# A Comparative Analysis of Green Financing Strategies for achieving Net Zero Energy in UAE

# تحليل لاستراتيجيات التمويل الأخضر لتحقيق صافي الطاقة صفر في دولة الإمارات العربية المتحدة

**by**

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**Dissertation submitted in partial fulfilment**

**of the requirements for the degree of**

**MSc SUSTAINABLE DESIGN OF THE BUILT ENVIRONMENT**

**at**

**The British University in Dubai**

**December 2023**

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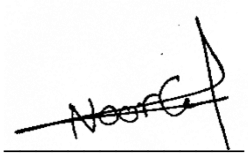

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# ABSTRACT

Net zero energy buildings (NZEBs) are a concept that is gaining more and more attention as a feasible way to lower building energy usage. As a growing nation, the United Arab Emirates (UAE) has established many policies and guidelines to coordinate the transition to zero energy by 2050. However, various studies conducted worldwide have classified the obstacles that stand in the way of achieving NZEB. This paper's backdrop examines several financial innovations and approaches to overcoming NZEBs' obstacles. In order to assess the viability of implementing these innovative techniques in the UAE, this research has selected three strategies—the Energy Performance Certificate (EPC), Property Assessed Clean Energy (PACE), and Green Bonds—that are used worldwide. The study uses two methods to paint a realistic image of the application in the United Arab Emirates. The first method is a literature review to combine ideas from various conceptual frameworks for each of the three tactics. From the perspective of members of the public and commercial sectors in the UAE, the second way involves using interviews to validate the three strategies' practicability. The literature review indicates that while they were very successful in the US and EU union, they also had a significant disadvantage. Furthermore, the analysis of the interviews revealed that the respondents had a strong desire to see the mechanisms implemented in UAE because they thought they held great promise for advancing sustainability and energy efficiency in the built environment. But overcoming obstacles like awareness, standardization, and regulations is necessary for success.



Keywords: net zero energy building, green bonds, property assessed clean energy program, energy performance certificate

# خلاصة

تعتبر المباني ذات صافي الطاقة الصفرية **(NZEBs)** مفهومًا يكتسب المزيد والمزيد من الاهتمام كوسيلة مجدية لخفض استخدام الطاقة في المباني. كدولة متنامية، وضعت دولة الإمارات العربية المتحدة العديد من السياسات والمبادئ التوجيهية لتنسيق لتحويل مبانيها إلى مباني ذات صافي الطاقة الصفرية بحلول عام 2050. ومع ذلك، فقد صنفت الدراسات المختلفة التي أجريت في جميع أنحاء العالم العقبات التي تقف في طريق تحقيق .إلى تصنيفات مختلفة. تتناول خلفية هذه الورقة العديد من الابتكارات والأساليب المالية للتغلب على عقبات البنوك الوطنية النيوزيلندية. ومن أجل تقييم مدى جدوى تنفيذ هذه التقنيات المبتكرة في دولة الإمارات العربية المتحدة، اختار هذا البحث ثلاث استراتيجيات - شهادة أداء الطاقة**(EPC)** ، والطاقة النظيفة التي تم تقييمها**(PACE)** ، والسندات الخضراء - التي يتم استخدامها في جميع أنحاء العالم. وتستخدم الدراسة طريقتين لرسم صورة واقعية عن التطبيق في دولة الإمارات العربية المتحدة. الطريقة الأولى هي مراجعة الأدبيات للجمع بين الأفكار من الأطر المفاهيمية المختلفة لكل من التكتيكات الثلاثة. ومن وجهة نظر أعضاء القطاعين العام والتجاري في دولة الإمارات العربية المتحدة، فإن الطريقة الثانية تتضمن استخدام المقابلات للتحقق من قابلية تطبيق الاستراتيجيات الثلاث. تشير مراجعة الأدبيات إلى أنه على الرغم من نجاحهم الكبير في الولايات المتحدة والاتحاد الأوروبي، إلا أنهم واجهوا أيضًا عيوبًا كبيرة. علاوة على ذلك، كشف تحليل المقابلات أن المشاركين لديهم رغبة قوية في رؤية الآليات المطبقة في دولة الإمارات العربية المتحدة لأنهم يعتقدون أنها تحمل وعدًا كبيرًا لتعزيز الاستدامة وكفاءة الطاقة في البيئة المبنية. لكن التغلب على العقبات مثل الوعي، والتوحيد القياسي، واللوائح التنظيمية أمر ضروري لتحقيق النجاح. ***(المباني الصفرية، السندات الخضراء، برنامج الطاقة النظيفة المقيّم على الممتلكات، شهادة أداء الطاقة)***

# DEDICATION

I dedicate this work to the unwavering pillars of strength and the guiding lights of my life—my beloved parents and family. Your endless support and boundless love have been the cornerstone of my journey towards achieving this milestone, the completion of my Master's degree.

To my Mother Aisha Al Hmoudi how sacrifices and tireless efforts have been the driving force behind my pursuit of knowledge. You have instilled in me the values of perseverance, dedication, and the importance of education. Through every challenge and triumph, your unwavering belief in my abilities has been my greatest motivation. Your sacrifices, late nights, and countless words of encouragement have shaped me into the person I am today.

# ACKNOWLEDGEMENTS

I am profoundly grateful to my supervisor, Prof. Bassam Abu-Hijleh for his unwavering support, guidance, and mentorship throughout the entirety of my Dissertation journey. His expertise, wisdom, and dedication have been instrumental in shaping the trajectory of my research and academic development.

I would like to show my appreciation to all the interviewees specially from the Ministry of the Energy and Infrastructure: Somayyah Alyammahi, Mozah Alnuaimi and Maitha Alketbi and From the Ministry of Climate Change Eng.Muna Alamoodi Also From IRENA Dr. Nawal Al-Hosany and Ms.Hanadi Al Nasa your expertise and willingness to share knowledge have expanded my horizons, providing me with invaluable insights that enriched my research and learning experiences.

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# Chapter 1: Introduction

## 1.1 Background of the Study

The energy demand is rising annually due to population growth and technological improvement. This is primarily because energy is the driving force behind most of the global economy. A significant development in 2018 was a discernible increase in electricity consumption, nearly twice as high as in 2010, according to a study by the International Energy Agency (IEA). Since most people spend most of their time indoors, it is critical to consider how buildings can conserve energy. Of the energy resources, 40% come from the built environment, and 1/3 comes from primary energy sources. Additionally, given the energy required to operate these structures, it is now imperative that new buildings be built. This is further supported by the requirement to use energy from renewable sources. (Wilberforce et al., 2023)

Net zero energy buildings, or NZEBs, are becoming increasingly well-liked in the building business worldwide as a potential way to lower building energy use.

Using the European Union (EU) as an example, the building industry is one of the significant energy users, accounting for 36% of carbon dioxide (CO2) emissions and about 40% of total energy consumption. More precisely, 66% of energy use and 64% of emissions in EU buildings are attributed to the residential sector. Furthermore, about 75–80% of the 210 million energy-inefficient homes in the EU will still be in use by 2050. Buildings provide the most promise for lowering energy use and carbon emissions. The EU has proposed guidelines

to phase out inefficient buildings gradually. The EU's primary legislative and regulatory tool for both new and existing buildings, the Energy Performance of Buildings Directive (EPBD), mandates that by 2050, all existing buildings must be converted into Nearly Zero Energy Buildings (NZEBs). Building industry energy efficiency and meeting the EU's decarbonization agenda are thus significant difficulties. (Li et al., 2019)

Likewise, buildings in the United Arab Emirates account for 70% of all energy consumption, according to Ministry of Energy and Infrastructure estimates. Furthermore, as shown in Figure (1), residential buildings accounted for 33% of the total power utilized in the United Arab Emirates in 2021. UAE concentrated on hastening the building sector's shift toward energy efficiency to conform with the UAE Zero Energy Strategy 2050.

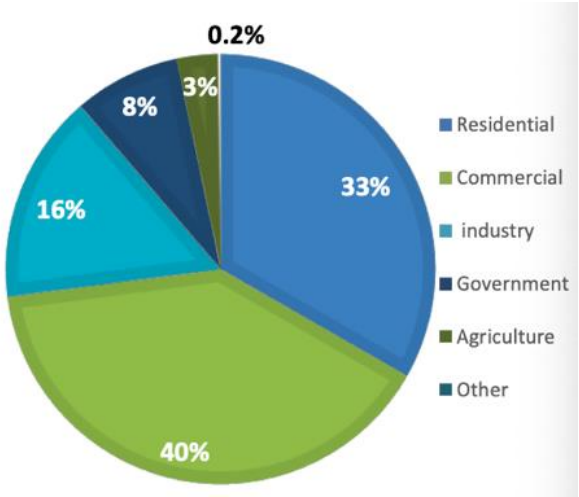


**Figure 1:** The amount of electricity consumed by the final user in 2021 (GWh).( The Ministry of Energy and Infrastructure,2023)

On the other hand, over the past few years, the issues that make it hard to adopt NZEBs have been looked at and ranked across different areas so that effective ways to deal with them can be mapped out. For example, one of the biggest problems with putting NZEBs on the market is that clients do not want to make the necessary capital inputs upfront. Many other studies agree that setting up NZEBs costs much money. (Abdullah et al., 2018) Because of this, many tools and tactics have been used in many countries worldwide to make the way toward net-zero energy buildings easier. Three of these mechanisms were picked to be studied in this paper, along with how well they would work in the UAE, which already has all the regulations and rules it needs to hit net-zero energy use by 2050. The choice to study financial mechanisms in this paper is linked to the fact that people worldwide are interested in economic strategies to reach zero-energy goals. More and more people think that the financial industry is essential for speeding up the move to sustainability and climate neutrality. It is one of the reasons that a significant amount of private capital must be obtained to finance investments that would enable the UN's Sustainable Development targets (SDGs) and the Paris Agreement's climate targets. The private sector allocates capital efficiently is another reason. This makes the financial sector a significant area where events that affect businesses worldwide can be felt. (Maltais & Nykvist, 2020)

## 1.2 Aim and Objectives

Globally, locally, and personally, there is a strong desire to see innovative international methodologies implemented to facilitate the adoption of net zero energy buildings in the United Arab Emirates. Since the globe is still in the early stages of the implementation, the

more our nation contributes in this direction and the more locally generated research papers in this context, the more support we give to our nation's efforts in this enormous and challenging field. This study aims to partially close the academic gap by proposing and assessing mechanisms to overcome barriers to NZEBs and validate its effectiveness in UAE society. There are many aspirations, strategic plans, and practical attempts to advance in the long road to the acceptable adoption ratio of net-zero energy buildings globally and locally.

**Objectives:**

1-Drew a holistic Overview about the NZEBs definitions and advantages.

2-Explore the barriers that suppress the implementation of NZEBs policies in the world and in UAE.

3-Review the sustainability preparation ground in UAE to apply NZEBs.

4-Study three mechanisms (PACE, Green Bonds, &EPCs) to overcome NZEB's barriers.

5-Examine the validation of implementing the three instruments in UAE.

## 1.3 Research Structure

Chapter 1 is an overview of the reason behind the goal of the research along with the aim and objectives.

Chapter 2 the literature review will be conducted to achieve deep understand about the NZEBs definitions taking into consideration the types and characteristics of NZEB term.

Moreover, the advantages and positive impacts of Net-Zero Energy buildings worldwide will be explored, along with the barriers that suppress the NZEBs implementation from different studies around the world and in UAE. It will also cover the available strategies and programmers that employed to overcome the mentioned barriers, in addition to the UAE efforts to build the sustainability ground to reach the target of zero energy 2050 plan.

Chapter 3 will identify the suited methodology that support achieving the research goal, in addition of a clear explanation, review the advantages and disadvantages and justification for the selected method along with the process needed to apply this method. The type of the research and the objective is nominated the semi-systematic literature review to be the first phase of the collecting data method along with semi structure interview to be the second phase to validate the obtained data from the literature.

Chapter 4: This chapter will explore through a literature review three financial mechanisms (Green Bonds, PACE, and, EPCs) that were applied in different parts of the world, in addition to study their aspects and characteristics such as definitions, advantages and disadvantages, gaps and availability in UAE. Moreover, the second part of the chapter will cover the interviews with experts from UAE to examine the validation of the three mechanisms elaboration in the literature review.

Chapter 5: This chapter will present the result and discussion from the analysis in chapter 4. This goes into great depth on every strategy obtained from the literature review along with the interview's outcomes.

Chapter 6 This chapter will discuss the research conclusion and recommendations as well as suggestions for the future research and studies.

# Chapter 2: Literature Review

## 2.1 Introduction

Because they are responsible for one-third of the world's greenhouse gas emissions and 40% of all primary energy use, buildings significantly impact climate change. Several efforts and laws set minimum standards for design, construction, and operation to address the excessive energy consumption of buildings and the resulting environmental implications. Countries differ in their level of building requirements, the strictness of their building regulations, the energy performance targets for buildings, and other elements, including climate, politics, economy, culture, and awareness, as well as how ambitious they are to increase the efficiency of the built environment.

As a result, several high-performing building designs, such as passive buildings, nearly zero energy buildings (nZEBs), zero energy buildings (ZEBs), and low energy structures, have evolved.

(EPBD) established by Directive 2010/31/EU, European Member States have set a target of having all new constructions be practically zero-energy buildings by 2020. Similarly, in the US, all new residential and commercial buildings in California aim to attain net zero energy buildings by 2020 and 2030, respectively.

The goal of the Advancing Net Zero worldwide program, which the World Green Building Council started, is to ensure that all buildings have zero carbon emissions by 2050. Green building councils have been urged to start zero carbon certification programs, establish

specific net zero training for green building experts, and assist in creating net zero demonstration projects in their nations as part of the Advancing Net Zero project.

Ten nations (Australia, Brazil, Canada, France, Germany, India, Netherlands, South Africa, Sweden and the US) committed, as of November 2016, to establishing and monitoring targets for pilot project implementation and industry training towards net zero carbon, as well as instituting a net zero carbon certification system for their respective markets by early 2018.

Many ZEB initiatives have been initiated in recent years as a consequence of the pilot projects' ability to validate the viability of the ZEB idea. For instance, as of 2015, 6,177 net zero energy residential units in the US and Canada were either built, under construction or still in the design stage, according to the inventory maintained by the Net Zero Energy Coalition. As of 2017, 411 nZEBs (newly built or rebuilt) outside North America were spread throughout 17 European nations, with 36% being non-residential and 64% residential.

The aforementioned indicates a discernible surge in triumphant "zero building" endeavors, coupled with an unwavering dedication from public and private sector participants to catalyze swift transformations in the built environment utilizing the progression of zero energy buildings. (Emirates Green Building Council,2017)

## 2.2 NZEBs Definitions

For deep understanding to the idea of Net Zero Energy Buildings (NZEBs) the study will start with explore the definitions of the concept. The balance between greenhouse gas

emissions and emissions extracted from the atmosphere is net zero. When a building is designated as a Net Zero Energy Building, it consumes zero net energy, equivalent to the total amount of renewable energy produced on the site each year. The concept of NZEBs has recently moved from study to application. Right now, there are very few highly prolific builders. Academic research, renewable energy systems, and building technology developments are making the construction of NZEBs more and more feasible. (Jaysawal et al. 2022)

Finding a structure that may be regarded as the original NZEB is difficult. One argument could be that NZEBs are just a contemporary moniker for dwellings rather than a novel concept for a structure. Nonetheless, there are not many publications from the late 1970s and early 1980s that use the terms "energy-independent house," or "autonomous energy house," or "zero energy home." At this point, the effects of the oil crisis became apparent, and conversations about fossil fuels and energy use started. (Jaysawal et al. 2022)

According to historical interpretation, a Zero Energy Building (ZEB) is an off-grid structure with a self-sufficient energy source. Distributed generation systems and renewable energy sources were considered to power and run these structures. Some renewable energy systems were enlarged to compensate for the seasonal imbalance between supply and demand. This sparked questions about sustainability in general, the effects of the storage systems on the environment, and the loss of generated energy. The idea of ZEB was examined in order to prioritize the following solutions to these problems: installing energy-efficient equipment, lowering energy consumption, and using the public grid as a source or sink of energy.

Reviewing the current building conceptions and determining the elements influencing them is crucial to comprehending the underlying principles of the growing definitions of ZEBs. Without a globally accepted definition and uniform building performance metrics that may inform ZEB policies and initiatives, government agencies, nonprofits, and industry players have created their definitions of ZEBs.

On the other hand, Nearly Zero Energy Buildings, Net Zero Energy Buildings, and Net Plus Energy Buildings all depend heavily on renewable energy. In order to balance energy usage following demand and energy reduction, it has been widely used as the primary energy source in these structures. The ZEB aim is reflected in the differential between energy generation and consumption (Figure 2). Renewable energy can be brought to the location or generated there. Off-site generation refers to investments in renewable energy technology or purchasing green power. On-site generation comprises renewable energy systems installed on the building footprint or the property next to the building.

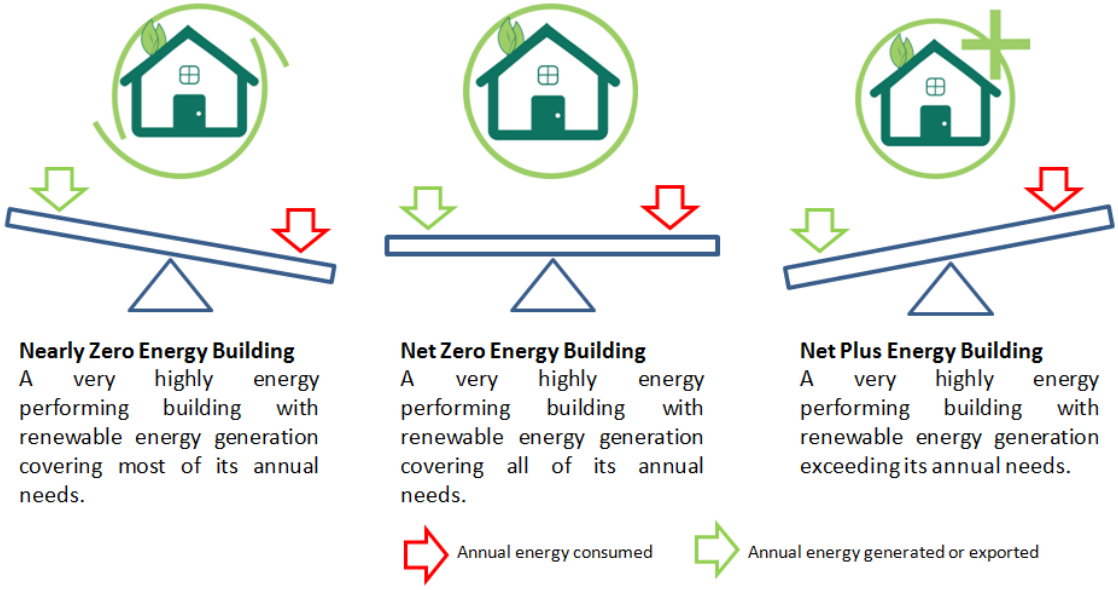


**Figure 2:** Definitions of buildings with virtually, net, and plus energy. (EmiratesGBC,2017)

The energy balance boundary is another crucial factor when defining a ZEB. This is because buildings use a variety of energy sources, such as thermal energy from district heating and cooling systems, electrical energy, renewable energy, and on-site use of fossil fuels. Either the source or the site can account for the energy balance border.

Only the quantity of fuel and electricity the building uses, as shown in the utility bills, is considered when discussing on-site energy. The final energy is the only factor to consider for on-site energy balancing. However, when using a source energy balance, transmission and delivery losses and transformations (such as turning oil into electricity) are considered when evaluating primary/source energies (Figure 2). As a better indicator of a building's level of energy efficiency, the US (EPA) claims that the energy source is the fairest and advantageous evaluation measure.

Applying ZEBs may also be significantly influenced by other rules and guidelines. For example, in US each Member State must reach the energy performance targets established while achieving cost-optimal levels under Directive 2010/31/EU. The energy performance level that results in the lowest cost over the predicted economic lifespan is known as the cost-optimal level. This means that each Member State has direct responsibility for figuring out this amount, which might include various expenses like energy savings, operational costs, and maintenance costs. Additionally, they must notify the European Commission of this outcome, which enables them to evaluate and document each Member State's progress toward achieving cost-optimal levels. (EmiratesGBC,2017)

Figure (4) displays the fundamental components of the definition of NZEB along with their relationship. The fundamental components are the weighting system, energy grid, and building system. A precise balance calculation for the building system with on-site renewable energy sources needs to be made to achieve the net zero target. Within this boundary, the building system uses supplied energy from on-site energy and renewable energy grids, such as natural gas and electricity, and outputs energy back into the grid when the renewable energy power (REP) system produces more electricity than it needs. Different weighting systems are selected to compute the net energy obtained by the building system due to differing design aims. For instance, building owners would instead select a weighting system in the cost balance over the energy balance because they are generally concerned about energy expenditures. In order to determine whether the particular technology solution can lead to a net zero balance, weighted supply and demand are finally compared. This is the fundamental NZEB evaluation process. (Deng et al., 2014)

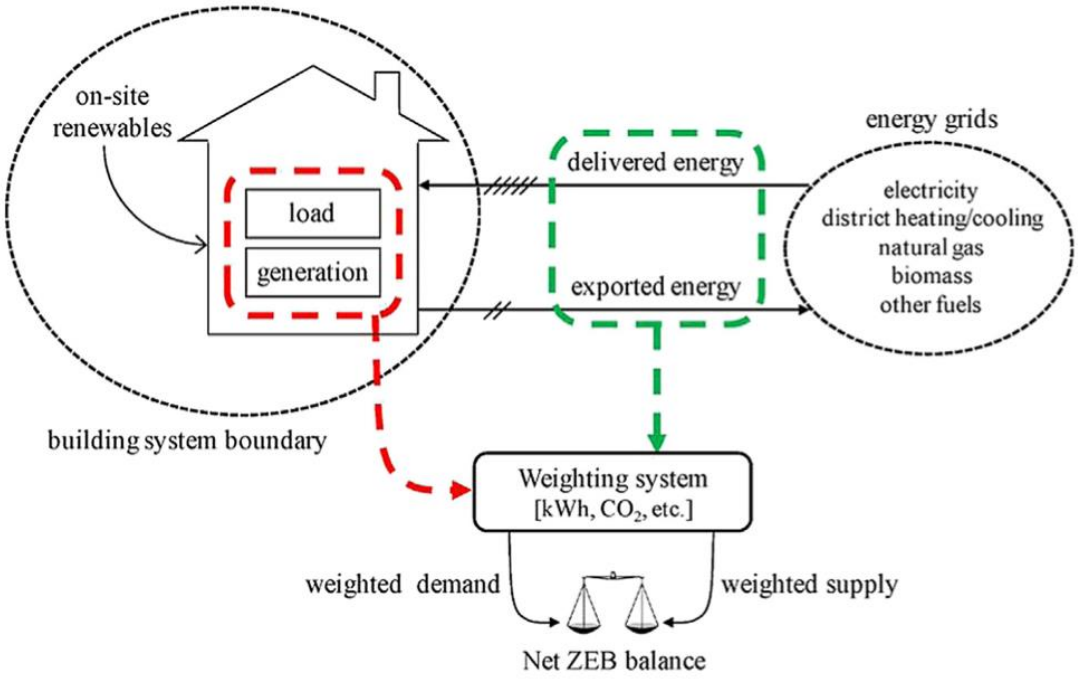


**Figure 3:** System structure and essential elements of NZEB (Deng et al., 2014)

Between 2014 and 2035, the global market for goods and services related to NZEB rehabilitation and construction is anticipated to develop at a compound annual growth rate of 44.5%. This is the method by which NZEB is becoming more and more popular. Caulfield (2017) talked about the NZEB's exponential rise in popularity over the following 20 years. The popularity and growth of NZEB income by products and services over the following 20 years are displayed in Figure (4).

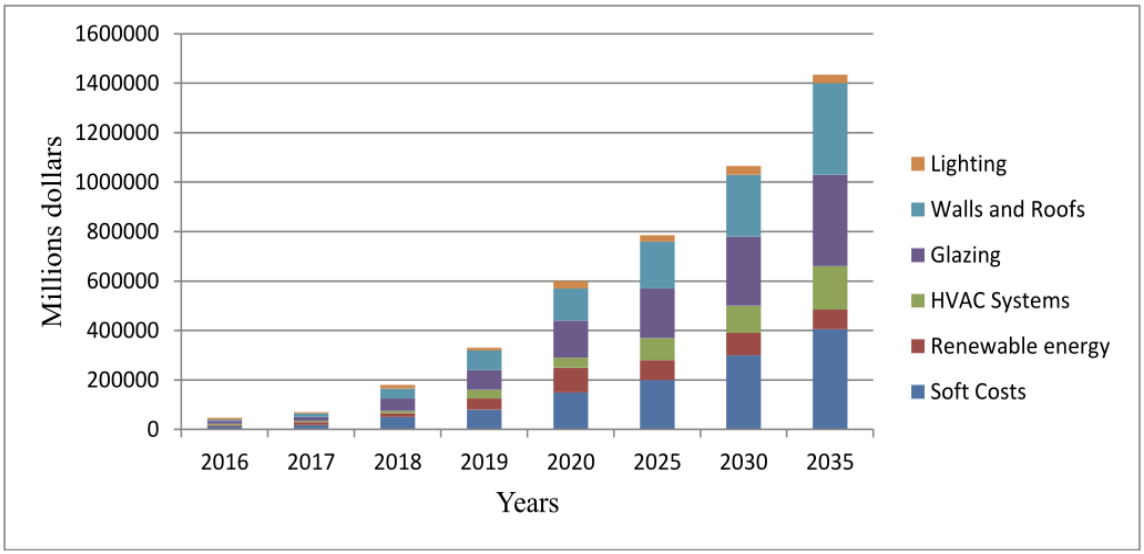


**Figure 4:** NZEB revenue by products and services for two decades (Jaysawal et al., 2022)

As per Iqbal's (2004) definition, a net zero energy building combines energy efficiency construction techniques with commercially available renewable energy technology, all while avoiding the usage of fossil fuels. According to Kilkis (2007), a net-zero-energy building transfers zero energy annually for all electrical and other transfers within a specific period. The general definition of zero-energy buildings (ZEBs) was provided by Laustsen (2008). ZEBs are buildings that rely entirely on solar and other renewable energy sources to supply their energy needs rather than using fossil fuels. NZEBs, according to Noguchi et al. (2008), are homes that utilize as much energy as they generate during a specific time. (Jaysawal et al., 2022)

According to Hernandez and Kenny (2010), the concept of "net energy," widely applicable in ecological economics and accounts for the energy used during a commodity's manufacturing process, applies to sectors like renewable energy evaluation. It reclaims the

original concept of "net energy." It provides a model and definition of a simplified technique to account for embedded energy combined with the usage of energy in action in order to describe a life cycle zero energy building. A building is considered an LC-ZEB (Zero Energy Building) if its overall energy consumption is equal to or less than the energy generated by renewable energy sources plus the energy stored in the materials and systems during its lifetime. (Jaysawal et al., 2022)

A 2013 study by Marique et al. looked into the "Definition of Zero Energy Neighborhood." The authors suggested a computation approach that considered three essential factors: the amount of energy used in buildings, how location affects how much energy is used for daily transportation, and how much energy is used in facilities powered by renewable energy sources. (Jaysawal et al., 2022)

The selected definition for this study due to its accuracy and simplicity for describing the concept of net zero energy buildings is Noguchi et al. (2008) definition, “homes that utilize as much energy as they generate during a specific time period”

## 2.3 NZEBs Benefits

The potential exists for a building with a more sustainable design to lessen the influence of humans on the environment. This effect is shown in Figure 6

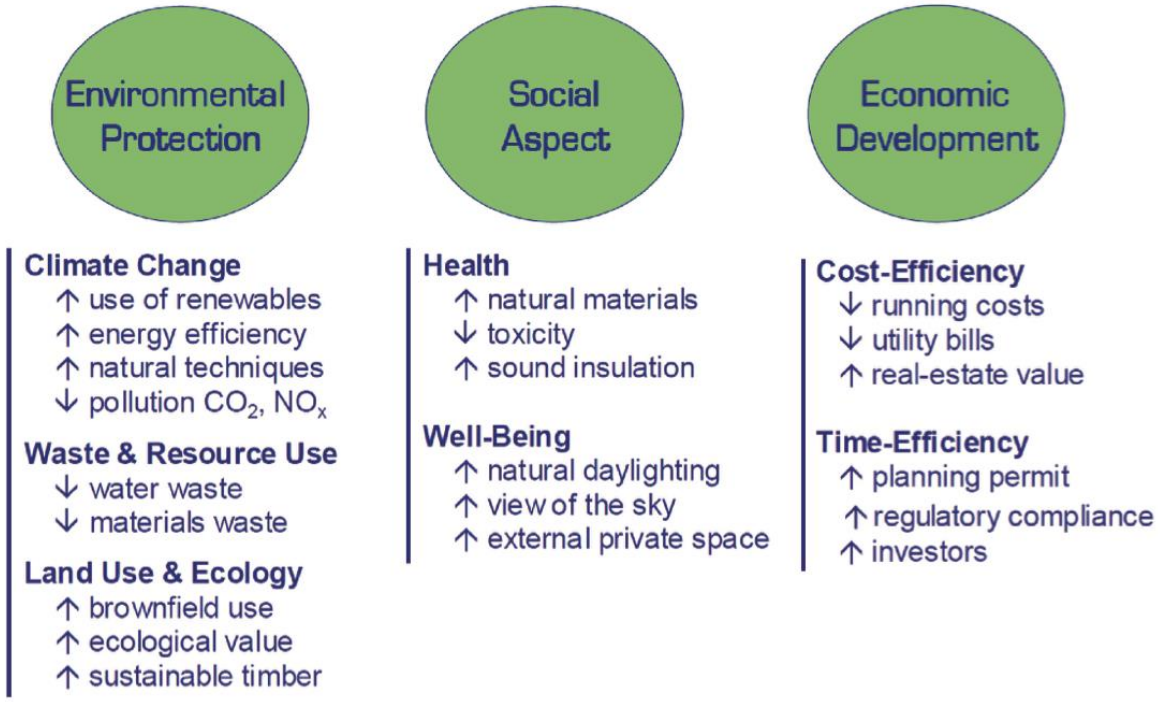


**Figure 5:** Effects of environmentally friendly construction on social development, the environment, and the economy. (Shehadi, 2020)

In this section we will shed the light on these potential advantages of net zero energy buildings in some detailes to promote the concept of NZEBs.

Firstly,The key environmental benefits of transitioning to net zero energy solutions are:

1-The substantial decrease in greenhouse gas emissions is one of the main environmental advantages of using renewable energy in net zero energy buildings. In contrast to fossil fuels, electricity produced by renewable energy sources like solar, wind, and geothermal power produces little to no emissions, hence contributing to the fight against climate change.

2- Mitigation of Air and Water Pollution: NZE systems help to lessen air and water pollution by reducing dependency on conventional energy sources. When fossil fuels are burned, pollutants are released into the atmosphere and water supplies. Making the switch to net zero energy benefits human health, ecosystem preservation, and reducing the damaging effects of pollution on biodiversity.( IEA,2023)

3-Conservation of Natural Resources: By emphasizing energy conservation and utilizing renewable sources, NZE practices encourage the economical use of resources. This lessens the need for limited resources like coal, oil, and natural gas, which are frequently extracted using methods that harm the environment. NZE minimizes habitat disruption and helps to conserve ecosystems by reducing the reliance on these resources.

4- Biodiversity Preservation: A major threat to biodiversity is climate change, which is made worse by conventional energy practices. Extreme weather, habitat loss, and rising temperatures can all cause the extinction of a species. By reducing the rate of increase in global temperatures and creating a more stable environment, net zero energy helps to lessen these threats and encourages the preservation of various ecosystems and wildlife.

5- Water Conservation: Low-flow fixtures, rainwater collection, and graywater reuse are a few more water conservation techniques that NZEBs can implement. NZEBs can contribute to water resource conservation and lessen the negative environmental effects of water use by encouraging sustainable water use practices and lowering water consumption. (EPA,2023)

6- Brownfield use: Brownfield sites are areas of previously developed land that are either underutilized or contaminated. It is regarded as a sustainable practice to use these locations for new construction, such as net zero energy buildings, as it prevents urban sprawl and protects greenfield areas. In addition, selecting wood from sustainably managed forests and making sure that forestry practices are environmentally friendly are necessary for the use of sustainable timber in construction, including net zero energy buildings

Secondly, the Social aspects for NZEBs are:

1-Better Public Health: Air pollution, which can have negative impacts on public health, is a byproduct of traditional energy sources, especially those that rely on fossil fuels. Communities can lower air pollution and consequently improve air quality and lower respiratory illnesses by making the switch to NZE. Consequently, this improves general public health and lessens the strain on healthcare systems.

2- Enhanced Indoor Air Quality and Utilizing Daylighting: Natural ventilation and daylighting are integrated into NZEB designs, which can enhance indoor air quality while increasing occupant comfort. NZEBs have better indoor air quality and fewer indoor pollutants than conventional buildings. There is extensive use of passive and renewable energy strategies, such as radiant heating and cooling, high-performance lighting, thermal mass, transpired solar collectors, natural ventilation through movable windows, full daylighting, and workstation configurations that maximize daylighting.(Turner & Frankel, 2008)

3- Health conservation: To guarantee that the materials selected contribute to a sustainable, non-toxic, and energy-efficient building, architects and builders frequently follow green building standards and certifications (e.g., LEED, BREEAM) when designing and constructing net zero energy buildings, using natural materials such as Bamboo for furniture and flooring because it has lower impact on the environment.

4- Toxicity: The use of low-VOC (volatile organic compound) materials is frequently prioritized in net-zero energy buildings. VOCs have been linked to health risks and can contribute to indoor air pollution. Sustaining good indoor air quality can be achieved by using paints, adhesives, and finishes that are low- or zero-VOC. Moreover, devoid of Formaldehyde Products such as Particleboard, plywood, and some insulating products are examples of materials that release formaldehyde, a dangerous indoor air contaminant. Selecting substitutes devoid of formaldehyde promotes healthier indoor air quality.

5-Sound insulation: Natural Fiber Insulation: Sheep's wool, cotton, or cellulose are examples of natural fiber insulation materials used in some net zero energy buildings. These materials enhance indoor acoustics by helping to absorb sound in addition to offering thermal insulation. In addition, Straw bales are occasionally utilized as an eco-friendly insulating material. They are biodegradable and renewable, with good thermal and sound insulation qualities.

Lastly, the Economic development of the NZEBs are:

1- Cost effective: The Business Case for Green Building States According to the owners of green buildings, their average Return On Investment (ROI) increased by 9.9% for new projects and 19.2% for existing green building initiatives. Even though NZEBs might cost more up front, they can save a lot of money over the course of the building. According to a New Buildings Institute study, NZEBs can have a lower total cost of ownership than conventional buildings because they require less energy and require less upkeep and replacement. (NBI,2022)

2- Infrastructure Upgrades and Investments: Installing renewable energy sources, smart grids, and energy-efficient buildings are just a few of the infrastructure improvements needed to achieve net zero energy. These expenditures promote long-term economic development by boosting the economy, generating employment in the building industry and allied fields, and updating infrastructure generally.

## 2.4 Current Situation of Energy Efficiency Buildings in UAE's

Climate change has become one of humanity's most urgent issues as its effects become increasingly apparent. The frequency and severity of storms, flooding, fires, and droughts have increased. The goal of the global effort to deal with this environmental issue is to keep heat to less than 2°C and, preferably, 1.5◦C over pre-industrial levels by achieving net-zero greenhouse gas (GHG) emissions by 2050. The building and construction industry is big in combating climate change because it accounts for more than 30% of worldwide energy consumption and related greenhouse gas emissions. This indicates that a significant and

aggressive shift toward a net-zero carbon-built environment is needed in this industry. Consequently, the notion of Net-Zero Carbon Building (NZCB) and Net Zero Energy Buildings (NZEB) have surfaced as a novel strategy for accomplishing the zero-emission and energy effecient goal in the building industry. Despite some minor distinctions, the two concepts—NZCB and NZEB—have nearly identical barriers.This is why the acceleration of NZCBs is being supported and encouraged by numerous organizations, nations, and areas. For the Paris Agreement's goals to be achieved, for example, the World Green Building Council is urging all new construction to operate at net-zero carbon from 2030 to 100% of buildings using net-zero carbon by 2050 through its "Advancing Net Zero" global effort. By 2020 and 2025, respectively, the goals established by the US Department of Energy are zero-energy residences and zero-energy commercial buildings. By 2016, all new homes in the UK are expected to be "zero carbon," by 2050, carbon emissions must have decreased by 80% from 1990 levels. Regarding the EU to decarbonize the building stock by 2050, the European Commission has proposed an ambitious goal of having zero emissions for all new construction by 2030. While there are examples of net-zero energy and carbon buildings worldwide, North America and Europe may have more. The rising trajectory of net-zero projects in North America through 2019 is depicted in Figure 7.

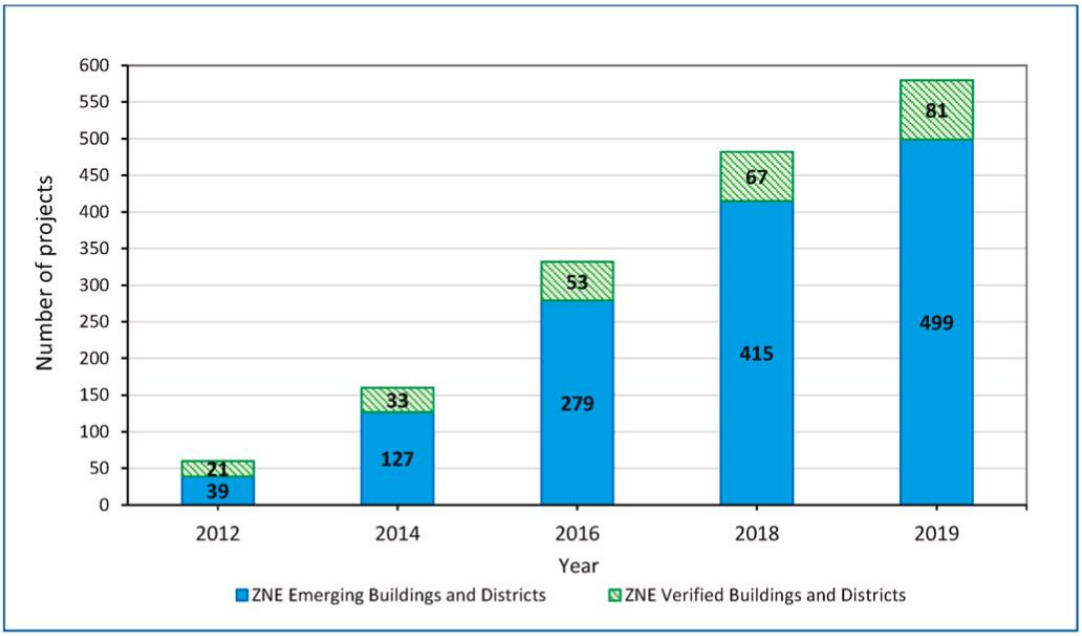


**Figure 6:** Trends of zero energy buildings in North America until 2019.

(Ohene et al., 2022).

It is fundamental to review tho UAE efforts to aceif sustainability and as a result overcome barriers to reach zero energy as part of the global effort to excute the Paris Agreement. The UAE government has made cutting building energy use a top priority, especially since it has been discovered that buildings in the UAE account for up to 70–80% of all electricity generated in the nation. The constructed environment of the United Arab Emirates is mainly inefficient due to existing buildings. According to the Dubai Supreme Council of Energy (DSCE), for example, 25% of the city's current building stock has been inefficient and has a significant potential for energy savings. Recent studies have assessed the potential for energy efficiency in the UAE's existing buildings; one such study carried out in 2013 estimated that the potential for savings in UAE public houses might reach as high as

30.8%. Since the focus of this study is on stratiges and mechanisms to overcome barriers and their remedies in the United Arab Emirates, the following explanation will concentrate on the country's current state and its approach to achieve zero energy by 2050.

To enhance the design and performance of buildings in the United Arab Emirates, national plans, rules, and codes have been developed in addition to research and development. ( Emirates Green Building Council,2017)

### 2.4.1 UAE Green Agenda 2015-2030

Due to the effective role of the legislations in facilitating the new strategies and mechanisms, our focus in this part of the paper on the UAE green agenda as a jaint legislation that could play the fundamental role in promoting and implementation the NZEBs concept.

The Cabinet of the United Arab Emirates decided in January 2015 to carry out the UAE Green Agenda 2015–2030. In January 2012, The Respected Sheikh Mohammed bin Rashid Al Maktoum, the ruler of Dubai and the UAE's vice president and prime minister disclosed the proposal. It wants to show that the country wants to become a global hub and a good model for the low-carbon green economy. This will help the country's growth be more competitive and long-lasting and protect the environment for future generations.

Following a thorough meeting with all relevant parties, the Green Agenda was created as a broad plan to carry out the strategy. It includes five goals (indicated as five strategic objectives) and twelve main programs, divided into 31 smaller programs (Figure 7).

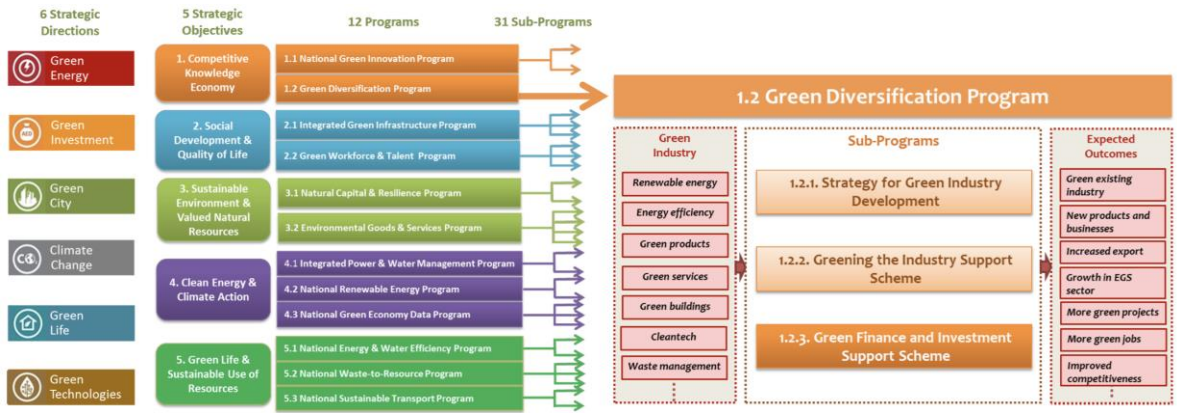


**Figure 7:** Structure of the UAE green agenda 2015-2030 (Ministry of Environment and Water,2015).

The UAE green agenda has been updated to reach net zero energy use by 2050. This was done because of recent changes in the energy sector related to climate change and global energy security, falling prices, and the maturity of new low-emission energy technologies. The UAE is also committed to the goals of the Paris Agreement. The new strategy aims to support the use of nuclear and renewable energies, make energy use more efficient, boost research and development (R&D) and new ideas in energy technologies, increase the country's clean energy capacity, and make investments more appealing in the renewable and clean energy sector.

A long-term national plan is part of the new strategy to fulfill the nation's expanding energy needs while safeguarding the environment for coming generations. The plan's first phase, which lasts until 2030, aims to make sure that the energy and water sectors have net-zero emissions by 2050 by cutting their pollution, and, increase energy use efficiency by 42 to 45% for individuals and businesses compared to 2019. (The Ministry of Energy and Infrastructure ,2023)

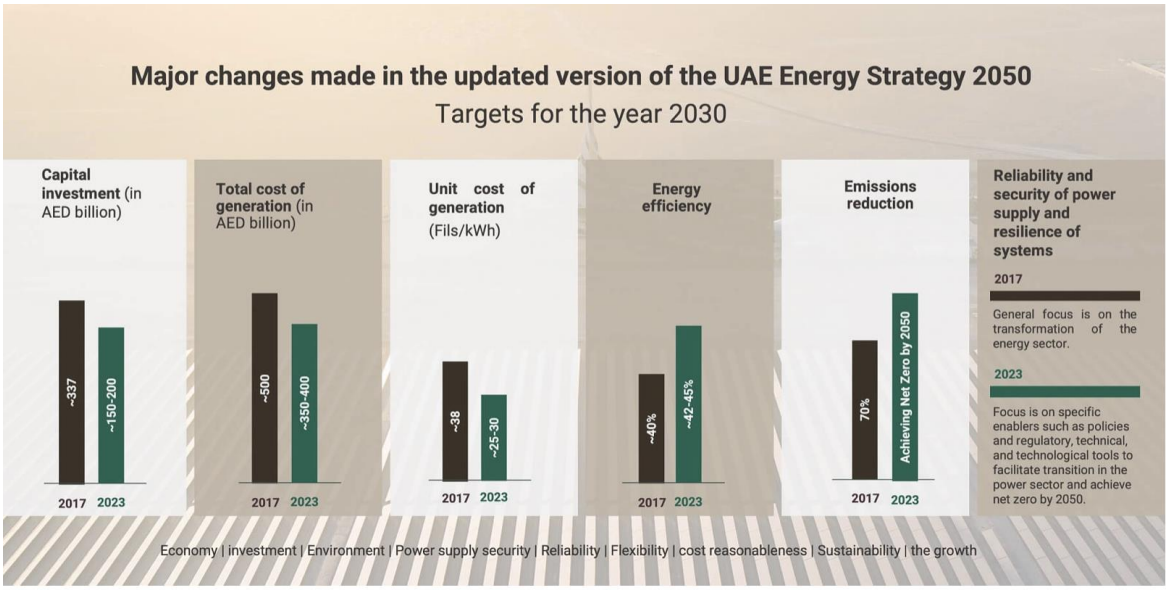


**Figure 8:** Elaborate the significant changes in UAE energy strategy 2050 (The Ministry of Energy and Infrastructure ,2023)

The sub-program of Green Finance and Investment Support Scheme is our focul point in the UAE green agenda.

### 2.4.2 UAE's Orientation to Sustainable Finance

As the United Arab Emirates advances in putting national objectives into action and encouraging a smooth transition to a green economy, capable government agencies and regulators recognize the importance of muscular coordination and engagement with the private sector. Specifically, the magnitude of the investment needed is significantly greater than what the public sector could handle, highlighting the need for sustainable financing as one of the critical pillars of the green economy.

The global COVID-19 pandemic has tremendously influenced all facets of UAE society, making the need to prioritize sustainable finance even more imperative. To prevent similar disruptions in the future, there is an increasing need to better understand and manage environmental, social, and governance (ESG) risks in addition to climate risks and addressing the immediate health issues. This is because the UAE economy is looking towards developing its recovery plans. Thus, sustainable finance will function as a means of managing and mitigating present and future risks related to the diverse array of environmental, social, and climate concerns, in addition to acting as a deal enabler or investor/implementor for sustainable projects.(The Ministry Of Climate Change And Environment,2021)

### 2.4.3 UAE's Framework for Sustainable Finance, 2021–2031

The Sustainable Finance Framework expands upon the actions implemented after the release of the 2016 State of Green Finance in the UAE report. A national survey conducted in association with the Securities and Commodities Authority (SCA) was also conducted, the Insurance Authority (IA), the Central Bank of the United Arab Emirates, the Ministry of Climate Change and Environment (MOCCAE), and the Dubai Financial Services Authority (DFSA).

More climate and green investments will be made in the UAE due to the UAE Sustainable Finance Framework, which attempts to improve the enabling environment for mainstreaming sustainable finance practices and strengthen collaboration between the public and private sectors.

The Framework offers suggestions to reduce the risks facing the private sector and encourage sustainable finance projects and solutions. Additionally, the Framework prioritizes better supply and demand for climate- and green-friendly investment initiatives and sustainable financial solutions. Finally, as a forward-looking recommendation, it is highlighted that capacity building for current and future sustainable finance professionals should be provided through the creation of accreditation schemes for training programs in sustainable finance, the encouragement of entrepreneurship and innovation in sustainable sectors, and the introduction of pertinent university curricula to foster ongoing innovation and expansion in the sustainable finance sector in the United Arab Emirates. The best example in the field of green finance in UAE is Dubai Green Fund. (The Ministry Of Climate Change And Environment, 2021)

#### *2.4.3.1 Dubai Green Fund(DGF)*

In an effort to promote investment in environmentally friendly and sustainable projects, the Dubai Green Fund was established in 2016 by the Dubai government and is supported by the Dubai Electricity & Water Authority, or DEWA.

DGF, the first MENA region-wide specialized green investment fund, is in line with Dubai's all-encompassing sustainability vision.

DGF serves as the foundation for the funding pillar of Dubai's Clean Energy Strategy 2050, which aims to establish a sustainable energy model that supports economic growth without endangering the environment and its resources, make Dubai the city with the lowest

carbon footprint in the world by 2050, and provide 75% of the emirate's total power output from clean energy sources by that time. Creating a global hub for the green economy in Dubai is another goal of the strategy.(DGF.2023)

## 2.5 Global Barriers

Despite favorable legislative, regulatory, and economic backing, several obstacles continue to hinder the extensive adoption of NZCB. It is crucial to gain a complete understanding of the challenges and hurdles before taking any action. That could prevent implementation is necessary to increase the uptake of NZCBs. Several obstacles to providing NZCB were found in earlier research, looking at it from various angles. Osmani and O'Reilly looked at the challenges faced by housebuilders in England while creating zero-carbon dwellings. They divided the obstacles into four categories: financial, cultural, legislative, and design. (Reilly & Osmani, 2009) Heffernan et al. divided the UK's obstacles to zero-carbon households into five categories: economic, legislative, skill and knowledge, cultural, and industry. (Heffernan et al., 2015)  Godin et al. examined the institutional impediments to rural Canada's adoption of net-zero energy dwellings from the viewpoint of several building specialists. The market, state (government interest and involvement), and cultural and technological barriers were the categories used in the study to group the hurdles. Pan and Pan, on the other hand, looked at the obstacles to zero-carbon buildings in the context of Hong Kong. Economic, legal, cultural, skills and knowledge, and geographic constraints were the categories used in their study to group the barriers. (Godin et al., 2021)

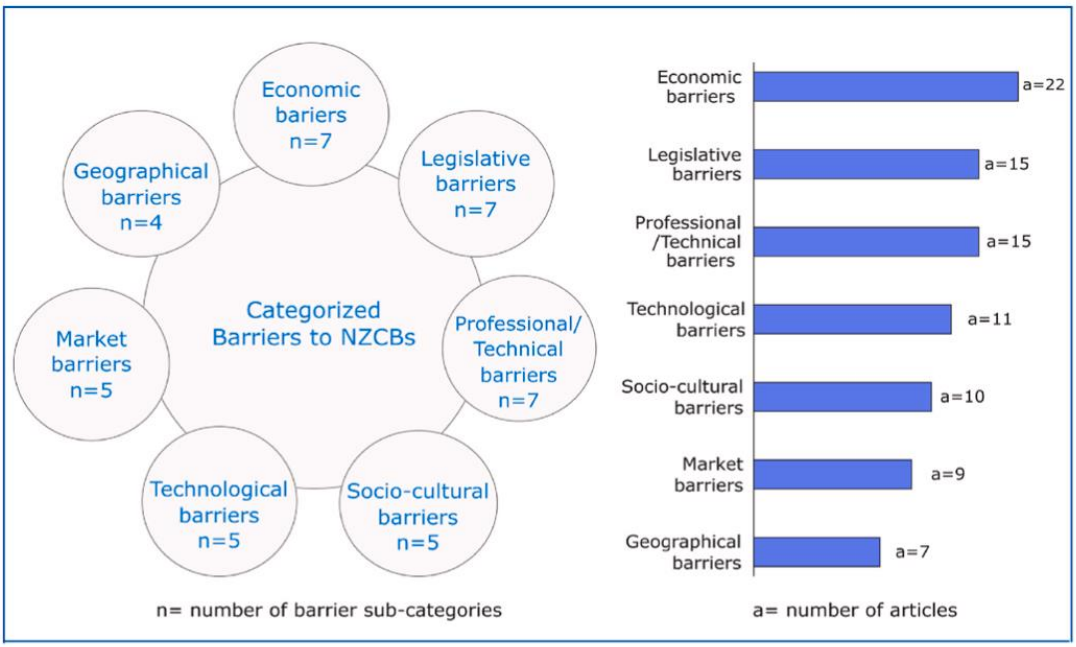


**Figure 9:** Barriers to NZCBs and publishing distribution might be classified (Ohene et al., 2022).

However, based on the previously mentioned studies, Ohene et al. categorized the barriers to NZCB into seven categories, which are as follows: legal, market, social-cultural, technological, professional/technical, economic, and geographical constraints. The distribution of the barriers according to Ohene et al.'s categories and the number of publications that mention them are depicted in Figure. Of the seven categories, most retrieved articles discussed economic barriers, with geographical constraints being the least covered. The following subsections cover the obstacle categories (Ohene et al., 2022).

### 2.5.1 Economic Barriers

The investments required to adopt and implement net-zero construction methods are associated with economic constraints. Osmani and O'Reilly have observed concerns over the

expenses and advantages of building zero-carbon homes among home builders. (Reilly & Osmani, 2009) According to Heffernan et al., the most essential subject was economic impediments. (Heffernan et al., 2015) Similarly, Pan and Pan determined that the biggest obstacles to implementing NZCB were economic (e.g., high initial expenses and commercial viability with business cases). They contend that one crucial economic factor that favorably affects the allure of zero-carbon buildings is their commercial feasibility. Pan and Pan (2021) Nonetheless, several studies demonstrate that higher initial capital expenditures hamper the implementation of zero-carbon buildings. Delivering net-zero buildings still needs to be improved by cost constraints, especially for underdeveloped and emerging economies. Utilizing sustainable building techniques raises the initial cost of housing investment. Therefore, the ability of lower- and middle-class earnings to purchase such sustainable housing is impacted by rising housing costs. (Ohene et al., 2022).

For instance, Toronto now lacks NZE infrastructures in Canada, which would enable specialists and contractors to receive funding and technical assistance. The Port Lands project suffered from the departure of federal and provincial funds, which hindered the sustainable development of NZE community buildings. More funding and resources are needed to ensure research and development innovation in the construction business. Current developments in the building industry restrict the GTA's ability to generate NZE housing. Excessive labor and land expenses also cause unfavorable building design techniques. To mitigate the high land and labor costs, developers are, for example, reducing the number of residential suites and floor-to-floor height and adopting less expensive building materials. These tactics, however, are ineffective at promoting NZE homes and have reduced costs at the expense of building

quality. Building costs will drop dramatically if obstacles to NZE housing are removed by strengthening micro-power grid access, loosening tight permit requirements, and simplifying the certification process for building enterprises. (Makvandia & Safiuddin, 2021)

### 2.5.2 Legislative Barriers

The construction sector is obligated by government rules and building standards to mitigate the environmental impact of their projects. Furthermore, government rules and policies may serve as a blueprint and guide for players in the building sector as they embrace NZCB. Nevertheless, energy consumption is not entirely regulated in many countries, energy efficiency requirements are inadequate, and implementation needs to be adequately monitored. Adoption may need more support from these essential stakeholders since governments and regulatory organizations play a crucial role in policy formulation in supporting NZCB (Ohene et al., 2022).

A primary legislative obstacle identified was the need for more government backing to promote ZCBs in Hong Kong. In terms of low standards regarding Gross Floor Area (GFA) concession, loose height restrictions, poor energy performance data acquisition, insufficient incentives for the private sector, and lack of a certification system, the focus group discussion, according to Pan and Pan's study conducted in Hong Kong, revealed that the government lacks a strong and clear policy to drive buildings toward zero carbon effectively. Another legislative concern would be the potentially substantial impact of renewable energy generation for ZCBs on the current energy networks. (Pan & Pan, 2021)

### 2.5.3 Psional/Technical Barriers

Both technological and professional obstacles hinder the implementation of NZCB. Professional or technical competencies drive the adoption of NZCB. However, Stevenson and Kwok claim that the labor force in construction needs more expertise to move the industry toward zero-carbon structures. (Ohene et al., 2022).

The Greater Toronto Area's (GTA) electric utility company employees need to be more knowledgeable about combining a home's green energy system with a conventional electrical supply to maintain the efficiency of energy-related systems and components. According to Healy, W.M. et al., advanced skills and knowledge are required for NZE design needs, such as advanced frames, open-web floor trusses, high-performance wall and roof enclosures, and solar power integration. (Healy et al., 2015) Piderit et al. concurred that NZE homes comprise a sophisticated system requiring experts with knowledge spanning numerous scientific, engineering, and technical fields. (Piderit et al., 2019) The multidisciplinary design method for NZE buildings is still used in the GTA construction sector. One of the main design requirements for a green construction project is to incorporate as many energy-producing and energy-saving solutions as is practical and affordable. Because NZE buildings have complicated technological requirements, improving energy efficiency is initially expensive. Moreover, the design and development of NZE homes may be impacted by regional variations in household energy consumption due to climate conditions.

According to Hamilton, surveys conducted on homes equipped with comparable energy-saving devices revealed differences in energy consumption between Canadian

temperature zones; for instance, the average yearly cost of home energy in Ontario is $2358, whereas it is $2903 in Nova Scotia. Furthermore, compared to regular residences, NZE dwellings have more significant initial construction costs. The NRC case study revealed that the high initial cost ($100,000 to $150,000) required to build their NZE home prevents it from being commercially viable. When energy-producing components are installed in homes, and passive design is maximized, the initial construction costs rise dramatically because of a lack of industry specialists and technological understanding. However, there needs to be a vigorous certification and evaluation mechanism specifically for NZE homes in the GTA for green energy developers. Toronto's leading developers have developed techniques to cut greenhouse gas emissions from buildings and improve their energy efficiency. However, according to a study by Healy, W.M. et al., Chile and Canada need help developing standards and best practices for net zero energy homes in the building sector. (Healy et al., 2015) Despite being designed explicitly for NZE construction, developers use LEED Canada (Leadership in Energy and Environmental Design) certification for residences. (Makvandia & Safiuddin, 2021)

### 2.5.4 Social and Cultural Barriers

Stakeholders, particularly end users, must be aware of the concept to improve NZCB adoption on a big scale. According to Godin et al., adoption may be significantly influenced by the degree of knowledge of the advantages of net-zero energy households. (Godin et al., 2021) Nonetheless, more public awareness and understanding is a significant obstacle to adopting NZCBs. One major obstacle to implementing NZCBs has been highlighted as

reluctance to change. Jones thinks the widespread opposition to moving toward a zero-carbon economy stems from people's perceptions of how difficult it will be to stop using fossil fuels. Adopting NZCBs is hampered, in large part, by housebuilders' unwillingness to stray from conventional methods. For instance, in Canada, the general public's ignorance about the advantages of net zero energy (NZE) homes has prevented them from gaining traction in the Greater Toronto Area. Individuals hesitate to contribute to projects with unclear advantages, mainly when there is a less expensive option. Hamilton's study on personal interviews revealed a need for more public education regarding the advantages of net zero energy (NZE) homes in advancing energy sustainability in Ontario. Although more people are aware of their part in home energy emissions, they need to know how NZE housing may lower greenhouse gas emissions and increase sustainability. (Makvandia & Safiuddin, 2021)

### 2.5.5 Technical Barriers

Technologies that improve the building envelope (e.g., sun shades), provide energy generation (e.g., solar photovoltaic cells), or handle heating and cooling (e.g., heat pumps) are critical to reaching NZCB. Cost implications were one of the first concerns regarding NZCB technologies. Nonetheless, the cost of this widely used technology in NZCBs has significantly decreased. For example, the benchmark cost of electricity for photovoltaic systems has dropped by more than 75% since 2009. Since 2010, wind turbine prices have also dropped by 32%. Because of this, recent conversations have centered on the ambiguity and unreliability of existing technologies and the challenges associated with integrating them into ZCBs,

especially in high-rise, high-density, and neighborhood contexts. Market obstacles (Ohene et al., 2022).

### 2.5.6 Market Barriers

Market-related issues significantly impact the supply of NZCBs. The lack of substantial market demand for NZCBs and a need for effective marketing techniques are examples of market obstacles. Regarding renewable energy systems, market barriers are typically associated with high initial investment costs that drive up market prices and make them costly for end users. Inadequate business models, high market unpredictability in demand, and a lack of awareness of the industry's potential are further obstacles. Building companies must innovate their business strategies to increase the market attractiveness for NZCBs.(Ohene et al., 2022).

### 2.5.7 Geographical barriers

One of the main barriers to NZCBs has been highlighted as geographic barriers to domestic renewable energy generation, especially in high-rise, high-density cities with small per-capita living spaces. The extent to which NZCB technology can be deployed may be restricted by climate and geographic location factors. For example, geographic location significantly impacts solar and wind energy, which could not be sufficient or dependable in some areas. Additionally, it is challenging to convert existing structures to produce zero carbon emissions. Other geographic barriers include those brought on by the high-rise, densely populated metropolitan environment, topographical impediments to using renewable energy at

home, and natural and geographical limitations on using renewable energy. (Ohene et al., 2022).

## 2.6 Barriers in UAE

Emirates Green Building Council (GBC) conducted a nZEB survey in May 2017 to assess the position and viewpoints of various stakeholders, including government, consultants, and academia, with the goal of measuring the market perception for nZEBs and identifying factors and parameters that need to be addressed in the UAE's definition of nZEBs.

For the nZEB survey, an online questionnaire was utilized in a cross-sectional analysis. The questionnaire was created in order to evaluate the market readiness and obstacles for net-zero energy buildings (nZEBs). It was based on an analysis of various Zero Energy Building concepts that are utilized globally.

EmiratesGBC requested that important industry players fill out the online survey. EmiratesGBC assembled an internal list of building experts based on their industry experience, role within the industry, and general knowledge of the area. Early in May 2017, 100 different building experts and leaders nationwide received an online invitation to participate in the survey; the deadline was May 25, 2017.

Out of the 100 building professionals contacted, 55% responded. Out of the 55 respondents, consultants made up the largest sector with 28 respondents, followed by the government with 11 respondents and academia with 7 respondents. Figure 11 displays the

complete breakdown of the participating sectors. It is evident that 80% of the questionnaire respondents are from the private sector (all categories except government).

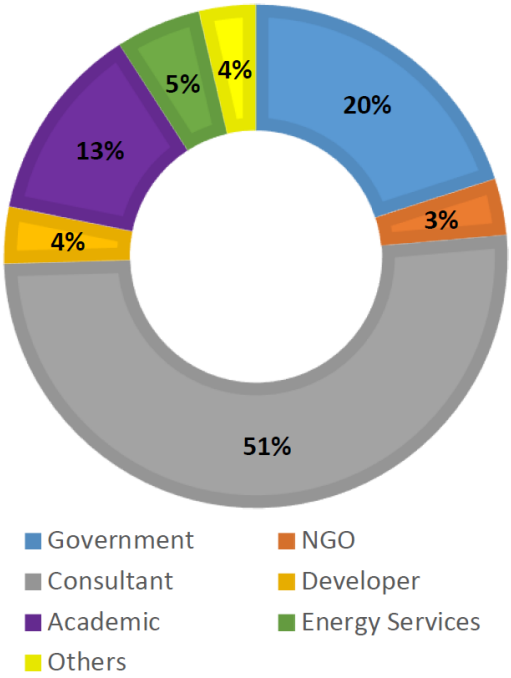


**Figure 10:** Sectoral distribution of the respondents who took part. (EmiratesGBC,2017)

Figure 12 demonstrates that the top perceived barriers to the adoption and spread of nZEBs in the UAE are the UAE climate (58% of total responses), building occupant behavior (64% of total responses), lack of government initiatives (53% of total responses), and lack of knowledge about the cost-effectiveness of energy efficient buildings (71% of total responses).

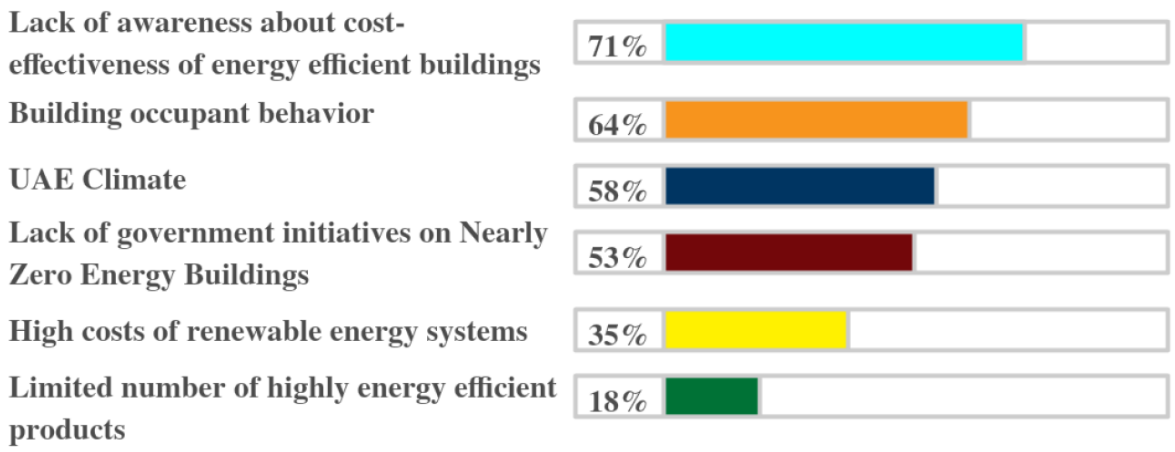


**Figure 11:** The survey's findings on the obstacles to nearly zero energy building adoption and dissemination in the United Arab Emirates (EmiratesGBC,2017)

Another study about the barrier in UAE conducted in 2019,where the researcher classified the barriers to net zero energy buildings based on an analysis of 34 respondents' email responses to a survey sent to the UAE's construction industry. The survey's results showed that the author had divided the barriers into four groups: legislative, social, economic, and technical.

First, under the technical groupings of hurdles, the three primary obstacles found are developing a realistic baseline for ZEB, needing more prior experience in ZEB projects, and needing more technical knowledge of ZEB principles. The economic barriers identifies many critical challenges to ZEB adoption, including high upfront investment costs, insufficient financial incentive to pursue ZEB, lengthier payback times, and a dearth of business models considering ZEB's short- and long-term aims. Third, concerning the social and cultural barriers, the respondents think that the main obstacles to putting ZEB policies into practice are

a lack of information sharing among stakeholders, a lack of understanding of the concept, a lack of instruction and training on ZEB, and changes in occupant behavior to reduce energy use. The last legislative group of barriers includes high energy subsidies, a lack of legislation and a legal framework for implementing ZEB, a lack of ZEB rules and standards to implement ZEB, and a lack of long-term promises from the authority to pursue ZEB. (Ather, 2019)

The researcher concluded that the following findings can be made in light of the data and analyses. According to the technical group of obstacles, setting reasonable baseline energy consumption for ZEB policies is the most crucial step in implementing ZEB policies. High upfront investment expenses were named number one in the economic category of hurdles, while a lack of financial incentive to pursue ZEB was placed number two. The next set of social and cultural challenges to ZEB policies is the need for more education and training about ZEB and the distribution of ZEB knowledge across stakeholders. Last but not least, the list of obstacles from a legislative standpoint only includes the absence of standards for implementing ZEB. (Ather, 2019)

The two studies regarding the barriers in the UAE were conducted two years apart, and there were differences between the concepts of NZEBs and nZEBs, but despite the time and differences, implementation challenges in UAE stemming from the high upfront costs associated with economic barriers, and a lack of knowledge about these kinds of buildings.

The study in this section will examine the current global strategies used to support the shift toward zero energy buildings in order to address these issues in the United Arab Emirates.

## 2.7 Strategies to Overcome Barriesrs to NZEBs

### 2.7.1 Energy Efficiency Financing Mechanisms/Programs

The term "energy efficiency financing mechanisms" or "programs" refers to a range of financial instruments, plans, and projects intended to encourage and facilitate investments in energy-saving projects. By offering financial incentives, lowering upfront costs, and enhancing the overall economics of energy efficiency measures, these mechanisms seek to remove obstacles that might prevent the adoption of energy-efficient technologies and practices. (IEA,2023). The Energy Efficiency Financing Mechanisms/Programs' essential elements include:

#### *2.7.1.1 On-Bill Financing*

On-bill initiatives have been introduced during the past ten years to finance low-carbon energy solutions, initially in the residential sector in the United States and subsequently in Europe. Theoretically, on-bill initiatives help low-carbon energy technology policies by removing significant upfront expenditures for energy users. Instead of being paid individually, installation charges for new, energy-efficient devices are added to the consumer's energy bill (by the contractor or a bank). The "Golden Rule," also known as "Bill Neutrality," states that costs cannot be more than the expected savings generated by the efficiency improvement. As a result, customers can benefit right away. A critical aspect of these programs is that the gas or electricity meter—rather than an individual—has payback obligations. According to Bell & Nadel (2012), Bell, Nadel, & Hayes (2011), Borgeson et al. (2012), Cillo & Lachman (2013),

Lachman (2013), and UK-GBC (2009), responsibility is passed to the new resident if a customer moves out. In real life, schemes fall into two primary categories: on-bill repayment (OBR) and on-bill financing (OBF). In both situations, the upfront expenses of the energy-saving measures are covered by a third party (the utility company or an energy service provider). The provider may look for outside funding or use it to pay for the renovations. The energy bill of the person who benefited from the increase in energy efficiency now includes the payback rather than having it as a separate payment stream. One of the main characteristics of OBF is that the on-bill product is delivered as a utility company service. The OBF design offers the benefit of avoiding classifying overdue service charges as debt from the consumer's point of view. Thus, in theory, taking part in an OBF program has no effect on one's capacity to obtain mortgage finance or credit for other purposes. This also holds for companies since they frequently hesitate to include debt on their balance sheets. On the other hand, the OBR model treats repayment like a debt. In 2018, Mundaca and Kloke

There have been few comprehensive empirical evaluations of the performance of the more than fifteen on-bill programs that have been implemented in six US states over the past ten years, particularly about their role and efficacy in mitigating climate change (cf. Gupta et al., 2014; Lucon et al., 2014). With the adoption of the so-called "Green Deal," the United Kingdom became the first nation in Europe to introduce a legislative framework to promote the uptake of on-bill programs (Rosenow & Eyre, 2013). Again, though, there are few comprehensive analyses of its effects and results. More significantly, comparable analyses have not been done to determine whether OBF or OBR models are better at overcoming

behavioral abnormalities and market failures to promote low-carbon policies. (Mundaca & Kloke, 2018)

The findings of Mundaca & Kloke point to the possibility of overcoming market failures and behavioral abnormalities through well-crafted programs that consider the financing and installation of energy-efficient measures as a service, thereby facilitating the commercialization and widespread adoption of low-carbon technologies. Some obstacles that may be successfully overcome are the split-incentive problem, significant upfront expenses, and a need for more funding. According to Mundaca & Kloke's analysis, the two most important factors are associating repayments with the building's energy meter and having third-party insurance that can cover upfront expenses.

Constructing the product as a service (OBF) rather than as a loan (OBR) under the various on-bill model subcategories is best. Reducing credit checks associated with loan applications should lower costs for both the provider and the client. It also addresses inconsistencies in consumer behavior since many people are hesitant to incur debt to make energy-efficient purchases, even if their financial circumstances permit it. Additionally, evaluating energy-saving potentials rather than a customer's financial situation when determining program eligibility may make it easier for lower-income individuals and small and medium-sized businesses to obtain financing for energy-efficiency upgrades. It is frequently difficult for these groups to access traditional capital markets.

This implies that the efficacy of (other) policy instruments in addressing issues like indifference, heuristics, present bias, lack of understanding, and internalizing energy pricing

inefficiencies will determine how effective public or utility-driven on-bill programs are. (Mundaca & Kloke, 2018)

Energy cost reductions must be used to cover program expenditures and energy efficiency initiatives in order for on-bill programs to be successful and nonsubsidized because of this, policymakers and operators should concentrate on lowering transactions and administrative costs through the implementation of streamlined, straightforward programs.

Another critical factor is having access to inexpensive capital. In the US, all programs for which data were available (including How$mart®) had access to low-cost capital (via government loan programs, for example), allowing them to charge their customers relatively low-interest rates. On the other hand, in the UK, financing costs did not drop considerably, and Green Deal financing options were difficult to market. The business case was significantly harmed by the relatively high interest rate (6.95%) since most energy cost savings were not enough to pay for the costs of technology, installation, administration, transactions, and financing. (Mundaca & Kloke, 2018)

#### *2.7.1.1 Power Purchase Agreement (PPA)*

A Power Purchase Agreement (PPA) is an extended agreement for the bilateral power purchase and sale between a plant operator and an electricity user. This agreement sets a price for the provision of power and provides a corresponding financial compensation. It is possible to know the electrical quantity profile with absolute certainty. PPAs have several benefits for both the seller and the buyer.

When a PPA is signed, the customer is freed from reliance on drastically fluctuating power or CO2 pricing during periods of peak demand. Large corporations can protect their business against long-term price threats by implementing value-neutral hedging—PPAs last up to 20 years, which means strong partnerships are also formed. Owing to the benefits mentioned above, some sizable software companies are forming their sustainable branding with the "First-Mover-Image" by signing sizable PPAs with owners of solar and wind farms.

Revenues from producing electricity from their renewable energy plants are the primary concern for plant operators. These revenues are established over an extended period under a PPA. As a result, it is possible to effectively finance both present and future investments, particularly at a time when government support for renewable energy sources is dwindling. Furthermore, the guaranteed power supply enhances the plant operator's trustworthiness, which lowers borrowing costs. The benefit of encouraging entry into the energy market is another advantage of such contracts.

Diversification in the procurement and customer power structure benefits buyers and sellers. As a result, if the counterparty defaults, both parties stand to lose out.

PPAs fall into two categories: virtual PPAs (typically synthesized or merchant PPAs) and physical PPAs (usually corporate or sleeved PPAs). In the first scenario, the consumer is directly sold the specified amount of electricity, which is then provided via a direct transmission line or the national grid. On the other hand, both parties will trade the specified amounts of power on the spot markets if a virtual PPA is reached. If the reference price—the contract price—differs from the spot market rates, the contracting parties will make up the

difference either monthly or annually. The contract of difference is the name given to this discrepancy. Figure 12 shows a schematic representation of both PPA models.

If allowed by the legislative framework, certificates of origin (physical and virtual PPAs) may be transferred to the consumer in addition to the sale of power.

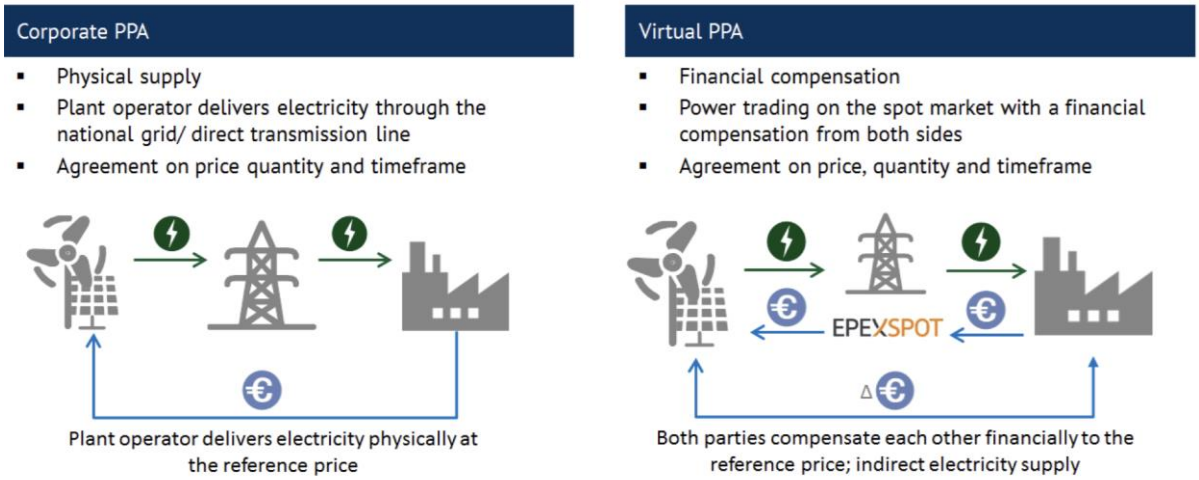


**Figure 12:** Two basic models of PPAs. (Huneke et al., 2018)

There is great flexibility in the contractual requirements about the quantity and price of power delivered. Both can depend on an index, have upper or lower bounds (like a minimum price or take-or-pay amounts), or be fixed (like a fixed price or quantity).

Because the gas business is weather-dependent, variable volumes are known in Germany as "take-or-pay" contracts. These contracts are typically employed in the gas industry. Similar circumstances apply to renewable energy sources, such as wind turbines, whose yearly power output can vary by 20%. As a result, a PPA's contract price may be set for

six years before being revised on a rolling basis. Setting rates for an even longer time is another option. However, in the futures market, this can no longer be hedged. In addition, customary options for PPAs during the contract include price floors, price ceilings, inflation adjustments, and price formulae (referring to energy cost). As a result, a price range rather than a set price is specified.

PPAs have been developed to promote renewable energies in the US, the UK, and, most recently, Norway, Ireland, and the Netherlands Figure 13. These long-term agreements are significant when utilities must partially use renewable energy sources to meet their energy needs. Furthermore, PPAs seem appealing if investors receive tax breaks for their investments in renewable energy (PTC/ITC or production/investments tax credits). Furthermore, photovoltaic PPAs are increasingly significant in emerging nations, rural areas, and sunny regions.

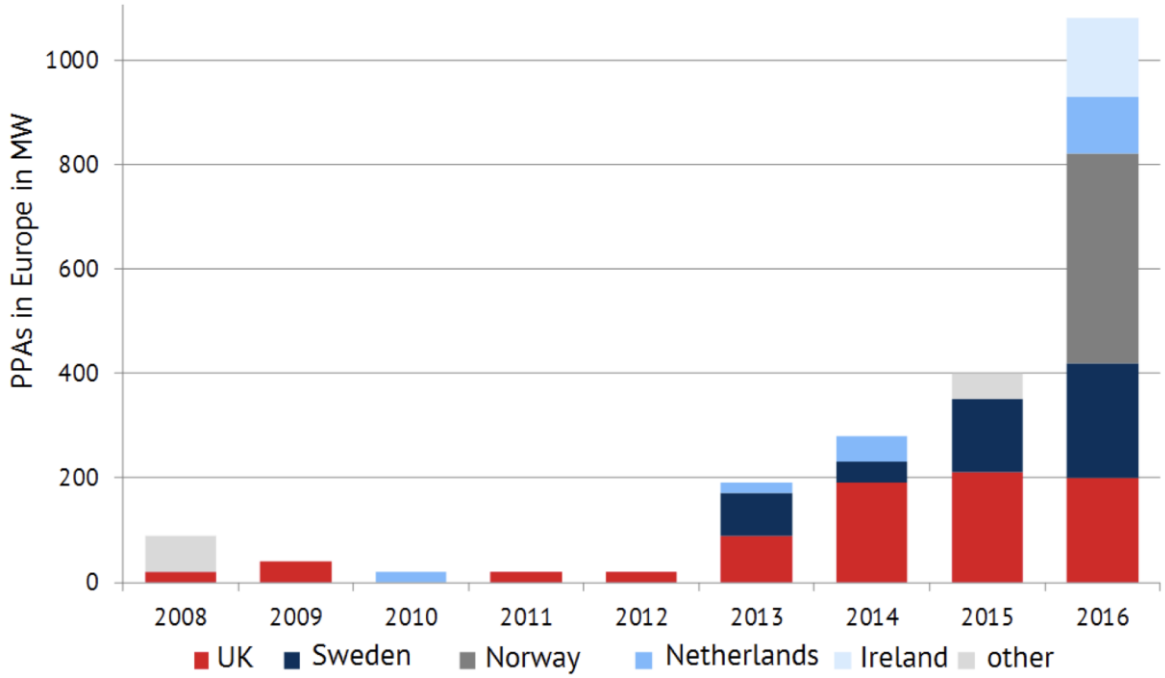


**Figure 13:** Renewable PPA capacities in Europe. (Huneke et al., 2018)

However, when a contract is longer than ten years, two issues come up. First, a weather-dependent volume risk is associated with the purchased electricity quantities for the consumer. The second issue is the unpredictability of PPA costs. PPAs can be evaluated and hedged using typical futures market products in a value-neutral manner for three to six years. As of January 2018, the value of a PPA with a model plant for 2020–2024 is 32 EUR/MWh. At this price, producers and consumers equally share the benefits and risks associated with the erratic evolution of the price of energy.

Contracts that are evaluated after that time require an analysis based on scenarios for power prices. The individual asset file, the underlying price assumptions (CO2, coal, gas), the

"cannibalization effect" of newly renewable sources, the evolution of power consumption, and their flexibility are some factors that affect this assessment. (Huneke et al., 2018)

#### *2.7.1.2 Green Mortgage Loans*

The International Energy Agency (IEA) projects that direct building emissions must decrease by 50% by 2030 to reach net-zero emissions by 2050. By 2030, these goals correspond to a 6% annual reduction in emissions from the building sector. Building envelopes need to be renovated, high-efficiency appliances need to be installed, and the building stock connected to alternative low-carbon energy sources to accomplish these significant reductions in gas emissions. Green mortgages are a significant, unexplored source of funding for these kinds of developments. The federal government may and should use green mortgages as a publicly available instrument to promote significant national expenditures in energy-efficient home repairs. A bank may provide financing for purchasing a new home equipped with energy-saving features or renovating an existing home under the terms of a green mortgage. Green mortgages have the potential to become an investment vehicle that satisfies the need for green home upgrades from consumers as well as investors. Although there has been progress in developing a market for green mortgage-backed securities for multifamily properties, there must be a comparable market for single-family houses.

Therefore, the RCRC advises that the Federal Government establish a precise national standard that defines a "green mortgage" under the jurisdiction of the FHFA. This standard should be connected to water and energy conservation in the home and contain a precise set of requirements for home efficiency standards. As part of the FHFA's definition of a green

mortgage, current home energy rating schemes like DOE's Home Energy Score or Home Performance with ENERGY STAR could be cited or expanded upon. The first sensible and uncomplicated policy plan will significantly lower greenhouse gas emissions from the energy consumed in the United States by over two hundred million single- and multifamily homes for heating and cooling. (Greene et al., 2021)

#### *2.7.1.3 Green Bonds*

Green bonds are regular fixed-income securities with the proviso that all proceeds "will be exclusively utilized toward new and existing green projects."

Green bonds are designed to fund projects that are good for the environment. These projects help with protecting and managing clean water, making transportation more sustainable, using energy more efficiently, stopping and controlling pollution, farming fish, preserving forests, and protecting both land and water ecosystems. The financing of green bonds has the specific goal of combating climate change, and it is available to anyone who can achieve those goals. (Humphreys et al., 2015). The sale of green bonds would undoubtedly increase if the investment strategies were transparent and easy to understand.

The stakeholders in green bonds comprise the issuers and investors of the bonds, market intermediaries (like stock exchanges), partners of the bonds, credit rating agencies, auditors, and regulators who support transparency in the growth of the green bond market. All bond categories' environmental benefits must always be defined and measured by the green bond issues. Bond profits must be expressed in terms of grams of CO2 equivalent per ton if

they are to be utilized toward reducing greenhouse gas emissions. It is also necessary to compare these advantages to appropriate counterfactuals. This validates the reliability of green bond criteria and protects against claims of greenwashing and reputational damage.

The three extraordinary characteristics of green bonds—tax incentives, tax exemptions, and tax credits—give them an advantage over other equivalent categories of taxable bonds. Such bond offerings must receive certification from the Climate Bond Standard Board attesting to the bonds' fulfillment of the stated goal of funding climate-friendly projects to be eligible for this type of financial incentive. The cost of borrowing decreases as the demand for green bonds rises. (Aggarwal1 & Pathak, 2021)

#### *2.7.1.4 A Property Assessed Clean Energy (PACE)*

A financially advantageous instrument that allows local governments to fund initiatives for green energy and energy efficiency on privately held residential or business land is the Land Assessed Clean Energy (PACE) program. Property owners can choose to have an assessment or special tax added to their property tax bill under a PACE program, which covers up to 100% of the cost of sustainable energy improvements. The special tax or assessment is not the individual property owner's responsibility; instead, it is protected by a lien on the asset. Enrollment in PACE initiatives is entirely discretionary.

PACE programs use the well-established and extensively used "land-secured financing" mechanism, which allows local governments to fund improvements and impose assessments or special taxes on properties affected by those improvements. Sewers, walkways,

seismic retrofitting, fire safety upgrades, and several other public works projects are funded nationwide by land-secured finance districts, also called special assessment districts. These districts have been a part of the tax lien structure and municipal finance for over a century. Secured by a lien on the property, the assessments or special taxes are collected as part of the ordinary property tax payment.

The economic reality many property owners face when trying to purchase clean energy installations is addressed by PACE programs. Although the financial benefits of energy cost savings are spread out over time, a comparatively high upfront expenditure is necessary to start reaping those benefits. PACE programs close this gap and enable the benefits of renewable energy installation to be spread gradually alongside the expenditures. Numerous sustainable energy installations, such as solar water heater systems, high-efficiency stoves, water heaters, energy-efficient windows, insulation, and rooftop photovoltaic solar energy systems, can be financed through PACE programs.

Numerous stakeholders that have supported strict underwriting guidelines and other PACE program components intended to safeguard borrowers and consumers have endorsed and supported PACE programs. A "Policy Framework for PACE Financing Programs" was created in cooperation between the White House and a few government agencies, and it was unveiled in October 2009. The US PACE program design is guided by this Policy Framework, which protects mortgage lenders, homeowners, and other stakeholders. Furthermore, the Department of Energy announced PACE program rules applicable to all PACE programs that use federal monies on May 7, 2010. (Ranchod et al., 2010)

#### *2.7.1.5 Energy Performance Certificate (EPC)*

The European Union created the Energy Performance Certificate (EPC) as a regulatory tool to address incomplete information in the housing market. A building's energy performance certificate must be provided to the owner or, if they choose, to the potential tenant or buyer, according to Article 7 of the EPBD, 2002/91/EC. The EPC can present cost-effective recommendations for upgrades that would raise the building's thermal energy efficiency in addition to data on the structure's energy performance.

For EPCs, there are two primary intermediary purposes, which are:

1. By outlining the energy status quo for building owners and occupants and offering suggestions for thermal retrofit, the EPC seeks to boost the pace and scope of building refit.

2. The EPC seeks to boost the market value of energy-efficient investments by giving prospective tenants and buyers dependable data on the energy efficiency of buildings. (Amecke, 2012)

A vital component of the EPBD is the energy performance certificate (EPC). The EU Parliament defined an Energy Performance Certificate (EPC) in 2002 as "a document that shows how energy-efficient a building or part of a building is and is accepted by a Member State or a legal person chosen by it" (EU Parliament, 2003, p. L 1/67). Building reference (identification, type, construction year), building geometry (floor area, envelope form), certificate methodology (measured vs. calculated data, audit period), factual energy consumption (energy use per source), calculated energy performance, energy system

installations (HVAC, solar), recommendations (and their implementation), additional information (reference values, emissions), and information from energy experts are among the data features that are typically included in an EPC. (Pasichnyi et al., 2019)

## 2.8 Knowledge Gap

The United Arab Emirates is a fast rising country with a strong commitment to environmental protection and sustainability. In order to combat climate change and decrease its carbon footprint, the UAE has set an ambitious and crucial objective of achieving zero energy by 2050.

The building industry in the UAE consumes a substantial amount of energy. Raising public awareness and educating the population about the advantages of net zero energy buildings and their role in energy conservation and improve sustainability is a crucial phase. Moreover, employ financial innovative technology to accelerate UAE' zero energy achievement is another critical phase. Researchers should investigate effective educational strategies to engage and mobilize the UAE's population in the transition towards a sustainable energy future, in addition to explore funding mechanisms that attract private and public investments, and facilitate the transition to a low-carbon economy. To be part of the upcoming movement towards Net Zero Energy Building in UAE and there are limited exploration of Financial mechanisms due to it fast development of this field worldwide. Therefore, this paper aims to perform a comparative analysis of green financing strategies for achieving net zero energy in UAE.

# Chapter 3: Methodology

## 3.1 Introduction

After a study plan and topic have been developed, data collection takes place. (Garg & Kothari, 2019). This chapter will go into the methods used in the study and the rationale behind the choice.

A research technique is an organized strategy for gathering and analyzing data to address research questions (Creswell, 2014). Qualitative and quantitative research methodologies are the two main types. The nature of the research questions influences the choice of approach, the study's objectives, and the data's accessibility.

Firstly, quantitative research is an empirical approach to investigation that uses statistical analysis and numerical data to measure and quantify relationships between variables. This strategy gathers data through structured methods such as experiments, surveys, and observational studies (Bryman & Bell, 2015). Often, quantitative research tests hypotheses, confirm causal relationships, and extrapolates findings to a broader population.

Conversely, qualitative research is an approach to investigation that is subjective and seeks to understand the intricacy and importance of social processes (Denzin & Lincoln, 2011). This strategy uses focus groups, interviews, and observation as data collection methods. Qualitative research is widely employed when examining and characterizing social phenomena, examining people's perspectives and experiences, and formulating new hypotheses.

In order to better grasp the research issue and produce the intended results, a combination of qualitative approaches will be used in this study. The primary information gleaned from literature review regarding three mechanisms employed in different nations to get over NZEB obstacles. Secondary data was gathered through interviews with UAE experts in the public and private sectors to confirm the information gleaned from the literature review. When both forms of data are gathered and examined in the framework of a single study, the two approaches complement one another and help us understand the phenomenon we are looking at in more detail.

## 3.2 Literature Review Method

A literature review is generally a methodical approach to gathering and summarizing prior information. As a research approach, an efficient and well-conducted review lays a solid foundation for knowledge advancement and helps with theory construction. A literature review can address research topics with a power that no study can match by incorporating the conclusions and points of view from numerous empirical findings. An overview of the fields where the study is interdisciplinary and diverse can also be helpful. A literature review is also an excellent tool for combining research findings to demonstrate evidence at a meta-level and identify areas that require additional study, which are essential for developing theoretical frameworks and conceptual models.

As outlined in Table 1, three general categories of frequently employed techniques will be discussed in the ensuing sections. The integrative, semi-systematic, and systematic reviews

are the three primary forms that will be covered. These review techniques can significantly aid in addressing a specific research question when used appropriately. (Snyder, 2019)

**Table 1:** Approaches to literature reviews. (Snyder, 2019)

| Approach | Systematic | Semi-systematic | Integrative |
|---|---|---|---|
| Typical purpose | Synthesize and compare evidence | Overview research area and track development over time | Critique and synthesize |
| Research questions | Specific | Broad | Narrow or broad |
| Search strategy | Systematic | May or may not be systematic | Usually not systematic |
| Sample characteristics | Quantitative articles | Research articles | Research articles, books, and other published texts |
| Analysis and evaluation | Quantitative | Qualitative/quantitative | Qualitative |
| Examples of contribution | Evidence of effect<br>Inform policy and practice | State of knowledge<br>Themes in literature<br>Historical overview<br>Research agenda<br>Theoretical model | Taxonomy or classification<br>Theoretical model or framework |

a) Systematic literature review

According to Liberati et al. (2009), a systematic review is a research method and procedure used to find and evaluate pertinent research and gather and examine data from that study. Snyder (2019).

b) Semi- Systematic review

The semi-systematic or narrative review approach is intended for subjects that are difficult for a complete systematic review procedure to cover since they have been conceptualized differently and explored by multiple research groups within different disciplines. (Snyder, 2019).

c) Integrated Review

An integrative review typically aims to evaluate, analyze, and synthesize the literature on a study issue in a way that allows for the emergence of new theoretical frameworks and viewpoints, which is a different goal than that of a semi-structured review (Torraco, 2005).

### 3.2.1 Literature Review Steps

- Phase 1: Creating the review

Since conducting a literature review is labor-intensive, it is a good idea to start by scanning the literature to take into account previous literature reviews that already exist, determine the number of research studies that need to be evaluated, and assist in defining the review's goal, parameters, and particular research question. (Tranfield et al., 2003; Wong et al., 2013).

- Phase 2: Carrying out the review

Depending on how many pieces are written, different methods will work best. The appropriate way is to review stages, reading the full-text articles afterward and making the

final selection, or reading the abstracts first and selecting, then focusing on the research methodology or findings.

- Phase 3: Evaluation

Considering how the articles will be used to conduct an appropriate analysis after completing the literature review is crucial. It is best to employ a consistent method for extracting pertinent data from each article. This must be completed by the goals and research question of the particular review; the format will differ.

- Phase 4: Writing the review

First and foremost, the purpose and necessity of the review must be made abundantly evident when writing it. The process of creating the review and the methodology for gathering the literature—how the author found, examined, synthesized, and reported the literature—must be openly and honestly described.

Even though deciding which strategy is best for a certain kind of review can be challenging, the research question and its particular goal always point to the best course of action. As a result, semi-systematic literature review will be employ in this paper because it provides a balance point between fully systematic reviews and narrative reviews with flexibility and conserving the systematic approach. Moreover, a thematic analysis will be utilizing to evaluate the literature review

Information from a variety of sources can be efficiently arranged and summarized using thematic analysis. Because it makes sense of the literature by pointing out recurring themes, patterns, and trends among various studies, this kind of analysis has been selected to assess the literature in this study. Here is some explanation for the thematic analysis process:

### 3.2.2 The Analysis by Theme

Theme functions as a concept, element, descriptor, and attribute. As an implicit theme, it helps researchers address the study issue by providing structure to recurring concepts. It unites concepts about the topic of inquiry by having codes with a high degree of generality and a shared point of reference. Table (2) elaborate the thematic analysis phases.

The term "category" describes the text's descriptive level and is an outward expression of the participants' narrative. Themes are described via categories. Like the theme, the researcher assigns meaning to each category, which may include subcategories that further define the category's meaning. The category is the primary product of the analytical process, has a descriptive identity, and is generally utilized at the beginning of the theme development process to classify discoveries. Three steps make up Constas' (1992) procedure for categorization: (i) originalization, (ii) verification, and (iii) nomination. The theme aims to extract the core of the participant's experiences.  (Vaismoradi et al., 2016)

**Table 2:** Phases and stages of theme development in thematic analysis (Vaismoradi et al., 2016)

| Phases | Stages |
|---|---|
| **Initialization** | Reading transcriptions and highlighting meaning units;<br>Coding and looking for abstractions in participants' accounts;<br>Writing reflective notes. |
| **Construction** | Classifying;<br>Comparing;<br>Labelling;<br>Translating & transliterating;<br>Defining & describing. |
| **Rectification** | Immersion and distancing;<br>Relating themes to established knowledge;<br>Stabilizing. |
| **Finalization** | Developing the story line |

Studies that used the literature review method are given here:

1.(Towards Net Zero Energy Office Buildings in Spain: A Review of 12 Case Studies)

(Sánchez et al., 2012) The study compares twelve office buildings that are currently in use in Spain and are designed to be low-energy or zero-emission structures. Following information collection from the chosen buildings and the creation of a central database, a synthetic analysis was carried out. An extensive literature review's conclusions were collated into a single Excel database. A column in Excel was filled with the details of each and every building. An initial set of items, or parameters, were identified from the available data and categorized into six groups: construction costs; design features; envelope characteristics; solar control and lighting; heating, cooling, and ventilation strategies; and renewable energy systems. The database was transformed into a heterogeneous spreadsheet that combined data in words, numbers, and sentences. Items were categorized based on response type to make the analysis easier to read. Three different response types were probably set up as follows: yes/no

(table and percentage bar graph), numeric data (columns graph), and standardized options (stacked bar graph).

2.(Joo et al.,2023) They explain in their paper “Contested net-zero target setting in a transitioning country: The case of South Korea” how they use a literature review as a research method in the following ways:

In order to analyze themes in the discourses of actors involved in the setting of the 2050 carbon neutrality target, we used expert interviews and policy documents as primary materials. We thought that the discourse of policy actors—presidents, legislators, and other government representatives—as well as their interactions with business and civil society could provide an explanation for the emergence and development of institutions.

In the years 2020–2021 we concentrated on setting the 2050 net-zero target. First, policy documents were examined to determine the main players and the discourses they were involved in. In relation to Korean climate policy, including the Korea Green Deal, Long-term low greenhouse gas Emission Development Strategies (LEDS), and the 2050 Carbon Neutrality Strategy, we examined more than 130 legal documents, reports from the government and national assembly, seminar reports, and position letters. Academic and grey literature from think tanks, NGOs, and other sources were also gathered and examined. We attended two public events in 2021: a public expert seminar on November 19, 2021, and a public consultation event for the 2050 LEDS on October 17, 2021. Both events were recorded and made publicly available on YouTube. For analysis, the speeches given by the different stakeholders were transcribed.

3. (Jaysawal et al., 2022) as stated in their article "Concept of net zero energy buildings (NZEB) - A literature review" how the literature review was used as a methodology:

The purpose of the study is to review the research on current net-zero energy buildings (NZEB) and how to make them self-sustaining. First, research articles, abstracts, and unpublished material are gathered from many sources, like IEEE, Springer, Wiley, Inderscience, Google Scholar, and Emerald. After carefully examining the concepts and going through an iterative study process, the paper identified several pertinent keywords as part of a state-of-the-art analysis. To locate pertinent papers in the database, search terms such as "net zero energy building," "energy analysis of NZEB," "energy integration to NZEB," and "performance of NZEB under various climatic conditions" were utilized. During the search, 2982 results in all were discovered. Between 2002 and 2022, 59 books, 296 magazines, 647 trade publications, 165 conference materials, and 1563 academic journals were produced. A second phase was created to identify the most significant information from frequently shared publications. By the end of the second iteration process, there were only 219 materials selected. Research papers and peer-reviewed publications were the only formats that were considered. Abstracts and unpublished theses were not taken into account. Out of the 219 items, only 170 were considered pertinent. The number was kept to a minimum by using the year of publication. The most recent documents were selected for the investigation since they contained the most recent information. They reviewed the literature spanning the preceding two decades, but the primary focus was on pertinent works released within the last ten years, with the last five years garnering the most attention. (Jaysawal et al., 2022)

### 3.2.3 Pros and Cons of Literature Review Method

1. A literature review can summarise and analyze the current researches, highlighting trends, knowledge gaps, and potential areas for further study. It can assist researchers in determining the most promising study areas and help them prioritize their efforts.
2. Recognizing Important Definitions and Concepts A literature survey provides an understanding of the essential terms and ideas linked to NZEBs. The review, for instance, can define terms like "net-zero energy" and "energy-efficient" buildings and the technical specifications needed to achieve net-zero energy. It can serve as an obvious starting point for more research.
3. Comparative Analysis of Various methods for obtaining net-zero energy, such as passive design tactics, renewable energy technologies, or energy storage systems, can be compared and contrasted in a literature study.

The drawbacks of adopting a literature review as a research approach for NZEBs will be covered in this section.

1- Limited to current research: The availability and caliber of prior research on the subject influence the literature review. A literature evaluation only offers a thorough grasp of the problem if there is more study on a particular component of NZEBs.
2- Possibility of bias: The choice and analysis of literature are subject to bias.
3- Inadequate empirical data: It is possible that literature evaluations need to offer the concrete evidence required to verify and confirm theories or research issues.

4- Time-consuming: Reading and reviewing the literature can take much time, especially if there is much of it.
5- The possibility of out-of-date information: New research is continually being published, and the field of NZEBs is constantly changing.

## 3.3 Interview Method

Interviewing is based on an interactive approach where participants learn from each other. This makes interviewing an active research process in which the interviewer and interviewee(s) form an interview or a "thematically linked and cooperatively made story." (Young et al., 2018). Three categories of interviews exist:

a) **Semi-structured interviews**: the interviewer prepares questions to which all interviewees must respond. In addition, further questions may be asked during interviews in order to elucidate and/or elaborate on specific topics.
b) **Structured interview:** each subject responds in the same sequence to a set of pre-planned questions. Because researchers may compare and evaluate different answers to the same questions, data analysis tends to be simpler.
c) **Open-ended or non-structured interviews** are frequently employed in qualitative research. Rather than a series of pre-written questions, they are frequently helped by an interview guide, timetable, or aide memoire that comprises topics, themes, or issues to be discussed throughout the interview. The interviewer should be adaptable and responsive during the interview to allow questions to alter in order and topic, as well as

to allow the interviewer to delve deeper into candidates' initial answers to obtain a more thorough or "in-depth" response.

Reputable academics caution that "the interviewer should try to create a friendly, non-threatening atmosphere when conducting an interview." Like a cover letter, the interviewer should emphasize the value of the subject's involvement, provide a quick, informal introduction to the study, and, if feasible, guarantee anonymity or secrecy. (Connaway & Powell, 2010)

### 3.3.1 Interview Process

The interview should be in a private, informal setting and may be conducted in person or via teleconferencing software like Zoom or Skype. Participants' identities and privacy should be safeguarded, and they should give their informed consent. (Frey and Fontana, 2000). Accuracy can be ensured, and a permanent record of the data acquired can be provided by having interviews taped and transcriptions. (Rubin & Rubin, 2005). The stages for utilizing interviews in research are outlined below in Figure12:

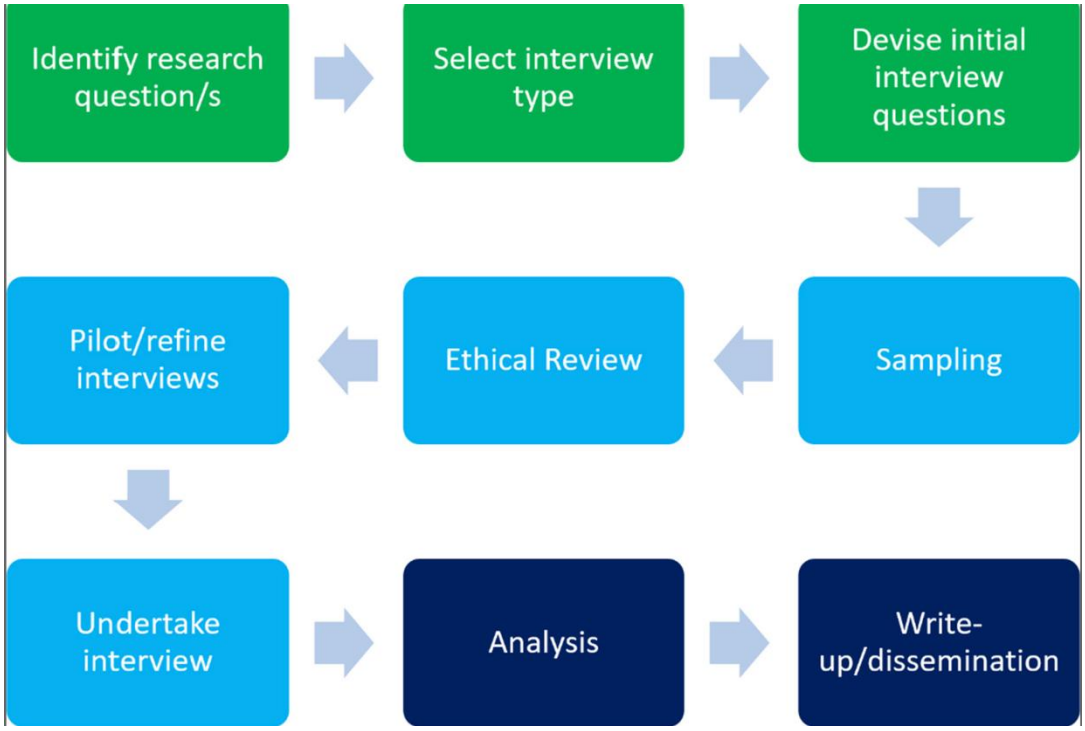


**Figure 14:** Typical interview processes include: first project design (phases 1-3), data gathering (phases 4–7), analysis, and report writing (8–9) (Young et al., 2018)

- The preliminary project design (determining the research question or questions, the interview format, and the interview questions)
- Data collection (sampling, conducting interviews, doing ethical reviews, and piloting/improving interviews)
- Analysis and report (including distribution and participant input on the results).

### 3.3.2 Examples of Using Interviews as a Methodology:

1-(Maltais & Nykvist, 2020), in their paper" Understanding the role of green bonds in advancing sustainability" provided the following explanation of their study methodology:

To answer these questions, we conducted 22 in-depth interviews with participants in the Swedish green bond market between the fall of 2017 and the spring of 2018. Seven green bond issuers from the public and three from the private sector that have issued green bonds in Swedish Kronor (SEK) were interviewed. A trio of interviewees has additionally released green bonds denominated in other currencies. Nine Swedish investors in green bonds, including insurance firms, governmental pension funds, and private pension investment funds, were questioned. In addition, we spoke with an expert in the current green bond investigation by the Swedish government, one exchange, and two Swedish banks that underwrite green bonds in the Swedish green bond market. Interviews with issuers and investors were conducted until repeatable, well-founded patterns in the data were discovered (Bowen, 2008).

We created interviewing procedures that were organized to address the three research questions.

Two semi-structured protocols were used for the interviews; they were comparable but altered to consider the different viewpoints of bond investors and issuers. The issuer and investor protocols' questions were used for the two banks. However, some were changed to reflect the bank's role as an intermediary or eliminated because they were unnecessary. The interview protocols were used as a topical guide for the exchange, service provider, financial regulator, and member of the Government of Sweden's green bond investigation; however, the interview questions needed to be more organized and evolved naturally throughout the interviews.

Anonymity was guaranteed to informants, and after every interview, handwritten notes were documented, and the interview guide's format made digital transcriptions. Most people who participated in the interviews agreed to be quoted for this study, sometimes in exchange for not having to assent to each recorded statement explicitly. In order to foster a trustworthy and candid interview interaction, it was decided to anonymize the results reporting, even though some respondents were less inclined to be directly quoted. This was due to the respondents' apparent caution during the initial interviews.

The most grounded patterns in the interview data were analyzed using open coding to determine the data quality (Coffey & Atkinson, 1996). The three main code categories were (a) the incentive system, (b) the effect of green bonds, and (c) the market's growth drivers and impediments. We coded for (i) financial, (ii) business case, and (iii) non-business case incentives under incentives (a). We coded for (i) boosting sustainable investment, (ii) greening business models, and (iii) improving organizational and operational aspects under impacts (b). We coded for (i) project supply, (ii) risks and bankability, and (iii) policies and standards under accelerators obstacles (c).

2-(Attia et al., 2013) In a study called: “Assessing gaps and needs for integrating building performance optimization tools in net zero energy buildings design”, elaborated the methodology as follows:

An interview was conducted to learn more about people's current use of optimization tools, the tools they use, the main obstacles they have faced, and their outlook on the field's future. Semi-structured interviews were used in a qualitative study design. Experts in

optimization from the business world and academia were brought in. Researchers or professionals with three or more publications in the BPO sector were considered experts. The IBPSA International and Regional Conference Proceedings from 1995 to 2010 contained the names of the participants. In order to incorporate research experts from Asia, Europe, and North America, a sample framework was created. These groupings reflected the variety of potential optimization users, including academics and designers who are considering optimizing in the construction of high-performance or net-zero buildings. A list of forty possible optimization experts was compiled and shared amongst the IEA Task 40 Subtask participants. It was requested of each interviewed expert to update the list and include any possible interviewees. The recruitment process persisted until a diverse range of specialists from various nations were included, and the sample as a whole reached theme saturation. A second round of specialists was invited to the IBPSA 2011 Conference in Sydney. January through November 2011 saw the interviewing of a total of 28 specialists.

The authors developed the interview questions and categorized them into five groups: background, methodology, output, design integration, and deficiencies and needs. The questionnaire aimed to learn more about the user's background with computational optimization methods and tools for NZEB design. The authors conducted pilot research to assess and improve the truth and dependability of the data of the questionnaire before speaking with the experts. Reviewers of the work were asked for their opinions and recommendations. Reviewers were requested to make revisions and offer insightful commentary to maximize the questionnaire's clarity and applicability.

3-(Godin et al., 2021). In their research ‘The transition to net zero energy (NZE) housing: An integrated approach to market, state, and other barriers’ suggest how their research methodologies should be processed:

The top ten obstacles found in the poll were divided into three groups in order to create the interview guide: (1) the cultural context to investigate the social acceptance of NZE buildings and the demand for this type of construction; (2) the technical and economic context to investigate the technical and economic feasibility of NZE buildings in New Brunswick; and (3) the governance context to investigate the topic of state involvement in NZE building adoption. In order to learn more about the experience of experts in the construction business in New Brunswick, general questions were developed.

The initial author's network was used to find respondents, and snowball sampling made it possible to find more participants. Merely nine specialists fulfilled the screening requirements overall. Six of them consented to take part after being contacted. Word processing software was used to record and transcribe the 30- to 60-minute interviews.

Grounded theory forms the foundation of qualitative data analysis. "An approach to coming up with theory that works for its stated purposes is to use grounded theory," states Glaser and Strauss (2017, p. 3). In order to analyze the data, significant concepts and elements from the interviews are first identified and coded (codes). These codes are then grouped into more general categories (themes) pertinent to the data. They can be utilized to explain the phenomenon being studied from the bottom up using the participants' accounts. This analysis applied codes to the obstacles that the performers had pointed out in the interview transcripts.

The questionnaire study's ten most significant barriers were coded, and new codes were applied to the other hurdles. When patterns emerged, different barriers were grouped to create categories and subcategories. As soon as transcripts became available, analysis was carried out throughout the interview process. This made it possible to modify the interview guide in light of newly discovered information, examine topics in greater detail, and validate or refine emerging findings with additional participants.

### 3.3.3 Pros and Cons of the Interview Method

1- The ability to gather rich and detailed data is one of the critical benefits of the interview approach.

2- It can help build rapport and trust with participants, resulting in sincerer and open responses. (Fernandez-Solis et al., 2020).

3- Researchers can learn more about the viewpoints of people directly impacting the research subject by tailoring interviews to specific stakeholder groups.

Using interview methods may have some disadvantages in addition to these benefits such as:

a. It can be time- and resource-consuming and necessitate extensive planning, recruiting, and data analysis. (Hill et al., 2018).
b. The data may be biased due to the participants' viewpoints and experiences or the researchers' interpretation of the data. (Fernandez-Solis et al., 2020).

c. Small sample size that may be obtained, which can restrict the generalizability of results.
d. Analyzing interview data can be difficult and time-consuming because the information gathered is frequently subtle and complex. (Gibson, 2012).

## 3.4 Research Method and Justification

The current regulations and rules about NZE buildings have been the subject of many past studies using various research methods. This study aims to investigate mechanisms for lowering the high initial cost of NZE buildings in the United Arab Emirates. In order to better meet its goal of identifying and addressing the solutions used to overcome the obstacles connected with establishing NZE buildings in the United Arab Emirates, a qualitative research methodology has been implemented.

To assess the possibility of enacting mandatory standards and guidelines for NZE buildings in the United Arab Emirates, two primary methodologies will be employed. The first research methodology is the literature review, which is among the more valuable ways to collect information and deeply understand the financial mechanisms concept. In addition, it will be used to investigate other international programs, rules, tactics, obstacles, and problems to ascertain what might be applied in the United Arab Emirates, with a particular emphasis on potential fixes for the main problems related to the NZE building. The second way will be conducted through interviews. This strategy aims to verify the recommended tactics from the literature review procedure and assess how well they mesh with UAE culture. A comprehensive view would be obtained, and different viewpoints and opinions would be

beneficial by interviewing government professionals, semi-government specialists, homeowners, businessmen, consultants, real estate developers, and bank experts. The purpose of this study is to provide a roadmap regarding the mechanisms being investigated so that regulators and legislators can verify which strategy is best suited to the needs of UAE society.

## 3.5 Methodological framework

The literature review will be examined, and theme analysis will be used to look into the study topic. The second phase involves verifying the idea from the literature review analysis by interviewing various UAE population groups. The interviews will be analyzed using Nvivo software, and the overall research findings will be gathered. The below figure14 explains the Research Methods and the Steps taken:

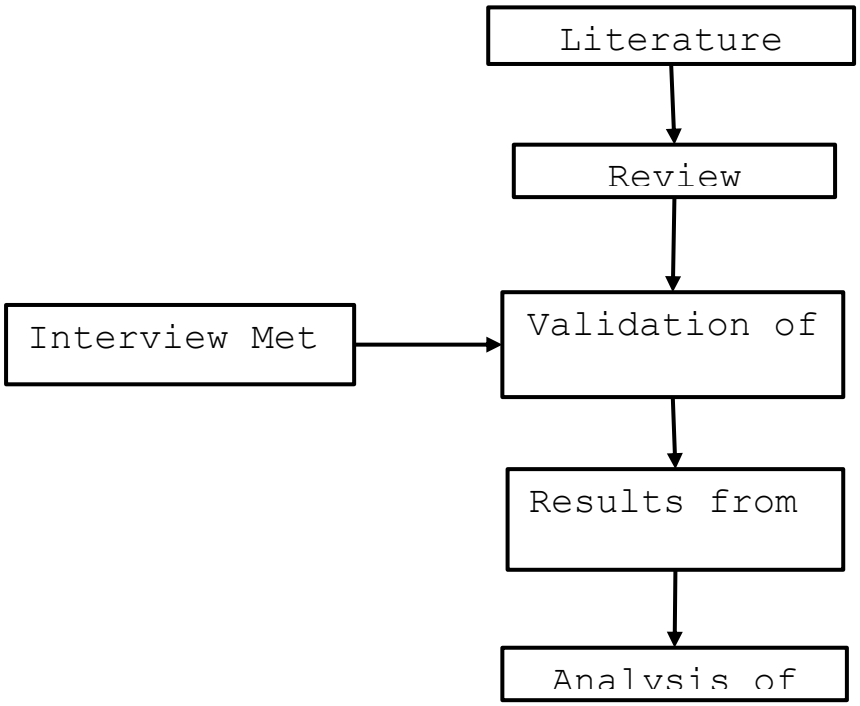


**Figure 15:** Methodological framework (By Author)

# Chapter 4: Mechanisms to Overcome Barriers

## 4.1 Introduction

The journey through the previous literature review about net zero energy buildings, the barriers preventing its global implementation, and the mechanisms used by various nations to get around those barriers, paved the way for the selection of a set of criteria to compare the mechanisms mentioned earlier in literature review in order to select the instruments that were nominated and conduct a thorough study for them. The mechanisms (green bonds, PACE, and EPCs) that were nominated and had the highest numbers will be the subject of a comprehensive examination and a thorough analysis in this research.

**Table 3 :**Comparison between mechanism to overcome barriers of NZEBs implementations *(by Author)*

| | **Green Bonds** | **PACE** | **EPCs** | **Green Mortgage Loans** | **Power Purchase Agreement (PPA)** | **On-Bill Financing** |
|---|---|---|---|---|---|---|
| **Initial Investment Cost** | 4 | 3 | 3 | 3 | 3 | 3 |
| **Energy Cost Saving** | 4 | 4 | 3 | 3 | 4 | 3 |
| **Availability of Financing options** | 4 | 5 | 2 | 4 | 4 | 4 |
| **Integration with Building Codes and Standards** | 3 | 3 | 4 | 3 | 2 | 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Education and Awareness** | 3 | 2 | 5 | 2 | 2 | 2 |
| **Simplicity in application** | 3 | 3 | 5 | 3 | 2 | 3 |
| **Total** | 21 | 20 | 22 | 18 | 17 | 18 |

This paper will examine in these chapter three mechanisms in detail using a literature review as a methodology by taking into account the findings from the above table and aligning the research from Ohene et al., 2022, and Ather, 2019 as explained in the previous literature review.

According to (Ohene et al., 2022) and (Ather, 2019), the high upfront costs and a lack of financial incentives considered as the most critical economic barriers in UAE and in the global. As a result, the financial mechanisms are the most effective instruments to gain the best results with energy efficient buildings.

That is why, this study will evaluate three suggested mechanisms: Green Bonds, Property Assessed Clean Energy (PACE), and Energy Performance Certificate (EPC). The first two involves high upfront costs (economic barriers). In contrast, the third has to do with people awareness about NZEBs (sociocultural barriers). However, the economic obstacles and sociocultural barriers are linked in different ways because people awareness about net zero energy buildings is the step precedes financing them.

## 4.2 Mechanism1: Energy Performance Certificate (EPC)

### 4.2.1 History of EPCs

On August 1, 2007, the UK government implemented EPCs for the first time in England and Wales. They were included in the Home Information Pack (HIP), which was provided by those selling homes with four bedrooms or more, as a result of the EU Directive's requirements regarding the energy performance of buildings. Then, all buildings, residential and commercial, were progressively required to have an EPC when a building was being sold or rented. Although the government modified the HIP requirement in May 2010, the requirement for an EPC persisted, and it is still a crucial component of selling or renting a building today.

### 4.2.2 Uses of EPCs

EPCs and their information can also help local governments and real estate companies study projects and decide how to use energy in cities. In some countries, like Estonia, Germany, Ireland, and Austria, homes need an EPC to get handouts and loans with low-interest rates. EPCs can also be used to keep an eye on and assess policies and come up with better ones for the future. Figure 15 illustrates some of the potential functions that EPC enables. (Zhuhai et al., 2022)

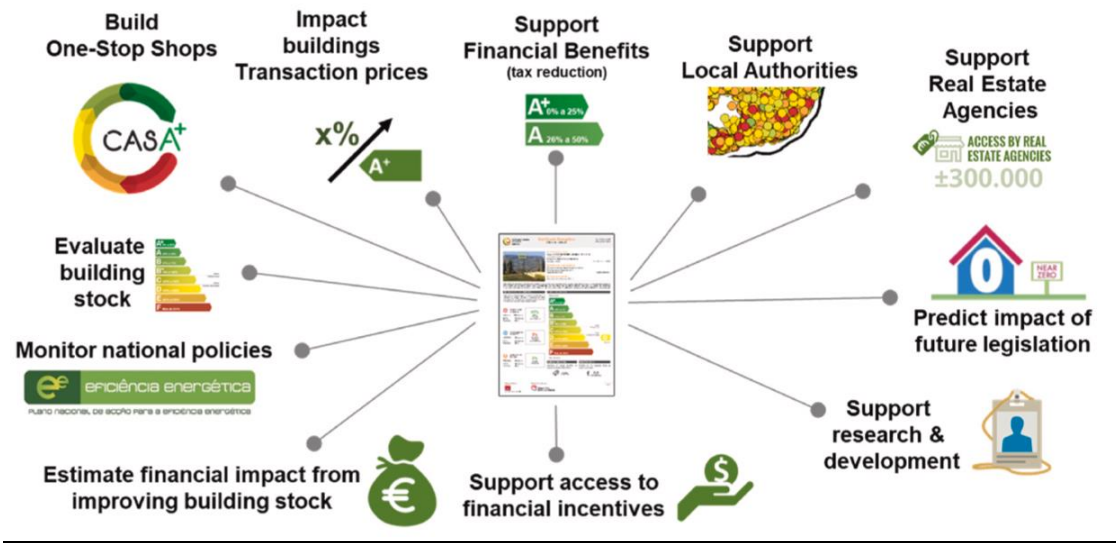


**Figure 16:** Other than energy performance data, examples illustrate the role of EPCs in Portugal. *(Zuhaib et al., 2022)*

### 4.2.3 How EPC Works:

The EPC must be provided to the buyer as it is a legal document. Nonetheless, "some portions of the certificate, such as the Energy Label, can be utilized as a condensed version." The document includes information about the building and the agent issuing the certificate, as well as an energy label with a scale from A to G representing the calculated delivered energy need and a colour-coded heating grade indicating how much of the building's space and water can be heated using renewable energy sources. It also includes recommendations for energy-saving measures and general information for the buyer. (Olaussen et al., 2017)

### 4.2.4 Energy Expenses

The EPCs form include three parts as shown in the figures below:

**Table 4:** Energy expenses, both present and future *(BPIE,2010)*

| Estimated energy costs of dwelling for 3 years: | | | £ 5,670 |
|---|---|---|---|
| Over 3 years you could save | | | £ 3,840 |
| **Estimated energy costs of this home** | | | |
| | **Current costs** | **Potential costs** | **Potential future savings** |
| **Lighting** | £ 381 over 3 years | £ 201 over 3 years | You could save £ 3,840 over 3 years |
| **Heating** | £ 4,083 over 3 years | £ 1,392 over 3 years | |
| **Hot Water** | £ 1,206 over 3 years | £ 237 over 3 years | |
| **Totals** | **£ 5,670** | **£ 1,830** | |

These figures show how much the average household would spend in this property for heating, lighting and hot water and is not based on energy used by individual households. This excludes energy use for running appliances like TVs, computers and cookers, and electricity generated by microgeneration.

An estimate of the property's present and future energy bills appears on the first page of the form. This is helpful in estimating the energy bills for a new property and estimating the potential savings on running costs in the event that energy efficiency is increased. These expenses only cover the hot water, heating, and lighting. The actual energy bills will be a little higher because the EPC does not account for any additional energy costs associated with the home appliances (such as the cost of operating the refrigerator, oven, or TV). Still, the costs displayed can be used to compare properties and determine which building might be less expensive to operate. In this case, a three-bedroom semi-detached house could save almost £4,000 over the course of three years.

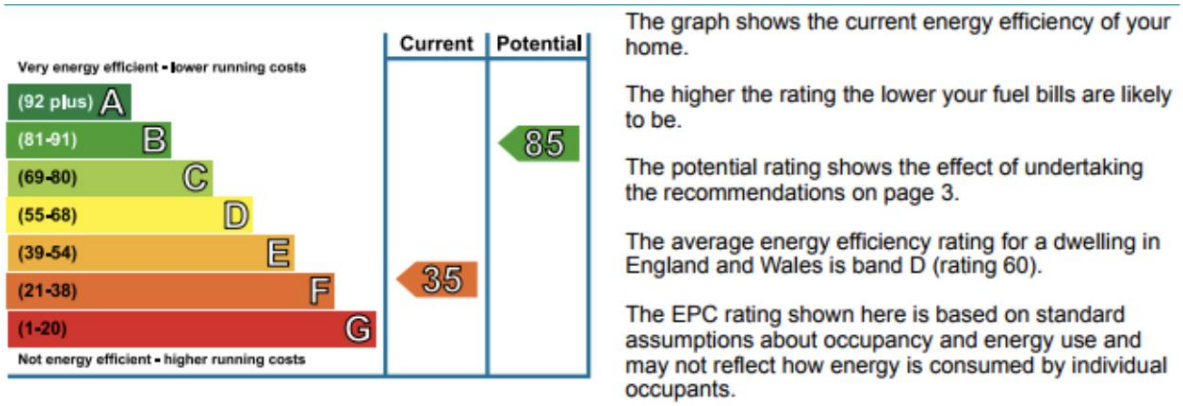


**Figure 17:** Rating for energy efficiency *(BPIE,2010)*

A brief visual comparison of property performance, akin to the energy labels found on household appliances, is presented in the following table on page one. There is a current energy efficiency rating for the property. These are arranged from A to G, where A is the best. Similar charts for a property's environmental performance are also available from some EPCs. It also displays the possible rating in the event that all of the recommended changes are made. This example shows how the suggested energy efficiency upgrades could move the house from band F to B. Figure (12) below elaborates the principal actions for energy efficiency:

**Table 5:** Principal actions for energy efficiency *(BPIE,2010)*

| Top actions you can take to save money and make your home more efficient | | | |
|---|---|---|---|
| **Recommended measures** | **Indicative cost** | **Typical savings over 3 years** | **Available with Green Deal** |
| 1 Internal or external wall insulation | £4,000 - £14,000 | £ 1,530 | ✓ |
| 2 Floor insulation (suspended floor) | £800 - £1,200 | £ 219 | ✓ |
| 3 Increase hot water cylinder insulation | £15 - £30 | £ 282 | ✓ |

### 4.2.5 *EPCs Cost*

The price of the certificates affects public acceptance of the EPC scheme, particularly in relation to how valuable people believe them to be and, to a lesser extent, how much per capita income is. The prices differ between the various member states. Several residential building examples (with the average per capita income in each country as a point of reference)

Germany: anywhere from €45 to €500: either a measured or computed rating (€34,200 per capita income); Austria: income per capita: €38,300; for multifamily homes, approximately €150–180 per home; for single family homes, approximately €450; and Belgium: from €205 for an apartment and €245 for a house (with a per capita income of €36,200). It should be mentioned that a variety of factors, make it challenging to establish a direct correlation between the cost of the certificate and the average income per capita. Generally, a residential EPC can cost anywhere from €45 to €800 total. (BPIE, 2010)

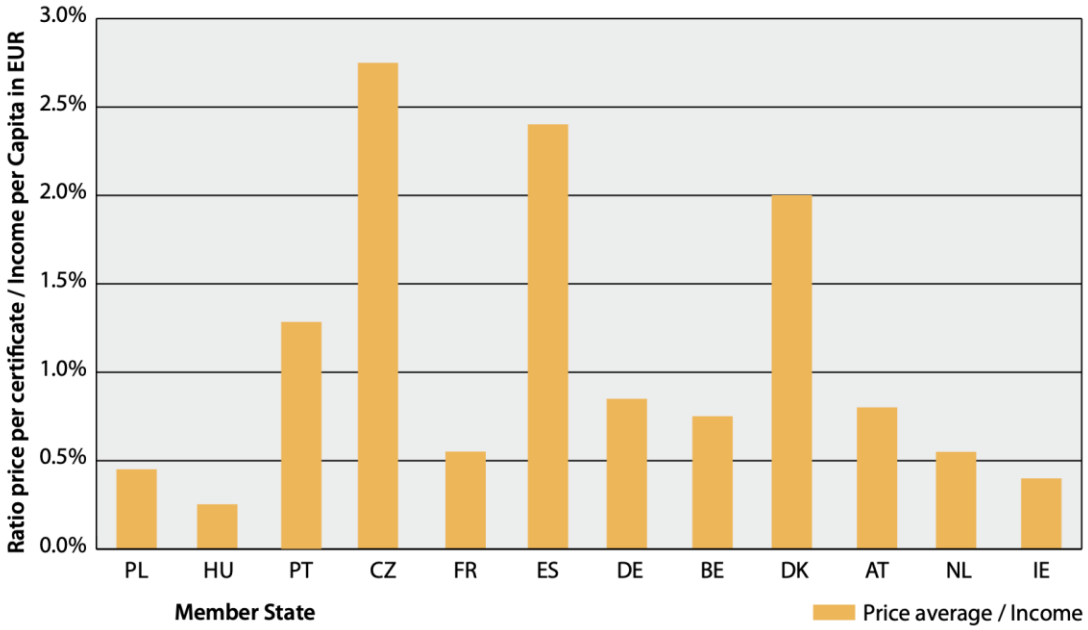


**Figure 18:** Certificate price to per capita income ratio for each of the 12 member states *(BPIE, 2010)*

other example of a certification system is the one in Norway, which lets owners of current flats and buildings do their assessments. More often than not, these licenses will be more comprehensive than those done by experts. For existing houses, getting certified usually costs at least NOK 1000.2. It includes the cost of the energy rating and the extra price of advertising for sale when energy label information is added. On the other hand, approval needs to be done for new buildings by a trained expert, which makes the process more expensive. The Norwegian Water Resource and Energy Directorate (NVE) job is quality control in the Norwegian license process. Incorrect inputs are seen as a breach of contract by this office. In this case, a fine is given. The NVE keeps a close eye on whether EPCs are given out for sale,

whether they accurately describe the building, and whether the experts meet the standards for their level of competence. (Olaussen et al., 2017)

### 4.2.6 Ratio of Adoption in E.U. Countries:

Only 10% of people in Cyprus use EPCs, but it is close to 100% in Portugal and France. It is important to note that the EPC should be given more time in decision-making to have an effect, even in places where adoption is high. There was a difference between how much energy was used and how much was expected based on standards and theory.

Norway fully implemented the Energy Labeling System for Houses and Dwellings in July 2010, based on the E.U.'s EPBD. The Ministry of Local Government and Regional Development and the Ministry of Petroleum and Energy were in charge of putting it into action as a whole. The Norwegian Water Resources and Energy Directorate administered inspections and licensing programs. From the start, an energy performance certificate (EPC) was required. In fact, since July 2010, all deals must include an EPC. (Olaussen et al., 2017). Polls and studies from the Building Performance Institute Europe (BPIE) have shown that EPCs are one of the best ways to find out about the energy efficiency of buildings in the E.U. (Li et al., 2019)

### 4.2.7 Studies on the Implementation of EPC:

- Study 1

Tenants, property owners, and possible buyers are the two key groups that will benefit the most from the EPC.

In Belgium, a poll found that the EPC affected the decisions of about half of buyers and three-quarters of renters. 30% of buyers and 18% of renters used the EPC to negotiate the price of their home. When renting or buying a house, homes with a better energy efficiency have higher prices because they use less energy, which can be seen in their energy bills. When the EPC is used correctly, it has been shown to affect real estate investments and renting returns positively. Studies have shown that homes with better energy performance rent or sell faster and for more money than homes with worse energy performance in the same area.

When constructing house price indices, the hedonic method is widely used to control heterogeneity. It was used to examine the connection between the energy-performance grade and the market price of Dublin homes. The writers said that the list price goes up by 1.5% for every 50 kWh/m2/year decrease in energy use. (Zuhaib et al., 2022)

Also, a poll of people in 12 E.U. countries found that 73% think EPC is a big reason why buildings must be fixed up. The suggestions with the EPC help building owners think of ways to improve their facilities. On the other hand, the energy stickers let them compare how much energy they saved before and after the fix. (Li et al., 2019)

- Study 2:

The X-tendo project did another study to create a system of ten "next-generation EPC features" that will make EPCs more compliant, easier to use, and more reliable. The main goal of this paper is to look at what end users want and expect from future EPCs by surveying people in five European countries. The results of this study would help solve problems like low reliability, lack of compliance, market growth, and end-user satisfaction. The customer

poll was done in April 2020 using the interview method of online surveys. Two thousand five hundred sixty-three end users filled out the vote, with sample numbers ranging from 501 to 519 per country. The poll results show that people are concerned about energy use, and the ideas behind the ten features were liked, even though some people needed to understand some of them, like innovative technology fully. More people who answer are interested in information directly related to their home and family. People who know how much energy they use at home will like these ten features the most, and energy performance is critical when buying or renting a home. (Zhuhai et al., 2022)

### 4.2.8 EPCs' Problems

The present EPCs are not designed to meet the end user's wants. Most people will get little out of seeing only how well the building uses energy, especially if the information is technical. According to the results, adding new EPC features could make the instrument more valuable and appealing. The study gave helpful information to help Member States make EPCs more reliable, compliant, and famous in the market and move closer to updating their current EPC system.

While the changing role of EPCs is positive, their success or acceptance by the public depends significantly on how end users in E.U. member states see them, how willing they are to use them, and how interested they are in them. A few studies have shown that EPCs could be more beneficial for homeowners. Still, many people think they can help solve problems like climate change, major home repairs, getting the money you need, getting the right advice,

healthy buildings, rising home prices, saving energy in the future, and sustainability in general. (Zuhaib et al., 2022)

- Study 3:

One well-known study by Eichholtz et al. (2010) found that U.S. office buildings with a "green rating" sold for about 16% more than those without one. A new study by Parkinson et al. (2016), on the other hand, found that U.K. office buildings had a much smaller and almost nonexistent premium. The first proof of the economic effects of EPC application for domestic buildings came from Brounen and Kok (2011). Based on data from about 170,000 home sales in the Netherlands, they did a hedonic regression study and found that homes labelled more energy-efficient sell for more money. In the same way, a survey made for the European Commission found that EPCs have a significant effect on purchase prices and rents in some E.U. countries. Twenty-two studies that employ hedonic regression models to examine whether or not EPCs affect home prices are included in the report's literature evaluation.

The study also includes an analysis using the hedonic regression model on data sets from the U.K., Austria, Belgium, France, and Ireland. In the end, it says that the research "overwhelmingly points to energy efficiency being rewarded by the market." ( Olaussen et al., 2017)

The report says that because of this result, the role of EPCs should be strengthened. EPCs should be put in place faster, made more noticeable (for example, by making the front page stand out more), published earlier in the transaction process (for example, when the ad is

made), and made more accessible to understand (for example, by using simple language and making the layout better). (Olaussen et al., 2017)

**Contrasting results**

Other research shows that EPCs do not have much of an effect on purchase prices. An online survey was used by Murphy (2014) to look into the role of the EPC in the buying and selling of houses in the Netherlands. She concludes that only some homeowners use the EPC during the purchase process. She also says that the EPC will have a different effect than what was meant, even if it is fully used. The results of similar studies in the U.K. (Laine, 2011) and Germany (Amecke, 2012) were the same: EPCs do not have much of an effect on price talks or the buyer's choice. Backhaus et al. (2011) also found that only some EPCs impact homeowners' investment decisions. They concluded after talking to homeowners in ten European countries and surveying many homeowners in five European countries. (Olaussen et al., 2017)

Regarding the part that EPCs play in energy saving, the empirical literature thus arrives at two entirely different findings. As an example, it has been discovered that the Netherlands' instance is particularly noteworthy. Survey data from Murphy (2014, p. 666) demonstrates that a higher EPC does not directly affect negotiations or decision-making.

A sizeable statistical study by Brounen and Kok (2011) indicates that the EPCs are capitalized into transaction prices in the same country and around the same time. The study uses an EPC database, a real-estate database, and economic and voting data.

The methodological layout of the statistical research may be the source of the divergent outcomes seen in the literature. Therefore, the apparent price premium of the energy labels captures something other than the labels themselves, and the purported positive price effect of EPCs in some of the statistical investigations is caused by the misspecification of the regression models. Stated differently, a limitation of this research is that missing factors may correlate with the energy label. This suspension has been tested using data from the Norwegian real estate market by taking advantage of the fact that energy labels were introduced by the Norwegian government "overnight" on July 1, 2010; thus, there is a quasi-natural experimental design with pre- and post-label data. When the given energy label of a home resold in 2014 is used as a variable in a hedonic regression for homes sold before EPCs were required in 2010, the relationship between the energy label and the home's sale price stays positive. In other words, the energy label's price premium appeared before its implementation. It suggests that the energy label describes something different from what it is. (Olaussen et al., 2017)

- Study 4:

Another paper was examined as the result of an E.U. project that tries to increase the use of BIM (Building Information Modelling) to make buildings more energy efficient. One of the project's goals is to find the flaws in the present EPC systems in the E.U. and offer expert training courses to improve the EPC generation process.

A poll in the U.K. found that the EPC has little effect on people's choices about buying or renting a home. Only 18% of those who get the information are changed by it, and more

than 80% think it has little or no effect. A different poll in the Netherlands found that only 10% of those asked said that the EPC had affected their decision to buy a home. More recently, a survey in Denmark showed that people think the EPC is a reliable and easy-to-understand source of information about energy efficiency. However, homeowners believe that the EPC needs more information to make them want to make home improvements in its current form. (Li et al., 2019)

### 4.2.9 EPC' Challenges

The next problem concerns how people act and how bright the building is. One of the ongoing and long-term causes of the deviations is the occupants' behaviour since their understanding and level of environmental awareness are different.

Even though policymakers, real estate companies, and research centres are starting to use the EPC more and more, issues still need to be fixed before it can be widely used across the E.U. Previous research in EPC has found that (1) there is not enough good data for evaluating energy performance, (2) there is not enough information to get people to renovate, and (3) there is not enough execution to give countries a solid source of information for energy planning. In particular, the energy estimated in EPC does not match the amount used. The process of delivering an EPC can be subjective. As a result, energy analysts can easily change the data quality because of the standard assumptions used to make the certificate. Energy efficiency is another crucial thing to think about when renovating a building. However, the EPC does not look at essential factors, like indoor air quality and daylight, which can negatively affect how people feel in buildings. (Li et al., 2019)

**The next generation of EPC:**

The EPC was supposed to get property owners to invest in buildings by building new ones and fixing up old ones. However, many problems still make people not entirely motivated to make their properties more energy efficient. Because of these issues, the current EPC system needs to be updated to show better how well a building is doing and move on to the next generation, EPC+, which is a better plan for the future of the EPC. Drawing up and putting the EPC+ into action is complex and extended. Several things that affect the project should be considered, and it should also work with the laws already in place, like building standards and rules. To help people figure out how to make buildings work better, the EPC+ will be a reliable, easy-to-find, clear, and complete source of knowledge. It allows lawmakers to figure out how to improve housing quality, how fast buildings should be renovated, how much they should be renovated, and where to put their money. At the same time, it makes it easier to get past the financial barrier that was stopping performance growth. (Li et al., 2019)

## 4.3 Mechanism 2: Property Assessed Clean Energy (PACE)

### 4.3.1 The Mechanism of PACE

PACE is a brand-new method of financing for investments in clean energy generation in which property owners take out a loan from their local government and pay it back with an assessment on their property taxes rather than with regular loan payments.

The PACE acronym encompasses many initiatives promoting geothermal, wind, or solar energy generation for both home and commercial use. A municipal lender secures the

loan by establishing a "special assessment district," which functions as a primary lien on the property. The two distinguishing similarities are that (1) the capital is loaned, and (2) the assessment for repayment is attached to the property and transferred to a new owner, along with other conventional property tax assessments. The municipality may seize and sell the property to recoup any unpaid balances if a borrower defaults on a property tax assessment. The renovations and the PACE assessment pass to the new owner if the borrower decides to sell their property. (Kirkpatrick & Bennear, 2014). Figure 17 below explain the Basics of **PACE Financing:**

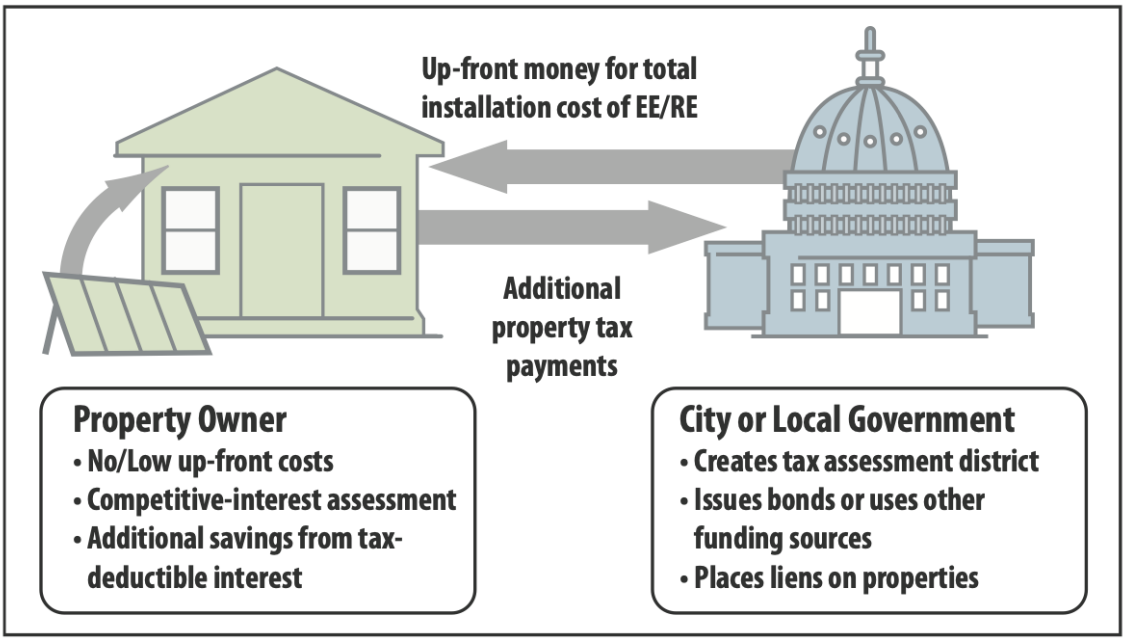


**Figure 19:** below explain the Basics of PACE financing. *(Speer & Koenig, 2010)*

### 4.3.2 PACE Types

1- R-PACE: Through residential PACE, homeowners can use private capital sources to finance energy-efficient, renewable energy, and other qualified home improvements. State laws are usually used to enable PACE programs, and local governments also authorize them. Municipalities can manage residential PACE programs either directly or through partnerships between one or more PACE providers and the public sector.

2-C-PACE: State law authorizes Commercial PACE, a voluntary tool for financing energy efficiency, renewable energy, and resilience upgrades in commercial buildings; additional authorization from local governments is required. C-PACE is implemented by state

and local governments in an effort to combat climate change, create jobs, and promote economic development. (Commercial Property Assessed Clean Energy Toolkit, 2018)

### 4.3.3 History of PACE in the USA

PACE was initially suggested as "On Tax-Bill Financing" in the Association of Monterey Bay Area Governments (AMBAG) 2006 Regional Energy Plan. The Palm Desert, California "Energy Independence Program" (PDEIP), formally approved on August 28, 2008, was the first PACE program to be implemented in the United States fully. Sonoma County, California, adopted the Sonoma County Energy Independence Program (SCEIP) in January 2009, and it started operating in March of the same year. August 2009 saw the implementation of the Yucaipa Energy Independence Program (YEIP) in Yucaipa, California. Five of the seven cities with running programs by 2010 were in California. (Kirkpatrick & Bennear, 2014)

### 4.3.4 PACE Distribution in US States

38 states and Washington, D.C. currently have PACE-enabling legislation in effect, and 30 states and Washington, D.C. currently have PACE programs launched and running. At the moment, California, Florida, and Missouri offer residential PACE. (PACE Programs,2019) Figure19 explain the distribution of PACE programs in US states:

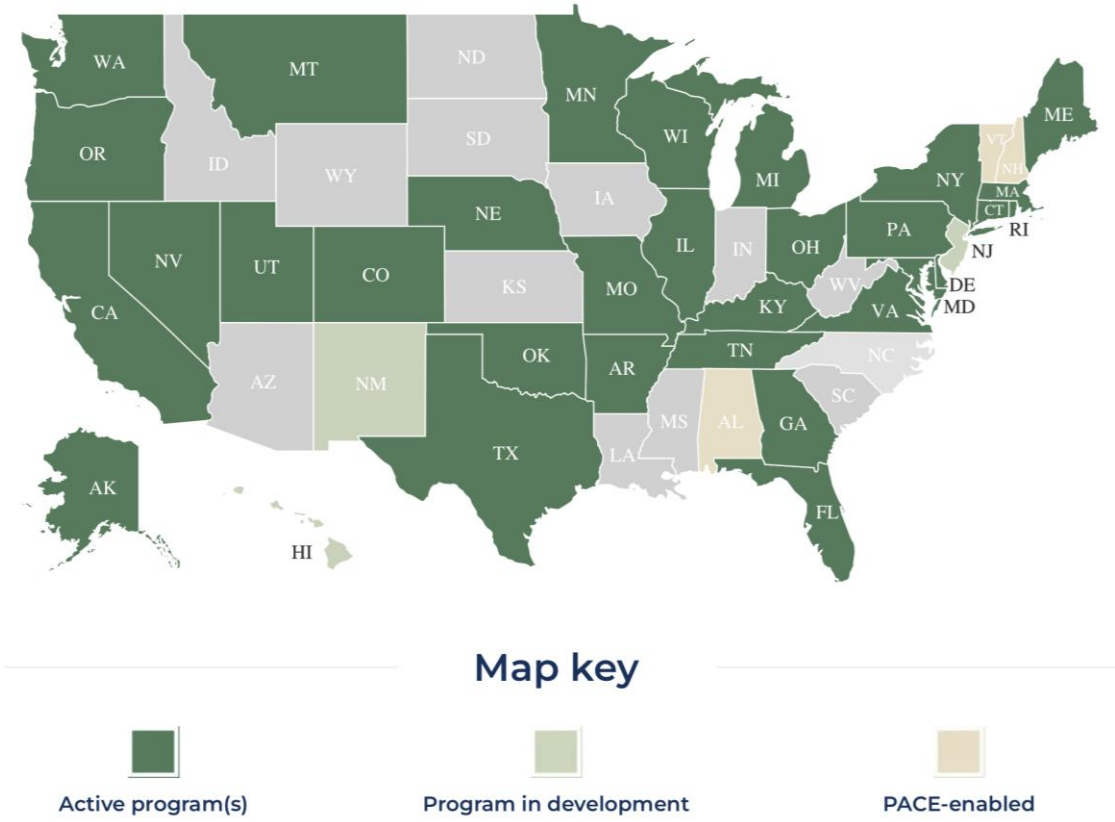


**Figure 20:** The distribution of PACE programs in US states. (*PACE Programs,2019)*

**Proponents & Opponents:**

PACE proponents contend that facilitating investments by businesses or homes in efficiency or clean energy generation projects will reduce reliance on non-renewable energy sources and maintain a more significant share of energy expenditures within the local economy. PACE program opponents highlight the financial risk that PACE programs impose on mortgages. Since a PACE loan is secondary to a mortgage, the holder may only be entitled to a smaller portion of the mortgage's value in the event of a default. In California, the upper-

bound loss for a mortgage holder facing foreclosure and the average installation cost are roughly $37,899 and $37,899. (Kirkpatrick & Bennear, 2014)

### 4.3.5 Benefits

There are direct benefits to PACE funding, such as less energy and water use, less pollution from these uses, and less vulnerability to hazards. However, the financing also has direct and indirect economic effects. These advantages are more complicated than those found in simple economic effect studies of normal economic stimuli like a new factory or mine opening. These kinds of incentives, along with PACE financing, all directly affect the site and multiplier or broader general equilibrium effects on the economy as a whole. However, many traditional stimuli only produce goods to be exported and have little impact on the economy that hosts them beyond a few supply chain effects like wage/salary income rises and spending. On the other hand, PACE improvements lower the cost of energy and water, making people spend more on things and helping businesses make extra money.

On the other hand, the price changes for conventional energy and centralized water services are caused by the efficiency gains that lower their production. Making changes to reduce hazards keeps people from using their savings to fix damaged buildings and compensate for lost business. (Rose & Wei, 2020)

The direct benefits of PACE financing are including: Less use of natural gas and electricity; More energy coming from renewable sources; Less greenhouse gas emissions; Less water being used; and Less likely to be damaged by earthquakes.

We measure these benefits in actual units and dollar amounts when possible. In general, they make the economy more efficient by eliminating useless ways of using water and energy and lowering the cost to society of "externalities" like pollution. Along with the "efficiency-improvement" benefits of PACE funding, the community is more equitable because the PACE Program is open to all small businesses and property owners, regardless of their income. (Rose & Wei, 2020)

In addition, the “co-benefits” of PACE financing are: Growth in GDP, employment, personal income, and company sales revenue; A rise in tax receipts for all governmental levels; Diminished property damage; and Relocation expenses after a tragedy are reduced. Table 6 below summarize the advantages and disadvantages of PACE:

**Table 6:** Advantages & disadvantages of PACE *(PACE Programs,2019)*

| Advantages | Disadvantages |
|---|---|
| Allows for secure financing of comprehensive projects over a longer term that enhances paybacks | Legal and administrative expenses to set up |
| Repayment obligation passes with ownership, overcoming hesitancy to invest in longer payback measures | May not be appropriate for small towns and cities as scale is required to reduce costs |
| Taps into private capital, such as the municipal bond market | Mortgage holder approval required |
| Allows governments to encourage energy efficiency and renewable energy without putting their general funds at risk | |

### 4.3.6 Studies about PACE Implementation

- Study 1:

Research conducted by Ygrene Energy Fund, Inc., one of the top companies in the industry, analyzes the regional economic impact of PACE financing. Ygrene has given more than $1.16 billion to finance over 54,500 property improvement projects in over 500 towns and counties in California, Florida, and Missouri from 2013 to the end of July 2018. It has been projected what these financing projects will ultimately do to the economy of California, one of the leading states where Ygrene conducts business. The leading macroeconomic indices of employment, personal income, GDP, and gross output (sales revenue) were emphasized. The estimation approach considers direct and indirect effects that spread across the economy's supply networks. Economic Consequence Analysis (ECA) is the method that applies most of the Benefit-Cost Analysis (BCA) concepts at the multi-market level. However, ECA focuses on macroeconomic indicators instead of emphasizing the usual welfare (human "well-being") assessments. (Rose & Wei, 2020)

Ygrene financed 31,867 residential and 646 commercial buildings in California between its founding in 2013 and July 2018. The distribution of the $0.76 billion contract dollars among the different Californian improvement categories is seen in table 8. It includes nine improvements from 2013 to mid-2018, eight of which have to do with lowering water or greenhouse gas emissions. Note that installations of renewable energy and energy efficiency improvements account for more than 92% of PACE funding. (Rose & Wei, 2020)

**Table 7:** Improvement category financing for Ygrene PACE in California (in thousands of 2015). *(Rose & Wei, 2020)*

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Total |
|---|---|---|---|---|---|---|---|
| Building Envelope Energy Efficiency | $259 | $2,782 | $18,718 | $57,171 | $68,486 | $22,405 | $169,821 |
| Solar | $802 | $7,904 | $40,024 | $151,942 | $77,342 | $25,537 | $303,552 |
| Energy-Efficient Windows and Doors | $104 | $1,322 | $10,357 | $32,767 | $35,132 | $9,420 | $89,102 |
| HVAC Efficiency | $180 | $2,437 | $26,083 | $55,680 | $32,828 | $9,919 | $127,126 |
| Water Conservation | $36 | $533 | $4,393 | $17,170 | $25,276 | $9,505 | $56,913 |
| Lighting Efficiency | $5 | $75 | $631 | $2,263 | $4,576 | $1,208 | $8,758 |
| High-Efficiency Water Heating | $0 | $0 | $0 | $171 | $1,934 | $709 | $2,814 |
| Earthquake Mitigation | $0 | $0 | $0 | $0 | $387 | $975 | $1,362 |
| High-Efficiency Pool Equipment | $0 | $0 | $0 | $30 | $338 | $132 | $500 |
| **Total** | **$1,386** | **$15,051** | **$100,207** | **$317,193** | **$246,300** | **$79,810** | **$759,947** |

Two significant studies have been conducted regarding the degree to which PACE financing has aided in the uptake of solar energy. In 2014, Kirkpatrick and Bennear conducted an econometric analysis and discovered that PACE financing led to a 108% rise in rooftop solar technology adoption in California. However, Deason and Murphy (2018) concluded that the state's impact was just 7%–12% of this kind. The broader economic effects of PACE financing have only been the subject of one research so far, and that one was carried out relatively early in the PACE Program's existence. An input-output (I-O) model was employed by ECONorthwest (2011), which was a far more straightforward modelling technique than the macro-econometric model used in the earlier study. The study, which looked at the possible economic effects of PACE financing in four U.S. cities, concluded that $10 million more in regional sales revenue would be generated by $4 million in program financing. The differing findings between the two research are most likely the result of I-O modelling's shortcomings, particularly its constrictive linearity. (Rose & Wei, 2020)

- Study 2:

This paper aims to determine how the FHFA decision affected things by determining how the PACE financing programs affected home photovoltaic solar installations. From the California Solar Initiative public database, socio-economic data from the American Community Survey (ACS) 3-year datasets for 2005–2010 and the 2010 U.S. Census, data on solar potential from the National Renewable Energy Laboratory, and data on which party representatives belong to from California GIS shapefiles, a city-level panel of data was made. This panel at the city level looks at how much solar energy has grown in three California PACE programs: Palm Desert, Yucaipa, and Sonoma County. It measures the increase in watts per owner-occupied home. The difference-in-differences and synthetic counterfactual methods were used to figure out the cause-effect. The study found that PACE financing boosts solar energy installations by about 3.8 W per owner-occupied house. It is 108% more than California's average watts per owner-occupied house. (Kirkpatrick & Bennear, 2014)

Using a differences-in-differences approach and a synthetic alternative method, the study looks at the cause-and-effect relationship of PACE financing in three cities and counties in California. Using both directions, they discover that PACE funding makes residential photovoltaic solar energy systems 108% more common, adding an extra 3.8 W per owner-occupied home on average. The FHSA ended the PACE programs in the study after only one or two years, so it could be more apparent if these average effects would last for more extended amounts of time. (Kirkpatrick & Bennear, 2014)

## 4.4 Mechanism 3: Green Bonds

Definition & purpose: mentioned earlier in literature review Green bonds and the rise of the green bond and other "labelled bonds" markets (such as sustainability and social bonds) have been among the most important financial innovations in sustainable finance over the past ten years. Most green bonds are set up the same way as regular investment-grade bonds. The only difference is that they have a "use of proceeds" clause that says the money will be used for green projects. Whereas "vanilla" bonds support the issuer's average operating capital, green bonds are only intended for financing or refinancing environmentally friendly projects or assets. However, when someone buys a green bond, they usually have access to the issuer's whole balance sheet. It means that the investor is not directly subject to the financial risks of the projects that the green bond funds. Green bonds are a big deal because they are a new way for large investors like pension funds, insurance companies, mutual funds, and sovereign wealth funds to invest in a good way for the environment. For instance, green bonds are sometimes praised as a new idea to help institutional investors spend more on sustainable infrastructure by making infrastructure assets more liquid. A new study of green bonds issued between 2013 and 2017 shows that, on average, the yields on green bonds are two basis points (bps) less than those on similar conventional bonds. One common reason for this difference in outcome is that green bonds are in high demand but unavailable. (Maltais & Nykvist, 2020)

### 4.4.1 Green Bonds Types

1- Green Use of Proceeds Bond

The most popular kind of bond ties the proceeds directly to approved green projects. The issuer pledges to finance or refinance these projects only with the money raised.

2- Green Revenue Bond

The proceeds of a green revenue bond are dependent upon the income produced by a particular project or collection of related projects. Returns to investors are contingent upon the project's success and revenue generation.

3- Green Project Bond

A single green project is the subject of a green project bond, the proceeds of which are allotted to the project itself. The success of the project directly affects the returns to the investors.

4- Green Securitized Bond

Green assets or projects, like energy-efficient structures or renewable energy installations, are combined to create green securitized bonds. The bond is secured by the pooled assets, and bondholders are paid from the cash flows produced by the assets. (Tamplin, 2023)

### 4.4.2 An Overview of Global Green Bond's History

In 2007, the European Investment Bank (EIB) released a EUR600 million "Climate Awareness Bond." It was the first green bond. A Swedish financial institution, SEB, assisted

the World Bank in issuing the first green bond in 2008. From 2008 until 2012, when the first business green bonds came out, multilateral development banks (MDBs) were the only ones that issued green bonds. The green bond market expanded rapidly after introducing both supply and demand from businesses. By December 2020, the global green bond market had hit a significant milestone: it had issued more than $1 trillion in bonds. However, it is essential to note that the market for green bonds worldwide is relatively small, even with this impressive increase. As of August 2020, the total value of all bonds outstanding in the global bond market was $128.3 trillion.

Vasakronan, a Swedish real estate company, launched the world's first corporate green bond in November 2013. The SEK 1.3 billion bond's proceeds were used to pay for upgrades to current buildings and the construction of new buildings that meet LEED Gold or higher standards. The next day, the French energy company EDF entered the market with its own EUR 1.4 billion green bond offering. The money from this sale will only be used to fund future renewable energy projects. Then, by the end of the month, with a USD 500 million green bond, American financial firm Bank of America Merrill Lynch forayed into the market. The sale would fund projects that save energy and use renewable energy. When corporations started issuing green bonds, the world market for these bonds entered a new growth phase. By the end of 2013, outstanding green bonds stood at approximately $15 billion. Figure 20 show the expansion of the green bond market. (The Ministry of Climate change and Enviroment,2022)

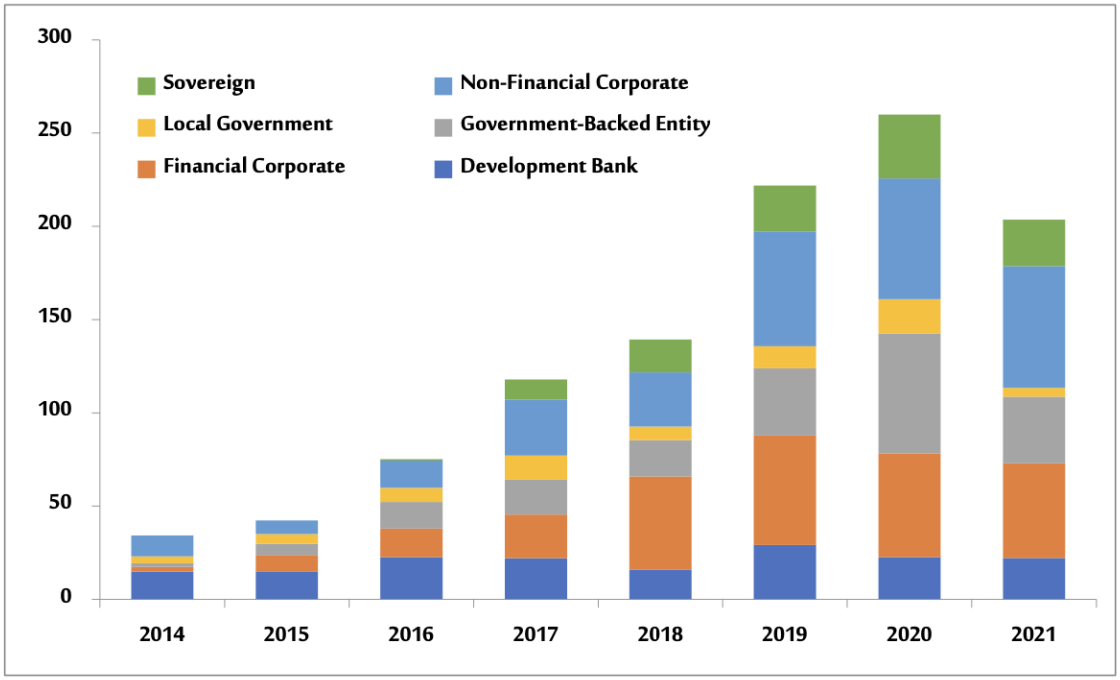


**Figure 21:** According to CBI, the issuance of green bonds by issuer kind (USD, billions) *(The Ministry of Climate change and Enviroment,2022)*

Because the green bond market need standard to follow, the green bond principles and certificate appears.

### 4.4.3 Green Bond Principles

The International Capital Market Association (ICMA) released the Green Bond Principles (GBPs) in January 2014. These guidelines made it easier for more companies to issue green bonds. ICMA is an international, non-profit group whose members work in the debt securities markets and help the group with its work on problems of regulation and market practice. ICMA put together a group of issuers, investors, and middlemen in the green bond market to write the first edition of the GBP. The goal was to give the market a set of voluntary

rules on how to issue green bonds. The GBP made it easier for investors to see how different green bonds were being evaluated and for possible issuers to understand the requirements and the whole process. (The Ministry of Climate change and Enviroment,2022)

### 4.4.4 The CBS Certification for Green Bonds

In December 2010, the Climate Bonds Initiative (CBI) started the CBS as a voluntary program. The CBI is an international non-profit organization aiming to increase investments leading to a low-carbon and climate-resilient global economy by giving investors, businesses, and the government information on green financial market intelligence. The CBS sets clear, sector-specific criteria for assets and projects that can be used for green bonds. Institutions making their green bond standards often use the CBS as a guide. It has been confirmed that $190 billion worth of debt from 387 issues as of October 2021.

### 4.4.5 Green Bond Benefits

Benefits for investors can include:

- Offer comparable financial returns along with environmental and social benefits;
- Meet ESG standards for sustainable investment mandates;
- Help with national climate adaptation, food security, public health, energy supply, and other issues;

- Allow direct investment in "greening" brown sectors and social impact activities;
- Make the use and management of proceeds more precise and accountable, adding another layer of risk management.

Benefits for Issuers can include:

- Give investors a more comprehensive range of options;
- Improve the issuer's name;
- Give investors another way to get long-term funds;
- Get everyone on the same page about how long instruments last and how long the project lasts;
- Involving many investors can lead to high oversubscription and price advantages (it has happened with some issues).

### 4.4.6 The Background of Green Sukuk

The ideas behind Islamic finance are very similar to those behind sustainable investment, so the green Islamic finance market is naturally set to grow. Shari'a law says that the money from a sukuk must be invested in specific assets or projects. Because of this, the rules for managing and keeping an eye on a green sukuk would already be in place if the money was used for planned sustainable investments.

The ASEAN region has had the most market growth, with Malaysia and Indonesia leading the way. As of 2019, green sukuk comprised 23% of green financing in the ASEAN area. The Securities Commission Malaysia created the Sustainable and Responsible Investment (SRI) Sukuk framework in 2014 to help the growth of green Islamic financing. By 2017, a Malaysian renewable energy group had issued the world's first green sukuk, with the money from it to build a 50MW large-scale solar project.

In February 2018, the Republic of Indonesia issued the world's first sovereign green sukuk. To this day, Indonesia is still the only sovereign green issuer in the ASEAN region. The $1.25 billion sukuk was used to fund projects in five main areas: renewable energy, waste-to-energy and waste management, energy efficiency, and climate change resilience. After its first issue's success, Indonesia returned to the market in February 2019 to buy another $750 million in green sukuk. The money from the two Sukuk has been used to cut CO2 pollution by a total of 8.9 million tons

The Islamic Development Bank (IsDB) saw the possibility of green Islamic financing worldwide and created the Sustainable Finance Framework. In November 2019, it issued its first green sukuk. It was the first AAA-rated green sukuk in the world, and it raised €1 billion. After that, in June 2020, IsDB released the first sustainability sukuk in the world, which raised $1.5 billion to help its Member countries respond to COVID-19.

**Sovereign Green Bond Issuances**

To be ready to issue a sovereign green bond, a country must already have a list of green spending projects that will be paid for with the bond's profits. In line with national planning strategies, the applicable sectors should be chosen based on the country's environmental priorities and current ability to meet those goals. (The Ministry of Climate change and Enviroment,2022)

France and the Netherlands are two countries that have issued sovereign green bonds that stand out. France gave the world's most significant sovereign green bond, and the Netherlands gave the world's first AAA-rated sovereign green bond. The figures 20&21 below shows how the money was spent, based on their allocation reports for 2019.

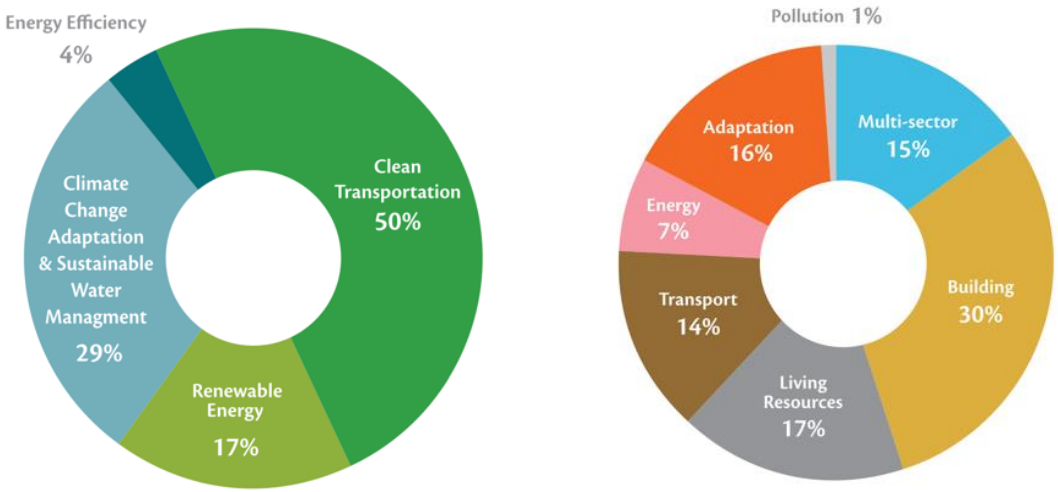


**Figure 22:** Actual use of proceeds in France (left) Netherland (right) *(The Climate change and Enviroment,2022)*

For example, in France, energy retrofits were chosen as one of the four main areas of the country's National Low-Carbon Strategy. To help with this priority, the building sector got

the most money from the green bond, and €1.4 billion was used as tax credits to help 930,000 households make energy-saving changes to their primary homes. At the same time, a big chunk of the money from the Netherlands' green bond was used to keep the country's train system running on 100% clean energy. The improvements were thought to have saved 0.18 Mton of carbon emissions each year in 2018 and 2019.

**Study in Sweden:**

Even though green bonds have grown significantly, there has yet to be much scholarly research done on the topic. Among the first scholarly empirical investigations using interview data, this paper examines the function of green bonds as a tool for "greening" the financial sector to achieve greener economies more broadly. Sweden has been chosen as a case study due to its widespread recognition as a leader in the green bond market and sustainable financing. Ten per cent of all SEK bonds were green bonds in 2018. The figure 23 illustrates how the Swedish green bond market has expanded rapidly since 2013. (Maltais & Nykvist, 2020)

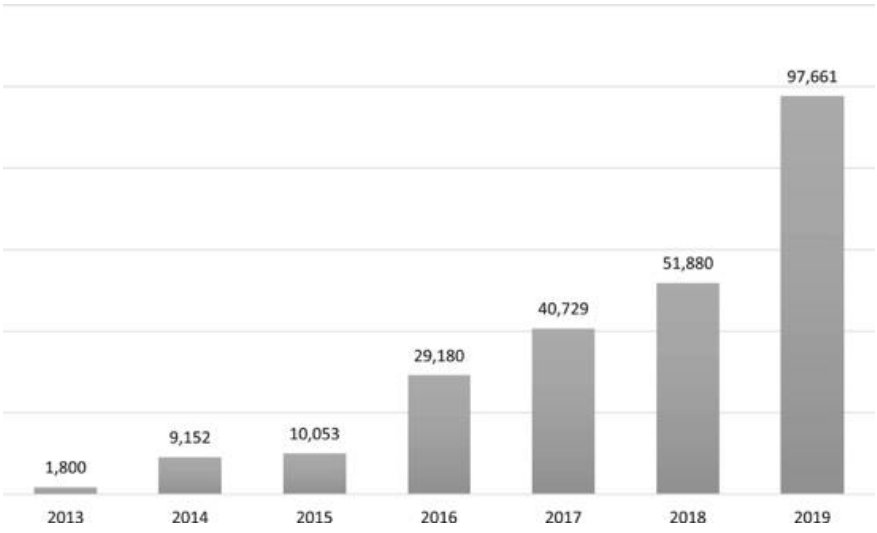


**Figure 23:** Sweden issues green bonds (million SEK). *(Maltais & Nykvist, 2020)*

Sweden presents a compelling case because it is a recognized leader in the green bond market. The proportion of green bond issuance to total issuance is shifting the asset class from exclusive to the mainstream. As a result, Sweden's green bond market is relatively developed. By examining the advantages and restrictions of Swedish green bonds, one can gain insight into the potential use of green bonds in other countries where labelled bond markets are still developing. (Maltais & Nykvist, 2020)

**Results of the study:**

Incentives to invest in green bonds

According to all research participants, the most apparent benefit of purchasing green bonds is the ability to finance specific environmentally friendly initiatives or assets that have undergone independent verification as ecologically friendly without assuming appreciably

more risk. Respondents emphasized how simple it is to invest in green bonds and how simple it is to explain to clients and stakeholders how their money supports sustainability when there is a clear purpose for the proceeds. Because of this, green bonds are a powerful signalling tool and an excellent place to start for green investing.

Green bonds are a means for businesses to draw in clients, and investors frequently cite rising client demand for specific sustainable investment instruments or for the chance to see how the company is advancing sustainability.

Respondents generally agreed that the high demand for green investments was why the yields on green bonds were slightly lower than those on comparable bonds. Crucially, every one of the investor respondents has a clearly defined sustainability agenda in place at their companies. The respondents repeatedly mentioned improved conversations on sustainability with issuers and within the organization as another significant advantage. The respondents also stated that green bonds aided the organization's ongoing integration of a sustainability viewpoint. Nonetheless, investors reached a consensus that the last five years have seen notable growth in the financial sector's involvement with sustainability and that largest economic actors in Sweden are enhancing their sustainable finance profiles.

These answers imply that there might be institutional and legitimacy-seeking incentives for investing, as does the evidence above showing that investors are somewhat ready to accept lower profits in exchange for purchasing green bonds. (Maltais & Nykvist, 2020)

**Incentives to issue green bonds**

The issuer respondents indicated that addressing investor demand for sustainable investment products, expanding the investor base, and lowering capital costs were the three main reasons for issuing green bonds.

**Conclusion of the study**

This research showed that in Sweden, the main reasons people are interested in the green bond market are business-case reasons, not financial ones. There are some clear economic benefits, especially for issuers who point out that the cost of capital is decreasing, and they can get money more efficiently. Caring about the environment has become the norm in the Swedish financial sector. There is substantial proof that people are interested in the green bond market for reasons like seeking legitimacy, protecting their interests, and following the rules. It is shown by investors being ready to take lower returns on green bonds than on similar non-labelled bonds. Issuers are prepared to do the extra work needed to issue green bonds because they have these kinds of incentives, even though they have easy access to capital.

The study found that the green bond market has grown from the bottom up. This is because issuers and buyers have strong incentives to work together. The people who answered do not think that green bonds play a significant role in moving money from investments that are not sustainable to assets that are. On the other hand, people believe that green bonds give

lenders a reason to make projects and their organizations more "green." (Maltais & Nykvist, 2020)

### 4.4.7 Green Bond and Sukuk in the UAE

At the end of exploring Green Bonds globally, it’s important to mention that there have been no public green bonds or sukuk in the UAE since the Ministry of Climate Change & Environment's report in 2022.

The Financial Services Authority of Dubai (DFSA) declared its Green Bond Best Practice Guidelines in August 2018 as a market brief. These guidelines explain how the DFSA plans to list green bonds to issuers and market professionals as a preparation step to issue public green bonds in the future.

#### *4.4.7.1 Green Bond and Sukuk in the Private Sector*

Regarding private issuers, the UAE has achieved several crucial green bond space achievements.

In March 2017, First Abu Dhabi Bank (FAB) put out a $587 million green bond, the first in the MENA area. It has since become a frequent issuer, using several other green private sales to return to the market. As of March 2020, FAB had chosen nine projects in the UAE that use sustainable energy and save energy to receive green bonds. These include four solar plant projects, two green building projects, and three district cooling projects. FAB issued a CHF 260 million bond in January 2021. It was the first green bond issued by a MENA

company and the most significant green bond ever issued in Swiss Francs (CHF). A second green bond in CHF worth 200 million was published in November 2021. It was issued on the same day as a USD 30 million green bond. (FAB,2022) Figure 23 below explain the distribution of proceeds from green finance projects as of March 31, 2022.

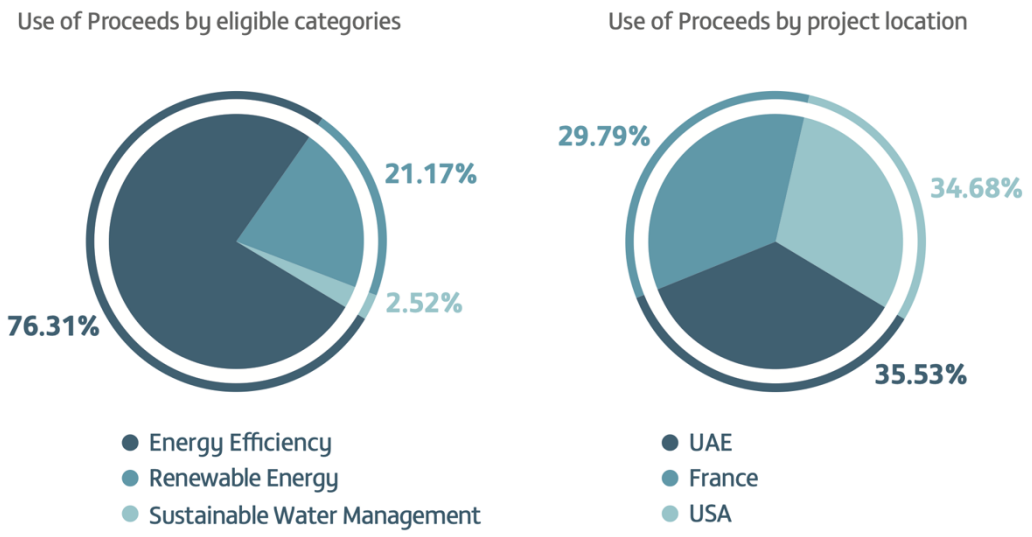


**Figure 24:** Distribution of FAB proceeds from green finance projects as of March 31, 2022 *(FAB.2022)*

Majid Al Futtaim raised $600 million by launching its first green sukuk in May 2019. It was the first green sukuk issued by a company in the MENA area and the world's first benchmark corporate green sukuk. In October 2019, a follow-up green bond for an extra $600 million was released. The money from both bonds has been fully put toward projects that help the green building industry as of 2020. (Majidalfuttaim,2019)

#### *4.4.7.2 Barriers to the UAE's Sukuk and Green Bond Market Development*

Since the UAE's green bond and sukuk markets are still in their infancy, it is critical to recognize and resolve any obstacles that may arise. Some of these challenges, per a study conducted by the Ministry of Climate Change and Environment (MOCCAE), include the following:

• Absence of guidelines for the green bond issuance procedure

There is a common misconception that issuing green bonds is more expensive because of a lack of knowledge about the standards. Global best practice guidelines—like the Green Bond Principles—can serve as a reference point for elucidating the overall methodology involved in issuing green bonds.

• Inadequate standards for determining which green projects qualify

Reviewing investments can be significantly aided, and a more comprehensive range of investors can be made possible by providing generally acknowledged norms and criteria for what qualifies as a green activity.

• Insufficiently established sustainability metrics

One of the main obstacles to the growth of the green bond and sukuk market is the absence of a unified framework for green bond issuance and taxonomy with standardized definitions and procedures, as noted by nearly all of the financial experts consulted during the preparation of the market analysis by MOCCAE. The development of this asset class will be

accelerated by the improvement of standardization and comparability of green bonds and sukuk that results from having a national taxonomy, particularly one that is in line with international principles.

The establishment of a government-backed green bond grant program in the United Arab Emirates, similar to those that have been successfully implemented in several other nations, may serve to lessen this obstacle and stimulate the local green bond market. Most nations issue sovereign green bonds primarily to promote the expansion of their local green bond markets and raise capital. (The Climate Change and Enviroment,2022)

## 4.5 Validation of the Mechanisms

The interview technique is the second step in investigating the three strategies to get through obstacles to NZEBs in the UAE. The interview is utilized to investigate the verification of the three mechanisms' implementation in the UAE. The interviews hold great significance as we continue our exploration because they may reveal innovative concepts, industry best practices, and workable solutions that can propel Green Bonds, PACE, and EPCs forward and gain widespread traction in the UAE.

By speaking with professionals and practitioners, we hope to get their insights on the difficulties encountered, the lessons discovered, and the ground-breaking projects that are reshaping the financial instruments for energy efficiency in UAE society.

Semi-structured interviews will be used in this study because they enable the interviewer to follow up with more questions if a fresh or intriguing line of inquiry emerges during the session.

The interview procedure is initiated by putting together a thorough set of inquiries covering a wide range of subjects, including the NZEBs concept's familiarity, the availability of three mechanisms, the availability of green technological innovations, difficulties encountered, and upcoming trends. Make sure the questions are suited to the experience and qualifications of each interviewee. Appendix 2 contains the complete set of interview questions used in the research.

The process of identifying interview subjects is the first stage of data collection. The development of a comprehensive sampling strategy is necessary to guarantee well-informed coverage of the target population. (Newing, 2010). To make sure the interview questions are clear and pertinent, we conduct a pilot interview with a colleague.

Applying for the ethical clearance is the next step, as stated by Silverman (2005). As a result, the names and titles of the experts will not be disclosed in the paper in order to protect participant privacy and prevent misrepresentation.

For this paper, twelve interviewees have been selected to speak for their organizations or themselves; the list of interviewees is shown in the table below:

**Table 8:** Interviews' participants *(By Author)*

| Category | Interviewee | Statues | No. |
|---|---|---|---|
| **intergovernmental** | IRENA | Done | 1 |
| **Government** | The Ministry of Climate change and Environment | Done | 2 |
| | The Ministry of Energy and Infrastructure | Done | 3 |
| | Dubai Electricity & Water Authority (DEWA) Utility company | Done | 4 |
| | Abu Dhabi Municipality | Done | 5 |
| **Developer** | Binghatti Holding Limited | Done | 6 |
| | Majid Al Futtaim Group | No Response | 7 |
| | Emaar Properties | No Response | 8 |
| **Owner** | Business man | Done | 9 |
| | Home owner | Done | 10 |
| **Banks** | First Abu Dhabi Bank | No Response | 11 |
| | Abu Dhabi Islamic Banks | No Response | 12 |

Owing to regrettable circumstances, four of the alleged interviewees did not repeatedly respond, bringing the total number of interviewees to eight. The participants were able to choose a convenient time for the interviews. The eighth interview was completed at various times. The preferred method of communication was via Zoom meeting as the most practical option. Every interview lasted between thirty and sixty minutes. The goal of the study and the intended use of the data were explained to each interviewee during the meeting, and all sessions are recorded to ensure accurate data transcription as well.

# Chapter 5: Results & Discussion

## 5.1 Introduction

According to Wong et al. (2013), the **semi-systemic review** is the best literature review for our research because it recognizes and understands every pertinent research tradition that could impact the studied subject. Our research aims to validate the three barriers' mechanisms for implementing NZEBs in the UAE. Additionally, the results will be analyzed and synthesized using the **Thematic technique**, which is a means of locating, examining, and summarizing patterns in the form of themes within a text, as described by Braun & Clarke (2006).

Analyzing the literature review using the thematic technique

First step: The themes:

**Energy Performance Certificates (EPCs), Property Assessed Clean Energy (PACE), and Green Bonds** are the three suggested ways to get beyond the obstacles in establishing NZEBs in the UAE. These three concepts will be considered as the three themes of the literature research as they are the dominant concepts in the context.

Second step: The categories:

Elveen categories will be created for each theme, as shown in the table below.

| No. | Category |
|---|---|
| 1- | Definition |
| 2- | History of the mechanism |
| 3- | Types |
| 4- | Application mechanism |
| 5- | The target of the instrument |
| 6- | Successful experience |
| 7- | Advantages of the instrument |
| 8- | Gaps |
| 9- | Factors that affect the application. |
| 10- | Adjustment |
| 11- | The availability in UAE |

The three mechanisms (Themes) have been compared concerning the eleven categories. The table explains the detailed comparison data that was extracted from the literature review is available in Appendix1.

The literature review of the three mechanisms was showed that EPCs worked well in E.U. member states, while PACE made significant progress in the USA. Green bonds are slowly making their way around the world's markets, and, started in the private sector in the UAE. Each of the three financing instruments has its advantages and disadvantages.

We looked at how well the three mechanisms could get around the economic and social problems that make it hard to adopt NZEBs in the UAE through a literature review. The Energy Performance Certificate (EPC) seems more straightforward to set up than PACE because it is a type of building approval that includes description about the home's energy use and general information about it, as well as suggestions for making it more energy efficient. Though the idea seems good, some issues are stopping adoption from moving forward quickly in some countries such as the inaccuracy. Nevertheless, the analysis table shows that the EPCS has positively affected the decisions of residents and renters and the negotiations of building prices in other countries. So, because EPCs are easy to use, come in updated versions, and are not too expensive to adopt (the cost of the energy assessment plus the extra cost of advertising for sale when energy label information is added plus the cost of the expert assessors for new buildings), they could be employed easily in the UAE.

Through Property Assessed Clean Energy (PACE), the property owner can get a loan and pay it back with their property tax. It is a complicated plan and a solid mechanism at the same time. The way that PACE applications work rests on property tax assessments being available outside the UAE community. PACE aims to make it easier and more appealing for people to invest in clean energy. In UAE society to reach this goal, the property owners must be aware of it (Sociocultural obstacles), and how much support, readiness, and participation it got from the local government. In addition, which type of PACE (R-PACE or C-PACE) will choose to apply due to the regulation’ availability in the federal and local government in UAE.

Green Bonds slowly made their way into the private sector in the UAE. As the country moves toward full cooperation with the private sector, as outlined in many of the regulations in the literature review chapter of the research, it is only a matter of time before the strategy takes over sustainable projects and NZEBs infrastructure.

People usually think it costs more to issue a green bond than a regular one. However, studies in E.U. countries showed that issuers and investors would instead invest in green bond-financed sustainable projects than non-ecofriendly ones, which shows that people are very aware of this issue.

To sum-up, the literature review indicates that EPCs and PACE has a good potential to implement in UAE if the suitable circumstances and regulations were prepared appropriately, and their drawbacks took into consideration. Moreover, Green Bond has the potential to grow. The validity of these data will depend on how the interviews went.

## 5.2Analyzing the Interview using the Nvivo Program

### Thematic Analysis

Interview transcripts were analyzed using the Nvivo program. To conduct the qualitative analysis in NVivo a thematic approach was followed by selecting sentences and paragraphs of the answers from the participants. We’ve suggested themes and coded those themes appropriately to align with the requirements. There are several subcodes that were

created and linked to relevant content of the interviewee's answers. The following figure is presenting parent codebook from our NVivo analysis:

**Table 9:** Coding flow *(By Author)*

Coding of All files

| Name | Files | Reference |
|---|---|---|
| Availability of Green Strategic Programs | 7 | 17 |
| Awareness of Energy Performance Certificates | 8 | 84 |
| Background of the organization of the interviewees | 8 | 11 |
| Beliefs about Financial Instruments Leading to Sustainable Investme | 8 | 37 |
| Beliefs about Long-term Effectiveness of Sustainability Programs | 8 | 39 |
| Beliefs about PACE Role in Energy Efficiency | 8 | 19 |
| Eco-Friendly Initiatives | 8 | 22 |
| Initiatives to Address Initial Costs and Economic Barriers | 7 | 17 |
| Level of familiarity with the concept of Net-Zero Energy Buildings | 8 | 23 |
| Organization's Participation in Green Bonds | 7 | 7 |
| Strategies to Overcome Economic Barriers | 8 | 18 |
| Sustainable Infrastructure | 8 | 35 |

The following charts generated from the analysis of interviews using NVivo illustrate the key themes and concepts that emerged from the discussions. The most prominent themes, as shown by the larger segments of the chart, are "Energy Efficiency Initiatives" and "Sustainability". This indicates that during the interviews, a considerable emphasis was placed on the importance and implementation of measures that enhance energy efficiency and sustainability.

Additionally, the sustainability includes different small segments of the chart, which are: "Sustainable Projects Portfolio", "Sustainable Infrastructure", "Sustainable Development Mechanisms", and "Sustainability Practices". Even the "eco-friendly initiatives" are another synonym used by the interviewees to describe the sustainability initiatives. Moreover, the green energy programs can be included in the sustainability or the energy efficiency.

"Implementation Challenges " occupies a significant portion of the chart, reflecting the respondents' recognition of the various challenges encountered when implementing energy efficiency solutions.

The Renewable Energy integration conquer a considerable segment of the chart, indicating interviewees’ acknowledgment of the role of employing renewable energy technologies to achieve sustainability and energy efficiency.

The "Financial Incentives" segment reveals that incentives were frequently discussed as key enablers for adopting renewable energy technologies and sustainable practices, pointing to their perceived importance in driving change.

The discussions appear to have encompassed a holistic view of sustainability, encompassing the practical aspects of adopting sustainable practices, the importance of developing supportive infrastructures, and the strategic approach of maintaining a diverse portfolio of sustainable projects.

In summary, the analysis indicates a rich and diverse dialogue on sustainability issues within the interviews, with a clear focus on the promotion of energy-efficient and Renewable

Energy initiatives alongside a recognition of the challenges and financial strategies necessary for successful implementation.

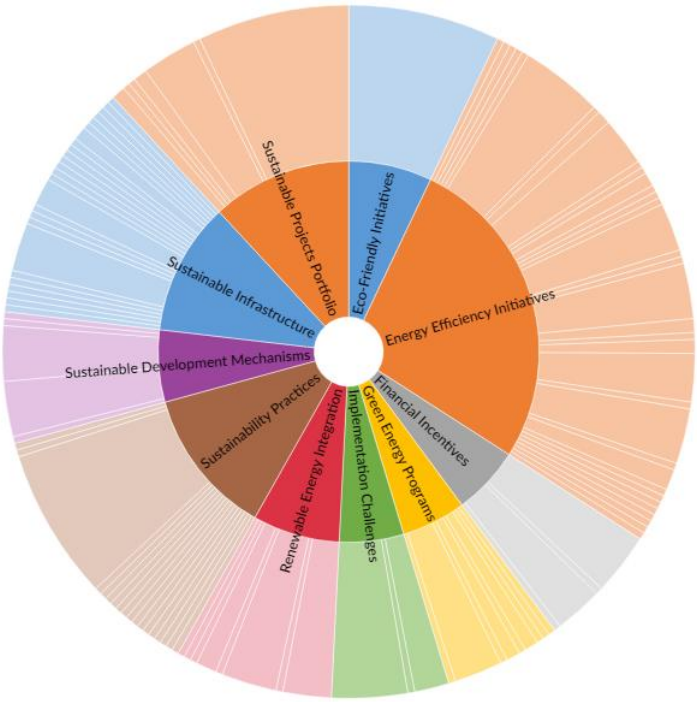


**Figure 25:** NVivo pie *(By Author)*

**Ratio of Items Coded**

This previous pie and following hierarchical chart show the proportionality of coded themes across interviews. The largest segment, Energy Efficiency Initiatives, shows that this was by far the most discussed topic of all interviews. This reflects a strong emphasis on measures to improve energy efficiency, which was clearly a top concern or interest for interviewees.  The “Sustainability” shows that green practices were also high on the agenda, demonstrating the interviewees’ commitment or interest in eco-friendly practices.

Other smaller but still significant segments, such as Financial Incentives and Energy Implementation Challenges, show that economic factors as well as practical barriers to adoption of energy efficiency initiatives were recurring themes across all interviews.

Other segments, such as Sustainability Development Mechanisms, Sustainability Practices, Sustainability Infrastructure, and Sustain Projects Portfolio, all take up smaller parts of the chart but demonstrate a holistic engagement with sustainability. Further, the chart shows a narrative that focuses on energy efficiency, green practices, and the challenges associated with implementing sustainable practices.

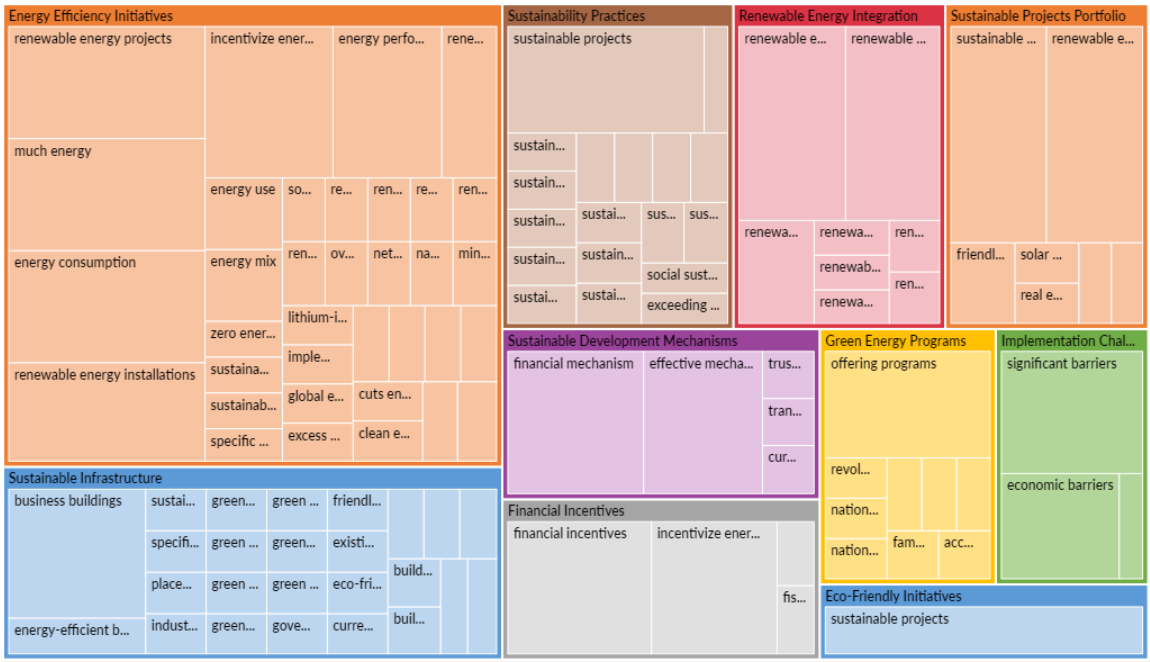


**Figure 26:** Combined word cloud *(By Author)*

The following combined word cloud illustrates the most prominent themes from research data, with the word "energy" being the most frequent, signifying its central

importance to the subject matter. Surrounding it are terms like "buildings," "efficiency," "sustainable," and "programs," which suggest a focus on energy efficiency in buildings and the implementation of sustainability programs. The relative size of each word indicates its frequency in the data; thus, terms like "property," "incentives," "assessment," and "green" also appear significant, though to a lesser extent than "energy." This visualization effectively covers the key topics of discussion, with an overarching emphasis on energy-related issues within the context of sustainability and efficiency in buildings and programs.

**Figure 27 :** Word cloud of theme *(By Author)*

**Cluster Analysis (with 5 clusters)**

This cluster analysis graph shows five different clusters of related topics in the data. The biggest cluster has terms like energy, green, sustainable, and efficiency, which are the prominent concept of the interviews' elaboration.

The next cluster has words like strategy, aims, national, and 2050, which seem to be focused the UAE zero energy 2050 strategic plan.

The third cluster has words like buildings, code, construction, and certificate, which means that the respondents' explanation are about the regulatory and compliance side of building sustainability.

The fourth cluster has tech, innovation, renewable energy, and solar, where the innovation technologies and renewable energy sources should be used to implement NZEBs are explained.

The fifth has words like finance, cost, barrier, and investment, which suggests they are talking about financial challenges and considerations when it comes to using sustainable energy solutions. All of these clusters together give a clear picture of the multi-faceted conversations around sustainability, strategy, and innovation in the data.

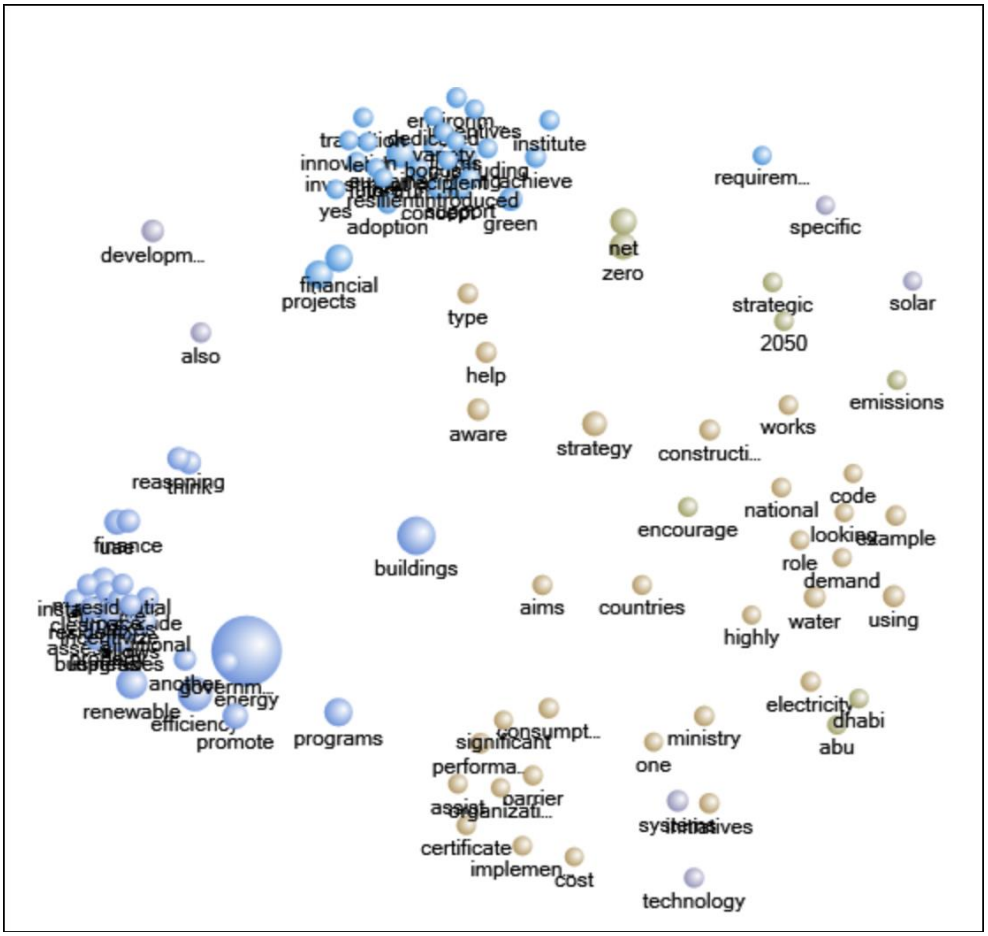


**Figure 28:** Cluster analysis *(By Author)*

**Comparison of Abu Dhabi and Climate Change Files Coded**

Figure 29 elaborate the following comparative thematic analysis is in the shape of an 'X' with both axes pointing in the same direction, which could mean there is a common theme between Abu Dhabi municipality and Ministry of Climate Change Files both sources. The lines represent themes or codes that have been found in both files. For example, energy efficiency upgrades, sustainable projects, renewable energy installations, and financial incentives are all themes that are relevant to both sources.

The focus areas in each interview are the themes that were most likely discussed or emphasized. These themes include financial incentives, green building standards, and energy efficiency upgrades. But the different branches leading from the main themes to the peripheral themes could represent the different points or details that were brought up in each interview. For example, Abu Dhabi Municipality might have talked about building licenses and clean energy, while the Climate Change Ministry might have talked about sustainability grading systems and eco-friendly initiatives. The strong connections show that each topic was discussed in connection with lots of other topics.

The importance of the themes and how close they are to each other could be a sign of the hierarchy or the importance of each topic. Bigger themes closer to the center could mean they are more dominant or often mentioned, while smaller, more peripheral themes could mean they are less emphasized.

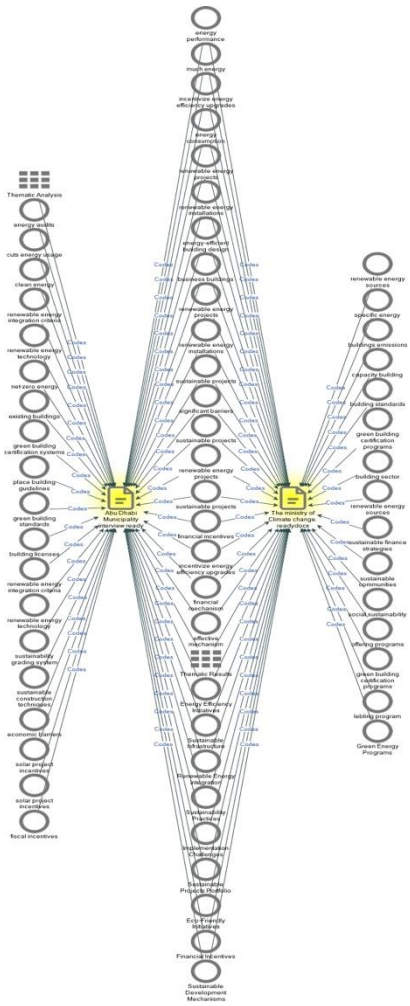


**Figure 29 :** Comparing files *(By Author)*

## Sustainability Practices and Eco-Friendly Initiatives

This graph shows a comparison of codes from different interviews that talk about sustainability practices, eco-friendly initiatives, and more. The interviews with government bodies, utility companies, real estate developers, businesspeople, and homeowners show that the sustainability occupied a broad range of the participants' organizations visions, programs, and future plans.

The interviews show that there is a wide range of organizations and people in UAE involved in sustainability and eco-friendly activities, not just those in one sector or one type of industry, which indicate the involvement of all sectors that participate in the interviews in sustainable projects or looking to reach that goal in the future. This means that there's a lot of engagement across society and the economy, and the findings could have an impact on policy. The interviews also include business and real estate, which implicates a real need in the private sector to implement or improve sustainability practices cooperatively with the public sector. Finally, the data shows that there's a system-wide approach to involve or promote sustainable projects in wide sectors in UAE.

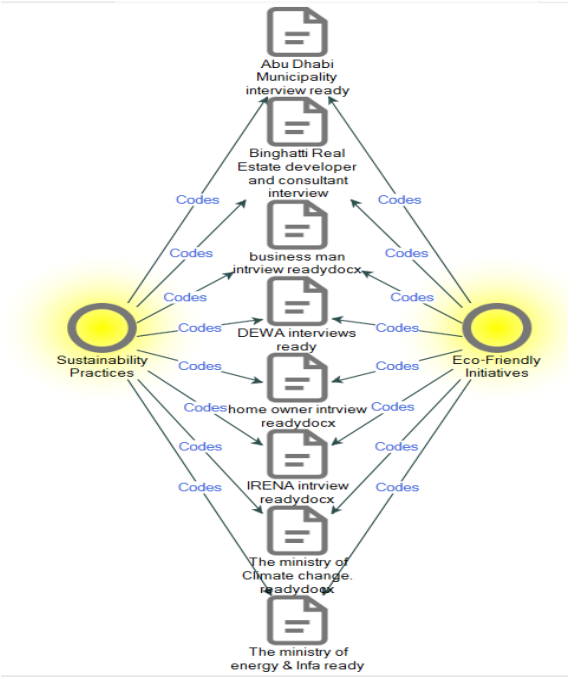


**Figure 30 :** Comparing codes 1 *(By Author)*

Sustainability Practices and Renewable Energy Integration

This theme focuses on the integration of renewable energy sources in existing systems. Interviews cover a wide range of stakeholders, including government bodies such as the ministry of Climate Change, utility providers (such as the Department of Energy and Water Supply (DEWA)), real estate developers and businesses, as well as homeowners. This suggests a cross-industry dialogue on how to integrate renewable energy into the fabric of the city, commercial activities, and residential spaces.

This theme also covers broader sustainability practices beyond energy use. This implies a holistic approach to sustainability that considers environmental, economic, and possibly social considerations. Interviews with the same range of stakeholders as those on the topic of renewable energy integration show that sustainability is an issue that is being discussed at every level of society and industry.

There is a clear overlap between the two themes, indicating that renewable energy is likely a significant component of the sustainability practices being discussed by these stakeholders. The presence of both themes across the interviews suggests a holistic approach where renewable energy integration is part of a broader sustainability strategy.

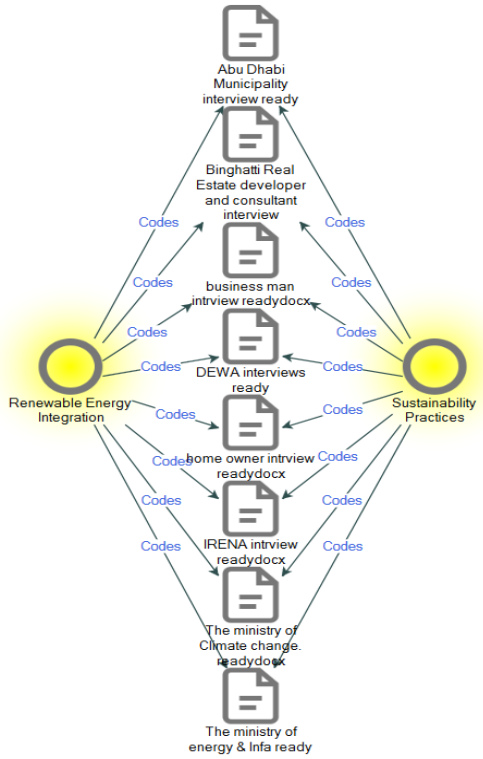


**Figure 31 :** Comparing codes 2 *(By Author)*

**Sustainability Infrastructure and Implementation Challenges**

The interviews discussed the concept of sustainable infrastructure, which is designed to be constructed, and operated in such a way that it can last for a longer period and have a minimal impact on the environment. Codes associated with various interview documents, including those from real estate developers, and ministries, suggest that sustainability is being considered at various levels, both in policy and practice, when planning and developing infrastructure.

The second theme, implementation challenges, addresses the challenges associated with the implementation of sustainable practices and their integration in existing systems. This

theme is presented through various interviews, indicating that stakeholders are both planning and facing obstacles in the implementation of sustainable infrastructure.

The two topics are interrelated, indicating that the journey to sustainable infrastructure presents challenges. These challenges are an integral part of the conversation, indicating that stakeholders are actively working to solve and adapt to more sustainable models as they move forward. Overall, the interviews demonstrate a dynamic conversation in which the ambition to create sustainable infrastructure is present yet is confronted with practical difficulties and obstacles. This suggests a transitional stage in which stakeholders are still determining how to incorporate sustainability into infrastructure initiatives. In conclusion, stakeholders from a variety of industries are actively exploring the idea of sustainable infrastructure, while also facing the practical difficulties of translating these ideals into practical projects. The interviews reveal a dedication to sustainability, but also a recognition of the challenges associated with bringing these initiatives to life.

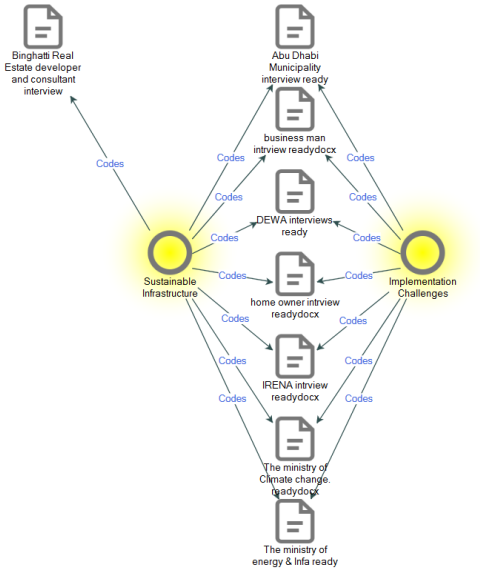


**Figure 32 :** Comparing codes 3 *(By Author)*

## 5.3 Explanation of Themes

### 5.3.1 Theme 1 "Background of the Organization of the Interviewees "

- **Rationale**

This theme plays an important role in setting the context for the answers given in the interviews. The theme covers the historical evolution, the current scope and the strategic objectives of the organizations represented in the interviews. It provides insights into the organizational culture, the mission, the size, the market position and their role in the UAE's sustainability strategy and net-zero objectives. Further, it examines the fundamental and operational nature of the organizations interviewed. It provides an important context against which to frame their views on sustainability and their participation in the UAE's Net Zero

2050. It examines the ethos, the operational scope and the strategic motivations underpinning their sustainability strategy.

- **Quotes from Interviews**

In our property development projects, we integrate renewable energy sources such as solar panels, HVAC systems and LED lighting to bring the concept of NZEB closer to reality.

The Abu Dhabi Municipal Authority is a key governmental entity in the Emirates, contributing to the development of a sustainable infrastructure in the capital.

DEWA is not only Dubai's utility provider but also a driving force behind the emirate's energy reform and sustainability initiatives.

IRENA, in addition to fulfilling its global mandate, plays an important role in establishing the renewable energy landscape in the UAE, leading the way internationally from its headquarters in Abu Dhabi.

- **Analysis**

The interviewees' responses provide insight into their views on sustainability and how they view their organizations' role in achieving the UAE's Net Zero 2050 goals. Sustainability is not a "one-size-fits-all" goal, but rather a multi-faceted approach that includes policy, innovation, and development. Each interviewee has a different perspective on what sustainability means in their organization. For example, one focuses on renewable energy integration, while another emphasizes sustainable urban development.

The interviewees agree on how important it is for organizations to play a role in achieving their country's sustainability goals, but they differ on the strategies they use. Some focus on policy changes, while others prioritize market-based solutions. All interviewees emphasize the importance of cross-sectoral collaboration and the importance of green finance and global collaboration.

**Figure 33 :** Word cloud of theme 1 *(By Author)*

**Table 10:** Weight Percentage of Top 20 words used in this theme *(By Author)*

| Word | Length | Count | Weighted | Similar Words |
|---|---|---|---|---|
| climate | 7 | 8 | 1.55 | climate |
| energy | 6 | 8 | 1.55 | energy |
| ministry | 8 | 8 | 1.55 | ministry |
| sustainable | 11 | 7 | 1.36 | sustainability, sustainable |
| constructed | 11 | 6 | 1.17 | constructed, constructing, construction |
| development | 11 | 6 | 1.17 | developer, developing, development, developments |
| emirates | 8 | 6 | 1.17 | emirate, emirates |
| environment | 11 | 5 | 0.97 | environment |
| minister | 8 | 5 | 0.97 | minister, ministers |
| project | 7 | 5 | 0.97 | project, projects |
| water | 5 | 5 | 0.97 | water |
| affair | 6 | 4 | 0.78 | affair, affairs |
| around | 6 | 4 | 0.78 | around |
| committed | 9 | 4 | 0.78 | commitment, commitments, committed |
| dedicated | 9 | 4 | 0.78 | dedicated, dedication |
| excellence | 10 | 4 | 0.78 | excellence, excellency, excellent |
| international | 13 | 4 | 0.78 | international |
| renewable | 9 | 4 | 0.78 | renewable |
| agreement | 9 | 3 | 0.58 | agreement |

- **Findings**

The analysis shows that there is agreement on the overall objective of sustainability, but divergent views on how to get there, reflecting the different roles and strategic priorities of these organizations. Sustainability is a priority for all of them, but the chosen paths, be it policy, technology, or funding, show the multi-faceted nature that the sustainability effort in the UAE will require.

Achieving Net Zero 2050 will necessitate a coordinated effort that capitalizes on the strengths and priorities of each organization. Government officials, energy providers and global agencies will all need to work together to address the diverse aspects of sustainability from renewable energy adoption, energy efficient infrastructure, innovative financing, and international partnerships.

By utilizing their strategies and working across sectors, all the organizations interviewed will be able to contribute to a unified national effort to achieve the UAE's environmental goals, while respecting the individual contributions of each stakeholder.

### 5.3.2 Theme 2 "Level of familiarity with the Concept of Net-Zero Energy Buildings"

- **Rationale**

One of the objectives of this study, therefore, is to determine how familiar subjects are with NZEB as one of the ways of assessing economic barriers and the effectiveness of financial schemes, such as green bonds, PACE, and EPC in the UAE. There is an emphasis on

gaining insights into the participants' knowledge as well as engagement in such sustainability projects.

- **Quotes**

One person who works in the construction industry said that we're not just looking at it, we're pushing for NZEB standards to be included in our projects.

Another person said that financial incentives are important for NZEBs, since they help make them more profitable and help us reach our efficiency goals.

**Figure 34 :** Word cloud of theme 2 *(By Author)*

- **Analysis**

The word "actively" with a high weighting, along with "driving" and "renewable" shows that people not only know about NZEB ideas, but they're actively involved in making them happen. The discussion around "efficiency," "assessed", and "related" shows that there's

a process in place to help NZEB standards fit into the bigger picture of sustainable growth and financial modeling.

- **Findings**

The findings highlight the level of awareness and involvement of stakeholders in the NZEB space. The frequent references to “promote,” “buildings,” and “allows” are indicative of a well-developed advocacy and support ecosystem for NZEBs within the sector.

The mention of “change”, “programs”, and “projects” is indicative of ongoing efforts and a shift toward more sustainable practices supported by well-structured financial programs.

All in all, the findings show that stakeholders are well-informed and actively involved in the development of NZEB ideas. Stakeholders are well-versed in the economics and environmental impact of the concept and are incorporating it into their strategies. This is indicative of a positive tendency to overcome economic barriers and validate financial mechanisms to achieve sustainable development goals in the UAE.

### 5.3.3 Theme 3 “Availability of Green Strategic Programs”

- **Rationale**

This analysis seeks to investigate whether there are appropriate strategies for greening the UAE. This research intends to explore how these programs are in harmony with national aspirations to achieve net-zero emissions by looking at the use and context surrounding the

usage of terms like “energy”, “water”, “program”, “strategy”, and “role”. Such programs are integrated in building practices, demand management, and green infrastructure planning.

- **Quotes**

One interviewee mentioned that the energy strategy is not a policy, but rather the spine of green growth.

Others mentioned that the water conservation programs represent an integral component of environmentally conscious living in the UAE, which encompasses other such initiatives.

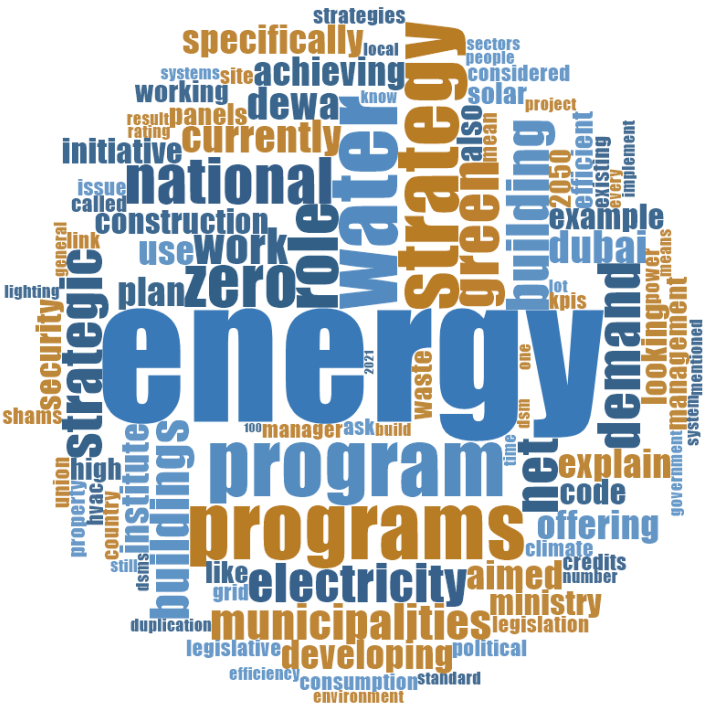


**Figure 35 :** Word cloud of theme 3 *(By Author)*

- Analysis

Targeted and robust strategic programs towards net-zero goals on energy and water management. This ongoing talk on buildings, electricity, and municipalities reflects a desire to enmesh sustainability in the very crucial of urban planning and administration. In addition, the talks related to strategic roles seem to emphasize how stakeholders are pushing structured and focal approach in the UAE's green growth framework.

- Findings

This theme is demonstrated in the discourse of Green Strategic Programs. It is mentioned by participants that energy and strategy programs highlight the importance of systematic means for controlling resources such as water and energy. This implies that these programs are not only existing but are among the ongoing and specifically aimed initiatives toward sustainable development, which forms an integral part of the national agenda reflected by the participants. In addition, stakeholders recognize the importance of Green strategic programs in the UAE's transition into sustainability. It is obvious that energy programs are strategic.

### 5.3.4 Theme 4 "Beliefs about PACE's Role in Energy Efficiency"

- Rationale

The PACE (Property Assessed Clean Energy) plan/program is recognized as a transformative mechanism for promoting energy efficiency and renewable energy installations

in properties. The purpose of this theme is to explore interviewees' beliefs about how PACE facilitates energy efficiency in the UAE, particularly in residential and commercial buildings.

- Quotes from interviews

Despite the enthusiasm for PACE, there are nuances in how different interviewees perceive its effectiveness.

Some express confidence in PACE's ability to transform the market. Others are cautiously optimistic, noting the need for careful implementation and continuous assessment to ensure the program meets its goals without unintended consequences.

**Figure 36 :** Word cloud of theme 4 *(By Author)*

**Table 11:** Weighted percentage of top 20 words *(By Author)*

| Word | Length | Count | Weighted Percentage (%) |
|---|---|---|---|
| energy | 6 | 76 | 8.50 |
| mechanism | 9 | 32 | 3.58 |
| efficiency | 10 | 30 | 3.36 |
| property | 8 | 30 | 3.36 |
| renewable | 9 | 30 | 3.36 |
| finance | 7 | 24 | 2.68 |
| financial | 9 | 20 | 2.24 |
| ministry | 8 | 17 | 1.90 |
| uae | 3 | 17 | 1.90 |
| assessed | 8 | 16 | 1.79 |
| buildings | 9 | 16 | 1.79 |
| clean | 5 | 16 | 1.79 |
| effective | 9 | 16 | 1.79 |
| incentivize | 11 | 16 | 1.79 |
| programs | 8 | 16 | 1.79 |
| projects | 8 | 16 | 1.79 |
| provide | 7 | 16 | 1.79 |
| upgrades | 8 | 16 | 1.79 |
| additional | 10 | 15 | 1.68 |

- **Analysis**

From the interviews, it's clear that PACE is a key factor in improving energy efficiency. They think it's a great way to help property owners invest in renewable energy and energy saving, and that the costs can be recouped through property taxes over time. It's part of the government's plan to create a more sustainable future, and it's seen as a great way to encourage businesses to invest in clean energy. People are talking about how PACE can be a game-changer, as it can create a ripple effect of energy upgrades, leading to bigger savings.

- **Findings**

The analysis shows that PACE has a lot of potential to help the UAE with energy efficiency. Its funding structure is a big plus, making it a popular option for many people. Interviewees think PACE can help promote renewable energy projects and energy efficiency improvements, and they think it's a key part of the country's sustainability plan. However, there's a lot that needs to be done to make sure PACE is successful. It needs to be backed up by clear regulations, have government support, and be well-known to the public. It also needs to be part of a bigger sustainability plan, with education and transparency.

Furthermore, interviewees think PACE is a great way to promote energy efficiency, but it needs to be monitored closely to make sure it's delivering on its promises and adapting to the changing needs of the energy industry.

### 5.3.5 Theme 5 “Organization's Participation in Green Bonds”

- **Rationale**

This research study aims at exploring views held by different stakeholders regarding companies’ participation in the green bond market in UAE. The role that greens bonds play in shaping the nation’s drive towards a net-zero emission and sustainable development. This paper seeks to highlight the integration of these financial instruments into wider environmental policies and their contribution towards sustainable economic development.

- **Quotes**

Most participants acknowledged that green bonds were key in mobilizing finances for sustainability projects, with one saying, “green bonds are instrumental.”

Another highlighted the adaptability of financial strategies to environmental goals: The statement that “we invest in green bonds to support the net zero campaign” is meant to support our commitment to the net-zero initiative.

**Figure 37 :** Word cloud of theme 5 *(By Author)*

- **Analysis**

The thematic analysis strongly links environmental objectives to financial mechanisms. The high frequency of such words as “green,” “bonds,” “finance,” “investment”, and “targets” in line with strategy and sustainability means an effective desire to integrate green bonds into sustainability strategic planning. There is a well-recognized demand for innovative financial

instruments that could help in a radical shift towards green practices in the energy and infrastructure sectors.

- **Findings**

The findings reveal the level of confidence among stakeholders that green bond is an effective approach towards UAE sustainability and net zero emission policy. Generally, there is common ground that green bonds are money-making ventures but with broader considerations for long-term sustainability. This includes frequent references to “energy,” “carbon,” and “mitigation” which imply investors care about how financial investment affects the energy efficiency development. Additionally, the emphasis on green bonds in the discourse denotes an appreciation on the part of stakeholders that such instruments are critical to financial and environmental sustainability. It is commonly assumed that green bonds will be essential in funding the UAE as it transitions to a greener economy through innovations, strategic planning, and targeted actions on high-impact issues such as energy efficiency and low carbon technologies.

### 5.3.6 Theme 6 “Level of Interviewees Awareness about Energy Performance Certificate (EPC)”

- **Rationale**

This theme aims to explore the level of understanding and awareness among stakeholders of the UAE sustainability plan and energy efficient building sector concerning EPC. EPCs are a critical aspect in facilitating sustainable construction and energy policies.

- **Quotes**

We're aware of EPCs but don't fully understand how they can be leveraged for financial benefits, noted an interviewee from the construction sector.

Another participant mentioned that EPCs are crucial, but there's a knowledge gap in utilizing them as a financial tool.

**Figure 38 :** Word cloud of theme 6 *(by Author)*

- **Analysis**

Energy, being a leading term frequently used by participants, highlights an emphasis on energies related conversations between interviewees. Subsequently, “efficient” along with other terms such building, and net-zero energy denote that EPCs are associated with energy conservations and zero net approaches. Moreover, the word “certification” and “performance” imply that EPC elements familiar enough between interviewees.

- **Findings**

The results indicate a widespread familiarity with EPCs among those interviewed, in respect of energy efficiency and sustainability, however the depth of specific understanding seems lacking. Failure to close this gap poses a hindrance to fully utilizing EPCs in surmounting economic challenges and deriving the rewards of economic programs such as green bonds and property-assessed clean energy (PACE). This highlights the fact that more education and information need to be disseminated regarding how EPCs can be incorporated into the financial mechanisms for promoting green buildings.

### 5.3.7 Theme 7 "Beliefs about Long-term Effectiveness of Sustainability Programs"

- Rationale

The objective of this theme is to gain insight into the views and opinions of interviewees on the sustainability program's long-term impact in the UAE. The focus is on the perception of sustainability programs as integral components of a holistic approach to environmental protection and energy management, with a particular focus on sustainable energy, green buildings, and financial instruments. The aim is to gain an understanding of how sustainability programs are seen in relation to their ability to promote a shift towards net-zero emission and resilient infrastructure while ensuring financial sustainability and promoting broad adoption across different sectors.

- Quotes

One interviewee emphasized the economic aspect such as Sustainability is not just an environmental concern but it’s a financial concern, and we're seeing more projects with clear long-term financial benefits.

Other interviewees highlighted innovation such as adoption of innovative technologies in our buildings is a testament to our dedication to long-term sustainability goals.

**Figure 39 :** Word cloud of theme 7 *(By Author)*

**Table 12:** Weighted percentage of top 20 words *(By Author)*

| Word | Length | Count | Weighted Percentage (%) | Similar Words |
|---|---|---|---|---|
| sustainable | 11 | 61 | 3.83 | sustainability, sustainable |
| energy | 6 | 49 | 3.08 | energy |
| buildings | 9 | 30 | 1.88 | build, building, buildings |
| projects | 8 | 30 | 1.88 | project, projects |
| financial | 9 | 28 | 1.76 | financial |
| net | 3 | 21 | 1.32 | net |
| zero | 4 | 21 | 1.32 | zero |
| green | 5 | 20 | 1.26 | green |
| funding | 7 | 19 | 1.19 | funding |
| instruments | 11 | 17 | 1.07 | instrument, instruments |
| adoption | 8 | 16 | 1.01 | adopt, adoption |
| innovation | 10 | 16 | 1.01 | innovation, innovative |
| strategies | 10 | 15 | 0.94 | strategies, strategy |
| renewable | 9 | 14 | 0.88 | renewable, renewables |
| concept | 7 | 13 | 0.82 | concept |
| development | 11 | 13 | 0.82 | develop, developed, developer, developers, developing, development |
| environmenta | 15 | 13 | 0.82 | environmental, environmentally |
| investment | 10 | 13 | 0.82 | investment |
| support | 7 | 13 | 0.82 | support, supports |

- Analysis

The interview's content reflects a multi-faceted mindset in which long-term performance is supported by economic and technological factors. The high frequency of terms related to financial stability and investments suggests that stakeholders consider economic factors to be essential for sustainability programs to be successful and long-lasting. The emphasis on innovation and adopting new technologies also indicates that stakeholders are

concerned with changing sustainability strategies to make sure they are long-lasting and effective.

- Findings

The analysis shows that stakeholders are confident in the long-term success of sustainability programs if they are backed by robust financial structures and ongoing innovation. Repeated references to “net zero” and “green” suggest a shared goal focus, while the emphasis on “energy” or “buildings” suggests a practical approach to sustainability in real-world, high-impact contexts. This harmonization of economic and environmental imperatives seems to be building a solid foundation for long-term sustainability initiatives.

In summary, stakeholders believe that with focused financial strategies, innovative practices, and an emphasis on specific sustainability goals such as net zero, sustainability programs are likely to be successful in the long run. The evidence shows a broad comprehension that sustainability is an ever-changing field that requires ongoing dedication to both financial sustainability and technological innovation.

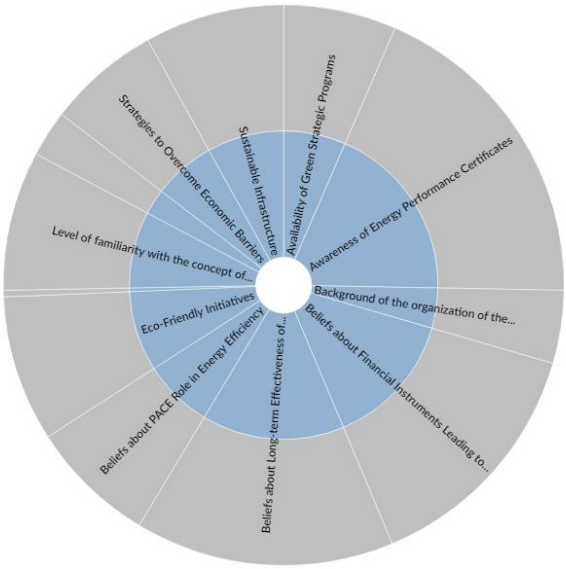


**Figure 40 :** Hierarchical chart of codes *(By Author)*

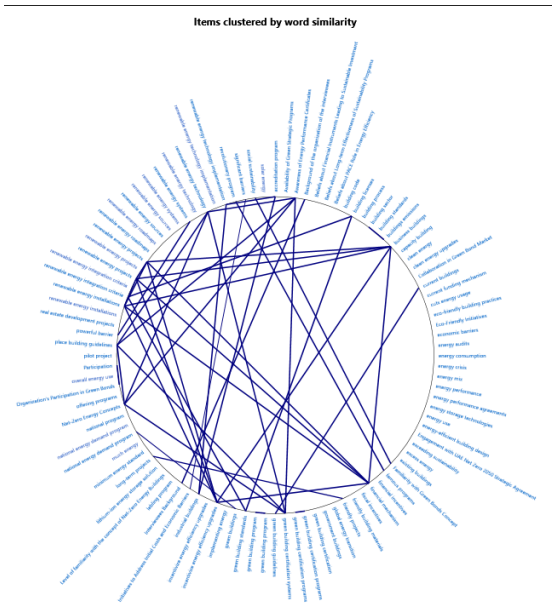


**Figure 41 :** Clustered Diagram (Word Similarity-Jacquard Coefficient) *(By Author)*

## 5.4 Interview' Findings

The interviewees were generally optimistic about the potential of Green Bonds, PACE and EPCs as viable financial tools to support sustainable projects, recognizing their potential to bridge financing gaps and promote a culture of sustainability investment. Participants were enthusiastic about PACE. They observed them as a driving force for energy efficiency, especially in residential and commercial settings. PACE' ability for example to link the cost of energy upgrades to property taxes seemed to be a strategic innovation that could potentially transform the market. However, they also acknowledged that for these programs to be successful, they need to be more transparent, have better reporting structures, and have a better understanding of the structure and advantages of the financial instruments. The analysis also revealed that the interviewees had a sophisticated understanding of these financial instruments and had various perspectives on how they could contribute to the sustainability journey of the nation. However, they were also aware of the need for further education to ensure that the concepts were understood and effectively implemented across various sectors.

In conclusion, the results of our interviews provide a convincing narrative that responds to our research questions in a variety of ways. The consensus of the interviewees is that, while there is a good understanding of financial mechanisms for sustainability and a positive outlook on them, there is a need for greater comprehension and strategic implementation. They suggest a collaborative approach that includes education, openness, and creativity to overcome economic obstacles and validate financial schemes. This analysis not only addresses our research question, but also provides a vision of a future in which financial

mechanisms are not merely theoretical ideas but are practical tools that will enable the UAE to reach its Net Zero 2050 objectives. This vision is based on a shared belief in the power of knowledge, financial creativity, and collaboration.

# Chapter 6: Conclusion& Recommendations

## 6.1 Conclusion

This study examines mechanisms to lessen obstacles to the UAE's adoption of NZEBs. In the study, two research methodologies were used. A semi-systematic literature review that offers a thorough exploration of the mechanism, then, a semi-structured interview is conducted to confirm the ability of green bonds, PACE, and EPCs to be adopted in the UAE. The literature review states that in order to be ready to implement the most recent advancements in the fields of energy efficiency, the UAE has established a sizable foundation of regulations and a strategic plan to reach zero energy by 2050. Conversely, the trio of mechanisms boast extensive global implementation experience spanning several decades. While EPCs are the well-known energy efficiency certification in the EU, PACE is regarded as a successful mechanism in the US. Regulators in the UAE can implement the three mechanisms, while building on their successful aspects, despite their shortcomings.

Green bonds are generally seen favorably because of their ability to direct funding toward environmentally friendly initiatives. They give investors a way to contribute to and encourage the shift to a low-carbon economy. Legislators and regulators value the transparency and accountability that come with green bonds because they guarantee that the capital is used for the intended environmentally friendly uses. The financing of energy-efficient building projects can be made easier with the help of green bond proceeds, encouraging sustainable practices in the real estate and construction industries. One of the challenges, though, is that "green" must be defined according to standardized standards. Since

green bonds are already in use in the UAE's private sector, it only makes sense that they will eventually find their way into the country's public sector given their increasing growth, as noted in the literature. The interviewees corroborate the notion that the country' orientation will speed up implementation of green bonds in our country, as do all the indicators from the literature review.

The market took notice of Property Assessed Clean Energy (PACE) programs because of their creative financing strategy. Regulators may investigate how PACE programs affect local economic development, property values, and the uptake of clean energy technologies. In order to pinpoint obstacles and opportunities, this study looked at the mechanism, advantages, and drawbacks. Our findings show that using PACE in the UAE to hasten the adoption of net zero energy buildings is both feasible and effective. The need for precise regulations, risk-reduction techniques, and resolving issues with property transfer and resale are obstacles, though.

Finally, our interviewees explained that Energy Performance Certificates (EPCs) are a widely known concept in the United Arab Emirates, serving as a gauge for measuring the energy efficiency of household appliances. Additionally, the study's findings highlight their contribution to increasing public awareness of building energy efficiency. They are an invaluable resource for real estate owners as well as potential tenants or purchasers. In addition to how well they work to improve energy efficiency and how much they affect consumer behavior. With all these advantages and more, EPCs are a great option for adoption in the UAE and as a means of removing obstacles posed by NZEBs.

## 6.2 Recommendations

Policymakers could use the mitigation mechanisms provided in this study as a guide when developing new policies and enhancing current ones that support NZEBs. Researchers may be able to expand their search in this important and productive field by building on the study's findings and going beyond the constraints imposed by the number of interviews conducted.

In order to facilitate the successful implementation of these mechanisms and promote the shift towards a built environment that is more energy-efficient and sustainable, cooperation between governments, financial institutions, and the real estate industry is imperative.

To comply with the legal framework and any particular requirements for implementing them, policy makers should research the regulatory environment in the UAE with regard to PACE financing and EPCs.

Create educational initiatives to educate communities, local companies, and property owners about the advantages of PACE financing and EPCs. Greater acceptance and involvement will be facilitated by increased knowledge and comprehensive.

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# Appendices

## Appendix A

| No. | | EPC | PACE | Green Bonds |
|---|---|---|---|---|
| 1- | Definition | A label provides general building information, the building's energy performance rating, and suggestions for enhancing the building's efficiency. | A novel form of funding for sustainable energy generation initiatives in which a landowner takes out a loan from their local government and pays it back with an assessment on their property taxes instead of making regular loan payments. | A financial instrument category with a structure like traditional investment grade bonds intended to finance initiatives and activities that favour the environment or climate. |
| 2- | History of the mechanism | 2002 by EPBD, became law in E.U. member states (M.S.s) and was mandatory. | "On Tax-Bill Financing" was the first regional energy plan proposal by the Association of Monterey Bay Area Governments (AMBAG) in 2006.<br><br>On August 28, 2008, the Palm Desert, California "Energy Independence Program" (PDEIP) formally launched the first wholly integrated | The European Investment Bank (EIB) introduced green bonds in 2007 with an offering of EUR 600 million, known as Climate Awareness Bonds.<br><br>In 2008, the World Bank and the Swedish bank SEB collaborated to launch the first green bond. |

| | | | | |
|---|---|---|---|---|
| | | | program in the United States. | |
| 3- | Application mechanism | The document includes information about the building and the agent in charge of granting the certificate, as well as an energy label with a scale from A to G representing the calculated delivered energy need and a colour-coded heating grade indicating how much of the building's space and water can be heated using renewable energy sources. It also includes suggestions for energy-saving measures and general advice for the buyer. | The loan is secured by two methods: (1) a municipal lender creates a "special assessment district," which acts as a primary lien on the property, to secure the capital, and (2) the assessment for repayment is attached to the property and passes to the next owner along with other conventional property tax assessments. | To fund environmentally friendly projects, the issuer determines the amount of capital required and then chooses projects that adhere to green finance principles and satisfy environmental standards and criteria. After receiving external review and certification, the issuer sells green bonds to investors and uses the money received. |
| 4- | The target of the instrument | # Offer trustworthy information about a building's energy performance to buyers and | Encourage and assist locals to contribute to clean energy-producing projects by using their homes and businesses as venues. | A financial invention known as "green bonds" was created to help institutional investors—such as pension funds, insurance companies, mutual funds, and sovereign wealth |

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| | | tenants at reasonable prices and the right moment.<br><br># Boost energy performance to raise the price at which buildings are sold and rented.<br><br># Provide financial incentives for energy efficiency investments | | funds—invest sustainably. |
| 5- | Successful experience | According to a Belgian poll, about half of purchasers and one-third of tenants said the EPC influenced their decisions. The EPC was used in price negotiations by 18% of renters and 30% of purchasers. | PACE funding raises the amount of solar energy installed on each owner-occupied home by about 3.8 W, 108% more than the average number of watts installed on each California owner-occupied home. | # France<br><br>Energy retrofits were chosen as one of the four main focus areas for France's National Low-Carbon Strategy. To help with this priority, the building sector got the most money from the green bond, and €1.4 billion was used as tax credits to help 930,000 households.<br><br># Netherland<br><br>Some of the money from the Netherlands' green bond was used to keep the country's train system in good shape. The system runs on 100% renewable energy. |

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| | | | | It was expected that the investments would save 0.18 Mton of carbon emissions each year in 2018 and 2019. |
| 6- | Advantages and benefits | 6-1: A vital building paper that gives people access to reliable information.<br><br>6-2: An essential tool for energy policymakers to push the building and real estate industries toward energy-efficient homes.<br><br>5-3: Thought to be a significant reason for renovating buildings.<br><br>5-4: This document states that homeowners must get state grants and low-interest loans.<br><br>5-5: Keep an eye on and review policies so that you can make better | 5. One of the direct perks of PACE financing is<br><br># Less use of water and energy.<br><br># Decrease in pollution linked to this use.<br><br># Make more energy from renewable sources.<br><br># Lessening the risk of being hurt by hazards.<br><br># Make society more fair and equal by making the PACE Program open to all small businesses and homeowners of all income levels.<br><br>5-2-Economic co-benefits include saving money on things like energy and water, which | Benefits for investors:<br><br>• Similar cash returns with extra uses for the environment and people;<br>• Meet the ESG standards for mandated sustainable investments;<br>• Help the country deal with issues like food stability, public health, energy supply, and adapting to climate change;<br>• Allow direct investment in activities that have a positive social effect and "green" brown areas;<br>• More openness and responsibility about how proceeds are used and managed adds to the risk management tools. |

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| | | ones in the future.<br><br>5–6–Useful for dealing with the problems of decarbonization and ecology in general. | makes people spend more on goods and helps businesses make more money.<br><br>#The savings could be used by business owners, such as boosting production, lowering prices, or raising wages and profits.<br><br>Improvements to hazard mitigation help keep people from having to use their funds to fix damaged buildings and make up for lost business. | Benefits for Issuers:<br><br>• Give investors a more comprehensive range of options;<br>• Improve the issuer's name;<br>• Give investors another way to get long-term funds;<br>• Get everyone on the same page about how long instruments last and how long the project lasts;<br>• Involving many investors can lead to high oversubscription and price advantages (it has happened with some issues). |
| 7- | gaps | The present EPCs are not designed to meet the end user's needs, especially when the information is given in scientific terms.<br><br>The difference between how well energy is used in real life and how well it | PACE loans are similar to other ways to get money, so they might not affect energy investments. | Even though green bonds have grown significantly, there needs to be more academic study<br><br>.<br><br>Issuing a green bond costs more than a regular bond. |

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| | | is used in theory and practice.<br><br>One of the ongoing and long-term causes of the deviations is the occupants' behaviour since their understanding and level of environmental awareness are different. | | |
| 8- | Factors affect the application | end-user's thoughts, desire to use, and passion for the product.<br><br>Some critical factors that affect people's experience in buildings, like indoor air quality and sunshine, are missed by EPC.<br><br>As a result of the subjective nature of the EPC delivery method, energy assessors can easily change the data quality. | 1-How people see them can affect how many people accept them. Lousy press or confusion about PACE can keep people from joining.<br><br>2-It is vital that local governments are willing to help and participate in PACE programs. Local governments can oversee PACE funding, make rules, and encourage property owners to use it.<br><br>3-The terms and interest | Green bonds are in high demand, but there are few available.<br><br>A set list of green spending is qualified for the bond's proceeds. |

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| | | | rates of PACE funding can significantly affect how appealing it is to property owners. | |
| 9- | Adjustment | We should make the current EPC system more reliable, follow the rules better, and reach more markets.<br><br>EPCs should be used more quickly, made public earlier in the purchase process, more noticeable, and more straightforward to understand.<br><br>EPC+ is an improvement to the current EPC system that better shows how well a building is doing. It can help a lot with the problems of going green, deep | | |

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| | | renovations, getting money, getting personalized advice, healthy facilities, rising property prices, saving energy in the future, and sustainability in general.<br><br>Several things that affect the plan should be considered, and it should also work with the laws already in place, like building rules and standards. | | |
| 10- | The availability in UAE | There needs to be academic proof that this strategy is available in the UAE. | No academic studies back the use of this strategy in the UAE. | There have been no public green bonds or sukuk in the UAE since the Ministry of Climate Change & Environment's report in 2022.<br><br>In March 2017, First Abu Dhabi Bank (FAB) put out a $587 million green bond, the first in the MENA area.<br><br>The company raised $600 million by launching its first green sukuk in May 2019. |

**Appendix B**

*Interview Question*

1-Can you briefly provide an overview of your institution?

2-What is your level of familiarity with the concept of Net-Zero Energy Buildings, which aim to produce as much energy as they consume over a given time period? Does your institute consider this approach to achieve the targeted UAE Net Zero 2050 Strategic agreement?

3- Are there any existing green strategic plan or programs offered by your Institute that specifically aimed to participate in achieving Net Zero Energy? If yes, could you provide details on how these programs work?

4-Upon the researchers conducted in many countries the upcoming initial cost and economical barriers are considered one of the highest barriers for implementing net zero energy worldwide do you agree? Do you promote or suggestion, strategy or program based on your experience could overcome this challenge?

5- Financial Incentives and Support could be introduced by many form to support achieving Net Zero Energy in building, Green Bonds which are financial instruments specifically dedicated to funding environmentally sustainable projects are you familiar with this concept? Does your institute participate in this type of funding? How?

6- Is your institute open for collaborations with stakeholders, including governments, financial institutions, and environmental organizations, to develop standards, guidelines, and reporting frameworks that ensure the integrity and credibility of green bond markets?

7-Another Financial mechanism is the Property Assessed Clean Energy (PACE), which allows property owners to finance energy efficiency and renewable energy projects through a special assessment on their property taxes what is your knowledge about this concept? And do you believe that this program can provide an effective mechanism for governments in UAE to promote and incentivize energy efficiency upgrades and renewable energy installations in residential and commercial buildings? Why or why not?

8-Do you believe that the widespread adoption of these strategies as a mainstream financial instruments can lead to greater investment in sustainable projects, foster innovation, and drive the transition towards a more sustainable and resilient future? Why or why not?

9-Another significant barrier was lack of awareness, the Energy Performance Certificate (EPC) which rate and summaries the energy efficiency of buildings is a strategy that aims to raise awareness about energy consumption, serve as a benchmarking tool and assist governments in monitoring and reporting energy performance. Are you aware of this type of this labelling program? Is your institute being willing to participate on promoting such a program?

# Appendix C

## Table of Analysis

| Theme | Sub-theme | Main Points | Perspectives | Commonalities | Differences | Direct Quotes |
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| Background of the organization of the interviewees | Interviewees Background | Historical evolution, strategic objectives, operational nature, and role in UAE's sustainability strategy. | Diverse perspectives on the integration and approach towards sustainability within their organizations. | Agreement on the significance of understanding organizational background to frame sustainability views. | Variances in the scope and scale of sustainability strategies among different organizations. | In our property development projects, we integrate renewable energy sources. Wile DEWA is not only Dubai's utility provider but also a driving force. |
| Beliefs about PACE's Role in Energy Efficiency | Collaboration in Green Bond Market | Potential of PACE in market transformation, need for multi-sector collaboration, the role of green finance. | Mixed confidence in PACE, with some interviewees expressing optimism and others caution. | Recognition of PACE as a potential catalyst for energy efficiency and sustainability. | Differences in opinions on how PACE should be integrated into the existing financial markets. | Despite the enthusiasm for PACE, there are nuances. While others are cautiously optimistic, noting the need for careful implementation. |
| | Current Funding Mechanism | Examination of PACE's current funding strategies and mechanisms. | Varied beliefs about the effectiveness of current funding mechanisms in achieving energy efficiency. | Consensus on the need for effective funding mechanisms for successful implementation of PACE. | Discrepancies in views on the adequacy and efficiency of current funding mechanisms. | PACE has the potential to transform the market, but its funding strategies need careful assessment. |
| | Financial Mechanism | Discussion on the role of financial mechanisms in supporting PACE programs. | Some see financial mechanisms as key to PACE's success, while others highlight potential challenges. | Agreement on the importance of robust financial mechanisms for PACE's role in energy efficiency. | Variances in perspective regarding which financial mechanisms are most effective for PACE. | The financial mechanisms in place are critical for the uptake of PACE, yet there is room for improvement. |
| | Transparent Reporting Mechanisms | Importance of transparency in reporting the outcomes of PACE initiatives. | General acknowledgment of the necessity for transparency in PACE's operations and results. | Shared belief in the value of transparency for accountability and trust in PACE initiatives. | Different approaches to how transparency should be maintained and reported in PACE programs. | Transparent reporting mechanisms are non-negotiable for the credibility of PACE. |

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| | Trustworthy Mechanisms | Trust as a factor in the adoption and success of PACE programs. | Uniform view that trust is essential, with variations in how it should be built and maintained. | Consensus that trustworthiness is foundational for PACE's broader acceptance. | Opinions differ on the best practices to establish and ensure trustworthy mechanisms. | Without trustworthy mechanisms, PACE cannot realize its full potential. |
| Beliefs about Long-term Effectiveness of Sustainability Programs | Exceeding Sustainability | Going beyond basic sustainability goals to achieve a more profound impact. | Shared aspiration to exceed minimum sustainability standards, though approaches vary. | Common goal to push the boundaries of what is considered sustainable practice. | Diverse strategies and definitions of what it means to exceed standard sustainability criteria. | We aim not just to meet, but to exceed sustainability benchmarks. |
| | Familiarity with Green Bonds Concept | Awareness and understanding of green bonds as a financial instrument for sustainability projects. | Varied levels of familiarity and expertise among interviewees regarding green bonds. | Recognition of green bonds as a useful tool in funding sustainable projects. | Differences in the depth of understanding and the perceived potential of green bonds among stakeholders. | Green bonds are a concept we're increasingly familiar with and see significant potential in. |
| | Social Sustainability | The social dimensions of sustainability programs, such as community engagement and social equity. | Perspectives vary from focusing on the environmental to the social aspects of sustainability. | Agreement on the importance of incorporating social aspects into sustainability efforts. | Differences in the perceived importance of social sustainability relative to other sustainability facets. | Social sustainability is pivotal, yet often overshadowed by environmental concerns. |
| | Sustainable Living Spaces | Creating environments that support sustainable lifestyles. | Shared vision of sustainable living spaces, with differences in implementation strategies. | Commonality in the goal of developing living spaces that promote sustainability. | Diverse opinions on how best to create and define sustainable living spaces. | Our commitment to sustainable living spaces is reflected in every project we undertake. |
| | Sustainable Solutions | Innovative solutions to environmental challenges, such as energy efficiency and waste reduction. | A consensus on the need for innovation, with distinct perspectives on what constitutes a sustainable solution. | Shared belief in the necessity of sustainable solutions for a viable future. | Variances in the approaches to developing and implementing sustainable solutions. | Innovative sustainable solutions are at the heart of our approach to overcoming environmental challenges. |

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| Organization's Participation in Green Bonds | Financial Strategy and Commitment | Organizations are leveraging green bonds to finance sustainability projects, reflecting a strategic approach to meeting net-zero emission goals. | Green bonds are seen as pivotal in the transition to a low-carbon economy. | All organizations recognize the importance of financial tools in achieving sustainability objectives. | The extent of participation and integration of green bonds may vary among organizations. | "Green bonds are instrumental in marshalling the necessary funds for our sustainability projects." |
| Availability of Green Strategic Programs | Program Integration and Impact | There's a strong emphasis on integrating energy and water management into national policy, with a focus on net-zero goals and sustainable development. | Strategic programs are necessary for managing resources and driving sustainability. | There's a consensus on the need for structured programs to manage energy and water efficiently. | Approaches to implementing these programs may differ based on regional and organizational needs. | "Water conservation programs are essential in our pursuit of sustainable living in the UAE." |
| Level of Familiarity with Net-Zero Energy Buildings | Knowledge and Engagement | Stakeholders demonstrate a high level of familiarity and proactive engagement with NZEB concepts, with a clear understanding of their economic and environmental importance. | NZEBs are recognized as a critical component of sustainable development strategies. | There is a shared understanding of the importance of NZEBs in achieving sustainability goals. | The depth of knowledge and application of NZEB concepts can vary among interviewees. | "We are not just assessing; we are actively driving the adoption of NZEB standards in our projects." |
| Level of Interviewees Awareness about EPC | Economic Barriers & Financial Tools | General awareness of EPCs and their link to energy efficiency and savings. | Recognition of EPCs importance; varying understanding of their financial leverage. | Recognition of the need for EPCs in achieving sustainability. | Knowledge gap in using EPCs as financial instruments and in detailed understanding of their benefits. | We're aware of EPCs but don't fully understand how they can be leveraged for financial benefits.<br>EPCs are crucial, but there's a knowledge gap in utilizing them as a financial tool. |