



Can
**CONGESTION
CHARGING**
help
solve traffic
&
air quality
problems
in *Bangkok*



EXECUTIVE SUMMARY

Bangkok is a vibrant city that has grown immensely in the past several decades. As one of the economic and cultural hubs in Southeast Asia with more than 10 million people and a growing middle class, Bangkok faces a lot of mobility challenges.

Already, Bangkok City has one of the largest car ownerships per capita in the world. This continuous increase in car traffic leads to several problems. Examples of such problems include, barriers to traffic flow as well as negative effects on public health and social benefits. Investing in more car infrastructure is likely to worsen this issue, thus it is worth looking at other measures. One of these measures is congestion charging, which can benefit other modes of transport, such as walking, cycling and public transport.

The method of congestion charging has helped several other cities worldwide, e.g., London, Singapore and Stockholm. Social benefits vary from 16-150 million US dollars per year and despite large resistance on forehand, public acceptance grew rapidly after introduction. Above that, car traffic reduced dramatically, and travel times reduced with up to 33%. Also, emissions of CO₂, NO_x and PM_{2.5} dropped significantly.

This study explores the possibilities of several congestion charging policies and zones in Bangkok. The seven different scenarios vary in size, location and level of charging. First, four scenarios in the centre of Bangkok were proposed for a steering committee and working group. After several consultation rounds, three more scenarios with political objectives (congestion, emission, equity and access to public transportation) were added.

The effect of each zone were calculated with prices of 50, 80 and 120 baht. A traffic modal calculated effects on gross revenue, CO₂ and PM emissions, consumer surplus, speed, transportation use and equity factor.

The results were promising, but further research to calculate the social benefits more accurate, as well as political and public acceptance is recommended. Also, the transportation model needs to be improved to give an in-depth insight in the effects of congestion charging.

With the introduction of congestion charging, there are several questions that need to be answered: from the way the identification of vehicles will take place, the enforce of payment and maintaining the road site equipment. These and many other institutional and legal aspects are still an open issue. Also, the role

of the public and private sector needs to be discussed further. However, it is recommended that the public sector has full control over the charging levels and the location to ensure positive societal outcomes.

To get to a sustainable framework of congestion charging, we need several professional disciplines. These include:

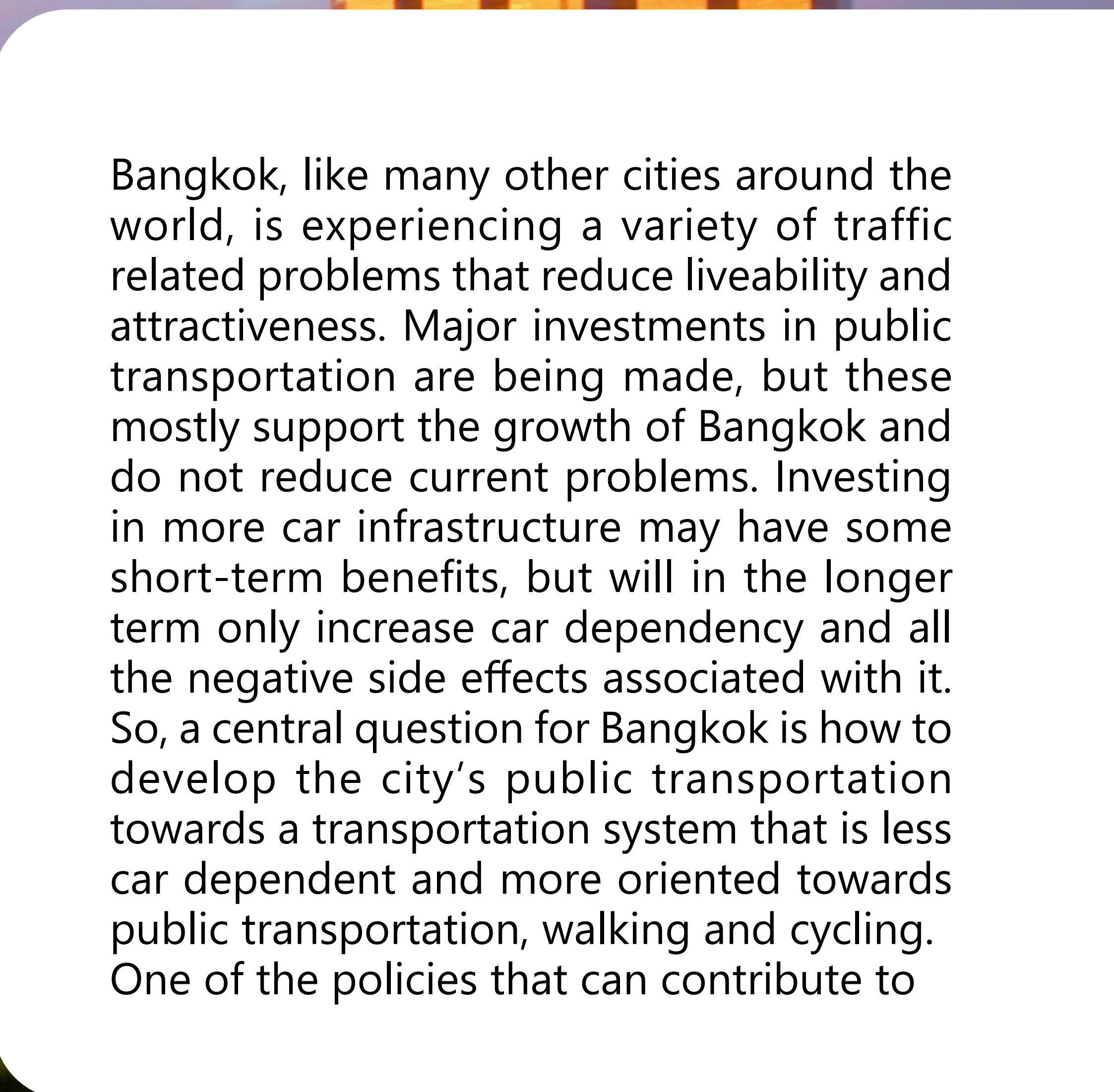
- Institutional & Legal design
- Communication strategy
- Technical design
- Functional design
- Policy development team

INTRODUCTION



Bangkok, like many other cities around the world, is experiencing a variety of traffic related problems that reduce liveability and attractiveness. Major investments in public transportation are being made, but these mostly support the growth of Bangkok and do not reduce current problems. Investing in more car infrastructure may have some short-term benefits, but will in the longer term only increase car dependency and all the negative side effects associated with it. So, a central question for Bangkok is how to develop the city's public transportation towards a transportation system that is less car dependent and more oriented towards public transportation, walking and cycling. One of the policies that can contribute to

a transportation system transformation towards more sustainability and a better integration with energy and emission efficient modes is congestion charging. Congestion charging introduces a charge for the use of a specific area and/or specific roads within Bangkok and by doing so demand for car trips reduces, lowering congestion (also for bus users) and emissions. It often also generates a revenue stream that can be used to invest in alternative travel options and to compensate for potential negative equity effects. Congestion charging is often regressive, when the use of revenues is not considered. However, when revenues are considered, progressive outcomes can be achieved.



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Policy design

Public outreach and communication



Congestion is a major issue in Bangkok. If the city is compared to other cities around the world, it ranks high in congestion index reports. These congestion levels have negative impacts on productivity and people's quality of life.

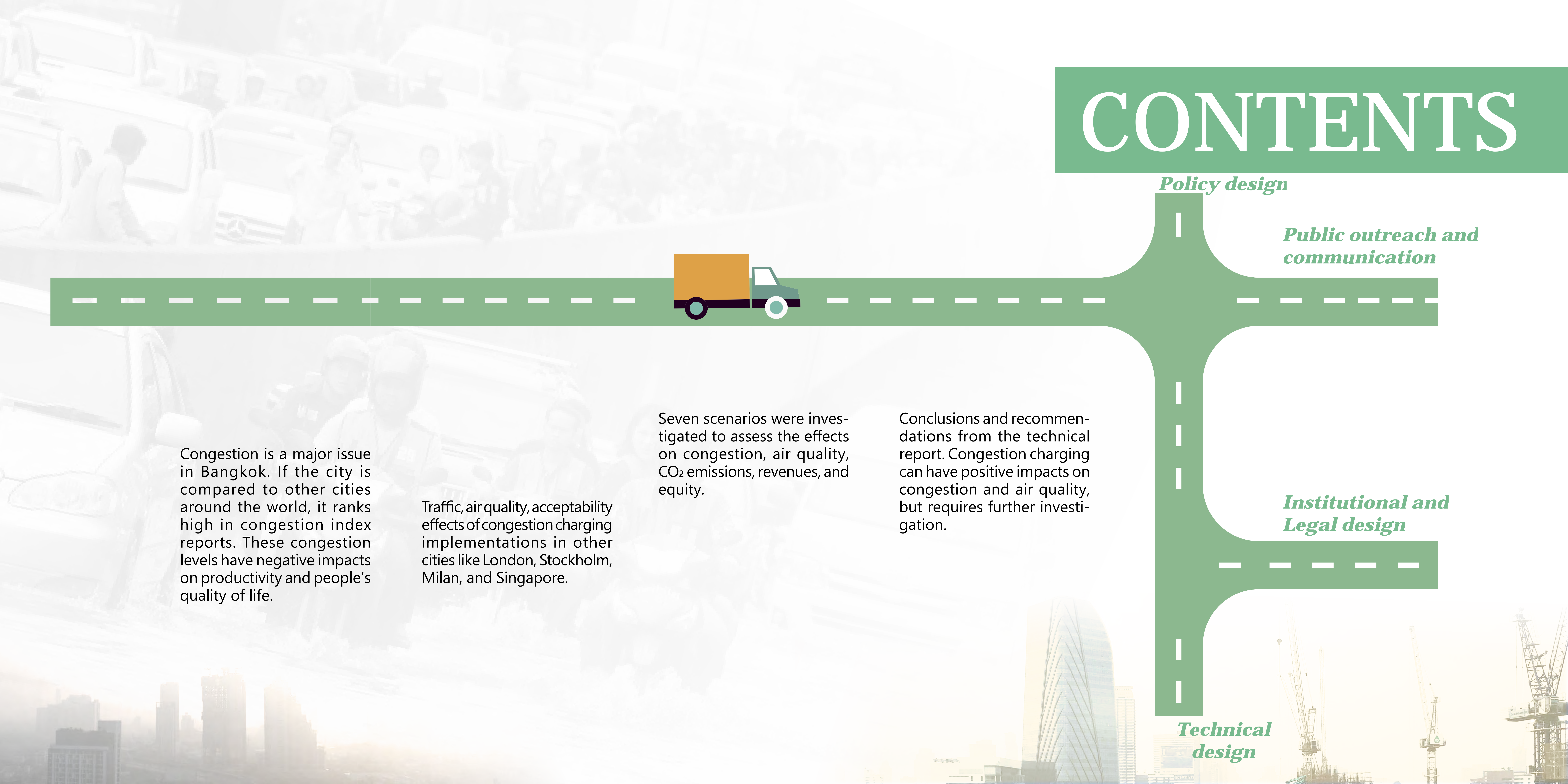
Traffic, air quality, acceptability effects of congestion charging implementations in other cities like London, Stockholm, Milan, and Singapore.

Seven scenarios were investigated to assess the effects on congestion, air quality, CO₂ emissions, revenues, and equity.

Conclusions and recommendations from the technical report. Congestion charging can have positive impacts on congestion and air quality, but requires further investigation.

Institutional and Legal design

Technical design



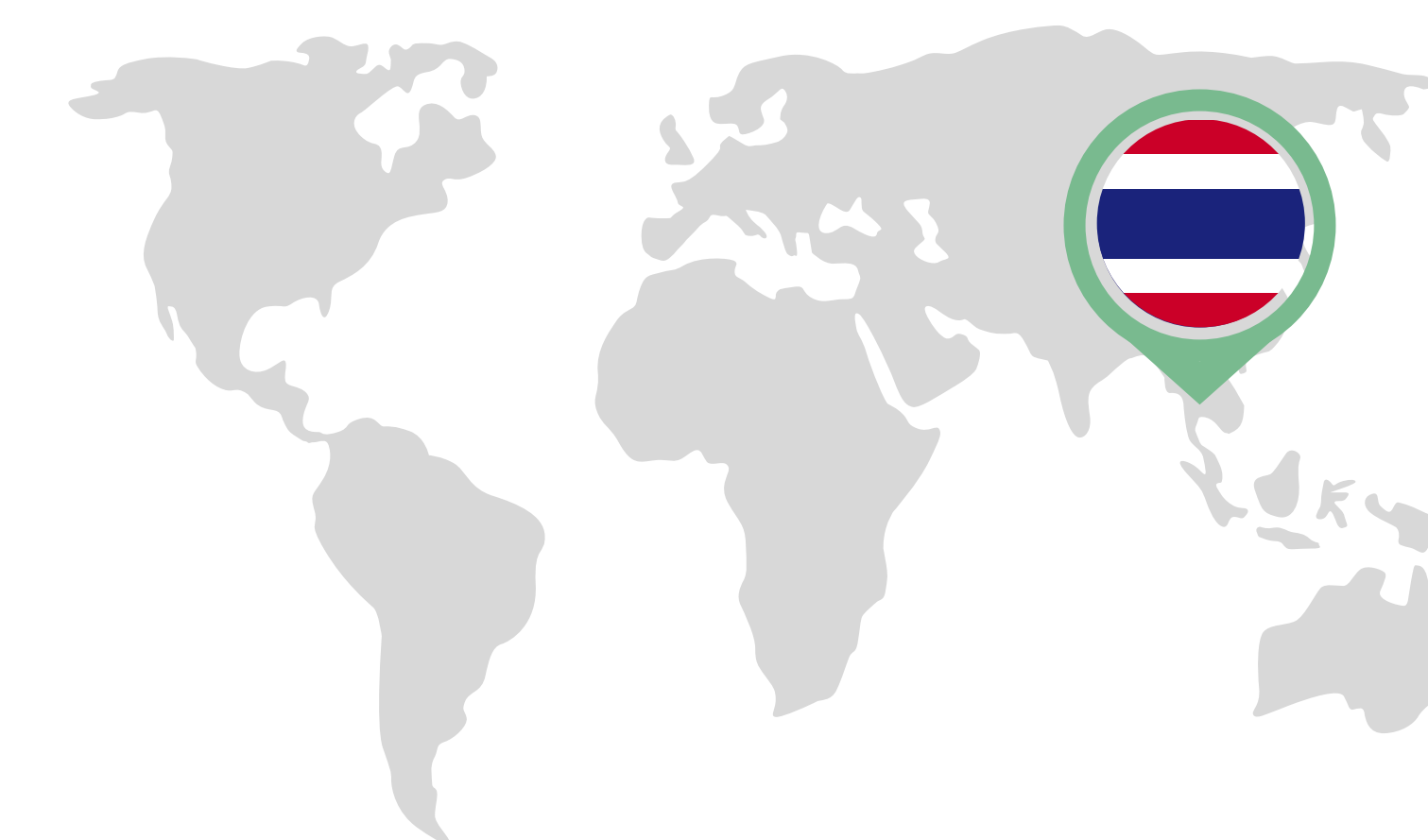
MEET BANGKOK



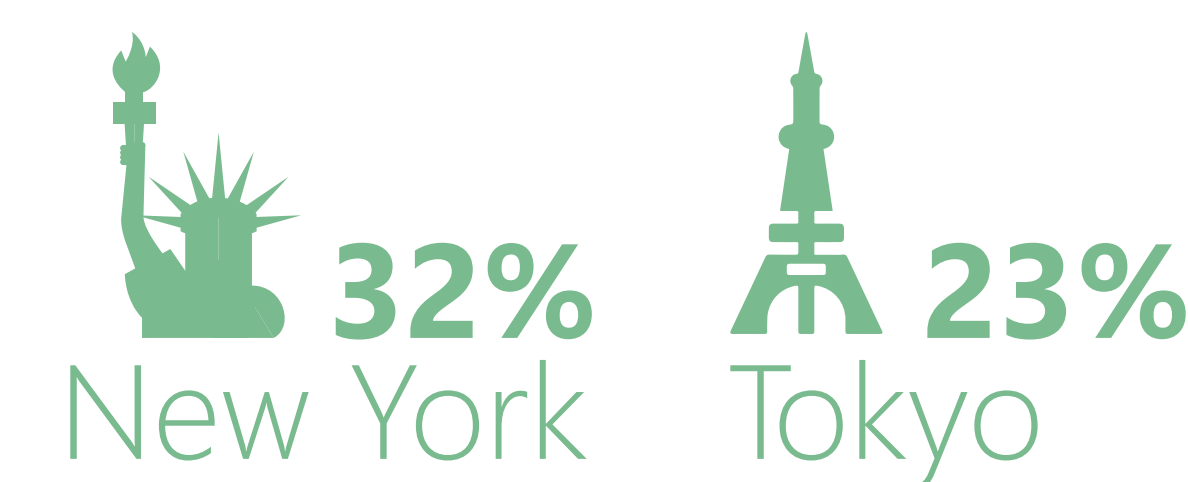
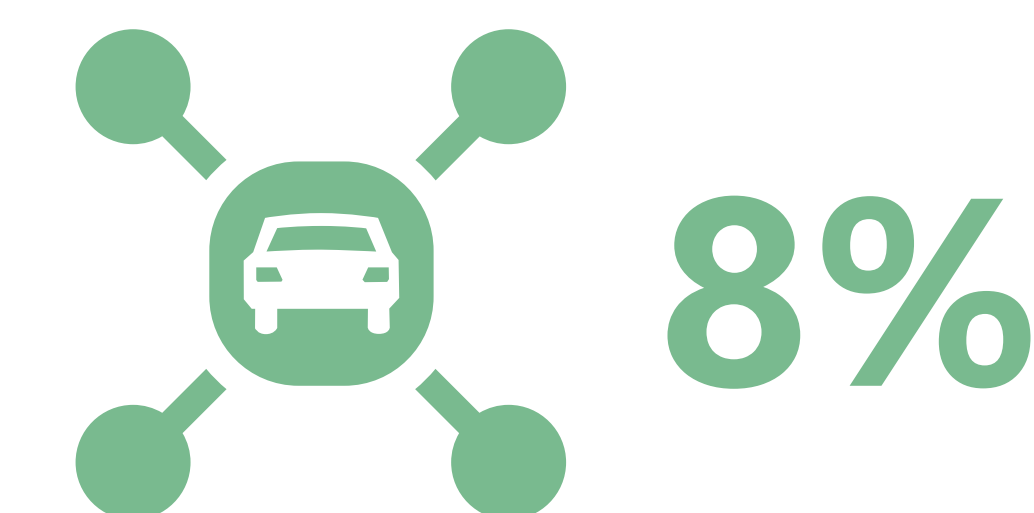
This is Bangkok, the cultural and economic centre of Thailand. Lying on the banks of the Chao Phraya River not far from the Gulf of Thailand, the city started as a small trading post in the 15th century and grew rapidly in the second half of the 20th century.

Nowadays, Bangkok is a vibrant place, home to more than 10 million people and growing. This growth comes with challenges. The public space is under pressure by more and more traffic. Emissions are a problem for the air quality. Also, inequity is a risk. If nothing is done, Bangkok will suffer severe consequences.

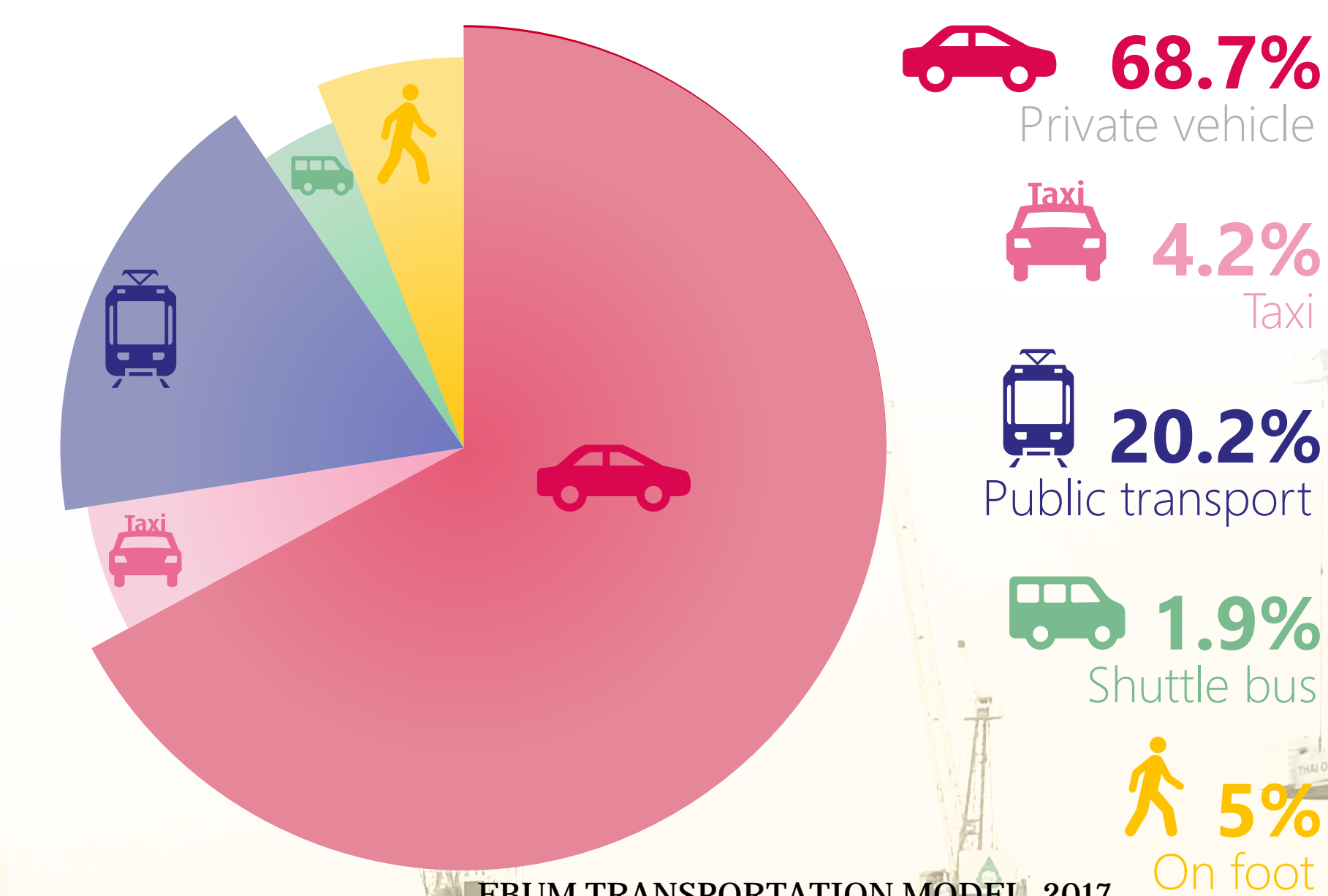
Fortunately, there are measurements that can be taken. One of these is a form of congestion charging, which still allows traffic in the city, but at a price. This system can come with various effects. How this works for Bangkok, was the subject of a study which is reported in this document.



KM OF ROAD PER 100 KM²



MODAL SHARE



POPULATION



THE WORLD FACTBOOK
CIA 2020

NUMBER OF VEHICLES



DEPARTMENT OF LAND TRANSPORT
2020

NUMBER OF PERSONAL CARS



DEPARTMENT OF LAND TRANSPORT
2020

CAR OWNERSHIP PER INHABITANT



EBUM TRANSPORTATION MODEL, 2017

AIR QUALITY

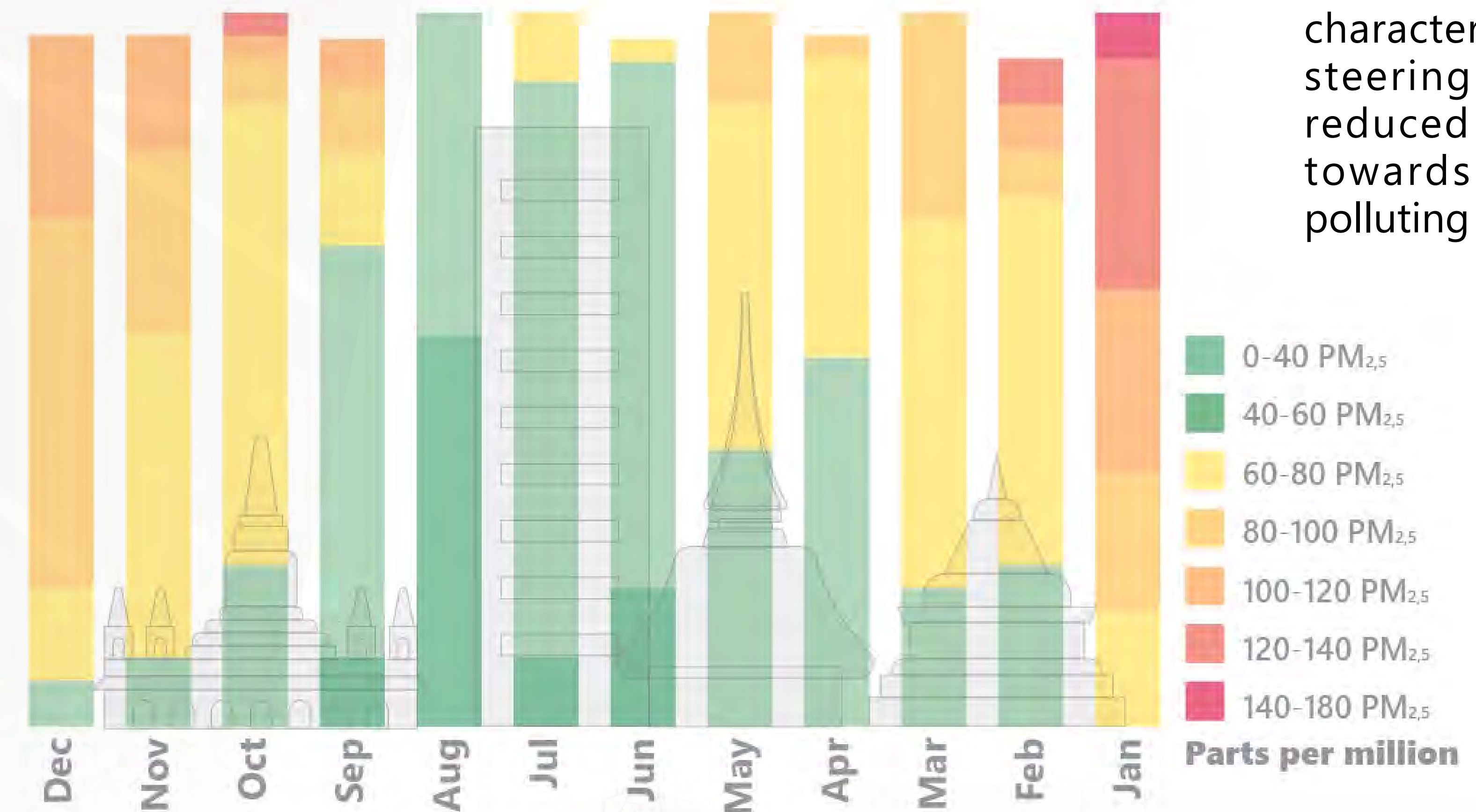
Bangkok has severe air quality problems, as the figure on the left shows. Particle Matters 2.5 (PM2.5) is one of the main pollutants. Values over 100 parts per million PM2.5 are considered unhealthy.

Road transport is an important contributor of PM2.5 emissions. 22% to 39% of the PM emissions in Bangkok go back to car travel. These high concentrations lead to a number of health issues as they affect the cardiovascular system.

The increased prevalence of respiratory symptoms among traffic police was associated with urban traffic air pollution.

Resolving these air quality problems will require a shift from car use towards an increased use of public transportation, more walking and cycling, and the use of cleaner, more emission efficient or entirely zero emission vehicles. Congestion charging can provide a push in that direction.

Daily average PM2.5 emissions - Bangkok



2016-2020 - <https://aqicn.org/city/bangkok/>

The primary effect of congestion charging on air quality is a decrease in car demand and vehicle kilometres. Charges can also be differentiated towards environmental characteristics of vehicles, steering towards both a reduced use of cars and towards the use of less polluting vehicles.

PM2.5

Dust Effects on health

39% from traffic

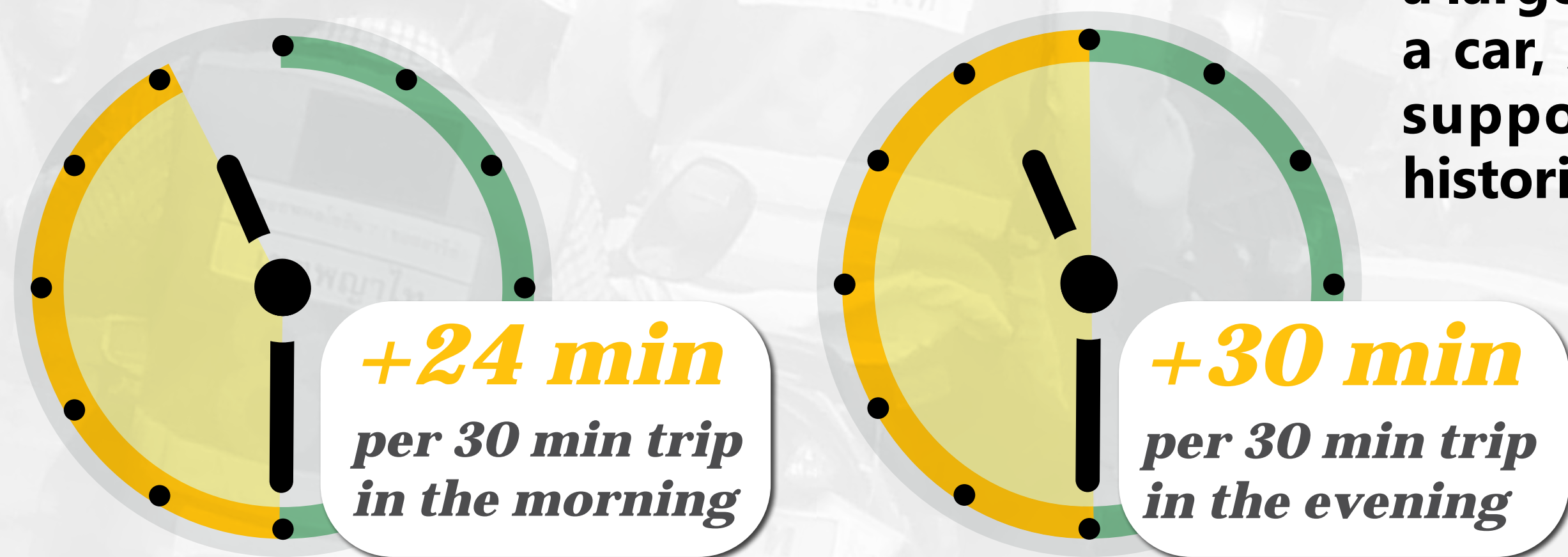


TRAFFIC PROBLEMS

Traffic is a major issue in Bangkok. If the city is compared to other cities around the world, it ranks high in congestion index reports. These congestion levels have negative impacts on productivity and people's quality of life.

TomTom reports that each 30-minute trip in the morning peak takes 24 minutes extra. In the afternoon peak, the situation is even worse. A 30-minute trip is doubled to 60 minutes due

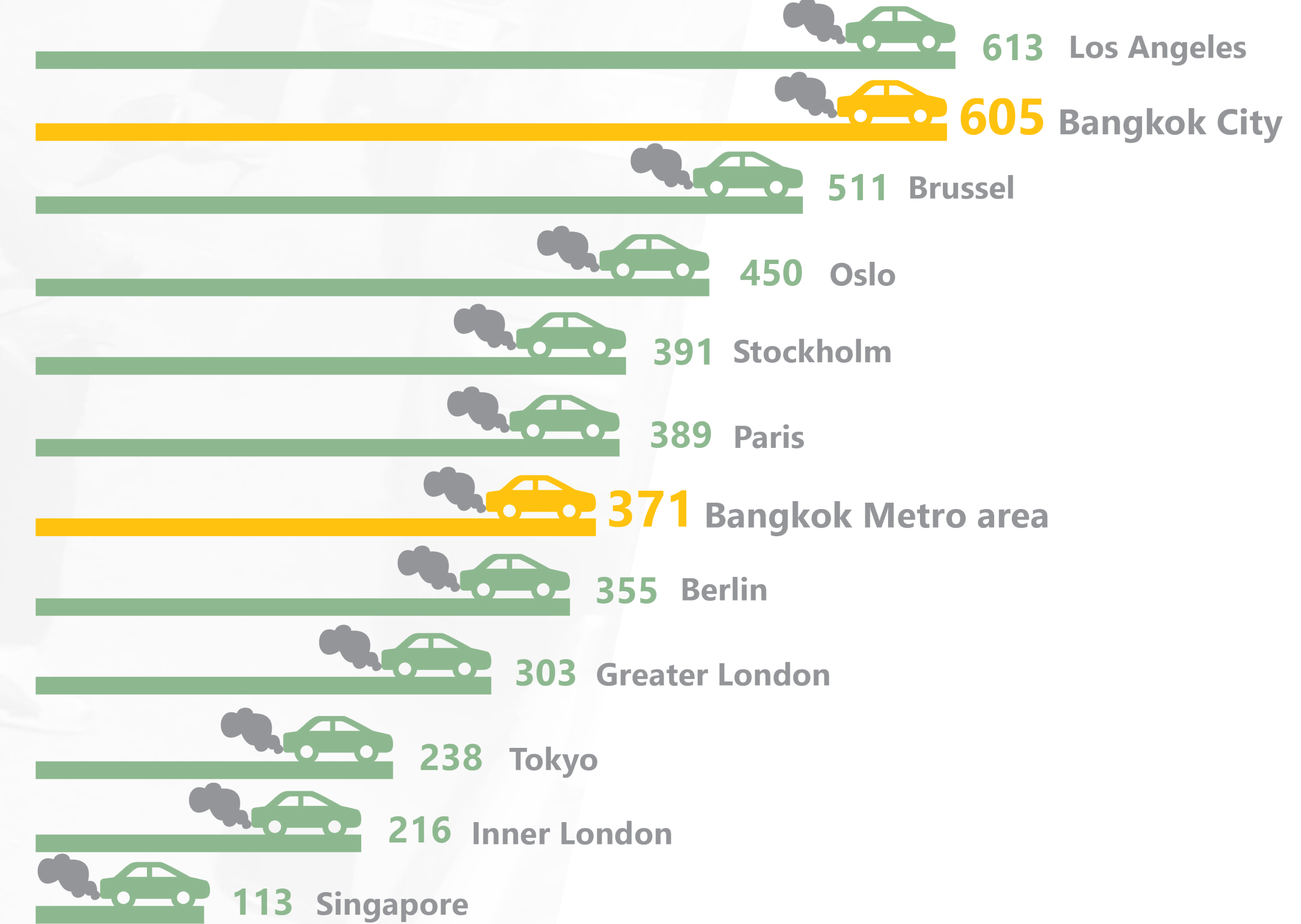
Time lost in rush hour - PER TRIP



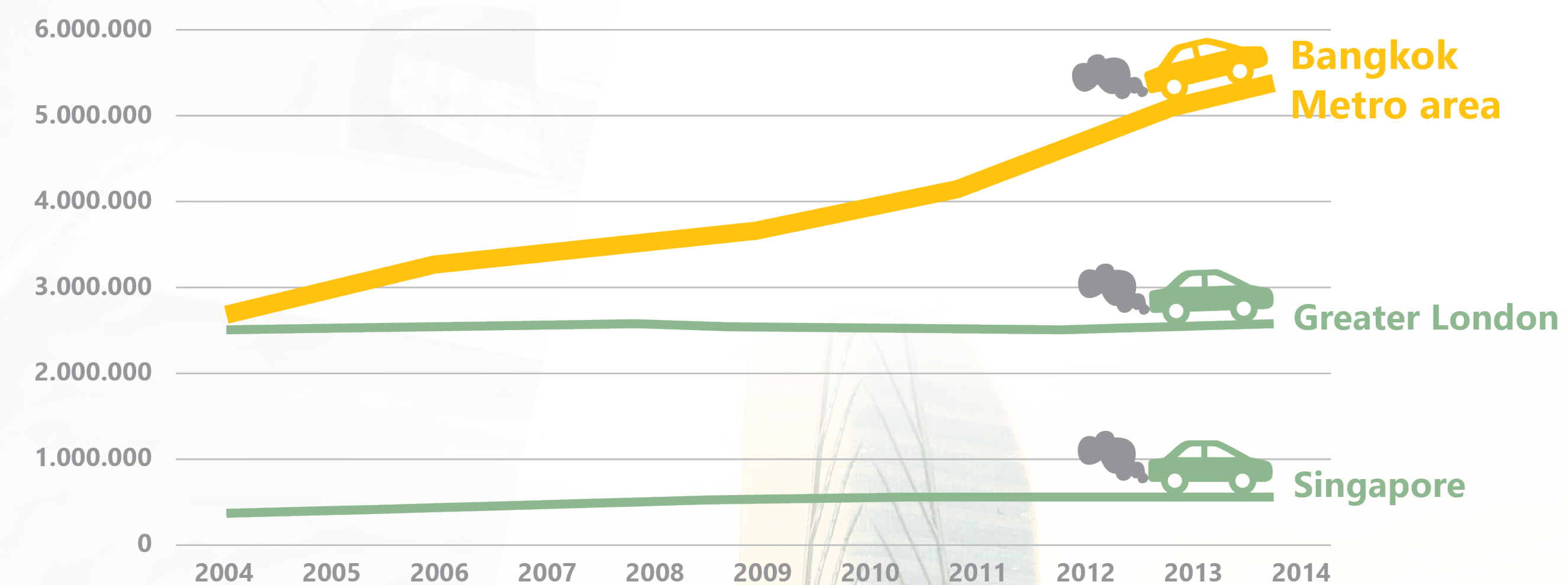
to congestion. People in Bangkok lose a significant amount of time by being stuck in traffic. On average, people in Bangkok spend a total of 8 days and 15 hours in congested traffic situations. Lost time in congestion amounts to about 11 billion THB (30 million EUR) per year and that when looking at the opportunity costs of these time losses this equates to about 60 million THB (1.66 million EUR) per day.

The underlying reasons why congestion is so bad in Bangkok, is because vehicle ownership is high and increasing. This may be the result of economic growth creating a larger middle class that can afford to own a car. Also, urban planning decisions that support urban sprawl and the city has historically insufficient investment in public transportation, walking and cycling infrastructure.

Vehicles per 1,000 population



Number of licensed cars



Bangkok is extending public transportation with a number of new (rail) connections. Public transportation demand is expected to increase from about 10 million in 2017 to about 12 million trips per day in 2042 with mode shares only marginally increasing (from 31.5% to 34%). The projected growth for Bangkok is so high that the total number of trips is expected to increase from about 32 million in 2017 to 40 in 2042. Of the 8 million additional trips, 2 million trips will be effectuated using public transportation. Thus, the investment in public transportation infrastructure supports Bangkok's growth, but they do not seem to cause a systemic change in public transportation shares nor do they reduce car use and congestion.

If Bangkok is going to reduce congestion, or at least keep it constant, it needs to reduce the demand and dependency on private vehicles. This will require significant policy changes and investments. These could include:

air pollution control and mitigation policies



investment in cycling and walking infrastructure improvement



The role of Congestion charging

Congestion charging can play an important role in making the use of the private car less attractive.

car purchase, car ownership and car use regulations



urban space reallocation from road towards bike lanes



public and community space planning



investment in public transport infrastructure, service improvement, or system integration with more energy and emission efficient modes.



HOW CONGESTION CHARGING HELPED OTHER CITIES

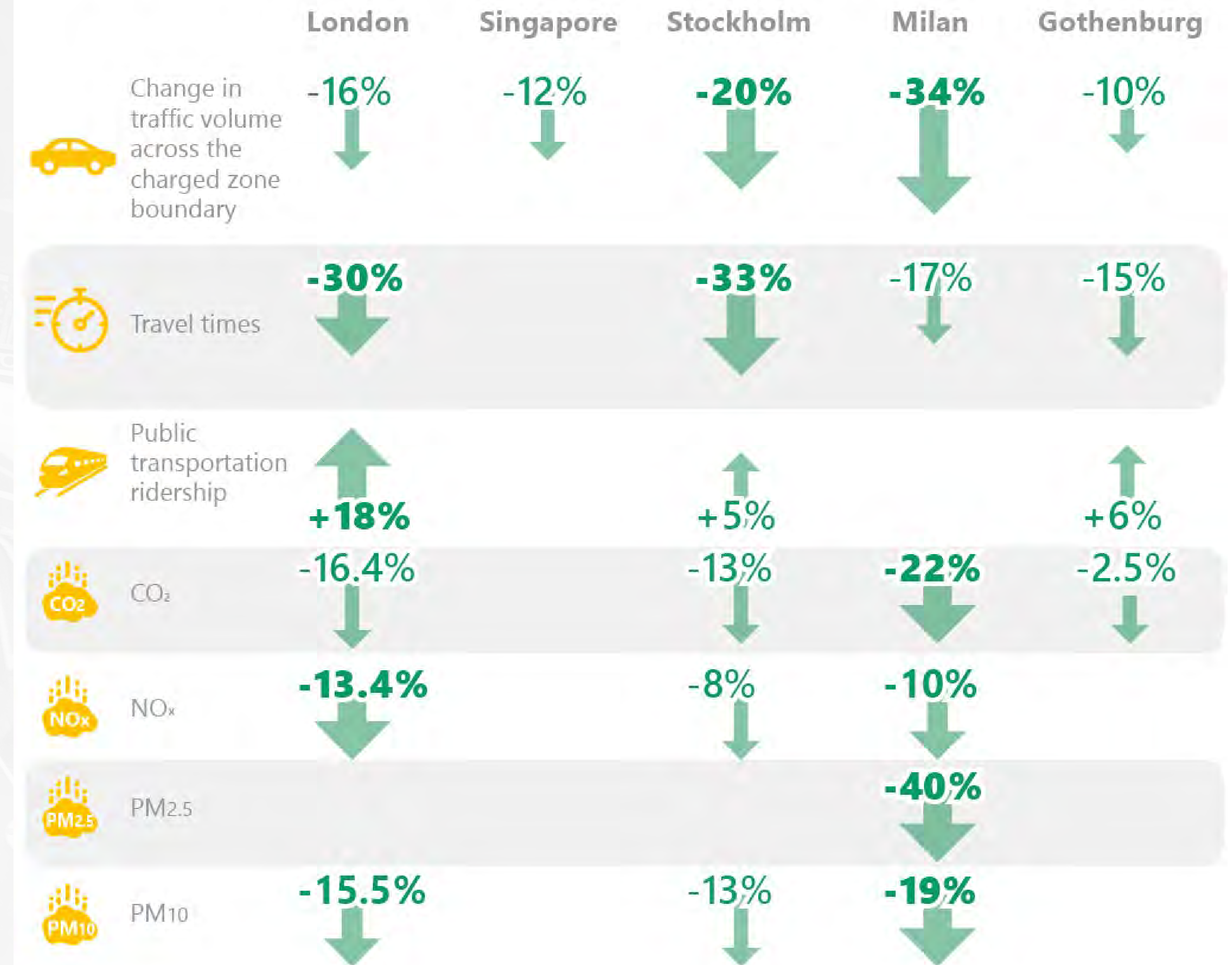
Bangkok is not the first city in the world to consider congestion charging. Norway has a number of tolled rings around cities. There are many cities that have low emission zones, such as London and Amsterdam. Low emission zones in Germany limit access for certain types of vehicles according to specific vehicle emission norms. In Italy there is a wide range of Limited Traffic Zones. In the figure on the right, you can see significant effect as a result of various congestion charging policies in London, Singapore, Stockholm, Milan and Gothenburg. As a consequence of reduced car use different types of emissions are likely to be reduced.

Research from several cities shows that the effects of congestion charging results in economic effects as well. Reducing congestion improves productivity, reduces emissions and higher traffic safety reduces costs for health care etc. Although congestion charging is aiming at efficiency improvement and reduction of economic losses from externalities caused by car use, the public and politicians often

discuss and argue about the potential negative effects of congestion charging on businesses and certain economic sectors. Concerning the business effects, the net effect could both be positive or negative. Some business may be highly dependent on car using customers, while other businesses might benefit from less cars (but more people and customers). As expected, all selected cities show substantial positive societal benefits, while the net effect on business is around zero.

The revenues of congestion charging are often used to benefit traffic in general. In Stockholm and Gothenburg infrastructure investment includes a bypass road around Stockholm, new metro line extensions, two tunnels in Gothenburg and a new bridge. Most cities have invested in new and better bus connections already prior to the introduction of the congestion charging scheme.

Changes in traffic other cities



However effective, congestion charging is often the subject of public and political debate. Potential economic negative impacts are often discussed. Concerning the business effects, the net effect could both be positive or negative. Some business may be highly dependent on car using customers, while other business might benefit from less cars (but more people and customers). All selected cities show substantial positive societal benefits, while the net effect on business is around zero. With the implementation of congestion charging a revenue stream is generated. The generated

revenue can be used for measures implemented to improve the acceptance and political support for the charging scheme, such as improvements in public transport.

After implementation of congestion charging, acceptance typically increased. Travel times improved more than motorists expected, negative consequences (amount of the charge, mode shift alternatives) proved less problematic than what was anticipated and people adapted and accepted a new status quo, no longer evaluating it as a "change".

Economic effects of congestion charging

	London	Singapore	Stockholm	Milan	Gothenburg
 Estimated societal benefits	110-150 million USD/year	51 million USD/year	80 million USD/year	16 million USD/year	1.8 million USD/year
 Business effects	Negligible		+5% in retail sales	No effects on business reported	No effects on business reported
 Revenues	352 million USD/year	160 million USD/year	94 million USD/year	28 million USD/year	99 million USD/year



PUBLIC ACCEPTANCE

Congestion charging can be a very effective policy, but in many cities around world politicians worry about public acceptance. This is with good reason since proposing congestion charging is always met with public resistance. Congestion charging is a change in how the current system works. People have strong habits and biases towards the status quo (current situation). These include:

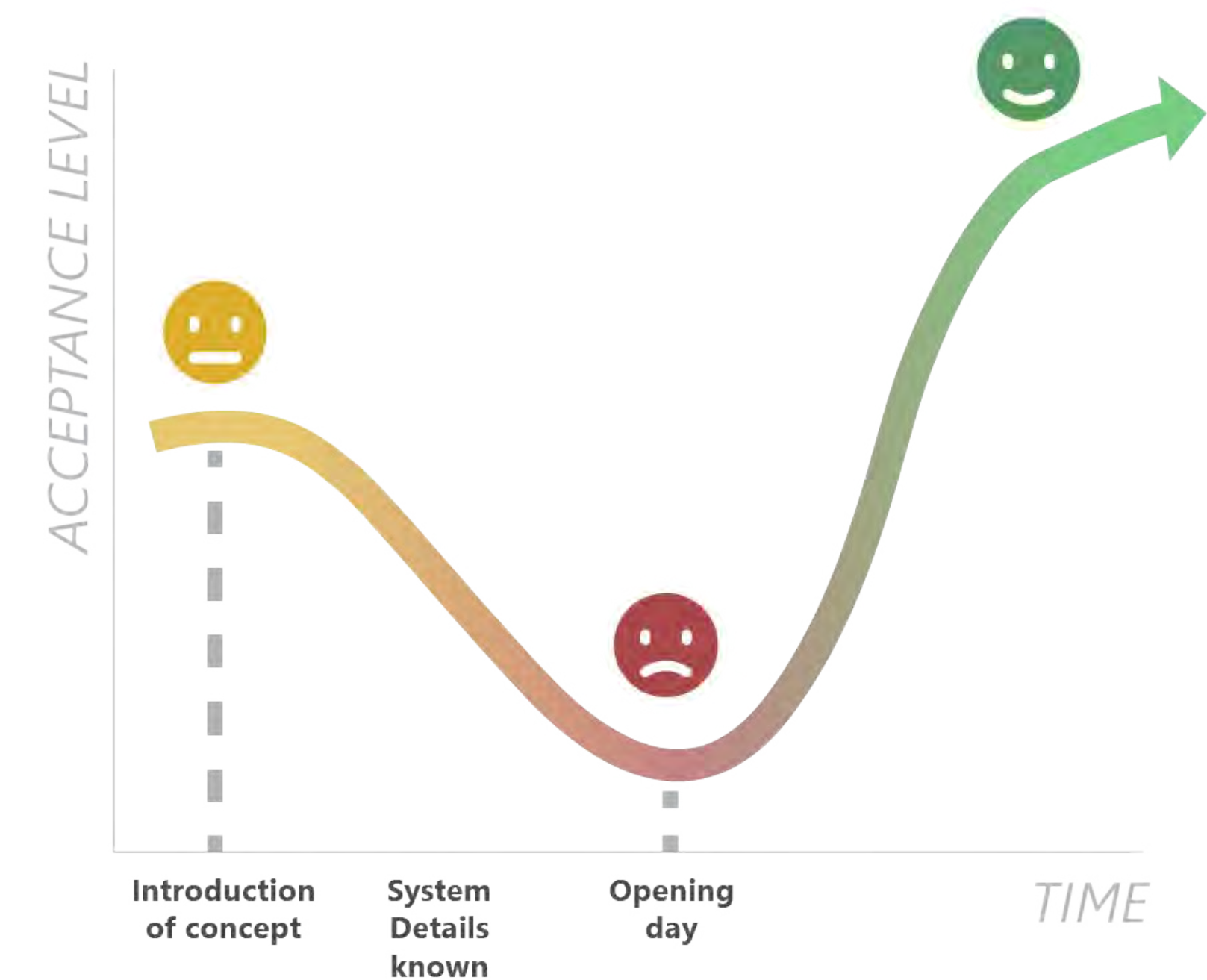
- **people may not trust that the positive effects will affect them;**
- **they tend to overestimate the cost increase;**
- **they may not see that the revenues are used for their benefit.**

A good communication strategy about the congestion charging policy and revenue is not likely to affect this negative opinion before introduction. Still, such a strategy is very important for accepting the policy after introduction. If people see that the outcomes align with the messages they received before introduction it will be easier to accept the new situation and to give up biases.

The public acceptance of congestion charging has been studied and measured in different cities. From these studies a pattern emerges about public acceptance where public acceptance decreases before introduction as more details of the policy become publicly available.

Typical dynamic pattern of acceptance

adapted from (Goodwin 2006) and (Schade, Seidel and Schlag 2004)



Acceptance in other cities



In this phase it is likely that media will highlight cost increases for households and less the benefits. **This is where many of the plans for congestion charging end as politicians fear the public opposition.** If however the policy is implemented and works like it was proposed, the public acceptance turns quickly.

Public acceptance is an important topic that can be supported by a good design of the policy that will deliver positive effects, a good communication strategy that is honest about what to expect, and a transparent use of revenues that further contribute to positive societal benefits.

OVERALL APPROACH

WHAT DID WE DO?

Congestion charging can have positive effects. But it does not by definition provide benefits for cities. There is a risk of a congestion charging policy leading to rerouting and causing even more congestion than it solves. Bangkok, with its dense networks and widespread congestion, could face this problem. Finding a suitable zoning could be difficult.

And there is more than just traffic issues. What also matters are themes as , change in mode of transportation and reduction in . The effects of congestion charging should be as positive as possible. In order to have a good image of what could happen, we made use of a transportation model.

Transportation model

The eBUM transportation model divides the entire area of Bangkok into smaller areas (zones). For each zone data is gathered about how many people live there, how many jobs exist, as well as household characteristics. Using these data and behavioural models the model determines

1. how many trips people will make,
2. where they will go,
3. what mode they will use, and finally
4. the route they will use.

The choices people make depend on their own characteristics (income, gender and so on), the purpose of the trip (work, shopping and so on), and the characteristics of alternatives (travel time, price, comfort and so on).

Bangkok is a large city. Many of the trips will not be affected at all by congestion charging. In order to ensure that the effects of congestion charging remain visible, we focused on a specific study area in central Bangkok.

After a knowledge workshop with the steering committee, we identified 4 that later were expanded upon to create 7 scenarios in total.

Once some initial suitable congestion charging scenarios were identified, they would be compared against the business as usual (BAU) scenario and against each other.

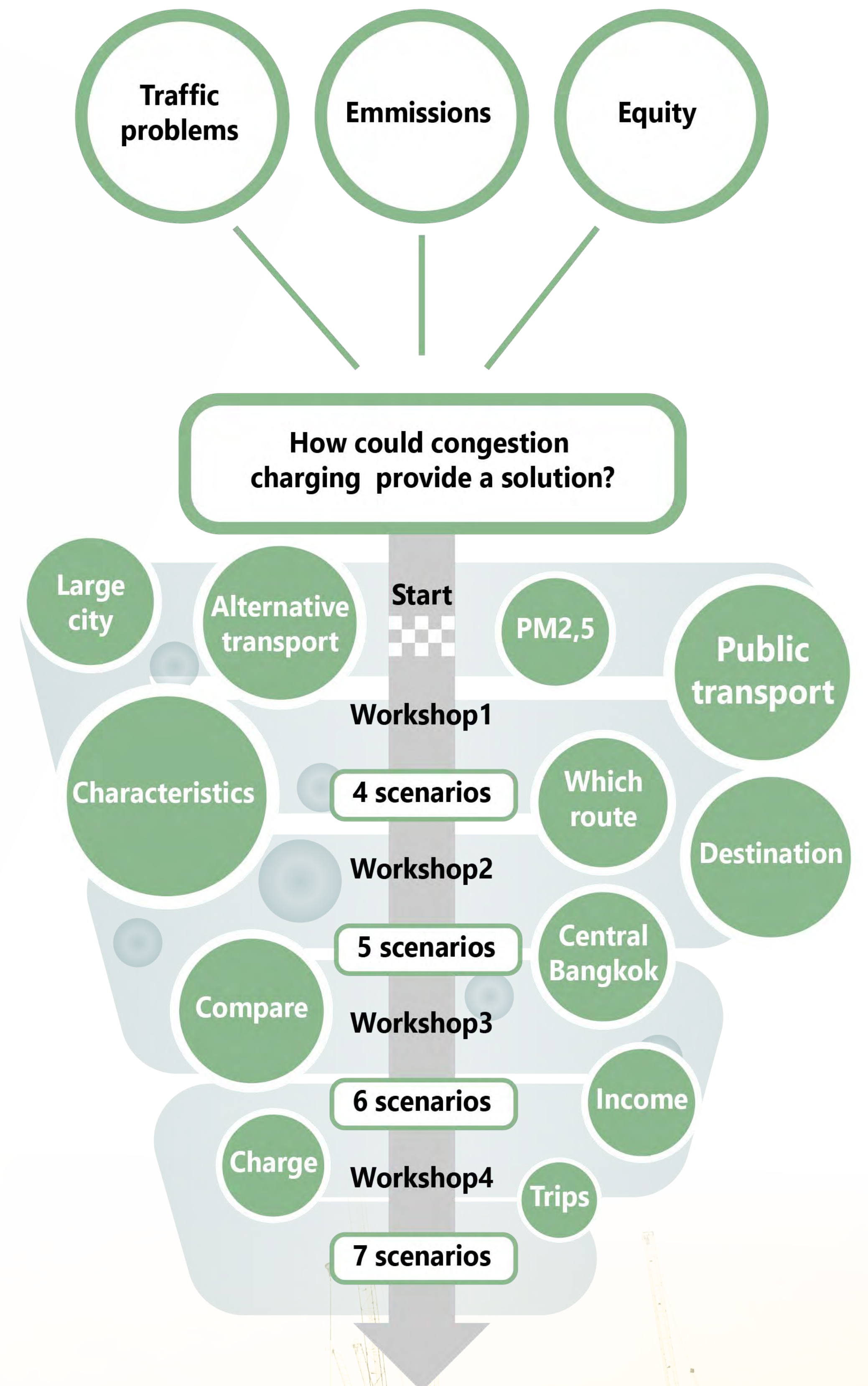
The evaluation criteria that was used in comparing scenarios are:

- PM2.5 emissions in the entire Bangkok network and the study area
- CO₂ emissions in the entire Bangkok network

In the first step data on traffic conditions in Bangkok and different congestion charging implementation cases were gathered. Based on these data a first congestion charge working group meeting with stakeholders was held to identify policy objectives for congestion charging. One of the major results was that equity effects and the availability of public transportation in and around the zone are equally important political criteria. It was also apparent that zones needed to be rather larger than smaller in size in order to have a noticeable positive effect.

BANGKOK

Things dat are going on



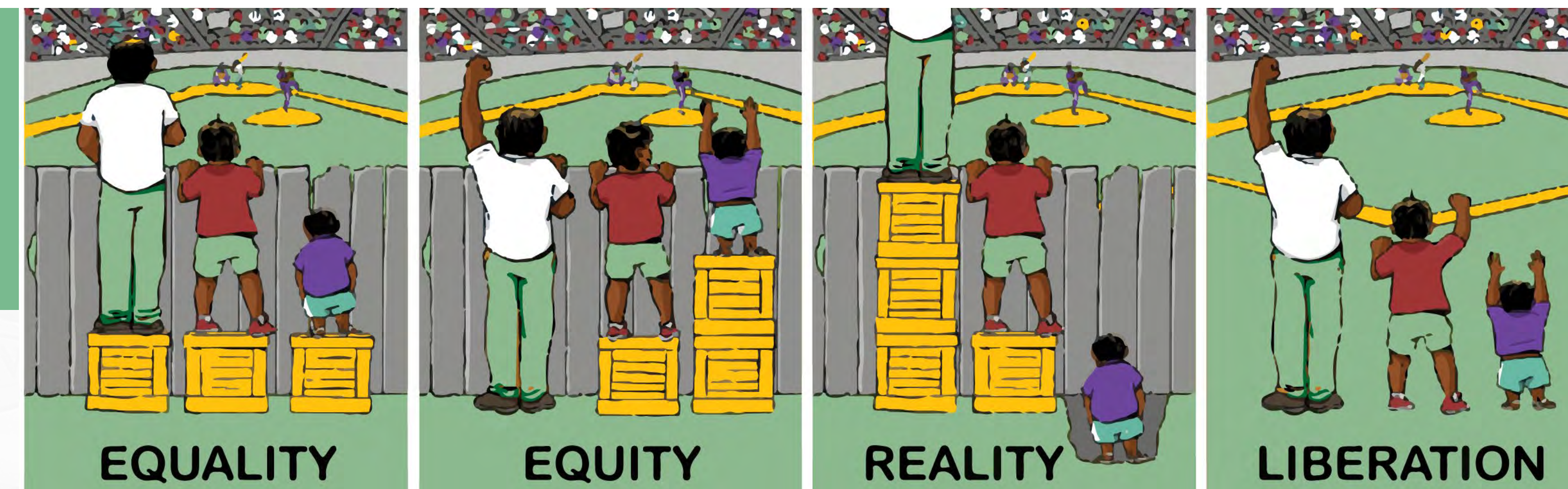
WHAT DID WE LEARN?

EQUITY



Equity means that not all people are affected in the same way by the same policy. Congestion charging will affect individuals differently. People differently. It is important to understand these differences as additional policies may be needed to make sure that the costs and benefits of congestion charging are fair. Low income people for example are more sensitive to a congestion charge than higher income people. Age, gender, disability, are other ways to look to define groups. Besides looking at different groups of people and their personal characteristics it is also important to consider geographical differences. People in a downtown area may be differently affected by congestion charging than people living in the suburbs. People living closer to good transit may be affected differently than those that live in more car dependent neighbourhoods.

There are different ways to analyse and address equity in congestion charging policies.



First, there is process equity, where especially vulnerable people are included in the design process of the policy to make sure their needs are heard and met.

Second, there is outcome equity, where affects on different groups are analysed. Outcome equity can be addressed in three ways:

- **EQUITY BY DESIGN**

Equity by design means that the policy is designed such that it provides more equitable or equal outcome compared to the current situation.

- **EQUITY BY COMPENSATION**

Equity by compensation means that the inequities that result from the congestion charging policy are compensated by for example rebates, credits or lower taxes.

- **EQUITY BY SYSTEMIC CHANGE**

Equity by systemic change means that revenues from congestion charging are used to change the current system. Transit investment, affordable housing around transit is built, higher density mixed use urban development which make society more equal and less car dependent.

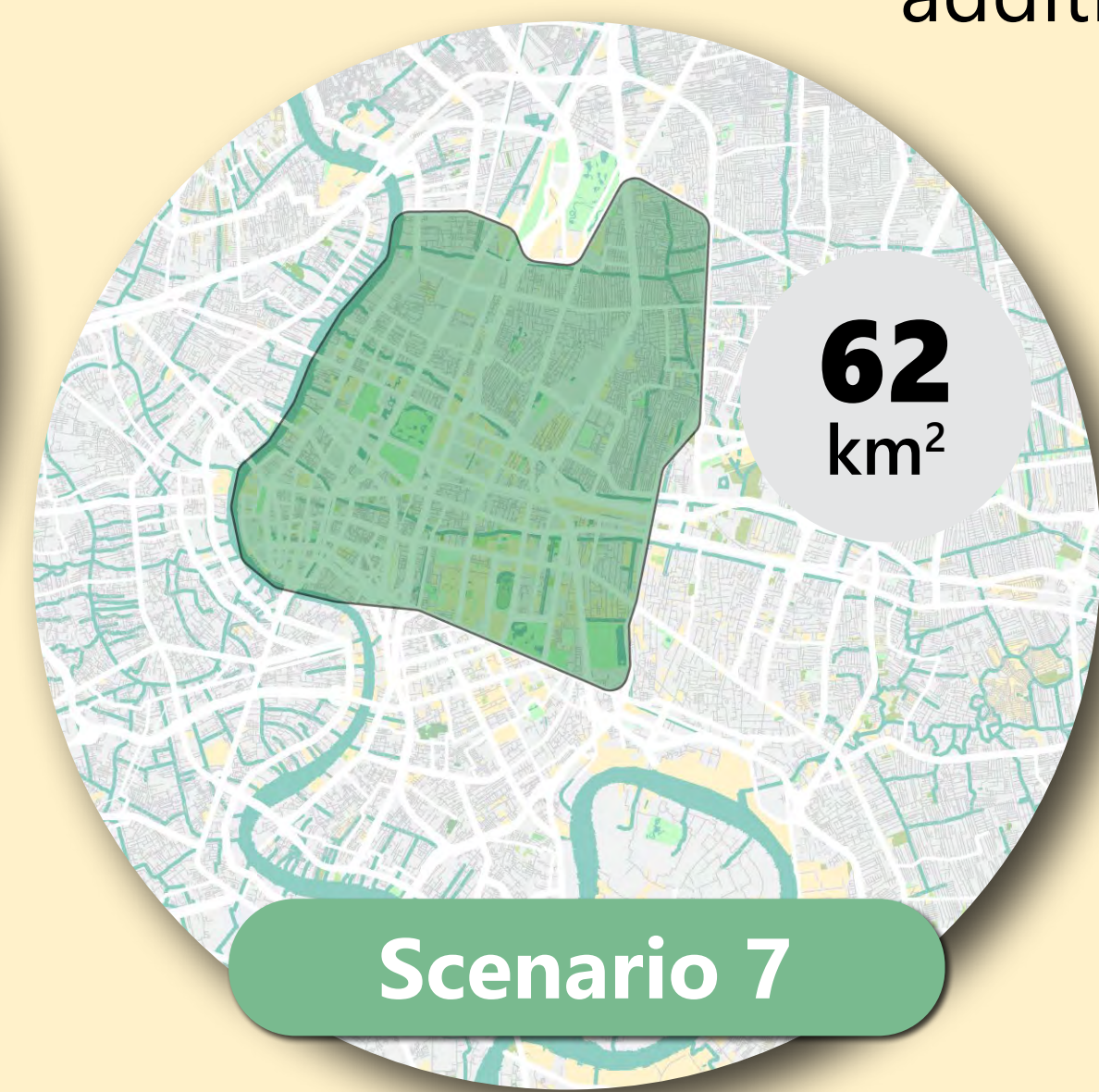
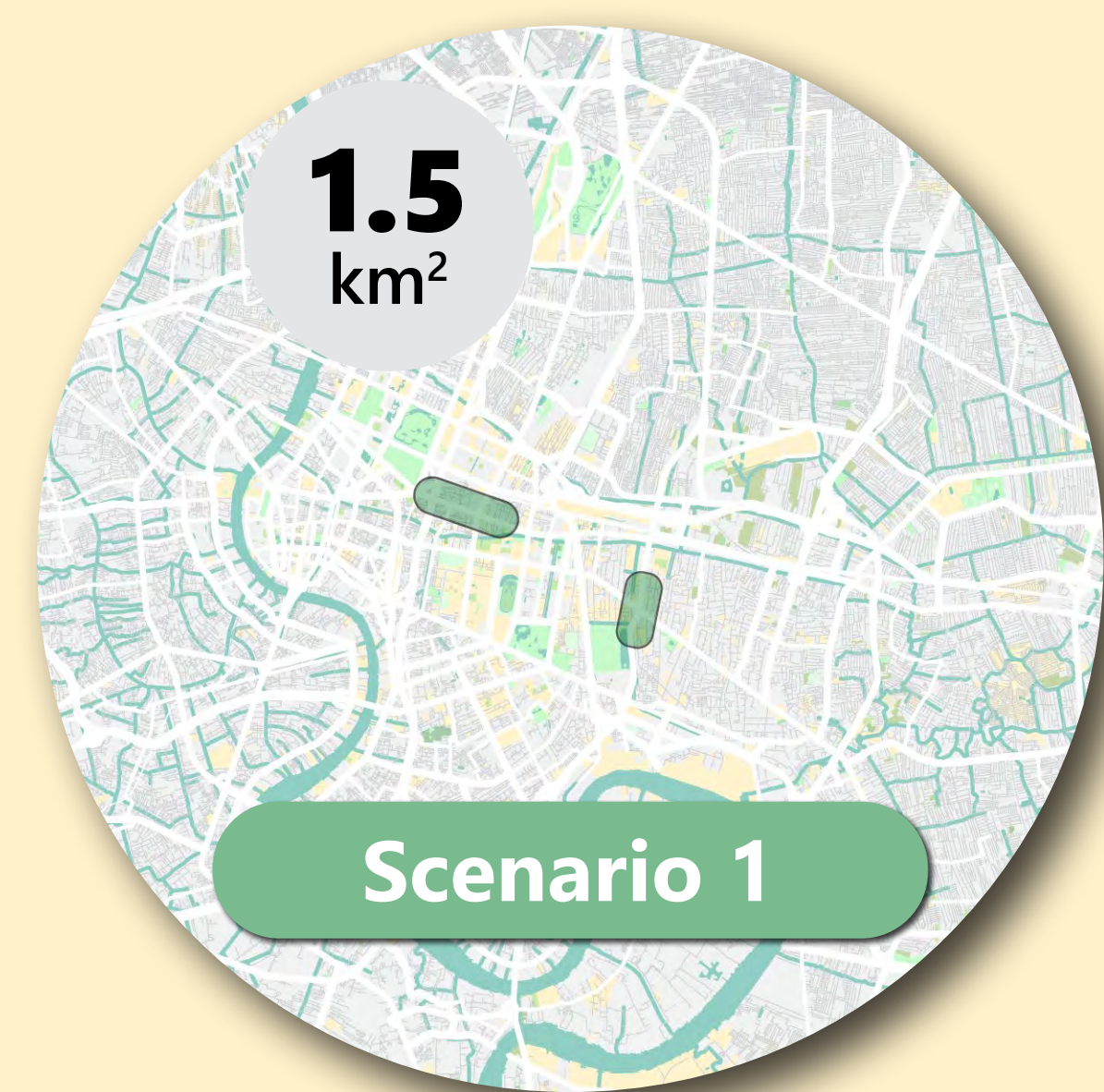
In the prefeasibility only outcome equity by design was included. In the design of congestion charging areas, neighbourhoods where more low-income household live are avoided when possible. Access to transit also was an important criteria in choosing suitable congestion charging areas. In the comparison of scenarios the effects of congestion charging were determined for low-income, middle-income, and high-income households separately. Ideally, low-income households spend the same or less on transportation relative to their income (for example 15%). The difference between how much low-income households and high-income households on average spend on congestion charging relative to their income is a useable indicator to see if and how much more burden the charges will put on lower-income households.



WE ANALYSED 7 SCENARIOS

Approach for identification of scenarios 1 to 4

Four scenarios were identified as a cordon charge located in the centre of Bangkok where congestion and air quality were identified as most problematic. Vehicles pay when they enter the **cordon**. No vehicles were exempted from the congestion charges at this point. Also, the charges were not yet differentiated in place or time. For each scenario three different charge levels were tested, namely 50, 80, and 120 THB (1.4, 2.2, 3.3 EUR) respectively.



Approach for identification of scenarios 5 to 7

After the effects of the first four scenarios were presented and discussed within the steering committee and working group, the identification of scenarios 5 to 7 occurred in a slightly different manner. First, access to public transportation and equity were included as congestion charging objectives. Secondly, rather than identifying different scenarios at once, this time only one scenario at a time was identified so that lessons learned could be included in each new scenario and the process would start to convert.

In order to identify new scenarios given the four key political objectives, **a methodology was used where indicators for each of the objectives, as they were discussed in previous sections, were overlaid upon each other.** Using this overlay, it was possible to visualise how many objectives are met for different locations in Bangkok.

Objectives	Option 1	Option 2
Congestion	1	2
Emission	2	4
Equity	1	1
Access to public transportation	4	1

The table above shows the two sets of weights that were supported by the workshop participants. In the first set, aligning the congestion charging policy with access to public transportation is the prime objective and reducing emissions the second. In the second set of weights, emissions are the prime objective and congestion comes second.

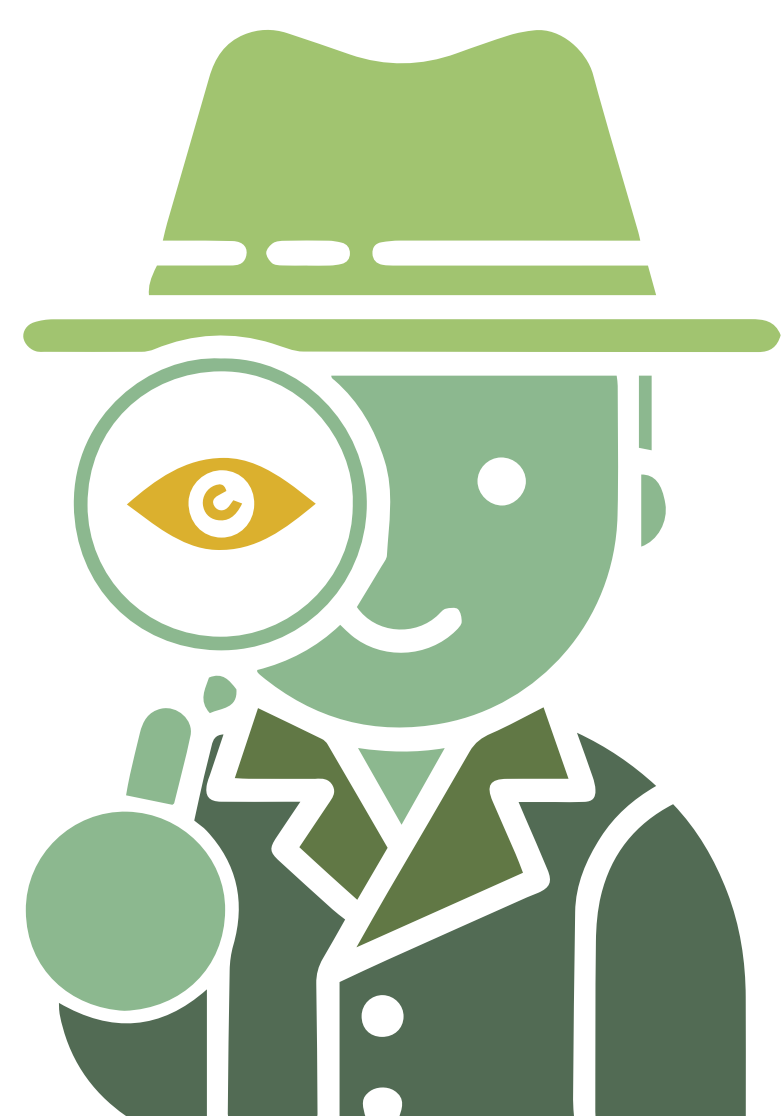
We see some differences, but also some similarities in the maps. One of the main differences with weighting set 1 (public transportation alignment most important) shows fewer areas that are highly suitable for charging. **The suitable areas are also more central.** In the centre of Bangkok, the two sets are more similar, which provides additional confidence that this is the area most suitable for congestion charging. In comparison with the previous scenarios, these maps also show that there is reason to include areas in the centre more to the North of where the current scenarios were focused.

SCENARIO ANALYSES, WHAT DID WE FIND?

▶ Scenario 7



RECOMMENDATIONS, WHAT DID WE LEARN?



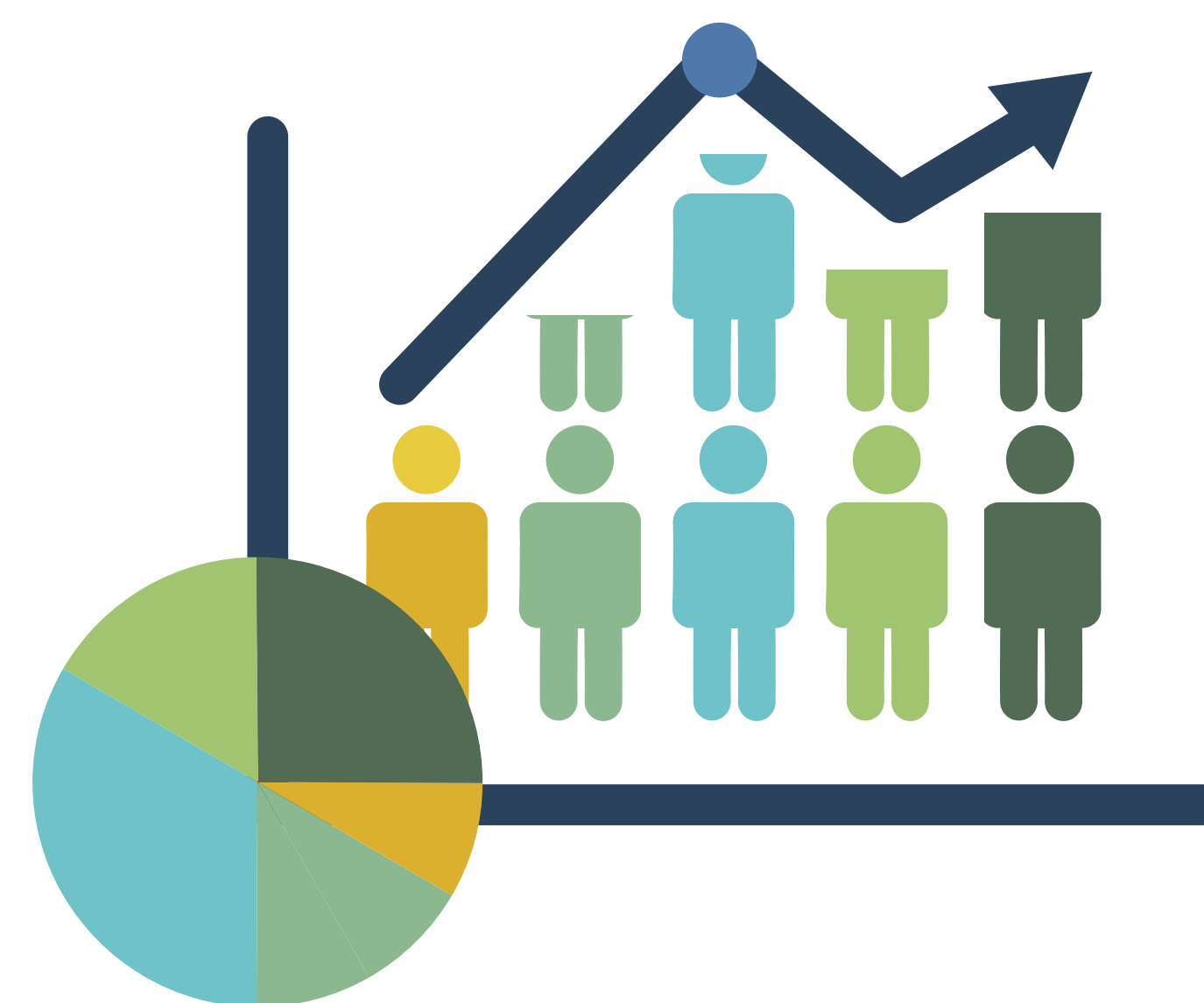
Further investigate scenarios.

Discussions around the results from the scenarios in this pre-feasibility study are very likely to lead to new ideas and thoughts on how to change or adapt some of them. **It is recommended to proceed with that process, together with stakeholders (not just public sector stakeholders),** and in the light of political and user acceptance. It is also recommended to investigate scenarios that potential stakeholders that oppose congestion charging might put forward so that decisions can be supported with facts and analyses.

Calculate societal benefits.

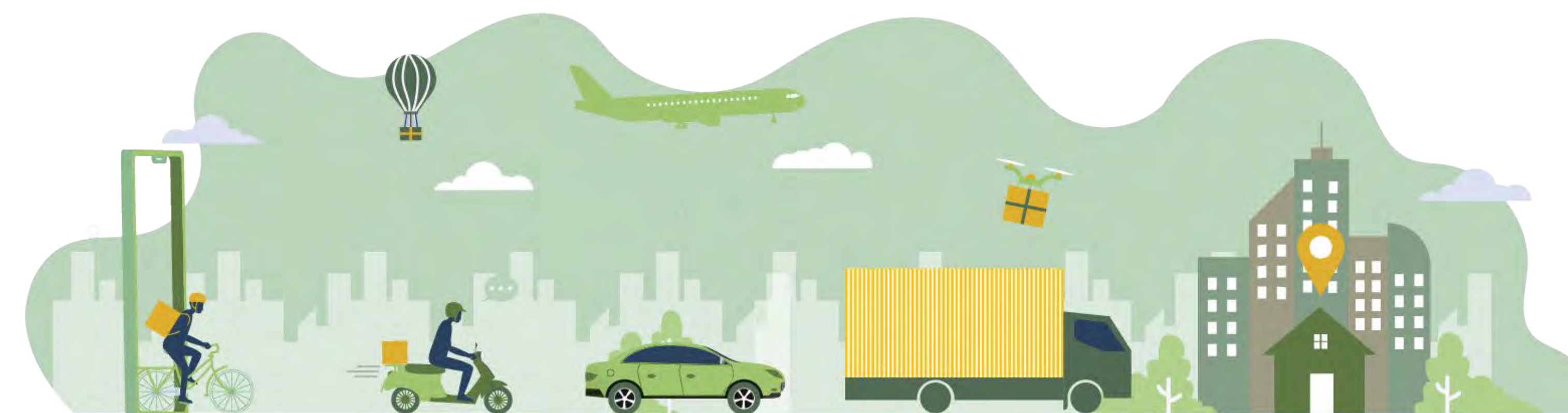
Social benefits can be one of the most important decision support evaluation criteria, especially when comparing scenarios where most other key evaluation criteria perform similarly.

In order to conduct a societal cost benefit analysis, **more benefits and costs need to be monetarised and included in the calculation.** These include amongst other: changes in emissions, changes in traffic safety, changes in health, system costs, changes in public transportation fare box revenues.



Review and update the transportation model.

There is potential to improve the model so that it is better suited to assess the effects of congestion charges. No model will ever be perfect, but there are some **key features that can help improve the forecasts** and reduce uncertainty for decision makers on what effects to communicate and expect.



RECOMMENDATIONS, WHAT DID WE LEARN?



Investigate institutional and legal aspects.

There are several roles that need to be fulfilled, and these include at least: identification of vehicles, charging the vehicle, invoicing vehicle owners, enforcement of payments, constructing and maintaining road side equipment, constructing and maintaining a back office, communication with the public on the questions related to congestion charging, communication with the public on how to use the system. **The roles need to be supported by different stakeholders and cooperation between these stakeholders needs to be established.** Besides institutional issues there are also a number of legal issues that need to be arranged. These legal issues may include: legal right to identify vehicles, the legal right to charge vehicle owners after identification and the legal right to enforce payment.



Investigate suitable technology for charging and enforcement.

The most commonly used technological solution for detecting and identifying vehicles are **automated license plate recognition (ANPR) and in-vehicle transponders that communicate with roadside equipment.**

In order to enforce a cordon or an area, every entrance to the zone needs to be monitored so no vehicle can enter without detection. This implies that larger zones, and zones that have more entries, are more expensive to set up and to maintain. This may be compensated by higher effects and revenues. The costs of these systems that make congestion charging possible vary between scenarios and for different combinations of institutional, legal and technical frameworks.



Investigate suitable procurement and business model.

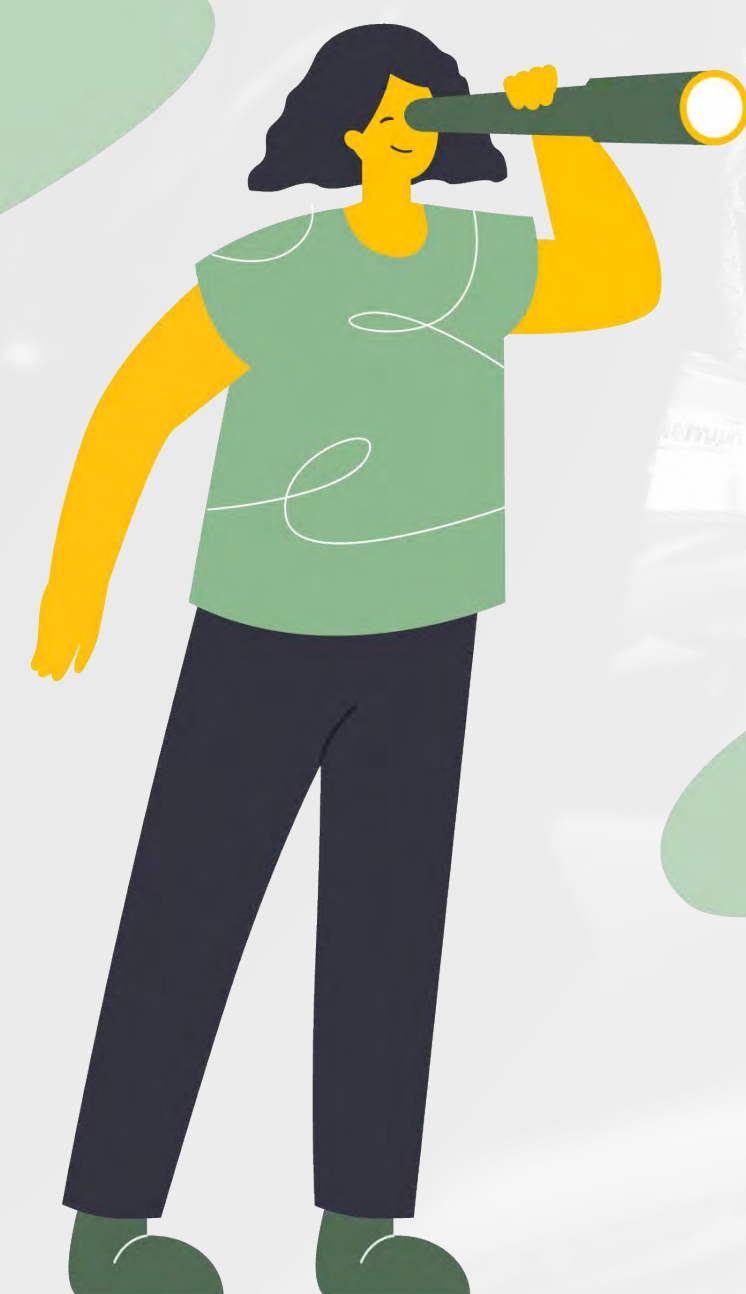
There are different procurement models that differ in how the public and private sector cooperate and share risks that may be suitable for Bangkok. Independent of what model Bangkok will choose **it is recommended the public sector has full control over the charge levels and locations to ensure positive societal outcomes** and that future adaptations and optimisations will always happen with that perspective in mind.



Discuss revenue use.

In some scenarios the revenues are substantial and **could help fund infrastructure investments** or other societal projects that would help achieve political objectives as well as **increase public acceptance** for the charging measure.

OUTLOOK, HOW TO GET THERE?



Institutional & Legal design

Traffic law specialist
Tax law specialist
Procurement specialist
Management consultant

Communication strategy

Communication specials (channels)
Outreach specialist
PR specialist (massages)
Graphic design specialist

Technical design

System integration specialist
Technical spcification specialist
Vehicle identification experts
Back-office specialist
Payment channel specialist
Telecommunications specialist

Functional design

Political representation
Stakeholders
Transportation planners
Transportation engineers
Economist & financial modeller
Enviromental engineer

CONGESTION CHARGING POLICY DEVELOPMENT TEAM

- Project manager
- Political representation
- Representative Functional design
- Representative Technical design
- Representative Institutional & Legal design
- Representative Communication Strtegy



COLOPHON

“If you have to pay a charge every time you drive into the city center, it might be a blessing in disguise. Conceivably, it could turn the tide of your daily commute.”

Bangkok and many cities around the world are facing challenges in solving transportation issues, traffic congestion problems, and quality of the weather condition caused by transport pollution emissions as well as the safety of traveling. These problems might not be easy to solve in the near future.

Therefore, many cities around the world have adopted the ‘Congestion Charging’ policy to solve the problem.

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