The forecast scenarios for the transformation of Thailand's environmental smart city into a carbon neutral city

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Abstract

Carbon emissions reduction study is currently ongoing, which the government has begun to focus on, and the government has committed to the world community to decrease carbon emissions to be carbon neutral by 2050 and net zero by 2065. Therefore, this article studies the prediction scenario of creating an environmental smart city into a carbon neutral city in Thailand. The objective is to examine environmental smart city development predictions to carbon neutral cities by modeling carbon neutral urbanization projections in four scenarios separated into three sectors: the home sector, the industrial sector, and the transportation sector. The four scenarios are as follow. 1: There is no support from the government. As a result, it is unable to exceed the government's emissions targets. Thus, enormous quantities of carbon credits must be acquired to offset greenhouse gas emissions. Scenario 2: There is a consensual campaign to reduce carbon dioxide emissions. As a result, the operation will be a non-investment measure that requires the purchase of a huge amount of carbon credits to offset greenhouse gas emissions. Scenario 3: The government sector has a strategy that helps, resulting in better interdependence in various areas. There are several programs underway to mitigate carbon dioxide emissions and reduce carbon expenditures. Scenario 4: The government's declaration of mandatory rules has resulted in concrete action, and there are more schemes to compensate greenhouse gas emissions. Long term plans encompass both public and private carbon credit trading. The recommendations for the development of smart cities about being carbon neutral cities are comprised of four major aspects based on the results of the four scenarios: 1) technology selection for renewable energy 2) improvement of efficiency and energy conservation 3) waste management, and 4) a scheme to reduce greenhouse gas emissions.

Keywords: scenario, environment, smart city, carbon neutral

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Introduction

To achieve net zero emissions, we must counterbalance what we release into the atmosphere with what we remove. To avoid the worst effects of climate change, 197 countries committed in 2015 to keep temperature rises "well below" 1.5°C. The Intergovernmental Panel on Climate Change (IPCC) found in its report of 2018 that "global net human-caused emissions of carbon dioxide would need to fall by about 45% from 2010 levels by 2030, reaching net zero around 2050. This means that any remaining emissions from human activity that cannot be reduced must be compensated by removing CO_2 from the atmosphere (IPCC, 2020). Thailand's Prime Minister Prayut Chan-o-cha attended the 26th United Nations Climate Change Conference (COP26) earlier this month in Glasgow. Prayut stated at the World Leaders Summit that climate change is a "matter of life and death," and Thailand is determined to achieve a net-zero emissions target by 2065. (Fu-Chun, 2021)

The consequences of climate change are becoming more noticeable in Thailand. Last year, the kingdom underwent its worst drought in four decades, and its northern capital Chiang Mai was dubbed the "most polluted city in the world" for several days in a row due to rising smog thresholds. Bangkok, in particular, is extremely vulnerable to rising sea levels. Riverside districts in Bangkok are being overwhelmed by swelling seas, and a gloomy prediction implies that all of Bangkok could be underwater by 2050 (UN Global Compact, 2021) The Thailand Development Research Institute (TDRI) forecasts that increased operating costs and trade restrictions triggered by climate change might ultimately amount to a 43.6 percent decline in gross domestic product (GDP). Green technology adoption and cross-governmental collaboration are thus required. Thailand has long demonstrated a commitment to addressing climate change by ratifying the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement. Last year, the country enacted an exclusive climate law, and there has been a growing trend toward greater use of electric vehicles and renewable energy sources. The concept of "smart cities" has become a fixture of forward-thinking media coverage and is gaining traction, with many cities around the world initiating smart city projects. Smart cities are constructed based on technology. In practice, this means that information and communication technology (ICT) devices such as the Internet of Things (IoT) are deployed to collect data, which is then used to optimize and improve assets and services, as well as manage resources such as urban transportation, utilities, crime detection, and community services (Das, 2019).

Carbon neutrality, as well commonly known as net zero carbon, alludes to striking a balance between the amount of carbon emitted into the atmosphere and the amount of carbon removed from it. If the world is to achieve net zero emissions by 2050, our cities, the very heart of global economies, will need to proactively transform themselves into low carbon or even zero carbon cities. As a result, the researcher is interested in conducting a research study in Thailand on the topic of the projected scenario for Thailand's environmental smart city's transformation into a carbon neutral city, with the goals of forecasting development and proposing solutions for environmental smart cities to become carbon neutral cities.

Objective

1. To study the forecast of environmental smart city development to become a carbon neutral city.

2. To propose a solution that transforms an environmental smart city into a carbon neutral city.

Literature review

Smart city: Environment

Environmental change is increasingly harming cities and their populations. This presents new issues for city planners, such as the need to enhance air and water quality, as well as reduce noise pollution, to maintain a healthy and enjoyable environment for city dwellers. Furthermore, the effects of extreme weather on a city, such as flooding produced by typhoons or heavy snowfalls, must be effectively handled to avoid negative consequences for a city's residents and companies (GSMA, 2022).

Carbon neutral

Thailand Carbon Neutrality Target: On 4 August 2021, the meeting of the National Energy Policy Council No. 2/2564 chaired by the Prime Minister tapped the framework of the "National Energy Plan" to focus on Carbon Neutrality by 2065-2070, highlighting that the government's energy preparation for today and the future in (Figure 1) (TGO, 2021).

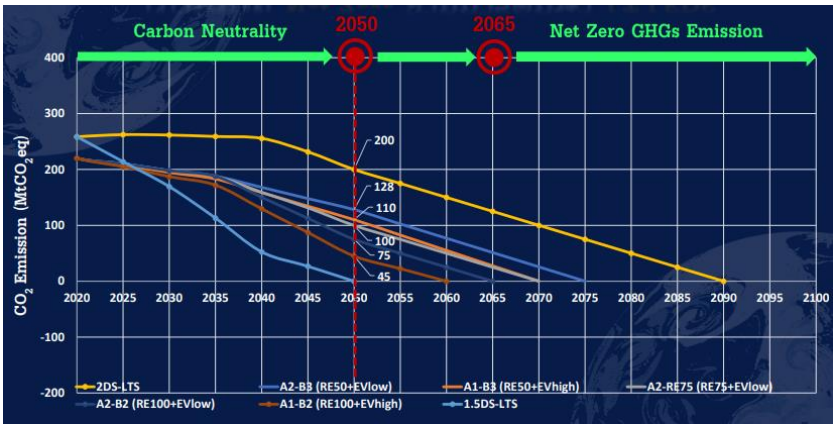

Figure 1 Thailand carbon neutrality Target. Source: TGO (2021)

To promote investment in green energy of the energy sector as follows: (IEA, 2022)

1. Raise the proportion of renewable energy in new electricity generation to at least 50%, considering the cost of long-term energy storage systems.

2. Change the transportation sector's use of green electricity with Electric Vehicle (EV) technology in compliance with policy to increase the ability to reduce greenhouse gas emissions and solve the PM 2.5 weather problem.

3. Improve energy efficiency by more than 30% using cutting-edge energy management technologies and innovations.

4. Restructuring the energy industry to support energy transition trends such as decarbonization, digitization, decentralization, deregulation, and electrification in compliance with the 4D1E guidelines.

Personal carbon neutrality can be a goal. Organizations or countries can achieve this by reducing and offsetting their carbon emissions to zero. Carbon or greenhouse gas emissions can be minimized by reducing or eliminating some unnecessary activities, using cleaner production and waste management technologies, or using clean energy. For example, solar or wind energy, and if there are still carbon emissions, offset or offset the remaining carbon through other decarbonizing activities such as planting forests, investing in renewable energy, or purchasing carbon credits, etc. (Tawichsri, 2021).

Energy sector in Thailand

Thailand's energy sector significantly contributes to the country's economy due to its abundant primary energy and high production capacity for final energy. The energy production facilities are also located throughout the country,

especially for natural gas, crude oil, and coal. These resources are required for generating power for the country and supplying electricity and gas to Thai households. Furthermore, as shown in (Figure 2), the GDP from electricity, gas, steam, and air conditioning in the country has been gradually increasing up until 2020 (DEDE, 2022).

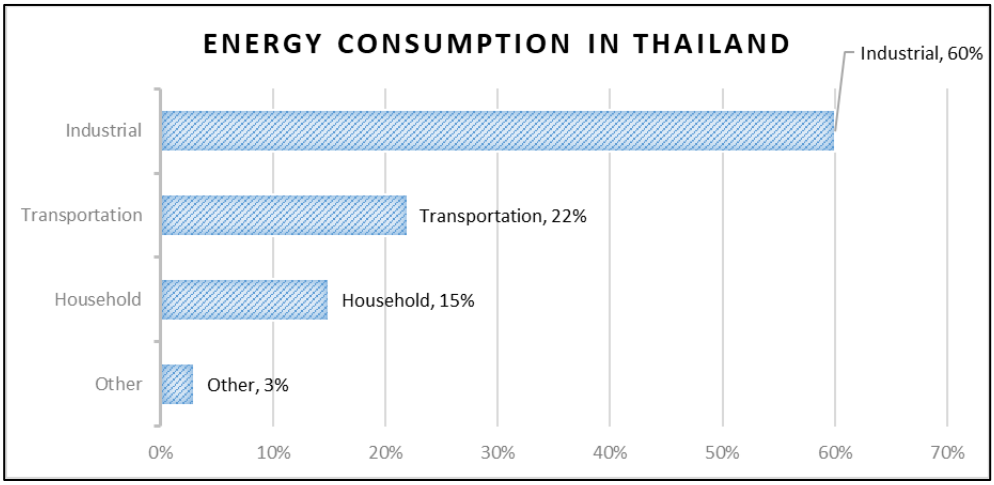

Figure 2 Energy consumption in Thailand. Source: DEDE (2022)

According to (Figure 2), Thailand's significant energy consumption is divided into three major parts

1. The industrial sector has the highest energy consumption when divided into four major categories: electrical 65%, fuel 30%, thermal 5%, and renewable 3%

2. Transportation sector divides energy usage into two main categories: Fuel 96% and Electric Vehicles 4%.

3. The household sector divides energy consumption into three main categories: Electrical 67%, Fuel 28% and Renewable 5%.

Carbon emission in Thailand

The current energy consumption affects both direct and indirect carbon dioxide emissions by dividing the share of carbon dioxide emissions as shown in (Figure 3).

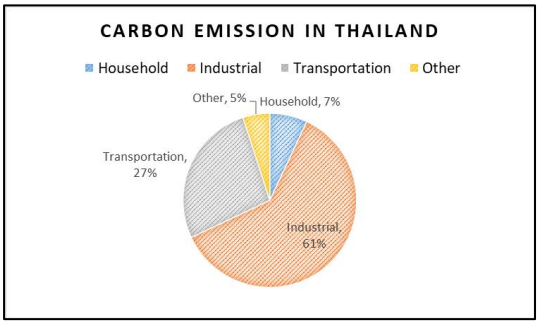

Figure 3 Carbon emission in Thailand. Source: TGO (2022)

According to (Figure 3), Thailand's significant carbon emissions are divided into three major sectors: industrial (61%), transportation (27%), and household (7%).

Assessing the potential for carbon-neutral urban development

1. The projects that can contribute to lowering carbon emissions

1.1 Increase efficiency projects such as choosing LED lamps, controlling equipment usage, selecting an inverter air conditioner system, etc.

1.2 Renewable energy projects such as installation of solar rooftop, solar farm, windmills, biomass, biogas, etc.

1.3 Waste management projects, such as waste sorting and disposal using environmentally friendly processes, etc.

1.4 Projects involving transportation management, such as trip planning, electric train travel, electric vehicle selection, etc.

2. The projects that can reduce carbon emissions (TGO, 2022)

2.1 Planting forests and green areas such as planting trees to absorb carbon dioxide, etc.

2.2 Buying and selling of carbon credits.

Forecast the situation of carbon neutral

Scenario tool analysis.

Scenario 1: The government has no support policy.

There is no environmental action in urban areas.

Scenario 2: Voluntary campaign.

There are public relations campaigns requesting cooperation in areas such as energy reduction, energy conservation, waste separation, etc.

Scenario 3: Government policy support.

Support for actions such as supporting the use of high-efficiency equipment, supporting the selection of EVs, supporting the selection of renewable energy, etc.

Scenario 4: Formulate compulsory policies.

Establish compulsory policies, such as legislation, requiring public and private organizations to reduce carbon emissions (TGO, 2022).

Results

1. Forecasting scenario

Developing an environmental smart city into a carbon neutral city can be divided into 4 scenarios.

Table 1 Scenarios for developing environmental smart city into a carbon neutral city.

sector	scenario 1 the government has no support policy	scenario 2 voluntary campaign	scenario 3 government support policies	scenario 4 formulate compulsory policies
industrial	reduce CO_2: low buy carbon credit: very high	reduce CO_2: medium buy carbon credit: medium	reduce CO_2: high buy carbon credit: low	reduce CO_2: very high buy carbon credit: No
transportation	reduce CO_2: low buy carbon credit: very high	reduce CO_2: low buy carbon credit: high	reduce CO_2: high buy carbon credit: low	reduce CO_2: very high buy carbon credit: No
household	reduce CO_2: low buy carbon credit: very high	reduce CO_2: low buy carbon credit: high	reduce CO_2: medium buy carbon credit: medium	reduce CO_2: high buy carbon credit: low

Remark: 6 level: very high, high, medium, low, very low and No (No is Not buy carbon credit because have project offset release CO_2 such as reforestation project, etc.)

According to (Table 1), the following scenarios for developing environmental smart city into a carbon neutral city can be explained as follow:

Scenario 1 The government has no support policy

Industrial: Reduce CO_2 (Low), Buy Carbon Credit (Very High)

Transportation: Reduce CO_2 (Low), Buy Carbon Credit (Very High)

Household: Reduce CO_2 (Low), Buy Carbon Credit (Very High)

Scenario 2 Voluntary campaign

Industrial: Reduce CO_2 (Medium), Buy Carbon Credit (Medium)

Transportation: Reduce CO_2 (Low), Buy Carbon Credit (High)

Household: Reduce CO_2 (Low), Buy Carbon Credit (High)

Scenario 3 Government policy support

Industrial: Reduce CO_2 (High), Buy Carbon Credit (Low)

Transportation: Reduce CO_2 (High), Buy Carbon Credit (Low)

Household: Reduce CO_2 (Medium), Buy Carbon Credit (Medium)

Scenario 4 Formulate compulsory policies

Industrial: Reduce CO_2 (Very High), Buy Carbon Credit (No)

Transportation: Reduce CO_2 (Very High), Buy Carbon Credit (No)

Household: Reduce CO_2 (High), Buy Carbon Credit (Low)

2. Carbon-neutral city initiatives

From considering the development of an environmental smart city to a carbon neutral city. The model can be designed as shown in (Figure 4).

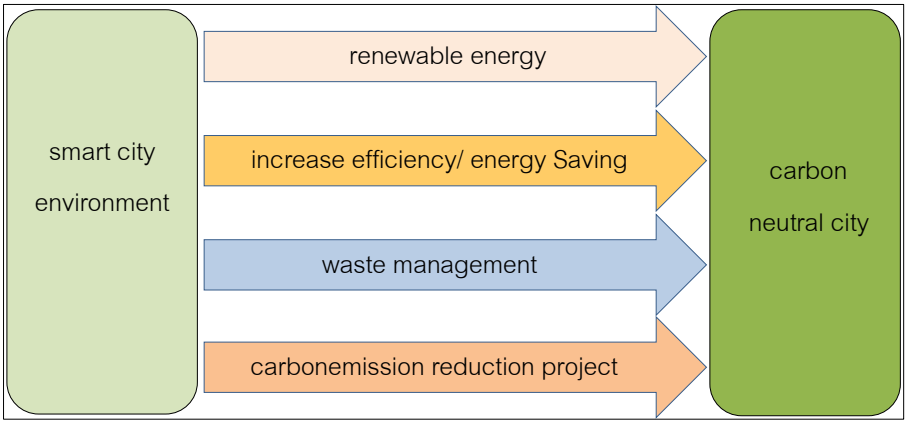

Figure 4 Carbon neutral city factor. Source: Mazzucato (2019)

According to (Figure 4), the guidelines for the development of smart cities to be carbon neutral cities are comprised of four major factors based on the results of the four scenario scenarios: 1) Selecting renewable energy technologies. 2) Improve efficiency and energy conservation. 3) waste management; and 4) a project to reduce greenhouse gas emissions.

Conclusion

There are 4 forecast scenarios for the transformation of Thailand's environmental smart city into a carbon neutral city. Scenario 1) is a non-government-supported situation. As a result, it is unable to achieve the government's emission reduction goals. As a result, large amounts of carbon credits must be purchased to compensate for greenhouse gas emissions. Scenario 2) there are voluntary campaigns to reduce carbon emissions. As a result, the operation will be a non-investment measure that will require the purchase of an enormous number of carbon credits to offset greenhouse gas emissions. Scenario 3) the government sector has a policy to support, resulting in increased cooperation in many sectors. There are various projects underway to offset carbon emissions and reduce the purchase of carbon credits. Lastly, Scenario

4) is the situation of the government's announcement of compulsory laws.

Suggestion

Suggestions in this research

1. The data can be used to develop a smart city to become a carbon neutral city.

2. Four scenarios can be used to assess the development of a carbon neutral city.

Suggestions for the next research

1. The study of leading to zero-emission urbanization should be added.

2. This research was conducted to analyze the 3 sectors without considering the sub-proportions. Other sectors should also be considered.

3. The dataset used in the analysis was data from TGO as the primary data. Secondary data should be used for higher analysis.

References

Das, D. (2019). *Smart city*. Retrieved 19 June 2021, from https://www.researchgate.net/profile/Diganta-Das/publication/332425909_Smart_City/links/5ce7a726299bf14d95b536df/Smart-City.pdf

DEDE. (2022). *Energy consumption in Thailand*. Retrieved 13 June 2021, from https://weben.dede.go.th/webmax/content/dede-says-overall-alternative-energy-usage-reaches-11

Fu-Chun, M. C. F. (2021). Accelerating towards net zero emissions: the most important global health intervention. *The Lancet Planetary Health, 5*(2), e64-e65.

GSMA. (2022). *Smart city: Environment*. Retrieved 10 June 2021, from https://www.gsma.com/iot/smart-cities-resources/smart-cities-environment/

IEA (2022). *World energy investment 2022*. Retrieved 22 January 2023, from https://iea.blob.core.windows.net/assets/b0beda65-8a1d-46ae-87a2-f95947ec2714/WorldEnergyInvestment2022.pdf

IPCC. (2020). *Global timeline to reach net-zero emission*. Retrieved 19 June 2021, from https://www.undp.org/turkiye/news/climate-change-widespread-rapid-and-intensifying-ipcc?c_src=CENTRAL&c_src2=GSR

Mazzucato, M., McPherson, M., & Hill, D. (2019). *A mission-oriented approach to clean growth*. Retrieved 29 January 2023, from https://www.researchgate.net/figure/Mission-Roadmap-for-100-Carbon-Neutral-Cities-By-2030-designed-for-the-European_fig1_353466785/download

Tawichsri, T. (2021). *Carbon neutrality*. Retrieved 4 March 2021, from https://www.pier.or.th/blog/2022/0301/

TGO. (2021). *Carbon emission in Thailand*. Retrieved 11 June 2021, from http://thaicarbonlabel.tgo.or.th/index.php?lang=EN&mod=YjNKbllXNXBlbUYwYVc5dVgybHo

UN Global Compact. (2021). *Thailand's long-term greenhouse gas emission development strategy*. Retrieved 14 June 2021, from https://globalcompact-th.com/news/detail/602