Industrial Zone;

5) Vinh Thanh Industrial Zone (Viet Nam–Singapore Industrial Park – VSIP).

However, due to the diversity of industrial activities—such as dairy processing, food preservation, etc.—across these zones, cooling demand may vary significantly in terms of temperature, pressure, duration, and cooling type.

# Annex 9. Letter on confirmation of pilot project in Can Tho

| | |
|---|---|
| UBND THÀNH PHỐ CẦN THƠ<br>**SỞ TÀI NGUYÊN VÀ MÔI TRƯỜNG** | **CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM**<br>**Độc lập - Tự do - Hạnh phúc** |
| Số: 802 /STNMT-TNKSNKTTV&BĐKH<br>V/v ý kiến về Danh mục dự án tiềm năng về làm mát bền vững đô thị tại thành phố Cần Thơ | *Cần Thơ, ngày 13 tháng 3 năm 2024* |

Kính gửi: Cục Biến đổi khí hậu

Căn cứ Công văn số 3309/VPUB-XDĐT ngày 20 tháng 8 năm 2020 của Văn phòng Ủy ban nhân dân thành phố về việc tham gia dự án "Thực hiện làm mát hiệu quả và thân thiện với khí hậu tại khu vực đô thị Việt Nam" trong đó, Ủy ban nhân dân thành phố giao Sở Tài nguyên và Môi trường phối hợp, hỗ trợ Cục Biến đổi khí hậu trong quá trình thực hiện dự án.

Thực hiện Công văn số 148/BĐKH-GNPT ngày 06 tháng 02 năm 2024 của Cục Biến đổi khí hậu về việc Danh mục dự án tiềm năng về làm mát đô thị bền vững tại thành phố Cần Thơ.

Để chọn được các dự án thí điểm làm mát bền vững phù hợp với thành phố, Sở Tài nguyên và Môi trường thành phố Cần Thơ đã gửi văn bản tham vấn ý kiến đến các đơn vị có liên quan. Trên cơ sở nghiên cứu Danh mục các dự án tiềm năng và tham khảo ý kiến tham vấn của một số đơn vị, Sở Tài nguyên và Môi trường thành phố Cần Thơ có ý kiến như sau:

- Dự án tiềm năng để thí điểm làm mát bền vững nên hướng đến tính hiệu quả, khả thi khi triển khai thực hiện, được sự đồng thuận của chủ đầu tư/cơ quan quản lý dự án và nên là dự án đầu tư mới để tích hợp hiệu quả các giải pháp làm mát bền vững từ giai đoạn xây dựng. Do đó, trong khuôn khổ Dự án "Làm mát bền vững ở các thành phố tại Việt Nam" do UNEP và GGGI tài trợ, Sở Tài nguyên và Môi trường nhận thấy dự án "Khu đô thị mới và khu công nghệ thông tin tập trung" do Quỹ Đầu tư phát triển thành phố làm chủ đầu tư phù hợp để tiếp tục đánh giá nghiên cứu tiền khả thi.

- Ngoài ra, một dự án tiềm năng khác cũng được đề xuất là "Kho lạnh phục vụ logistics tại bến cảng Cái Cui": đây là công trình công cộng, phục vụ hoạt động vận tải hàng hóa xuất nhập khẩu đóng container của vùng đến các cảng đầu mối quốc gia, Campuchia và các nước tiểu vùng sông Mekong, triển khai thí điểm dự án này để góp phần đáp ứng nhu cầu làm lạnh và bảo quản sản phẩm cho logistics của Cảng và góp phần phát triển kinh tế - xã hội, làm rõ hơn hiệu quả làm mát bền vững phục vụ phát triển kinh tế - xã hội. Do đó, hy vọng dự án tiềm năng này có thể tiếp tục được xem xét hỗ trợ thực hiện trong tương lai nhằm góp phần thực hiện mục tiêu ứng phó với biến đổi khí hậu và phát triển bền vững của thành phố.

Sở Tài nguyên và Môi trường thành phố Cần Thơ kính gửi Cục Biến đổi khí hậu nội dung nêu trên./.

*(Đính kèm các văn bản tham vấn của Sở Xây dựng, Sở Công thương, Quỹ Đầu tư phát triển thành phố Cần Thơ; Ban Quản lý chợ quận Ninh Kiều)*

***Nơi nhận:***
- Như trên;
- Lưu: VT, BĐKH.

**KT.GIÁM ĐỐC**
**PHÓ GIÁM ĐỐC**

CỘNG HÒA X.H.C.N VIỆT NAM SỞ TÀI NGUYÊN VÀ MÔI TRƯỜNG THÀNH PHỐ CẦN THƠ

**Phạm Nam Huân**

# Annex 10. Potential categories of urban trees for cooling purposes in Can Tho City

| Name | Name in Vietnamese | Average height (fully grown status) (m) | Trunk diameter (m) | Feasible position |
|---|---|---|---|---|
| Dipterocarpus alatus Roxb | Dầu con rái | 20 - 40 | 8 - 16 | Pavement and / or median strip |
| Terminalia mantaly H.Perrier | Chiêu liêu nước | 10 -15 | 6 - 10 | Pavement and / or median strip |
| Largerstroemia calyculata Kurz | Bằng lăng ổi | 10 - 15 | 5 - 8 | Pavement and / or median strip |
| Pterocarpus indicus Willd | Giáng Hương Ấn | 12 - 20 | 8 - 15 | Pavement and / or median strip |
| Pterocarpus macrocarpus Kurz | Giáng Hương rái to (Giáng Hương lá nhỏ) | 10 - 20 | 8 - 10 | Pavement and / or median strip |
| Xylia Xylocarpa (Roxb.) Taubert | Căm xe | 12 - 18 | 6 - 10 | Pavement |
| Tectona grandis L.f. | Tếch (Giá Tỵ) | 20 - 40 | 8 - 12 | Pavement |
| Afzelia xylocarpa (Kurz) Craib | Gõ đỏ | 15 - 25 | 8 - 12 | Pavement |

This report was developed as part of the cooperative initiative 'Sustainable Urban Cooling in Viet Nam's Cities', led by the Department of Climate Change under the Ministry of Agriculture and Environment of Viet Nam, in collaboration with the United Nations Environment Programme and the Global Green Growth Institute.


DCC
Department of Climate Change

DEPARTMENT OF AGRICULTURE AND ENVIRONMENT OF CAN THO CITY

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GGGI