FY 2021 Commissioned Work for the Inter-City Cooperation

Project for the Realization of a Decarbonized Society

(Project to Support the Formation of a Decarbonized Society Through Inter-City Cooperation Between Yokohama City and Da Nang City)

Final Report

March 10, 2022

Institute for Global Environmental Strategies

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1. Background to Participation in the Project

Yokohama City and Da Nang City (Socialist Republic of Vietnam) signed a “Memorandum of Understanding on Technical Cooperation on Sustainable Urban Development” in 2013, and since then, the two cities have jointly held the “Da Nang Urban Development Forum” almost every year under inter-city cooperation and have discussed long-term environmental planning and smart city development. The following are the main achievements.

(1) Support for Da Nang City from Yokohama City and Related Organizations in the Field of Waste Management

Promotion of separated waste collection from households from 2017 to 2020 through a JICA Grassroots Technical Cooperation Project. The second phase of this project will begin in 2022. The city of Yokohama is sharing its experience and knowledge on public awareness and public relations for waste separation and other issues through JICA's Grassroots Technical Cooperation Projects. In the waste sector, Da Nang City is planning to implement two projects in cooperation with the public and private sectors: the “Project to Improve the Efficiency of Waste Collection by Building Waste Transshipment Facilities Throughout the City" and the "Project to Develop a Complex Waste Treatment Facility in the Khanh Son Landfill Area." Yokohama City is following up on the possibility of city companies participating in these projects.

(2) Project to Construct a Comprehensive Sewage Treatment System in Da Nang City

The Yokohama Water Corporation, a wholly owned subsidiary of the Yokohama Waterworks Bureau, participated in a feasibility study for a project related to sewage system development using a yen-based loan as part of JICA's preparatory study for a water environment improvement project in Da Nang City (2015-2016). Since 2016, the company has been installing high-efficiency pumps at water treatment plants managed by the Da Nang City Water Supply Company as part of a JCM equipment subsidy project. A project related to wastewater treatment in an industrial park in Da Nang City conducted by MURATA Keisokuki Service Co., Ltd., a co-applicant of this project, was selected by JICA as a project for dissemination, demonstration, and commercialization in FY 2021. The project aims to improve water quality and reduce wastewater treatment costs (power consumption and sludge treatment costs) by installing an environmental Automatic Monitoring System (AMS) at centralized wastewater treatment facilities to improve the efficiency of wastewater treatment in response to changes in water quality. With the support of the World Bank, Da Nang City is planning to build public sewage systems and sewage treatment facilities in the eastern region and Da Nang Bay area (for which some construction has already begun), and these projects are expected to play an important role

in improving the water environment in Da Nang City.

(3) Results of Support for Energy Conservation Potential Studies

In the energy sector, Osumi, a co-applicant for this project, implemented energy conservation audit technology services for factories and civilian structures as part of a JICA dissemination and demonstration project from 2015 to 2017. Currently, the company has set up a representative office in Da Nang City and is working on developing a full-fledged energy conservation audit service business. Since 2020, the company has been conducting energy conservation audits of buildings and surveys of related systems for a new JICA partnership project. Yokohama National University and Osumi are jointly conducting the surveys, and Yokohama City is sharing its knowledge of systems.

Through the results of inter-city collaborations such as the one mentioned above, a system of cooperation among companies in Yokohama, related organizations, and research institutes has been steadily established. For this reason, a comprehensive support system has been put in place that includes methodologies for accurately grasping information, methodologies for designing systems, and even the transference of suitable technologies in accordance with local conditions. In addition, private companies from both cities are participating in the "Da Nang Urban Development Forum" held by the two cities, and it is expected that environmental projects by private companies in both cities will be promoted through consultations between the two sides. The forum was most recently held for the tenth time in September 2021, this time online.

2. Project Outline

2.1 Objectives of the Project

With the entry into force of the Paris Agreement in November 2016, we have finally entered the implementation phase of the Paris Agreement. The Paris Agreement also calls for the acceleration of climate change actions by non-governmental actors including municipalities and cities in addition to the central government, but cities and municipalities are key players in considering and implementing specific local climate change measures and projects. In order to realize a decarbonized society throughout the whole world, it is necessary to accelerate the movement toward building a sustainable decarbonized society and a low-carbon society as a transit point to decarbonization, especially in Asia where economic growth is particularly remarkable. There is a growing international movement to support the efforts of cities to decarbonize and reduce carbon emissions, as they are the sites of activities that support social and economic development.

In this project, Yokohama City government, research institutes, and private companies,

which have experience and know-how for the formation of a carbon-free and low-carbon society, will conduct a research project to support the efforts to form a carbon-free and low-carbon society in Da Nang and the introduction of equipment that will contribute to the formation of a carbon-free and low-carbon society.

2.2 Description of the Project

The city of Da Nang, which is under the direct control of the central government of Vietnam, is the economic center of the central region of Vietnam, and plans are underway to build a hub port and develop a trading base. However, with rapid development, environmental pollution problems have become apparent, and the development of environmental plans has become an important policy issue. Da Nang City cooperated in this project conducted in the last fiscal year as it revised its “Ten-Year Environmental Plan” for 2021-2030 based on an evaluation of results from the “Ten-Year Environmental Plan” for 2010-2020.

Under the framework of the inter-city collaboration that has been developed between Yokohama City and Da Nang City, the project will support the revision of the “10-Year Environmental Plan” (2021-2030) based on a request from Da Nang City, and will also support the formulation of a Local Climate Change Action Plan (hereinafter referred to as an LCCAP). In addition to supporting the formulation of the “Ten-Year Environmental Plan” and an LCCAP, the project will also support the implementation of a feasibility study using low-carbon technologies that can be applied in Da Nang City. As an exit, we aim for this project to lead to the use of the JCM equipment subsidy program.

This project is expected to last for three years, and the results of the last fiscal year and the plan for this fiscal year are described below. In the next fiscal year, we will examine specific measures to contribute to the decarbonization of Da Nang City, focus on sectors with high greenhouse gas reduction potential, and examine Japanese technology options that can be introduced in these sectors, with a view to identifying projects that may be tied to JCM and connecting them to JCM equipment subsidy projects. It is also envisioned that the project will propose to Da Nang City the policy and institutional options necessary for disseminating the technology.

（1）Main Results of the Last Fiscal Year (Year 1)

1) Reflection of Japanese proposals in the final draft of Da Nang's “Ten-Year Environmental Plan”

Priority programs and projects are listed in the final draft of the “Ten-Year Environment Plan.” Among these programs and projects, the following items have been proposed by

the Japanese side or are related to the proposals.

① Study, verify, and propose solutions to make Da Nang a low-carbon city.
② Establish an information disclosure system and use IT (websites) to share environmental monitoring results.
③ Investigate and evaluate the current status of complaints and reports from the public regarding environmental pollution, and raise public awareness regarding environmental protection and the efficient use of natural resources.
④ Survey and evaluate people's satisfaction with the quality of the environment.

It is especially important to emphasize that the term "low-carbon city" was not mentioned in the initial draft prepared by the Department of Natural Resources and Environment (DONRE) of Da Nang City, but it was clearly stated in the final draft. One of the major factors that contributed to the positive evaluation of Japanese proposals was the workshop for the draft of the “Ten-Year Environmental Plan” held by DONRE in mid-October, inviting the Deputy Minister of the Ministry of Natural Resources and Environment (MONRE) and the Vice Chairman of the Da Nang City People's Committee.

2) Working toward a climate change action plan

After organizing the analysis methods for climate change policies in other cities, we shared this information with research institutions such as the University of Da Nang, while preparing the necessary data and a collaborative system for joint analysis in Da Nang City. Specifically, we compiled information on climate change policies in Yokohama City, London, and other cities, information related to regional circular and ecological spheres, and key information from “The World in 2050 (TWI2050),” a backcasting and modeling analysis project for making the structural changes necessary to achieve SDGs. We also analyzed the GHG reduction potential in the building and transportation sectors in Da Nang City.

In order to propose a climate change action plan, the cooperative system between Yokohama City and Da Nang City has been made the basic pillar of the project, and together with the research team from the University of Da Nang, the project has established a support system of international research institutes that are partners of IGES. The consortium as a whole has established a comprehensive system to examine the technical proposals and business plans of private companies in Yokohama.

3) Progress in the JCM applicability study for energy conservation projects

In this study, we investigated the applicability of three technologies.

① Energy conservation in factories (use of exhaust heat)

With regard to technology for the utilization of waste heat from Da Nang Steel, this

year's objectives were to conduct a survey of the current situation at the site, study design methods in accordance with local standards, and examine feasible work methods and schedules, and activities were implemented accordingly. As a result, it was determined that it would be difficult to introduce the relevant technology and systems for a waste heat utilization project from the standpoint of efficiency and economy because of the small scale of Danang Steel's production.

② Introduction of LED bulbs for streetlights

At the beginning of this fiscal year's survey, we attempted to coordinate with relevant local organizations and the Road Traffic Department of Da Nang City in order to contribute to the smart lighting concept of Da Nang City. At that time, we conducted activities with the goal of setting the quantity that can be introduced and a budget scale by concretely examining work methods, illumination intensity, and the number of placements according to the local conditions while coordinating with local organizations. As a result of an illumination verification test with other companies' products on the premises of the Da Nang Industry and Trade Promotion Center (ITPC), the products selected for this study were found to be superior.

③ Improving the efficiency of air conditioning (installing radiant heating and cooling systems)

The plan was to understand the efficiency and power consumption of the equipment due to the local climatic conditions in Da Nang City and to predict the power consumption and GHG emissions once the equipment has been installed. Since we could not travel to the site due to the novel coronavirus, we explained the radiant heating and cooling system to the Department of Industry and Trade (DOIT) of Da Nang City through several web conferences and gained some understanding. After discussing the evaluation methods, we agreed to conduct an evaluation test at the ITPC of the Technology Evaluation Division of the Department of Industry and Trade. However, due to the fact that we were not able to travel to the site, we were not able to conduct an evaluation test using the evaluation equipment.

(2) Details for This Fiscal Year (Year 2)

In this study, through support for the formulation of a Local Climate Change Action Plan (LCCAP) for Da Nang City, we analyzed specific actions and the potential for greenhouse gas reductions, mainly in the building and transportation sectors. In addition, the following activities will be carried out to propose measures in the energy and urban infrastructure sectors, which are particularly important in the LCCAP, and to formulate JCM projects that will contribute to these measures.

1) Development Support Sector for Smart and Sustainable Urban Planning Strategies

・Conduct science-based analysis to identify key drivers of GHG emissions in Da Nang and the latent potential for reduction

・Proposals of possible sectors for cooperation on climate change action plans and low-carbon technologies

2) Support Sector for Model Development for Low-Carbon Technologies

・Feasibility study on a project to optimize energy supply and demand and to achieve a low-carbon society by combining renewable energy and energy conservation technologies in a specific area of Da Nang City.

3) Support Sector for Improving Climate Change Education and Awareness

・Discussion of ways to enhance the education and awareness of citizens (especially elementary and junior high school students) for climate change

・Implementation of education and awareness raising activities for climate change in pilot areas targeting primary and secondary schools in Da Nang City

Specific activities are as follows.

[Development Support Sector for Smart and Sustainable Urban Planning Strategies]

1) Scenario Analysis for Climate Change (Focusing on Building and Transportation Sectors)

We will work with the University of Da Nang to develop a long-term scenario for Da Nang City with the aim of establishing a program of mitigation measures in priority areas (especially transportation, construction, and industry) in terms of GHG emissions in Da Nang City, while relating the scenario to national climate change policies, including Vietnam's NDC.

2) Local Data Collection and Sectoral Scenario Analysis

Data collection will focus on the building and transportation sectors. The obtained data will be used to analyze the reduction potential for carbon dioxide emissions. In doing so, the potential for technological transformation, the potential for changes in people's behavior, and forecasts of socioeconomic changes (e.g., changes during the COVID-19 pandemic) will be effectively incorporated based on the scenario analysis described in (1) above. A system will be created in which a panel of experts from Japan and abroad will provide support in conducting the analysis as external experts.

3) Proposal of a Climate Change Action Plan

Based on the scenario analysis, we will consider the items of the climate change action plan that are realistic and suitable for the social background and cultural aspects of Da Nang City. While the above analysis focuses on emission reduction potentials that can lead

to recommendations for mitigation measures, the city of Da Nang is expected to face other mounting environmental and socio-economic problems as a result of its large population growth and the accompanying rapid urbanization. Therefore, a panel of experts will be assembled to provide a comprehensive discussion and recommendations for policy and action for general social problems related to water, food, and disaster measures, not just climate change mitigation measures.

4) Stakeholder Discussions at Workshops

In the formulation of action plan for climate change, we emphasize the entire process of collaborative planning with policy makers and relevant stakeholders, not just experts, so we will design and implement an entire planning process that includes policy dialogue and consensus building in workshops.

[Support Sector for Model Development for Low-Carbon Technologies]

We will examine the feasibility of a model project for smart energy systems. Targeting a single industrial park, the project aims to optimize the energy supply and demand of the entire area through energy conservation on the demand side and renewable energy on the supply side. Specifically, we will consider projects that combine technologies such as solar power generation, storage batteries, smart LED lighting, and radiant heating and cooling systems to optimize energy supply and demand and achieve a low-carbon society. The study will be conducted with the cooperation of Yokohama City companies. The details of the study are as follows.

① Selection of the target industrial park and understanding of power consumption, GHG emissions, and the emission structure of the park (factories)

② Examination of the possibility of introducing technologies and measures proposed by Yokohama City companies in the target industrial park (factories) (technological compatibility, provisional calculation of the scale of introduction, drafting of the overall plan, etc.)

③ Estimation of the energy conservation and GHG emission reduction effects to be realized by the introduction of the above technologies

[Support Sector for Improving Climate Change Education and Awareness]

1) Review of Necessary Knowledge and Awareness Raising Methods for Climate Change in Elementary and Secondary Schools

We will review the objectives, details, methods, and teaching materials of current education and awareness raising activities for climate change in elementary and secondary schools in Da Nang City.

2) Selection of Pilot Elementary and Secondary Schools and Implementation of Classes and Events

We will select an elementary school and a secondary school in the pilot area. The selection will be made after consultation with the Department of Natural Resources and Environment of Da Nang City and with the consent of the schools. In the pilot schools, we will (1) conduct classes on climate change, (2) hold contests such as poster and photo exhibitions on climate change, and (3) conduct training workshops for teachers in the schools.

(3) Preparation of Training Materials for Climate Education and Awareness

Based on the above analysis and the results of the pilot project in elementary and secondary schools, training materials for climate education and awareness will be prepared.

[Workshops]

Workshops will be held to share the main results of the above activities with the Da Nang City government, businesses, and academics and to provide a forum for exchanging opinions.

2.3 Project Implementation Structure

The implementation structure is shown in the figure of the next page.

The participants of this project on the Japanese side are as follows.

Yokohama City: The City of Yokohama has a track record of closely providing information and exchanging opinions on information, policies, and system design such as in the joint implementation of the "Da Nang Urban Development Forum" with Da Nang City on 10 occasions. The project will share knowledge and make suggestions as appropriate to contribute to the preparation of Da Nang City's “Ten-year Environmental Plan,” the preparation of a climate change action plan, and environmental and climate change education.

Osumi Co., Ltd. and Macnica, Inc.: Through the "Da Nang City Urban Development Forum" and other events, these companies already have a track record of interacting with local stakeholders and implementing projects, especially with regard to energy conservation audits, and they also have a long track record as local companies. As companies registered in Yokohama City, they also have a wide range of experience in contributing to Yokohama City's overseas collaborative projects. In this project, a study on JCM candidate projects will be conducted.

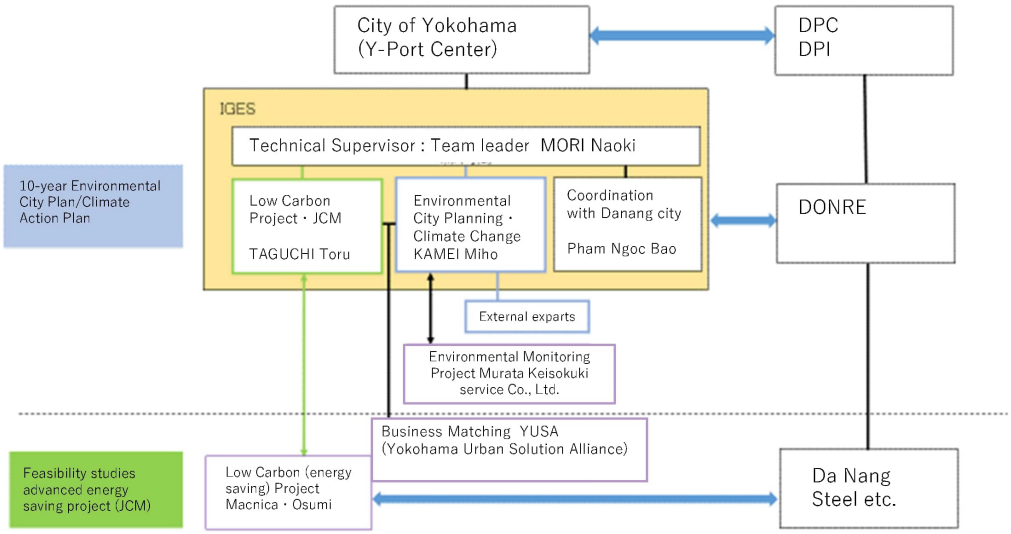
MURATA Keisokuki Service Co., Ltd.: This company has conducted a JICA project for

the support of the overseas development of small and medium-sized enterprises (a feasibility study) in Da Nang City, as well as a JICA field study on industrial wastewater management. Additionally, in the last fiscal year, a project based on the results of the study was adopted by JICA as a dissemination, demonstration, and business development project. The company also has experience in measurement, monitoring, and environmental assessments for air, noise, and soil pollution. In the last fiscal year, the company reviewed Da Nang City's "Ten-year Environmental Plan" and made proposals.

The Yokohama Urban Solution Alliance (YUSA): YUSA has a network of member companies in Yokohama City and expertise in business matching. Through the YUSA Secretariat, Yokohama member companies are informed of relevant information (such as local environmental improvement needs and low-carbon business needs) at workshops held in Japan and in Da Nang City as part of this project. YUSA is expected to play a role in promoting the full-scale participation of member companies in environmental infrastructure projects, such as JCM equipment subsidy projects in the next and subsequent fiscal years.

The Institute for Global Environmental Strategies (IGES): IGES has experience in preparing urban GHG inventories and supporting the preparation of city-level climate change action plans for several Asian cities. In Da Nang as well, through JICA's grassroots projects in the waste management sector, IGES has established a system of cooperation with DONRE and the local governments who are the stakeholders and has conducted surveys of local information and field surveys for JCM subsidy projects. IGES will bear responsibility for overall coordination and implementation in this project.

On the Da Nang side, DONRE is the lead department for environmental management and climate change policy and will be the direct counterpart for this project. However, as it is essential to cooperate with other related departments, such as the Department of Industry and Trade for energy conservation projects, the Department of Transportation for clean transportation, the Department of Construction for green buildings, the Department of Education and Training for environmental and climate change education, and the Department of Planning and Investment for overall planning and investment planning, the project will be carried out in close cooperation with the Da Nang City People's Committee. Studies related to JCM projects will involve the cooperation of institutions and companies in Da Nang related to these studies.



Implementation Structure for the Project

3. Major Results

3.1 Support for the Development of Climate Change Action Plans

In FY 2021, based on the system of cooperation with local experts established in the previous fiscal year, we collected detailed local information and data and used this data to analyze the potential for reducing carbon dioxide emissions, mainly in the building sector, on a trial basis. The long-term future vision for Da Nang City was understood from the city's development master plan and other sources, and future projections for this year were made based on these assumptions. Thanks to the cooperation of the Department of Architecture at the University of Da Nang, with whom we have a collaborative relationship, we were able to receive very high quality local data. However, the city of Da Nang itself does not have a database that is updated regularly, making it difficult even for local experts to obtain the latest data. This fiscal year, other international experts (in climate change, construction, transportation, agricultural policy, etc.) joined us in creating a plan for the orientation and framework of a comprehensive climate change action plan. In spite of the limited data, we were able to present a somewhat developed framework while using various estimation methods. It was also a great achievement to hold an effective stakeholder workshop chaired by the city of Da Nang to discuss the outline version jointly with relevant departments of Da Nang City. The officers from the participating departments were able to convey very detailed thoughts, the availability of data, and their opinions, such as expectations and hopes for the future. In addition, a system has been set in place that allows for cooperation in so far as is possible for the provisioning of additional information and data. The establishment of a solid

cooperative system with the relevant departments, including experts from Da Nang City, is expected to be one of the important foundations for future projects and friendly relations between Japan and Vietnam.

3.2 Feasibility Study on the Application of JCM to Projects Combining Renewable Energy and Energy Conservation

In this fiscal year's activities, based on the results of the Year 1 we selected a target region and target companies for the introduction of low-carbon technologies, surveyed the current status of the companies and examined the technologies to be introduced, and based on these results, made a trial calculation of the amount of greenhouse gas reductions necessary to apply for a JCM subsidy project. For (1) in this fiscal year’s plan, the selection of a target industrial park was carried out, and Hoa Khanh Industrial Park, where many large energy users are located, was selected as the candidate park. Moreover, the project was proposed and agreed upon at the kick-off meeting with DONRE, and the selection of companies and concrete planning for the target industrial park began. In order to promote this activity, in January 2022, with the cooperation of DONRE, the Da Nang People's Committee formally approved the implementation of a project (to be formed under this project) to introduce renewable energy, energy conservation, and supply and demand control systems using the JCM system as part of the project to support the formation of a decarbonized society based on the Yokohama City-Da Nang City Intercity Cooperation Project. The Da Nang Hi-Tech Park and Industrial Zones Authority (DHPIZA) was appointed as the department in charge of implementing the project. With the cooperation of this Authority, we plan to continue with the selection of specific companies and planning. On the other hand, based on the selection of the industrial park, we estimated the expected reduction in CO_2 emissions, assuming an approximate scale for the enterprises.

3.3 Implementation of Climate Change Education for Elementary and Secondary Schools

An analysis of the existing literature shows that climate change education has been integrated to some extent into the formal classroom in primary and secondary schools in Da Nang City. In other words, climate change perspectives are included in nature, geography, biology, and other classes. In this project, three pilot climate change lessons (trainings) were conducted online on a trial basis, further issues were discussed among participants, and materials (guidance) for training students and teachers were developed. The trainings were conducted with 4th and 5th graders of Tran Cao Van Elementary School (90 attendees), 8th graders of Tay Son Secondary School (117 attendees), and secondary school teachers from 7 districts in Da Nang City (52 attendees).

Through these activities, it was found that the recent environmental education in Da Nang City has focused on education such as plastic waste reduction and waste separation at the source, and that there are fewer opportunities to carry out climate change lessons in the classroom. In addition to this, the new coronavirus infection has made such hands-on education impossible. Teachers also commented that there is a lack of teaching materials, training opportunities, and exchange of experiences among teachers to teach about climate change.

As a deliverable of this project, we prepared educational materials (guidance) for student and teacher training, respectively. In particular, the educational materials for students were designed to provide easy-to-understand information on the types of actions related to climate change in daily life (e.g., energy conservation, not leaving trash out, not leaving food out for dinner, etc. for mitigation measures).

3.4 Guiding Da Nang to a Decarbonization Declaration

Although there is a clear reference to reducing carbon in Da Nang's "Ten-Year Environmental Plan" revised in 2021, it does not go as far as decarbonization. However, the Vietnamese government's declaration of carbon neutrality by 2050 at COP26 held in Glasgow, UK last year prompted Yokohama City to step up its efforts to encourage Da Nang City to decarbonize. Specifically, at the 10th Da Nang City Development Forum co-hosted with Da Nang City in November last year, Yokohama City and IGES mentioned the possibility of cooperation on decarbonization in Da Nang City based on the decarbonization declaration of the Vietnamese government and drew positive comments from the deputy director of DONRE, the department responsible for decarbonization. As a follow-up to this, Yokohama City has held discussions with relevant organizations in Da Nang, including DONRE, and coordination is being carried out in the direction of Da Nang issuing a declaration for decarbonization by 2050. Specifically, on March 10, 2022, Da Nang City will participate in the Decarbonized Cities Forum organized by the Japanese Ministry of Environment and the U.S. State Department Office of the President's Special Envoy for Climate Change Issues, where it is expected that Da Nang City will issue a declaration for decarbonization in 2050.

4. Conducted Activities

4.1 Work 4-1: Development of Support Sector for Smart and Sustainable Urban Planning Strategies

4.1 <Support for development of smart and sustainable urban planning strategies>: Climate action component

4.1.1 Scenario analysis on climate change

In Da Nang City at the start of the project (August 2021), decarbonisation (policymaking and initiatives on carbon neutrality) had yet to be incorporated in any concrete way in the city's planning for urban development. However, at the national level, a revised version of the National Determined Contribution (NDC) had already been submitted to the UNFCCC in 2020, and the setting of substantial emission reduction targets beyond the target year of 2030 had become an urgent issue. In this context, it is imperative for the emerging city of Da Nang, expected to experience rapid growth in population and economy, to recognise that it is facing a critical stage in the development planning process that will shape the sustainable development of the city over the long-term future.

For this project, the study conducted in 2020 has already assessed the basic conditions of Da Nang and its relationship with neighboring cities, based upon which an outline of scenarios have been drafted.

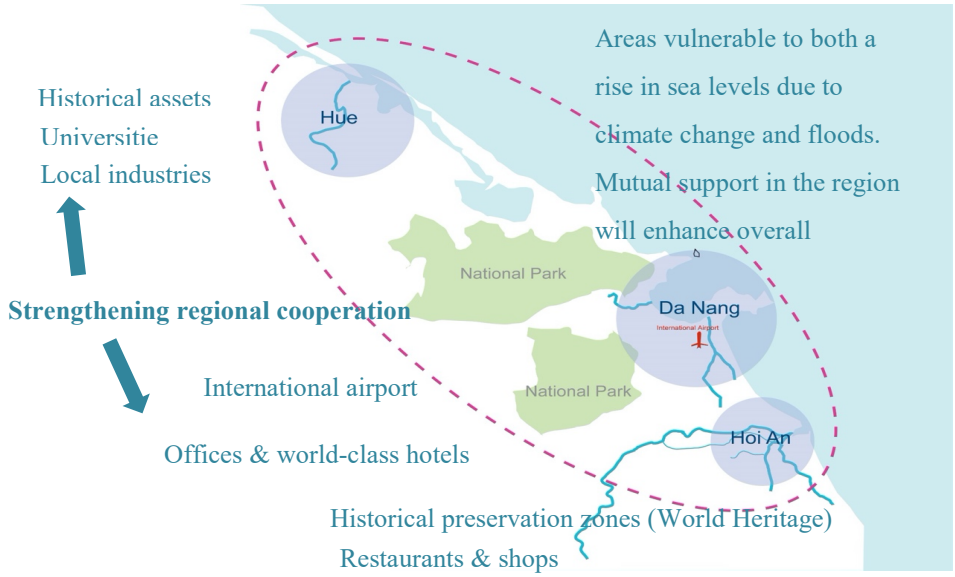


Figure 1-1: 2020 draft of proposed partnership scenario for strengthened cooperation across a wider area (prepared by IGES)

Table 1-1: Overview of scenarios drafted last fiscal year (prepared by IGES)

Factors	**Indicators**	**BAU scenario (SSP2)**	**High Growth scenario (SSP4)**	**Balanced sustainability scenario (SSP1)**
Social factors	Population	Maintain the status quo	Increase in central area	Balance
	Cultural value	Decline	Diluting of value	Inheriting and maintaining tradition
	Lifestyle	Slight change	Modern lifestyle	Traditional and modern
	Societal human resources	Low	High	Moderate (diversity)
	Community	Maintain	Decrease	Increase
Urban structural elements	Urban form	Widening disparity and suburbs with poor infrastructure	Urban sprawl begins and urban area expands	Well-balanced distribution
	Urban space quality	Increasing inequality	Improvement in central area; Suburban growth remains low	Overall improvement

However, in order to examine the desirable direction of development over the long-term future, it is essential to hear the opinions of local stakeholders and collect detailed data for various sectors. The purpose of the 2021 study was to develop ideas and effective draft action plans for climate change policies for each specific sector, based on a system of cooperation with local experts and policymakers (Da Nang City).

Data collection in the field will be described in detail in section 4.1.2 of this chapter. Although focus is placed on the transport sector, which has a large share of emissions and reduction potential, and the building sector, an overview study was also carried out for the food-related agriculture sector in order to conduct a comprehensive examination.

An overview of the framework for the development of climate change action plans for Da Nang City is shown below (Figure 1-2).

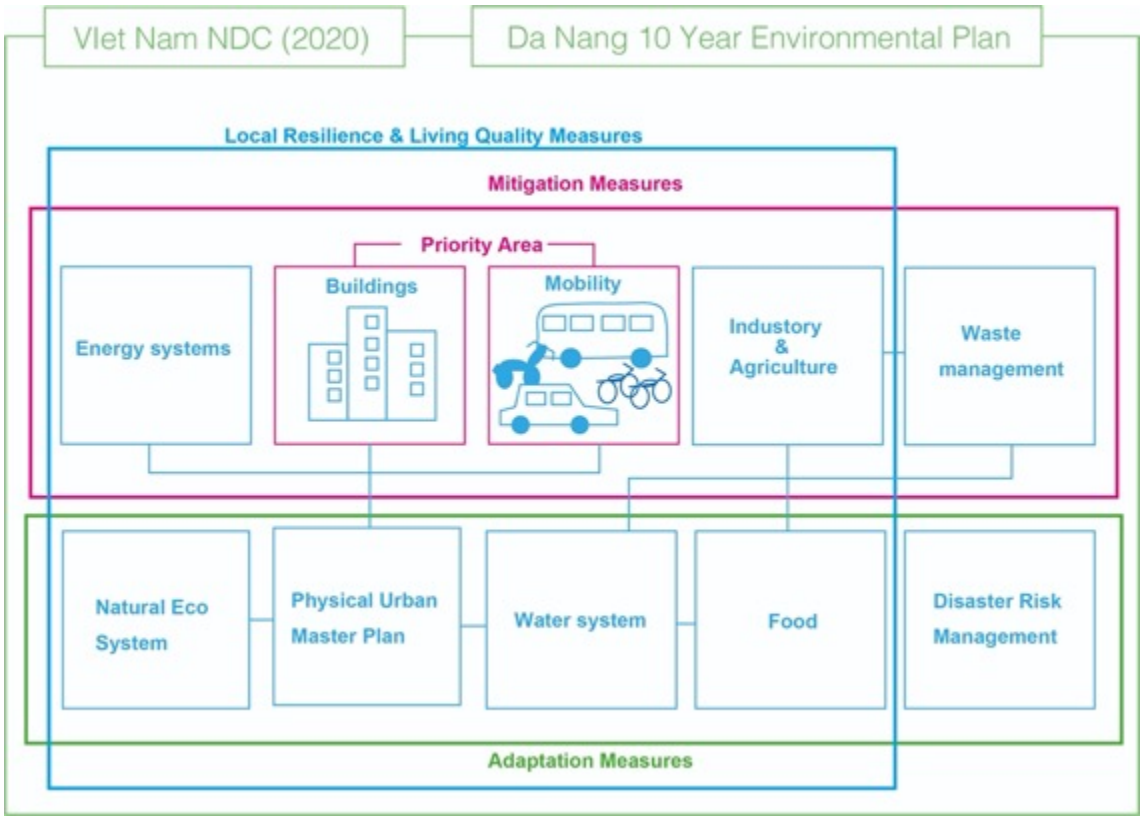


Figure 1-2: A framework for the development of climate change action plans for Da Nang City

While the priority sectors are buildings and transport, the areas of energy systems, industry & agriculture and waste management are designated as related sectors for mitigation measures, while the areas of water, food, natural ecosystems, and disaster risk management are designated for adaptation measures. The framework proposes the comprehensive consideration of mitigation and adaptation measures for an integrated area of key sectors for improving local resilience and living quality.

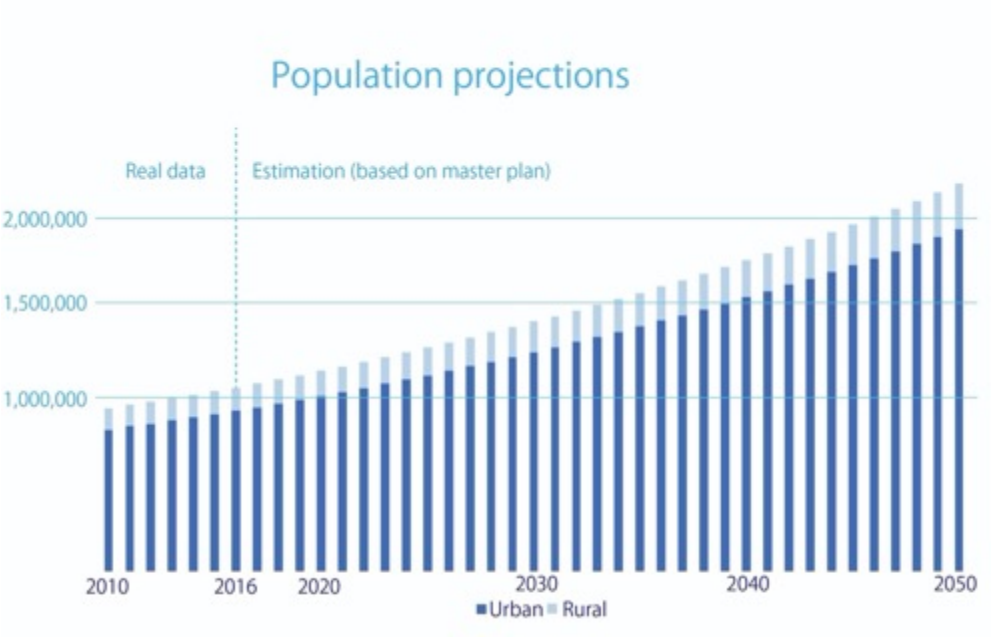


Figure 1-3: Projected shift in population of Da Nang (prepared by IGES based on Da Nang City Master Plan to 2030)

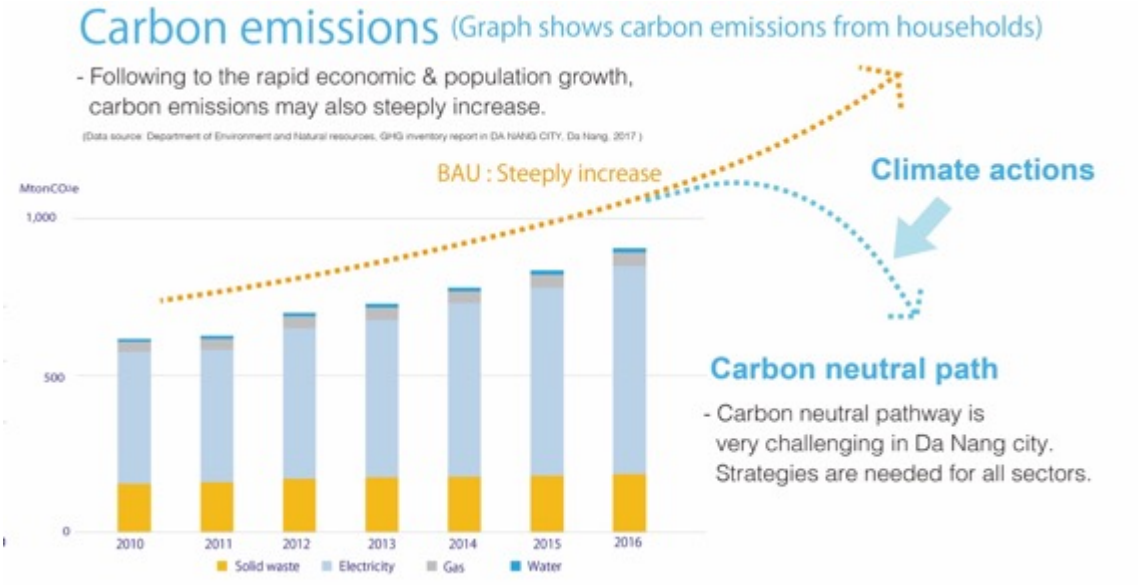


Figure 1-4: Growth in CO2 emissions and carbon neutral reduction pathway (prepared by IGES)

In the city's currently formulated development plan, the future population of Da Nang is predicted to have the potential to increase by about 1.5 times the 2010 level by 2030 (see Figure 1-3). When a simple estimation is made assuming growth continues along the same

trend (Business As Usual), by 2050 the population could conceivably almost double from the 2010 level. Alongside this population growth, and taking into account the current emissions trend, a rapidly increasing trend in emissions can be predicted for the future, as shown in Figure 4. It must be recognised that, for Da Nang, measures aimed at decarbonisation and low-carbon development are very challenging indeed given these current trends.

However, going hand in hand with its development, Da Nang City has also developed a smart city plan and an integrated master plan aimed at green growth (Masterplan 2030 vision to 2050), as well as draft plans for large-scale public transport (construction plan for subway and BRT expansion). The inclusion of a carbon-neutral vision in the city's development plans is expected to be an important point for Da Nang, as it would be prepared for further investment if plans move forward to construct an eco-industrial park to attract foreign companies. Vietnam's declaration on aiming for carbon neutrality at COP26 in November 2021 can be expected to bolster this vision in a more realistic way. At the present stage, the city of Da Nang has not yet set any specific targets for carbon neutrality. However this project aims to contribute to the development of an integrated plan as a final outcome by working together to determine targets and concrete actions. Activities in 2021 established outlines of action plans by sector, laid the foundations for discussions with policymakers in relevant departments, and aimed to determine the basis and basic strategy for collaborative development (framework of the action plan).

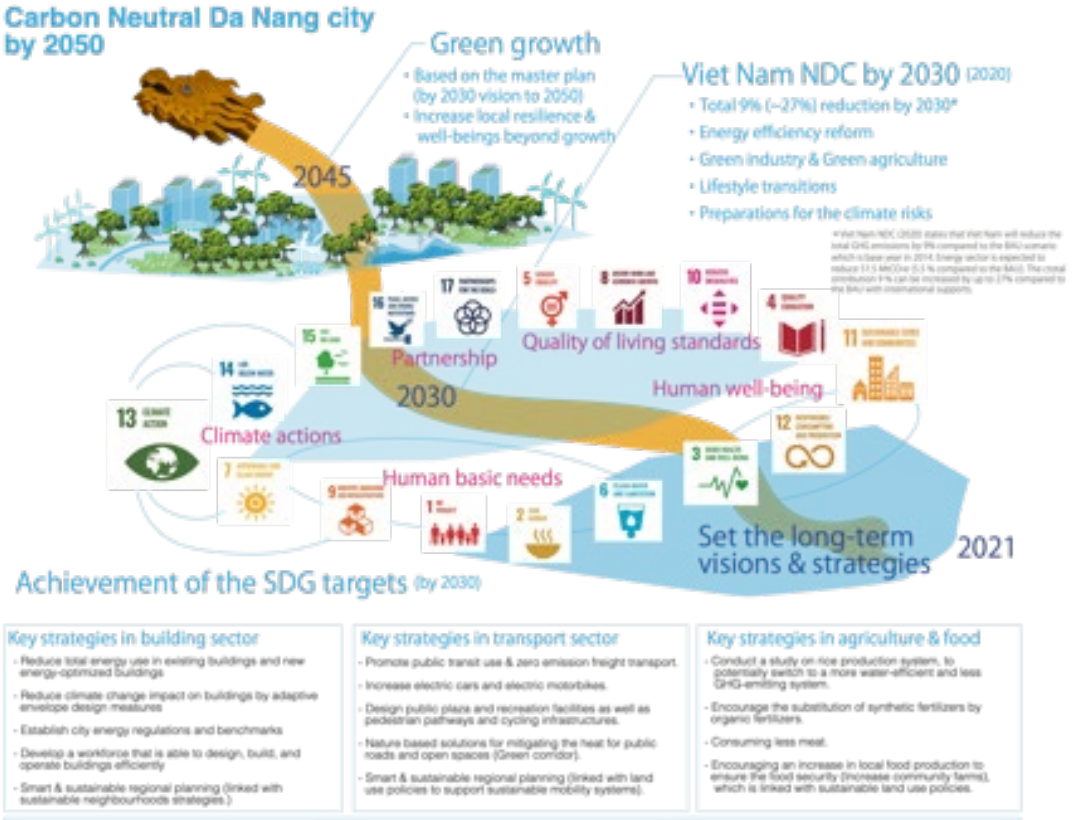


Figure 1-5: Da Nang City's long-term visions and three climate actions (prepared by IGES and expert panel)

4.1.2 Local data collection and scenario analysis by sector

For activities in 2021, collection and analysis of data was continued from 2020 focused mainly on the building sector. Data, including measurement data for the locale compiled to date, was provided by the Department of Architecture of the University of Da Nang, our counterpart and collaborator on this project. We then developed a framework for analysis combining the analytical experience of IGES and UCL as a working group consisting of three institutions.

First, Figure 1-6 shows data held by the University of Da Nang on emissions from the energy, solid waste, gas and water sectors that was provided directly by the city of Da Nang that indicates actual values over time for the period 2010-2016. Emissions from the gas and water sectors are relatively low and do not show any striking increase in recent years. In contrast to emissions from solid waste, which are relatively high but stable with few fluctuations, emissions from energy sources reveal a striking upward trend. This trend also holds true at the national level according to the NDC.

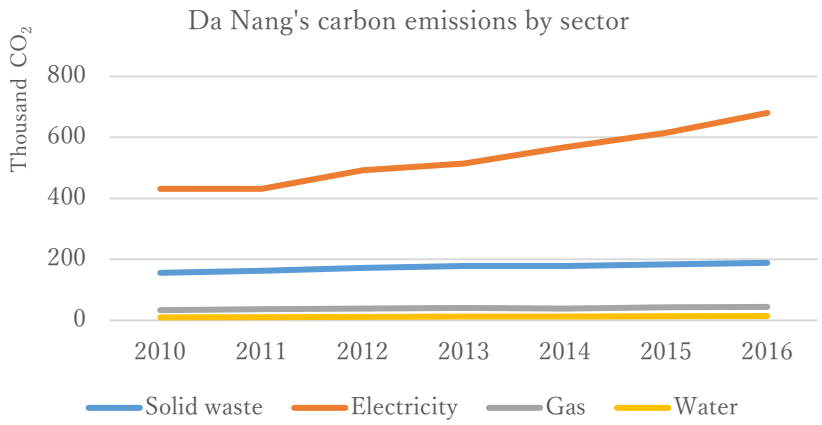


Figure 1-6: Da Nang emissions by sector (2010-2016, provided by Da Nang City)

Meanwhile, Figure 1-7 shows a comparison of energy consumption by sector in 2010. The graph reveals the remarkably high emissions from the industry and transport sectors, followed by emissions from the building sector, which comprises residential and commercial, as well as public buildings.

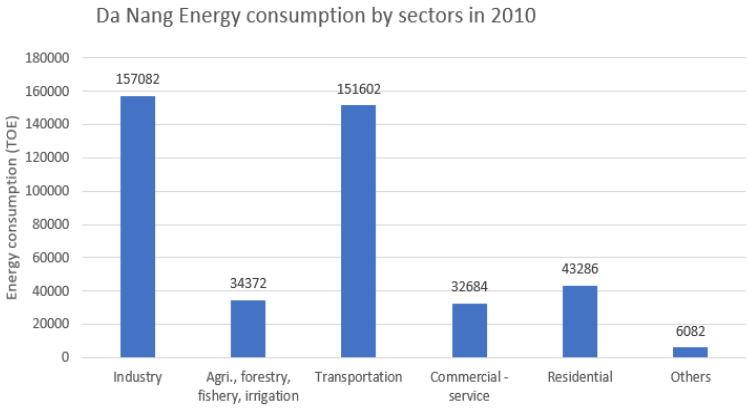


Figure 1-7: Comparison of energy consumption by sector in Da Nang City (2010) (Courtesy of the University of Da Nang)

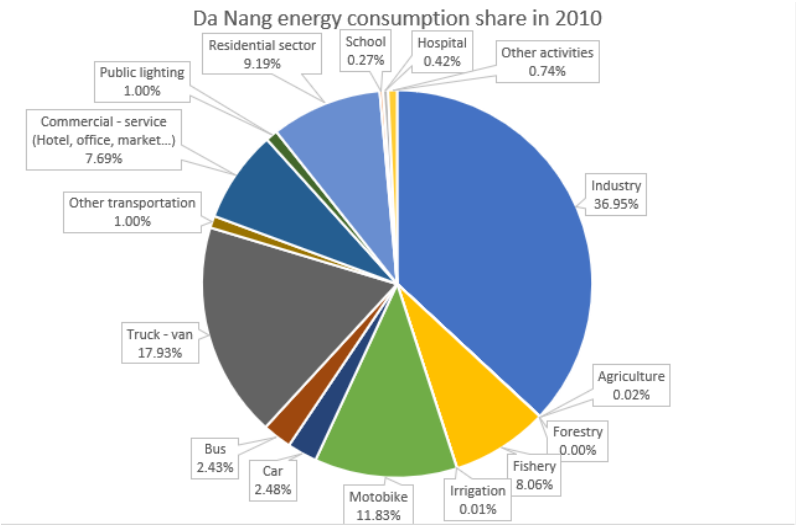


Figure 1-8: Share of carbon dioxide emissions by sector in Da Nang City (Courtesy of the University of Da Nang)

Figure 1-8 shows a detailed comparison of energy consumption share by sector. In the high-consuming transportation sector, energy consumption for motorbikes in particular is high compared to cars and buses, which is characteristic of the transport situation in Vietnam. (This was identified as a priority in the 2020 study as well.) Another notable trend is the high consumption of trucks for distribution. This shows that, for a city like Da Nang where tourism is the main industry, the distribution network functions as an important lifeline as goods to support the service industry are brought in from outside the city. Analysis of these figures can also show a high potential for a radical reform of distribution in Vietnam, where green logistics

itself is not yet mainstream. Moreover, in the building sector, the overall consumption of residential buildings exceeds that of commercial buildings such as hotels that support the tourism industry. This trend needs to be analysed and discussed in more detail.

Figure 1-9 shows a comparison of consumption by energy source. The graph shows the consumption of diesel and gasoline to be remarkably high. An examination of this data also allows for consideration of the high reduction potential of electrification of transport and industry.

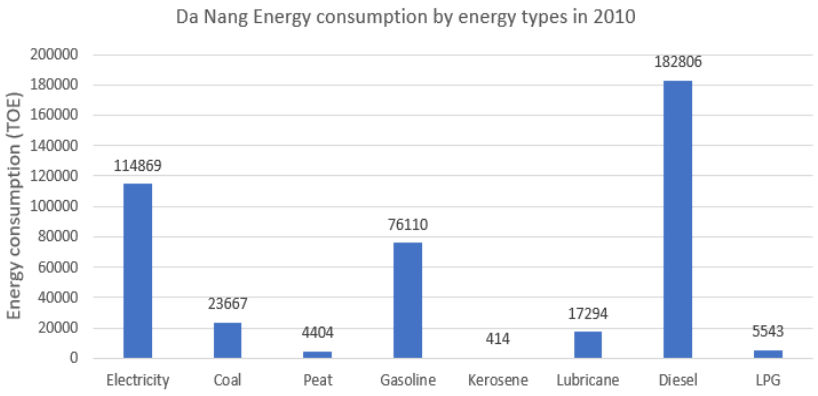


Figure 1-9: Comparison of consumption by energy source (2010) (Courtesy of the University of Da Nang)

Using the basic data shown above as well as measurement data of each type of building, a trial analysis was carried out to examine the potential for future emission reductions. The analytical method was based on a framework for long-term future scenarios and a method of scenario analysis of emission reduction from buildings used in a past study of Tokyo by IGES researchers. The study was conducted as a working group (University of Da Nang Department of Architecture, IGES, UCL) using the data of Da Nang City.

Shared socio-economic pathways (SSPs) were considered as a framework for scenario analysis. This framework was envisioned by a global climate change research team as societal pathways positioned along the two axes of mitigation and adaptation in order to predict uncertain long-term futures. Figure 1-10 shows the original version of the SSPs narrative, which is currently the most widely cited. The SSPs comprise five societies, SSP1 to SSP5.

Figure 1-10: Shared Socio-economic Pathways (SSPs) climate change policy analysis framework, global version (O'Neill et al., 2017)

Using the global version of the SSPs as a base, the framework was downscaled to an urban version of the SSPs (Kamei et al., 2016). These include detailed social, economic, environmental and urban structure indicators and are intended to lead to quantitative assessments in each sector. This framework emphasises the importance of an integrated assessment that combines qualitative analysis based on consideration of socio-economic scenario stories and indicators, and quantitative analysis setting detailed parameters for each sector based on scenarios (see Figure 1-11).

Figure 1-11: Urban version of SSPs: Scenario Narratives for Tokyo (Kamei et al., 2016)

This scenario narrative also includes projections of changes, such as those in urban structures, industrial transition and people's values, and serves as a common set of assumptions for conducting quantitative analysis in each sector (e.g. building, transport, land use, energy, water, resources). For the analysis of the Tokyo Metropolitan Area, predictions of the lifespan of buildings and long-term transitions in stock, as well as predictions of CO2 emissions from the building sector, were made (see Figure 1-12).

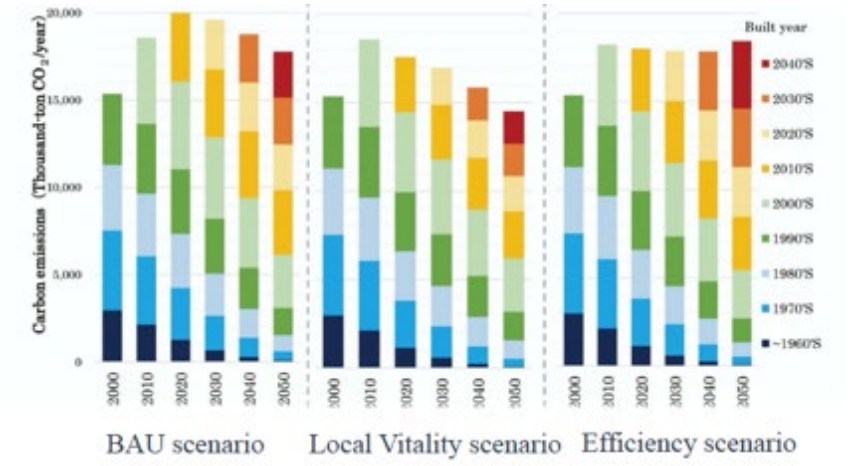


Figure 1-12: Projected CO2 emissions by scenario for buildings (wood) in Tokyo (Kamei et al., 2019)

Within the scope of this project's study, we aim to develop a method of analysis that combines the analysis in Figures 1-11 and 1-12 with the building stock analysis adapted by UCL for the city of London. In 2021, main activities included organisation of information to be adapted for the analysis and base scenario analysis. Some scenario pathways and their analyses are being designed for the next plan. For the wider area, an overview survey was carried out in 2020 (see Figure 1-1 and Table 1-1).

Figure 1-13: Building typology for Da Nang City (Photo: Courtesy of the University of Da Nang)

Figure 1-13 shows a typology of buildings in Da Nang. In recent years, high-rise buildings, mainly made of reinforced concrete, have become more prominent, while residential buildings are mostly low-rise at three to four stories high. The housing style is unique to Vietnam, with the ground floor connected to the street, similar to the style of Japanese row houses. The climate change action plan for the building sector is described in section 4.1.3 below on the proposed climate change action plan.

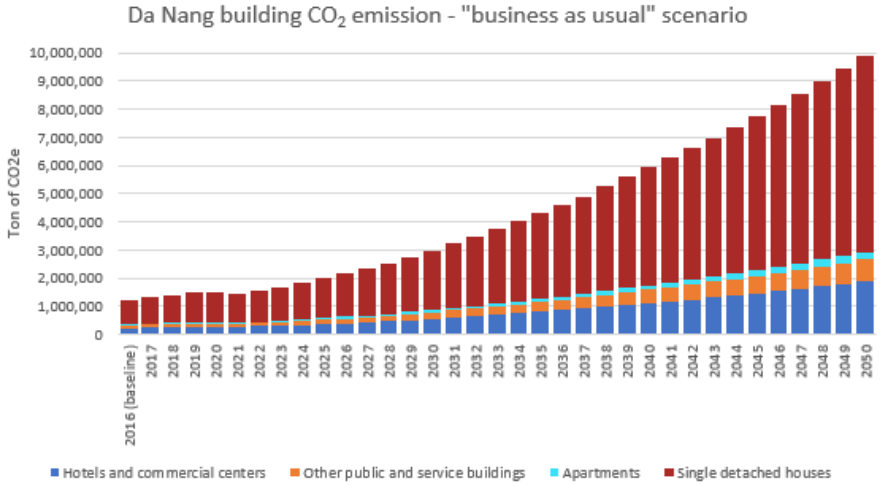


Figure 1-14: Projected emissions from the building sector in Da Nang, 2016-2050 (prepared by the Building working team)

In 2010, CO2 emissions from the building sector in Da Nang totalled roughly 76,000 tonnes, a figure that has exhibited a rapidly increasing trend over the years. According to estimates by Da Nang's Department of Industry and Trade, this figure increased at an annual rate of about 9.95% (2010-2015) in the household sector, and at a rate of about 16.3% for commercial facilities. These estimates calculate Business-As-Usual emissions assuming increases of approximately 7-8% annually from 2016 to 2035 and approximately 5-6% from 2035 to 2050. When calculated so, the emissions from the Da Nang building sector are predicted to reach 2,970,000 tonnes by 2030 and 9,980,000 tonnes by 2050.

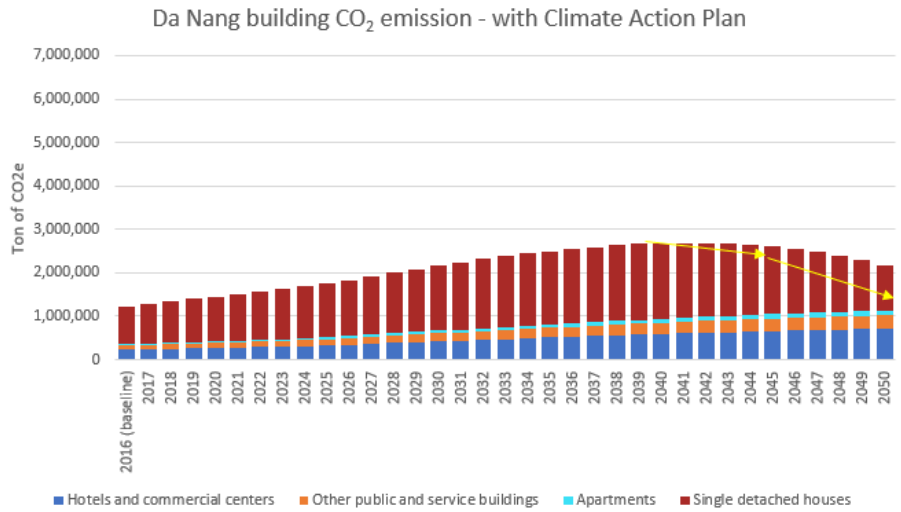


Figure 1-15: Projected emissions based on adaptation to the Da Nang Climate Change Action Plan (prepared by the Building working team)

The estimates shown in Figure 1-15 show the reduction potential when the actions of the Climate Change Action Plan proposed by this project, as described below (4.1.3), are effectively implemented. At present, these are approximate values that accommodate for information and data accumulated by the University of Da Nang.

4.1.3 Proposed Climate Change Action Plan (see First Draft in Appendix1 for details)

The action plan as a whole, as shown in Figure 1-2 in Section 4.1.1, is designed to be cross-sectoral, with both mitigation and adaptation measures for a comprehensive range of sectors, from the perspective of resilience. This report presents an overview of the action plan for the priority sectors of building and transport.

<Overview of action plan for the building sector>

As shown in the previous section on long-term projections of CO2 emissions in the building sector (BAU and action-adaptation scenarios), while the potential for reducing emissions in the building sector is great, the building sector faces very high hurdles should it aim for net zero towards achieving carbon neutrality. The following are four targets and five mitigation actions to achieve them that the building sector must work urgently towards. The mitigation measures aim for a reduction of about 64.6% in the implementation of the five actions.

TARGETS

Target 1: Develop and promote concrete city programs that improve building energy efficiency by 2025 and 50% of the total floor area of new buildings are energy efficient buildings by 2030.

Target 2: By 2050, all non-residential buildings are equipped with advanced BMS (building management system) and 60% of households has smart meter; nearly 74% non-residential buildings and 57% of “100m2 or higher-footprint” houses are integrated with rooftop PV and hot water systems.

Target 3: 80% new buildings over 2500 m2 floor area complied with the national building code QCVN 09:2017 (or updated versions) by 2030.

Target 4: develop city energy benchmarks for all important commercial building types by 2030 and 100% commercial buildings are checked and labeled using city benchmarks by 2050.

Target 5: reduce building solid waste 18% by 2030 and 58% by 2050.

ACTIONS

The energy consumption per capita in Da Nang is not high, compared with that of other cities of the world, however, there is expectation of increase of energy use in line with the economic and population growth.

Mitigation action 1: Reduce total energy use in existing buildings and new energy-efficient buildings

Energy waste costs Da Nang residents and businesses millions of dollars annually. Energy efficiency is a powerful economic opportunity as well as a resource to meet our sustainability and climate goals. For a building to be energy efficient, it must perform at the same level or better with less energy. As technology becomes more embedded into our daily lives, we are placing unprecedented demands on the electricity grid. By improving the efficiency of our

building stock, we can ensure our growing energy demand does not outpace current capacity. Efficient buildings are not only more cost-effective to operate and maintain value longer, they also provide healthier and more comfortable spaces to enjoy. By retrofitting the existing building stock or establishing new guideline for renovations, this goal can be achieved.

Mitigation action 2: Reduce climate change impact on buildings by adaptive envelope design measures

Under climate change conditions, buildings are expected to increase energy consumption for cooling to ensure biological comfort in the building. Accordingly, this will increase greenhouse gas emissions, and as a result, the greenhouse effect causing global warming is even more serious.

Studies show that the increase in building energy consumption under the long-term RCP 4.5 climate change scenario is from 6% ≈ 12%. Meanwhile, the increase corresponding to the long-term RCP 8.5 climate change scenario is from 12.6% ≈ 22%. Restaurants and hotels are the types of commercial facilities with the most significant increase in emissions, while supermarket, factory and office buildings have a lower and fairly uniform increase.

Mitigation action 3: Establish city energy regulations and benchmarks

Energy codes, regulations establish minimum performance requirements for design, construction, and building components that must be met by new and renovated buildings. Buildings that are code-compliant reduce power demand and are more cost-effective to operate. Updated national building energy codes QCVN09:2017 (from 2013 to 2017) have increased potential energy savings from 10% to 25% for building occupants (see Figure 3.3). Studies in USA show for each dollar spent on energy code enforcement, there is a $6 return on investment from energy savings. In order to achieve these savings, buildings must be designed and constructed to meet the locally adopted code and regulation.

Building energy benchmarking is another control policy to improve building energy efficiency. It is the ongoing review to determine if your building's energy performance is getting better or worse. Energy benchmarking can be an internal process, measuring your building’s performance against its own past performance or against other buildings in your portfolio, or it can be an external process, comparing your building to a city benchmark of the same building type. Whether internal or external, regular energy benchmarking provides strong data that encourages building operators to strive for continuous improvement. Since commercial buildings are usually big consumers, 100% of them need to be controlled under a consistent benchmarking process of the city.

Mitigation action 4: Reduce energy consumption in the residential sector

Residential sector is a crucial energy consumer of Da Nang as it accounts for 73.7% of building energy consumption. Residential buildings are characterized by overwhelming numbers in the city and are operated by the inhabitants of the city, thus solutions for this area need to involve and have impacts on individual residents. Following key measures should be considered:

- Encourage use of natural ventilation all year. Scientists pointed out that Da Nang climate is naturally comfortable in 36.6% of a year, which can be extended to 58.7% with natural ventilation (Nguyen & Reiter, 2014).
- Building smart meters for households: Consumers will be offered an In-Home Display (IHD) and this will provide real time information on their energy use both in terms of consumption and cost as well as other useful information. Smart meters are possible for a reduction of household electricity consumption between 1.1% and 2.7%. The corresponding reduction of gas consumption was between 2.2% and 2.8% (Dromacque, et al., 2013).
- New housings should apply for the energy efficiency standard and Energy efficiency retrofits for the old dwellings (see above-mentioned Action 1).
- Recommendations for choosing energy efficiency home appliances: home appliances account for 20% of your home's total electric bill. This can be reduced by 10-50% by using energy efficient appliances (Energysage, 2021). Equipment that achieves the 4- to 5-star rating of the energy label of Ministry of Industry and Trade should obtain a priority policy in the residential sector.

Mitigation action 5: Installing on-site renewable production systems (Rooftop PV and solar hot water systems)

The global solar energy market was valued at $52.5 billion in 2018 and is projected to reach $223.3 billion by 2026, growing at a Compound Annual Growth Rate (CAGR) of 20.5% from 2019 to 2026[1]. Residential solar PV market size is expected to expand at a CAGR of about 5.6%. Rooftop PV systems and solar hot water systems are becoming cheaper and cheaper due to the rapid increase in the number of users. Based on an estimation from this study, with 57% of households and buildings in Da Nang installing small rooftop PV systems by 2050 (which means an annual increase rate of 2% to 2040 and 1.85% to 2050), Da Nang could save 3 million tons of CO_2 equivalent by 2050. It is estimated that rooftop solar and power systems could account for 61% of Danang's total GHG reduction by 2050. Thus, these

[1] Solar Energy Market Outlook – 2026, available at: https://www.alliedmarketresearch.com

measures will play the most important role in the decarbonisation process (see Fig. 1-16).

Mitigation action 6: Reduce building solid waste by strict waste classification and recycle rules.

Solid waste generally requires much effort to resolve safely and efficiently, including waste collection, transportation, classification, treatment and solving consequent affects related to human health. Solid waste accounts for 9.52% of the total emission in the household area and might be up to 23.3% in the commercial & service building area. This can be reduced by applying strict waste management scheme throughout the city along with a long-term encouraged campaign of waste recycling within the community. Organic waste might be a useful input in increasing composting in the food/agriculture sector of Da Nang.

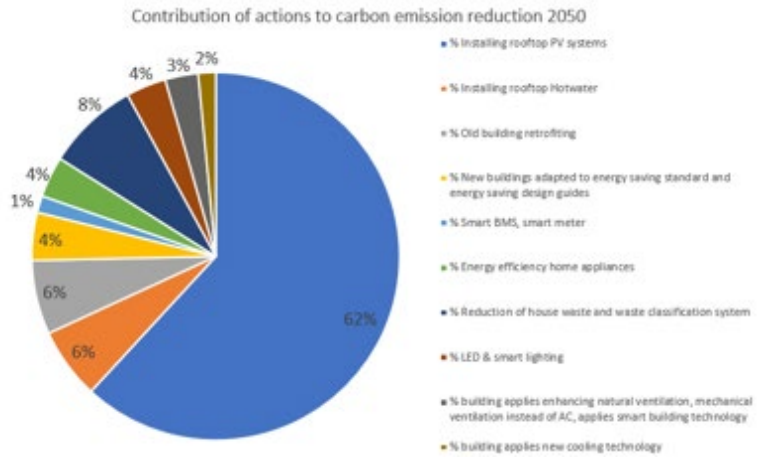


Figure1-16, Contribution of actions to carbon reduction by 2050

<Overview of action plan for the transport sector (see First Draft in Appendix1 for details)>

Although the project lacks a counterpart in the transport sector and previously faced a lack of data, information and data on emissions, modal shares and future development plans (e.g. construction of public transport) were obtained for the 2021 study, which enabled the formulation of a basic vision and framework for an action plan.

Main visions for transport sector to achieve the carbon neutral Da Nang city focuses on increase of public transit use as one of the priorities. Public bus service will play a key role continuously, which will be fueled by clean fuel and electricity. Therefore, electric vehicles for public transit (bus, taxi, tram (light rail), and water bus, Metro (by when), BRT) should be increased with the target of 100% by 2050. Private cars and motorbikes should also be replaced by energy efficient electric ones with the target more than 80% by 2050. In addition,

green logistic strategies should be developed align with national decarbonization strategies, and promote zero emission freight including outside of administrative boundaries. Walking and cycling are also significantly recommended to the communities and the city should develop comfortable pedestrian spaces and safe & green cycle lane networks attracting visitors to use for their city tours as well as local residents' daily use. These public realm policies should be connected with other sustainable development strategies with effectively managing the land use and local urban structure plans.

Da Nang current transport modes:

Figure 1-17: Share of emissions from the transport sector in Da Nang, 2016 (Da Nang City)

Mitigation action 1: Improve and develop public transit services and create the effective network systems involving all transport modes.

In Da Nang city, around 12% of total GHG emissions comes from motorbikes. Cars and Buses are in charge of 2.48%, 2.43% respectively. While tracks and vans emit relatively high GHG emissions with around 18% of total which also contribute to the increase of air pollutions, the other transportations including railway, waterway and airway account only 1% of total. Therefore, shifting to more public transport use will significantly contribute to GHG reduction. However, only public buses and some water ways are main public transportations in the city.

These public vehicles should be replaced by electric vehicles as the first priority by the city government, and electric vehicle charge stations should be created all the necessary points by 2040. City bike scheme (cycling) can be a part of green public transport program in the city for both local communities and tourists (this is included in the Mitigation action 4). All such public transport systems will be effectively networked within the city's key nodes by the smart technologies (for instance; Da Nang MaaS).

Mitigation action 2: Improve traffic flow and reduce congestions

Logistic freight transport is the highest emitters at the current level in the transport in Da Nang city. Green logistic involving private business is one of the key priorities (this is also included in the Mitigation action 5). City should monitor the congested time schedules during a daytime and week days, city may set congestion charge to mitigate the air pollutions and GHG emission from the city centre. Also some outer ling road can be planned to avoid the cars that aim to just pass through the city areas. Smart transport network system can monitor such traffic situations and manage to balance the safe and comfortable traffic flows.

Mitigation action 3: Increase of EV (and energy stations)

In Da Nang city, overall approximately 90% of total emissions comes from road based emissions. Therefore, replacement to EV can produce the significant GHG reductions and mitigate the air pollution level. However, the deployment of EV requires energy chargers as a fundamental infrastructures instead of gasoline stations.

Mitigation action 4: Car sharing and Bike sharing schemes (Life style changes)

Car parking spaces in the city centre are limited and the cost of EV is still relatively not affordable for the all residents, car sharing scheme can support the city's green & circular economy strategies under the carbon neutral visions. This car sharing and bike sharing scheme enhance the sustainable community networks and the shift to the environmental friendly life styles. These programs should be included in the local structure plans under the revised city's master plan visions for 2045.

Mitigation action 5: Green logistics (within and between cities)

Green logistic programs require the large commitment of private business sectors, therefore, city government needs to actively work with all related stakeholders to motivate them to move forward to the smart & environmental friendly business mind overall by 2030, which can strongly support the achievement of SDG9 and SDG12. The cooperation and network with other business partners beyond the city boundaries are also necessary to achieve the

reduction target. These collaborations will create the new business opportunities and great business eco systems beyond the sectors through the innovative supply chain systems.

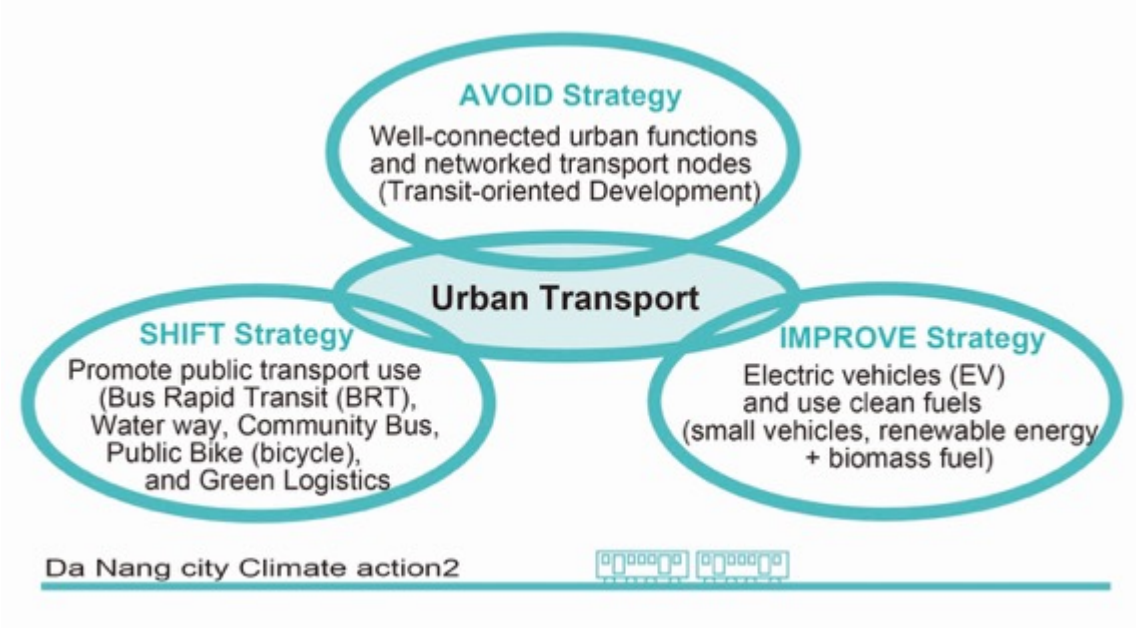


Figure 11-8: Suggested basic strategies of transport sector (Adopted to the Avoid-Shift-Improve framework)

4.1.4 Stakeholder discussion at workshop (see Appendix2 & Appendix 3 for details)

A Stakeholder Workshop was held with Da Nang City on 27 January 2022, with the following agenda.

DA NANG CITY People's Committee
DEPARTMENT OF RESOURCES AND ENVIRONMENT
No.: /GM-STNMT

SOCIAL REPUBLIC OF VIETNAM
Independence - Freedom - Happiness

Da Nang, dated January 2021

INVITATION

to the Draft Consultation Workshop Implementation plan of the component "Support to develop local climate action plans" within the framework of the project "Support to develop Da Nang's Climate Change Action Plan and Low Carbon Technology Projects" funded by the Japanese Ministry of Environment

With the consent of the City People's Committee in Official Dispatch No. 376/UBND-STNMT dated January 19, 2022 on participating in the Project "Support for the development of the Action Plan". climate change of Da Nang city and Low Carbon Technology Projects" funded by the Japanese Ministry of Environment, in order to have a basis for implementing project components, the Department of Natural Resources and Environment presides over the organization. Organized a consultation workshop on the draft implementation plan of the component ***"Support for the development of local climate action plans"*** within the framework of the Project, specifically as follows:

1. Chair: Mr. Vo Nguyen Chuong - Deputy Director Director of the Department of Finance Resources and Environment.

2. Time: 16:00, January 27, 2022 *(Thursday afternoon).*

3. Participants, respectfully invite:

a) From the Japanese side: Project team members include: Dr. Miho Kamei (IGES), Dr. Pamela Fennell (UCL), Professor Peter Jones (UCL), Dr. Louise Guibrunet (UNAM), Dr. Marinella Davide (CMCC), Pham Ngoc Bao (IGES).

b) On the side of Da Nang:

- Representatives of the Departments: Construction, Transport, Industry and Trade, Agriculture and Rural Development, Education and Training, Science and Technology;

- Experts: Assoc.Prof.Dr. Nguyen Anh Tuan, Dr. Kieu Thi Kinh.

4. Contents of the workshop:

Introduction of the project and the draft Plan for the relevant component, including 05 main contents: (1) Developing a climate action plan; (2) Climate Action Plan in the Transport Sector; (3) Climate Action Plan in Agriculture; (4) The Sustainable Development Goals (SDGs) in the Climate Action Plan; (5) Climate Action Plan in the Education Sector; Discussion,

Environment: At Meeting Room No. 1, 15th Floor, City Administration Center, 24 Tran Phu, Da Nang : Including the Department of Natural Resources and Environment and agencies, units and experts of the city.

- Second bridge point: From Japan, including members of the Project team.

6. Workshop agenda: Attached in the appendix.

To connect the online meeting system and send documents, we would like to suggest that your agencies, units and experts contact: Environmental Protection Sub-Department, 57 Quang Trung, Da Nang (see expert Le Thi Thanh Ha, phone: 0236.3.537929; 0984.777.236, email: haltt1@danang.gov.vn).

Therefore, the Department of Natural Resources and Environment invites agencies, units and experts to arrange to attend and exchange ideas on the proposed contents of Japan for the Conference to achieve good results./.

Receiving place:
- As above;
- City People's Committee (replace b/report);
- Director of Department (b/report);
- Foreign Service;
- City Police;
- International cooperation group;
- VPS;
- Save: VT, CCMT, H.

KT. DIRECTOR
VICE DIRECTOR

Vo Nguyen Chuong

The workshop was chaired by Mr. Vo Nguyen Chuong, Vice Director of the Department of Natural Resource and Environment, Da Nang City, with the participation of relevant departments (Department of Transport, Department of Transport, Construction, Agriculture and Rural Development, Industry and Trade). Discussion was led by the team of experts from Japan for development of the Climate Change Action Plan. The workshop opened with an address by an official from the Ministry of the Environment Japan (MOEJ), who expressed expectation for improved cooperation and implementation of carbon neutral initiatives between Vietnam and Japan. An Advisory Board from Japan and the UK was also in attendance.

Workshop opening presentation (Working Team)

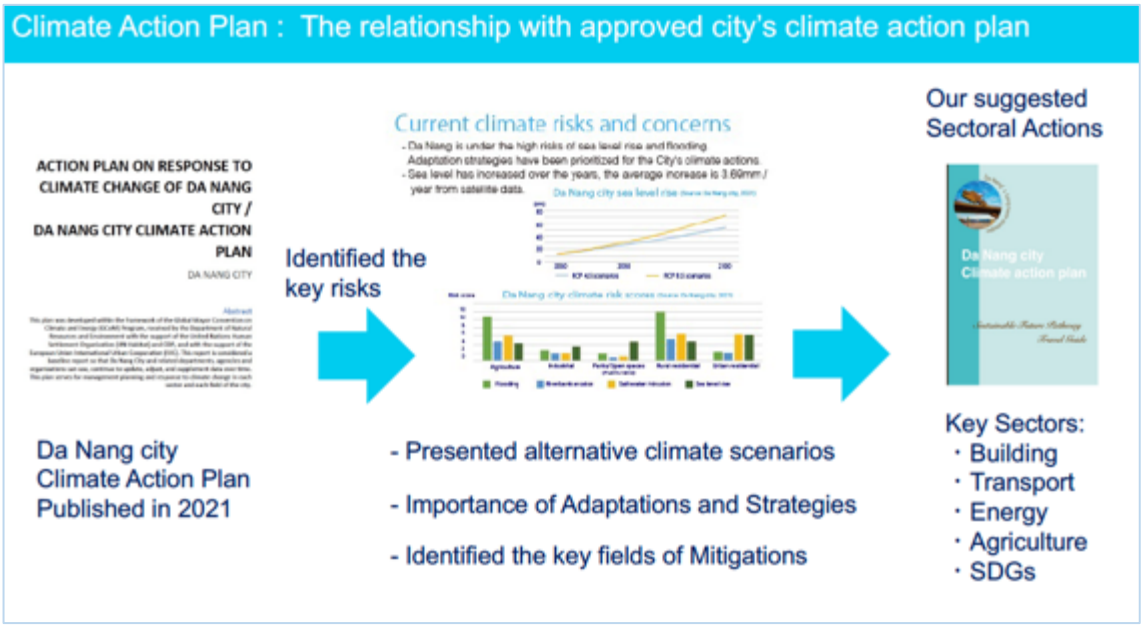
The three main objectives of the workshop were as follows.

(1) To demonstrate the difference in positioning between the risk assessment "Climate Action Plan" already officially approved by Da Nang City and the climate change action plans by sector to be developed for the city, and to confirm with the relevant agency (Department of Natural Resource and Environment, Da Nang City).

(2) To confirm the direction of Da Nang City's long-term vision for carbon neutrality in order to reflect it in the development of scenarios going forward.

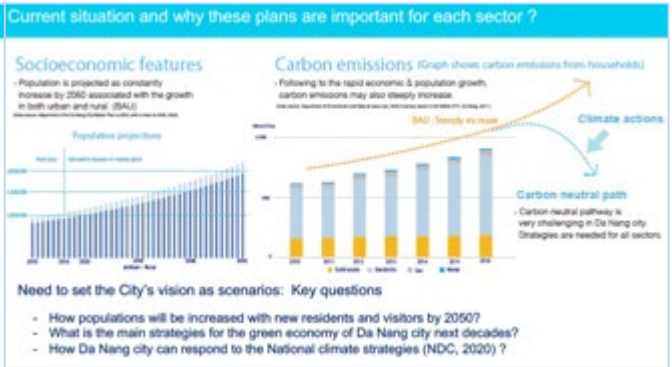
(3) To present the draft action plans for sectors that have already been developed and to establish working relationships with the relevant departments in order to receive feedback and additional data.

Regarding (1), Slide 1 explains the purpose of developing this action plan and the significance of developing sectoral action plans for stakeholders in Da Nang City. Comments from the Danang City side indicated that they understood the distinction, and agreement was reached on important points (**Workshop Outcome 1**).

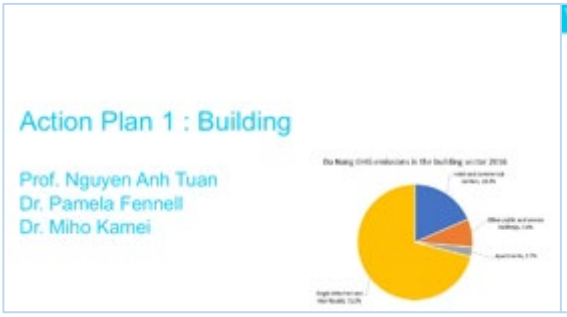


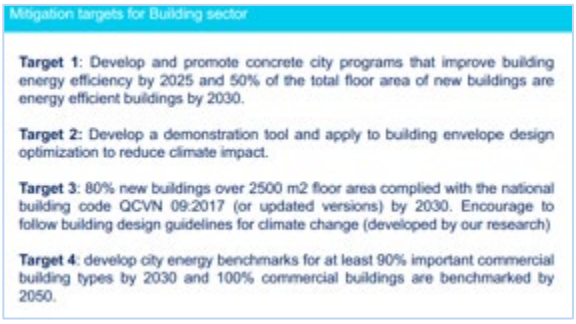
Regarding (2), Slides 2 (left) and 3 (right) were used to illustrate the timeline for achieving carbon neutrality and the SDGs (including the 2030 NDC) and consistency with the Development Master Plan (Slide 2), and to share the importance of assessment analysis with a concrete outlook for the socio-economic development for this purpose (Slide 3). Subsequently, participants were asked to share their specific suggestions on outlooks as related to population growth rate, scale of economy and the direction of green growth as a development plan.

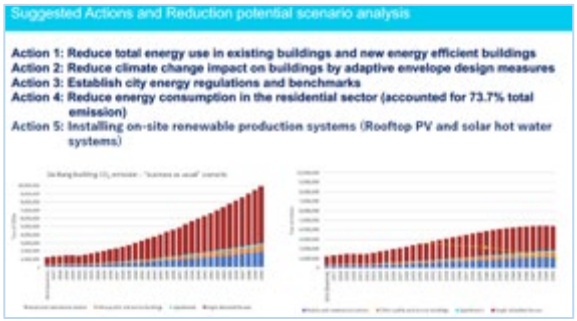
Although it was difficult for participants to provide specific outlooks during the discussion as answers to these questions do not come easily, they shared a sense of the importance of analysing the long-term scenarios presented here and asked for some scenarios to be provided for Da Nang City **(Workshop Outcome 2)**.

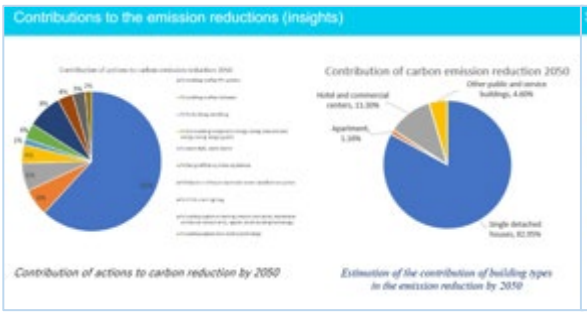


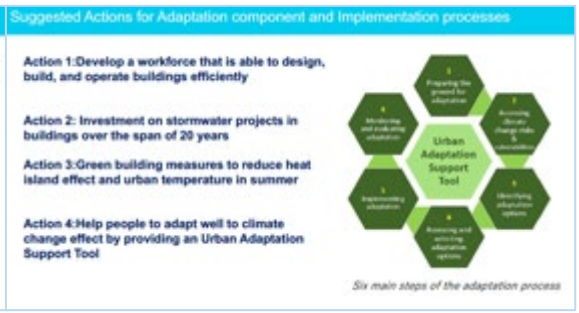
Regarding (3), each working group made a presentation to indicate their findings, draft proposals and considerations to date, after which they received opinions, comments and additional suggestions from the relevant departments of Da Nang City.







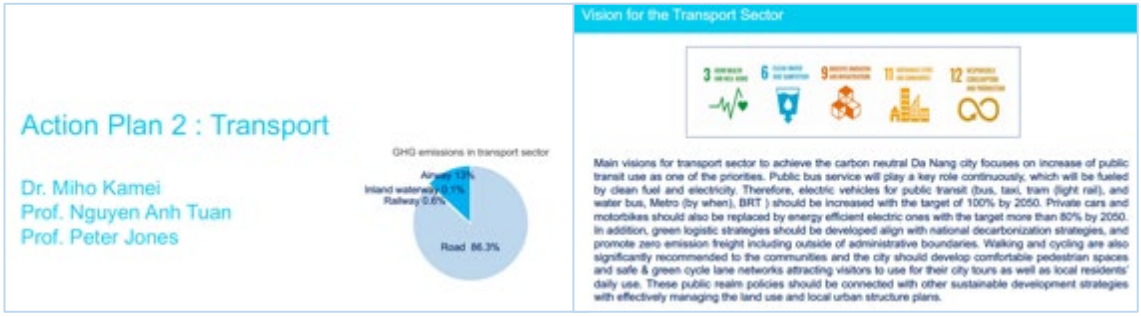


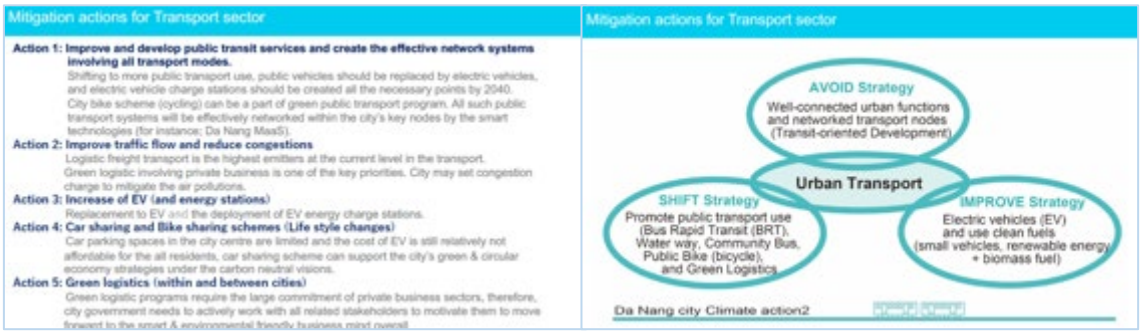


For the building sector, Associate Professor Anh Tuan of the University of Da Nang, who is a member of the Da Nang expert panel, was mainly in charge, with experts in the building sector from IGES and UCL providing support. The three institutions formed a working team to formulate the action plan while engaging in analysis and consideration.

Thanks to the substantial research experience and utilisation of data to date in the Department of Architecture of the University of Da Nang, the content of the action plan for the building sector is highly reliable and even indicates estimates of reduction potential.

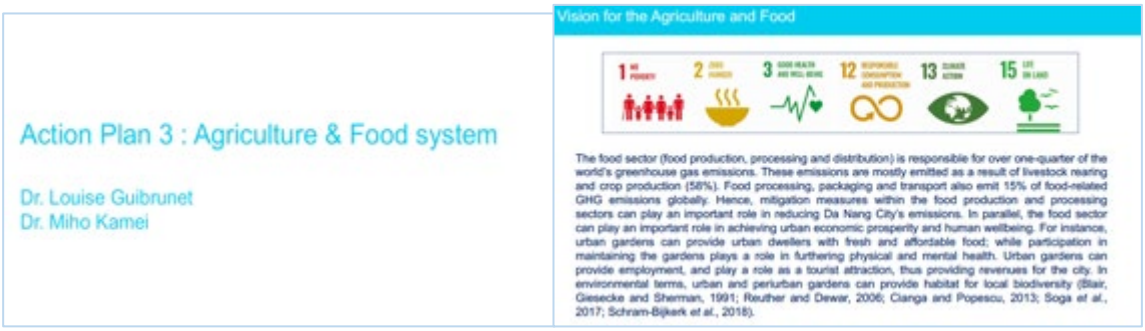
During the workshop, agreements were reached on basic actions. However, there were additional requests from Da Nang City regarding several originally-planned scenario analyses (adaptation to the scenario analysis methodologies shown in Figure 11 and Figure 12) that respond to various socio-economic changes. Going forward, scenarios are expected to be developed for Da Nang City that are adaptable for all sectors.

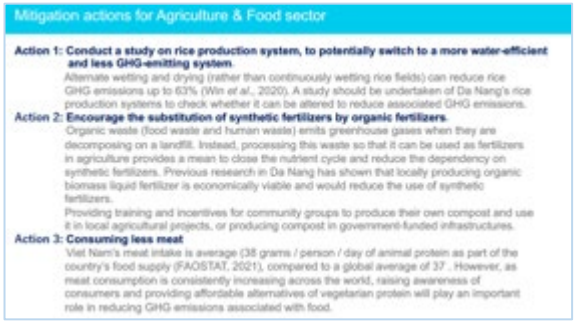




For the transport sector, IGES experts led in the development of the basic strategy, supported by the Department of Architecture of the University of Da Nang and transport experts from UCL. Although the overwhelming lack of information compared to the building sector was a cause for concern, the aim was to develop an action plan that took into account the direction Da Nang City was headed by ascertaining the current situation based on plans for development presented in the Development Master Plan and available data on CO2 emissions by sector and transport option.

For this initial draft, as in the case of the building sector, an agreement was reached on the general direction and an outline of actions to be taken. With the establishment of direct support from Da Nang City, more detailed data from recent years is expected to become available. Thus, the current outline version will be expanded with supporting data estimates and scenario-specific estimates as requested by Da Nang City.





While the reduction potential of the agriculture sector is not as high as other sectors (e.g. building and transport), it is a sector of particular interest in Da Nang considering experiences in the COVID-19 pandemic and the increasing importance of adaptation measures due to recent climate change impacts on crops. Therefore, expectations for in-depth analysis and data collection, especially for this sector, were discussed during the workshop. One of the major outcomes of the workshop was the commitment to share relevant reports and detailed data, as adaptation measures are already included in Da Nang's approved risk assessment climate action plan.

It was also confirmed that in Da Nang, the process of discussing the agriculture sector in the bigger context of other areas of development has not yet taken place, and one of the challenges will be to effectively indicate linkages in the action plan.

Action Plan 4 : SDGs and climate strategies

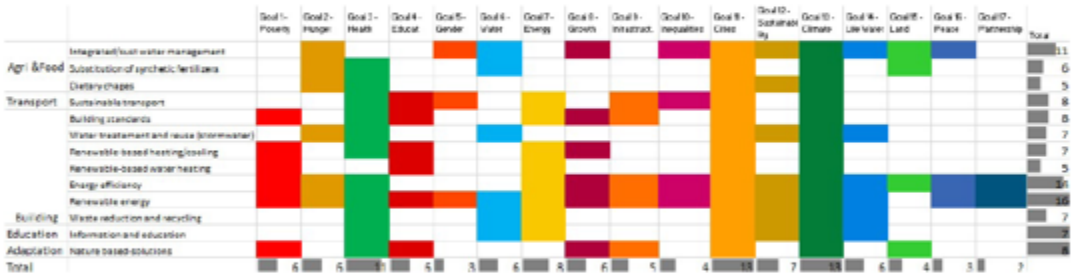
Dr. Marinella Davide
Dr. Miho Kamei

How achievement of SDGs is important for Da Nang's Sustainable Development Vision?

Climate change issues go far beyond the environmental dimension to enter the broader context of development and its sustainability. At the city level, climate challenges are strongly intertwined with other socioeconomic dynamics, such as poverty and inequality, public health, housing conditions, waste management, etc. Through the implementation of both mitigation and adaptation actions Da Nang would foster the achievement of multiple Sustainable Development Goals (SDGs).

Linkages between climate mitigation action & adaptation actions in Da Nang city

The table below tracks the linkages between the actions outlined by this climate plan and the SDGs, as defined by the 2030 Agenda for Sustainable Development.



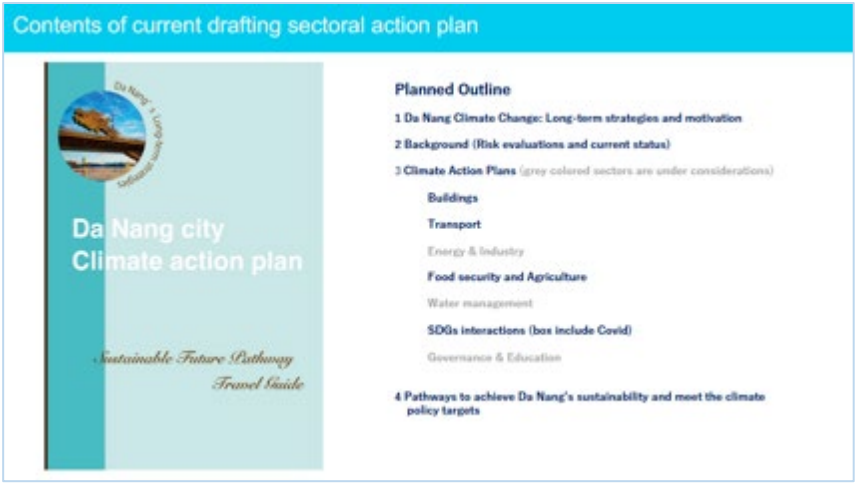
Renewable energy, energy efficiency, integrated water management provide key opportunities for Da Nang to make progress in other sustainable objectives.
Major synergies of the actions proposed in this plan are related to health, energy, growth, food security, (beyond SDG11- sustainable cities and SDG13- climate change).

Regarding the SDGs, Da Nang City has yet to draft policies or action plans to achieve the goals by specifically linking them to climate actions or development plans. For the current action plan, it will be meaningful to indicate along with the framework how specific actions are related to each of the SDGs and can contribute to their achievement. However, along with improvements to the action plan, promoting awareness in Da Nang City can also be recognised as a major challenge in this area going forward.

This chapter will also incorporate an analysis of the current impacts of the COVID-19 pandemic. To avoid confusion, this topic was not included in the workshop.

This slide shows the most important objective of the workshop—to ask for cooperation in providing more detailed information and data going forward. It proposes the sharing of reports and data on the state of the city that are not available to the general public, and collaboration on the creation of the plan to further enhance the reliability of its contents. As an outcome of the workshop, a general agreement was reached on confirming the content on the current state of affairs (2) **(Workshop Outcome 3)**. However, Da Nang City indicated a future wish to address the lack of data and further enhance its reliability, and promised to set up a system, asking for as much cooperation as possible from each department of Da Nang City.

Through establishing a cooperative system with the city, a detailed scenario analysis (requested by Da Nang City) and a realistic final structure to improve the accuracy of the action plan were established in order to finalise the sectoral action plans **(Workshop Outcome 4)**.



As for overall action plans for each sector, deliberations with Da Nang City will be ongoing concerning other areas not included in this presentation in an aim to create the

completed plan. The content of the action plan was also discussed at the workshop, and it was agreed that this would be the subject of collaborative deliberations going forward.

4.2 Work 4-2: Support Sector for Model Development for Low-Carbon Technologies

4.2.1 Studies on the Feasibility of Model Projects for Smart Energy Systems

In this fiscal year's activities, based on the results of the Year 1 we selected a target region and target companies for the introduction of low-carbon technologies, surveyed the current status of the companies and examined the technologies to be introduced, and based on these results, made a trial calculation of the amount of greenhouse gas (GHG) reductions necessary to apply for a JCM subsidy project. In Year 1, based on the "Comprehensive Energy Efficiency and Conservation Project at Da Nang Steel," which was proposed as an inter-city cooperation project in the business matching session held at the 9th “Da Nang Urban Development Forum” jointly held by Yokohama City and Da Nang City, we sought to survey energy conservation (the use of exhaust heat) in factories, examine the possibility of introducing LED light bulbs for street lights, and significantly reduce power consumption by improving the efficiency of air conditioning. We also studied the feasibility of commercializing radiant heating and cooling as a corresponding technology. Based on the results of the study, it became necessary to reconsider the regions and companies due to the scale of the target companies and factories. Through discussions with DONRE, we selected the a target region and contacted specific companies. On the other hand, due to the effects of the novel coronavirus, which have continued since the previous fiscal year, it has been difficult to discuss and negotiate with the officials of Da Nang due to an inability to be active locally and restrictions on work systems both in Vietnam and Japan. However, based on the advice of DONRE, an industrial park was chosen as the target area, and we were able to proceed with specific activities.

(1) Selection of the Target Industrial Park and Understanding of Power Consumption, GHG emissions, and the Emission Structure of the Park

1) Results for the Current Fiscal Year

Based on consultations with DONRE and other relevant local organizations, Hoa Khanh Industrial Park was selected as the target industrial park, and information was collected to understand the current status of the industrial park. Specifically, we tried to understand the power consumption, GHG emissions, and the structure of emissions in the entire industrial park.

2) Implementation Methods

The following studies were conducted to select the target industrial park.

① Listing of the industrial parks located in Da Nang City (Appendix .4).

② Study of large energy users among the enterprises in Da Nang (Appendix 5).

③ Study of Japanese companies operating in Da Nang.

Large energy users in Da Nang City were studied in three sectors: the manufacturing sector, the transportation sector, and the commercial sector, which includes hotels, supermarkets, and hospitals. We selected the target industrial park and customers based on the judgment that the industrial park was appropriate for proposing a model project for the JCM equipment subsidy program. Through the selection process, Hoa Khanh Industrial Park, where many large energy users are located, became a strong candidate, and on October 8, 2021, during a kick-off meeting with Da Nang City's DONRE, we discussed and examined the location for introducing a pilot plant for renewable energy and energy conservation using the JCM system. In the same discussion, DONRE recommended this industrial park, and it was decided to select this industrial park as the target park. The park is home to 17 manufacturers (based on 2019 numbers) that use more than 1,000 TOE (tons of oil equivalent) of crude oil per year, and the park even includes three Japanese companies (There were a total of 26 manufacturers in Da Nang that use 1,000 TOE or more as of FY 2019. Of these, 17 are in the Hoa Khanh Industrial Park, and three of these are Japanese companies. Furthermore, there are 29 commercial establishments in Da Nang that use more than 500 TOE.).

There are three Japanese energy users that use more than 1,000 TOE: Murata Da Nang, Mabuchi Motor Vietnam, and Daiwa Vietnam. All three are located in Hoa Khanh Industrial Park.

We had an interview with Mabuchi Motor Vietnam concerning its plans to introduce roof-mounted solar power generation (for its own consumption) in one of its factories in 2022. According to the company, it has confirmed that it will not use the JCM system for this installation because it wants to retain the rights to the reduced CO_2. The company stated that they plan to expand the introduction of solar power in the future, and we will continue discussions with the company.

After the completion of the new plant in 2023, Murata Da Nang plans to install roof-mounted solar power generation systems at the new plant. A briefing session was held for related parties including Saitama Murata (Tsurugashima City, Saitama Prefecture), the Japanese headquarters of Murata Da Nang. In the briefing session, we visited the head office face-to-face and connected online with the Murata Da Nang office in Vietnam to explain the JCM system. We obtained information from Murata Da Nang that the current plan is to install

photovoltaic panels on the new buildings with an area of 2,544 m^2 and that the total electrical demand for the new buildings is approximately 10,000 kW, and we have proposed equipment installation based on this information (Appendix 6). The details of the policy for introducing renewable energy in Murata Vietnam will be decided in FY 2022 and the equipment is scheduled to be introduced after the completion of the new factory in 2023. We plan to continue discussions with the company going forward.

We are also planning to deal with Daiwa Vietnam as an eco-factory in the future and will continue to encourage the introduction of renewable energy systems using the JCM system.

On the other hand, since large energy users are mainly locally capitalized manufacturers, we have asked DONRE, DOIT, and DHPIZA to introduce potential businesses that are interested in introducing renewable energy, energy conservation, and optimal supply and demand control systems using the JCM system. In January 2022, the Da Nang People's Committee officially approved the implementation of a project to introduce renewable energy, energy conservation, and supply and demand control systems using the JCM system as part of the project to support the formation of a decarbonized society based on the Yokohama-Da Nang Intercity Cooperation Project, and appointed the Da Nang Hi-Tech Park Industrial Park and Industrial Zones Authority (DHPIZA) as the department in charge of implementing the project. Although no referrals have been made yet, we hope to actively promote the selection of companies in the future, as we can expect specific referrals and information to be provided by DHPIZA.

3) Review of Activities and Future Tasks

As for the selection of the target industrial park, which was the goal of this fiscal year's activities, we were able to reach a consensus with Da Nang City to target the Hoa Khanh Industrial Park. In addition, we were able to obtain the approval of the Da Nang City People's Committee for the implementation of this project, an agency in charge of implementation was also appointed, and we established a system to promote future initiatives. In the future, we plan to hold discussions with the local agency in charge of implementation and collaborate to create a concrete project for the realization of the pilot plant. In addition, we would like to strengthen our approach to the three Japanese companies in the Hoa Khanh Industrial Park to introduce low-carbon technology by utilizing the JCM equipment subsidy program.

(2) Examination of the Possibility of Introducing Technologies and Measures Proposed by Yokohama City Companies in the Target Industrial Park

1) Results for the Current Fiscal Year

(1) Consideration of Technologies to be Introduced

The goal of the JCM equipment subsidy projects, utilizing the results of this inter-city collaboration project, is to combine technologies such as photovoltaic power generation, smart LED lighting, and radiant heating and cooling systems to optimize energy supply and demand and achieve a low-carbon society from the perspective of optimizing energy supply and demand for the entire region by saving energy on the demand side and introducing renewable energy on the supply side, with a single industrial park as the target. For this reason, this fiscal year, we drew an overview of the project (see figure below) while collecting information from Japanese companies and local companies for the introduction of the technology, and also while building a relationship with the target Hoa Khanh Industrial Park.

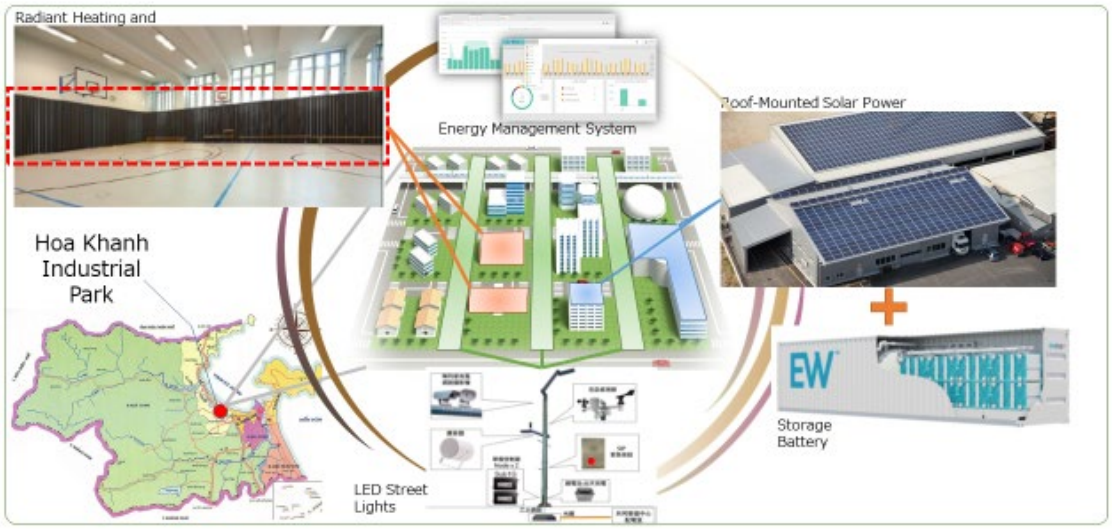


Figure 2-1: Visualization of Energy Optimization

(2) Methodological Study of Radiant Heating and Cooling Systems

With regard to the radiant heating and cooling system, we studied the characteristics and the possible methodologies including the method of calculation for the CO_2 emission reduction to be achieved by the introduction of the system, based on the application for JCM equipment subsidy projects.

In the case of air conditioners commonly used in JCM projects, the CO_2 reduction is sought by conservatively referring to air conditioners that are currently in widespread use in the market with respect to the coefficient of performance (COP)[2] and the annual performance

[2] A coefficient used as a guide for the power consumption efficiency of cooling devices, etc. Value representing cooling and heating capacity per kW of power consumption

factor (APF) and making a comparison with the COP of the newly introduced high-efficiency air conditioners of the project. The power consumption of the project air conditioners is also measured and recorded. The COP used in the calculation of reference emissions is calculated so that the CO_2 emission reductions from the project will be conservative, based on the perspective of BaU (business as usual) for the air conditioners.

On the other hand, in the case of a radiant heating and cooling system, the energy conservation effect differs greatly depending on the environment of the installation site, so the COP also differs depending on the installation site. Therefore, it is necessary to devise a rational calculation method because it is not possible to simply calculate the CO_2 emissions of the reference or the CO_2 emissions and emission reductions from the project. In other words, it is presumed that it will be necessary to construct a new methodology. Therefore, the items of the methodology envisioned in this study (eligibility requirements, calculation formula for CO_2 emission reductions) were examined. Furthermore, after conducting an interview with the individual in charge of development for support institutions for JCM methodology development, in addition to examining this new methodology, we received the opinion that, when applying to JCM subsidy projects, it would be sufficient to use the existing methodology to determine CO_2 emission reductions based on the actual results to date. The decision on whether or not to develop a new methodology will be made formally after the application is accepted, but if the development of a new methodology is necessary, we will cooperate in this development based on the results of this examination.

2) Implementation Methods

(1) Consideration of Technologies to be Introduced

a) Redox flow battery (Appendix 7)

For storage batteries to be used in conjunction with solar power generation, an examination was made for the introduction of a new type of storage battery with 12-hour continuous discharge, a minimum of 400 kWh, no performance degradation for 25 years, and virtually no disposal costs. We are confirming Da Nang Murata factory requirements for an initial proposal. It will be necessary to determine how to use the redox flow batteries and compatible specifications after setting the final usage requirements. We will determine the amount of electricity generated from renewable energy sources and the amount of electricity that can be stored, conduct simulations to quantify the effects of peak-shift discharging for discharges at nighttime and times when power is not being generated, and work on quantifying the effects of introducing the batteries. While it is expected that adapting the

(dimensionless). The COP equals cooling capacity or heating and cooling capacity divided by power consumption.

system to individual factories will produce results, a great effect can be expected if the system can be used as a common storage battery in industrial parks (use of renewable energy for nighttime electricity, creation of an environment in which BCP measures are carried out in the community rather than individually).

b) Energy management system (EMS)

We studied and examined the effects of and a scope compatible with the introduction of a system that would allow the visualization of and predictive controls for various energy usage conditions, such as for electricity, water, gas, heat, carbon emissions, etc., from a small scale and that would promote the analysis of energy usage and optimal use (energy conservation and efficient use). Discussions on the suitability of the project for the Hoa Khanh Industrial Park and the Hi-Tech Park are underway, but they have not led to discussions on setting the scope of the examination or the verification items. We recognize that this is a matter that should be implemented early in the next fiscal year.

c) LED street lights (smart LEDs) (Appendix 8)

We explored an examination of the possibility of introducing smart pole technology instead of LED lighting equipment alone. Since the requirements for street lighting in Da Nang City are simple illuminance requirements, it is necessary to establish the requirements for use, select the conditions for use, and select an implementing agency, but we were unable to conduct a detailed examination with the Department of Industry and Trade (DOIT) in Da Nang this fiscal year.

d) Radiant heating and cooling systems

We verified the power-saving effect of radiant heating and cooling technology (a reduction of power consumption by 30% to 50% compared to existing air conditioners), which is a characteristic of radiation heating and cooling technology. At the same time, an actual radiant heating and cooling device was installed at the ITPC as a verification device, with the aim of making calculations for devices certified as JCM equipment compliant (an actual radiant panel was installed to examine the possibility of compliance with the environmental requirements in Vietnam and to verify the use and operation of a chiller made in Vietnam). Due to transportation problems caused by the novel coronavirus and the upgrading of the panel products, the completion of the installation was significantly delayed from October 2021 to December 2021, but the installation was successfully completed. In addition, we participated in ENTECH 2021 held by the Department of Industry and Trade (DOIT) of Da Nang City on December 21-23, 2021, and we exhibited the radiant cooling system. ENTECH

is a conference to share energy conservation and renewable energy technologies and an event to exhibit environmental products. At this event, not only was the radiant heating and cooling system exhibited, but a lecture was also given by Macnica (see photos below).

In the future, we plan to verify the results during the summer season in Vietnam starting in March. Based on the results of this verification, we will calculate a suitable budget for cooling devices in spaces of 40 m^2 or greater and examine the introduction of the devices in factories, hotels, and public facilities.

Outdoor unit installed

Control panel

Installation inside ITPC


JADE COOL
COLD WATER MACHINE
MADE IN VIETNAM
R404A

Radiant heating and cooling device booth

Display of radiant panels

Online lectures

Figure 2-2: Participation in ENTECH 2021

(2) Methodological Study of Radiant Heating and Cooling Systems

As mentioned above, it is important to calculate the amount of greenhouse gas emissions to be reduced in the implementation of a JCM equipment subsidy project using radiant heating and cooling systems, so we examined the proposed methodology in anticipation of applying for a project. This paper reports on the eligibility requirements and the formulae for calculating CO2 emission reductions (see Appendix 9 for the proposed methodology and Appendix 10 for the examination background documents).

a) Eligibility requirements

With a view to the implementation and diffusion of energy conservation projects that introduce radiant heating and cooling systems in factories and offices in Da Nang City, it is assumed that the following five eligibility requirements should be included in the proposed methodology to be used so that CO_2 emission reductions can be evaluated in a reasonable and conservative manner while paying attention to environmental integrity.

Eligibility Requirement 1	The air conditioning system to be introduced in the project shall be a "radiant air conditioning system" or a "hybrid air conditioning system" combining a conventional air conditioning system and a radiant system.
Eligibility Requirement 2	The coefficient of performance (COP) of the radiant air conditioning system installed in the project shall be set by actual measurements for each type of room. Or, the COP shall be verified for each type of room by a public institute or university. In addition, when calculating CO_2 reductions in the preparation of PDDs and in the application stage of JCM equipment subsidy projects, approximate calculations should be made by setting a provisional COP for the radiant air conditioning system based on past knowledge.
Eligibility Requirement 3	Reducing the burden on project implementers is one of the aims of JCM projects. Therefore, it should be possible to measure the power consumption for the entire air conditioning system, rather than having to find every COP for each project air conditioning system. In other words, an integrated COP is calculated as a weighted average from the COP, operating hours, and power consumption of each project air conditioning system, which is then used as the default value. (The power usage of each air conditioning system may also be monitored. However, in this case, the burden on the JCM operator increases.)
Eligibility Requirement 4	A JCM project may feature joint participation by multiple factories and establishments in the industrial park, provided that all the eligibility requirements are satisfied.
Eligibility Requirement 5	The ozone depletion potential (ODP) of the refrigerant used in the installed radiant air conditioning system shall be 0 (zero).

b) Formula for calculating CO_2 emission reductions

Considering the existing methodologies, reference emissions, and the method of setting

COPs for project emissions calculations, the emission reductions calculation formula is envisioned as follows. Since this is only a methodology proposal that was discussed by the project affiliates, we would like to participate in the development of a new methodology based on this case when we apply for and are selected for a JCM subsidy project.

[Obtaining Reference Emissions}

Reference emissions are calculated using the power consumption of the project air conditioning system, the ratio of the COP of the project and reference air conditioning systems, and the CO_2 emission factor for power consumption. The reference scenario is more conservative than the BaU scenario, which is the natural case, in consideration of the sales market for air conditioning systems in Vietnam.

- The COP of the reference scenario is calculated from the average COP value and its standard deviation (σ) for output from the air conditioners of major manufacturers that are prevalent in the country of Vietnam.
- The "average value + σ" for the COP in a given cooling capacity range is defined as "COP_{RE}."

i) Calculation of reference emissions

Reference emissions are calculated based on the set reference COP, the project COP, and the power consumption during the project period.
Specifically, the reference emissions are calculated according to the following steps.

a) Setting the COP of the reference air conditioning system

Ensure conservatism in setting the COP so that appropriate emissions can be obtained.

$$COP_{RE} = \overline{COP_{Ren}} + \sigma_{RE}$$

$$\sigma_{RE} = \sqrt{\sigma_{RE}^2}$$

$$\sigma_{RE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(COP_{RE,i} - \overline{COP_{REn}}\right)^2}$$

COP_{RE}: Confirmed COP of the reference air conditioning system [-]

σ_{RE}: Standard deviation of the reference air conditioning system COP [-]

σ_{RE}^2: Variance of the reference air conditioning system COP [-]

$COP_{RE,i}$: COP of the reference air conditioning system i [-]

$\overline{COP}_{RE,n}$: Average COP of n number of reference air conditioning system devices [-]

n: Total number of air conditioning system devices [pieces]

i : Display number of the air conditioning system [-]

b) Setting the COP of the project air conditioning system

Since the performance of radiant heating and cooling systems differs depending on the type of installation site, it is necessary to set the COP for each type of site. There are two methods: one is to calculate the COP by actual measurement and the other is to adopt a COP for each type of installation site that has been verified by public research institutes and universities. In this section, we introduce the method for calculating a COP by actual measurement. In this method, one measures the power consumption of the air conditioning system currently in use and of the project air conditioning system every thirty minutes or hour for at least one week each and then calculates the COP based on the relationship with the outdoor temperature.

Specifically, the COP is calculated according to the following procedure.

1. Measurement of power consumption and outdoor temperatures for one week or more for both air conditioning systems
2. For both air conditioning systems, obtain the amount of power consumed at an outside temperature of 28°C from the formula relating power consumption to outside temperature.

   * Collect temperature and solar radiation data at the nearest observation point to the project site.
3. Correct for deterioration using the catalog COP value of the existing air conditioning system. The deterioration rate is assumed to be 3%/year*.
4. Based on the results of 1, 2, and 3, set the COP of the project air conditioning system (the radiant heating and cooling system).

$$COP_{PJ,i} = \frac{EM_{Actual,i}}{EM_{PJ,i}} \times COP_{Actual,i}$$

$$COP_{Actual,i} = COP_{First,i} \times (1 - (0.03 \times Years))$$

$COP_{PJ,i}$: COP of the project air conditioning system [-]

$EM_{Actual,i}$: Measured power consumption value (kWh) of the current air conditioning system at an outside temperature of 28°C

$EM_{pj,i}$: Measured power consumption value (kWh) of the project air conditioning system at an outside temperature of 28°C

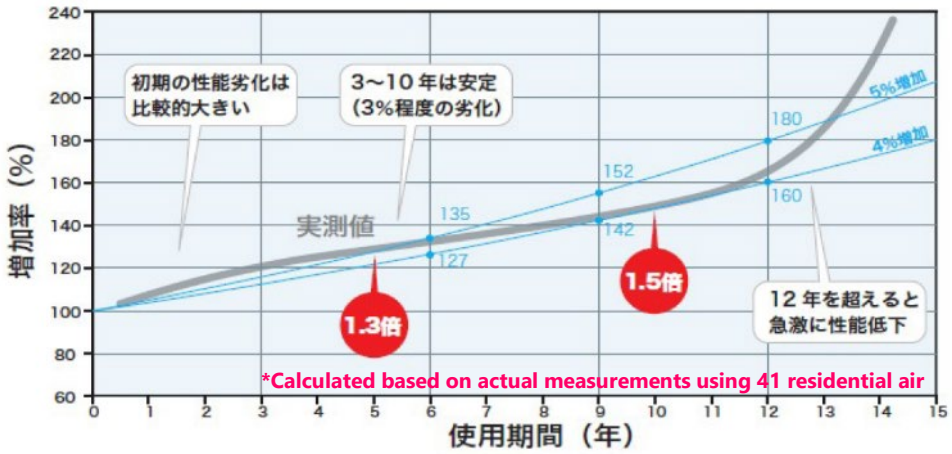
$COP_{Actual,i}$: Actual COP of the air conditioning system currently in use [-]

$COP_{First,i}$: COP of the air conditioning system currently in use at the time of installation [-]

0.03: Deterioration of the air conditioning system (3%/year) *

Years: Operating years of the current air conditioning system [years]

※ Deterioration Rate



Source: ECOTEC Co., Ltd.https://eneduce.net/aging.html
Source: Oji Engineering Co.,

Deterioration of the Coefficient of Performance (COP) of Air

c) Calculation of reference emissions

In the last step, the reference emissions are calculated according to the set reference and project COPs. In addition, it would be complex to monitor the power consumption for each air conditioning system with a different COP after the implementation of the JCM project. Therefore, an integrated COP will be set as the default value and serve as a substitute in monitoring the overall power consumption. The integrated COP will be calculated as a weighted average of the COP, operating hours, and power consumption for each project air conditioning system.

$$RE_p = \sum_{i=1}^{n} \left\{ EC_{PJ,i,p} \times \left(COP_{PJ,i} \div COP_{RE,i} \right) \right\} \times EF_{elec}$$

RE_p : Reference emissions during the period p [tCO_2/p].

$EC_{PJ,i,p}$: Power consumption of project air conditioning system i in period p [MWh/p].

$COP_{PJ,i}$: COP of the project air conditioning system [-]

$COP_{RE,i}$: COP of the reference air conditioning system [-]

EF_{elec} : CO_2 emission factor for power consumption [$t\text{-}CO_2/MWh$]

i	: Air conditioning system type [-]

ii) Calculation of project emissions

Project emissions are calculated from the amount of power consumed by the radiant cooling and heating system during the project period and the power grid CO_2 emission factor.

$$PE_p = \left(\sum_{i=1}^{n} EC_{PJ,i,p} \right) \times EF_{elec}$$

PEp	: Project emissions during period p [tCO_2/p]
$EC_{PJ,i,p}$	: Power consumption of project air conditioning system i in period p [MWh/p]
EF_{elec}	: CO_2 emission factor for power consumption [tCO_2/MWh]
i	: Air conditioning system type [-]

iii) Calculation of emission reductions

$$ER_p = RE_p - PE_p$$

ER_p	: Emission reductions during period p [tCO_2/p]
RE_p	: Reference emissions during period p [tCO_2/p]
PE_p	: Project emissions during period p [tCO_2/p]

For the examination of the proposed methodology mentioned above, in the case of general air conditioners, the reference emissions can be calculated from the COP of the introduced high-efficiency air conditioner, the measured power consumption, and the COP of the reference air conditioner. However, the COP of radiant heating and cooling systems varies depending on the conditions of the installation site, and it is necessary to set the COP of the project air conditioner in a reasonable and conservative manner. If the value cannot be set appropriately, it may directly affect the volume of CO_2 reductions (the amount of credit) obtained from this technology as well as the net reduction. Therefore, when this technology is adopted for JCM subsidy projects, we expect that a new methodology will be developed, and we would like to collaborate in the development of this new methodology with the supporting organization that will be created in this process. On the other hand, when applying for JCM subsidy projects, one option is to calculate CO_2 emission reductions based on the

existing methodology (AM_VN006).

3) Review of Activities and Future Tasks

In FY 2021, it took a great deal of time to make progress in discussions concerning the establishment of the implementation target, as it was not possible to travel due to the effects of the COVID-19 pandemic. It is essential to select issues for the demonstration of devices assumed to be compliant, explanations of the compliant effects, and actual verification, but the essential confirmation of these issues is taking time. With regard to the methodology for calculating GHG emission reductions, we believe that it will be necessary to cooperate in the preparation of a methodology, if a new methodology is necessary, based on the situation of this project after adoption, while continuing to use the existing methodology. On the other hand, since cost-effectiveness is one of the criteria for being selected, we would like to continue our activities in Year 3 while giving consideration to specifications and plans that will meet the same criteria.

As for future tasks, it is necessary to set individual requirements and conduct local procurement as a set, as well as to take local actions that will enable the early implementation of simulations for measuring effectiveness. In addition, it is necessary to conduct careful and accurate hearings on local demands, as well as to repeatedly explain the effects of the introduction of the technology to the users.

(3) Estimated Energy Conservation and GHG Emission Reduction Effects to Be Realized by the Introduction of the Above Technologies

1) Results for the Current Fiscal Year

Since we were not able to narrow down the list of specific companies this fiscal year, we were not able to obtain trial calculation results that can be used to apply for JCM subsidy projects. On the other hand, since the target industrial park was selected, we attempted to estimate the effects of the equipment and technologies (solar + storage batteries, radiant heating and cooling systems) to be introduced at the companies based on the amount of power they consume based on interviews with the companies in the industrial park. This result is not a joint calculation with Da Nang City, but an estimate by this research team.

Table 2-1 Estimation of CO_2 Emission Reductions

	CO_2 Emissions Reduction
Solar + Storage Batteries	249.75 tCO_2/year
LEDs	Currently being studied

Radiant Heating and Cooling	964.21 tCO_2/year

2) Implementation Methods

This fiscal year, we were not able to narrow down the specific companies to which we would introduce the equipment and technology, so we calculated the amount of greenhouse gas reductions only as a trial calculation. For the purpose of this trial calculation, it is necessary make assumptions of the scale of the facilities where the equipment and technology are to be introduced, so assumptions of the scale for introduction were made based on the results of previous surveys and interviews with related parties. The technologies to be introduced are expected to include solar power generation, storage batteries used in conjunction with this power generation, LED street lights, and radiant heating and cooling systems. Although detailed usage settings are required for this equipment in practice, since the situation is as described above, detailed specification settings were avoided and estimations were made using only the information necessary for estimating the reduction.

(1) Solar + storage batteries

[Assumptions]

- Solar Power Generation Capacity: 500 kW
- Storage Battery Capacity: 500kWh
- Sunlight Hours x Conversion Efficiency: 1,500 hours
- Storage Battery Discharge Time: 1 hour/time x 2 times/day
- The power generated will replace the current grid power.
- No power consumed by solar and ancillary equipment
- Grid Emission Factor (From JCM Methodology): 0.333 tCO_2/MWh

The explanations for the above hypothetical setup are as follows.

- The 500-kW scale is a common scale in factories so it was used as a rough estimate. The installation area is approximately 5,000 m^2.
- The assumed capacity of the storage batteries is based on the solar power generation capacity.
- Daylight hours were assumed to be about 1.2 times as long (2,280 hours) as Tokyo in 2020 (1,889.5 hours[3]). Also, the conversion efficiency was assumed to be 0.65, resulting

[3] Daylight hours in Tokyo (JMA website: https://www.data.jma.go.jp/obd/stats/etrn/view/monthly_s3.php?prec_no=44&block_no=47662&year=&month) =&day=&view=p4, accessed on 2/12/2022)

in 1,482 hours, but for ease of calculation, it was estimated to be 1,500 hours.

- It is assumed that the generated power will be basically consumed by the companies.
- Grid power is assumed as the reference power for JCM, and calculations are made using the emission factor used by JCM for the introduction of renewable energy in Vietnam.

Based on the above assumptions, the annual power generation and CO_2 emission reductions were calculated as follows.

- Amount of Power Generated: 500 kW x 1500 hours = 750,000 kWh (750 MWh)
- CO_2 Reduction: 750 MWh x 0.333 tCO_2/MWh = 249.75 tCO_2/year

Based on the above, the installation of a 500-kW solar power plant in an industrial park in Da Nang City is expected to reduce CO_2 emissions by approximately 250 tons per year.

(2) LED street lights (smart LEDs)

Assuming that the reference street lights in the JCM project are incandescent lamps, a reduction of about 90% can be expected, but the specifications and power consumption of the street lights in the target Hoa Khanh Industrial Park have not been identified in this year's activities and are currently under investigation.

(3) Radiant heating and cooling system

For radiant heating and cooling systems, as with solar power generation above, the amount of power and carbon dioxide emissions that can be reduced depends on the scale of the company or factory installing the system. On the other hand, since the target companies and factories have not yet been determined in Year 2, we made a trial calculation assuming an approximate scale.

[Assumed Conditions]

- Power Consumption for Cooling of the Target Factory: 11,000 MWh/year
- Replacement Rate: 30%
- Reduction Rate from Radiant Heating and Cooling: 50%
- Grid Emission Factor (From JCM): 0.8458 tCO_2/MWh

The explanations for the above hypothetical setup are as follows.

- Since it is known from interviews that the annual power consumption for cooling for a Japanese company with a rather large factory in Hoa Khanh is 11,000 MWh, the target power consumption was assumed to be about 70% of that amount.

- It was assumed that 30% of the air conditioning in the target companies and factories will be replaced with radiant heating and cooling systems (past results).
- We used an average value of 50% for the reduction in power consumption that can be achieved by installing radiant cooling devices.
- Grid power is assumed as the reference power for JCM, and calculations are made using the emission factor used by JCM for the introduction of renewable energy in Vietnam (0.8458 tCO_2/MWh).

Based on the above assumptions, the annual power generation and CO_2 emission reductions were calculated as follows.

- Reduction of Power Consumption:
  Cooling power consumption of the target factory (7,600 MWh/year) x 30% (replacement rate) x 50% (reduction rate with radiant system)
  →7,600 MWh x 0.3 x 0.5 = 1,140 MWh
- Reduced Carbon Dioxide Emissions: 1,140 MWh x 0.8458 tCO_2/MWh = 964.21 tCO_2/year

Based on the above, if approximately 30% of the cooling systems used by the companies and factories that consume about 7,000 MWh of energy per year for cooling can be replaced by radiant cooling devices, it is expected that here will be a reduction of approximately 960 tons of CO_2 per year.

3) Review of Activities and Future Tasks

In this fiscal year, we were not able to make a trial calculation of the specific target for the introduction of technologies and equipment because we only made it as far as selecting the target industrial park. Therefore, it is necessary to select more specific targets for the next fiscal year and then quickly carry out a trial calculation and prepare to apply for the JCM equipment subsidy program. In particular, since cost-effectiveness is an important requirement for being selected, we believe that trial calculations at an early stage will enable the smooth revision of equipment installation plans.

4.3 Operations 4-3: Support Sector for Improving Climate Change Education and Awareness

4.3.1 Review of Necessary Knowledge and Awareness Raising Methods for Climate Change in Elementary and Secondary Schools

A desk review was conducted at the beginning of the project. Desk review aimed to collect

the publications, project reports, and other secondary data related to climate change education in Vietnam in general and in Da Nang city in particular. The desk review also allowed the project team to identify key actors in climate change education for further in-depth interviews

4 major topics were covered in the in-depth interviews, including:

- The existing implementation of climate change education (CCE) at schools
- The challenges of CCE
- The opportunities of CCE
- The expectations/demands of schoolteachers to advance CCE

The list of interviewees is presented as follows:

Table3-1 List of interviewees

No.	Name	Organization	Position
1	Phan Thanh Giau	DOET	Staff
2	Le Thi Thanh Ha	DONRE	Staff
3	Bui Nguyen Nu	Skyline secondary school	Teacher
4	Ho Hai Son	Tay Son secondary school	Teacher
5	Dang Thi Viet ha	Nguyen Van Linh secondary school	Vice-principal
6	Dinh Thi Hoai Thu	Tran Cao Van primary school	Teacher
7	Dang Thi Thuy Lien	Hoang Du Khuong primary school	Principal

Results from the review and interviews

A. Climate change education in Vietnam

Vietnam has been recognized as one of the world's most vulnerable countries to the effects of climate change (World Bank, 2010), hence climate change-linked natural disasters have become an urgent concern in Vietnam. Since the Action Plan for the Education Sector's response to climate change from 2011-2015 and the Action Plan of the Education Sector for prevention and mitigation of natural disasters in 2011-2015 was approved, climate change education (CCE) and education for disaster risk reduction has been widely disseminated from the elementary to university level. However, most programs are not implemented in formal education but by NGOs and other civil society actors, such as youth unions and

environmental clubs (Kieu et al., 2016).

Since the launch of the UN Decade of Education for Sustainable Development (DESD) in 2005, many diverse topics have been taught at schools. Climate change, environment, energy, and disaster prevention are among the most popular themes. Notably, plastic waste is becoming a hot topic under the environmental theme. There are more concerns to embed climate change in formal education following Decree 4620/QĐ-BGDDT (MOET, 2010). During 2014 to 2017, various researches were focused on how to integrate climate change into subjects of the general education systems (Đỗ, 2017; Nguyễn, 2016; Tong, 2015), as follows:

1. Primary school: Natural Science, Drawing and Ethics
2. Secondary school: Geography, and Physics, Chemistry, Biology (for the new general education program knowns as Natural Science)
3. High school: Geography, Physics, Chemistry, Biology, and Citizen Education

The review of existing climate change education materials is described in the following sub-sections.

(i) Targets of climate change education

- Knowledge

a. Know the manifestations of climate change: The Earth is getting warmer, extreme weather events are happening more and more and on a large scale; sea level is increasing day by day.

b. Know some causes of CC

- The negative impact of humans on natural components changes the composition of the air. Know some chemicals that cause climate change.
- Socio-economic development, especially the development of industry and transportation, causes environmental pollution, increases the greenhouse effect.
- Other causes.

c. Know the consequences of climate change: floods, droughts, heat waves; landslides in mountainous areas, river/sea bank erosion; melting ice, rising sea level...

d. Know some solutions and ways to respond and adapt to climate change to minimize damage caused by climate change.

e. Link with locality regarding the manifestations, causes, and consequences of climate change, solutions to respond to climate change.

- Skill development

a. Be able to identify some signs of CC

b. Be able to handle a few cases to reduce the causes and respond to climate change simply in production life and chemical learning in high school.

c. React to save energy consumption, particularly fossil fuels to prevent climate change.

- Attitudes

a. Students have positive attitudes such as interest in learning about climate change; Sense of responsibility to self, society, and community; detect and solve problems objectively and honestly based on scientific analysis; Consciously apply learned chemical knowledge to life and mobilize others to do the same.

b. Enhancing education is considered an effective "key" for individuals and communities to respond to the challenges of climate change. It is important to innovate methods and forms of educational organization, not to limit climate change education in hard lessons but to increase practical and lively activities outside of class time.

c. Climate change education is one of the contents of education for sustainable development, helping learners understand and understand the impacts of global warming, and at the same time encourage behavior change to respond to climate change.

(ii) Review of pedagogical approach

a. Climate change education in formal education

Integrated teaching is a pedagogical perspective in which learners need to mobilize (all) resources to solve a complex – problem situation to develop personal competencies and qualities.

Basic principles when integrating education to respond to climate change through subjects at schools are as follows:

i. Do not change the characteristics of the subject, do not turn the subject's lessons into climate change education.
ii. Exploiting climate change education content selectively and focusing on certain chapters.
iii. To give full play to students' positive cognitive activities and practical experiences they have had, to make the most of their abilities to let students have direct contact with the environment.

There are different levels of integration of climate change into the national curriculum:

- Link with the formal lessons
- Create a climate change-related section or a module

Regarding teaching pedagogies in CCE, MOET (2014) also highlighted that teaching methods should pay attention to the following requirements:

- Increasing opportunities for students to learn through experience, place learners on

requirements and tasks for related issues to CC in real life.

- Streamlining academic knowledge, aiming at capacity building in learners, especially changing attitudes and behaviors in response to climate change.
- Ensuring the systematic knowledge of the subject, having a close connection between theoretical and practical knowledge associated with climate change education, and enhancing cooperation/collaboration.

With such requirements, in integrated teaching of general education, different teaching methods can be used flexibly. In addition to the familiar and traditional teaching methods such as lectures, discussions, conversations, game methods, etc., it is necessary to apply hands-on methods including study tours, field survey investigation; project-based learning, problem-based solving. Those interactive pedagogies aim to form and develop teaching capacity to integrate climate change education for students

b. Climate change education in non-formal education

Extracurricular activities are held regularly at the school to reinforce the formal education lessons and to promote the student's competence in reality. Regarding climate change education, non-formal education includes:

- Flag raising activity on the first Monday morning: topics related to climate change are introduced to students through mini-games and quizzes.
- Organizing competitions on climate change: painting, oratory...
- Organizing movie screenings outside of regular school hours
- Organizing drills to respond to natural disasters
-

Capacity building for teachers

In the period 2012 - 2015, there were some projects to improve teaching capacity on climate change education for teachers at all levels. However, at present, primary and secondary school teachers are often updated on climate change through seminars.

Main contents of training for teachers:

- General knowledge about climate change for teachers to understand the causes, consequences, and solutions to cope with climate change
- Pedagogical knowledge: so that teachers can organize climate change teaching in class creatively and inspire students

In parallel with the training, illustrated materials and lectures are compiled and distributed to teachers to advance their teaching afterward. NGOs have been relatively active in teacher training on climate change education. Live&learn, for instance, cooperated with MOET to prepare a teaching manual on CCE (MOET et al., 2012). The "Teacher Manual on Climate

Change Education" is one of the first specific and concrete teaching manuals to help teachers and students raise their awareness and ability to respond to climate change. The Manual includes three main parts: (i) part 1: teaching and learning activities to provide teachers basics of climate change mechanism and its impact; (ii) part 2: teacher fact sheet to provide teachers the solid evidence of climate change and concrete numbers of climate change impacts; and (iii) part 3. Handouts to provide teachers printable hand-outs using for their teaching at school.

VVOB, an international education NGO, has been supporting education in Vietnam since 1993, including environmental education. Regarding CCE, VVOB published a CCE guidebook for teacher training in 2013 (VVOB, 2013) under a project to enhance teachers' competencies in EE nationwide. The guidebook was designed based on 5 teacher training activities: (i) Activity 1: Introduction of terminologies; (ii) Activity 2: Causes of Climate change; (iii) Activity 3: Climate change in Vietnam; (iv) Activity 4: Climate change response; and (v) Activity 5: Integrating Climate change into formal education. Notably, different evaluation sheets were included in this document to encourage teachers in evaluating their students.

(iii) Common challenges of CCE in Vietnam

CCE is a vital measure to enhance people in the general and young generation, in particular, to cope with future environmental changes. Yet teaching climate change is a challenging task for many reasons. Climate change is a complex and uncertain topic that requires multidisciplinary knowledge, climate science, for instance, is not an understandable subject (Monroe et al., 2019). In the research of (Apollo & Mbah, 2021), four challenges of CCE were identified, including ascertaining the role of the educator, grappling with misconceptions, complexities of interdisciplinary, and understanding the content of climate change education. In Vietnam, alongside the above-mentioned challenges, the country has its challenges in CCE, as follows:

1. The launch of the new curriculum program nationwide (known as the 2018 New Program) for general education which means both old and new programs are applied currently, the new program is only applied at grade 1, 2, and 6. Teachers have to spend time and energy on the new program much more than normal.

2. The overloaded curricula with the integration of diverse issues such as gender education, gender equality, traffic safety, school violence, food safety, etc. Within this context, teachers who familiarize themselves with the integrated approach can flexibly design the teaching activities but for those who have not, it will become stressful for "add-on" content.

3. Environmental education in general and climate change education, in particular, require strong interactive (hands-on) activities, but due to the impact of the Covid-19 epidemic, online

learning has become popular. When the epidemic subsides and students go to school, such valuable time will be spent directly updating their knowledge instead of organizing extracurricular activities. And in this circumstance, EE or CCE may be ignored.

B. Environmental education and climate change education in Da Nang

(i) An overview of the process

In the accordance with the 2030 Agenda for Sustainable Development, many of the goals for education, environment, science, and technology are being pursued and developed by Da Nang city. The city aspires to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. In the concern of the environment, the city aims to take urgent measures to combat climate change and its effects, etc. To achieve the set goals, Da Nang city has approached the method of environmental education, which aims to train human resources in terms of environmental knowledge, towards sustainable development

With the orientation of building an ecological city, environmental education has been introduced and implemented at levels of schools and universities. Specifically, in 2018, the Department of Education and Training has deployed and implemented a compiled plan and appraised local educational documents according to the general education program in the city. The local education focuses on knowledge related to culture, history, geography, and the environment... suitable for primary school level. The teaching content is communicated in line with the experiential learning methods and is integrated into the main subjects, enhancing their application for students

In terms of climate change education, Da Nang was a pioneer in the country in integrating the content of climate change into the standard curriculum. This activity is considered an effective and sustainable solution for building resilience in communities and local schools to cope with the impacts of climate change. The Department of Education and Training (DOET) has cooperated with the Asian Cities Climate Change Resilience Network (ACCCRN) to raise awareness and build adaptive skills for students and teachers on the negative impacts of climate change. According to the project “Building Resilience through Integrated Urban Climate Education”, DOET developed crucial content and integrated climate change education into the formal curriculum. The project was piloted at three schools in the Cam Le district to improve students’ understanding and adaptation skills to the negative impacts of climate change. During the implementation of the project, a set of documents on "Integrating climate change into extracurricular activities" for different levels of school (primary to junior high school) had been published to provide teaching tools for teachers. Feedback and evaluations from teachers had recorded as follows:

At Ngo Quyen Primary School, climate change education has integrated into the subjects, including natural and social in grade 3, Science and History - Geography in grade 4. Due to the characteristics of primary school age, the integrated content only focuses on communicating basic concepts about natural phenomena and their harmful effects. Besides the regular classes, the school also organizes extra-curricular sessions with many fun contests, such as contests of sandbag columns for fighting storms and floods, painting or eloquence about natural disasters, etc.

In addition, the school has organized many extra-curricular activities, aiming to help students have more soft skills to apply in their daily lives, such as teamwork or contests to understand the impact of climate change on life. For example, redrawing the path of the storm

Recently, Da Nang has launched a new project "Scientific education for Da Nang's sustainable development" with support from Sweden's Boras city. The project is set to assist Da Nang in establishing a tripartite cooperation model (administration-business-school) that is similar to the model at Sweden's Navet Science Centre. This cooperative education model is expected to provide students hands-on experiences in learning and applying 17SDGs in their lives practically.

(ii) Implementation of CCE

Currently, CC topics are integrated into the formal curriculum under the guidance of textbooks. The integration level depends on education programs and teachers' experiences.

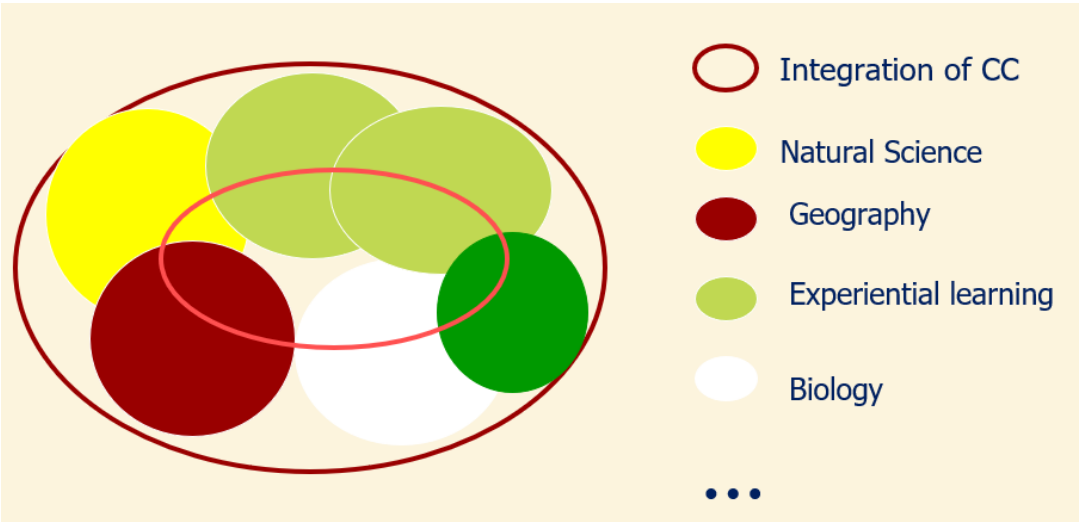


Figure 3-1 Approach in climate change integration into the formal education

The interviews indicated that teachers in Da Nang were encouraged to integrate CC topics into their formal lessons flexibly. Some teachers who participated in training explained clearly

the process of such integration, including 2 stages:

i. Teachers' learning about climate change issues: teachers are required to promote their self-study after training participation. The materials will enhance teachers' understanding of climate change such as global warming, greenhouse effect, climate change response, etc.

ii. Determining the "integration address": teachers will identify the overlap between climate change knowledge and lessons in textbooks, then they will determine to what extent CC can be taught and which pedagogical strategy should be applied.

Teachers also revealed that sharing CCE experiences within a professional group at school was crucial to ensure consistent knowledge, lessons and to reduce the overlapping among different subjects.

In terms of non-formal education, interviewees listed various activities:

- Moviemaking
- Competitions
- CCE events (exhibition)
- Establishment of environmental clubs at school
- Disaster drill
- Field study

The opportunities and challenges of CCE in Da Nang are presented as follows:

Table 2-2 Opportunities and challenges of CCE in Da Nang city

Opportunities	Challenges
1. Da Nang approved climate change action plan and 10-year-environmental city plan which allows stable finance for CCE 2. There are some projects in Da Nang city to support CCE and EE 3. Materials for teaching are available for both teachers and students	1. Da Nang city is heavily affected by the Covid-19 pandemic. Over the last two years, the city experienced several waves of Covid-19 which results in negative economic growth. The duration that students go to school has plummeted and makes it difficult to organize extracurricular activities, including CCE. 2. Currently, the city prioritizes education to separate waste at source and reduce plastic waste because of the urgency and news. Therefore, most activities or projects focus on these contents. Previous climate change education models have been replaced by

	models such as “waste-free-school” or “say no to plastic waste at school”

Despite the current opportunities, there remain several expectations shared by the interviewed teachers, including:

- Materials “ready to use”: teachers revealed that most of the materials are about climate change but lack guidance to integrate them into the new education program. Thus, teachers must spend much time and energy working to design the lessons.
- More training: CCE training was popular in the period 2010 – 2016 but afterward, the number of training significantly declines. For instance, most of the senior teachers who participated in ACCCRN’s project had retired. Such training is particularly helpful to young teachers.
- Experiences shared from expert teachers and professors
- Pilot teaching and pedagogical advancement: this is the most pressing need. Teachers want to not only participate in theory training but also real pilot teaching to visualize CCE activities.

4.3.2 Selection of Pilot Elementary and Secondary Schools and Implementation of Classes and Events

1. The training for student program

There are three training programs conducted in the project including (i) one training for primary school; (ii) one training for secondary school; and (iii) one training for teachers

(i) Training at Tran Cao Van primary school

a. Target audience

Participants in the training include:

- The school administrator and 16 homeroom teachers from Tran Cao Van primary school
- 90 students in grade 4 and 5 from Tran Cao Van primary school
- Dr. Kieu Thi Kinh
- Building Up Sustainability Centre (BUS) staff

b. Training implementation

- Time: 2:00 pm – 4:00pm on December 31st, 2021
- Form of training: Online

c. Pedagogical approach

Interactive pedagogies were applied to ensure effective engagement of students including videos, pictures related to climate change. Additionally, several mini-games were used to

increase the students' attention and participation.

d. Contents

- Knowledge: (1) climate change concept; (2) How does climate change affect children; (3) What children can do to respond to climate change.
- Skills: teamwork and systematic thinking.
- Behaviors: be more environmental friendly

e. Brief evaluation

Training contents

The contents are relatively suitable for the acquisition level of students in grades 4 and 5. To convey the message about climate change to students and teachers, facilitating skills were used to integrate knowledge and soft skills into the training to guide students on how to respond to climate change.

Besides, a questionnaire was designed to assess understanding and knowledge application in their daily lives. The results showed that 90% of students understood the terms and causes of climate change as well as the actions to take to protect themselves when natural disasters occur. Notably, students proposed actions to respond to climate change, including:

- Planting trees
- Saving energy to decrease emissions of greenhouse gases
- Walking and doing exercise
- Dispose of garbage properly
- Sorting domestic waste at school, home, and public places
- Discuss with their parents about using eco-friendly bags, sorting waste at home
- Investing in good infrastructure to respond to natural disasters

In addition, the collaboration between the program and the BUS Centre aims to launch "Ecology Week". In other words, the students will carry out green actions proposed by themselves this week. This is an activity that encourages children to use soft skills when practicing life lessons and support the creation of the foundation for the process of changing behavior, and attitude towards environmental protection.

Teacher engagement

Despite the busy schedule, 17 teachers were engaged in the online training. The teachers expressed their interest in teaching students more about climate change-related issues. The vice-principal revealed that Tran Cao Van school had received an announcement from DOET the UPU letter-writing competition for 2022: "UPU's theme for 2022 International Letter-Writing Competition gives young people a voice in climate crisis". Thus, students are expected to comprehensively perceive the climate change impacts and how to respond to this crisis not only for the competition but also for their future.

(ii) Training at Tay Son secondary school

a. Target audience

Participants in the training include:

- The school vice-principal and 16 homeroom teachers from Tay Son secondary school
- 117 students in grade 8 from Tay Son secondary school
- Dr. Pham Ngoc Bao
- Dr. Kieu Thi Kinh
- Building Up Sustainability Centre (BUS) staff

b. Training implementation

- Time: 8:30am – 11:00am on February 12th, 2022
- Form of training: Online

c. Pedagogical approach

Interactive pedagogies were applied to ensure effective engagement of students including videos, pictures related to climate change. Additionally, a mini-game was used to increase the students' attention and participation. Rapid Q&A was also applied to encourage students in proposing climate change actions.

d. Contents

- Knowledge: (1) climate change worldwide; (2) Climate change in Vietnam and Da Nang; (3) How does climate change affect children; (4) What secondary students can do to respond to climate change.
- Skills: communication and systematic thinking.
- Behaviors: prepare a list of climate change actions to mitigate and adapt to climate change

e. Brief evaluation

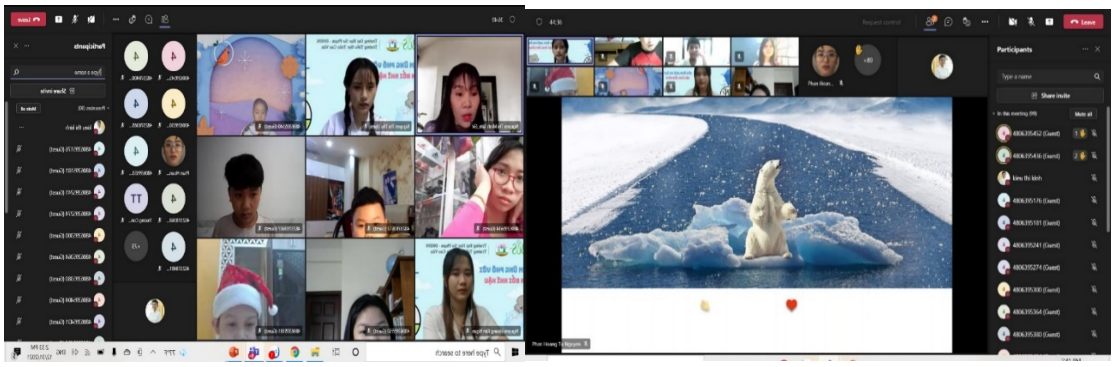
The contents are relatively suitable for the acquisition level of students in grades 4 and 5. To convey the message about climate change to students and teachers, facilitating skills were used to integrate knowledge and soft skills into the training to guide students on how to respond to climate change.

Besides, a questionnaire was designed to assess understanding and knowledge application in their daily lives. The results showed that 95% of students understood the terms and causes of climate change as well as the actions to take to protect themselves when natural disasters occur. Notably, students proposed actions to respond to climate change and disasters, including:

- Planting trees, especially in mountainous areas to prevent the landslide
- Practice 5R instead of 3R (Rethink – Refuse – Reduce – Reuse – Recycle)
- Promote a green lifestyle (as a trend at school)

- Update the local weather and regulations or guidance when disasters occur
- Sorting domestic waste at school, home, and public places
- Discuss with their parents about environmental friendly products, using eco-friendly bags, sorting waste at home
- Use public transportation

In addition, the collaboration between the program and the BUS Centre aims to launch a "Video competition". Students were required to create a climate change-related video to enhance the awareness of people. This is a follow-up activity to reinforce students' understanding of climate change and to encourage students to talk with family, friends, and others about climate change.



2. The training for teacher program

a.Target audience

Participants in the training include:

- 52 teachers of secondary schools from 7 districts in Da Nang city
- Department of Education and Training of Da Nang city (DOET)
- Institute for Global Environmental Strategies (IGES)
- Building Up Sustainability Centre (BUS)

Training implementation

- Time: 8:30 am – 12:00 am on February 15th, 2022
- Address: Tay Son Secondary school

<u>Pedagogical approach</u>

a. Integrated teaching method

The integrated teaching method is an oriented teaching tool. Accordingly, teachers organize and guide students to synthesize knowledge and skills in many different fields to solve learning tasks. Therefore, new knowledge and skills have been formed and developed to provide the necessary competencies, especially the ability to solve problems in learning and

practice.

Integrated Principles

- Do not change the subject's characteristics; do not turn the lesson into a climate change education lesson. Teachers ensure the structure of the lesson subject.
- Building the content of climate change education must be selective, systematical, not pervasive, or arbitrary.
- The content of climate change education must be associated with both subjects and practice.
- The teacher should make opportunities for students to interact with the environment. According to it, students are encouraged to study and share their living capital. The teacher must highlight the role of students in environmental improvement, adaptation, and mitigation of climate change.
- Diversify the types of learning activities, at different cognitive levels.

b. Facilitation skills

Facilitation skills are the necessary methods that support teachers in guiding students to study actively. This method is often applied and brings effective results in teaching activities, such as teamwork, communication, or the formulation of an idea. In environmental education, teachers would play the role of instructors who build a comfortable environment for the student to express feelings and thoughts in class. Therefore, teachers should use facilitation skills to support and encourage students to learn from each other and deepen their understanding of lesson content.

Contents

The training program has developed two main components to provide teachers with the knowledge and teaching tools to integrate climate change content into the standard curriculum, as follows:

- Knowledge: includes two main contents that were transmitted to help teachers learn about: (1) the climate change crisis and solutions for Vietnam; and (2) methods for integrating climate change content into formal education and non-formal education.
- Skills: provide the teachers with ten facilitation skills that they could use to create interest and vibrancy in the subject. According to it, the student could feel free to share their thought and teaching ideas

Brief evaluation

The contents are relatively suitable for the needs of teachers and the urgency in the context of climate change education in Da Nang city. The witness is that teachers have interested in teaching methods and information sources on the climate crisis in both Vietnam and the world. In addition, doing teamwork was deployed to apply the knowledge and skills in developing a

framework for extracurricular lessons on climate change. The results showed that, at the secondary level, the content of climate change education was integrated into the subjects of technology, geography, science, and biology. Besides, the experiential learning method is often preferred when teaching integrated themes such as climate change, environmental education, and disasters. Accordingly, the facilitation skills used to promote this method effectively include:

- Creation of space: careful preparation and flexible operation
- Question design: stimulating dialogue
- Acceptance: creating an environment where students can speak with peace of mind
- Method to convey ideas: brief and simple presentations
- Reflection and sharing: valuable time to deepen learning

Notably, during the time for presentation, teachers from six districts had the opportunity to share positive results in climate change education in the area. Take the secondary schools within Thanh Khe district as an example. The teachers provided documents in the form of videos, pictures, and reports about the students' experiential activities "Survey of public awareness on climate change issue in Da Nang city". This activity helps enhance student engagement and provides an in-depth understanding of climate change.

4.3.3 Preparation of Training Materials for Climate Education and Awareness

There are two CC training materials developed in parallel within this project, one for teachers and one for students.

(i) CCE material for teachers

Teachers are responsible for generating lesson plans that provide knowledge about climate change, disaster risks, and mitigation measures that can be applied to local settings while also engaging students in the learning process. Furthermore, by developing community

awareness through students, educational activities build a relationship between the school and the community. As a result, teachers must be equipped with the necessary knowledge and skills in climate change response and disaster prevention to pass on the above knowledge and skills to students and communities in the region, thereby contributing to the reduction of climate change's harmful effects and promoting sustainable development.

This material is intended to provide an extra helpful tool to increase awareness and knowledge for teachers and students about climate change, including its causes, manifestations, and effects, as well as measures to adapt and mitigate the effects of climate change in Vietnam in general, and in Da Nang city in particular. This document can also be used as a reference to enrich knowledge about climate change in the community in general. The contents of the whole document are divided into 4 main parts:

- Part 1. Introduction to the concept of climate change and adaptation solutions,
- Part 2. Introduction to climate change in Vietnam and the adaptation solutions that have been implemented,
- Part 3. Introduction to specific lessons and actions to promote students towards sustainable lifestyles,
- Part 4. Suggestions for organizing teaching activities to increase effectiveness, including teaching methods and some recommendations related to how to integrate the content of climate change education into the main curriculum, as well as extracurricular activities, at primary and secondary schools in Da Nang.

(ii) CCE material for students

Children are particularly vulnerable, and many schoolchildren are affected by natural catastrophes. According to a UNICEF assessment, Vietnamese youth is one of the most susceptible populations to the effects of climate change, which poses a threat to their health, education, and safety. For example, the 2008 Sichuan earthquake in China killed 70,000 people, with students and instructors accounting for more than 10% of the overall casualties. However, boosting awareness will help to reduce the number of people who lose their lives. If individuals are aware that a tsunami may occur as a result of an earthquake, they can seek shelter in higher places. If people know that water becomes polluted after a flood, they would not drink it. Thus, awareness is extremely important.

Education on disaster reduction can help children raise awareness and take actions to reduce the impact of climate change. If students are taught how to minimize catastrophe risks at school, they will not only be able to protect themselves, but they will also be able to communicate with their parents and others. As a result, students act as a bridge between school and community, spreading awareness about the importance of climate change.

This series of materials was created to provide students with a helpful and accessible tool for learning about climate change and taking concrete measures to protect the environment, to achieve common and long-term goals to reduce the hazards posed by climate change, and ensure sustainable development globally.

The contents of the whole document are divided into 5 main parts:

- Part 1: Introduction
- Part 2: Climate Change
- Part 3: Climate Change in Vietnam
- Part 4: Climate change action plan for kids

Parts 5: Sustainable development and 17 SDGs

For the reference, the training material for teachers on climate change education is shown in the Appendix 11.

4.4 Workshops

4.4.1 Conducting Workshops with Relevant Stakeholders in Da Nang City

A workshop was scheduled to be held on March 4, 2022, to explain the progress and achievements in the above three areas, and to hear and exchange opinions on activities of high priority for Da Nang City for the next fiscal year. On the Da Nang City side, DONRE will convene relevant departments and experts, including the Department of Transportation, Department of Construction, Department of Commerce and Industry, Department of Agriculture and Rural Development for the project component of Climate Change Action Plan, Da Nang High-Tech Industrial Park Management Board for the project component of the JCM potential project, and Department of Education and Vocational Training for the project component of climate change education.

However, due to a new corona outbreak in the department in charge of this work at DONRE, in which several staff members were infected, it was decided to postpone the workshop to March 9. The results of the discussions at the workshop will not be available in time for this report, so the following is a summary of what will be explained at the workshop, as well as verbatim comments obtained from DONRE in advance of the workshop.

In the workshop, the overall framework of the project, progress and expected results of each project this fiscal year, proposed activities for the next fiscal year, and points to be discussed were presented in a PowerPoint presentation, which was translated into Vietnamese and sent to DONRE in advance of the workshop. The points to be discussed are: (1) Based on this year's activities, what specific results are expected in the next fiscal year from the view

point of Da Nang city? (2) For the three project components as activities for the next fiscal year, where do you think the City of Da Nang should place its priorities? (3) In terms of the implementation of projects in the next fiscal year, is it acceptable for the city of Da Nang to have DONRE coordinate the overall implementation, but for the specific projects to be carried out by the relevant departments?.

From the view point of the Japan's side, basic direction to prioritize the activities for the next fiscal year is as follow; the following priorities: (1) prioritizing activities in consideration of the needs of Da Nang City, the knowledge that Yokohama City can provide, and the areas and activities that can achieve a certain level of results within one year; (2) prioritizing activities that will help Da Nang City to decarbonize by 2050 under the collaboration between the cities of Da Nang City and Yokohama City, in order to respond to the intention of the Ministry of the Environment of Japan, which is supporting this project. The PowerPoint presentation of the workshop is shown in Appendix 12.

The comments obtained in advance from DONRE were that they would like to see as concrete results as possible in this project, for example, tangible results that can be realized as a project in the future. And, although DONRE is responsible for de-carbonization of the city, cooperation with related departments is indispensable. The implementation of the project should be realistically structured so that DONRE would have overall coordination, but each component of the project would be led by the directly related department.

5. Lessons Learned from the Project

The lessons learned from the implementation of this project are summarized below.

(1) Perspectives for policy formulation and drafting of specific programs with relevant departments of Da Nang City

In Da Nang City, the accumulated experience on climate change policy mitigation measures is not yet abundant, and distinctions from adaptation measures, including disaster management, and the organization of data are not yet in order. Since the city-level data, which is essential for this project, has not been prepared by Da Nang City itself, it was found that the additional organization of national-level information and data that allows for estimations is also necessary. The understanding of such data published by non-city entities requires adequate communication. We also recognized the need to clarify the borderline in communication, such as to what extent a comprehensive action plan can be proposed as a detailed program for the city. The experts involved in this project aimed to create a high-level plan based on relatively global examples, while the city of Da Nang was expecting a concrete program that could be started tomorrow, creating a gap between the two. However, through the workshop this fiscal year we were able to receive more ideas

and opinions than we had expected from the officials in charge of the relevant departments. We recognized the importance of further improving the accuracy of communication going forward and of aiming to create a plan where we aim for the same landing point together.

(2)Project formation involving local companies and organizations

In Vietnam, where the movement to build a decarbonized society is accelerating, we reaffirmed the importance of building relationships with companies and related organizations to facilitate the formation of projects in this sector. In particular, one of the challenges of this project was to establish a collaborative system for the formation of projects involving a mixture of local and Japanese companies in industrial parks under the jurisdiction of Da Nang City.

In Da Nang City, DONRE has been playing a central role in activities related to decarbonization, and with the cooperation of Yokohama City, we have been able to gradually expand the scope of activities while receiving assurances of cooperation from public institutions. This made it easier for the companies and organizations we contacted to cooperate with us, and we believe that this enabled us to proceed with our activities efficiently and to build good relationships. In addition, since new technologies for the partner countries are used at the introduction site in JCM projects, it was reaffirmed that the use of actual machines and evaluation machines is highly effective. This fiscal year, we were able to set up a sample unit of the radiant heating and cooling system at the ITPC, which made it easier for us to hold discussions with companies that are considering introducing the system in the future.

(3) Environmental education combining knowledge and experience, formal and informal classes, and face-to-face and online

It is important for schools to incorporate climate change content into hands-on activities along with classroom learning, so that teachers and students have more opportunities to interact with nature and learn solutions to mitigate the effects of climate change. Teachers should also meet regularly in schools to share and unify their methods regarding climate change and environmental education, which is a prerequisite for saving time and energy, reducing duplication between subjects, and combining both formal and informal classes. As for informal classes, it would be realistic to link them to campaigns such as Earth Hour, Eco Week, or Environmental Day, for example. Furthermore, since students are accustomed to online learning environments, this approach should be considered in future classes and trainings. On the other hand, it would be effective to combine online and offline events in order to promote behavior change among students. In this regard, teachers

should increase their competencies in information and communication technology (ICT) literacy.

6. Future Plans

Based on the results and lessons learned from this project, we are currently considering the following directions for the next fiscal year, but we plan to further exchange opinions with related parties and narrow down the direction in the future, taking into account the needs of Da Nang for an environmental city that includes decarbonization, as well as the resources that can be provided by Yokohama City.

(1) Objective

In the next fiscal year, we will aim to achieve more concrete results that will contribute to the decarbonization of Da Nang City in the medium and long term, taking into account the purpose of this project and the Vietnamese government's 2050 decarbonization declaration.

(2) Anticipated activities

1) Deepening decarbonization aspects of climate change action plan

In the climate change action plan examined this fiscal year, we will strengthen our cooperative relationship with the departments of Da Nang City to jointly work on more specific plan proposals and emission estimates. In addition, we will present several scenario analyses requested by Da Nang City as visions that take into account the direction Da Nang City is aiming to take and consider concrete actions in line with these scenarios. Preferably we could show contributions to the country’s NDC. We will also aim to clarify actions in the industrial sector related to JCM, which were difficult to include this fiscal year.

2) Proposal of a smart energy business plan for an industrial park

Based on the results of a feasibility study of a plan to combine low-carbon technologies targeting companies in the Hoa Khanh Industrial Park (both Japanese and local companies), such as solar power generation, storage batteries, and radiant heating and cooling systems, to optimize energy supply and demand and achieve a low-carbon footprint for all participating companies in said industrial park, which was selected this fiscal year, we will prepare a draft business plan aimed at applications to JCM equipment subsidy programs.

3) Support for awareness raising activities for climate change and decarbonization in Da Nang City

The goal is to increase the number of pilot schools using the training materials created this time and to have them used as reference materials for education in Da Nang City. In doing so, the relevance of climate change and de-carbonization to other related SDGs may also be covered. Pilot trainings involving school parents and the local community are also envisioned. In doing so, exchange activities between teachers and students in Yokohama and Da Nang will also be kept in mind.

Appendix

Document 1: Draft climate change action plan

Document 2: Stakeholder workshop agenda

Document 3: Stakeholder workshop presentation materials

Document 4: Industrial parks located in Da Nang City

Document 5: Large energy user companies in Da Nang

Document 6: Proposed equipment installation by Murata Da Nang

Document 7: Overview of Redox Flow Storage Batteries

Document 8: Overview of LED Street Lighting (Smart LED)

Document 9: Methodology to calculate GHG reduction effect by Radiant Heating and Cooling System

Document 10: Approaches to develop methodology for radiant heating and cooling systems

Document 11: Climate change training materials for elementary and secondary school teachers

Document 12: Workshop presentation materials