THE INVESTIGATION OF THE CARBON FOOTPRINT IN THE TOURISM SECTOR: THE SCENARIOS ANALYSIS OF FRENCH TOURISTS

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ABSTRACT

Tourism sector is a core economic factor to drive growth across the countries. This is the reason that tourism is responsible almost 8 percent of the world's carbon emissions based on the World tourism organization. Therefore, the relationship between tourism activity and carbon emission should be further explored. Since the emerging disease of Covid-19, the number of international tourists has significantly declined. Especially in France where it uses to be the top's tourist destination, and tourism drive its national GDP. Then to promote the domestic travel is way for country to survive. Therefore, these inspired the research objectives including to identify the characteristics of the domestic trip in France concerning the transportation and accommodation generating the tourism sector's carbon footprint, and to propose productive solutions to minimize the amount of carbon footprint in the Tourism sector.

As an extension of the consulting project, this study will use secondary data analysis technique to estimate the result of simulation trips and its scenarios. The four simulation trips that use in this study were completed by four French tourists, to represent the tourist behavior. This study stimulated nine more scenarios for each trip. At this point, one real actual trip is formulated together with different scenarios for comparison across the different scenarios.

According to the results of these study reveal that there six main influential characteristics that impact the amount of Carbon footprint of domestic tourism in France including transportation mode, accommodation type, geographic scope, length of stay, distance travel and choice of destination. Therefore, to propose a practical solution to reduce the emission as a whole, many related stakeholders ranging from the tourists, the hotels and accommodations, business entrepreneurs and the government. This study recommends supporting slow tourism and responsible tourism, promote natural-based destination, select proper transportation mode and accommodation type to reduce the unnecessary carbon equivalent emission.

KEY WORDS: Tourism Sector/ Domestic Tourism/ Carbon Footprint/ CO2 equivalent/ Carbon Emission

77 pages

CONTENTS

CONTENTS (cont.)

CONTENTS (cont.)

LIST OF TABLES

LIST OF FIGURES

CHAPTER I
INTRODUCTION

1.1 Introduction

1.1.1 Rationale

The term "Carbon Footprint" has become a buzzword in academic society in recent years due to a mounting concern of climate change, generating a more severe impact on society at both regional and national levels. Several attempts to find a realistic methodology to calculate the carbon footprint, specifically in the tourism sector at an individual level, have been introduced to specify how a set of activities generated by humans or organizations produce a certain number of $CO_{2\text{-eq}}$ emissions. This is because the tourism sector is widely assumed as a considerable determinant stimulating the emission in numerous forms, not limited to the CO_2. The calculation of the CO_2 emission is, in fact, intangible because of a significant variation from a wide range of activities producing different levels of the certain CO_2. Therefore, an investigation of the CO_2 emission via the proxy of CO_2 equivalent ($CO_{2\text{-eq}}$ emission) is technically taken into account and increasingly used in large organizations and cross-country studies.

CO_2 emissions are considered the total amount of carbon dioxide released into the atmosphere caused by human pollution and are constantly increasing and contributing to global warming. On the other hand, a carbon footprint corresponds to the whole amount of greenhouse gases (GHG) produced to, directly and indirectly, support a person's lifestyle and activities. Carbon footprints are measured in equivalent tons of $CO_{2\text{-eq}}$ during a year; they can be associated with an individual, an organization, a product, or an event, among others. The GHGs, whose sum results in a carbon footprint, can come from the production and consumption of fossil fuels, food, manufactured goods, materials, roads, and particularly the service sector.

Even it is significant. Carbon footprints are difficult to calculate due to a multi-layer relationship among factors, inadequately scientific knowledge, diversification of the primary data source, and intervening factors under the investigation; this includes an influence process that stores, or release carbon dioxide based on the natural conditions (Youmatter, 2020).

By and large, a measurement of the CO_{2-eq} emission by examining the carbon footprint has been considered a productive methodology but still varied according to the specific activity, time spent, geo graphic scope, and other related diverse settings. Therefore, a realistic instrument to precisely calculates the exact amount of the carbon footprint could allow scientists and management scholars to comprehend the determining factors and scenarios affecting the CO_{2-eq} emission that contributes to climate change in a holistic view.

Countries across the regions emit massive amounts of heat-trapping gases into the atmosphere, which estimates the CO_2 emissions from the combustion of coal, natural gas, oil, and other fuels, including industrial waste and non-renewable municipal waste. Statistically considered the per-capita CO_{2-eq} consumption, the Global Carbon Project's findings revealed that the United States and China were ranked the 11^{th} and 36^{th}; In contrast, Qatar was ranked 37^{th} as the most emitting countries in terms of CO_{2-eq} (Ritchie & Roser, 2018).

Carbon dioxide emissions, primarily from fossil fuel combustion, have risen dramatically since the Industrial Revolution. Most of the world's greenhouse gas emissions come from a relatively small number of countries. China, the United States, and the nations that make up the European Union are the three largest emitters on an absolute basis (International Energy Agency, 2020). However, developed nations have high carbon dioxide emissions per capita, while some developing countries lead to the growth rate of carbon dioxide emissions.

However, these uneven contributions to the climate crisis at the core of the challenges the global community is experiencing (Union of Concerned Scientists, 2020). See figure 1 below:

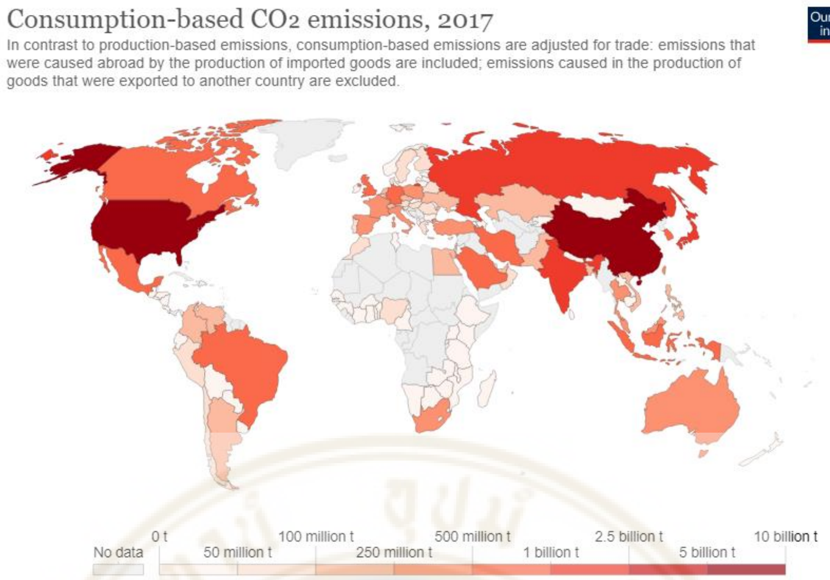

Figure 1.1 Consumption-based CO_2 Emissions, 2017 (Our World in Data, 2019)

Over the decades, the global community has realized the importance of reducing the GHG emissions across the economic sectors to maintain growth and sustainability without disturbing patterns of human behaviors. Initial solutions have been identified, such as less-electricity consumption, green transportations, avoidance over-consumption, and recycling; still, they are inadequate to address this problem and fail to provide solutions on a global scale.

Therefore, introducing a new methodology to measure the $CO_{2\text{-eq}}$ emissions based on the simulation trips with additional scenarios toward a variety of trips under the context of carbon footprint in the real-world situation is thought-provoking and needs further research, especially in the tourism sector.

1.1.2 Carbon footprint and nexus to sustainable tourism

The carbon footprint strongly correlates to sustainable tourism and $CO_{2\text{-eq}}$ emission in various aspects, similar to the air transport that correlates to the tourism industry. As a result from the international community, the Paris Agreement was adopted in 2015 aiming to limit global temperature increase caused by a variety of business industries in this century to limit the global temperature rise to be below 2 °C compared to pre-industrial levels and to strive for 1.5 °C in the coming decades (The Intergovernmental Panel on Climate Change, 2021). The Paris Agreement intentionally sets landmark goals for taking action on climate change, aiming to keep temperature rise to well below 2 degrees C (3.6 degrees F) and pursue efforts to limit the temperature increase to 1.5 degrees C (2.7 degrees F).

The results from the Paris Agreement have made a warning call to the global community by introducing lots of tourism concepts that help mitigate the adverse impacts from the $CO_{2\text{-eq}}$ and climate change as a whole. This includes the aspiration to preserve the environment by tracking every single step of the human-made activities resulting in the formulation of the sustainable tourism concept (or interchangeably called responsible Tourism.)

By definition, "Responsible tourism" is any form of tourism that can be consumed more responsibly, and it is a term frequently used by industry (SustainableTourism, 2021). Responsible tourism also covers tourism's economic, environmental, and social responsibility towards tourists and global justice and equity (Mihalic, 2016). It primarily consists of the following characteristics:

- The minimization of negative social, economic, and environmental impacts.
- The generation of the greater economic benefits and well-being for people.
- An improvement of working conditions and access to the industry.
- An involvement of local people in decisions that affect their lives and life chances.
- The positive contributions to the conservation of natural and cultural heritage embracing diversity.
- The provision of more enjoyable experiences for tourists through more meaningful connections with local people and a greater understanding of local cultural, social, and environmental issues.
- A cultural sensitivity that encourages respect between tourists and hosts and builds local pride and confidence.

More collection of carbon footprint data to trace back the certain amount of the carbon footprint and $CO_{2\text{-eq}}$ emission at a personal level has become more systematic. To achieve this, people need to be more aware of unintended effect of CO_2-eq emission by tourism and daily activity at the individual level. Countries need to address peak global emissions at the regional levels soon as possible; countries then agreed to reduce emissions rapidly to reach net-zero greenhouse gas (GHG) emissions in the second half of the century (Waskow & Morgan, 2015).

More importantly, climate action is included in the 2030 Agenda for Sustainable Development as a stand-alone Sustainable Development Goal (SDG), SDG 13, which provides a roadmap to reduce emissions and build climate resilience. These reasons have raised the climate change awareness across the business industries and emerged to introduce sustainable tourism and responsible tourism concepts targeting the resolve the problem at its root.

1.1.3 Tourism in France and its environmental impact

One of the most substantial service sectors to drive growth is the tourism sector, especially in the Asia Pacific countries, where the tourism sector is a critical economic engine for development. Mt countries have experienced a dramatic increase in income from this sector throughout the decades; (Moore, 2020). The tourism sector was also proven to be a vital industry for the East Asian country's economy providing huge GDP contributions across the region, similarly to the advanced countries like the UK and France, whereby tourism and sub-related sectors significantly boost revenues and growth of their economies.

In France, tourism plays a significant role in the economy. The accommodation and food service sectors represented the largest part of the tourism sector; it represents close to 8% of the overall GDP. Approximately 90 million international tourists visited the country in 2019; around 40% of international arrivals come from the United Kingdom, Germany, and Belgium, including positive direct and indirect effects to employment for over 2 million jobs (Ministry for Europe and Foreign Affairs, 2020). It was also claimed that France's tourism sector is the most significant contributor to the balance of payments between 2015 and 2016 (OECD, 2018). Traveling in France is rewarding; business entrepreneurs can enjoy a series of benefits and supportive policies provided by the state, while travelers could have a great time with various cultures and heritages such as museums, historical monuments, and beautiful sceneries.

At the global level, it was reported that the tourism industry's carbon footprint around the planet grew by 15% from 3.9 to 4.5 Gigatons of equivalent carbon dioxide. That is four times more than previously thought and accounted for about 8% of global greenhouse gas emissions in the surveyed period (Avenido, 2020). This is the core reason why the notion of sustainable tourism is more aggressively brought up to global attention; it is believed that knowing the carbon emission will provide insights on which aspect of lifestyle people can change.

According to Emissions drivers (Ritchie & Roser, 2018), they claimed a strong connection between the country's CO_2-eq emissions, prosperity, and living standards. The significant increase in GDP has been a major driver to increase those total emissions; it is even a more vital driver than the increase in population. Therefore, there are commonly rich countries with high living standards and high levels of emissions, also the poor countries with low levels of emissions and poor living standards.

On the contrary, France is one of the countries that can demonstrate that we can make progress in reducing emissions while still maintaining their high standard of living. Aside from France, some countries such as the USA, UK, Spain, and that have shown to reduce emissions whilst increasing its GDP (Global Carbon Project, 2020).

For France, tourism is one of the crucial sectors of its economic activity, and it is one of the world's famous tourist destinations. According to UNWTO Tourism Highlights 2016 Edition (World Tourism Organization, 2016), France was in the first rank of the World's top tourism destination by international tourism arrivals (84.5 million arrivals), following by the United States, Spain, and China. Therefore, it generated international tourism revenue of 44.5 US dollars for France in that year.

This result is not only because it is located at the heart of western Europe but also because of all the larger countries in the region - Italy, Spain, Germany, Belgium, Switzerland with the Paris Charles de Gaulle airport and others for international tourism. As a country, France provides the best experience for travelers due to its tourism infrastructure; the country has many choices of accommodations ranging from luxury hotels, budget hotels, Airbnb, and holiday cottages. Also, it provides transportations that with exemplary system and modern technology linking all main towns and cities altogether.

1.2 Research Objectives

- To identify the characteristics of the domestic trip in France concerning the transportation and accommodation generating the tourism sector's carbon footprint
- To propose productive solutions to minimize the amount of carbon footprint in the Tourism sector

1.3 Research questions

- What are the influential characteristics of the domestic trip in France concerning transportation and accommodation generating the tourism sector's carbon footprint?
- What are the viable solutions to diminish the amount of carbon footprint in the Tourism sector?

CHAPTER II
LITERATURE REVIEW

This part highlights two main types of activities, specifically under this examination, contributing a massive amount of the carbon footprint based on the simulation trips, including carbon footprint in transportations and carbon footprint in accommodations.

2.1 Carbon footprint in transportation

The advancement of air transport considerably causes the substantial growth of international tourism over the last decades as to the rise of the middle-income class, communications technology, mobility of people across the borders, and forces of globalization. By 2012, over half of all international tourists arrived at their destination by air; similarly, air transport growth linked to the massive expansion of the tourism sector and relevant industries. It was stated that the majority of international air passengers are traveling for tourism purposes, whether leisure or professional, and in many countries, aviation is critical for domestic tourism development. Aviation has a significant multiplier effect on the economy, and research suggests that aviation generates some US$539 billion of GDP worldwide directly with an indirect effect double that amount (UNWTO, 2013).

Specifically, transport-related $CO_{2\text{-eq}}$ is projected to increase from 1,597million tons to 1,998 million tons between 2016 and 2030, representing a 25 percent increase. Transport-related emissions from tourism are said to represent 5 percent of all human-made emissions in 2016 and will rise to 5.3 percent by 2030. Unfortunately, tourism-related transport emissions contributed the highest rate of 22 percent of all transport emissions in 2016 (World Tourism Organization, 2019).

Among all the travel consumption elements, the modes of transportation (aviation/air, rail, and road), the distance traveled to destinations (short, medium, and long flights), and the level of luxury services rendered are all essential factors that control the carbon footprint journey. In detail, transportation consists of different modes and distances that travelers have selected.

2.1.1 Mode of Transportation

Different modes of transport have contributed to a diverse amount of CO_{2-eq} emission in a broad sense. The mode of transport directly affects the level of fuel consumption and emissions. Each type of transportation uses a different source of energy. Compared to traveling by car, airplanes generate more greenhouse gas emissions due to their high carbon intensity. (Sustainable Travel International, 2020)

Also, for air travel, displacement can be very significant depending on the number of passengers. The location of flight transfers can contribute about one gigaton of CO_{2-eq} to the planet every year. Cruise and ferry ships cannot be left out as it has a fuel consumption rate and produces billions of tons of trash, fuel, and sewage that are directly released and endanger the ocean.

The carbon footprint of any form of transport depends on the number of passengers, the length and distance of the journey, type of engine, and fuel. By far, aviation is considered the fastest-growing contributor to CO_{2-eq} emissions. See full details below:

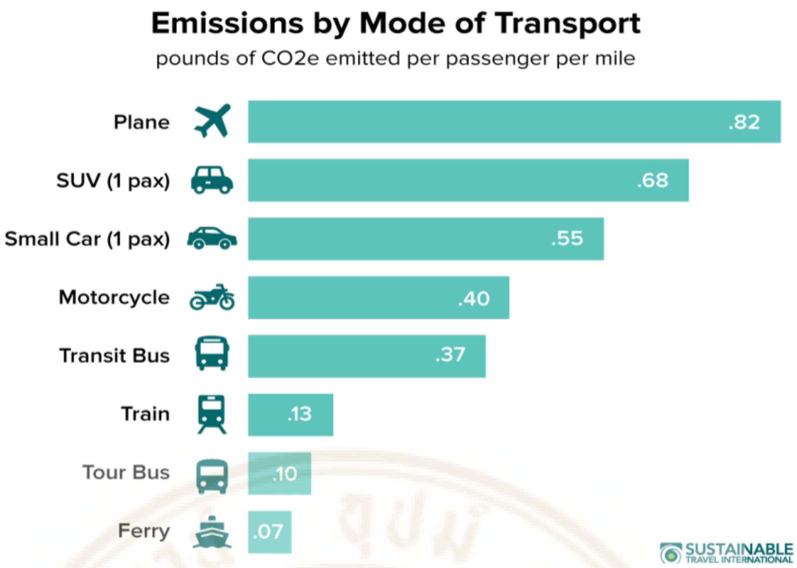

Figure 2.1 Emissions by Mode of Transport (Sustainable Travel International, 2020)

As a piece of empirical evidence from the Greenhouse gas reporting, conversion factor 2019 by the UK Department for Business, Energy and Industrial Strategy (2019) mentioned an exciting viewpoint according to the means of transport used to get around. The means of transport that emit the most grams of Carbon footprint per km traveled include the plane for domestic flights and the petrol-powered car when there is only one person onboard. Among the means of transport, it undoubtedly revealed that ferries, rail, electric vehicles and, of course, cycling and walking are the least polluting means of transport as shown in the graph below.

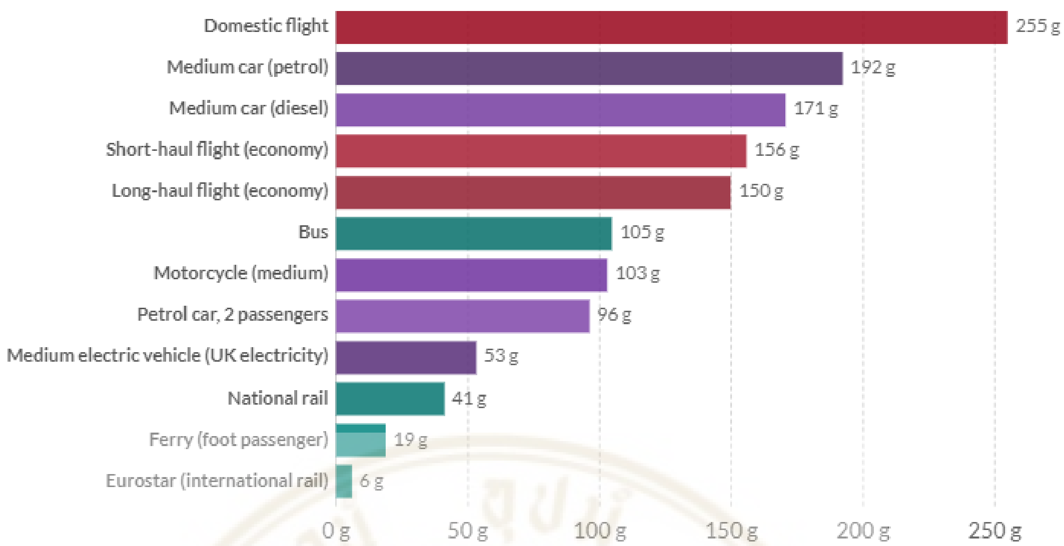

Figure 2.2 The carbon footprint of travel per km in 2018 (UK Department for Business, Energy & Industrial Strategy (BEIS), 2019)

Another aspect to consider in $CO_{2\text{-eq}}$ emissions is travel distance. Most emissions come from passenger flights which accounted for 81 percent of air emissions in 2018. Out of that, 60 percent is reported to come from international travel and in-country or domestic flights. Passengers' flight emissions can further be divided into three categories: short-haul (less than 1,500 kilometers), medium-haul (1,500 to 4,000 kilometers), and long-haul (greater than 4000 kilometers) journeys (Ritchie H. , 2020).

Long-haul flights emit vast amounts of $CO_{2\text{-eq}}$ (a longer route requires more services, food consumption, and activities devoted to higher levels of $CO_{2\text{-eq}}$ emission). If the aircraft does not use efficient fuel technologies flying at high altitudes, climate change has a more significant effect. Furthermore, aircrafts flying at high altitudes produce trails of water vapors condensation, contributing significantly to global warming. A long-haul round flight can generate more emissions than any other activity undertaken during and in travel. Similarly, many short-haul flights can produce as much $CO_{2\text{-eq}}$ as one long-haul flight (Hammond, 2007).

Additionally, for the same type of vehicles, the travel distance between two places can vary significantly. It can be seen that the longer the distance, the higher carbon footprint emissions to the environment. For example, with the same number of passengers and transport types, the traveling route with 5 miles will require more energy consumption and release intense carbon dioxide. (Lee, et al., 2021)

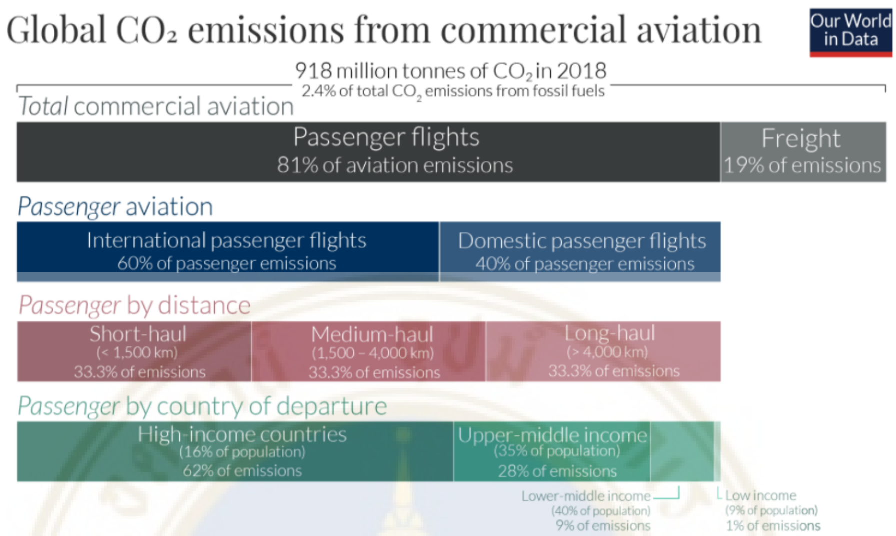

Figure 2.3 Global CO_2 Emissions from Commercial Aviation (Lee, et al., 2021)

2.2 Carbon footprint in accommodation

2.2.1 Energy consumption

In the travel and tourism sector, energy consumption at destinations and related GHG emissions strongly depend on the accommodation infrastructure, particularly installations for heating and cooling. The UNEP emission gap reports that electricity and heat generation accounts for 24 percent of total GHG emissions (United Nations Environment Programme, 2020). Serrano-Bernardo et al. (2012) a that energy consumption in the destination is usually expressed in the duration of stay (number of days) in the property.

Most tourist accommodations equip with air-conditioning and heating systems to provide a suitable temperature for guests, making it comfortable during their stays. Correspondingly, the hotel business's specific nature needs to be operated 24/7 to provide special on-site services, amenities, and leisure activities to serve their customers (Filimonau, Dickinson, Robbins, & Huikbregts, 2011a). Additionally, tourist accommodations' geographical location affects their energy consumption and efficiency, and relative distribution of energy across the operation. Bohdanowicz and Martinac (2007) provide a concrete example that the hotels in the North will require more intense energy for heating the room, while the hotel in the tropical country involves energy for air-conditioning.

This makes the tourist lodging signified one of the highest energy-intense types of commercial buildings as the study by Dascalaki and Balars (XENIOS-a methodology for accessing refurblishment scenarios and the potential of application of RES and URE in hotels, 2004). Electricity is also a contributor, especially at places with inefficient systems. The study of energy use in hotels in Barbados shows that air-conditioning system contributes almost half of the total energy consumption (Sustainable Travel International, 2020). As well as the study in 1996, the highest energy consumption categories of the hotels came from the buildings. It elaborated that 85% of total energy use in the hotel contributed to the heating, ventilation, air-conditioning, use of electronic applicants, and lighting system for the buildings (Santamourisa, Balarasb, Dascalakia, Argirioub, & A., 1996). Furthermore, resorts and hotels that offer modern and luxurious services tend to have the highest emissions because of the energy-intensive system that creates $CO_{2\text{-eq}}$.

For example, water heaters are used to warm spas, pools, and spas. This also related with the past research's findings by Karagiorgar, Tsoutsos, & Moia-Pol (A simulation of an energy consumption monitoring in the Mediterranean hotels: Application in Greece, 2007) indicated an example of adding a swimming pool and restaurant services into the hotel, it resulted in more than double in its energy consumption.

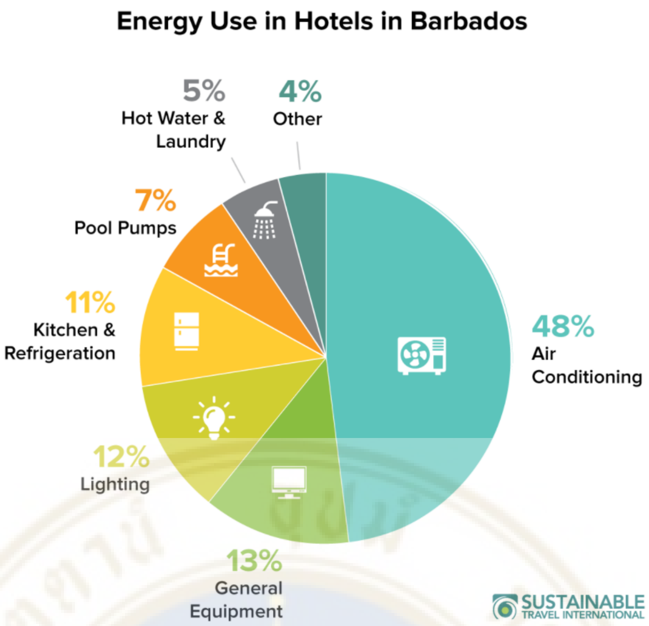

Figure 2.4 Energy Use in Hotels in Barbados (Sustainable Travel International, 2020)

In 2016, accommodation building's energy-related emissions represented 10.9% of the total GHG produced (Ritchie & Roser, 2018). The lodging carbon footprint depends on the quantity of energy used. For example, the quantity of natural gas that using to heat up the hotel buildings. To assess the energy consumption in hotels and accommodation buildings has many critical factors to consider. The energy use depends on the geographic zone, climate conditions, buildings, ages and types, categories of use, its specific component, the buildings materials, and energy types. (Sartori & Hestnes, 2007).

Regardless, the research in the past decades agreed that energies do not have the same footprint depending on which country they are produced/used. In 2019 in Europe, each kWh of electricity produces 275g of CO_2 equivalent emissions (European Environment Agency, 2020).

On the other hand, this ratio was 408g $CO_{2\text{-}eq}$ /kWh in the USA for 2019 (U.S. Energy Information Administration, 2005). Water consumption, waste, and carbon emissions related to construction are also part of the accommodation footprint.

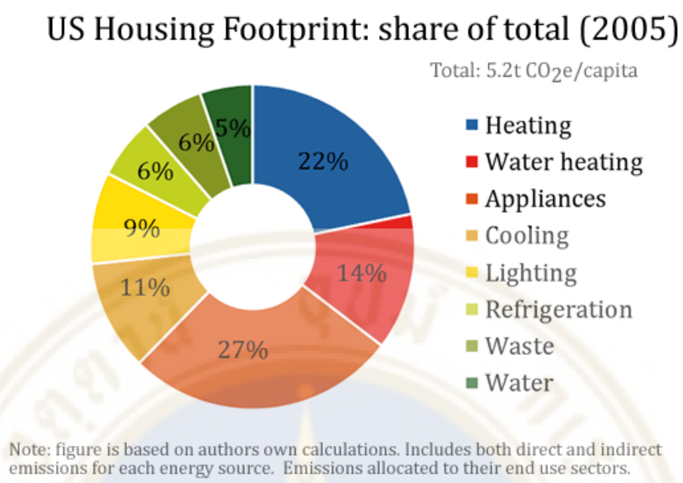

Figure 2.5 U.S Housing Footprint: share of total (U.S. Energy Information Administration, 2020)

In water consumption, heating, cleaning, and transportation are needed to get proper water for households. This process consumes the energies that are producing carbon emissions. The impact depends on the quantity produced and how it is treated (recycling for example).

The accommodation energy used can be divided by the number of people to get an individual carbon footprint. Some energy consumption ratios according to Carbonfootprint.com data can be found below (Carbon Footprint, 2021):

- Natural Gas: 1.84 metrics tons $CO_{2\text{-}eq}$ /10,000 kwh
- Heating Oil: 2.54 metrics tons $CO_{2\text{-}eq}$ /1,000 liters
- Coal: 2.88 metrics tons $CO_{2\text{-}eq}$ /1 metric ton
- LPG: 1.56 metrics tons $CO_{2\text{-}eq}$ /1,000 liters
- Propane: 1.56 metrics tons $CO_{2\text{-}eq}$ /1,000 liters
- Wood: 7.23 metrics tons $CO_{2\text{-}eq}$ /100 metric tons

2.2.2 Size of accommodation

The study of carbon footprint analysis of two hotels in Poole, Dorset in the UK, assess their carbon emission revealed that the bigger hotel had been more energy-intense and emitted more carbon footprint than the smaller hotel base on one guest night basis. The bigger hotel provides, the bigger gross are floor; while the smaller hotel uses less space for its reception area and operates the rest for the guest room. This indicated that the smaller hotel is better utilized its area for better efficiency (Filimonau, Dickinson, Robbins, & Huikbregts, 2011a)

The study of the Carbon footprint of 12 homestays in Thailand using the screening method – Life Cycle Energy Analysis (LCEA), indicated that homestays' overall carbon footprint was relatively low due to the small size and limited facilities. The carbon footprint 'per guest night' of homestays was responsible for 0.32 kg of $CO_{2\text{-}eq}$ per homestays on average, comparable to the emission of budget hotels in Thailand (Jarotwan Koiwanita; Viachaslau Filimonau, 2021).

2.2.3 Energy efficiency

As energy and environmental issues have attracted more attention towards tourism, especially the hotel industry, the recent study indicated that 71.4% of Macau's hotels had implemented Leadership in Energy and Environmental Design (LEED), which aims to enhance the energy-saving and environmental protection. More importantly, the evidence reveals that the higher star hotels are more interested in improving their energy efficiency. There is no evidence that 2-star hotels implemented the carbon auditing and energy management measurement project, while 63.6% of the 5-star hotels executed it. (Wang, Wu, Qiao, & Song, 2018)

The recent research demonstrated that new hotel buildings are more energy-efficient over time due to the building constructions and materials; therefore, it minimized the impact of carbon footprint (Dimoudi & Tompa, 2008). There is a correlation between the energy use intensity (EUI) and certain building conditions, operations, and other factors in the hotels in Taiwan (Wang J. C., 2012)

Furthermore, the Canadian hotel industry's case indicated implementing a hotel renovation or simple adjustments such as installing a more efficient lighting system, air conditioning, or heating system; can reduce the energy consumption down by 20–40%. (Graci & Dodds, 2008).

The study of 200 hotels in Taiwan on hotel buildings' energy performance presented that the energy use intensity (EUI) and energy use per guest room of higher-rated star hotels are greater than the Taiwanese international tourist hotels' low star hotels. (Wang J. C., 2012)

2.2.4 Food waste from the hospitality

Moreover, some hospitality and aviation that provide food services in terms of the buffet, such as the luxuries hotels or flying in business class, also create food waste which is another factor that should be considered in carbon emissions associated with travel. Nevertheless, new research from scientists at Lund University in Sweden and the University of Queensland in Australia suggests a significant impact from the meals we enjoy when traveling (Fagan, 2020). This could be attributed to the increasing trend in tourism and travel, which is boosting out-of-home dining.

According to Sustainable Travel International (2020)the food waste hospitality sector is a major global concern. The sector contributes to 12 percent of the total food waste, and people tend to indulge more on vacation than at home. Hotels in the UK alone produce about 79,000 metric tons of food waste every year. The National also reported that hotels and restaurants mainly fueled food waste in Dubai. Food waste can be generated from storage, preparation, and mostly oversized restaurants and buffets leftovers. With less than half of hotels composting their food waste, food waste left to decompose in landfills tends to produce more methane that is more dangerous than $CO_{2\text{-}eq}$ (Tostivint, et al., 2016).

Many hotels and restaurants import most of their food products from other countries to satisfy guests and provide. Islands mostly rely on the importation of food products. It is estimated that up to 80% of the food consumed by the tourism industry in Pacific islands is overseas. In such secluded Islands, food travels a very long distance, multiplying missions generated (Sustainable Travel International, 2020).

Managing food waste is another way to respond to sustainable development for the hospitality sector. Accor group had reinforced Planet 21, which was determined to put sustainable development at the heart of its activities. Food is one of its aspects of

Planet 21 in the commitment of 2020. The chain aims to reduce 30% food waste, and all of the restaurants strictly follow the charter on healthy & sustainable food. For example, the Accor hotels in Bangkok have the redistribution of buffets leftovers project, making the best use out of the leftover buffet food. Another commitment project is the Plant for the planet program aiming to plant 1,000 urban vegetable gardens in the hotel areas. Instead of importing food overseas, the hotels will be able to produce locally. Hence, the fewer transportations occur during the process, the lower the carbon footprint was left behind (Accor, 2020).

As empirical evidence, the research of Kitamura et al. l (2020) about the carbon footprint (CFP) of the Japanese tourism industry was calculated based on tourist consumption. It was underlined that the major source of emission came from transportation (56.3%), then follow by accommodation (9.8%), and food and beverage (7.5%).

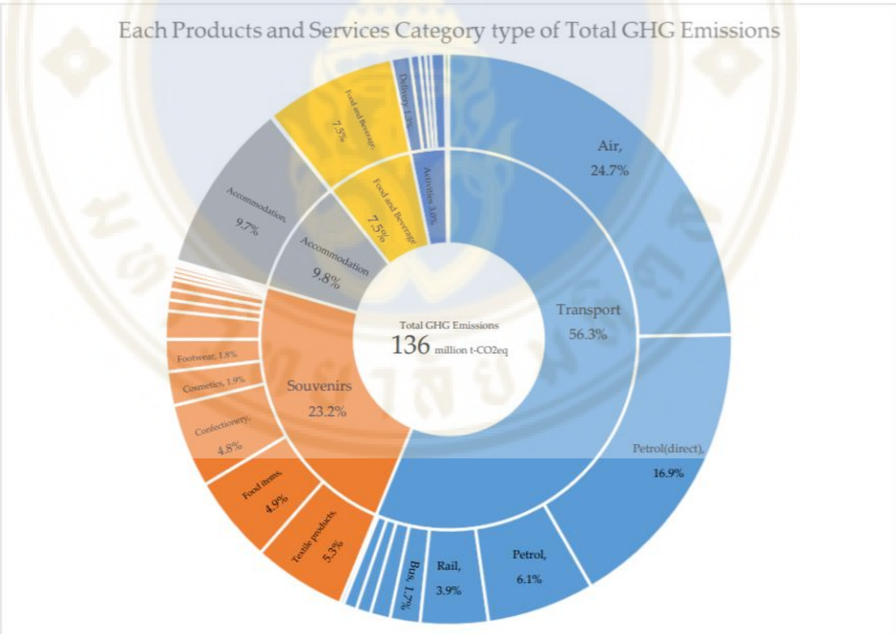

Figure 2.6 Products and Services Category type of Total GHG Emissions (Kitamura, Ichisugi, Karkour, & Itsubo, 2020)

2.3 Responsible tourism

In order to maintain the sustainable development of the tourism industry despite the continuing intense attention towards environmental awareness, the scholars had introduced alternative tourism models, namely responsible tourism, ecotourism, and sustainable tourism., with the ultimate to promote local culture and environmental conservation at the same time (Kirkby, et al., 2011)

Responsible tourism can be described as any form of tourism that can be consumed more responsibly. Responsible tourism covers economic, environmental, social responsibility through various tourism activities; its responsibility towards tourists and global justice and equity are also required for consideration (SustainableTourism, 2021). In the tourism-related industry, responsible tourism is dubbed one of the frequently used terms that link to the carbon footprint via a series of activities. On the other hand, responsible tourism advocates the fair and equitable distribution of benefits to local communities and protects the natural world at large (Funnell, 2008).

Responsible tourism is similar to sustainable tourism in that the idea was adopted after the word sustainability. It defines any type of tourism that can be consumed in more responsible ways that are involved broad range of stakeholders such as minimizes negative social, economic and environmental impacts, return economic benefits for local communities and enhances the well-being of local people, involves local people in decisions making that affect their lives, makes contributions reserved of natural and cultural heritage embracing diversity, offer experiences for tourists with more meaningful connections with local people, culture, tradition, social and environmental, and also focus on culturally sensitive to create local pride by encourages respect between tourists and hosts (SustainableTourism, 2019). In fact, the notion of responsible tourism was much discussed since early 2000s and became an important element within the then emerging concept of sustainable tourism attracting a large-scale research interest in the idea that tourism-related actors can develop a sense of ethical and moral responsibility that has gone beyond self-interest with the ability to change behaviors paving a way towards the sustainable development in practice (Bill Bramwell; Bernard Lane; Scott McCab; Jan Mosedale; Caroline, 2008). At this point, it could be argued that the concept of responsible tourism is not a brand-new concept, but it is constantly developed according to the specific interdisciplinary and core issue at the certain time.

Towards the tourism industry, the idea of responsible travel is dynamic. It involves traveling in numerous forms such as length of stay per journey, selection of destinations closes to home, and transportation types that produce relatively fewer emissions. This concept is also echoed by the emerging slow tourism concept — an environmentally friendly way of experiencing journeys. The key ingredients of slow tourism include the importance of experiences in route to and at the destination, the enjoyment of local culture, and the use of low-carbon transportation modes based on a strong environmental consciousness. The essential spirit of slow tourism is the pursuit of quality over quantity (Sun & Malik, 2019)

Also, slow tourism had been developed and evolved in the tourism industry as an alternative way of conceptualizing responsible tourism. The slow tourism concept is significantly required not only holiday style choices that diverse among the tourists' self-identity and lifestyles. Nevertheless, also including transportation mode that the tourists chose. The transportation that is considered as slow tourism are namely walking, cycling, riding on a bus, and train, while the airplane and car are not facilitating the slow tourism (Dickinson, Lumsdon, & Robbins, 2011)

It is worth noting that the growth of tourism relatively has a negative impact on the environment and climate change; it is significant to build awareness, share knowledge, and inspire all related stakeholders in the tourism industry to promptly take action that will accelerate the shift towards a more sustainable tourism sector by complying policies, business operations and investments with the tourism and the Sustainable Development Goals – Journey to 2030 (World Tourism Organization and United Nations Development Programme, 2017). It could be argued that the growth of tourism has caused numerous unintended consequences to society and the economy at large, and the empirical evidence addressing this issue is still inconclusive. Therefore, a more concrete study on responsible tourism and a precise relationship to the carbon footprint via tourism activity must be explored.

In the academic area, responsible tourism is a well-established boundary relating to tourism research and is typically understood as a broad set of tourist interactions that engage with and benefit local communities and minimize negative social and environmental impacts (Robert Caruana; Sarah Glozera; Andrew Crane; ScottMcCabe, 2014)

2.4 Tourist destination in France

Undoubtedly, France is a destination for all regardless the nationality. France is the country that is always on top of the tourism destination to visit at all times. The country's attractiveness comprises a diversity of attractions, the fabulous tangible and intangible historical heritage, vitality of artistic creation, cultural and creative industries, language, the art of living, natural environments, and more importantly, the unparalleled opportunity for the shopping experience. Many cities and towns in France provide their specialized characteristics that can significantly capture tourist attention; it is considered a paradise for some.

Cities and towns in France are renowned for international and domestic visitors; even a relatively high living cost is observed. They shared common characteristics as its own the natural attractions and variety of transportation type within the area such as metro, train bus, bike or even on foot, which are suitable for the responsible tourism where tourist can enjoy the activities that less harmful to the environment. The researcher stated that tourist locations with more buildings contribute to the higher amount of total GHG emission in the previous study. (Cellura, Guarino, Longo, & Tumminia, 2018). Furthermore, those cities and towns have a greater potential in reducing the enormous amount of carbon footprint from the atmosphere due to a larger forest area (Hamdan, Abd Rahman, & Mimi, 2016). Therefore, there are seven key destinations mentioned in the study:

Pointe-à-Pitre city: it is the commercial center of Guadeloupe in the French overseas department of Guadeloupe, composed of a small group of enchanting islands. It is near the Salt River, which separates Grande-Terre from Basse-Terre Island. It is located on the southwest portion of the island of Grande-Terre, facing the Caribbean Sea, where the tourist can experience the combination of French tradition and Creole culture. (Encyclopedia Britannica, 2013).

The town of Pointe-à-Pitre: it is mesmerizing beauty of both lush tropical landscapes and the perfect beaches. It provides the magical atmosphere of the city while surrounded by natural attractions such as the Petit Cul-de-Sac Marin bay that offer a sheltered port, the Place de la Victoire colonial buildings and the Marché Saint-Antoine local market to shopping for spices, fruits, vegetables, local products and souvenirs. Also, the Petit Cul-de-Sac bay, Petit Cul-de-Sac Marin and the Le Gosier marina in a commune of Pointe-a-Pitre that offer a sheltered port and environmentally friendly activities. (Guadeloupe Islands Tourist, 2019).

Carcassonne: a hilltop town locates in southern France's Languedoc area; it is famous for its medieval citadel. Carcassonne is widely known for its medieval citadel, La Cité, with numerous watchtowers and double-walled fortifications. It also the place of a UNESCO Heritage Site, the Canal du Midi, where the tourist can enjoy the boat trip and enjoy spending time in nature. Moreover, it offers vineyards, wine caves, and magical castles such as the Château Comtel and ramparts, the Basilica of Saints Nazarius and Celsus, and the Bastide de Saint-Louis. Tourists can also enjoy the Lac de la Cavayère lake, 40 hectares of water, and pine woodland, with three small beaches perfect for enjoying peaceful getaways or a family picnic. (Pioli, 2017)

Leucate: it is a commune in the Aude department in southern France located between the Mediterranean Sea and the lagoon Étang de Leucate. It is best known for its lighthouse and port with various water activities for visitors to enjoy. While it still offers a variety of tourist attractions such as the small traditional village La Palme, the Sigean Nature Reserve - a vast terrain of 300 hectares with thousands of wild animals, and the Fort de Salses, which was listed as a Historic National Monument for over 100 years (France This Way, 2021)

Bordeaux: it is a port city located on the Garonne River in the heart of southwestern France; it is a well-known famed wine-growing region. It is a popular destination famous for the Gothic Cathédrale Saint-André, 18th- to 19th-century mansions, and notable art museums such as the Musée des Beaux-Arts de Bordeaux. For the natural attractions, there are the public gardens surrounded by the curving river quays. In 1998, UNESCO declared a Bordeaux since the city is an appealing tourist destination and surrounded by more than 350 buildings classified as historical monuments indicating a rich cultural heritage dating back to antiquity. (Alexander, 19 Top-Rated Tourist Attractions & Things to Do in Bordeaux, 2020)

Toulouse: it is the city in the capital of France's southern Occitanie region. It is bisected by the Garonne River and sits near the Spanish border. Due to its beautiful settings and the terra-cotta brick of buildings' architecture, it is known as the pink city (La Ville Rose). Its 17th-century Canal du Midi connected with the Garonne to the Mediterranean Sea. Toulouse is renowned for the UNESCO-listed Basilique Saint-Sernin, its archaeology, fine arts museums, and its local culture. Visitors can walk around the Place du Capitole to discover the red-brick architectural landmarks. (Alexander, 16 Top Tourist Attractions & Things to Do in Toulouse, 2021)

Paris: it is France's capital that is a major European city and a global center for art, fashion, gastronomy, and culture. The city has always been the top tourist destination due to its spectacular atmosphere. It always has a reputation for the city of love with the Eiffel Tower as the city symbolic, the Louvre Museum, and the Gothic Notre-Dame cathedral from the 12th-century. It is also known for its cafe culture and famous designer boutiques along the Rue du Faubourg Saint-Honoré (Paris Discovery Guide, 2021)

2.5 Theoretical Framework

Based on literature reviews and previous studies, the theoretical framework under this investigation can be drawn for the data analysis in the following part. Independent variables contain two groups of variables: transportations and accommodations. Transportations consist of a series of transport types such as plane, train, bus, and car. Accommodations include friend's place, Airbnb, 2-star hotel, and 5-star hotel.

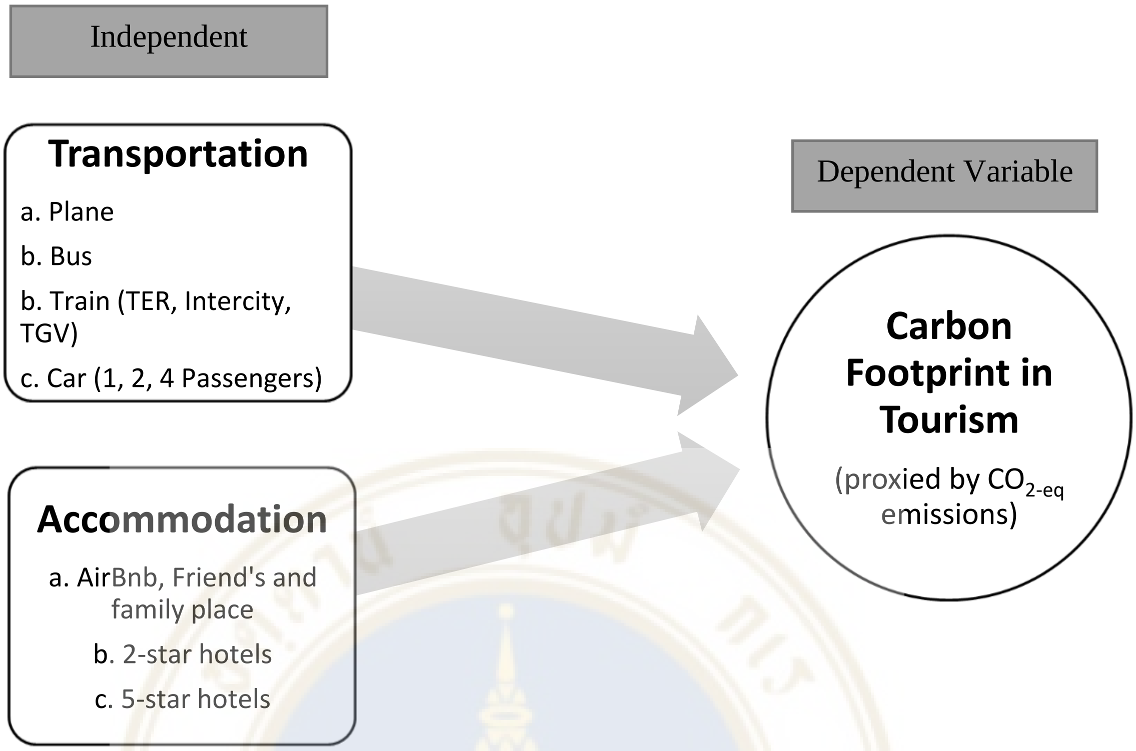

Figure 2.7 Theoretical Framework

CHAPTER III
METHODOLOGY

3.1 Research Methodology

This part illustrates the research methodology for investigation under the context of the tourism carbon footprint emission. This study uses the secondary data analysis technique to estimate the result of simulation trips and their scenarios. The secondary data sources were combined to simulate the virtual scenarios for comparison with the actual previous trip.

A supplement for each scenario's validity and reliability was reassured based on the estimation technique with robust analysis. The researcher selected an interview method as a research instrument to gain more insight into data collection from three French citizens who completed their trips only in France within its vicinity areas in the past two years.

This study is based on the domestic travel analysis in France and its territories by focusing on two critical factors contributing to the $CO_{2\text{-eq}}$ emission: Transportations and Accommodations. In the following analysis part, identifying sub-determinants affecting the $CO_{2\text{-eq}}$ emission in each type of transportations and accommodation is also demonstrated. However, it should be noted that the calculation is designed to only focus on the individual level of the $CO_{2\text{-eq}}$ emission, regardless of the number of people accompanying a similar trip.

3.2 Data Collection and Data Sources

The data collection in this study is collected from secondary data sources. The data source in this part includes the source from accommodation and transportation types to estimate the carbon equivalent emissions. There are five data sources to collect the GHG emission factors that use for calculating the emission of accommodation and transportation; each consists of the subsequent factors. See full descriptions below:

3.2.1 Accommodation

3.2.1.1 Apartment (Airbnb, Family's place and Friend' place)

Table 3.1 GHG emission factors of Airbnb, Family's place and Friend' place

Consumption Type	Geographic Scope	Emission Factors	Data Source
Water	UK	0.00298 kg $CO_{2\text{-}eq}$/liter	Water UK (2008)
Electricity	France	0.065 kg $CO_{2\text{-}eq}$/kWh	Energy Regulatory Commission (CRE) (https://www.rte-france.com/eco2mix/les-emissions-de-co2-par-kwh-produit-en-france) * Data are fluctuating depending on the time and day; this study took an average

3.2.1.2 Hotels - according to the Hotel Foot printing Tool (Greenview Hospitality, 2020), this data was based on studying the median value from Hotel Sustainability Benchmarking Index 2020: Carbon, Energy, and Water (Ricaurte & Jagarajan, 2020). This research estimated the room carbon footprint of the hotel segments by city and country worldwide. In this matter, the researcher intends to use this data to calculate the simulation trips and the 2-star and 5-star hotels' scenario analysis.

Table 3.2 GHG emission factors of hotels

Destination	Accommodation Type	Emission Factors (gCO_{2-eq}/room)	Data Source
Pointe-à-Pitre	2-star hotel	9	Hotel Sustainability Benchmarking Index 2020: Carbon, Energy, and Water, 2020 - (https://www.hotelfootprints.org/footprinting)
	5-star hotel	55	
Carcassonne	2-star hotel	2	
	5-star hotel	14	
Leucate	2-star hotel	2	
	5-star hotel	14	
Bordeaux	2-star hotel	2	
	5-star hotel	14	
Toulouse	2-star hotel	2	
	5-star hotel	14	
Paris	2-star hotel	No data	
	5-star hotel	No data	

3.2.2. Transportation

3.2.2.1 Mode of Transportation factor: UK dataset - all data is retrieved from the UK Department for Business, Energy & Industrial Strategy (BEIS), 2019. Since the data collection of France transportation type under this examination is quantitatively limited, such as car, plane, and bus. The researcher then decided to employ the UK's data source, which is considered more conclusive and can use as a reference compared to France.

Table 3.3 GHG emission factors by Mode of Transportation

Mode of Transportation	Emissions Factors ($gCO_{2\text{-}eq}/km$)	Data Source
Black cab (taxi)	211.76	UK Department for Business, Energy & Industrial Strategy (BEIS), 2019 - (https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019)
Bus	104.71	
Coach	27.79	
Diesel car, 2 passengers	85.305	
Diesel car, 4 passengers	42.6525	
Domestic flight	254.93	
Eurostar (international rail)	5.97	
Ferry (car passenger)	129.518	
Ferry (foot passenger)	18.738	
Large car (diesel)	209.47	
Large car (hybrid)	131.77	
Large car (petrol)	282.95	
Large car (plug-in hybrid electric)	77.31	
Large electric vehicle (UK electricity)	66.88	
Light rail and tram	35.08	
London Underground	30.84	
Long-haul flight (business class)	434.46	
Long-haul flight (economy)	149.81	
Long-haul flight (economy+)	239.7	
Long-haul flight (first class)	599.25	

Table 3.3 GHG emission factors by Mode of Transportation (cont.)

Mode of Transportation	Emissions Factors (gCO_{2-eq}/km)	Data Source
Medium car (diesel)	170.61	UK Department for Business, Energy & Industrial Strategy (BEIS), 2019 - (https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019)
Medium car (hybrid)	108.95	
Medium car (petrol)	192.28	
Medium car (plug-in hybrid electric)	70.83	
Medium electric vehicle (UK electricity)	53.17	
Motorcycle (large)	135.01	
Motorcycle (medium)	102.89	
Motorcycle (small)	84.45	
National rail	41.15	
Petrol car, 2 passengers	96.14	
Petrol car, 4 passengers	48.07	
Short-haul flight (business class)	233.6	
Short-haul flight (economy)	155.73	
Small car (diesel)	142.08	
Small car (hybrid)	105.2	
Small car (petrol)	153.71	
Small car (plug-in hybrid electric)	29.35	
Small electric vehicle (UK electricity)	45.67	
Taxi	150.18	

3.2.2.2 Mode of Transportation factor: France dataset - the information from "Information on the quantity of Greenhouse gas issued in the opportunity of a transportation service" by SNCF, the French National Railway Company demonstrated (The Société nationale des chemins de fer français, 2020). This dataset was used to calculate the emission of bus, TGV, TER, and intercity train as the specific data for France is available. Later, the framework for analysis will align with the GHG emission to reaffirm the validity and accuracy of the scenarios' results.

Table 3.4 GHG emission factors by Mode of Transportation – France dataset

Mode of Transportation	Emissions Factors ($kgCO_{2-eq}/km$)	Source
Bus	0.104	The Société nationale des chemins de fer français (SNCF) – (https://www.transilien.com/fr/page-corporate/calcul-emissions-co2)
National rail - TGV	0.0019	
National rail - Intercity	0.00529	
National rail - TER	0.02481	
Metro	0.0025	

3.3 Carbon footprint assessment

To assess the certain amount of carbon footprint, this research attempt to navigate almost 30 calculators that available on the market, it is unfortunate that there are not specific tools for the tourism sectors, the carbon equivalents tools that available are mainly for the household emission, only some include the tourism activities during the year. However, this study adopts the calculation technique from United Nations carbon offset platform (United Nations Framework Convention on Climate Change, 2021). The calculation was divided by two segments: transportation and accommodation, then the transportation mode and accommodation type. The calculation details are shown in table 3.5.

Table 3.5 Carbon footprint assessment

Type			Calculation
Transportation			Travel Distance * GHG emission factor by transportation mode
Accommodation	**2.1 Hotels**	**2.1 Hotels**	Number of Day * GHG emission factor by hotels
	2.2 Airbnb, Friend, and family’s place	**2.2.1 Electricity**	(Quantity Electricity consumption * GHG emission factor) * Number of Days
		2.2.2 Water	(Quantity Water consumption * GHG emission factor) * Number of Days

CHAPTER IV
FINDINGS AND DISCUSSION

4.1 Simulation trip analysis

This section revealed the empirical findings based on the prior scenario's analysis methodology based on the simulation trips compare to the different scenarios. Detailed information included estimating the $CO_{2\text{-}eq}$ emission while traveling performed by three French masters' degree students concerning their recent trip in France and nearby locations.

Based on the recent study detailed in the literature review, this discussion bases the $CO_{2\text{-}eq}$ emission calculation on two separated segments: transportation and accommodations. These two are the significant components contributing to the carbon footprint while traveling. The transport segment includes the entire trips made during the journey emitting the $CO_{2\text{-}eq}$. It comprised bus, metro, train, plane, car, etc. The accommodation segment covers the carbon footprint emissions involving the place of residence and includes water and electricity consumption.

Therefore, this study will examine four trips in total. Four of them have different characteristics such as duration of stays, distance traveled, transport mode, and accommodations. The details for each trip shown below.

Table 4.1 Patterns and characteristics of four domestic trips in France

Trip	Type	Durations	Distance	Transportation	Accommodation
1. Tarbes to Pointe-à-Pitre	Long Trip	18 days	15,188 Km.	Plane, Car	Family's Place
2. Toulouse to Carcassonne	Single-day trip	1 day	186.6 Km.	Train (TGV)	None
3. Toulouse to Leucate	Short trip	7 days	719.2 Km.	Car	Apartment (Airbnb)
4. Tarbes to several cities in France	Short trip	13 days	1,888 Km.	Train (TGV), Metro	Friend's place

4.1.1 Trip 1 - From Tarbes to Pointe-à-Pitre in Guadeloupe

This scenario is for an 18-day trip completed in December 2020. The duration for this trip could be considered an average tourist season. The traveler traveled alone from Tarbes, France, to join her family living in Pointe-à-Pitre, the commercial capital of Guadeloupe, located on the Southwest of Grande-Terre Island, facing the Caribbean Sea in France. The traveler stayed directly in her family home; she did not rent a place to stay.

4.1.1.1 Transportation - The mean of transportation computation was divided into two parts. First, the tourists travel by plane 1. Plane (economy class) domestic flight from Tarbes to Pointe-a-Pitre. The domestic flight's total distance was 587 km or equivalent to 1,174 km round trip. 2 Plane (economy class) long-haul flight from Paris to Pointe-à-Pitre. The length of the flight was 6,757 km or 13,514 km round trip. The second part is the travel by bus during the trip (on the island) - When the traveler was in Guadeloupe, the travelers use a car as the main transportation during the trip traveling within the island. The car was a medium-sized petrol car that belongs to her relatives. She mentioned that within those 18 days, she commuted approximately 500 km. Other than that, she walked around the city. Therefore, it was not included in this scenario.

4.1.1.2 Accommodation - As mentioned above, the traveler was hosted by her family in an individual house. The house was about 150 m², and we were three adults living there. To compute the carbon emission emissions related to this housing, it will be divided into two segments: electricity and water consumption. 1. Electricity – To estimate the electricity consumption during her travel, it can be assumed from the house size data in France that usually cost the electricity consumption is around 7,500 kWh per year._2. Water - The estimation of water consumption is done based on different consumptions such as shower, dishwasher, washing machine etc. She estimated that based on her normal behavior, she consumed 128 liters of water per day.

4.1.2 Trip 2 - From Toulouse to Carcassonne

This scenario took place from Toulouse, France, to Carcassonne, the city in Aude. It was a one-day domestic trip. Carcassonne is a French fortified city in the department of Aude, located in the region of Occitanie. The distance between these two cities is around 186.6 kilometers (round trip). This trip was taken in the peak season of summer in 2019.

4.1.2.1 Transportation - The transportation from Toulouse to Carcassonne was made by the TGV train, a high-speed train that connects Paris with major cities in France. The distance during her single-day trip was 186.6 kilometers in total.

4.1.2.2 Accommodation - Since this was a single-day trip, there was no accommodation during the trip, which is considered a benefit to the environment.

4.1.3 Trip 3- From Toulouse to Leucate

The scenario was a 7-day domestic trip that was made in February 2019. The tourist starts from Toulouse to Leucate in France. Leucate is a city located in the Aude department in southern France.

4.1.3.1 Transportation - For this trip, the traveler used only the petroleum medium car to commute for one week. She used it every day with four passengers in the same car. The total traveled distance was 719.2 kilometers.

4.1.3.2 Accommodation – Similar to trip 1, the traveler was spending the night at Airbnb. The accommodation was 30m² with four people sharing the same room. To calculate the $CO_{2\text{-eq}}$ emissions related to lodging, this study focuses on two elements, electricity and water consumption. First, the accommodation's electricity, the tourist decided to spend the night at an Airbnb for the week. The apartment is 30 square meters, which she spent seven days in total. Using the average of 50 kWh per m^2 per year, she approximately used 28.77 kWh for these seven-day trips. It represented 7.19 kWh per person. Second, the water consumption estimated the quantity used as 296 liters per day for four people and so 74 liters/day/person.

4.1.4 Trip 4 - From Tarbes to several cities in France

This scenario is for a 13-day round trip done in France in January 2021. This period could be considered as a low tourist season. The traveler traveled alone to meet her friends and family; the destination was located in different parts of France. She started the Tarbes journey and spent five days in Toulouse, then three days in Paris, and finally five days in Bordeaux. During the trip, she only stayed at a friend's apartment. Thus, she did not book any Airbnb, Hotel or Hostel

4.1.4.1 Transportation - During the trip, she used only low emission means of transport, including train and metro. The first mode of transportation was the TGV train which was from Tarbes to Toulouse. The traveled distance between these two cities was 158 kilometers. The second, third, and fourth routes of the journey took the TGV for 1,690 kilometers. Then, the tourist used the metro during the trip; once in the different cities she visited, she commuted by metro three times; in Paris, over a total distance of about 40 km. was recorded.

4.1.4.2 Accommodation - For the housing side, as mentioned above, she did not book any hotel, Airbnb, or hostel. She only stayed at a friend's apartment. During the trip, the traveler stayed in an $80m^2$ flat with two people living inside. The computation of carbon emissions will be separated into two parts. First, the electricity, for a house of this size in France, it can be assumed that the electricity consumption is around 167 kWh/month/person. Second, water, the estimation of water consumption is done based on different consumptions such as shower, dishwasher, washing machine etc. The daily water consumption was previously estimated in trip 1. She was consuming, on average, 128 liters of water per day.

4.2 Scenarios analysis

Scenario's analysis is consistent with the research objectives aiming to examine the carbon footprint results made while traveling via a different mode of transportations and typology of accommodations.

In this matter, nine scenarios for each original trip were simulated based on the respondents' empirical data collection. To develop the realistic scenarios corresponding to travelers' actual behaviors, this study concerns the sensitivity and reliability of each scenario simulated with a customized criterion. For example, the first trip, Tarbes to Pointe-à-Pitre in Guadeloupe, was a long-distance travel distance (15,188 kilometers,) which is not reasonable to create the scenario metro or bus. While the second trip, Toulouse to Carcassonne, was a short-day trip with only 186.6 kilometers of travel distance; hence it was not logical to commute by airplane.

At this point, one simulation trip is formulated together with different scenarios for comparison. The scenarios used in this research include four simulation trips and 36 scenarios (a total of 40 scenarios). The table in Microsoft Excel will be used to represent the comparative findings across the diverse scenarios.

Table 4.2 The scenarios of each simulation trip

Trip	Transportation	Accommodation
1. Tarbes to Pointe-à-Pitre	Scenario 1 (Bus) Scenario 2 (Train, TER) Scenario 3 (Train, Intercity) Scenario 4 (Train, TGV) Scenario 5 (Car, four passengers) Scenario 6 (Car, 2 passengers) Scenario 7 (Car, 1 passenger)	Scenario 8 (2-star hotel) Scenario 9 (5-star hotel)
2. Toulouse to Carcassonne	Scenario 1 (Plane) Scenario 2 (Bus) Scenario 3 (Train, TER) Scenario 4 (Train, Intercity) Scenario 5 (Car, 4 passengers) Scenario 6 (Car, 2 passengers) Scenario 7 (Car, 1 passenger)	Scenario 8 (2-star hotel) Scenario 9 (5-star hotel)
3. Toulouse to Leucate	Scenario 1 (Plane) Scenario 2 (Bus) Scenario 3 (Train, TER) Scenario 4 (Train, Intercity) Scenario 5 (Train, TGV) Scenario 6 (Car, 2 passengers) Scenario 7 (Car, 1 passenger)	Scenario 8 (2-star hotel) Scenario 9 (5-star hotel)
4. Tarbes to several cities in France	Scenario 1 (Plane) Scenario 2 (Bus) Scenario 3 (Train, TER) Scenario 4 (Train, Intercity) Scenario 5 (Car, 4 passengers) Scenario 6 (Car, 2 passengers) Scenario 7 (Car, 1 passenger)	Scenario 8 (2-star hotel) Scenario 9 (5-star hotel)

4.3 Carbon footprint assessment of the scenarios

4.3.1 Trip 1 - From Tarbes to Pointe-à-Pitre in Guadeloupe

Table 4.3 Carbon footprint emission of Trip 1 and its scenarios

1. Tarbes to Pointe-à-Pitre	Simulation Trip	Scenario 1 (Bus)	Scenario 2 (Train, TER)	Scenario 3 (Train, Intercity)	Scenario 4 (Train, TGV)	Scenario 5 (Car, 4 passengers)	Scenario 6 (Car, 2 passengers)	Scenario 7 (Car, 1 passenger)	Scenario 8 (2-star hotel)	Scenario 9 (5-star hotel)
Transportation										-
Plane	2326	-	-	-	-	-	-	-	2326	2326
Bus	-	1528	-	-	-	-	-	-	-	-
Train (TER)	-	-	364	-	-	-	-	-	-	-
Train (Intercity)	-	-	-	78	-	-	-	-	-	-
Train (TGV)	-	-	-	-	28	-	-	-	-	-
Car (4 passengers)	-	-	-	-	-	705	-	-	-	-
Car (2 passengers)	-	-	-	-	-	-	1410	-	-	-
Car (1 passenger)	-	-	-	-	-	-	-	2820	-	-
Car (during trip)	48	48	48	48	48	48	48	48	48	48
Metro (during trip)	-	-	-	-	-	-	-	-	-	-
Total - Transport (kg CO_2-eq)	2674	1576	412	126	76	753	1458	2868	2674	2674
Accommodation	-	-	-	-	-	-	-	-	-	-
Family's place	9	9	9	9	9	9	9	9	-	-
Airbnb	-	-	-	-	-	-	-	-	-	-
2-stars hotel	-	-	-	-	-	-	-	-	81	-
5-stars hotel	-	-	-	-	-	-	-	-	-	495
Total - Accommodation (kg CO_2-eq)	9	9	9	9	9	9	9	9	81	495
Total kg CO_2-eq per TRIP	**2683**	**1584**	**421**	**134**	**85**	**762**	**1467**	**2877**	**2755**	**3169**
Total kg CO_2-eq per Day	**149.0**	**88.0**	**23.4**	**7.5**	**4.7**	**42.3**	**81.5**	**159.8**	**153**	**176**
Total kg CO_2-eq per Km.	**0.18**	**0.10**	**0.03**	**0.01**	**0.01**	**0.05**	**0.10**	**0.19**	**0.18**	**0.21**
Total kg CO_2-eq per trip CHANGE(%)	**0%**	**-41%**	**-84%**	**-95%**	**-97%**	**-72%**	**-45%**	**7%**	**3%**	**18%**

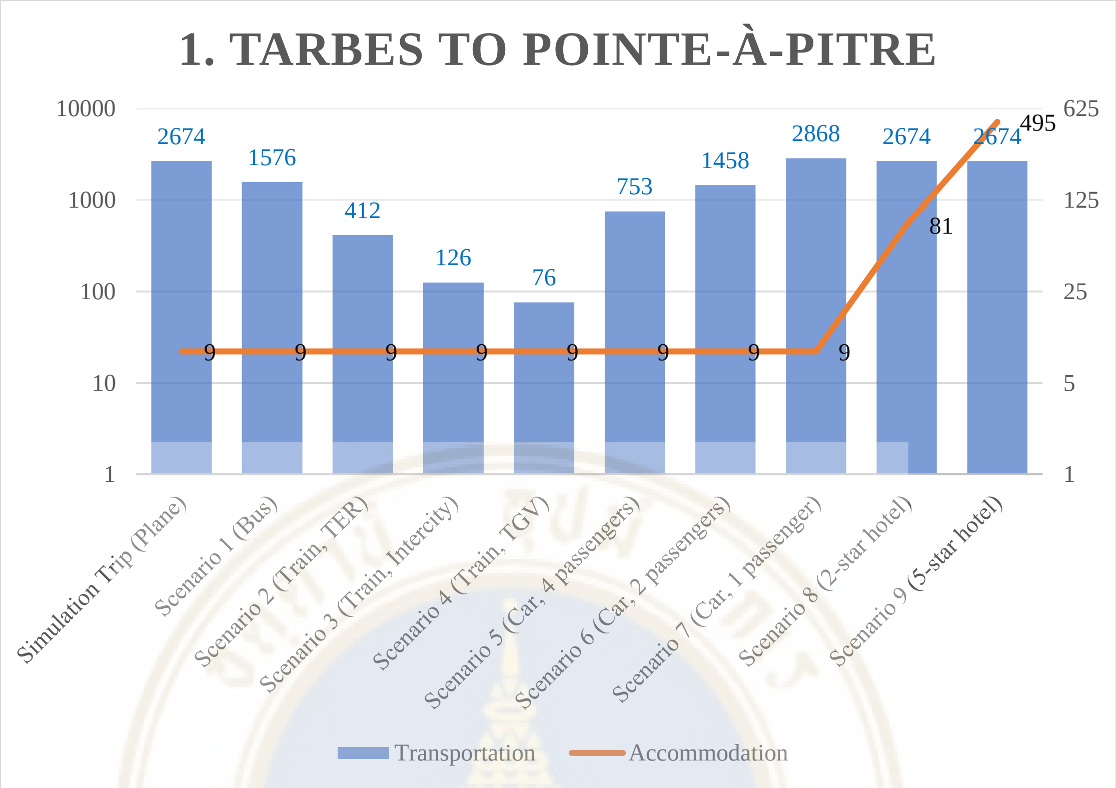

Figure 4.1 Comparing of Carbon footprint emission between Trip 1 and its scenarios

The first simulation trip is an 18-day trip from Tarbes to Pointe-à-Pitre in Guadeloupe, which is considered a long domestic trip; it was considered a long distance (15,118 km.). Therefore, it was evident that the domestic plane and car's simulation trip was selected as the mode of transportations, contributing around 99.7% of the total trip emission. This also depended on the time spent at night with her family's house producing a relatively low carbon footprint (0.3%).

For scenarios 2 to 7, the calculation was intended to test the carbon equivalent emission by different transportation types. The bar graph and table represent the variation of eight alternative ways for travel; the medium car (Petrol) with one passenger on board slightly produces more emissions than the airplane, 2868 kg $CO_{2\text{-eq}}$ and 2674 kg $CO_{2\text{-eq}}$, respectively. The lowest mode of transportation is the TGV train, merely generating 76 kg $CO_{2\text{-eq}}$, compared to the simulation trip; it reduces the total trip emission down by 97% (85 kg $CO_{2\text{-eq}}$), followed by the Intercity train, the TER train, the medium car (Petrol) with four passengers and the bus.

The bar chart evidently indicated that the simulation trip at family's place originating the lowest emission level on the accommodation segment. With the 2-star and 5-star hotels in the Pointe-à-Pitre region, the emission rate dramatically increased from 9 kg CO_{2-eq} to 81 kg CO_{2-eq} for the 2-star hotels and 495 kg CO_{2-eq} for the luxury hotels. This phenomenon affected the total trip emission that went up, skyrocketing by 3% and 18%.

By comparing the emission rate to the number of days, the simulation trip is emitted roughly around 149 kg CO_{2-eq}. From scenario analysis, the highest GHG emission per day is from scenario 9 with the 5-star hotels at 176 kg CO_{2-eq} daily, closely followed by the car with one passenger in scenario 7 (153 kg CO_{2-eq}) and the 2-star hotels in scenario 8 (159.8 kg CO_{2-eq}).

For the Carbon footprint emission relating to the distance travel, the airplane's simulation trip emitted around 0.18 kg CO_{2-eq} per kilometer travel. Simultaneously, the highest scenario produced emission per kilometer from the 5-star hotel in scenario eight and the 2-star hotel in scenario 7, which still use the airplane as the main transportation, it released 0.21 and 0.18 kg CO_{2-eq} per kilometer, respectively. On the contrary, the Intercity and TGV train produced just 0.01 kg CO_{2-eq} per kilometer. The TER train is considered an excellent choice producing only 0.03 kg CO_{2-eq} while traveling by car accompanied by four passengers discharged slightly higher at 0.05 kg CO_{2-eq}.

4.3.2 Trip 2 - From Toulouse to Carcassonne

Table 4.4 Carbon footprint emission of Trip 2 and its scenarios

2. Toulouse to Carcassonne	Simulation Trip	Scenario 1 (Plane)	Scenario 2 (Bus)	Scenario 3 (Train, TER)	Scenario 4 (Train, Intercity)	Scenario 5 (Car, 4 passengers)	Scenario 6 (Car, 2 passengers)	Scenario 7 (Car, 1 passenger)	Scenario 8 (2-star hotel)	Scenario 9 (5-star hotel)
Transportation										
Plane	-	48	-	-	-	-	-	-	-	-
Bus	-	-	19	-	-	-	-	-	-	-
Train (TER)	-	-	-	5	-	-	-	-	-	-
Train (Intercity)	-	-	-	-	1	-	-	-	-	-
Train (TGV)	0.35	-	-	-	-	9	-	-	0.35	0.35
Car (4 passengers)	-	-	-	-	-	-	18	-	-	-

2. Toulouse to Carcassonne	Simulation Trip	Scenario 1 (Plane)	Scenario 2 (Bus)	Scenario 3 (Train, TER)	Scenario 4 (Train, Intercity)	Scenario 5 (Car, 4 passengers)	Scenario 6 (Car, 2 passengers)	Scenario 7 (Car, 1 passenger)	Scenario 8 (2-star hotel)	Scenario 9 (5-star hotel)
Car (2 passengers)	-	-	-	-	-	-	-	36	-	-
Car (1 passenger)	-	-	-	-	-	-	-	-	-	-
Car (during trip)	-	-	-	-	-	-	-	-	-	-
Metro (during trip)	-	-	-	-	-	-	-	-	-	-
Total - Transport (kg CO_2-eq)	0.35	48	19	5	1	9	18	36	0.35	0.35
Accommodation	-	-	-	-	-	-	-	-	-	-
Family's place	-	-	-	-	-	-	-	-	-	-
Airbnb	-	-	-	-	-	-	-	-	-	-
2-stars hotel	-	-	-	-	-	-	-	-	-	-
5-stars hotel	-	-	-	-	-	-	-	-	1	7
Total - Accommodation (kg CO_2-eq)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	7.00
Total kg CO_2-eq per TRIP	0.35	47.58	19.41	4.63	0.99	8.96	17.91	35.83	1.35	7.35
Total kg CO_2-eq per Day	0.35	47.58	19.41	4.63	0.99	8.96	17.91	35.83	1.35	7.35
Total kg CO_2-eq per Km.	0.002	0.26	0.10	0.02	0.01	0.05	0.10	0.19	0.01	0.04
Total kg CO_2-eq per trip CHANGE(%)	0%	13321%	5374%	1206%	178%	2426%	4953%	10005%	282%	1974%

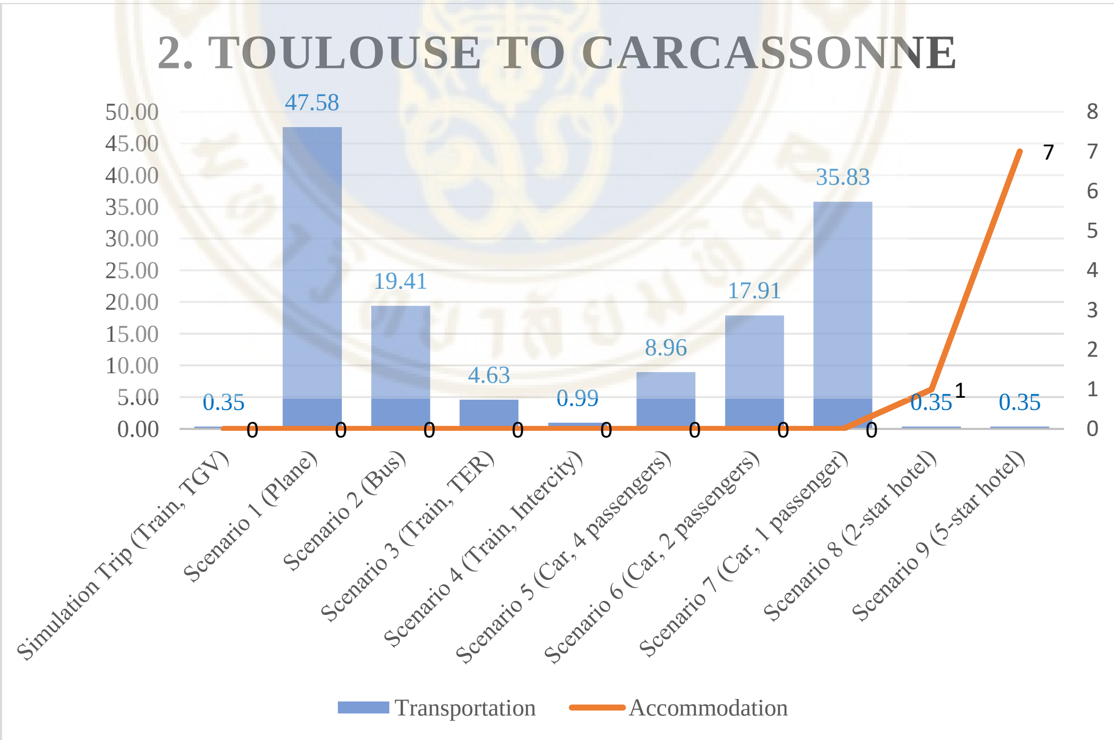

Figure 4.2 Comparing of Carbon footprint emission between Trip 2 and its scenarios

This second sample is a single-day trip from Toulouse to Carcassonne; it is the shortest trip in the study. Only 186.6 kilometers traveled; therefore, there is no accommodation included in the simulation trip. Scenario 2 to 7 of total trip emissions are from transportation. The main transportation is the TGV train that tourists commute from Toulouse to Carcassonne, only producing around 0.35 kg CO_{2-eq}. For the transportation segment, the highest emission type is the domestic airplane at 47.58 05 kg $CO_{2-eq.}$ The lowest contribution is from the Intercity train (0.99 kg CO_{2-eq}), the TER train (4.63 kg CO_{2-eq}), and the medium car with four passengers (8.96 kg CO_{2-eq}).

To examine the impact of accommodation type on carbon footprint emission, this study creates scenarios 8 and 9 whereby the tourist spends one night in the hotel located in Toulouse city. It undoubtedly shows that one night stay in the 5-star hotel in Toulouse city emits seven times higher than the 2-star hotel, which released 7 and 1 kg CO_{2-eq}.

According to the total emission per kilometer for this day trip, the simulation trip produced lower emission at 0.002 kg CO_{2-eq} per kilometer, closely followed by the Intercity train at 0.01 and the TER train 0.02 kg CO_{2-eq} per kilometer. While the medium car with 4 passengers in Scenario 5 released 0.05 kg CO_{2-eq} per passenger-kilometer. The biggest contribution per travel distance is evidently from the plane's trip in the first scenario releasing around 0.026 kg CO_{2-eq}. The car with one passenger also produced nearly the plane did; that is it emitted by 0.19 kg CO_{2-eq} for one kilometer of traveling.

4.3.3 Trip 3 - From Toulouse to Leucate

Table 4.5 Carbon footprint emission of Trip 3 and its scenarios

3. Toulouse to Leucate	Simulation Trip	Scenario 1 (Plane)	Scenario 2 (Bus)	Scenario 3 (Train, TER)	Scenario 4 (Train, Intercity)	Scenario 5 (Train, TGV)	Scenario 6 (Car, 2 passengers)	Scenario 7 (Car, 1 passenger)	Scenario 8 (2-star hotel)	Scenario 9 (5-star hotel)
Transportation										
Plane	-	183	-	-	-	-	-	-	-	-
Bus	-	-	75	-	-	-	-	-	-	-
Train (TER)	-	-	-	18	-	-	-	-	-	-
Train (Intercity)	-	-	-	-	4	-	-	-	-	-
Train (TGV)	-	-	-	-	-	1	-	-	-	-
Car (4 passengers)	35	-	-	-	-	-	69	-	35	35

3. Toulouse to Leucate	**Simulation Trip**	**Scenario 1 (Plane)**	**Scenario 2 (Bus)**	**Scenario 3 (Train, TER)**	**Scenario 4 (Train, Intercity)**	**Scenario 5 (Train, TGV)**	**Scenario 6 (Car, 2 passengers)**	**Scenario 7 (Car, 1 passenger)**	**Scenario 8 (2-star hotel)**	**Scenario 9 (5-star hotel)**
Car (2 passengers)	-	-	-	-	-	-	-	138	-	-
Car (1 passenger)	-	-	-	-	-	-	-	-	-	-
Car (during trip)	-	-	-	-	-	-	-	-	-	-
Metro (during trip)	-	-	-	-	-	-	-	-	-	-
Total - Transport (kg CO_2-eq)	35	183	75	18	4	1	69	138	35	35
Accommodation										
Family's place	-	-	-	-	-	-	-	-	-	-
Airbnb	-	0.6	0.6	0.6	0.6	0.6	0.6	0.6	-	-
2-stars hotel	-	-	-	-	-	-	-	-	7.0	-
5-stars hotel	-	-	-	-	-	-	-	-	-	49.0
Total - Accommodation (kg CO_2-eq)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.0	49.0
Total kg CO_2-eq per TRIP	**35**	**184**	**75**	**18**	**4**	**2**	**70**	**139**	**42**	**84**
Total kg CO_2-eq per Day	**2**	**10**	**4**	**1**	**0**	**0**	**4**	**8**	**2**	**5**
Total kg CO_2-eq per Km.	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total kg CO_2-eq per trip CHANGE(%)	**0%**	**424%**	**115%**	**-47%**	**-87%**	**-94%**	**98%**	**295%**	**18%**	**138%**

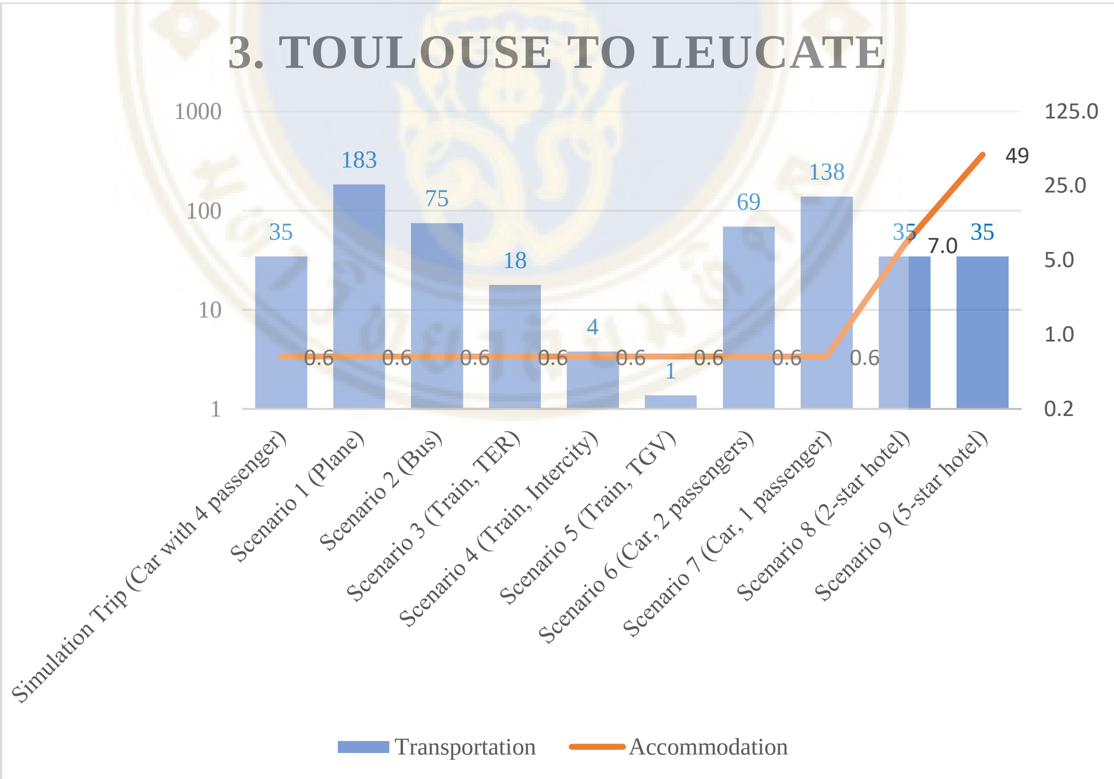

Figure 4.3 Comparing of Carbon footprint emission between Trip 3 and its scenarios

The fourth trip from Toulouse to Leucate is a 7-day trip with 719.2 distance travel for the whole trip. The tourist uses the medium car (petrol) throughout the trip, and she stays in the Airbnb with her friend. This becomes the main reason to argue the accommodation segment only produced 0.6 kg of carbon equivalent, accounting for 98% of the total trip emission. In comparison, traveling by car released 35 kg $CO_{2\text{-eq}}$ equal to 2% of the entire trip.

The carbon equivalent emission analysis by a different type of transportation in scenario 2 to scenario 7 was obvious; the empirical result signified that the airplane produces the highest amount at 183 kg $CO_{2\text{-eq}}$ among those eight ways of transportation. The second-largest emission mode is the medium car (Petrol), with one passenger responsible for 138 kg of carbon footprint emission. The bus and the car with two passengers emitted roughly around 75 and 69 kg $CO_{2\text{-eq}}$, respectively.

However, the lowest transportation mode is the TGV train that only produced only 1 kg $CO_{2\text{-eq}}$, compared to the simulation trip, reducing the total trip emission down by 94% (2 kg $CO_{2\text{-eq}}$). The Intercity train, the TER train, the medium car (Petrol) with four passengers and the bus released 4, 18 and 35 kg $CO_{2\text{-eq}}$.

For the accommodation category, the bar chart indicates that the simulation trip at Airbnb apartment led to the lowest carbon equivalent emission. The hotel's accommodating in Leucate city sharply drives the emission rate from 0.6 kg $CO_{2\text{-eq}}$ to 7 kg $CO_{2\text{-eq}}$ for the budget hotel and 49 kg $CO_{2\text{-eq}}$ for the luxury hotel. These findings disclosed that the accommodation type also affects the total trip emission that dramatically increased by 18% and 138% compared to the original trip.

By comparing the emission rate to the number of days, the simulation trip daily emission is 35 kg $CO_{2\text{-eq}}$. From the scenario analysis, the highest emission per day is from scenario 9 with the plan as the mean of transportation, accounting for 10 kg $CO_{2\text{-eq}}$ each day. To travel by car with only one person on board also produce a substantial daily number of emissions at 7.7 kg $CO_{2\text{-eq}}$, then closely follow by the bus, the 5-star hotel, and the car with two passengers, it contributes the daily carbon footprint at 4.6, 4.2, and 3.9 kilograms of carbon equivalent.

Another substantial factor is the distance travel in the trip versus the total carbon footprint emission; since the simulation trip use by a medium petrol car that accommodates four passengers, the total individual emission is 0.0489 kg $CO_{2\text{-eq}}$ per kilometer travel. In the scenario analysis, the scenario producing the highest emission per kilometer came from the airplane releasing around 0.2559 kg CO_{2-eq} each kilometer., while the car with one passenger produced at 0.1929 kg CO_{2-eq} per kilometer, the 5-star hotel in scenario eight responsible for 0.1161 kg CO_{2-eq}, and the bus release 0.1049 kg of carbon equivalent per one kilometer travel.

On the other hand, the TGV train considers the most effective way of transportation; it originated only 0.0028 kg CO_{2-eq} per kilometer. The intercity train is also a practical choice promoting environmental awareness. It released just around 0.0062 kg CO_{2-eq} per kilometer; In contrast, the TER train produced a slightly higher emission rate at 0.0257 kg CO_{2-eq} and the 2-star hotel scenario at 0.0577 kg CO_{2-eq} accordingly.

4.3.4 Trip 4- From Tarbes to several cities in France

Table 4.6 Carbon footprint emission of Trip 4 and its scenarios

4. Tarbes to several cities in France	Simulation Trip	Scenario 1 (Plane)	Scenario 2 (Bus)	Scenario 3 (Train, TER)	Scenario 4 (Train, Intercity)	Scenario 5 (Car, 4 passenger)	Scenario 6 (Car, 2 passengers)	Scenario 7 (Car, 1 passengers)	Scenario 8 (2-star hotel)	Scenario 9 (5-star hotel)
Transportation										
Plane	-	471	-	-	-	-	-	-	-	-
Bus	-	-	192	-	-	-	-	-	-	-
Train (TER)	-	-	-	46	-	-	-	-	-	-
Train (Intercity)	-	-	-	-	10	-	-	-	-	-
Train (TGV)	5	-	-	-	-	-	-	-	5	5
Car (4 passengers)	-	-	-	-	-	89	-	-	-	-
Car (2 passengers)	-	-	-	-	-	-	177	-	-	-
Car (1 passenger)	-	-	-	-	-	-	-	355	-	-
Car (during trip)	-	-	-	-	-	-	-	-	-	-
Metro (during trip)	1	1	1	1	1	1	1	1	1	1
Total - Transport (kg CO_2-eq)	5	472	193	47	11	90	179	356	5	5
Accommodation										
Family's place	5	5	-	-	-	-	-	-	-	-
Airbnb	-	-	-	-	-	-	-	-	-	-
2-stars hotel	-	-	-	-	-	-	-	-	-	-
5-stars hotel	-	-	-	-	-	-	-	-	-	-

4. Tarbes to several cities in France	Simulation Trip	Scenario 1 (Plane)	Scenario 2 (Bus)	Scenario 3 (Train, TER)	Scenario 4 (Train, Intercity)	Scenario 5 (Car, 4 passenger)	Scenario 6 (Car, 2 passengers)	Scenario 7 (Car, 1 passengers)	Scenario 8 (2-star hotel)	Scenario 9 (5-star hotel)
Transportation										
Total - Accommodation (kg CO_2-eq)	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	13.00	91.00
Total kg CO_2-eq per TRIP	**9.80**	**477.5**	**198.5**	**52.14**	**16.06**	**94.99**	**183.70**	**361.10**	**17.75**	**95.75**
Total kg CO_2-eq per Day	**0.54**	**26.53**	**11.03**	**2.90**	**0.89**	**5.28**	**10.21**	**20.06**	**0.99**	**5.32**
Total kg CO_2-eq per Km.	**0.01**	**0.26**	**0.11**	**0.03**	**0.01**	**0.05**	**0.10**	**0.20**	**0.01**	**0.05**
Total kg CO_2-eq per trip CHANGE(%)	**0%**	**4773%**	**1925%**	**432%**	**64%**	**869%**	**1775%**	**3585%**	**81%**	**877%**

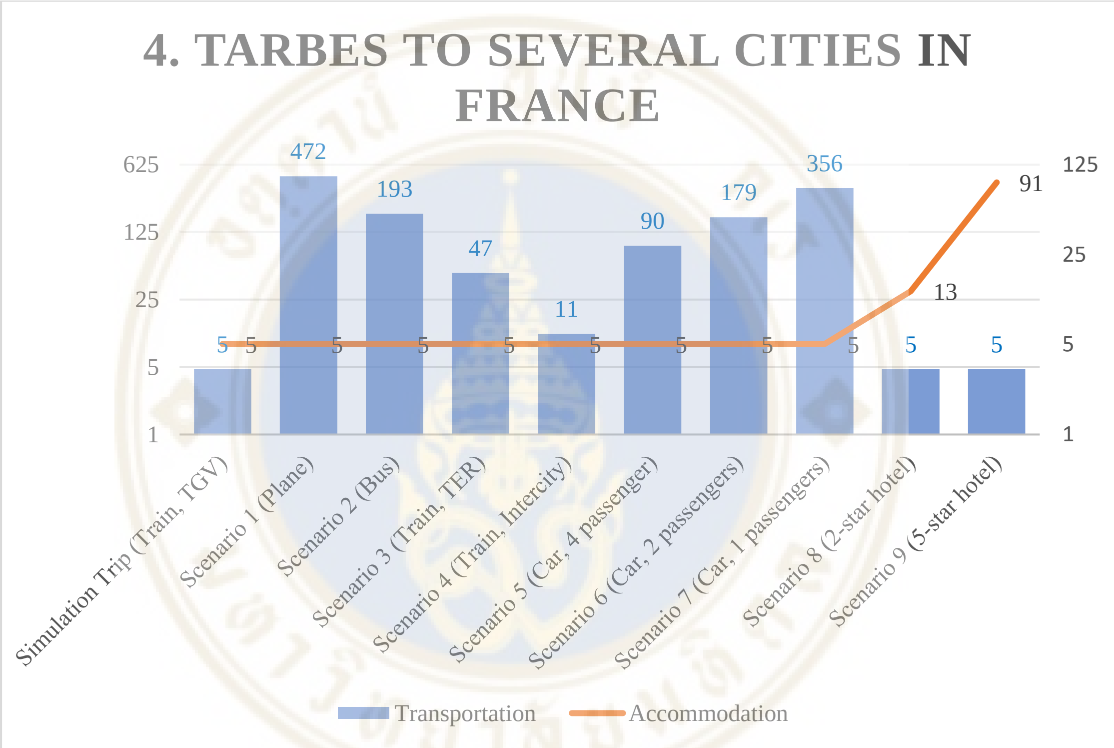

Figure 4.4 Comparing of Carbon footprint emission between Trip 4 and its scenarios

This trip is a 13-day trip starting from Tarbes to Toulouse, Paris, and Bordeaux. The main transportation between the cities is the TGV train, and some of the metros use to commute within the cities. Hence, this trip contained the longest total travel distance of 1,888 kilometers. The total emission from this simulation trip accounted for 9.80 kilograms of carbon equivalent; the transportation segment produced 5 kg $CO_{2\text{-eq}}$ or 48%. The accommodation at her friend's place contributed 52% of total trip emission or 5.05 kg $CO_{2\text{-eq}}$.

According to the implications of scenarios 2 to 7, the findings underlined that within those eight modes of transportation, the most significant emission produces by airplane at 472 kg $CO_{2\text{-eq}}$ dramatically raise the total trip emission to 4773%. The second-biggest contribution is the car with one passenger producing 356 kg of carbon, equivalent with a sharply drove up the total by 3585%. The third-largest type is the travel by bus in scenario 2; it emitted roughly 193 kg $CO_{2\text{-eq},}$ causing the total emission to increase by 1925%.

Considering the lowest transportation mode, the TGV train in the simulation trip is obvious, followed by the Intercity train releasing 11 kilograms of carbon equivalent. It resulted in a 64% diminished in total trip emission. In contrast, the TER train releases at a relatively low rate of 47 kg $CO_{2\text{-eq}}$ with a 432% drop in total emission.

To examine the accommodation category in scenarios 8 and 9, the results are similar to other trips. Since the GHG emission from staying at a friend's place is comparatively low, accommodating in the hotels can cause a significant rise in the emission rate. The 2-star hotel scenario releases 13 kg $CO_{2\text{-eq},}$ resulting in an 81% higher total trip emission. The worst scenario is to accommodate in the luxury hotel, which dramatically increases the total by 877% or 96 kg $CO_{2\text{-eq.}}$

In addition to a daily emission, the most negligible emission per day is the actual scenario with the TGV train; it emits just 0.54 kg $CO_{2\text{-eq.}}$ The Intercity train, also an effective type of transportation, produced 0.89 kg $CO_{2\text{-eq}}$ per day. Similarly, the 2-star hotel that accountable for 0.99 kg $CO_{2\text{-eq}}$ each day. However, the biggest daily emission is from the plane scenario. It emits a huge daily number of emissions at 26.53 kg $CO_{2\text{-eq}}$, closely followed by the 20.06 kilogram per day from the car with one passenger.

Additionally, to navigate the distance travel in the trip along with the carbon footprint emission. The lowest emission for one kilometer traveled is from the TGV train (0.0053 kg $CO_{2\text{-eq}}$ per km.), then follow closely with the Intercity train (0.0087 kg $CO_{2\text{-eq}}$ per km.), and the 2-star scenario (0.0096 kg $CO_{2\text{-eq}}$ per km.).

The largest carbon equivalent per one kilometer travel is from the plane scenario accounting for 0.2584 kg $CO_{2\text{-eq.}}$ The second highest scenario producing emission per kilometer came from the car with one passenger, which releases around 0.1954 kg $CO_{2\text{-eq}}$. Also, the bus is not an ideal mode of transportation to care for the environment. It releases 0.1074 kilograms of GHG emission per one passenger-kilometer.

Another essential factor to examine is the distance travel in the trip versus the total carbon footprint emission. Since the simulation trip was made by a medium petrol car that accommodates four passengers, the total individual emission is 0.0489 kg $CO_{2\text{-}eq}$ per kilometer travel. In the scenario analysis, the highest scenario producing emission per kilometer came from the airplane, which releases around 0.2559 kg $CO_{2\text{-}eq}$ each kilometer it flies. The car with one passenger produces at 0.1929 kg $CO_{2\text{-}eq}$ per kilometer, the 5-star hotel in scenario eight responsible for 0.1161 kg $CO_{2\text{-}eq}$, and the bus release 0.1049 kg of carbon equivalent per one kilometer travel.

On the other hand, the TGV train is the most effective way of transportation. It produces only 0.0028 kg $CO_{2\text{-}eq}$ per kilometer. The intercity train is also an excellent choice to be more environmentally conscious. It releases nearly 0.0062 kg $CO_{2\text{-}eq}$ per kilometer. In contrast, the TER train produces slightly higher emissions at 0.0257 kg $CO_{2\text{-}eq}$, and the 2-star hotel scenario discharges at 0.0577 kg $CO_{2\text{-}eq}$.

4.4 Discussion

Table 4.7 Comparing the Carbon footprint emission by scenarios for each trip

Trip	Total emission	Total kg CO_2-eq per TRIP	Total kg CO_2-eq per Day	Total kg CO_2-eq per Km.
1. Tarbes to Pointe-à-Pitre (18 days, 15,188 km.)	Scenario 9 (5-star hotel)	3169	176	0.21
	Scenario 7 (Car, 1 passenger)	2877	160	0.19
	Scenario 8 (2-star hotel)	2755	153	0.18
	Simulation Trip (Plane)	2683	149	0.18
	Scenario 1 (Bus)	1584	88	0.10
	Scenario 6 (Car, 2 passengers)	1467	81	0.10
	Scenario 5 (Car, 4 passengers)	762	42	0.05
	Scenario 2 (Train, TER)	421	23	0.03
	Scenario 3 (Train, Intercity)	134	7	0.009
	Scenario 4 (Train, TGV)	85	5	0.006

Trip	Total emission	Total kg CO_2-eq per TRIP	Total kg CO_2-eq per Day	Total kg CO_2-eq per Km.
2. Toulouse to Carcassonne (one day, 186.6 km.)	Scenario 1 (Plane)	47.58	47.58	0.26
	Scenario 7 (Car, 1 passenger)	35.83	35.83	0.19
	Scenario 2 (Bus)	19.41	19.41	0.10
	Scenario 6 (Car, 2 passengers)	17.91	17.91	0.10
	Scenario 5 (Car, 4 passengers)	8.96	8.96	0.05
	Scenario 9 (5-star hotel)	7.35	7.35	0.04
	Scenario 3 (Train, TER)	4.63	4.63	0.02
	Scenario 8 (2-star hotel)	1.35	1.35	0.01
	Scenario 4 (Train, Intercity)	0.99	0.99	0.01
	Simulation Trip (Train, TGV)	0.35	0.35	0.00
3. Toulouse to Leucate (7 days, 719 km.)	Scenario 1 (Plane)	183	10	0.26
	Scenario 7 (Car, 1 passenger)	139	7.7	0.19
	Scenario 9 (5-star hotel)	84	4.6	0.12
	Scenario 2 (Bus)	75	4.2	0.10
	Scenario 6 (Car, 2 passengers)	70	3.9	0.10
	Scenario 8 (2-star hotel)	42	7.7	0.19
	Simulation Trip (Car, 4 passengers)	35	1.95	0.05
	Scenario 3 (Train, TER)	18	1.0	0.03
	Scenario 4 (Train, Intercity)	4	0.2	0.01
	Scenario 5 (Train, TGV)	2	0.1	0.003
4. Tarbes to several cities in France (13 days, 1,888 km.)	Scenario 1 (Plane)	478	27	0.26
	Scenario 7 (Car, 1 passengers)	361	20	0.20
	Scenario 2 (Bus)	198	11	0.11
	Scenario 6 (Car, 2 passengers)	184	10	0.10
	Scenario 9 (5-star hotel)	96	5.32	0.05
	Scenario 5 (Car, 4 passengers)	95	5.28	0.05
	Scenario 3 (Train, TER)	52	2.90	0.03
	Scenario 8 (2-star hotel)	18	0.99	0.01
	Scenario 4 (Train, Intercity)	16	0.89	0.01
	Simulation Trip (Train, TGV)	10	0.54	0.01

4.4.1 Accommodation

The finding in this section is consistent with the majority of previous studies contending that accommodation size could positively correlate to the level of CO_2 emission; that is, the massive amount of the $CO_{2\text{-eq}}$ emission tended to come from a large or 5-star hotel. While the lower-star hotels, mid-sized apartments, and Airbnb contributed the smaller amount of carbon equivalent emission.

The recent investigation of Koiwanit and Fillimonau supported this argument by pinpointing that the carbon footprint of the homestays in Rayong province only generated 0.32 kg of $CO_{2\text{-eq}}$ per night on average, apparently lower than full-service hotels because of its smaller size and limited guest amenities (Carbon footprint assessment of home-stays in Thailand, 2021).

This finding also joins the chorus of the Hotel Sustainability Benchmarking Index 2020, citing that the carbon intensity of 2-star hotels is relatively low, especially in the small town and the city; 2 g of $CO_{2\text{-eq}}$ in Carcassonne, Bordeaux, and Toulouse (Ricaurte & Jagarajan, 2020). It is supplemented by an investigation of the backpacker hostels in New Zealand, concluding that accommodation is an energy-intense sector as a primary tourism sub-sector, roughly accounting for 6.2 kg $CO_{2\text{-eq}}$ (Beckena, Framptonb, & Simmons, 2011).

This study's results go in line with the previous examination entitled determinants and benchmarking of resource consumption on hotels - a case study of Hilton international and Scandic in Europe; it was partially proved that small size, less availability of amenities, facilities, and services influenced the lower emission per guest night. (Bohdanowicz & Martinac, 2007). Another empirical evidence made a similar assumption that the average Carbon dioxide-equivalent emission within the guest house only generated 4 kg of $CO_{2\text{-eq}}$ (Gösslinga, et al., 2005).

Concerning trip 1, this set of findings is noticeable. It is considered the longest in both duration and distance of all trips in this study; the tourists spent 18 days, making the accommodation a critical factor during the whole trip to specify the carbon footprint emission level. Another aspect for comprehension is that this trip contained a very long distance; therefore, it reduced the total emission per kilometer, making the transportation segment less impact on the total trip emission. Hence, the 5-star hotel and 2-star hotel scenario in the first trip is on the first and third rank the generated the highest emission.

These empirical results can be interpreted that both the GHG emission number of the specific area and the length of stays are critical implications to determine the emission rate and the higher rank in these scenarios. Therefore, it obviously describes the 5-star hotel and 2-star hotel scenario in the first trip on the first and third rank generated the highest emission.

To sum up this part, this paper argued that the size and facilities of the accommodation matter since it could determine a certain amount of the CO_2 in most cases, mainly found in many cross-country studies. Therefore, a proper selection of hotel accommodation could determine the level of CO_2 emission more precisely. Living in a small hotel with fewer amenities could promote environmental preservation leading to long-term sustainable tourism.

4.4.2 Transportation

Previous scholarly works advocated that transportation is the critical factor determining the level of carbon footprint emission, and it becomes a key challenge to the policymakers to come up with a proper strategy to reduce the aviation greenhouse gas emissions, including in the tourism sector (Sgouridis, Bonnefoy, & Hansman, 2011). This implies that transportation is another vital factor affecting global climate change in a holistic view.

The findings in this section were supplemented by the analytical paper entitled the tourism's carbon footprint in Spain (Cadarso, Gómez, López, Tobarra, & Zafrilla, 2015) concluding that the domestic carbon footprint accounted for 10.6% of the total emissions of the country; it is worth to note that transportation segment was reported the most significant contributor making up to 26% of it. The study suggested that tourists' encouragement to use other transportation modes that discharge lower carbon footprint emissions is thought-provoking. The consideration to offer incentives to minimize the emission effect indirectly should be taken into account.

Recently, transportation in tourism was found a massive contributor to GHG emission because of the variety of tourism-related consumption and activity (Prideaux & Yin, 2019). A similar finding in Amsterdam's case showed a similar productive result, citing that the carbon footprint from inbound tourism originated by the transport sector to Amsterdam was nearly equal to 70%. In comparison, local transportation emissions constituted a relatively low at 1% (Peeters & Schouten, 2006).

The result from scenario analysis demonstrated the same assumption. To complete a trip, it needs at least one travel from one destination to another; therefore, every trip involves the transportation segment. On the other hand, accommodation is not required for a day trip. As shown in trip two from Toulouse to Carcassonne, 100% of GHG emissions came from the accommodation segment.

Another point for contemplation is the transportation-related discharges also depend upon the type of transportations. Based on the GHG emission factors (UK

Department for Business, Energy & Industrial Strategy (BEIS), 2019); 255 g of $CO_{2\text{-eq}}$ per passenger-kilometer from a domestic flight, 192 g of $CO_{2\text{-eq}}$ from the medium petrol car with two passengers, 195 g of $CO_{2\text{-eq}}$, from the bus, 41 g of $CO_{2\text{-eq}}$ from the national rail, and 6 g of $CO_{2\text{-eq}}$ from the Eurostar international rail.

Moreover, the country context is another critical issue. The emission rate from the same type of transportation might be different in each country due to its infrastructure, technology, and energy sources. In the context of France, the SNCF (The Société nationale des chemins de fer français, 2020) reported the GHG emission factors such as 104 g $CO_{2\text{-eq}}$/km from the bus, 1.9 g $CO_{2\text{-eq}}$/km from national rail - TGV, 5.29 g $CO_{2\text{-eq}}$/km from national rail – Intercity, 24.81 g $CO_{2\text{-eq}}$/km from national rail – TER, and 2.5 g $CO_{2\text{-eq}}$/km from metro.

In this matter, the empirical evidence from the scenario analysis states that only the GHG emission alone cannot determine tourism emission; it also depends on the trip's characteristics. The trip traveled by the highest GHG factors as a domestic flight cannot conclude as the most emitted trip over the car trip. As represented in Trip 1, the plane's simulation trip is in the third rank of the most generated GHG emission, while the highest emission cane from accommodating in the 5-star hotel. This is a result form the 18 lengths of stay and a 15,188 kilometers travel distance.

However, the trips' destinations can also determine the transportation choices that tourists can use during their trip; in some small towns, there is no proper infrastructure to commute within the town while the distance to each tourist's destinations is too far for a walk or bike. Hence the tourist must use the bus has higher emission rate; it raises the GHG emission. To illustrate an example from the second trip (Toulouse to Carcassonne) and the third trip (Toulouse to Leucate), these two trips were in a small town surrounding eco-friendly activities and the short distance between the tourists' attractions that tourists travel by bike and by foot. As a result, these destinations do not tricker the carbon footprint emission from commute within the town.

On the contrary, on the fourth trip from Tarbes to several France cities, the tourist travels to Paris, a prominent and civilized city. She travels by metro while in Paris for 40 kilometers, and the GHG emission is at 31 g of $CO_{2\text{-eq}}$, which is more significant than travel across the city by TGV train that only discharge at 19 g kg of $CO_{2\text{-eq}}$. Like the first trip from Tarbes to Pointe-à-Pitre, the tourist travels by car within the town for 500 kilometers. Therefore, these two trips are the empirical evidence that destination choice can potentially affect the total trip emission.

CHAPTER V
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study concluded that the variety of travelers' behaviors including typology of the transportations, accommodation type, length of stays, travel distances, geo graphic scope, and destination choice could result in the multiple levels of the carbon footprint emission; that is to say, the pattern of the $CO_{2\text{-}eq}$ emission is not unified. Therefore, a proper selection of travel methodology would help cushion the adverse impacts from the $CO_{2\text{-}eq}$ emission recorded by the carbon footprint. It is worth noting that a concrete engagement from stakeholders can minimize unintended negative effects to the environment and the carbon equivalent emission as a whole. At the same time, the tourists can still enjoy traveling experiences on their vacations.

Even though some research indicated the GHG emission factors for each type of transportations and accommodations, these scenarios showed a mixed result on how each tourism scenario's diverse characteristics could affect the particular level of the carbon footprint left beside the local community and the environment.

There are three main issues for consideration: the distance we travel, the duration we spend at a place, and the means of transport we use during the trip. Transportation is one of the critical factors producing the emission, then followed by accommodation.

The distance travel and the trip duration are the critical factors determining the best solution for responsible tourism.

The number of passengers on the trip also matters; the car with only one passenger produces a higher carbon footprint; anyway, the more people on the exact vehicle dramatically reduce the emission. Therefore, four or two passengers produce a much lower effect on the environment.

5.2 Recommendations

This paper recommends that a proper selection of transportation and typology of accommodation according to the trip needs to be well-designed to reduce the unnecessary carbon equivalent emission. This includes raising awareness on environmental preservation such as using less materials and traveling with more responsibility. Therefore, to minimize the negative effect of the tourism industry's carbon footprint, all related stakeholders must take responsibility and require a hand in hand corporation to preserve and protect the natural resources.

5.2.1 The tourist

The tourists' choices significantly impact how much carbon footprint were produced during the trip; therefore, here are the practical aspects that the tourist choices consider.

According to the transportation, section findings unveiled that even air travel releases the highest amount of GHG emission, especially the domestic flight. It is still suitable for long-distance journeys and travelers who have no time. However, the most effective way to fly on an airplane is for the longer distance and length of stay trip; that is, the higher the days, the less emission per day.

For the trip with one person on board, it is necessary to use public transportation, such as the metro and train. The bus produces quite a high emission, but it is still acceptable to travel alone within the small town with no other less emitted transportation type. On the contrary, for a trip that accommodates two or more people, the tourists should consider using a car, since the car with two passengers emits less than the bus.

It was evident that Airbnb or small apartments are the best solutions for accommodation choices, especially for the long trip. It crucially helps minimize the number of the total emissions. The tourists can choose the hotels that comply with the environment protocol or show responsibility towards the environmental concern for the hotel choices. For instance, some hotels implement the saving energy system to reduce the emission rate, use recycled products, and minimize the cleaning process to save water. These factors can ensure we are responsible for our world during the trip.

Apart from the accommodations and transportations, each destination's tourist activities significantly impact the particular amount of CO_{2-eq} emission. The tourists who care about the environment can choose the destination that can travel by foot, bike, or metro, instead of a big city with car heavy traffic to diminish the GHG emission. By changing vacation destination to a small city surrounded by the natural resource, low-carbon-footprint activities such as picnicking, sailing, swimming, walking around the canal, or sitting by the lake should be more promoted. This type of tourism is suitable for tourists who concern about the environment and love traveling with nature.

5.2.2 The hotels and accommodations

Both hotels and accommodations undoubtedly demonstrate on the research result and the related literature review that the accommodations the bigger the accommodations, services, and activity area, will result in the higher amount of carbon footprint.

To mitigate the impact of carbon footprint, hospitality owners should consider moving towards a more sustainable energy source. The solar panel generates electricity with less impact on carbon dioxide equivalent emission, considers a small renovation to utilize their shared space better, or implements the saving energy system to reduce the emission.

For the luxury hotels, the activities, services, food waste from the buffet, and throw away amenities products also contribute to higher emission compared to Airbnb or budget hotels. Hence, to moving towards responsible tourism, the hotels use the local ingredients for restaurants instead of imported food to minimize the carbon emission from transportation. They can implement no room cleaning or towel changing for two or more days of stay to save water, reduce chemical contamination and waste from amenities products. Besides, the accommodation should comply with the environment protocol to show responsibility towards the environmental responsibility.

5.2.3 The destinations, business entrepreneurs and travel agencies

The destinations and local communities are the crucial stakeholders in the tourism sector. The local people and public companies in the destinations should have been aware of tourism's environmental impact; they must take responsibility to protect, preserve, and sustain their valuable resources.

Apart from the above recommendation, the tourists are not the only party responsible for the environment; hence, all related stakeholders, namely business entrepreneurs, government agencies, and the local community, should consider promoting Airbnb or budget hotels while traveling instead of luxury hotels. The travel agencies can provide various choices to the customers; hence they can influence and guide tourists' decisions. They can help promote the local community, small-town, nature-based destinations and heritage destinations that will produce less emission. Provide tourism packages that by airplane with longer staying days. Offer one day trip within the city on a bike with eco-friendly activity.

5.2.4 The transportation company

Since transportation in the tourism sector significantly contributes to carbon footprint, the transportation companies are the key players that must consider reducing environmental impact. They should move towards renewables and green energy sources to reduces the carbon equivalent emission rate. For example, the electricity, solar, wind, and hydro sources.

Moreover, due to the emerging technology, there are much cutting-edge knowledge and equipment that can reduce greenhouse gas emissions. It protects the environment and creates strong competitive advantages to sustain the company in the long run. Therefore, the transportation company should take into consideration to implement the energy conservation plan and invest in the environmentally friendly vehicles., such as electricity metro and car.

5.2.5 The government agency, institutions, and organizations

This study made a significant theoretical contribution in introducing the responsible tourism concept and providing practical recommendations for travelers and large-scale related tourism businesses to be more responsible for the environment. The findings from this study can be used as a guideline for the government and private agencies to develop action plans on responsible tourism to the extent of sustainable tourism via the promotion of tourism in a small town and use less convenient facilities to preserve the environment long run. To prevent over-tourism, the government can implement the national conservation plan to limit the number of tourists per day on this island, the national park's close duration to preserve the local environment and biodiversity.

This includes the rise of environmental awareness at the school and university level on responsible and green tourism. Tourists should be aware of the unintended carbon footprint emission generated during their trips and change a certain set of behaviors to reduce the adverse impact. Moreover, the government incentivized business sector by rewarding system along with implemented the greenhouse gas permit for tourism business from environmental protection.

5.2 Limitations

Despite this research's contribution to determine influential characteristics of carbon footprint emission in tourism, several limitations and future research opportunities must be addressed.

5.2.1 Limited factors of Carbon footprint emission

Based on the research this study has carried out, in the case of travel-related footprints, even though this research aims to examine only two crucial factors that will generate the highest amount of GHG emissions in tourism. However, other factors that contribute to the tourism emission not mentioned in this research: type of travel, destinations and seasonality, duration and activities, food, and shopping. Types of travel are business travel or leisure travel (cultural, family, friend, long vacation, etc.). Transportation depends on the vehicle used and the distance. Destination and seasonality also have an impact on carbon emissions. During a high tourist season in an attractive destination, a high number of tourists create a surplus in demand for water and energy, which increases the environmental impact.

There also other factors related to carbon footprint in Tourism. One of the dominant factors that contribute to the food segment. Food production is responsible for one-quarter of the world's greenhouse gas emissions. The global food system, which encompasses production, and post-farm processes such as processing, and distribution is also a key contributor to emissions. Furthermore, it is a problem for which we do not yet have viable technological solutions.

5.2.2 Data availability and scarcity

Even though it is understandable that information is a valuable resource, it still prevents the research from accessing and collecting the correct data. This limitation can happen in many ways. For instance, it is difficult to determine the energy consumption rate of the Airbnb apartment that the tourist stayed in since it is unable to access the data of building ages, power source, electronic gadgets, etc. Also, GHGs emission factors for specific hotel locations are still a myth that makes the result less accurate.

Moreover, the data for GHGs emission factor that this research use to compute the emission are very limited, and some are not up to date. It does not provide enough specific data on the country, city, and town level. As the author attempts to collect the transportation factor in France, but the data are nowhere to be found or not specific enough, this research uses a combination of different sources available to generate the most reliable results.

5.2.3 Data reliability and accuracy

This limitation also in line with the two above issues. The limitation of inaccessible data affects the reliability and accuracy of the results. Another point regards this issue is while collecting information about the simulation trips, the tourists cannot precisely remember the specifics information. For example, each day, the distance traveled within the city, the amount of water and electricity used in accommodation, especially for friends' apartment, Airbnb, and family's place. Therefore, they estimated these numbers in the assessment.

5.2.4 Emerging technology

Another limitation to this research is that technological advancement emerged in every business sector, especially the aviation, automobile, and tourism industry. It made advanced technology more affordable and effective. For the tourism industry, the cheaper plane tickets and lower energy consumption in the aviation business drive international tourism's most significant demand.

Aviation, automobile, and tourism are evolving around this cutting-edge technology as it is their competitive advantage. It directly affects the GHG emission factors, such as new renewable energy and low-consuming national train engine that significantly minimized the carbon footprint impact. These are the factors that are limited to the study.

5.2.5 The home-related emission

Not only the emissions from tourism that matter, but the tourists also stop discharge their home-related emission at home while travelling on a trip. Based on normal basis, tourists tend to stop the activities that they normally doing at home which also release the certain amount of carbon footprint, such as travel on a car to work, eating imported food, washing dishes, doing the laundry, also heating and air-conditioning in the house. These factors also substantially contribute the home-related emission; these daily behaviors may vary across the country, culture, norms, and environmental attitudes. Consequently, it needs to be further investigated and subtract from the tourism emission to get more reliable results.

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APPENDICES

Appendix A: Trip 1 Tarbes to Pointe-à-Pitre and scenarios 1 to 4

1. Tarbes to Pointe-à-Pitre	Simulation Trip (Plane)		Scenario 1 (Bus)		Scenario 2 (Train, TER)		Scenario 3 (Train, Intercity)		Scenario 4 (Train, TGV)	
Transportation	**a.1 Plane (Domestic flight)**		**a.Bus**		**a.Train (TER)**		**a.Train (Intercity)**		**a.Train (TGV)**	
	Distance (km.)	1174	Distance (km.)	14688	Distance (km.)	14688	Distance (km.)	14688	Distance (km.)	14688
	Emission rate/km. (kg CO_2-eq)	0.255	Emission rate/km. (kg CO_2-eq)	0.104	Emission rate/km. (kg CO_2-eq)	0.02481	Emission rate/km. (kg CO_2-eq)	0.00529	Emission rate/km. (kg CO_2-eq)	0.0019
	Total (kg CO_2-eq)	299.37	Total (kg CO_2-eq/km)	1527.552	Total (kg CO_2-eq/km)	364.40928	Total (kg CO_2-eq/km)	77.69952	Total (kg CO_2-eq/km)	27.9072
	a.2 Plane (Long-haul flight)									
	Distance (km.)	13514								
	Emission rate/km. (kg CO_2-eq)	0.15								
	Total (kg CO_2-eq)	2027.1								
	Total plane (kg CO_2-eq)	2326.47								
	b.Car - Medium Car (Petrol)		**b.Car - Medium Car (Petrol)**		**b.Car - Medium Car (Petrol)**		**b.Car - Medium Car (Petrol)**		**b.Car - Medium Car (Petrol)**	
	Distance (km.)	500	Distance (km.)	500	Distance (km.)	500	Distance (km.)	500	Distance (km.)	500
	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.096
	Total (kg CO_2-eq)	48	Total (kg CO_2-eq)	48	Total (kg CO_2-eq)	48	Total (kg CO_2-eq)	48	Total (kg CO_2-eq)	48
	Total - Transport (kg CO_2-eq)	2673.84	**Total - Transport (kg CO_2-eq)**	1575.552	**Total - Transport (kg CO_2-eq)**	412.40928	**Total - Transport (kg CO_2-eq)**	125.69952	**Total - Transport (kg CO_2-eq)**	75.9072
Accommodation	**Family's place (150m²)**		**Family's place (150m²)**		**Family's place (150m²)**		**Family's place (150m²)**		**Family's place (150m²)**	
	a.Eletricity used - 150m² with 3 people		**a.Eletricity used - 150m² with 3 people**		**a.Eletricity used - 150m² with 3 people**		**a.Eletricity used - 150m² with 3 people**		**a.Eletricity used - 150m² with 3 people**	
	Number of days	18	Number of days	18	Number of days	18	Number of days	18	Number of days	18
	Electricity consumptionrate (Kwh/yea	7500	Electricity consumptionrate (Kwh/yea	7500	Electricity consumptionrate (Kwh/yea	7500	Electricity consumptionrate (Kwh/yea	7500	Electricity consumptionrate (Kwh/yea	7500
	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065
	Total (kg CO_2-eq)	24.0411	Total (kg CO_2-eq)	24.0411	Total (kg CO_2-eq)	24.0411	Total (kg CO_2-eq)	24.0411	Total (kg CO_2-eq)	24.0411
	Total per person (kg CO_2-eq)	8.0137	Total per person (kg CO_2-eq)	8.0137	Total per person (kg CO_2-eq)	8.0137	Total per person (kg CO_2-eq)	8.0137	Total per person (kg CO_2-eq)	8.0137
	b.Water used		**b.Water used**		**b.Water used**		**b.Water used**		**b.Water used**	
	Estimation per day (litre)	128	Estimation per day (litre)	128	Estimation per day (litre)	128	Estimation per day (litre)	128	Estimation per day (litre)	128
	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298
	Total (kg CO_2-eq)	0.6866	Total (kg CO_2-eq)	0.6866	Total (kg CO_2-eq)	0.6866	Total (kg CO_2-eq)	0.6866	Total (kg CO_2-eq)	0.6866
	Total - Accommodation (kg CO_2-eq)	8.7003	**Total - Accommodation (kg CO_2-eq)**	8.7003	**Total - Accommodation (kg CO_2-eq)**	8.7003	**Total - Accommodation (kg CO_2-eq)**	8.7003	**Total - Accommodation (kg CO_2-eq)**	8.7003
Total kg CO_2-eq per TRIP		**2682.54029**	**Total CO2e per TRIP**	**1584.2523**	Total CO2e per TRIP	421.1096	**Total CO2e per TRIP**	**134.3998**	**Total CO2e per TRIP**	**84.6075**
Total kg CO_2-eq per Day		**149.03002**	**Total kg CO_2-eq per Day**	**88.0140**	Total kg CO_2-eq per Day	23.3950	**Total kg CO_2-eq per Day**	**7.4667**	**Total kg CO_2-eq per Day**	**4.7004**
Total kg CO_2-eq per Km.		**0.17662**	**Total kg CO_2-eq per Km.**	**0.1043**	Total kg CO_2-eq per Km.	0.0277	**Total kg CO_2-eq per Km.**	**0.0088**	**Total kg CO_2-eq per Km.**	**0.0056**
Total kg CO_2-eq per trip CHANGE(%)		**0%**	**Total kg CO_2-eq per trip CHANGE(**	**-41%**	Total kg CO_2-eq per trip CHANGE(	-84%	**Total kg CO_2-eq per trip CHANGE(**	**-95%**	**Total kg CO_2-eq per trip CHANGE(**	**-97%**

Appendix B: Trip 1 Tarbes to Pointe-à-Pitre and scenarios 5 to 9

1. Tarbes to Pointe-à-Pitre	Simulation Trip (Plane)		Scenario 5 (Car, 4 passengers)		Scenario 6 (Car, 2 passengers)		Scenario 7 (Car, 1 passenger)		Scenario 8 (2-star hotel)		Scenario 9 (5-star hotel)	
Transportation	**a.1 Plane (Domestic flight)**		**a.Car - Medium (Petrol) 4 passengers**		**a.Car - Medium (Petrol) 2 passengers**		**a.Car - Medium (Petrol) 1 passenger**		**a.1 Plane (Domestic flight)**		**a.1 Plane (Domestic flight)**	
	Distance (km.)	1174	Distance (km.)	14688	Distance (km.)	14688	Distance (km.)	14688	Distance (km.)	1174	Distance (km.)	1174
	Emission rate/km. (kg CO_2-eq)	0.255	Emission rate/km. (kg CO_2-eq)	0.048	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.192	Emission rate/km. (kg CO_2-eq)	0.255	Emission rate/km. (kg CO_2-eq)	0.255
	Total (kg CO_2-eq)	299.37	Total (kg CO_2-eq/km)	705.024	Total (kg CO_2-eq/km)	1410.048	Total (kg CO_2-eq/km)	2820.096	Total (kg CO_2-eq/km)	299.37	Total (kg CO_2-eq/km)	299.37
	a.2 Plane (Long-haul flight)								**a.2 Plane (long-haul flight)**		**a.2 Plane (long-haul flight)**	
	Distance (km.)	13514							Distance (km.)	13514	Distance (km.)	13514
	Emission rate/km. (kg CO_2-eq)	0.15							Emission rate/km. (kg CO_2-eq)	0.15	Emission rate/km. (kg CO_2-eq)	0.15
	Total (kg CO_2-eq)	2027.1							Total (kg CO_2-eq)	2027.1	Total (kg CO_2-eq)	2027.1
	Total plane (kg CO_2-eq)	2326.47							Total plane (kg CO_2-eq)	2326.47	Total plane (kg CO_2-eq)	2326.47
	b.Car - Medium Car (Petrol)		**b.Car - Medium Car (Petrol)**		**b.Car - Medium Car (Petrol)**		**b.Car - Medium Car (Petrol)**		**b.Car - Medium Car (Petrol)**		**b.Car - Medium Car (Petrol)**	
	Distance (km.)	500	Distance (km.)	500	Distance (km.)	500	Distance (km.)	500	Distance (km.)	500	Distance (km.)	500
	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.096
	Total (kg CO_2-eq)	48	Total (kg CO_2-eq)	48	Total (kg CO_2-eq)	48	Total (kg CO_2-eq)	48	Total (kg CO_2-eq)	48	Total (kg CO_2-eq)	48
	Total - Transport (kg CO_2-eq)	2673.84	**Total - Transport (kg CO_2-eq)**	753.024	**Total - Transport (kg CO_2-eq)**	1458.048	**Total - Transport (kg CO_2-eq)**	2868.096	**Total - Transport (kg CO_2-eq)**	2673.84	**Total - Transport (kg CO_2-eq)**	2673.84
Accommodation	**Family's place (150m²)**		**Family's place (150m²)**		**Family's place (150m²)**		**Family's place (150m²)**		**2-stars hotel (2 person)**		**5-stars hotel (2 person)**	
	a.Eletricity used - 150m² with 3 people		**a.Eletricity used - 150m² with 3 people**		**a.Eletricity used - 150m² with 3 people**		**a.Eletricity used - 150m² with 3 people**		Number of days	18	Number of days	18
	Number of days	18	Number of days	18	Number of days	18	Number of days	18	Emission rate/room (kg CO_2-eq)	9	Emission rate/room (kg CO_2-eq)	55
	Electricity consumptionrate (Kwh/yea	7500	Electricity consumptionrate (Kwh/yea	7500	Electricity consumptionrate (Kwh/yea	7500	Electricity consumptionrate (Kwh/yea	7500	Total (kg CO_2-eq)	162	Total (kg CO_2-eq)	990
	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Total per person (kg CO_2-eq)	81	Total per person (kg CO_2-eq)	495
	Total (kg CO_2-eq)	24.0411	Total (kg CO_2-eq)	24.0411	Total (kg CO_2-eq)	24.0411	Total (kg CO_2-eq)	24.0411				
	Total per person (kg CO_2-eq)	8.0137	Total per person (kg CO_2-eq)	8.0137	Total per person (kg CO_2-eq)	8.0137	Total per person (kg CO_2-eq)	8.0137				
	b.Water used		**b.Water used**		**b.Water used**		**b.Water used**					
	Estimation per day (litre)	128	Estimation per day (litre)	128	Estimation per day (litre)	128	Estimation per day (litre)	128				
	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298				
	Total (kg CO_2-eq)	0.6866	Total (kg CO_2-eq)	0.6866	Total (kg CO_2-eq)	0.6866	Total (kg CO_2-eq)	0.6866				
	Total - Accommodation (kg CO_2-eq)	8.7003	**Total - Accommodation (kg CO_2-eq)**	8.7003	**Total - Accommodation (kg CO_2-eq)**	8.7003	**Total - Accommodation (kg CO_2-eq)**	8.7003	**Total - Accommodation (kg CO_2-eq)**	81	**Total - Accommodation (kg CO_2-eq)**	495
Total kg CO_2-eq per TRIP		**2682.54029**	**Total CO2e per TRIP**	**761.7243**	**Total CO2e per TRIP**	**1466.7483**	**Total CO2e per TRIP**	**2876.7963**	**Total CO2e per TRIP**	**2754.8400**	**Total CO2e per TRIP**	**3168.8400**
Total kg CO_2-eq per Day		**149.03002**	**Total kg CO_2-eq per Day**	**42.3180**	**Total kg CO_2-eq per Day**	**81.4860**	**Total kg CO_2-eq per Day**	**159.8220**	**Total kg CO_2-eq per Day**	**153.0467**	**Total kg CO_2-eq per Day**	**176.0467**
Total kg CO_2-eq per Km.		**0.17662**	**Total kg CO_2-eq per Km.**	**0.0502**	**Total kg CO_2-eq per Km.**	**0.0966**	**Total kg CO_2-eq per Km.**	**0.1894**	**Total kg CO_2-eq per Km.**	**0.1814**	**Total kg CO_2-eq per Km.**	**0.2086**
Total kg CO_2-eq per trip CHANGE(%)		**0%**	**Total kg CO_2-eq per trip CHANGE(**	**-72%**	**Total kg CO_2-eq per trip CHANGE(**	**-45%**	**Total kg CO_2-eq per trip CHANGE(**	**7%**	**Total kg CO_2-eq per trip CHANGE(**	**3%**	**Total kg CO_2-eq per trip CHANGE(**	**18%**

Appendix C: Trip 2 Toulouse to Carcassonne and scenarios 1 to 4

2. Toulouse to Carcassonne	Simulation Trip (Train, TGV)		Scenario 1 (Plane)		Scenario 2 (Bus)		Scenario 3 (Train, TER)		Scenario 4 (Train, Intercity)	
Transportation	**Train (TGV)**		**Plane**		**Train (Bus)**		**Train (Bus, TER)**		**Train (Intercity**	
	Distance (km.)	186.6	Distance (km.)	186.6	Distance (km.)	186.6	Distance (km.)	186.6	Distance (km.)	186.6
	Emission rate/km. (kg CO_2-eq)	0.0019	Emission rate/km. (kg CO_2-eq)	0.255	Emission rate/km. (kg CO_2-eq)	0.104	Emission rate/km. (kg CO_2-eq)	0.02481	Emission rate/km. (kg CO_2-eq)	0.00529
	Total - Transport (kg CO_2-eq)	0.35454	**Total - Transport (kg CO_2-eq)**	47.583	**Total - Transport (kg CO_2-eq)**	19.4064	**Total - Transport (kg CO_2-eq)**	4.629546	**Total - Transport (kg CO_2-eq)**	0.987114
Accommodation	**None**		**None**		**None**		**None**		**None**	
	Total - Accommodation (kg CO_2-eq)	0	**Total - Accommodation (kg CO_2-eq)**	0	**Total - Accommodation (kg CO_2-eq)**	0	**Total - Accommodation (kg CO_2-eq)**	0	**Total - Accommodation (kg CO_2-eq)**	0
Total kg CO_2-eq per TRIP		**0.3545**		**47.5830**		**19.4064**		**4.6295**		**0.9871**
Total kg CO_2-eq per Day		**0.3545**		**47.5830**		**19.4064**		**4.6295**		**0.9871**
Total kg CO_2-eq per Km.		**0.0019**		**0.2550**		**0.1040**		**0.0248**		**0.0053**
Total kg CO_2-eq per trip CHANGE(%)		**0%**		**13321%**		**5374%**		**1206%**		**178%**

Appendix D: Trip 2 Toulouse to Carcassonne and scenarios 5 to 9

2. Toulouse to Carcassonne	Simulation Trip (Train, TGV)		Scenario 5 (Car, 4 passengers)		Scenario 6 (Car, 2 passengers)		Scenario 7 (Car, 1 passenger)		Scenario 8 (2-star hotel)		Scenario 9 (5-star hotel)	
Transportation	Train (TGV)		Car - Medium (Petrol) 4 passengers		Car - Medium (Petrol) 2 passengers		Car - Medium (Petrol) 1 passenger		Train (TGV)		Train (TGV)	
	Distance (km.)	186.6	Distance (km.)	186.6	Distance (km.)	186.6	Distance (km.)	186.6	Distance (km.)	186.6	Distance (km.)	186.6
	Emission rate/km. (kg CO_2-eq)	0.0019	Emission rate/km. (kg CO_2-eq)	0.048	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.192	Emission rate/km. (kg CO_2-eq)	0.0019	Emission rate/km. (kg CO_2-eq)	0.0019
	Total - Transport (kg CO_2-eq)	0.35454	Total - Transport (kg CO_2-eq)	8.9568	Total - Transport (kg CO_2-eq)	17.9136	Total - Transport (kg CO_2-eq)	35.8272	Total - Transport (kg CO_2-eq)	0.35454	Total - Transport (kg CO_2-eq)	0.35454
Accommodation	None		None		None		None		2-stars hotel (2 person)		5-stars hotel (2 person)	
									Number of days	1.00	Number of days	1.00
									Emission rate/room (kg CO_2-eq)	2.00	Emission rate/room (kg CO_2-eq)	14.00
									Total (kg CO_2-eq)	2.00	Total (kg CO_2-eq)	14.00
									Total per person (kg CO_2-eq)	1.00	Total per person (kg CO_2-eq)	7.00
	Total - Accommodation (kg CO_2-eq)	0	Total - Accommodation (kg CO_2-eq)	0	Total - Accommodation (kg CO_2-eq)	0	Total - Accommodation (kg CO_2-eq)	0	Total - Accommodation (kg CO_2-eq)	1.00	Total - Accommodation (kg CO_2-eq)	7.00
Total kg CO_2-eq per TRIP		0.3545		8.9568		17.9136		35.8272		1.3545		7.3545
Total kg CO_2-eq per Day		0.3545		8.9568		17.9136		35.8272		1.3545		7.3545
Total kg CO_2-eq per Km.		0.0019		0.0480		0.0960		0.1920		0.0073		0.0394
Total kg CO_2-eq per trip CHANGE(%)		0%		2426%		4953%		10005%		282%		1974%

Appendix E: Trip 3 Toulouse to Leucate and scenarios 1 to 4

3. Toulouse to Leucate	Simulation Trip (Car with 4 passenger)		Scenario 1 (Plane)		Scenario 2 (Bus)		Scenario 3 (Train, TER)		Scenario 4 (Train, Intercity)	
Transportation	**Car - Medium Car (Petrol) 4 passengers**		**Plane**		**Bus**		**Train (Bus, TER)**		**Train (Intercity**	
	Distance (km.)	719.2	Distance (km.)	719.2	Distance (km.)	719.2	Distance (km.)	719.2	Distance (km.)	719.2
	Emission rate/km. (kg CO_2-eq)	0.048	Emission rate/km. (kg CO_2-eq)	0.255	Emission rate/km. (kg CO_2-eq)	0.104	Emission rate/km. (kg CO_2-eq)	0.02481	Emission rate/km. (kg CO_2-eq)	0.00529
	Total - Transport (kg CO_2-eq)	34.5216	**Total - Transport (kg CO_2-eq)**	183.396	**Total - Transport (kg CO_2-eq)**	74.7968	**Total - Transport (kg CO_2-eq)**	17.843352	**Total - Transport (kg CO_2-eq)**	3.804568
Accommodation	**AirBnb**		**AirBnb**		**AirBnb**		**AirBnb**		**AirBnb**	
	a.Eletricity used - 30m² with 4 people		**a.Eletricity used - 30m² with 4 people**		**a.Eletricity used - 30m² with 4 people**		**a.Eletricity used - 30m² with 4 people**		**a.Eletricity used - 30m² with 4 people**	
	Number of days	7	Number of days	7	Number of days	7	Number of days	7	Number of days	7
	Electricity consumptionrate (Kwh/yea	50	Electricity consumptionrate (Kwh/yea	50	Electricity consumptionrate (Kwh/yea	50	Electricity consumptionrate (Kwh/yea	50	Electricity consumptionrate (Kwh/yea	50
	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065
	Total (kg CO_2-eq)	0.062328767	Total (kg CO_2-eq)	0.062328767	Total (kg CO_2-eq)	0.062328767	Total (kg CO_2-eq)	0.062328767	Total (kg CO_2-eq)	0.062328767
	Total per person (kg CO_2-eq)	0.467465753	Total per person (kg CO_2-eq)	0.467465753	Total per person (kg CO_2-eq)	0.467465753	Total per person (kg CO_2-eq)	0.467465753	Total per person (kg CO_2-eq)	0.467465753
	b.Water used		**b.Water used**		**b.Water used**		**b.Water used**		**b.Water used**	
	Estimation per day (litre)	74	Estimation per day (litre)	74	Estimation per day (litre)	74	Estimation per day (litre)	74	Estimation per day (litre)	74
	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298
	Total (kg CO_2-eq)	0.1544	Total (kg CO_2-eq)	0.1544	Total (kg CO_2-eq)	0.1544	Total (kg CO_2-eq)	0.1544	Total (kg CO_2-eq)	0.1544
	Total - Accommodation (kg CO_2-eq)	0.6218	**Total - Accommodation (kg CO_2-eq)**	0.6218	**Total - Accommodation (kg CO_2-eq)**	0.6218	**Total - Accommodation (kg CO_2-eq)**	0.6218	**Total - Accommodation (kg CO_2-eq)**	0.6218
Total kg CO_2-eq per TRIP		**35.1434**		**184.0178**		**75.4186**		**18.4652**		**4.4264**
Total kg CO_2-eq per Day		**1.9524**		**10.2232**		**4.1899**		**1.0258**		**0.2459**
Total kg CO_2-eq per Km.		**0.0489**		**0.2559**		**0.1049**		**0.0257**		**0.0062**
Total kg CO_2-eq per trip CHANGE(%)		**0%**		**424%**		**115%**		**-47%**		**-87%**

Appendix F: Trip 3 Toulouse to Leucate and scenarios 5 to 9

3. Toulouse to Leucate	Simulation Trip (Car with 4 passenger)		Scenario 5 (Train, TGV)		Scenario 6 (Car, 2 passengers)		Scenario 7 (Car, 1 passenger)		Scenario 8 (2-star hotel)		Scenario 9 (5-star hotel)	
Transportation	**Car - Medium Car (Petrol) 4 passengers**		**Train (TGV)**		**Car - Medium (Petrol) 2 passengers**		Car - Medium (Petrol) 1 passenger		**Car - Medium (Petrol) 4 people**		**Car - Medium Car (Petrol) 4 people**	
	Distance (km.)	719.2	Distance (km.)	719.2	Distance (km.)	719.2	Distance (km.)	719.2	Distance (km.)	719.2	Distance (km.)	719.2
	Emission rate/km. (kg CO_2-eq)	0.048	Emission rate/km. (kg CO_2-eq)	0.0019	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.192	Emission rate/km. (kg CO_2-eq)	0.048	Emission rate/km. (kg CO_2-eq)	0.048
	Total - Transport (kg CO_2-eq)	34.5216	**Total - Transport (kg CO_2-eq)**	1.36648	**Total - Transport (kg CO_2-eq)**	69.0432	**Total - Transport (kg CO_2-eq)**	138.0864	**Total - Transport (kg CO_2-eq)**	34.5216	**Total - Transport (kg CO_2-eq)**	34.5216
Accommodation	**AirBnb**		**AirBnb**		**AirBnb**		AirBnb		**2-stars hotel (2 person)**		**5-stars hotel (2 person)**	
	a.Eletricity used - 30m² with 4 people		**a.Eletricity used - 30m² with 4 people**		**a.Eletricity used - 30m² with 4 people**		**a.Eletricity used - 30m² with 4 people**		Number of days	7	Number of days	7
	Number of days	7	Number of days	7	Number of days	7	Number of days	7	Emission rate/room (kg CO_2-eq)	2	Emission rate/room (kg CO_2-eq)	14
	Electricity consumptionrate (Kwh/yea	50	Electricity consumptionrate (Kwh/yea	50	Electricity consumptionrate (Kwh/yea	50	Electricity consumptionrate (Kwh/yea	50	Total (kg CO_2-eq)	14	Total (kg CO_2-eq)	98
	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Total per person (kg CO_2-eq)	7	Total per person (kg CO_2-eq)	49
	Total (kg CO_2-eq)	0.062328767	Total (kg CO_2-eq)	0.062328767	Total (kg CO_2-eq)	0.062328767	Total (kg CO_2-eq)	0.062328767				
	Total per person (kg CO_2-eq)	0.467465753	Total per person (kg CO_2-eq)	0.467465753	Total per person (kg CO_2-eq)	0.467465753	Total per person (kg CO_2-eq)	0.467465753				
	b.Water used		**b.Water used**		**b.Water used**		**b.Water used**					
	Estimation per day (litre)	74	Estimation per day (litre)	74	Estimation per day (litre)	74	Estimation per day (litre)	74				
	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298				
	Total (kg CO_2-eq)	0.1544	Total (kg CO_2-eq)	0.1544	Total (kg CO_2-eq)	0.1544	Total (kg CO_2-eq)	0.1544				
	Total - Accommodation (kg CO_2-eq)	0.6218	**Total - Accommodation (kg CO_2-eq)**	0.6218	**Total - Accommodation (kg CO_2-eq)**	0.6218	**Total - Accommodation (kg CO_2-eq)**	0.6218	**Total - Accommodation (kg CO_2-eq)**	7	**Total - Accommodation (kg CO_2-eq)**	49
Total kg CO_2-eq per TRIP		**35.1434**		**1.9883**		**69.6650**		**138.7082**		**41.5216**		**83.5216**
Total kg CO_2-eq per Day		**1.9524**		**0.1105**		**3.8703**		**7.7060**		**2.3068**		**4.6401**
Total kg CO_2-eq per Km.		**0.0489**		**0.0028**		**0.0969**		**0.1929**		**0.0577**		**0.1161**
Total kg CO_2-eq per trip CHANGE(%)		**0%**		**-94%**		**98%**		**295%**		**18%**		**138%**

Appendix G: Trip 4 Tarbes to several cities in France and scenarios 1 to 4

4. Tarbes to several cities in France	Simulation Trip (Train, TGV)		Scenario 1 (Plane)		Scenario 2 (Bus)		Scenario 3 (Train, TER)		Scenario 4 (Train, Intercity)	
Transportation	**a. Train (TGV)**		**a.Plane (Domestic flight)**		**a.Plane (Domestic flight)**		**a.Plane (Domestic flight)**		**a.Plane (Domestic flight)**	
	Distance (km.)	1848	Distance (km.)	1848	Distance (km.)	1848	Distance (km.)	1848	Distance (km.)	1848
	Emission rate/km. (kg CO_2-eq)	0.0019	Emission rate/km. (kg CO_2-eq)	0.255	Emission rate/km. (kg CO_2-eq)	0.104	Emission rate/km. (kg CO_2-eq)	0.02481	Emission rate/km. (kg CO_2-eq)	0.00529
	Total (kg CO_2-eq)	3.5112	Total (kg CO_2-eq)	471.2400	Total (kg CO_2-eq)	192.1920	Total (kg CO_2-eq)	45.8489	Total (kg CO_2-eq)	9.7759
	b.Metro		**b.Metro**		**b.Metro**		**b.Metro**		**b.Metro**	
	Distance (km.)	40	Distance (km.)	40	Distance (km.)	40	Distance (km.)	40	Distance (km.)	40
	Emission rate/km. (kg CO_2-eq)	0.031	Emission rate/km. (kg CO_2-eq)	0.031	Emission rate/km. (kg CO_2-eq)	0.031	Emission rate/km. (kg CO_2-eq)	0.031	Emission rate/km. (kg CO_2-eq)	0.031
	Total (kg CO_2-eq)	1.24	Total (kg CO_2-eq)	1.24	Total (kg CO_2-eq)	1.24	Total (kg CO_2-eq)	1.24	Total (kg CO_2-eq)	1.24
	Total - Transport (kg CO_2-eq)	4.7512	**Total - Transport (kg CO_2-eq)**	472.4800	**Total - Transport (kg CO_2-eq)**	193.4320	**Total - Transport (kg CO_2-eq)**	47.0889	**Total - Transport (kg CO_2-eq)**	11.0159
Accommodation	**Friend's apartment (50m²)**		**Friend's apartment (50m²)**		**Friend's apartment (50m²)**		**Friend's apartment (50m²)**		**Friend's apartment (50m²)**	
	a.Eletricity used - 50m² with 2 people		**a.Eletricity used - 50m² with 2 people**		**a.Eletricity used - 50m² with 2 people**		**a.Eletricity used - 50m² with 2 people**		**a.Eletricity used - 50m² with 2 people**	
	Number of days	13	Number of days	13	Number of days	13	Number of days	13	Number of days	13
	Electricity consumptionrate (Kwh/mo	167	Electricity consumptionrate (Kwh/mo	167	Electricity consumptionrate (Kwh/mo	167	Electricity consumptionrate (Kwh/mo	167	Electricity consumptionrate (Kwh/mo	167
	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065
	Total (kg CO_2-eq)	4.5521	Total (kg CO_2-eq)	4.5521	Total (kg CO_2-eq)	4.5521	Total (kg CO_2-eq)	4.5521	Total (kg CO_2-eq)	4.5521
	Total per person (kg CO_2-eq)		Total per person (kg CO_2-eq)		Total per person (kg CO_2-eq)		Total per person (kg CO_2-eq)		Total per person (kg CO_2-eq)	
	b.Water used		**b.Water used**		**b.Water used**		**b.Water used**		**b.Water used**	
	Estimation per day (litre)	128	Estimation per day (litre)	128	Estimation per day (litre)	128	Estimation per day (litre)	128	Estimation per day (litre)	128
	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298
	Total (kg CO_2-eq)	0.4959	Total (kg CO_2-eq)	0.4959	Total (kg CO_2-eq)	0.4959	Total (kg CO_2-eq)	0.4959	Total (kg CO_2-eq)	0.4959
	Total - Accommodation (kg CO_2-eq)	5.0480	**Total - Accommodation (kg CO_2-eq)**	5.0480	**Total - Accommodation (kg CO_2-eq)**	5.0480	**Total - Accommodation (kg CO_2-eq)**	5.0480	**Total - Accommodation (kg CO_2-eq)**	5.0480
Total kg CO_2-eq per TRIP		**9.7992**		**477.5280**		198.4800		**52.1368**		**16.0639**
Total kg CO_2-eq per Day		**0.5444**		**26.5293**		11.0267		**2.8965**		**0.8924**
Total kg CO_2-eq per Km.		**0.0053**		**0.2584**		0.1074		**0.0282**		**0.0087**
Total kg CO_2-eq per trip CHANGE(%)		**0%**		**4773%**		1925%		**432%**		**64%**

Appendix H: Trip 4 Tarbes to several cities in France and scenarios 5 to 9

4. Tarbes to several cities in France	Simulation Trip (Train, TGV)		Scenario 6 (Car, 2 passengers)		Scenario 7 (Car, 1 passengers)		Scenario 8 (2-star hotel)		Scenario 9 (5-star hotel)	
Transportation	**a. Train (TGV)**		**Car - Medium (Petrol) 2 passengers**		**Car - Medium (Petrol) 1 passenger**		**a. Train (TGV)**		**a. Train (TGV)**	
	Distance (km.)	1848	Distance (km.)	1848	Distance (km.)	1848	Distance (km.)	1848	Distance (km.)	1848
	Emission rate/km. (kg CO_2-eq)	0.0019	Emission rate/km. (kg CO_2-eq)	0.096	Emission rate/km. (kg CO_2-eq)	0.192	Emission rate/km. (kg CO_2-eq)	0.0019	Emission rate/km. (kg CO_2-eq)	0.0019
	Total (kg CO_2-eq)	3.5112	Total (kg CO_2-eq)	177.4080	Total (kg CO_2-eq)	354.8160	Total (kg CO_2-eq)	3.5112	Total (kg CO_2-eq)	3.5112
	b.Metro		**b.Metro**		**b.Metro**		**b.Metro**		**b.Metro**	
	Distance (km.)	40	Distance (km.)	40	Distance (km.)	40	Distance (km.)	40	Distance (km.)	40
	Emission rate/km. (kg CO_2-eq)	0.031	Emission rate/km. (kg CO_2-eq)	0.031	Emission rate/km. (kg CO_2-eq)	0.031	Emission rate/km. (kg CO_2-eq)	0.031	Emission rate/km. (kg CO_2-eq)	0.031
	Total (kg CO_2-eq)	1.24	Total (kg CO_2-eq)	1.24	Total (kg CO_2-eq)	1.24	Total (kg CO_2-eq)	1.24	Total (kg CO_2-eq)	1.24
	Total - Transport (kg CO_2-eq)	4.7512	**Total - Transport (kg CO_2-eq)**	178.6480	**Total - Transport (kg CO_2-eq)**	356.0560	**Total - Transport (kg CO_2-eq)**	4.7512	**Total - Transport (kg CO_2-eq)**	4.7512
Accommodation	**Friend's apartment (50m²)**		**Friend's apartment (50m²)**		**Friend's apartment (50m²)**		**2-stars hotel (2 person)**		**5-stars hotel (2 person)**	
	a.Eletricity used - 50m² with 2 people		**a.Eletricity used - 50m² with 2 people**		**a.Eletricity used - 50m² with 2 people**		Number of days	13	Number of days	13
	Number of days	13	Number of days	13	Number of days	13	Emission rate/room (kg CO_2-eq)	2	Emission rate/room (kg CO_2-eq)	14
	Electricity consumptionrate (Kwh/mo	167	Electricity consumptionrate (Kwh/mo	167	Electricity consumptionrate (Kwh/mo	167	Total (kg CO_2-eq)	26	Total (kg CO_2-eq)	182
	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Emission rate/Kwh (kg CO_2-eq)	0.065	Total per person (kg CO_2-eq)	13	Total per person (kg CO_2-eq)	91
	Total (kg CO_2-eq)	4.5521	Total (kg CO_2-eq)	4.5521	Total (kg CO_2-eq)	4.5521				
	Total per person (kg CO_2-eq)		Total per person (kg CO_2-eq)		Total per person (kg CO_2-eq)					
	b.Water used		**b.Water used**		**b.Water used**					
	Estimation per day (litre)	128	Estimation per day (litre)	128	Estimation per day (litre)	128				
	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298	Emission rate/litre (kg CO_2-eq)	0.000298				
	Total (kg CO_2-eq)	0.4959	Total (kg CO_2-eq)	0.4959	Total (kg CO_2-eq)	0.4959				
	Total - Accommodation (kg CO_2-eq)	5.0480	**Total - Accommodation (kg CO_2-eq)**	5.0480	**Total - Accommodation (kg CO_2-eq)**	5.0480	**Total - Accommodation (kg CO_2-eq)**	13	**Total - Accommodation (kg CO_2-eq)**	91
Total kg CO_2-eq per TRIP		**9.7992**		**183.6960**		**361.1040**		**17.7512**		**95.7512**
Total kg CO_2-eq per Day		**0.5444**		**10.2053**		**20.0613**		**0.9862**		**5.3195**
Total kg CO_2-eq per Km.		**0.0053**		**0.0994**		**0.1954**		**0.0096**		**0.0518**
Total kg CO_2-eq per trip CHANGE(%)		**0%**		**1775%**		**3585%**		**81%**		**877%**