Review on Decarbonizing the Building Sector in Oil and Gas Countries: The Case of Qatar

Reem Al-Mohammed
Department of Architecture and Urban Planning, Qatar University, Doha, Qatar
200753670@qu.edu.qa

Djamal Ouahrani
Department of Architecture and Urban Planning, Qatar University, Doha, Qatar
djamel@qu.edu.qa

Abstract

Climate change is a serious international issue, and nations must move to carbon reduction to mitigate this problem. Therefore, Qatar is building strategies, towards energy transitions and decarbonization. Whereas, energy transitions from hydrocarbons to renewable energy is challenging, since Qatar is a gas producing country. Thus, decarbonization in energy-based countries is challenging, due to their economic development dependence on fossil-fuel by exporting oil and gas, and generating energy and electricity. However, most of the global carbon emissions are caused by buildings. Hence, the challenge of energy demand reduction in buildings in hot climate regions such as Qatar, is due to using air conditioning systems. Therefore, the research aims to investigate the decarbonization strategies implemented in the building sector in oil and gas countries, where electricity bills are subsidised by the government. In order to tailor decarbonization strategies for Qatar, according to the country's context and social status.

Keywords: Decarbonization; Buildings; Energy; Qatar

1 Justification of the Study

Buildings account for 48% of the global emissions. Furthermore, 40% is caused by the energy consumption in the building operating phase such as cooling (Lechner, 2015). Therefore, there is a high potential in decarbonizing the building sector, by reducing greenhouse gas (GHG) emissions by 2050 up to 85–95% (Kranzl et al., 2019). Accordingly, many international building codes have been established, to minimize energy consumption and to reduce GHG emissions (Lechner, 2015), such as the Global Sustainability Assessment System (GSAS), which was developed to improve sustainability in the built environment for Qatar and the MENA region countries (Khater, 2013). This work addresses the challenges of decarbonizing the building sector in oil and gas countries, and showcasing global case studies, to study the decarbonization strategies in the building sector in oil and gas countries such as Qatar, where electricity bills are subsidized by the government. It is significant to identify the decarbonization strategies

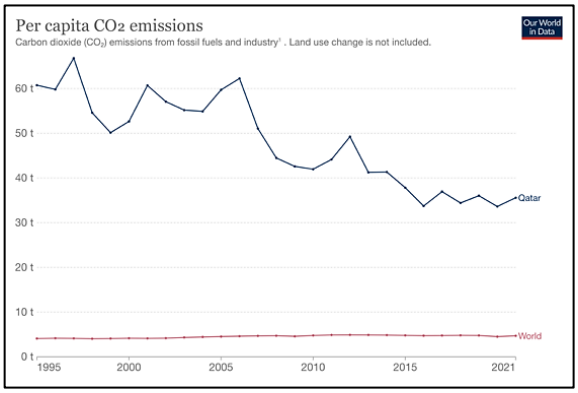

Fig. 1 : Per Capita CO2 emissions in Qatar - Our world in data based on Global Carbon Project (2022).

implemented in the oil and gas countries, including buildings energy efficiency measures, based on the current research context. In order to accelerate the process of decarbonization in Qatar .

Qatar is a gas exporter country, and one of the highest income per capita, and the highest energy consumers in the world with high Gross Domestic Product (GDP) (KAHRAMAA, 2020). The state of Qatar has the highest per capita CO_2 emissions in the world (Figure 1). According to KAHRAMAA annual statistics report (2018), as illustrated in (Figure 2) the residential sector consumes more electricity than the industrial sector (KAHRAMAA, 2020). Moreover, 80% of the electricity used in the Qatari buildings is consumed in air conditioning; which is the highest consumption globally (Meier et al., 2013). However, electricity bills are subsidised by the government for the local population in Qatar. Therefore, assessing the efficiency of decarbonizing the building sector, accelerates and improves the decarbonization process in the country.

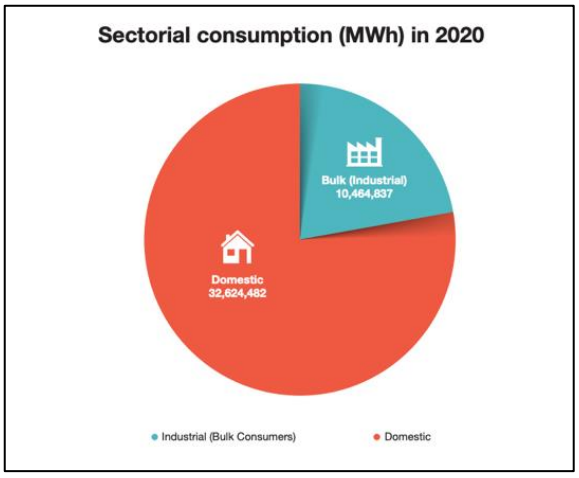

Fig. 2: Sectoral Consumption in 2020, MWH in Qatar, (Kahramaa annual statistics report, 2020)

2 Case Studies

The following global case studies review the different decarbonization methods implemented in different cities and countries.

2.1 Oil and Gas Exporter City:

2.1.1 Oslo, Norway

Oslo has the largest economic, and knowledge hub in the country (Eriksson et al., 2016). Therefore, the City of Oslo has implemented measures to reduce CO2 emissions by 41% compared to 2009 levels by 2020, 50% by 2022 and by 95% in 2030, in order to reach carbon neutrality by 2050 (Figure 3) (City of Oslo, 2020). The majority of the reduction achieved after 2013 proves that GHG emissions in large cities can be rapidly reduced by targeted measures through buildings and construction. However, there was a difficulty to meet Oslo's 41% climate target for 2020. The decreased use of oil for heating is a result of the ban on using mineral oil to heat buildings, which has resulted in a significant decrease in emissions from fossil heating. Moreover, several zero-emission options, such as zero-emission automobiles and fossil-free district heating, have been phased out in Oslo. The building energy efficiency strategies undertaken in the city of Oslo are listed in Table 1.

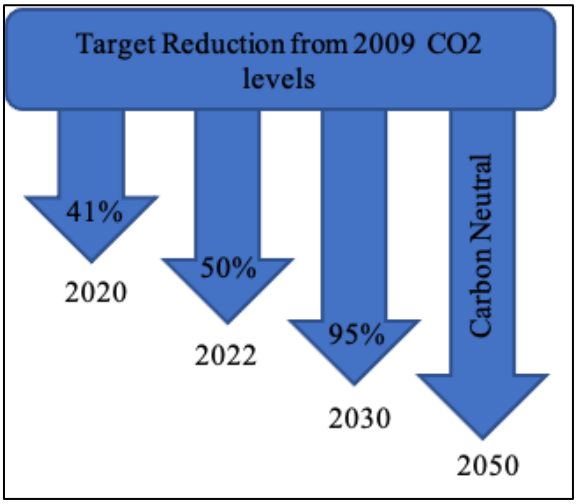

Fig. 3: Target Reduction from 2009 CO2 levels

Table 1: Building Energy Efficiency Strategies in Exporting Country: Norway

City	Carbon Reduction targets	Building energy efficiency strategies
1) Oslo, Norway	**Target:** 50% by 2030, and 100% by 2050 (100% fossil fuel-free)	1- electricity supplies are 100% carbon neutral . 2- city cooperation with citizens, business communities and organizations. 3- annual fund to promote research and development. 4- **prioritized emissions reduction goals** and annual progress **reports.** 5- Oslo's Climate Budget highlights the measures Oslo will apply to reduce CO_2 emissions (*Climate Budget 2019*, 2019). 6- The successful development of the Climate Budget depends on: **Governance and commitment, Communication and collaboration** of the population, and business communities, **cross-sectoral commitment** from public and private organizations, and **City agencies** involved in the design process. 7- The transparency of the Climate Budget enables the budget to be easily understood by stakeholders and **promote trust** in the process. 8- Statistic Norway records **Emissions statistics** to achieve the aims of the Climate Budget. 9- **Oslo has chosen 16 areas as a priority, which reflects strategic and long-term decisions** (*Climate Strategy for Oslo towards 2030*, 2020)(Climate Strategy for Oslo towards 2030, 2020).Some of them are: • construction activities and buildings in Oslo will be fossil-free and emission-free by 2030. • The greater source of energy in Oslo will be generated locally. • The buildings in Oslo will utilize electricity efficiently and decrease the consumption of energy. • low greenhouse gas emissions construction materials.

2.2 Oil and Gas Importer Cities

2.2.1 Stockholm , Sweden

Stockholm has stated its intention to be fossil-fuel-free by the year 2050. The Environment and Public Health Committee was commissioned in the 2012 budget with developing a roadmap to show how this target can be achieved. This roadmap is based on indicators that have been monitored since 1995 and are reported to the Environment and Public Health Committee on an annual basis. The calculations indicates the emissions produced from energy for heating uses, transportation, and for gas and electricity uses (Lönngren & Nilson, 2014). (Figure 4) shows significant carbon reduction per capita after 2012 in sweden. Emisssions reduction in Stocholm from 1990 is 49% in 2019, and economic growth has increased by 100% , and 33% of the emissions is from buildings (Stockholm - Sweden, 2022).

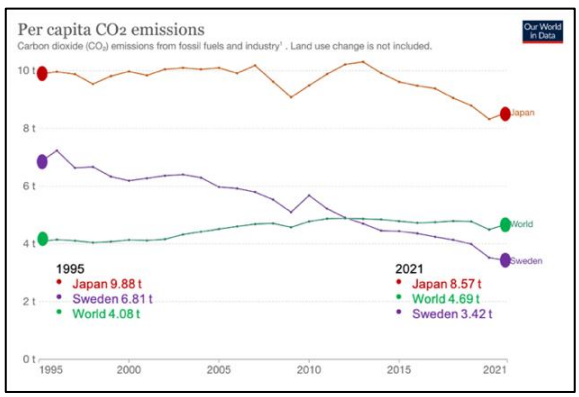

Fig. 4: Per capita CO2 emissions in Sweden and Japan, our world in data (2022)

2.2.2 Yokohama, Japan

As SDGs FutureCity Yokohama (chosen, 2018), the city constructs local and worldwide alliances and promotes innovative measures that simultaneously tackle environmental, economic, and social challenges in order to contribute to the achievement of the world's agreed upon Sustainable Development Goals (SDGs) ("SDGs Future City Yokohama," 2019). The greenhouse gas emissions in 2020 were 17.13 million t-CO2, 20.6% less than 2013 level (Figure 5). Moreover, 46% of the electricity is generated from gas and 20% is from nuecleare (Yokohama - Japan, 2022).

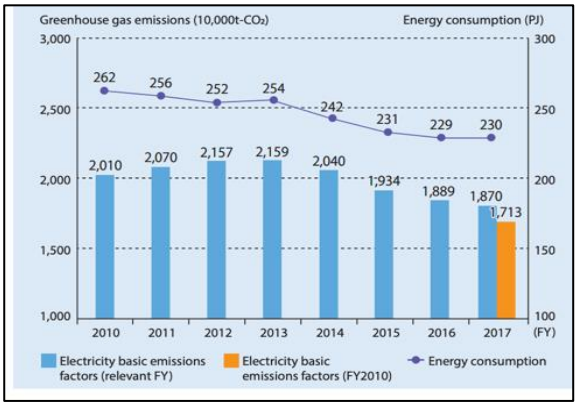

Fig. 5: Greenhouse gas emissions and energy consumption in Yokohama (Yokohama's Climate Change Countermeasures / SDGs FutureCity Yokohama, 2020)

Table 2: Building Energy Efficiency Strategies in Importing Countries: Sweden & Japan

City	Carbon Reduction targets	Building energy efficiency strategies
1) Stockholm, Sweden	**Target:** 100% by 2050 (100% fossil fuel-free)	1- target to become "fossil-fuel free by 2050." 2- The city assessed 50 potential measures to reduce carbon, according to four criteria: reduction potential, impact achievement speed rate, level of city control, and cost efficiency (Lönngren et al., 2010). 3- Finance climate change concepts. 4- The city predicted a 40% growth in population from 2012 to 2050, creating a demand for 5,000 new residential buildings annually, and 190,000 new homes by 2050. consequently, the total energy demands are expected to increase by 40% .
2)Yokohama, Japan	**Target:** 25% by 2020, 80% by 2050	1- The city's integrated Building Energy Management System (BEMS) has a control on a 29 separated BEMS's in Yokohama's amenities, which has reduced the peak demand by 22.8% ("SDGs Future City Yokohama," 2019). 2- In the summer of 2013, the city tested the energy management systems in around 3,500 residential buildings, and discovered that the power peak demand dropped up to 15.2% .

3 Conclusion

One of the primary components of city climate action plans to measure carbon emissions on regular basis, by setting benchmarks to annually track and report the progress. In order to assess the strategies and actions on carbon reduction, and to conduct comparison of potential costs and impacts of employing carbon reduction technologies. Moreover, the five-milestone framework for implementing the climate action plan are as follow: 1) Decarbonation and carbon mitigation starts with collecting data and analysing the existing emissions in order to predict future emissions; 2) Emission reduction targets should be set; 3) The development of a community action plan, according to the targets; 4) The implementation of the action plan; 5) To regularly monitor and record the progress of implementing the climate action plan. The successful development of decarbonization strategies relies on the government commitment and collaboration, targeting measures and benchmarks, enforced regulations, transparency, and reporting.

There are two decarbonization methods in the oil-exporter countries such as Qatar and Oslo 1) the implementation of carbon capture within the production of oil and gas, to sustain the industry and the

environment, and 2) to reduce energy consumption, by the implementation of energy efficient processes and sustainable buildings, and moving to renewable energy, which are the processes implemented by both oil-exporters and non-exporters countries. Therefore, the decarbonization methods that should be adopted will be according to how the energy is consumed in existing buildings in oil and gas countries.

The cities have set the reduction targets according to the country's capability to reach that target. Some cities have reached their targets such as the City of Stockholm, due to the high awareness in Sweden. Therefore, Sweden has set 100% achievable target to be reached by 2050. This is achieved by setting benchmarks and milestones, annual monitoring and reporting. However, some cities have set targets less than 100% , because they are not capable to reach it such as Yokohama. The city has formulated a medium and long-term strategy extending to 2050 and policies to be implemented by phases with priority during the years. On the other hand, the city of Oslo had a difficulty to meet the targets. Therefore, to accelerate the decarbonization process in the state of Qatar, measurable targets and milestones should be set, to reduce CO2 emissions from 2010 levels (Figure 6).

The decarbonization process was established according to the decarbonization purposes of the countries in each category. In the oil and gas exporting countries, decarbonization strategies were implemented mainly for environmental purposes. Since they have ample resources, their main purpose of the decarbonization process is to sustain the environment, due to the high level of awareness. On the other hand, the decarbonization strategies in the oil and gas importing countries, were implemented for environmental and economical purposes. Since they have to move to renewable energies.

Awareness is the key to accelerate the decarbonization process in Qatar. It is essential to establish an awareness campaign, to increase the awareness and involve the people in the decarbonization process. This might be the most appropriate strategy to decarbonize Qatar. Thus, it is essential to collect the energy consumption data in the building sector in Qatar. In order to investigate the energy consumption in the residential sector. This is to create mechanisms to encourage people to retrofit their houses with sustainable building materials, which leads to a whole economical green industry that support the decarbonization process in Qatar.

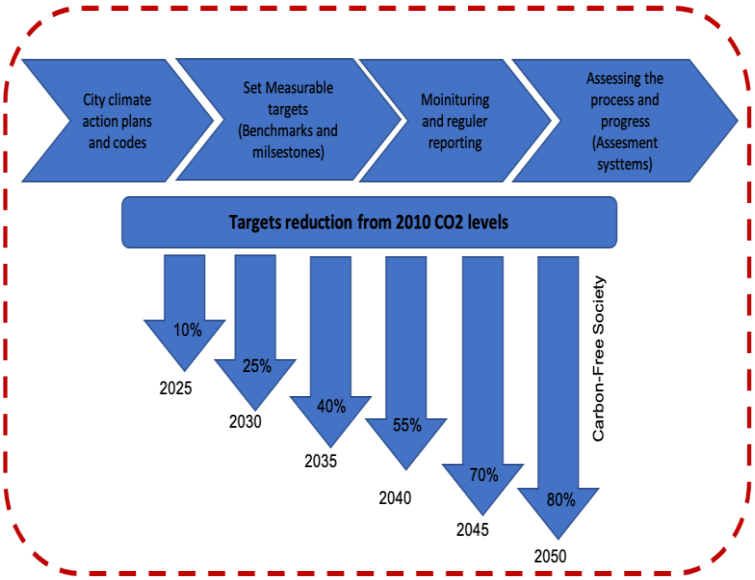

Fig. 6: Accelerating the decarbonization process in Qatar

The oil and gas industry is out of the context and excluded from this study, since the state of Qatar is exporting the oil and gas globally, and it is not used for local purpose only. However, the oil and gas countries need to measure and monitor the annual CO_2 consumption from buildings in kWh/sq^2. Such as

the case in Sweden the electricity demand is declining, due to retrofitting and buildings regulations. Therfore, the consumption per square meters is declining.

The electricity bill is 100% subsidized by the state of Qatar for the local population. Therefore, it is essential to encourage the local population to reduce the electricity consumption. This is achieved by 1) increasing the awareness within the local population, without removing the subsidies; 2) calculating the average electricity consumption for the local residential sector in kWh/sq^2 ; 3) to set a reasonable and reachable benchmark according to the average local population electricity consumption; 4) to set financial rewards for individuals based on the reduced amount of electricity consumption; 5) to measure, monitor and report the electricity consumption reductions on annual basis; 6) government subsidise a percentage of the energy efficient retrofits and materials for residential buildings. This is a proposed draft of the decarbonisation strategy in oil and gas countries, where the electricity subsidized by the country.

There should be more studies on developing the carbon emissions reduction measures and policies in the building sector, to achieve a non-carbon-based society by 2030, and a zero-emission society by 2050 in Qatar. Moreover, setting milestones requires a deeper understanding on how the energy is consumed, to be able to set up achievable goals, and develop long-term efficient decarbonizing strategies for the building sector in Qatar. In order to accelerate the process of decarbonization in the country.

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