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Guidelines to Reduce the Carbon Footprint of Kuwait

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ABSTRACT

Carbon footprint can be defined as the amount of carbon dioxide emitted directly or indirectly by an activity through its lifecycle. It directly contributes to global warming, which is a major concern worldwide. Kuwait's share of the world's total carbon footprint was around 21,623 metric tons per capita in the year 2018. This high rate of carbon emissions is partially due to low awareness by both the State and its citizens and residents. The goal behind this study is to highlight Kuwait's high carbon footprint, study it across different sectors, and suggest guidelines for these sectors to lower their share of the problem. The sectors studied are the major contributors to the carbon footprint, and they are the government, power, oil and gas, road transportation, construction, and information communication technology sectors. The proposed guidelines can play a key role in reducing the carbon emissions in the State of Kuwait in order to fulfill its pledge of signing the Paris Climate Agreement to limit the global warming temperature to 1.5 degrees Celsius.

INTRODUCTION

Carbon footprint can be defined as the amount of carbon dioxide emitted directly or indirectly by an activity through its lifecycle (Turek, Dziembek, and Hernes 2021). It has been a major concern worldwide as it directly contributes to the global warming problem of the planet. Due to humankind's increasing greenhouse gas emissions, the world's temperature keeps increasing at a rate that will lead to the melting of ice and glaciers around the world which will eventually result in the rising of sea levels. According to (Shahzad 2015), the rising of sea levels is the most dangerous and life-threatening effect of global warming as it will lead to floods in many countries. This has led to 191 countries, including the State of Kuwait, to come together and sign the Paris Climate Agreement back in 2015. The goal of this agreement is to limit the global warming temperature to below 2 and preferably to 1.5 degrees Celsius (Sachs 2020). Also, in late 2021, Kuwait attended the United Nations Climate Change Conference (COP26) in the United Kingdom. The attending countries pledged to reduce methane emissions, stop and reverse deforestation, speed-up the phase-out of coal and end fossil fuels financing among other commitments (Yi Wang, Liu, and Gu 2022). So today, countries are in a race to reduce their carbon footprint, and the State of Kuwait is no exception. The state aims to reach a sustainable living environment as part of its strategic plan for the year 2035 (Government, n.d.). An important factor to sustainable living is the reduction in the carbon footprint of the country. In a world where renewable energy and recyclables are being widely adopted to reduce the carbon footprint, Kuwait's high consumption of gas, electricity and paper resulting in its high greenhouse gas emissions and increasing its carbon footprint is unacceptable. According to (World Bank 2019), Kuwait's total CO₂ emissions in the year 2018 was 21,623 metric tons per capita. In comparison, the total CO₂ emissions in the year 2018 for the United States of America according to (World Bank 2019), was 15.2 metric tons per capita. This means that Kuwait, despite its relatively small size and lower number of citizens, has a much

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larger CO₂ emission rate per capita than the USA.

This paper contributes to the ongoing efforts of environmental researchers to highlight Kuwait's increasing CO₂ emissions and to pave the way for its reduction among different sectors by providing sector-specific guidelines. The issue of global warming demands immediate attention from both authorities and individuals in the country as it affects the sustainability and quality of life for future generations. As Kuwait already suffers from high temperatures in the summer and borders the Arabian Gulf, it could first-hand face the consequences of global warming in the form of dry hot weather and potential floods. So, awareness and immediate steps are required to reduce the greenhouse gas emissions and their eventual effects in the country. It is noteworthy, however, that to the best of our knowledge, no work has been published providing guidelines to reduce the carbon footprint of the State of Kuwait which makes this study unique and important.

The sectors included in this study are the major contributors to the carbon emissions in the State. Namely, the government, power, oil and gas, road transportation, construction and the information communication technology sectors. Following the guidelines presented in this paper will decrease the carbon emissions of each sector, which will reduce their contribution to the global warming problem worldwide. The guidelines will also prove beneficial to Kuwait's stance in front of the world as an outcome of following both the Paris Climate Agreement and the Kyoto Protocol.

The organization of the paper is as follows. The next section will explore research work related to carbon footprint. Then, we will introduce the guidelines suggested for Kuwait to reduce its carbon footprint. Afterwards, we will provide a general summary of the guidelines. Lastly, we will include the concluding remarks and suggested future areas of study.

RELATED WORK

A lot of research has been conducted regarding the reduction of carbon footprint in different sectors and industries. In this section, we'll review some interesting papers relevant to this topic.

Carbon Atlas

In 2017, (Al-Mutairi et al. 2017) published a survey paper providing in-depth analysis of Kuwait's CO₂ emissions. A carbon atlas for the State of Kuwait was developed, which is a scientific database used to explore and visualize the sources of CO₂ emission coming from human activities. It concludes that the power industry is the highest source of CO₂ emissions (41.6%) followed by the chemical industry (25.5%) and then road transportation (16.6%). Table 1 showcases Kuwait's carbon footprint across different sectors in the year 2016. Furthermore, an observation was made that the facilities with the high source of emission are mainly clustered in the southeast industrial area of the country. This observation of distribution could help in forming a capture and storage mitigation mechanism.

Table 1: Kuwait's Carbon Footprint Across Different Sectors in 2016 (Al-Mutairi et al. 2017)

Sector	Anticipated CO ₂ emission (MtCO ₂ /y)
Air transportation	0.122
Aluminum	0.167
Sea transportation	0.226
Cement	0.322
Iron and Steel	0.312
Petroleum upstream processes	0.255
Petrochemical	2.642
Building and Construction	0.545
Petroleum downstream processes	8.962
Road Transportation	16.314
Chemicals Industry	25.45
Paper	1.0454
Power and water sector	41.636
Total	98

Environmentally Sustainable Computing

According to (Lannelongue et al. 2021), the IT sector's share of global CO₂ emissions is estimated to be from 2% to 6%, with a possibility to reach 20% by 2030. A noteworthy fact mentioned in (Lannelongue et al. 2021) is that servers represent half the energy consumption of a data center, and their power usage is 4 times more than the idle power usage. This makes it crucial to calculate the carbon footprint of running an analysis on the server since it draws more energy. The paper also provides simple rules to make computing more environmentally sustainable, leading to a reduction in the total carbon footprint of the Information and Communication Technology (ICT) sector. Increasing code efficiency, offsetting the carbon footprint and carefully choosing the hardware are examples of the rules suggested by the authors.

Emission Inventory

The author of (Ramadan 2022), developed an emission inventory for the State of Kuwait, which is the first bottom-up attempt. The project was initiated in 2015 and spanned 6 years during which the author studied and analyzed the greenhouse gas emissions in different sectors in the country. Table 2 summarizes the key findings of the research project in terms of each sector and their respective contributions to the emissions in Kuwait. The greenhouse gas emissions, expressed in CO_{2e}, were found to be 4.92E+11, 9.15E+09, and 2.85E+09 kg of CO_{2e} for CO₂, CH₄ and N₂O, respectively. This means that Kuwait, with a population of approximately 4.5 million back in 2016, had a per capita CO_{2e} emissions of 1.12E+05 kg.

Table 2: Sectors Emissions Contribution as Found in the Emission Inventory Project (Ramadan 2022)

Petroleum	Ministry of Electricity & Water (MEW)	Vehicles	Landfill Sites
90% NH ₃	9% CO ₂	4% NO _x	53% CH ₄
96% Benzene	4% CO	16% CO	100% H ₂ S
87% CO ₂	12% NO _x	10% NH ₃	
79% CO	11% N ₂ O		
77% NO _x	41% SO ₂		
90% NH ₃	14% PM ₁₀		
86% N ₂ O	23% PM _{2.5}		
46% PM ₁₀	29% SO ₂		
72% PM _{2.5}			
28% SO ₂			

The outcome of these related works is the definition of carbon footprint, its causes, and effects on the environment. The papers specifically based on Kuwait will help us form the guidelines as they specify the sectors causing the problem. Also, we learned the steps already taken by the State to reduce its greenhouse gas emissions and thus its carbon footprint. This will help us build guidelines on top of existing procedures. Moreover, we learned how to tackle the reduction of the carbon footprint in specific sectors (i.e., ICT) so that we can create related guidelines targeted to Kuwait. The aim of the next section is to present sector-specific guidelines that can be directly executed by Kuwait to reduce the carbon footprint.

GUIDELINES TO REDUCE THE CARBON FOOTPRINT

To properly tackle the carbon footprint issue in Kuwait, we will divide the guidelines across different sectors based on their contribution to the problem. First, we have the government sector which is mainly the government. This sector controls the rest of the sectors as the government, as an authoritative entity, can pass laws and regulations to handle the carbon footprint problem. Next, we have the power sector which contributes 41.6% of carbon dioxide emissions, the highest in the country according to (Al-Mutairi et al. 2017). Afterwards, we have the oil sector since the petroleum industry emits 9.2% of carbon dioxide. Then, we have road transportation that contributes to 16% of the total carbon emissions in the country. So, guidelines must be presented to reduce all of these percentages since Kuwait's emissions per capita is one of the highest in the world.

Government Sector

The government sector is the biggest sector in Kuwait. It consists of ministries, authorities, state-owned oil companies, and public transportation among other entities. It is also linked with the Information Technology (ICT) sector as the

Communication and Information Technology Regulatory Authority (CITRA) and the Central Agency for Information Technology (CAIT) are examples of ICT entities within the government sector. The following are the suggested guidelines for the government sector to reduce its carbon footprint share in the country.

Pass Legislative Laws. Since the government is an authoritative entity, it holds power to reduce the carbon footprint of not only itself but also of all other entities and sectors in the country through laws and regulations. An important fact stated in (Freitag et al. 2021) is that all study analysts agree that no reduction in the emissions of the ICT sector will happen unless political and industrial efforts are jointly arranged. Therefore, the government should pass legislative laws forcing all industrial companies, especially those in the power and chemical sectors, to calculate and disclose their carbon footprint in an annually submitted report. If a company sees an increase in its CO₂ emissions, they will be legally forced to offset their carbon footprint or face financial penalties. Moreover, financial and legal penalties should be enforced if a company refuses to disclose the annual report, or if any manipulation in the submitted data is discovered.

There are 3 ways to calculate the carbon footprint in an organization: bottom-up using Process Analysis, top-down using Environmental Input-Output Analysis or a combination of both (Recker, Rosemann, and Gohar 2011). Reporting and announcing annual CO₂ emissions will create transparency and promote ownership of actions among companies. It will also make companies think multiple times before approving and executing processes that increase the CO₂ emissions in the country without offsetting them.

Implement a Paperless Government. According to (Yutao Wang et al. 2016), the paper and pulp products contribute around 3% of the world's carbon footprint. To produce a single kg of paper, 10 liters of water and 2-3 times the paper's weight in trees are needed. This means that if every citizen of the world used 200kg of paper per year, there will be no trees left on earth. And as is known, trees naturally absorb CO₂ and release O₂ contributing to a reduced carbon footprint and a higher quality of air (Yutao Wang et al. 2016). There are more than 70 paper-specialized companies in Kuwait which, according to (Al-Mutairi et al. 2017), jointly produced a staggering 432 million kg of paper in the year 2013 alone. The estimated carbon footprint of the paper industry in Kuwait is 1.045 MtCO₂/y (Million Metric Ton of Carbon Dioxide Per Year). To reduce this, we suggest a paperless government. In order to become a paperless government, a gradual process where manual transactions are slowly eliminated by digitizing services and automating workflows should be implemented. Interestingly, Kuwait already took the first step towards a digitized, paperless government in 2021 with the release of Sahel, the government's first unified mobile application for integrated electronic services.

Pursue Carbon Offsetting. According to (Freitag et al. 2021), a mature tree can sequester 11,000 gCO₂ per year. Sequestration is the process of capturing and storing CO₂ from the surrounding atmosphere (Lal 2008). Based on the total carbon footprint of Kuwait in 2016, which was 98 MtCO₂/y (Al-Mutairi et al. 2017), the government needs to pay around \$1,216,199,934.13 per year to offset the total carbon footprint (Carbon Footprint, n.d.). This money would be used for tree planting, reforestation, and clean and renewable energy generation projects in the world. In retrospect, Kuwait's expenditure budget for the financial year 2021-2022 is 23 billion KWD (Kuwait Ministry of Finance, n.d.) equivalent to \$76,002,902,000. This means that if the government wishes to pursue carbon offsetting, the project will amount to only 1.6% of the expenditure costs.

Power Sector

According to (Al-Mutairi et al. 2017), the power sector contributes 41.6% of the total carbon dioxide emissions in Kuwait, which is the highest rate in the country. The following are some guidelines aimed to reduce this percentage.

Use Renewable Energy. Renewable energy can be defined as the usage of the wind, solar and ocean to generate power and energy. The production of electrical energy from its alternative clean sources and then using it in desalination plants and other sectors of the state will achieve many advantages and objectives. Among which is the diversification of energy sources instead of relying on a single source of energy. Also, there will be a reduction in the emission of harmful gases that negatively affect the natural life. Moreover, the country will achieve a preservation of the oil stock and avoid the fluctuation of prices. The goal planned by the Ministry of Electricity, Water and Renewable Energy (MEW) within the 2035 vision is for the production of electric energy alternatives to reach 15% of the country's total need of electric power. Another initiative in this regard is the Shagaya Concentrated Solar Power (CSP) Project, which is the first commercial CSP in Kuwait developed by the Kuwait Institute for Scientific Research (KISR). The project consists of multiple phases and makes use of several renewable

energy sources such as: wind farms, a photovoltaic plant, and a concentrated solar power plant. The aim of the project is the production of 180GWh/year across a total area of 250 hectares, and the reduction of emissions by more than 81,000 tons of CO₂ per year (Kuwait Institute for Scientific Research, n.d.). The official opening of the Shagaya CSP plant took place in February 2019.

Promote Rationalized Consumption. According to (Alfadhli, Alghoussein, and Alarifi 2019), Kuwait offers electricity to its citizens at the lowest price in the GCC area, and the amount of electricity aid it provides is one of the highest in the world, approximately \$8.8 billion yearly. Many consumers take advantage of this aid for private residential areas by renting out their houses and overwhelming the residential power station. Also, due to the cheap price of electricity in the country, many consumers use it excessively. For example, leaving the lights of the entire house on while no one is inside, or in the morning when the sun is out and can sufficiently light up the house. The mindset of the people needs to be reprogrammed to rationalize their use of both electricity and water. The citizens of Kuwait hold a lot of responsibility regarding the carbon emissions, and until sustainable alternatives are fully implemented in the power and water stations, rationalized consumption is encouraged. One of the many ways to encourage the people is an incentives program. In 2021, the Minister of MEW announced an incentives program to promote the rationalized consumption of water and electricity in the country. The program promises consumers 40% and 50% cuts on monthly bills for electricity and water, respectively, given that their consumption in this month is less than that of the same month the previous year. The aim of this program is the rationalization of electricity and water consumption, contributing to reducing the cost of fuel to the State, achieving financial savings in the public interest, and collecting the amounts owed to the Ministry by paying customers' debts. This program is subscription-only, and we encourage all citizen to subscribe and take part in such a great initiative. In order to validate the effect of this guideline, a quantitative analysis research that studies the reduction in carbon emissions after the promotion of rationalized consumption is needed.

Oil and Gas Sector

The oil sector, comprised of state-owned and private oil companies, contribute to the high greenhouse gas emissions of Kuwait. The process of drilling, processing, refining, and distributing petroleum is a carbon-intensive one. According to (Al-Mutairi et al. 2017), the oil sector produces approximately 9.2% of CO₂, the second highest in the country. This section focuses on providing guidelines to reduce this percentage. It is important to point out that the oil sector is tightly coupled with the government sector. Therefore, most of the abovementioned guidelines for the government sector apply here.

Implement and Adhere to the Carbon Tax. In 1991, Norway, an oil-rich country like Kuwait, implemented the carbon tax. It is a tax on oil companies paid per cubic meter of gas or per liter of oil. It aims to reduce the country's overall greenhouse gas emissions. The highest rate in the country is \$44 per ton of CO₂, one of the highest in the world. In (Bruvoll and Larsen 2004), the authors observed that since this tax was implemented, the average emissions per unit GDP decreased by 16% showing effectiveness. That is why we propose a similar tax to be implemented and enforced in Kuwait. The government alone has around 10 oil companies: KOC, KNPC, KIPIC, KOTC, KAFC, KFPEC, KPI, KGOC, among other companies. And the private sector owns some oil companies as well, namely: Schlumberger, Halliburton, etc. If the government imposed a carbon tax on the emission of all these public and private oil companies, we estimate the reduction in CO₂ will be significant and similar to Norway's.

Implement Smart, Sustainable Reservoirs. One of the biggest challenges in the oil and gas (O&G) industry regarding environmental efforts is reducing the carbon footprint of reservoirs while maintaining high production levels. A promising initiative was seen in CO₂ sequestration in order to overcome this challenge, but it can barely keep up with the O&G industry's increasing carbon emissions. In (Katterbauer et al. 2021), the authors propose implementing a smart, sustainable reservoir management framework to achieve the goal of minimizing the carbon footprint while sustaining the production levels. The framework was developed using a nonlinear, autoregressive deep learning framework. After simulating it using real data of multiple injection strategies, it showed promising results in reducing CO₂ emissions and keeping the production level maintained. That is why we propose using similar frameworks for the reservoirs in Kuwait's oil companies to achieve the same goal. After implementing sustainable reservoirs, the CO₂ emissions of Kuwait's O&G industry can be estimated and compared with previous estimations (i.e., Table 2) to validate the usefulness of the guideline.

Use Renewable Energy. As mentioned earlier, renewable energy can be defined as the usage of the wind, solar and ocean to generate power and energy. For a long time, renewable energy has been associated with the oil industry, as many

people believe that it will be its substitute in the future. For example, instead of electricity being generated by oil and gas, it would be generated by renewable energy. But this energy has some limitations such as: solar power can only be obtained when the sun is out and at certain temperatures, and even then it is capable of producing energy less than that obtained by conventional methods. Another limitation is that not all countries and territories have strong winds, or even contact with the ocean. Nevertheless, Kuwait can benefit from solar and wind renewable energy sources. Solar energy consists of using two technologies: photovoltaics (PV) cells and concentrating solar power (CSP). Both of these technologies have previously been successfully deployed in the O&G industry to support its production. In (Saadawi 2019), the author mentions a similar project going on in the Sultanate of Oman, the project is called Miraah and once it is finished, it will produce 6,000 tons of solar steam to be used for injection. This project would save as much natural gas as would provide 200,000 residents with electricity. Also, it would reduce the CO₂ emissions by 300,000 tons per year, which is as much as the result of removing 63,000 cars off the road. Interestingly, Kuwait is within the ideal latitude for capturing solar radiation (Saadawi 2019). That is why using solar energy in a project similar to Oman's Miraah project is recommended as it would leverage from the country's hot weather and reduce the CO₂ emissions coming from fuel operations. As is mentioned in (Avaritsiotis 2018), using solar steam production for enhanced oil recovery in Kuwait would produce a peak power of 7MWth and an output of 517 tons of steam annually. The proposed system would require 5.2 acres of land and can successfully eliminate 44,698 tons of CO₂ annually.

Promote Corporate Social Responsibility. Corporate Social Responsibility can be defined as a company's responsibility towards the society it operates in with regards to its business activities and decisions (ISO 26000). Among the guidelines mentioned by ISO for organizations to follow in order to promote social responsibility is that organizations should be accountable and responsible to clarify their impact on the environment. According to (Duttagupta et al. 2021), corporate sustainability is defined as "meeting the needs for the present generation without compromising the ability of the future generation to meet theirs". That is why all organizations in the O&G industry should develop an effective sustainable strategy, with an emphasis on transparency to the society. An example of initiatives implemented by an O&G company, BP, as a social responsibility is their investment in a low carbon future. BP invested in the production of wind energy and sugar cane ethanol and tried to reduce its carbon emissions by 0.7 million tons, which is as much as 334,000 European cars would emit. It also actively supports the World Bank's initiative "Zero Routine Flaring by 2030", where flaring is the burning of natural gas during production. This initiative aims to reduce the greenhouse gas emissions. If corporates were more socially responsible, we would see similar initiatives developed and implemented in the O&G industry such as: developing renewable energy and enhancing energy efficiency.

Road Transportation

According to (Al-Mutairi et al. 2017), road transportation contributes approximately 18% to the total carbon emissions in Kuwait. It came in third place as of total emissions after the power sector and the chemical industry. That is why some steps must be taken by the government, oil sector and individuals to reduce the carbon footprint resulted by road transportation. The following are the related guidelines.

Use Public Transportation. According to the Central Statistical Bureau (CSB) of Kuwait, the number of private vehicles in the country has seen an increase of 8.1% between the years 2018 and 2019. Also, and according to (Al-Mutairi et al. 2017), there's an average of one car for every two residents in the country. This average, according to the World Bank, is the highest in the world for developed countries, where on average every three residents own a car. That is why we suggest public transportation. The government can limit the number of driving licenses issued per year, the oil sector can reduce the gas prices for the public transportation vehicles and individuals can use them for their daily trips. This will not only reduce the congestion on the roads, but also effectively reduce the CO₂ emissions since public transportation vehicles such as a bus can accommodate around forty people who would have otherwise used forty private vehicles to reach their destination. According to (Ercan, Onat, and Tatari 2016), CO₂ emissions could be reduced by 766,000 tonnes annually by the year 2050 if a 9% increase in public transportation ridership is established. Another great means of public transportation is a metro rail, which is a project currently under development in the country. This metro rail will also connect Kuwait with its neighboring countries in the GCC which will be prove effective in reducing the carbon emissions of airplanes and private vehicles.

Shift to Electric Vehicles. According to the United States Environmental Protection Agency (US EPA), electric vehicles (EVs) have a smaller carbon footprint than fuel vehicles, including the electricity used to charge the vehicle (United States Environmental Protection Agency, n.d.). Moreover, the greenhouse gas emissions associated with EVs are lower than

the average fuel vehicles, including cost of manufacturing. As of now, there are approximately 5.6 million electric cars in the world, an increase of 64% since 2018 (Kopestinsky, n.d.). The demand for electric cars is growing and the shift from fuel vehicles to electric ones is inevitable. That is why Kuwait needs to prepare for the day electric vehicles become the new norm and fuel vehicles become the past.

Construction

According to (Gholipour, Arjomandi, and Yam 2022), the construction industry is responsible for approximately 38% of the world's total CO₂ emissions. The paper also mentions the factors that contribute to this percentage, such as: income, energy price, outdoor temperature, and population. The building industry consists of many types, such as residential and commercial buildings. In this section, we propose guidelines to tackle and reduce the carbon footprint of the building industry.

Move to Energy Efficient Buildings. The latest buildings scan conducted by the Central Statistical Bureau was in 2011. The results of the scan showed that the total number of buildings in Kuwait amounts to 182,681. In 2022, although no official data is available, we can certainly say this number has increased a lot. We cannot reduce the number of buildings, especially residential ones, as people are in constant need for a home. But what we can do is move to energy efficient buildings since energy is the carbon consuming part of a building. In order to establish efficient buildings, architects can reuse old buildings instead of building new ones from scratch. This could potentially save up to 75% of the incorporated carbon emissions of the building. Moreover, using concrete mixtures that are low in carbon and limiting usage of carbon intensive materials during construction will also reduce the CO₂ emissions (Huang et al. 2018).

Information Communication Technology

Information Communication Technology (ICT) consists of many technologies such as computers, laptops, servers, cell phones, networking devices such as routers, and more. According to (Lannelongue et al. 2021), the IT sector's share of global CO₂ emissions is estimated to be from 2% to 6%, with a possibility to reach 20% by 2030. And according to (Freitag et al. 2021), these emissions will not be reduced without political and industrial joint interventions. In this section, we propose guidelines to reduce Kuwait's share of these emissions.

Use Green and Sustainable Cloud Services. According to (Turek, Dziembek, and Hernes 2021), server rooms require a huge amount of electricity due to their 24/7 availability requirement. This produces outstanding amounts of CO₂ emissions. That is why we propose using cloud computing services. Cloud computing consists of on-demand services with a pay-as-you-go payment option. These services are shared and configurable and can be servers, storage, networks, etc. A great environmental advantage of using cloud services is that data centers can be placed in geographical regions that leverage from using solar energy or wind farms regardless of where the users are located. Also, computing power can be shared among users using the same amount of electricity which is better than having each user power their own data center. Kuwait could potentially reduce the overall carbon emissions by implementing this guideline since migrating physical data centers to the cloud can reduce CO₂ emissions by 84% (Turek, Dziembek, and Hernes 2021). Moreover, using the public cloud can also reduce the emissions by 59 MtCO₂/y. According to (Freitag et al. 2021), the ICT sector can reduce its share of emissions by 80% if renewable energy sources were used to produce electricity. And to further enforce reductions, users can make a point by only acquiring services from cloud providers that power their data centers with renewable energy sources or providers that offset their carbon footprint.

Individuals

A thousand-mile journey begins with a single step. As mentioned before, Kuwait has one of the highest CO₂ emissions per capita in the world. So, it is only natural that individuals have a section of guidelines of their own in this paper. Awareness is key when it comes to reducing the carbon footprint of Kuwait's citizens and inhabitants. If every person living in Kuwait became self-aware of their effect on the environment and took small but effective steps towards reducing their contribution to the problem, then the country will be further down on the list of top contributors to worldwide CO₂ emissions. Table 3 summarizes the steps that can be taken by individuals to reduce their carbon footprint (Carbon Footprint, n.d.). The total potential savings are estimated to be approximately 437 kg of CO₂ per year for every person. According to Kuwait's CSB, Kuwait's population is estimated to be 4,216,900. So, assuming every individual followed the proposed reduction steps, the

country will see a decrease of 1,842,785,300 kg in its total CO₂ emissions per year.

SUMMARY

In order to fulfil its pledge to the Paris Climate Agreement, the government of Kuwait needs to reduce its overall carbon footprint to reach sustainable levels. To tackle this, we propose dissecting the problem and looking at the emissions of sectors instead of the overall country. In this paper, we provided sector-specific guidelines to reduce the carbon emissions and therefore footprint of the country of Kuwait. Table 4 summarizes all the guidelines presented in this paper and the sectors that can apply them in order to reduce their contribution to the problem. We believe that following these guidelines will greatly reduce the carbon footprint of each sector and thus the country.

Table 3: Guidelines for Individuals to Reduce Their CO₂ Emissions (Carbon Footprint, n.d.)

Guideline	Reduction in CO ₂ (per year)
Dry clothes by hanging them instead of using drying machine	153 kg
Reduce household heating system by 1°C	184 kg
Boil only the needed amount of water	73 kg
Reduce shower time by 1 minute	23 kg
Turn off unused electronic devices (LED TV)	5kg

Table 4: Summary of All the Guidelines to Reduce the Carbon Footprint Across All Sectors in Kuwait

Sector	Guidelines
Government	Pass Legislative Laws Implement a Paperless Government Pursue Carbon Offsetting Use Renewable Energy
Power	Promote Rationalized Consumption
Oil	Implement Smart, Sustainable Reservoirs Use Renewable Energy Promote Corporate Social Responsibility Use Public Transportation Shift to Electric Vehicles
Road Transportation	
Construction	Move to Energy Efficient Buildings
Information Communication Technology	Use Green and Sustainable Cloud Services

CONCLUSION

No change in the carbon footprint can be made without the joint efforts of all sectors and individuals in Kuwait. The government has a lot to work on, starting with laws and regulations and enforcing them. The individuals must be aware of their contribution to the problem and reduce their effect to it. The oil and gas, power and water station, road transportation, construction, and IT industries are all huge contributors that must act immediately to reduce and offset their carbon emissions. Kuwait has a long way to go in order to reach a zero-carbon environment, but by implementing change, one small step at a time, it will reach that goal. It is noteworthy, however, that future studies are needed to accurately gauge the carbon footprint in the country and re-evaluate our guidelines. The most important study of which will be a quantitative analysis with clear metrics after the implementation of the guidelines to further assess their effect in the reduction of carbon emissions.

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