Nonthaburi in 2030

Envisioning 1.5-Degree Lifestyles

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Partner Organisations (Listed in alphabetical order)

Project Implementation Partners
Akatu Institute, Brazil
Chulalongkorn University, Thailand
ICLEI Africa, South Africa
Swechha, India

Communications and Outreach Partners
Hot or Cool Institute, Germany
ICLEI Japan
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Advisory Partners
D-mat, Finland
National Institute for Environmental Studies (NIES), Japan

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EXECUTIVE SUMMARY

This report, 'Nonthaburi in 2030', recommends some plausible options for 1.5-Degree Lifestyles and measures to support them. This will put society on a path towards realising the globally unified 1.5-Degree Lifestyles target of 2.5 t-CO_2e/capita/year, which is compatible with the Paris Agreement's target of limiting global warming to 1.5°C above pre-industrial levels. Based on an assessment of consumption data across housing, food, mobility, goods, services and leisure, it is calculated that the average lifestyle carbon footprint in Nonthaburi is currently 3.15t-CO_2e/capita/year.

Our proposed consumption side measures can reduce Nonthaburi's average lifestyle carbon footprint from 3.15t-CO_2e/capita/year to 2.5t-CO_2e/capita/year (-23%), assuming no changes in renewable energy share and no changes in environmental efficiency improvement.

Current average per capita lifestyle carbon footprint in Nonthaburi (2015-2020 reference data)	3.15t-CO_2e/capita/year
2030 average per capita lifestyle carbon footprint in Nonthaburi after lifestyles change with assuming no improvements in renewable energy share and environmental efficiency from the current level	2.5t-CO_2e/capita/year

We identified 54-actionable lifestyle change options based on project-wide extensive literature review and estimated their potential to reduce carbon footprints based on consumption amounts and energy intensity for production across the housing, food, mobility, goods, services and leisure domains. Selecting options for the 1.5°C Lifestyles is personal, and can vary from one person to another. Through participatory workshops with Nonthaburi's citizens, the feasibility and desirability of the identified options were evaluated. Workshop participants conducted a two-week household experiment to confirm the viability of the options selected in the workshop. This household experiment enabled identification of obstacles to implementing the options and what supporting measures are needed to overcome them.

In Nonthaburi, the food domain accounts for the maximum carbon footprint, followed by leisure, and then mobility. For food, the average carbon footprint is 733 kgCO_2e/capita/year. The highest contributor is beverages because high temperatures and humidity for most of the year in Thailand mean the people consume, on average, 440 kg of drinking water annually, or 1.21 L/person/day. Lifestyle carbon footprint reduction options like decreasing food waste and controlling portion size can have substantial impacts in reducing the carbon footprint of the food domain.

The key messages are as follows:

1) Nonthaburi households focus on key terms, 'values' and 'practices' as part of a unified vision to achieve future sustainable lifestyles.

2) The highest carbon reduction options are: having meals at home instead of going out, eliminating food waste, and avoiding fast fashion consumption.

3) To promote sustainable lifestyles in Nonthaburi, a combination of actions across domains is required. Multiple time-scale strategies also play an essential role in these different actions.

4) There is no one-size-fits-all policy. We propose a set of policy recommendations in four sections: i) cooperative strategy (ii) main sectoral strategies, (iii) stakeholder roles, and (iv) themes and choices for implementation.

Citizens identified various obstacles to implementing these 1.5°C Lifestyles options. For example, a significant challenge to attaining a low carbon lifestyle is that people do not understand the true meaning of sustainable development, and misconceptions can lead to unsustainable practices. Urban sprawl along with inadequate/inefficient infrastructure such as roads or water transport results in an increase in energy consumption, and adds to the challenges. Supportive measures by government and business can enable households to implement the recommended options for effective transition to the 1.5°C Lifestyles, and conversely awareness and willingness of households to take action can encourage government and businesses to provide supporting measures.

The lifestyle carbon footprint analysed in this report, as well as the carbon footprint reductions associated with citizen behaviour change, assume average consumption values for Nonthaburi. Citizens' carbon footprints are highly variable, corresponding to differences in income, occupation, age, family structure and health. The report argues that it is vital to reduce the average lifestyle carbon footprint of citizens below the 2030 target (2.5tCO_2e/yr per person), even as cities are expected to grow economically and increase consumption in the future. However, it is neither realistic nor desirable to expect all citizens to take the carbon footprint reduction actions described in the report, regardless of their different standards of living and diversity of needs such as mobility, housing and food.

This report accentuates that a 1.5°C Lifestyle of 2.5 t-CO_2e/capita/year target is very ambitious but can be achieved if all the stakeholders take adequate action in a collaborative manner. It aims to provide ideas for a diverse range of citizens towards realising 1.5°C Lifestyles, while noting that adoption rates are only indicative figures, and not future projections or targets.

CONTENTS

1. INTRODUCTION

Current climate debates largely focus on production-based strategies to reduce carbon emissions. Production-based accounting covers direct emissions from domestic production activities within geographical boundaries and offshore activities under the control of a country, but does not account for embodied emissions from international trade (Boitier, 2012; Moore, 2013). Consumption-based accounting (carbon footprinting) includes both direct emissions and embedded emissions due to the production and distribution of products and services, including imported products, reflecting the global impacts of individuals' final consumption and lifestyles. This approach addresses carbon leakage in production-based strategies and promotes comprehensive mitigation options while not burdening developing countries with excessive emissions obligations (Peters and Hertwich, 2007).

The analysis of individual lifestyles offers the possibility of a comprehensive assessment of consumption-related carbon emissions in different areas of life such as housing, food, mobility, goods, services and leisure, as well as the links between these areas (Institute for Global Environmental Strategies, Aalto University and D-mat Ltd, 2019). Lifestyle carbon footprints can be assessed through national or city boundaries. Given the availability of consumption data, the city where an individual resides provides appropriate geography to account for carbon emissions across production, distribution, use, and disposal of purchased products and services including those embedded in trade.

This scenario provides recommendations on how to substantially reduce consumption-based carbon emissions through the 1.5°C Lifestyles, developed in consultation with the citizens of Nonthaburi, who were selected by Chulalongkorn University based on their existing network and practical considerations for project implementation. This scenario accentuates that the adoption of a low-carbon lifestyle options relies on supporting measures by governments and businesses to facilitate individual efforts, and emphasises the importance of collaborative efforts by all stakeholders.

1.1 Background

Nonthaburi Province, located in Central Thailand, is a metropolitan area adjacent to Bangkok. The main city in the province also goes by the name Nonthaburi. Two-thirds of the province's land consists of residential and economic activity areas, and most parts are urbanized as part of the capital; in many ways, it is developed to support the urban expansion and growth of Bangkok. Nonthaburi Province is divided into six districts: Mueang Nonthaburi, Bang Kruai,

Bang Yai, Bang Bua Thong, Sai Noi, and Pak Kret. Nonthaburi, also the name for the main city in the province, has the second-highest population density in the country after Bangkok. The 701,932 households have a total of 1,265,387 people, with population density of 2,033people/km2 (Nonthaburi Provincial Statistical Office, 2020).

The total land area of 622 km2 is about 56% agricultural, with the remaining 44% non-agricultural. Interestingly, the non-agricultural sector's contribution to provincial income is more than nine times greater than the agricultural sector. The annual gross provincial product (GPP) is $10,066 million USD. The provincial economy is mainly based on 1) wholesale and retail trade, repair of motor vehicles, motorcycles, and personal and household goods, 2) manufacturing, and 3) healthcare and social work, and community, social, and personal service activities (Provincial Labour Office Nonthaburi, 2019). The average household income in Nonthaburi is$9,314 USD/year, while for individuals the average income of $4,521 USD/person/year is above the poverty baseline of $1,176 USD/person/year. Average expenditures are $5,885 USD/year for households, and $2,856 USD/year for individuals. Based on expenditures for consumption, the poverty rate is listed as the 4th lowest among 77 provinces, at the rate of 0.75% (Office of the Database and Social Indicators Development, 2018). Note: the exchange average of $1 USD to THB in 2018 = 32.31 (Bank of Thailand (BOT), 2021).

Similar to other cities around the world, increasing population, the demands of urban environments, and changes in consumption patterns lead to environmental threats in Nonthaburi Province. For the province to do its part in limiting global temperatures to 1.5°C above pre-industrial levels, requires transformative systemic change. This includes the upscaling and acceleration in implementation of far-reaching, multilevel and cross-sectoral climate mitigation, from city-level to national and international scales. Community engagement is considered vital to lowering local households' overall greenhouse gas (GHG) emissions and making low-carbon lifestyles part of the vision for the future.

Since 2010, the Thai government, and a number of its key agencies, have initiated a number of policies and practices to shift the country towards a Low-carbon Society (LCS). The Thailand 2015-2050 Climate Change Master Plan (CCMP) (The Office of Natural Resources and Environmental Policy and Planning, 2015) was prepared to launch strategic plans in response to the United Nations Framework Convention on Climate Change (UNFCCC). A challenge for its implementation is the lack of a bottom-up approach from household participatory.

Nonthaburi Province has announced a "Livable City" vision in its 5-year development plan (2018-2022) (Nonthaburi Governor Office, 2018), which can be seen as a leap forward and an opportunity to connect the city-level to larger scales. Comprehensive data from the 2017-base year revealed that Nonthaburi's GHG emissions largely come from five sectors – stationary energy; transportation; waste; industrial process and product use (IPPU) and; agriculture, forestry and other land use (AFOLU). The province emitted 5.56 $MtCO_2e$ and 3.15 $MtCO_2e$ per capita. Eleven long-term measures and twelve short-term measures were recommended to cut GHG emissions to approximately 2.06 $MtCO_2e$/year by 2030 (Thai Greenhouse Gas Organization, 2018). To our knowledge, domains of household consumption with the highest impacts on the environment include housing, mobility, food, goods, services, and leisure. However, a consumption-based approach for these lifestyle domains has not yet been considered. Synchronizing the country's top-down low-carbon strategy with the local community's bottom-up interaction with current sustainable knowledge and practices therefore helps make sustainable development more accessible, by limiting carbon emissions to no more than 2.5 tCO_2e/person/year by 2030, the level required for attaining the global 1.5°C target.

To achieve the 1.5°C target in Nonthaburi Province, we need to answer these questions: How much of the current carbon footprint is generated by people's lifestyles? What percent of each lifestyle domain contributes to total carbon footprint emissions resulting from consumption-based lifestyles? What options are feasible for household practices to reduce the carbon footprint in daily life and to meet the city vision? And what are possible recommendations and policies to upscale and accelerate the implementation of far-reaching, multilevel and cross-sectoral climate mitigation in the city? This study classified household resource consumption into six domains after the previous 1.5°C report (Institute for Global Environmental Strategies, Aalto University and D-mat Ltd, 2019).

1.2 The Scenario

Co-created with citizens, this scenario—Nonthaburi in 2030—recommends options and their supporting measures to reduce lifestyle carbon footprint and realise 1.5°C Lifestyles, defined as sustainable lifestyles that are compatible with the 1.5°C target of the Paris Agreement, limiting global warming to 1.5°C above pre-industrial levels. Choice of a decarbonised lifestyle is personal, and can vary from one person to another, hence it is crucial to select low-carbon lifestyle options across housing, food, mobility, goods, services and leisure that suit individual preferences and needs. Before considering specific lifestyle options, it is

necessary to benchmark an individual carbon footprint, and identify hotspots for footprint reduction across housing, food, mobility, goods, services and leisure domains. Analysis of Nonthaburi citizen's average lifestyle carbon footprint and its related hotspots provides both policymakers and citizens with an indicative carbon footprint benchmarking, and a hotspot analysis along with 54 actionable lifestyle change options, specific to Nonthaburi's culture and socio economic context. These options are also in line with a conceptual city vision, developed based on a participatory workshop about the desired future of the city and lifestyle. Preferences made by citizens in terms of these 54 options are indicated through their adoption rates. Through household experiments, citizens were able to identify the obstacles and the required supporting measures from government and businesses to effectively mainstream the decarbonised lifestyles options. Thus this policy report aims not only to encourage citizens to make environment-friendly choices every day but also to solicit actions to other stakeholders, including the government and the business sector, to enable and facilitate citizens to make such choices. In other words, our objective is not only to inspire citizens, governments and businesses to embrace and promote conscious living, but also to broaden the narrative of taking action from policymakers to every citizen and resident of Nonthaburi regardless of their age, gender, nationality or socio-economic status.

The next section details the methodology involved in developing this scenario. Sections 3, 4, and 5 introduce the project findings of average baseline carbon footprint in Nonthaburi, desired future city vision, and low-carbon lifestyle options across housing, food, mobility, goods, services, and leisure domains. Section 6 identifies the supporting measures for different low-carbon lifestyle options and recommends actions for various stakeholders to facilitate transition towards a 1.5-Degree Lifestyles (1.5°C Lifestyles).

2. METHODOLOGY

The lifestyle carbon footprints targets are set at 2.5 t-CO_2e/capita by 2030, 1.4 t-CO_2e/capita by 2040, and 0.7 t-CO_2e/capita by 2050 (Institute for Global Environmental Strategies, Aalto University and D-mat Ltd, 2019). This scenario focuses on the 2030 target.

For co-creating the scenario, a twofold research method was deployed, involving quantitative analysis and a participatory consultative process. The key steps under each of these methods are elaborated below.

2.1 Quantitative Analysis

The quantitative analysis followed a top-down and bottom-up approach. Top-down approach is typically based on a national input-output database, has the completeness of covering the whole economy. However, the resolution of sectors may not be sufficiently detailed to quantify specific consumption habits. Only a limited number of countries have a precise breakdown of sectors in the input-output data such that key consumption items (e.g. different transport modes and different types of meat) can be distinguished. In addition, to estimate the carbon footprint per physical amount of consumption (such as passenger-km, food-kg), it is necessary to collect physical consumption amounts and their associated monetary expenditure (Koide et al., 2021).

The bottom-up approach, on the other hand, is more suitable for analysing the needs, satisfaction and substitution of items because it is based on the physical amount of consumption (e.g. food-kg, passenger-km of mobility demand). Also, the bottom-up approach can estimate lifestyle carbon footprints with more detailed product and service categories than the top-down approach, especially as input-output tables have limitations in the level of specificity. The physical amount of consumption can be estimated from government statistical data (e.g. statistics for fuel consumption, or a nutrition intake survey). Life cycle greenhouse gas intensity data for various products are available through a global LCI database (e.g. Ecoinvent). However, due to the nature of the data, the bottom-up approach has limitations in terms of coverage. For example, services are not typically covered in a bottom-up LCA database. The database for the bottom-up approach is mainly based on the National Statistical Office's 2018 Household Socio-Economic Survey (NSO, 2019), with detailed expenditure by households in Nonthaburi Province drawn from a Consumption Survey in 2019. For food-related consumption, we used the Thailand National Consumption Database 2013-2016 from the National Bureau of Agricultural Commodity and Food Standards (ACFS). The life cycle greenhouse gas intensity data is collected and estimated by the National Metal and Materials Technology Center (MTEC) and the Thailand Greenhouse Gas Management Organization (TGO).

This study mainly uses the bottom-up approach, combining micro-level carbon footprint data with national statistical data for major domains and items, while using the top-down approach to increase the coverage of estimates. Specifically, the bottom-up approach will be used primarily for the three major domains contributing to footprints, namely food, mobility, and housing, whereas data for physical amounts of consumption (e.g. weight of food, distances covered by transport) is relatively well available. In contrast, the top-down approach will be used mainly for the goods, leisure, and services domains and other minor items in order to improve the estimation coverage.

Combining these two data, the quantitative analysis is used to (i) calculate Nonthaburi's baseline carbon footprint; (ii) identify lifestyle carbon footprint reduction hotspots; and (iii) estimate the potential of low-carbon lifestyle options when adopted in tandem.

Step 1: Calculation of Nonthaburi's Average Carbon Footprint

- Carbon footprint calculation takes into account the consumption amount and energy intensity for production of different items across housing, food, mobility, goods, services and leisure domains.
- For Nonthaburi, the average carbon footprint was calculated by aggregating carbon footprints of about 149 lifestyle items, with 2015-2020 used as the reference years, depending on data completion. In the absence of specific data, that from the latest available year was used, with the assumption that the level of consumption or intensity was constant over the following years.
- The boundary of estimation for the consumption of goods and services by households covers 'from cradle to grave', including resource extraction, material processing, manufacturing, delivery, retail, use, and disposal, but excluding land use, land use change, and forestry (LULUCF).
- If the scope of the GHG intensity data was not compatible with this boundary setting, supplementary data was used to increase the coverage of the estimation wherever possible.

Step 2: Hot Spot Analysis

- Assessment of carbon footprint across housing, food, mobility, goods, services and leisure enabled a comparative analysis to identify which of these domains within Nonthaburi accounts for the largest carbon footprint.
- Taking a closer look at each domain enabled identification of carbon footprint hotspots. Here, hotspots mean the individual lifestyle items that have either a high consumption amount or a high carbon intensity in production, or both of these.
- Hotspot analysis helps to identify lifestyle options that have maximum potential to reduce carbon footprint.

Step 3: Development of Lifestyle Carbon Footprint Reduction Options

- Through analysis of carbon footprint hotspots for each domain and following a systematic literature review, 54 lifestyle carbon footprint reduction options were identified.
- These options were graphically illustrated along with their carbon footprint reduction in an options catalogue. The options catalogue provided simplified communications tools.
- The carbon footprint reduction potential of the 65-lifestyle options was used to design a puzzle game.

Step 4: Estimation of Aggregated Reduction Effects

- There are many interactions among lifestyle carbon footprint reduction options, for example, teleworking reduces commuting distance and consequently affects reduction potentials of shifting car commute to other low-carbon mobility means. The aggregated reduction effects of implementing multiple options were estimated by taking into account their interactions. Accounting for interactions resulted in substantially smaller carbon footprint reduction potentials than a simple summation of the reduction potential of each option.

2.2 Participatory Consultative Process

The reduction potentials of low-carbon lifestyle options are based on the estimation for current lifestyle footprints and proposed per-capita targets. In order to reach the target of 1.5°C, lifestyle carbon footprints should be reduced by 650 $kgCO_2e$/capita/year. This value applies to the summation of all the categories. Assuming that all options share the same adoption rates, we estimate that a 41% rate of adoption is required to achieve the 1.5°C target. With a 41% adoption rate, the lifestyle carbon footprints are reduced by 23%, or 650 $kgCO_2e$/capita/year.

The participatory consultative process aims to reflect citizens' ideas and opinions to co-create the scenario. We conducted two workshops with local participants in Nonthaburi in order to find out acceptable adoption rates

and difficulties in adopting the various options. Two criteria for recruiting and selecting the participants were: i) variation of demographic characteristics (i.e. gender, age, material status, number of household members, income, education level, and occupation) and ii) participants having a high level of environmental consciousness. We recruited participants through community leaders and their local networks The selection process was mainly based on people's past engagement in environmental-related activities in Nonthaburi.

Step 1: Workshop 1

- In the first workshop, 42 participants were asked to discuss and choose lifestyle carbon footprint reduction options which felt doable and practical.
- The participants were asked to share their vision for Nonthaburi in 2030. This enabled them to identify lifestyle carbon footprint options that were most in line with the collective long-term city vision held by other participants.

Figure 1 Nonthaburi participants discussing lifestyle carbon footprint reduction options during the workshop

Step 2: Household Experiment

- After the workshop they participated in the experiment, which was to practice those chosen options for two weeks. The data and difficulties were recorded during the experiment period. Later, in the second workshop, participants were asked to share information and their views on the practicability of the options and the difficulties they encountered.
- We provided a diary for each participant to record the low-carbon lifestyle activities which they put into practice. Each participant was assigned practical options, to be practiced for two weeks. They recorded their daily activities and the difficulty rate of the assigned options during the implementation period.
- The objective of the household experiment was to identify the obstacles in implementing 1.5°C lifestyles and apply this analysis in the recommendations for multi-stakeholder collaboration.

Step 3: Workshop 2

- The second workshop was held on March 9th, 2021, to discuss the practicability of the chosen 40 options.

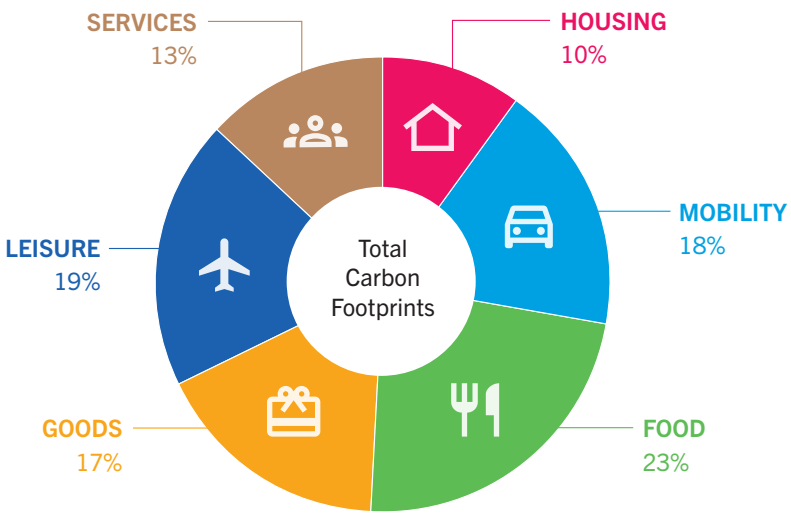
Findings from the quantitative analysis and participatory consultative process are elaborated further in sections 3, 4, 5 and 6.

3. OVERVIEW of BASELINE DATA

The total average lifestyle carbon footprint of households in Nonthaburi Province in 2020 is estimated to be 3.15 tons (tCO_2e) per capita per year which moderately overshoots the lower limits of GHG emission targets proposed for 2030 (2.5 tons per capita in terms of all GHGs). The biggest contributor to the average lifestyle carbon footprint in Nonthaburi is food (23%: 0.73 tCO_2e), followed by leisure (19%: 0.59 tCO_2e), mobility (18%: 0.55 tCO_2e), and goods (17%: 0.54 tCO_2e).

Out of the consumption domains considered, food, leisure, and mobility have the largest impact (approximately 60%) on total lifestyle carbon footprints in Nonthaburi.

Figure 2 Distribution of carbon footprint in six domains



3.1 Food

The food domain's average carbon footprint in Nonthaburi is 733 kgCO_2e/capita/year. The highest contributor is beverages because high temperatures and humidity for most of the year in Thailand mean the people consume, on average, 440 kg of drinking water annually, or 1.21 L/person/day. This number was slightly lower than average drinking consumption in Chiangmai Province, Thailand which ranged from 1.62 to 1.88 L/person/day (Sawangjang et al., 2019), but higher than cold tap water consumption in Sweden, with a median value of 1.17 L/person/day (Säve-Söderbergh et al., 2018).

Figure 3 Hotspot analysis in Food domain

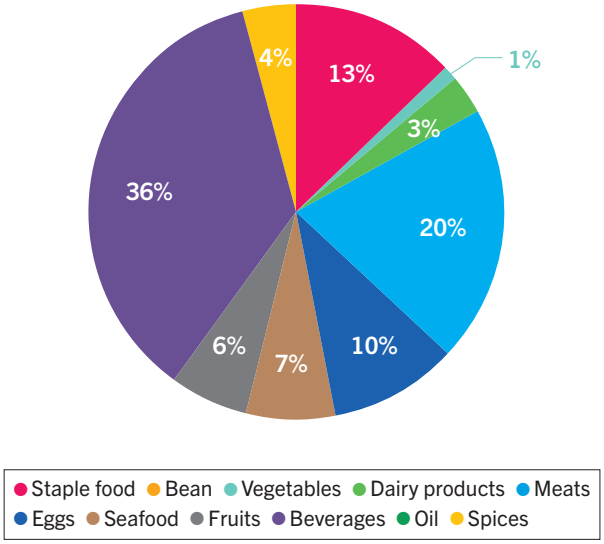
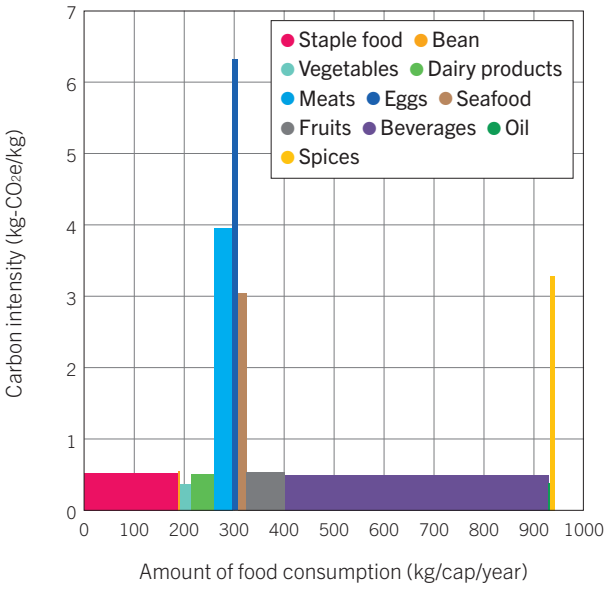


Figure 4 Carbon intensity and consumption amount in Food domain



3.2 Leisure, Goods and Services

Leisure activities in Nonthaburi contribute 588 kgCO_2e/capita/year, whereas consumption outside the household (eating at restaurants) accounts for 477 kgCO_2e/capita/year. This reflects the lifestyle of Thai people, who enjoy going out to eat. The cost of food at stalls and in some restaurants is affordable and often wallet-friendly for a small family when compared to cooking at home. Goods and services contribute 542 and 410 kgCO_2e/capita/year, respectively. Over half (56%) of the goods carbon footprint is caused by clothing. Finance/insurance services and communication services are the two largest contributors in the services domain.

Figure 5 Hotspot analysis in Leisure domain

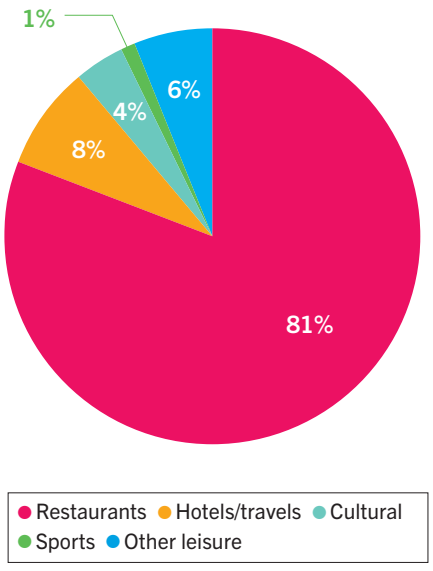


Figure 6 Carbon intensity and consumption amount in Leisure domain

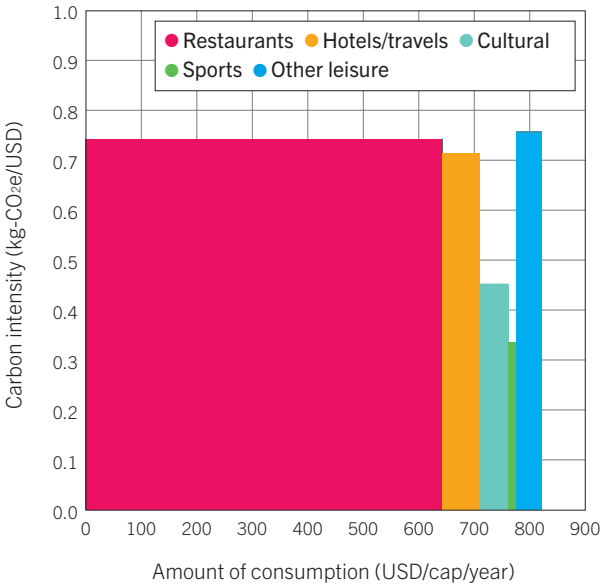


Figure 7 Hotspot analysis in Goods domain

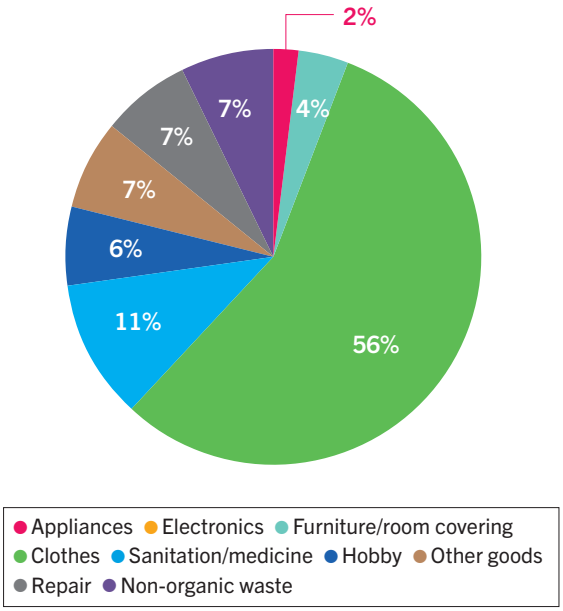


Figure 8 Carbon intensity and consumption amount in Goods domain

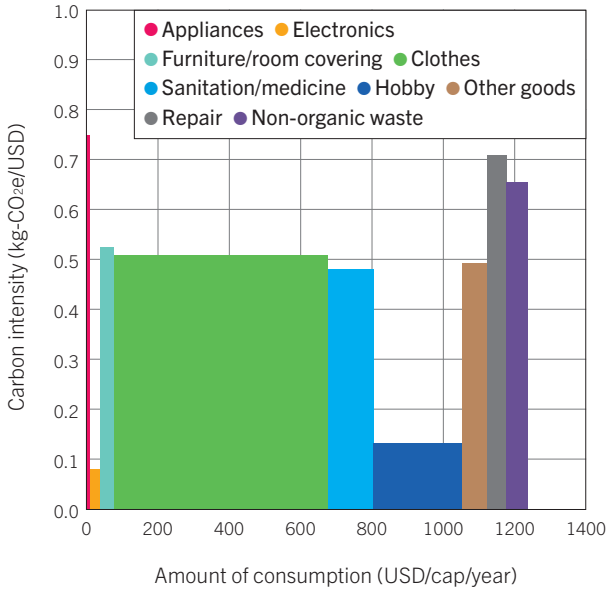


Figure 9 Hotspot analysis in Service domain

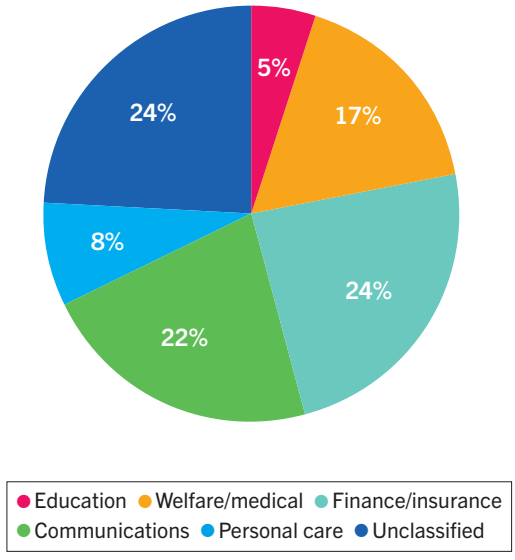
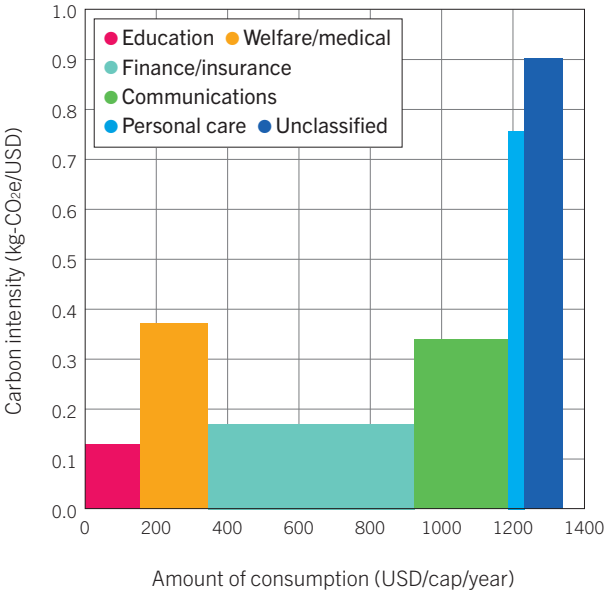


Figure 10 Carbon intensity and consumption amount in Service domain



3.3 Mobility

The mobility domain in Nonthaburi contributes around one-fifth (18%) of the carbon footprint, or 554 kgCO_2e/capita/year, nearly a half of which is due to private car use.

Figure 11 Hotspot analysis in Mobility domain

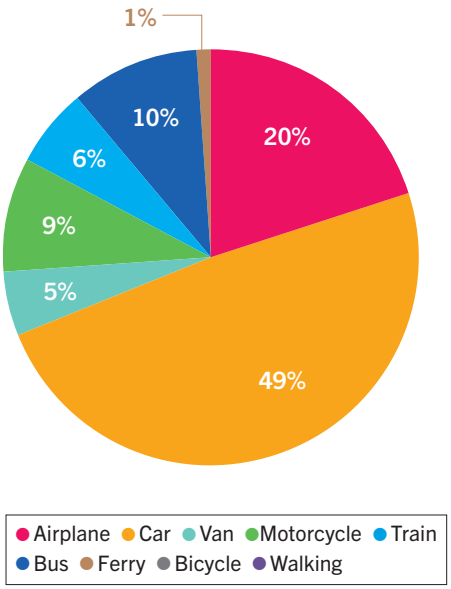
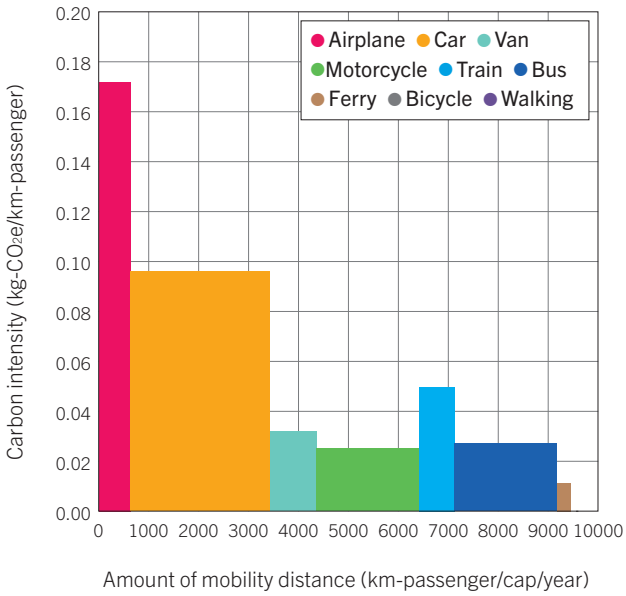


Figure 12 Carbon intensity and consumption amount in Mobility domain



3.4 Housing

In Nonthaburi, the housing domain contributes around one-tenth (10%) of the carbon footprint, or 323 kgCO_2e/capita/year. About 40% comes from electricity usage. In comparison to developed countries, the housing carbon footprint in this city is very low.

Figure 13 Hotspot analysis in Housing domain

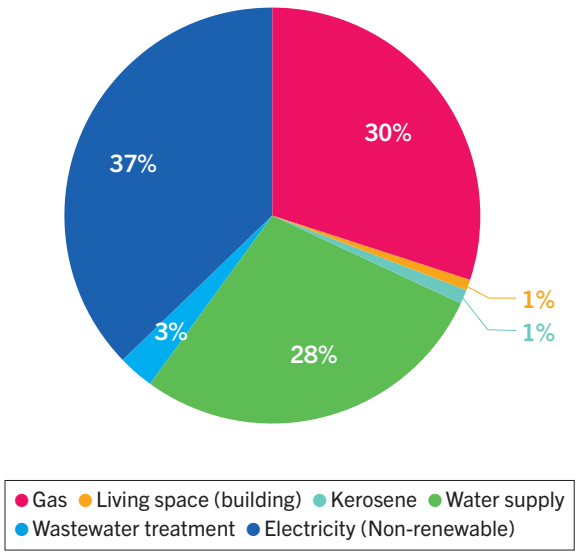
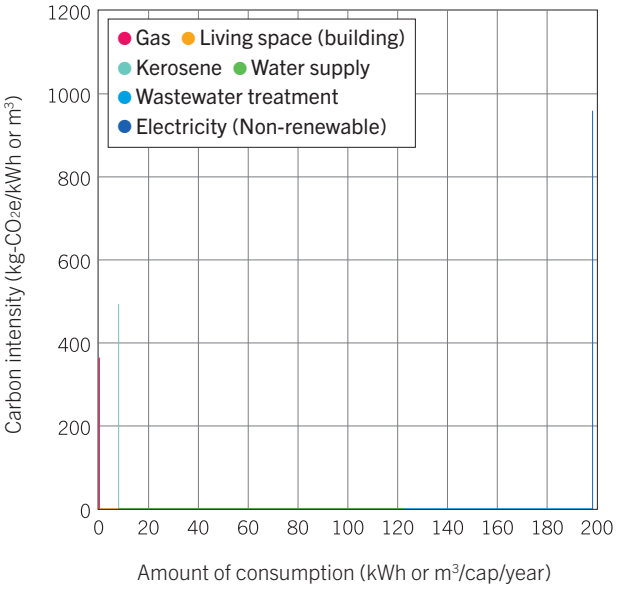


Figure 14 Carbon intensity and consumption amount in Housing domain



The carbon-intensive hotspots for each domain are summarized in Table 1.

Table 1 Carbon-intensive hotspots for each domain

Domain	Percentage of total footprint	Carbon-intensive hotspots	Footprint measure ($kgCO_2e$/capita/year)
Food	23%	Beverages	259
		Meat	147
Leisure	19%	Restaurants	477
Mobility	18%	Private cars	268
		Air transport	110
Goods	17%	Clothing	305
Service	13%	Financial/Insurance	98
		Communications	89
Housing	10%	Electricity	118
		LPG and city gas	99

3.5 Identifying Key Impact Areas

The examination of lifestyle carbon footprints based on physical consumption units revealed several hotspots, including beverage and meat consumption, fossil-fuel based energy, as well as car use and travelling by airplane, which are currently the major causes of climate change from the perspective of household consumption. These hot-spots can be impactful intervention areas for activating low-carbon lifestyles compatible with the Paris Agreement. This study identified the top-5 highest carbon-intensive hotspots, as shown in Table 2.

Table 2 The top-5 highest household carbon-intensive hotspots and their lifestyle domains

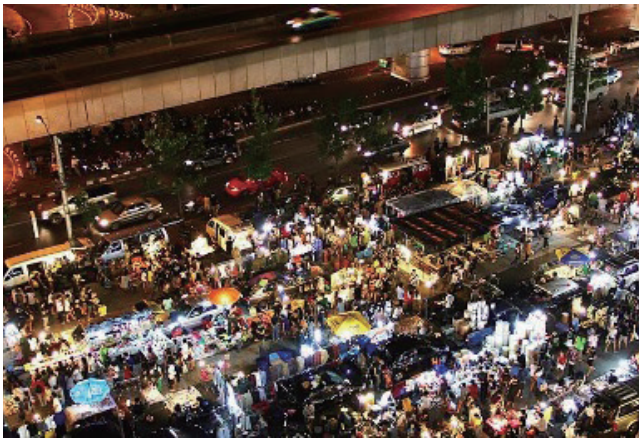
Rank	Hotspots	Domain	Amount of footprint ($kgCO_2e$/capita/year)
#1	Restaurants	Leisure	477
#2	Clothing	Goods	305
#3	Private cars	Mobility	268
#4	Beverages	Food	259
#5	Meat	Food	147

The main reasons underlying the identified hotspots are summarized as follows.

Rank #1 – Restaurants

Thai people seem to have a much more excessive approach when eating at restaurants. They view unfinished restaurant food as an indication that every person seated around the table has eaten their fill. The cost of food at the stalls and some restaurants is affordable and often wallet-friendly for a small size family when compared to cooking at home. One can expect to spend between 30 and 60 baht for a basic meal (around $2 USD) and approximately 300-500 baht for a mid-range restaurant.

Figure 15 The Night Owl Market in Nonthaburi Province provides a large parking lot, variety of food stores, clothing, and fashion accessories[1]



Rank #2 – Clothing

Currently, the fashion industry's operating model is exacerbating the problem of larger carbon footprints by stepping up the pace of design and production — so-called 'fast fashion'. The replacement of clothing inventories has become much more frequent, and most fast fashion brands tend to reduce the cost and quality of clothing and encourage shoppers to purchase more. With the power of online shopping, people in Nonthaburi can buy clothing from anywhere and anytime.

Rank #3 – Private cars

Since there is only one rapid transit line connecting the centre of Nonthaburi city to the central business district (CBD) of Bangkok, commuting to work/study by private car is the most convenient means of travel. Shifting from single-vehicle use to shared or public transport serves as a promising strategy to reduce traffic congestion and vehicular emissions.

Rank #4 – Beverages

The amount of bottled drinking water, soft drinks and juice consumed is particularly great, due to the high-temperature and humidity of weather in Thailand. Moreover, most of the bottled drinks available in stores contain high amounts of sugar, which also partly contributes to an increased carbon footprint.

Rank #5 – Meat

Even a small amount of meat consumption accounts for a significant share of footprints due to its high carbon intensity. The consumption of beans, vegetables, and fruits, which are low-carbon and can be nutritious food items, offer strong potential for impactful interventions.

1 https://thailandtourismdirectory.go.th/th/attraction/23306

4. CITY VISION

4.1 City Scenario

Participants were informed about the rationale and goal of the project. Risks and vulnerabilities for all aspects of climate change are driven by global-social dynamics but are greatly shaped by local contexts. Effective lifestyle carbon footprint reduction needs to be based on good understanding of the local community and strong local adaptive capacity. The lower limit target for GHG emissions is 2.5 tCO_2e per capita by 2030, necessary to cap global emissions and keep global average temperature rise to no more than 1.5°C. At the city level, Nonthaburi Province's "Livable City" vision provides clear goals to develop and drive the city to achieve a good quality of life for its residents.

The scenario development process was developed based on Schwartz (1991) and Voros (2001), to help participants create scenario frameworks and imaginary but plausible stories for the next 10 or so years, and which would advance Nonthaburi Province as part of the country's vision towards low-carbon lifestyles. Four steps within the process were: conducting a historical timeline exercise, identifying key stakeholders, determining driving forces, and generating the scenario framework.

1) Conducting the historical timeline exercise

The interactive dialogue exercise involved building a historic timeline of Thailand for the past 20 to 25 years. The purpose of this step was to sensitize participants about the trends, patterns, and deep drivers facing social's ideology, values and their lifestyle. The workshop output was based on looking at history, seeing influences from the past (behind the scenes) and present stage (the current situation) before looking at the future.

Participants viewed the Thai government's success story in drawing attention towards sustainable production and consumption, and attempts to translate a concept into actions. Thailand has planned for massive infrastructure and services investment projects, in particular energy, mobility, and transport. In addition, the education system has been reformed, with regard to the social safety net and self-sufficiency matrix.

On the downside, there has been poor legislative and weak regulative environmental enforcement due to a lack of coordination among policymakers and stakeholders. Policymakers are often accused of coming up with projects in 'ivory towers', implying that their ways of thinking are not practical in real-world situations. Democracy in Thailand comes with freedom, but not responsibility.

The historical look back in time raised additional points about environmental trends in Thailand. The quality and quantity of sustainable extension research has been declining. Collaboration between the private sector and stakeholders is not strong or quick enough to respond to the crisis of climate change. Environmentally-friendly market mechanisms are not working for the poor and this is anticipated to continue in the future. Technology adoption and adaptation have been limited by issues of affordability and accessibility. The population is growing and putting greater pressure on land. Increasing urbanization leads to an increase in natural resource consumption. Economic instability arises from the unstable political system. The vision for 2020 is as a technology and innovation-driven year, but this has not yet been achieved. The country is lacking technical experts for emerging sectors such as eco-business and the green economy.

One of the important challenges for attaining a low-carbon lifestyle is that people do not understand the true meaning of sustainable development, and misconceptions can lead to unsustainable practices. Urban sprawl along with inadequate/inefficient infrastructure such as roads or water transport results in an increase in energy consumption.

2) Identifying key stakeholders

In this step, the participants were asked to compile a list of key stakeholders relevant for the future of Thailand. These are the agencies/actors who will play dominant roles or affect the direction of society. The policies they make might unfold over the next 10 years (between now and 2030). These include people/living and non-living things/parts of the environment that interact with the country and Nonthaburi's future, moving forward towards a low-carbon society.

From the workshop dialogue, five groups of stakeholders were identified: i) policymakers, civil society, municipalities, and local governments, ii) the private sector and non-governmental organizations (NGOs), iii) technical experts and academia, iv) media, and v) local communities, local organizations, traditional leaders and youth.

3) Determining driving forces

The session involved a discussion about the driving forces which will shape the future of Thailand and its move towards a sustainable society with low-carbon lifestyles. These drivers of change are underlying and impacting factors that set the pattern of events and determine the outcomes of how society and the economy will evolve in Thailand and Nonthaburi over the next 10 years. Two factors are certainty and uncertainty in the key driving forces.

The next crucial step was to create the scenario logic. We asked participants to discuss two key driving forces that would move the country and society towards a low-carbon lifestyle society. The conclusion of the discussion underscored the drivers required to limit global temperature rise to 1.5°C.

First – key drivers and issues related to the nature of social values. The result represents the influence of social structures, the nature of the economy and political values.

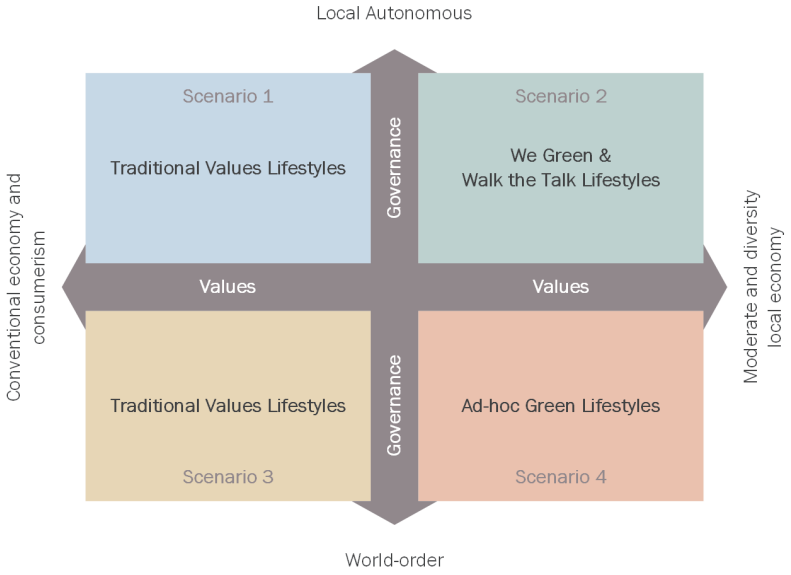
Second – key drivers and issues related to the nature of country-level and local governance. The result was the way in which institutions/agencies or key actors exert control in societies at local and national levels, and in consequence respond to the global system.

4) Generating the scenario framework

All key drivers extracted from the previous step were clustered in a group with related themes. Participants were requested to score each driving force on a scale from 1 to 10 points according to how uncertain and important (impactful) they are. Once the participants rated the most important and uncertainty driving forces, the scenario logics were developed on a matrix with two axes (Figure 16). These two axes, values and governance, represented the opposing characteristics that defined the aforementioned drivers.

The plenary session revealed that 'values and practices' were considered as one of the most important drivers in moving towards a low-carbon society associated with socially sustainable lifestyles. Further, this driver describes national policies-influenced by conventional economy and consumerism. Another important driver selected by participants was governance. Two important developments in the area of governance are: i) "Social Laissez-fair or World Order": most countries' policy and decision-making power revolve around the world and country order, and ii) "Local Autonomous": radical decentralization, with most political and decision-making power (and financial resources) moved to the local level.

Figure 16 Scenario logics generated by local participants



The cross of these two spectrums, values and governance, result in a 2x2 matrix of four quadrants. This matrix is used to plot the scenario (a process shown in Figure 1).

The horizontal 'values' dimension captures alternative developments in Thailand's core social values, represented in choices made by institutions, agencies and policymakers. On this axis, the 'conventional economy and consumerism' is dominated by the drive to increase the country's economic and personal affluence, including consumption. The 'moderate and diversity local economy' is limited by the social group and the future view.

The vertical 'governance' dimension aims to show alternative structures of political and economic power and decision-making. On this axis, the 'World-order' is influenced by the global and regional scale, while in the 'Local Autonomous' economic and political power is retained and stewarded at the local and national level.

4.2 City Storylines

Participants created scenario storylines, also referred to as Thailand's 'window of opportunities', and thought about how climate strategy would play a role in each scenario story.

Scenario 1 – We Green and Walk the Talk Lifestyle

This is a world of sustainable policy concentration, with more open and sharing of sources such as sustainability knowledge platforms, such as the so called 'Walk the Talk and Together We Can' environmental surveillance and diversity of local values. National, regional and local sustainable development are based on closer links to local capabilities and sustainable resources.

In this scenario, social safety nets have actively incorporated climate change and environmental concerns. Human centric is a pattern of resource use to meet people's needs. Environmental concerns are taken into account in policy decisions. Although natural resource exploitation is still challenging, sustainable policy and strategy are initiated in the context of local natural resources and economic patterns. This is a possible future for Thailand, where politicians are altruistic and make decisions for the betterment of all people. The economy is growing in a self-sufficient system. Both civic and public use of skills is grounded in values of sustainability. Everyone has something valuable to give or to do. Society's success depends on each person contributing and on everyone's ability to be good citizens, family members, neighbours and professionals. There is self-improvement through socially active sustainable consumption with civic activities also much appreciated within low-carbon lifestyles activities.

Scenario 2 – Traditional Values Lifestyles

In this world, conventional and economic growth-path efforts emphasize local worldviews and values. Social capability is limited with global economic patterns - conventional ideologies of economics and consumerism. Furthermore, modern science and technological knowledge dominate local natural resources management and the environment, with catastrophic results.

In this scenario, the future of Thailand's politics is promoted with limited altruism. Sustainable policies are formulated to address the country's bounded rationality and fragmentation. Sustainable strategies are put in place and implemented in the context of the Thailand National Sustainable Strategy, but not compatible with what is

necessary and needed at the global level and among local people to support them. The most commercially valuable professional skills are the source of power of the local economy. Policies and structures are customized to facilitate the work of leading industries and professions.

Scenario 3 – Functional Green Lifestyles

Here, the world is dominated by global culture and international economics. This worldview encourages acquisition of goods and services at all levels of society, and in ever-increasing amounts. The economic policies focus on consuming natural resources and expanding production.

Politicians act in their own interest. The economy is based on one-dimensional thinking, and it is given priority when it comes to natural resources. In addition, the demands of social lifestyles are high, resulting in overexploitation of natural resources. Local communities' sustainable solutions emerge from the global-level conditions. The corpus of global science and technology expands, yet local knowledge remains powerful. People's lifestyles are driven by efficiency and innovation gained through thinking and acting locally. People are more interested in money and material welfare than sustainable livelihoods.

Scenario 4 – Ad-hoc Green Lifestyles

A world where government tends to exert more central authority in local communities. The sustainable policy system tends to be tried first and evaluated afterwards. In this world a country government might use global power to impose environmental regulations and controls on local governments.

The future of the economy is one of growth and diversification under global patterns of trade. Sustainability and welfare policy go hand in hand. Globally, it is a highly competitive world. There will be economic and technological disruptions with social values and movements, yet the consumer ethic of micro-economic sufficiency is still there. Sustainable growth and some social safety-nets emerge as concerns for a green and clean environment.

4.3 City Vision Development

Based on the scenarios, we encouraged participants to debate and add further ideas about whether they agreed or disagreed with the storylines/statements. They were allowed to freely share their thoughts to support their opinions. The participants mutually agreed that the 'We Green and Walk the Talk Lifestyles Scenario' was the most preferred.
We engaged participants to generate a core vision, to be used as society's mental model and shared values, including ideas driving the promotion of environmental practices. Further, the vision will be used as ambition for new and existing opportunities to enable, encourage, engage and exemplify a country's low-carbon lifestyles, and hence transform society's role and response to global climate change.

The core vision proposed by participants was **"Community's Environmental Values and Practices – Together We Can".**

4.4 Co-Creation Learning Module

The Local Living Labs (Bergvall-Kareborn et al., 2009) method was employed to create a social implementation guideline and refine and improve their existing plans and regulations in Nonthaburi under each plausible scenario.

Questions were raised as follows:

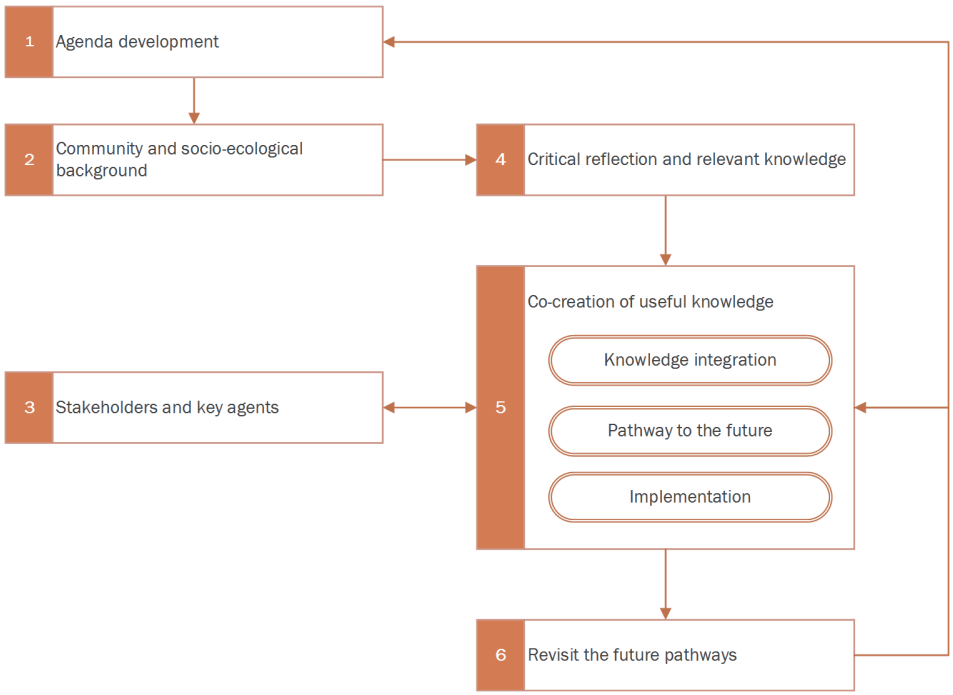
- *To what extent do local institutional capabilities apply to these storylines?*
- *How can sustainable lifestyles play out in each of the scenario stories?*
- *How would the interaction of local communities and key agents lead to action plans?*

The phrase 'Thailand Vision 2050' expresses the aspiration to transform the country's society from being agricultural to modern and prosperous. It sets out to transform the country into a knowledge-based society and creative economy, with stability and peace as well as a social harmony, uniting culture and biodiversity. Under Thailand's Low-Carbon Society Vision 2030 many sectors are involved in order to mitigate emissions; these include efforts in the residential sector, energy efficient buildings, energy efficient industries and fuel switching, and fuel substitution in the transport sector and electricity generation sector.

Based on the scenario storylines, core vision and development of lifestyles strategies, the learning modules were framed as 'Social Learning Mechanisms' where an episode of transformation was realized (Nevens et al., 2013). After that, co-creation learning modules facilitated cities' creation of (social) innovation and where social change agents could initiate or induce urban sustainability transitions (Trencher et al., 2017).

Based on the method of using a participatory co-creation learning module, Local Living Labs were developed.
They translated the essential elements of transition strategy options, with six crucial ingredients (sub-learning modules), into hands-on and public learning capability modules moving towards low-carbon lifestyles society, as shown in Figure 17 below.

Figure 17 Co-creation transformative learning modules



Module 1: 'Agenda development' specifies broad and significant trends/issues that local governments and communities need to respond to shifting their current economic, social and environmental development. It might be associated with a global- or national-level sustainable development agenda, e.g. Sustainable Development Goals (SDG), Green Society or sustainable strategy, a drift toward self-sufficiency.

Module 2: 'Community and socio-ecological background' considers the interconnections between communities, places, key resources, environments, and current policy and management. In this module, local governments and communities are better able to understand themselves and what they need to learn and solve.

Module 3: 'Stakeholders and key agents' include all involved organizations which can implement lifestyle carbon footprint reduction options, e.g. local communities and relevant networks, central government, social organizations, NGOs, and academic institutions. Each of these stakeholders has their own specific goals or objectives which produce their motivations at the individual-level, although the overall goal for the society is unified.

Module 4: 'Critical reflection and relevant knowledge' represents a process that explores content and the premise of the agenda identified from Module 1. Local governments and communities need to debate current gaps in and the relevance of knowledge. This process is about how local governments reflect on the problem, which helps them to identify why and what knowledge, skills and technologies they need to transform.

Module 5: 'Co-creation of useful knowledge' is a cumulative module that combines 'Knowledge integration' and 'Pathway to the future'. It considers the skills and capability required for local governments and key stakeholders in their 'Implementation' of projects, programmes and activities that contribute to the transition to a sustainable society.
Module 6: 'Revisit the future pathways' is the ongoing dialogue between local government and key stakeholders to revisit their sustainable policy and action plans by determining activities, programmes and projects implemented, and whether they have reached the outcomes defined in module.

Illustration: Tania Vicedo

5. LIFESTYLE CHANGE TOWARDS 2030

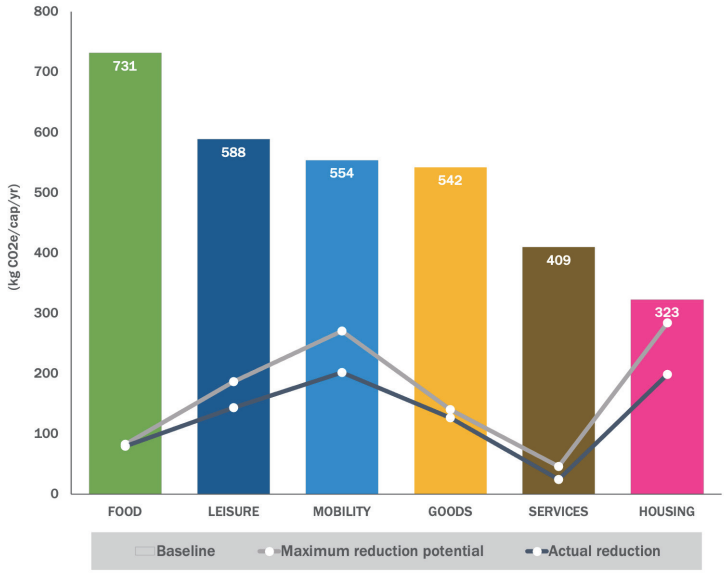
Based on the 41% adoption rate (to achieve the 1.5°C target), 40 out of the 54 options were selected by participants based on adjusted adoption rates during the first workshop, and later included in the household experiment. The other 14 options were excluded since some of them were difficult to apply in a short period, required additional investment, or were not available in Thailand. For example, using hybrid cars and biodiesel fuel cannot be implemented in the short run due to technological or financial constraints. Some participants already owned pets, and so the option 'do not own pets' was not selected. Mitigating carbon footprints in tourism activity cannot be recorded in a short time period. Choice of vegan diets is too restrictive, and not an easy behavioural shift as compared to eating a vegetarian diet. Fax machines are only used in workplaces, rather than in daily life. Sometimes we cannot avoid its usefulness for communication.

The following explanation would make sense: The adoption rates by survey participants for some options was 100%, but 40% for other options. This meant that the participants were aware that some options could not be fully implemented. If the adoption rates of all 40 options by the survey participants were extrapolated to the entire city, then a carbon footprint reduction of up to 1,010 kg CO_2e/capita/year could be feasible.

To meet the city carbon footprint goal of 2.5 tCO_2e/capita/year by 2030, reductions of 650 kgCO_2e/capita/year from baseline of 3.15t-CO_2e/capita/year are required. Our findings show that the major GHG emissions contributors within the lifestyle domains and household preference for lifestyle changes do not always reflect the magnitude of emission reductions (Figure 18).

Though food consumption is the leading contributor to emissions, it accounts for only 11% of total reductions as indicated by the participants. Leisure, the second largest emissions contributor, makes up 24% of total reductions. Housing, on the other hand, causes the lowest contribution to emissions but shares the largest proportion in mitigation, with 26% of potential reductions. Mobility makes the highest contribution in terms of emissions reduction, accounting for 36% of the total. Overall, the key reduction impacts on lifestyles come from the combination of four domains: mobility, housing, leisure, and goods, which together made up 671 kg CO_2e/capita/year, 87% of total reductions.

Figure 18 Allocations of the carbon footprint reductions in 2030 compared to the 2020 baseline of Nonthaburi's households



Practically speaking, households are quite versatile in adapting themselves towards lifestyles related to goods and housing, with high adoption rates above 41% for each domain. This implies that households can easily cope with any lifestyle carbon footprint reduction options that support these domains. The challenging part is in the mobility sector. Although this is the domain with comparatively high emissions and reduction potential, it has the lowest adoption rate much below the 41% target. Even if people are willing to change their transportation lifestyles, investment in infrastructure is required in order to facilitate the change. Given proper infrastructure to support public transportation, emissions reductions in the mobility domain can be increased much further, and become one of the highest reduction potentials in the long run. Co-benefits of improved public transportation infrastructure would be reduction of noise pollution from engines, and decreasing the amount of raw materials used in the private vehicle production process.

The possible carbon footprint reductions are shown in Table 3. We focus on carbon footprint reduction options with a magnitude of reduction above 10 $kgCO_2e$/capita/year, along with the time-scale strategies to be considered.

Table 3 Possible carbon footprint reduction options for sustainable lifestyles with time-scale strategy

Domain	Action	Carbon footprint reduction (>10 $kgCO_2e$/cap/yr)	Time-scale strategy
Leisure	Reduction in having buffet or a meal at a restaurant (eat at home)	142	Long-term system actions
Food	Reduction of food waste (e.g. reduce oversized portion)	92	Short-term individual actions
Goods	Do not buy fast fashion and double lifetime of clothes	79	Short-term individual actions
Mobility	Closer weekend leisure/ hobbies (reducing car, flight, bus)	52	Short-term individual actions
Housing	Save water used	51	Short-term individual actions

Domain	Action	Carbon footprint reduction (>10 $kgCO_2e$/cap/yr)	Time-scale strategy
Food	Reduction of dairy products (milk)	46	Short-term individual actions
Mobility	Private travelling by sky train or subway (car free)	36	Long-term system actions
Goods	3Rs and zero waste pattern	28	Mid-term system actions
Food	Pesco-vegetarian	25	Short-term individual actions
Services	Take good care of health	23	Short-term individual actions
Mobility	Private traveling by bus (car free)	21	Short-term individual actions
Mobility	Eco-driving	17	Short-term individual actions
Mobility	Reduction of domestic flights	16	Mid-term system actions
Food	Reduction of sweets and soft drinks	14	Short-term individual actions
Mobility	Ride-sharing	12	Mid-term system actions

Note: Short-term individual actions can be implemented. Mid-term system actions can be carried out after some supportive conditions are in place, probably within 1-5 years. Long-term system actions require systematic change and are often connected to regulation, perhaps taking more than 5 years.

6. RECOMMENDATIONS TO STAKEHOLDERS

The recommendations aim to guide parties in implementing policies that promote low-carbon lifestyles in Nonthaburi, and are divided into four sections: (i) cooperative strategies (ii) main sectoral strategies, (iii) stakeholder roles, and (iv) themes and choices for implementation.

6.1 Cooperative Strategies

The Guidelines for Nonthaburi Greenhouse Gas Inventories and Mitigation Plan (2018) lists 23 measures to reduce the carbon footprint. While their measures focus on the commercial and government sectors, there are some overlapping options that relate to future lifestyle carbon footprint reductions. If the same strategies are applied at the household level and in the commercial and government sectors, the magnitude of carbon emissions reduction will rapidly increase. The overlapping measures, for example, include development of an urban public transportation network, improvement of non-motorized transport, use of LED lighting applications, and smart use of electrical home appliances.

6.2 Main Sectoral Strategies

The key question is based on the transformative learning module: How can we envisage and provide mechanisms and tools that country/city/key agencies/local government/ communities can apply through various levels of policy to create the future we want? Sectoral areas and recommendations are summarised in Table 4.

Table 4 Main sectoral strategies and feasible recommendations

Sectoral areas	Recommendations
International commitment	• Low-carbon society policy and strategy must be made in public outreach campaigns. • Education must be infused with a low-carbon society ideology across all grade levels and disciplines.

Sectoral areas	Recommendations
National level	• Establish a permanent committee on climate impacts and environmental sustainability to develop, monitor, and implement policy recommendations related to human-environment relations. • Develop national policies in conjunction with local communities, to ensure strong local support for their implementation.
Culture and environmental behaviour	• Support social and political sustainable values and 'national identity'.
Market mechanisms	• Establish fiscal incentives to encourage investments in low-carbon technologies. • Endeavor and mobilize the private sector in moving to green and clean businesses.

6.3 Recommendations to Stakeholders

From the carbon footprint baseline and household experiment, we realize that Nonthaburi Province has a positive view of the 1.5℃ carbon mitigation target over the next 10 years. The future of this city is in the hands of multiple stakeholders, and Table 5 illustrates how key players can play key roles to offset emissions.

Table 5 Assumed roles of stakeholders and corresponding low-carbon options

Recommendations to Stakeholders	Expected impacts
Municipalities and local governments should recognize that transport infrastructure reflects individual well-being and economic growth. They should focus on a holistic approach to improve transport infrastructure and make it happen from planning and design, to incentives.	More households will change lifestyle patterns from private mobility to public transportation. With infrastructure to support public transportation, low carbon mobility has high potential in reducing lifestyle carbon footprint.
Private sectors should make advancements in logistics and technology.	The intensity of the carbon footprint in the supply chain will be reduced.
Academia and technical experts should advocate and conduct in-depth research on sustainable lifestyles.	More informative academic studies on sustainable lifestyles are needed by bridging the scientific results and local practice is also encouraged across levels.
Local communities should help spread the values and practices of sustainable lifestyles.	Individuals will be educated and encouraged to be role models for each other. They will take informed actions to choose lifestyle options with maximum carbon footprint reduction potential.
Youth should be aware of and take action to lead society towards a stronger low-carbon movement.	The younger generation can incorporate at least five low-carbon lifestyle options into their daily activities. In addition, they can inspire their family members and neighbours.
Media should prioritize sustainable development as a vital issue. They should also help address challenges and recommendations that can inspire stakeholders to work more cohesively.	Media will be an effective platform in promoting sustainable lifestyles. They can promote touching stories that engage and connect with people's lives to values and practices of low-carbon activities.

Recommendations to Stakeholders	Expected impacts
All sectors can consider work from home/anywhere as a means of reducing the mobility carbon footprint.	• A work from home or work from anywhere policy can foster reduction of emissions from work- related transportation. • A mix of on-site and remote work, based on whichever is most suitable for a particular job shall be considered. Private sector can seize the opportunity to invest in better internet connections. • However, this needs further evaluation when effective public transport is available and people will use fewer private cars.

6.4 Supporting measures for 1.5°C Lifestyles

According to the workshop discussion, themes and its related supporting measures for 1.5°C Lifestyles are listed in Table 6.

Table 6 Supporting measures for 1.5°C Lifestyles

Themes	Supporting measures for 1.5°C Lifestyles
Education	• Build capacity of governmental and non-governmental institutions at various levels to identify, prepare and implement relevant cross-sectoral educational programmes for addressing the challenges of climate change. • Develop and implement educational programmes that target local governments / municipal authorities as well as specific groups, such as women, children and youth. • Promote informal, formal and non-formal education through, inter alia, school environment/climate clubs and other community clubs to educate families on various aspects of climate change, including appropriate adaptation and mitigation actions, and sustainable consumption and lifestyle patterns. • Collect, disseminate, and utilize indigenous knowledge and good practices to promote sustainable lifestyles. • Identify and address education needs and priorities continuously through a country-driven participatory approach.
Training	• Develop and implement 'train the trainer' environmental programmes for different target agencies and audiences. • Develop and implement training programmes for mass media/reporters to enable them to effectively communicate a message on climate change and its adverse effects. • Support specific training programmes related to country and local needs and priorities, including those emerging from deliberations under the Climate Convention.
Public awarenePublic participation	• Develop mass communication strategies or strengthen agencies, where they already exist, focusing on media that reach the widest possible audience. • Promote innovative approaches to spread climate awareness at national and community levels. • Implement pilot activities that promote public awareness and foster adoption of good practices. • Mainstream climate change issues in environmental awareness-raising campaigns.

Themes	Supporting measures for 1.5°C Lifestyles
Public participation	• Encourage local government and municipal authorities to engage local communities and NGOs in decision-making processes. • Carry out public consultations before developing local projects and programmes related to sustainable lifestyles plans and Climate Convention policy.
Public access to information	• Promote public access to mass media, such as print, audio and visual media, to the extent possible. • Develop reader-friendly information materials on climate change in local languages. • Ensure that non-classified information related to climate change is readily available to all stakeholders through various means of communication.

7. CONCLUSIONS

Key findings of this scenario indicate that after the adoption of identified low-carbon lifestyle options, the average carbon footprint of Nonthaburi's citizens can be reduced from 3.15t-CO_2e/capita/year to 2.5 t-CO_2e/capita/year in 2030 (-23%) based on a flat adoption rate of 41% for 40 lifestyle carbon footprint reduction options, assuming no changes in renewable energy share and no environmental efficiency improvement. There are existing initiatives in Nonthaburi and Thailand to increase renewable energy share, to improve environmental efficiency, and to promote the digital transformation, artificial intelligence, autonomous and shared mobility, reduction in material consumption, all of which are expected to contribute to reducing the carbon footprint and narrowing the gap to be filled by households to achieve the 1.5°C Lifestyles target of 2.5 t-CO_2e/capita/year by 2030.

In conclusion, this scenario envisions Nonthaburi in 2030 with the implementation of 1.5°C Lifestyles, where households will adopt various lifestyle change options through collaborative efforts by all key stakeholders, such as national and local governments, the business sector and local communities. A wide range of stakeholders must share the responsibilities and expected roles in achieving a net-zero carbon society whilst also having good quality of life. This scenario provides a roadmap for the co-creation of a desired decarbonised and sustainable future by diverse stakeholders. In this context, the importance of households becomes clearer: not only do they implement lifestyle change options but they can also send a message to governments and businesses calling on them to provide supporting measures that in turn provide the enabling conditions for stakeholders to take action. This will open the window for discussions on the co-creation of 1.5°C Lifestyles beyond the boundaries of government, business and citizens. Consumer practices, markets, services, technology and social rules need to be interdependent, and must co-evolve. Consumer behaviour change requires three aligned factors: motivation and intention, ability, and opportunity. If consumers are to overcome obstacles and smoothly transition to 1.5°C Lifestyles, then stakeholders must collaborate. Key stakeholders (national and local governments, producers and businesses, citizens and Civil Society Organisations) need to play their part and work together on co-creation. In particular, governments should review existing regulations, start indicative planning and transition management to overcome lock-ins, and stimulate a sustainability focus for long-term change. Governments must also provide infrastructure for sustainable choice, and motivate citizens and business sectors to take action, as well as provide feedback. The business sector should offer innovative products and services, and come up with related new business models. Citizens should exercise sustainable choice, and work with governments and businesses to develop goods and services (e.g. Living Lab). Communities, workplaces and schools can carry out short-term, grass-root initiatives and dissemination actions.

8. REFERENCES

Boitier, B. (2012) 'CO 2 emissions production-based accounting vs consumption: Insights from the WIOD databases', in *WIOD*. Available at: http://www.wiod.org/conferences/groningen/paper_Boitier.pdf (Accessed: 28 September 2021).

Institute for Global Environmental Strategies, Aalto University and D-mat Ltd (2019) *1.5-Degree Lifestyles: Targets and Options for Reducing Lifestyle Carbon Footprints. Technical Report, Institute for Global Environmental Strategies, Hayama, Japan.* Available at: https://www.iges.or.jp/jp/pub/15-degrees-lifestyles-2019/en (Accessed: 28 September 2021).

Koide, R., Kojima, S., Nansai, K., Lettenmeier, M., Asakawa, K., Liu, C. and Murakami, S., 2021. Exploring carbon footprint reduction pathways through urban lifestyle changes: a practical approach applied to Japanese cities. *Environmental Research Letters, 16*(8), p.084001.

Moore, J. L. (2013). *Getting serious about sustainability: exploring the potential for one-planet living in Vancouver.* University of British Columbia. Doi: 10.14288/1.0074187.

National Statistical Office. (2019). *The 2019 Household Socio-Economic Survey* (p. 108). Ministry of Digital Economy and Society.

Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2013). 'Urban Transition Labs: Co-creating transformative action for sustainable cities'. *Journal of Cleaner Production, 50,* 111–122. https://doi.org/10.1016/j.jclepro.2012.12.001

Nonthaburi Governor Office. (2018). *Nonthaburi 5-year Development Plan: 2015-2022.* Nonthaburi Governor Office. http://nonthaburi.go.th/วิสัยทัศน์

Nonthaburi Provincial Statistical Office. (2020). *Nonthaburi Provincial Statistical Report: 2020.* National Statistical Office. http://nontburi.nso.go.th/images/report_2020-v1-min.pdf

Office of the Database and Social Indicators Development. (2018). *Thailand's Poverty and Inequality Analysis:* (p. 92). Office of the National Economic and Social Development Council. https://www.nesdc.go.th/ewt_w3c/ewt_dl_link.php?filename=social&nid=10855

Peters, G. P. and Hertwich, E. G. (2007). 'Post-Kyoto greenhouse gas inventories: production versus consumption', *Climatic Change 2007* 86:1. Springer, 86(1), pp. 51–66. doi: 10.1007/S10584-007-9280-1.

Provincial Labour Office Nonthaburi. (2019). *Nonthaburi's Annual Economic and Labour Situation Report: 2019* (p. 55). Ministry of Labour. https://nonthaburi.mol.go.th/wp-content/uploads/sites/41/2020/02/เนื้อหา-ปี-2562-140263.pdf

Säve-Söderbergh, M., Toljander, J., Mattisson, I., Åkesson, A., & Simonsson, M. (2018). 'Drinking water consumption patterns among adults—SMS as a novel tool for collection of repeated self-reported water consumption'. *Journal of Exposure Science & Environmental Epidemiology, 28*(2), 131–139. https://doi.org/10.1038/jes.2017.8

Sawangjang, B., Hashimoto, T., Wongrueng, A., Wattanachira, S., & Takizawa, S. (2019). 'Assessment of fluoride intake from groundwater and intake reduction from delivering bottled water in Chiang Mai Province, Thailand'. *Heliyon, 5*(9), e02391. https://doi.org/10.1016/j.heliyon.2019.e02391

Schwartz P. (1991). *The art of the long view* (1st ed.). Doubleday Currency.

Thai Greenhouse Gas Organization. (2018). *Guidelines Development for Urban Cities Greenhouse Gas Inventories and Mitigation Plan: A case study in Nonthaburi Province* (p. 10). Thai Greenhouse Organization. http://conference.tgo.or.th/download/tgo_or_th/Article/2018/Article_scale-up_Nonthaburi.pdf

The Office of Natural Resources and Environmental Policy and Planning. (2015). *Climate Change Master Plan 2015-2050.* Ministry of Natural Resources and Environment. https://climate.onep.go.th/wp-content/uploads/2019/07/CCMP_english.pdf

Transport Statistics Group. (2018). *Number of Registered vehicles in Nonthaburi* [Government]. https://web.dlt.go.th/statistics/

Trencher, G., Nagao, M., Chen, C., Ichiki, K., Sadayoshi, T., Kinai, M., Kamitani, M., Nakamura, S., Yamauchi, A., Yarime, M., Aquilani, B., & Rosen, M. (2017). 'Implementing sustainability co-creation between universities and society: A typology-based understanding'. *Sustainability, 2017.* https://doi.org/10.3390/su9040594

Voros, J. (2001). 'A primer on future studies foresight and the use of scenarios'. Prospect: The Foresight Bulletin, 6(1).

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