NetZero Buildings in Jordan

JORDAN GBC
المجلس الأردني للأبنية الخضراء
Jordan Green Building Council

FRIEDRICH EBERT STIFTUNG

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About FES Regional Climate & Energy Project MENA

The Regional Climate and Energy Project MENA advocates for an energy transition into renewable energy and energy efficiency. It continues to search for solutions for a just transition in the energy sector ensuring both, the protection of the planet and the people.

As the MENA region is one of the most affected areas by climate change, we contribute to policy advising, research, and advocacy in the areas of climate change policy, energy transition, and urban sustainability, with the support of research institutions, civil society organizations, and other partners in the region and in Europe.

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NetZero Buildings
in Jordan

The Hashemite Kingdom of Jordan

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PREAMBLE

OZONE **Depletion**

has led to an increase in awareness regarding the implications of climate change in the past few years. This has led emerging nations and countries to take serious actions to mitigate the anthropological impact on the Ozone layer. [1]

In 2015 ***the United Nations' Climate Change Convention***

brought together 196 parties for the first time into an effort to combat climate change and mitigate its effects. This convention was called *"The Paris Agreement"* which requires all parties to set goals and targets that reduce greenhouse gas emissions to limit the temperature increase of the earth to 1.5°C or further.

The agreement puts forward all parties' efforts through *Nationally Determined Contributions (NDCs)* [1].

The implementation of NDCs includes - but is not limited to:

01

Switching to low emission technologies which are charging on CO_2 emissions and other greenhouse gases

02

Limiting organizations' annual greenhouse gas emissions

03

Providing grants and subsidies to incentivize the reduction of greenhouse gas emissions.

NetZero Buildings are of a significant interest to nations that contribute to reducing the impacts of the greenhouse gas emissions, as they are major contributors to achieving the goals of the Paris Agreement.

Two goals have been set to promote and support the acceleration of NetZero Buildings:

- **All new buildings must operate at NetZero CO_2 emissions from 2030**; and they must become a standard practice to meet the Paris agreement goals.

- **100% of buildings must operate at NetZero CO_2 emissions by 2050**; existing buildings will require an acceleration of current renovation rates so that all buildings are NetZero CO_2 emissions in operation by 2050.

Globally, buildings contribute to

39% of the CO_2 emissions:

28% from operational emissions (energy needed to heat, cool and power), and 11% from materials and construction [2].

The major contributor to CO_2 emissions in buildings is

energy use during the operational stage.

Therefore, reducing the energy use of buildings by implementing Energy Efficiency Measures (EEM) or Energy Conservation Measures (ECM) is the first priority to reduce greenhouse gas emissions.

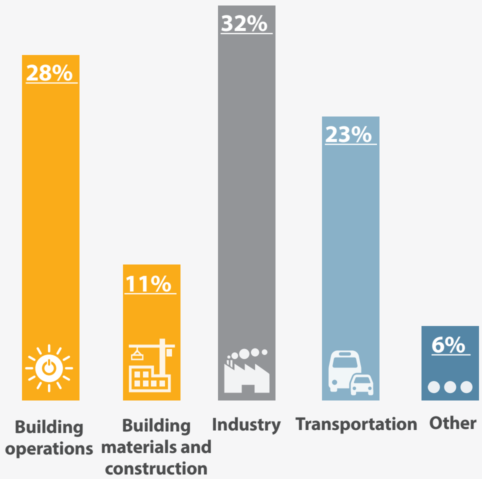


Figure 1: Global CO_2 Emissions by Sector [2].

In Jordan, the total greenhouse gas and carbon emissions from all sectors are increasing.

The residential sector contributes the least to carbon emissions and other greenhouse gases compared to transportation and industry sectors, as shown in figure 2.

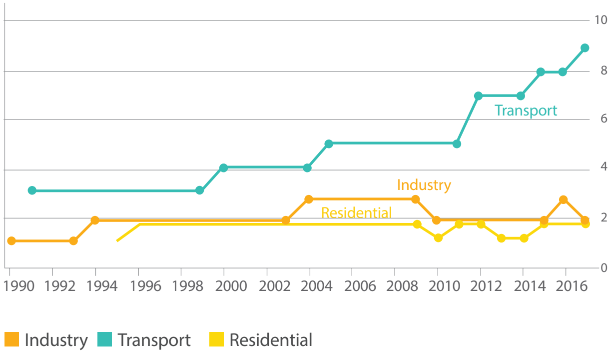


Figure 2: CO_2 Emissions in Jordan by Sector 1990 – 2016 [4].

The residential sector is responsible for around [3]:

46% Of the electricity consumption

22% Of the total energy consumption

Therefore, reducing its energy and electricity consumption can be a significant contributor to reducing the overall greenhouse gas emissions.

Nonetheless, all CO_2 emission predictions have been affected by the pandemic of the COVID-19 at the beginning of 2020. A global crisis in the energy sector has occurred as well as an unprecedented global health crisis. As a result of the pandemic, countries in full lockdown have been experiencing an average decline of 25% in the energy demand per week, while countries in partial lockdown have been experiencing an average decline of 18% in energy demand (Figure 3).

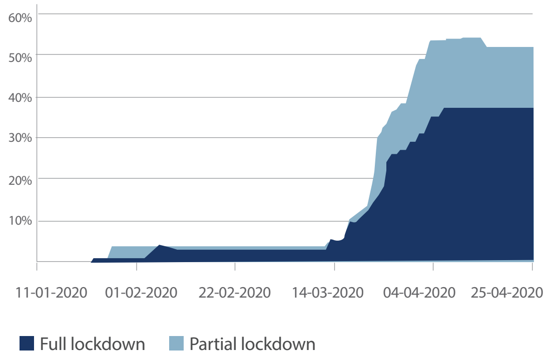
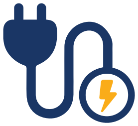


Figure 3: Share of Global Primary Energy Demand Affected by Mandatory Lockdowns [5].

The major decline in energy use was in the transportation sector, however, the residential gas heating and electricity use have increased.



Residential electricity demand has increased by 40% compared to the first quarter of 2019 [5].

In addition, news about the healing of the ozone layer has been arising

after the first quarter of 2020 [6].

A significant reduction in the greenhouse gas emissions has been reported. This is due to the global reduction in the primary energy demand and the reduction in air pollution mainly because of the partial or full shut down in the air travel, worldwide. Nevertheless, emissions are expected to rise to pre-pandemic standard or higher in the aftermath of the pandemic. This should be avoided at all costs.

For example, in China, **the lockdown resulted in:**

25%
reduction in carbon emissions [7]

50%
reduction in nitrogen oxides emissions [8]

The impacts of the COVID -19 pandemic have raised awareness to the importance of preparing homes for working remotely and for longer occupancy hours. Thereupon, NetZero Buildings can introduce a solution for energy-independent and pleasant indoor environments.

The purpose of this booklet is to deliver a guide for the implementation of NetZero buildings for affordable, typical homes in Jordan. The guide compiles the best strategies to create a significant step towards a more sustainable built environment by implementing the concept of NetZero Buildings in the residential sector in Jordan. Additionally, the guide targets local practitioners including engineers, contractors, and people working in the governmental and non-governmental organizations, as well as the general public.

01

INTRODUCTION TO NETZERO BUILDINGS

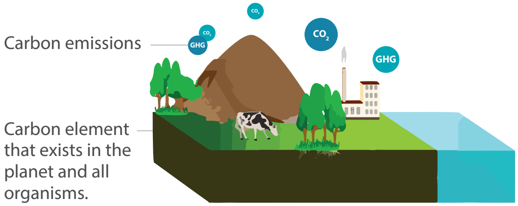
I. WHAT IS A NETZERO BUILDING?

> *A NetZero building is a green building which is designed, constructed, operated and deconstructed based on the green building criteria that ensure the building is highly resource efficient and offsets all its associated CO_2 emissions.*

According to the World Green Building Council,

is "a building that is highly energy efficient with all remaining energy from on-site and, or off-site renewable resources".

In NetZero buildings, the consumed energy and CO_2 emissions should be equal to or less than the generated renewable energy on an annual basis. The next will introduce the definition of the terminology which are used to describe types of NetZero buildings. It is worth noting that the term "carbon" in NetZero carbon buildings indicates the CO2 emissions and other greenhouse gas emissions, rather than the carbon element that exists in the planet and all organisms.



Types of NetZero Buildings

NetZero Energy Building	nearly NetZero Energy Building	NetZero Water Building
Net-Zero Operational Carbon Building	NetZero Carbon Building	

NetZero Energy Building (NZE)

Also known as a Zero Net Energy (ZNE) or a Zero Energy Building (ZE); is an energy-efficient building that ***produces as much energy as it consumes over the course of a year,*** usually by incorporating renewables on-site. This definition is delivered by the New Buildings Institute and it refers to the operational energy use only [9].

Nearly NetZero Energy Building

The nearly NetZero Energy Building (nNZEB) indicates that the generated energy does not cover a hundred percent of the energy consumption on an annual basis but covers a high percentage of it. A nearly NetZero Energy Building is defined as a building that has demonstrated significant technical progress towards the goals of energy use reduction, even though it may not have pursued a ZNE path by investing in on-site renewables [9].

NetZero Water Building

Is a building which achieves a balance case between the water consumption from potable water and the reused, treated, and/ or reclaimed water.

NetZero Operational Carbon Building

Is a building that achieves the balance in carbon emissions associated with energy and water consumptions in the operational stage of the building. In other words, the building is a NetZero Energy Building, yet, it attains a water balance case.

NetZero Carbon Building

Is a building that is highly energy, water and material-efficient which compensates the carbon emissions associated with the building operation and the whole life cycle of the building by carbon offset strategies including the production of carbon-free renewable energy either on-site or offsite.

The definition indicates that NetZero Carbon is extended to the operational stage of the building as well as the whole life cycle of the building. The whole life cycle of the building includes the material production stage, the construction stage, the operational stage and finally the deconstruction / demolition stage.

Benefits of
NetZero Buildings

A NetZero Building is a major contributor in the mission of reducing greenhouse gas emissions to mitigate the impact of climate change. As a result, NetZero Buildings have become a revolution internationally in the built environment in the past few years; not only for the environmental benefits associated with these buildings, but also for their social, economic, and political benefits.

NetZero buildings combine the benefits of green buildings which include:

Environmental Benefits

Human Aspects Benefits

Economical Benefits

Environmental Benefits

- **Combat Climate Change:** NetZero buildings produce lower greenhouse gas emissions through the whole life cycle of the building, including the material selection, the implemented technologies and the operation of the building, which contribute to combating climate change.

80% OF CARBON EMISSIONS

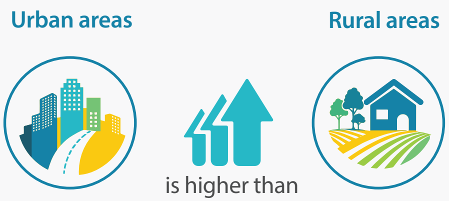
from buildings can be

reduced by 2050

by incorporating low-cost, low-regret strategies. The reduction is measured from emissions levels in 1990. [10]

Provide Better Ambient Outdoor Air: The reduction in CO_2 emissions and other greenhouse gas emissions through the whole life cycle of the building and the building operation activities will keep the ambient outdoor air cleaner so building occupants will tend to use natural ventilation.

Environmental reports show that the concentration in contaminants of the outdoor air in:

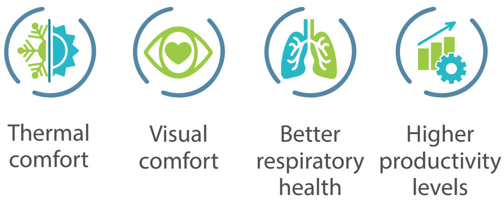


due to the higher development activities and fuel consumptions [11].

The Human Aspects Benefits

Provide an Educational Value: Everyone involved during the design, construction, operation and maintenance of the building will gain valuable knowledge and understanding about the NetZero concept and resource efficiencies. When understanding the concept and implementation of NetZero buildings, users will be more capable to limit their in-house energy consumption and water use.

A Pleasant Home to Live: Energy efficient and NetZero Buildings can achieve higher comfort levels for occupants compared to traditional buildings, such as:



Moreover, to achieve the required energy efficiency, the NetZero building must comply with passive design principles and green building criteria that ensure better indoor air quality such as:

- Increasing daylight
- Increasing sun penetration during the cold seasons
- Increasing natural ventilation

Tightly sealed buildings reduce the possibility of outdoor contaminants or pollutants from entering.

This results with:

- **Better indoor air quality**
- **Low concentrations of CO_2 and pollutants**
- **High ventilation rates**

and can lead to:

- **Up to 8%** Improvements in **occupants performance** [12]
- **23%** Increase in **productivity** from better lighting
- **11%** From better **ventilation**

Economical Benefits

Community Level:

Job creation: NetZero buildings contribute to integrating and benefiting communities by hiring expertise which leads to improved socio-economic dynamics.

Increase market **transformation to green building technologies** and products.

Building Level:

Zero energy and/or Zero Water Bills: Saving on energy and water bills is one of the major benefits of NetZero Buildings. The amount of savings depends on the contributed path of the NetZero. For instance:

$0

A NetZero Energy Building means all energy and electricity bills are equal to zero. In addition, the water bills will be zero in case of the NetZero Operational Carbon Building.

Durability: The techniques of designing a NetZero building rely on selecting more durable materials which last longer and require less maintenance and less replacement.

NetZero Buildings Growth Trends

Due to the great benefits of

NetZero buildings,

the growth across the world since 2000s has risen significantly. It is expected to encompass a wider range of building types and sizes in the upcoming years as policies of NetZero Buildings are expanding.

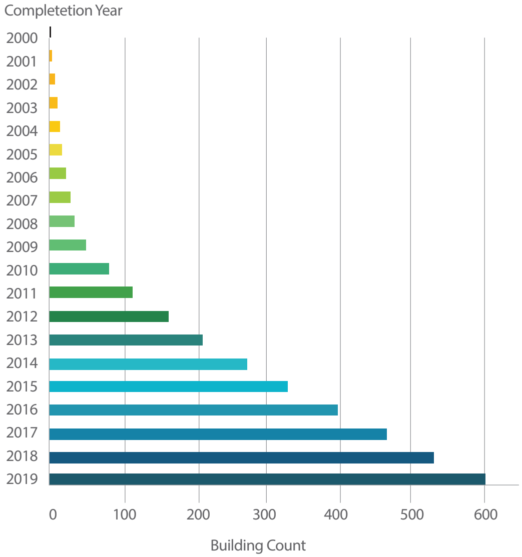


Figure 4: The Growth in NetZero Energy Buildings Count 2000 - 2019 [13].

As Jordan's maturity level in the implementation of NetZero buildings is still developing, there is lack of information on the growth rate. The data in the chart was collected from US to show the growth of NetZero Energy Buildings for all building typologies from 2000 - 2019.The chart shows an exponential growth in the number of NetZero Energy Buildings in the period of nine years. [13].

Accordingly, it is expected that **NetZero Energy Homes will increase by 28% between 2019 and 2028** as a steadily-increasing trend in the whole world. [14]

In conclusion, a NetZero building is an energy-efficient, water-efficient and material-efficient building. Accordingly, the three key aspects to achieving the NetZero goal are:

II.ENERGY

The key to approaching NetZero is to understand the fundamentals of energy and heat flow in buildings. This will enable designers to predict energy consumption that needs to be compensated by efficiency measures and energy generated from renewables.

Energy Definition and Measurement Units.

Energy

is defined as the power (or force) required in a capacity of time. It is also defined as the ability to do work.

According to the energy definition, the energy unit of measurement is Watt-hour. Other units are Joule, Calorie or Btu. The official measuring unit in Jordan is Kilowatt-hour, where:

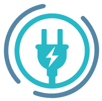
1 kWh = 3.6 MJ (Mega Joule)

These are some Units of Measurement Magnitudes:

Kilo	Mega	Giga
$=10^3$	$=10^6$	$=10^9$

Types of Energy in Buildings:

Buildings use different mixes of energy types, including:



Electricity

Natural gas

Fuel oil

In order to evaluate the energy performance of the buildings, we have to express all of the different energy types in a single common unit.

Source Energy is the primary energy needed to extract and deliver energy to a site, including the energy that may be lost or wasted in the process of generation, transmission and distribution [15].

It is the most equitable unit of evaluation because it includes the energy "losses" associated with generating and delivering the fuel. Moreover, source energy traces the heat and electricity requirements of the building back to the raw fuel input, accounting for the losses and enabling a complete energy assessment [16].

Site Energy: is the amount of heat and electricity consumed by a building as reflected in utility bills and does not include the "losses."

Site energy may be delivered to a facility in one of two forms:

Primary Energy

is the raw fuel that is burned to create heat and electricity, such as:

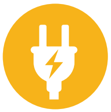

Natural gas

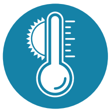

Fuel oil


Coal

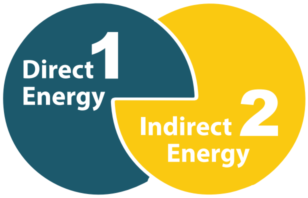
Secondary Energy

is the energy product created from a raw fuel, such as:


Electricity


Heat (received from a district steam system)

On the other hand, energy in buildings is classified into two forms:



Direct Energy:

Energy consumed directly in buildings such as electricity used for lighting, heating, cooling, cooking and electrical devices and equipment. In addition to diesel burned in boilers and LPG used for cooking and heating.

Indirect (Embodied) Energy:

The sum of the energy required to extract, produce, manufacture and transport materials. For instance; the embodied energy in water is the power needed to pump water from a well to the building. For electricity; extracting oil/natural gas, transforming them to electricity, and finally supplying to buildings require energy. Expansively, the concept of indirect energy can be recognized in compliance with the concept of Life Cycle Assessment.

Primary Energy Sources

Globally, energy consumption increased in 2018 at nearly twice the average rate of growth since 2010 because of the robust global economy and the higher heating and cooling needs in some parts of the world. Electricity demand was responsible for over half of the growth in energy needs.

The higher energy consumptions **resulted in rising CO_2 emissions** by 1.7% in 2018. [18]

Figure (5) illustrates the shares of primary energy sources globally in 2018 [18]. As shown, the greatest shares are for oil, coal and gas with 31%, 26% and 23% respectively which are known as the major CO_2 emitters compared to other primary energy sources. On the other hand, alternative and renewable energy shares are 10%, 5%, 3% and 2% to biomass, nuclear, hydro and other renewables respectively.

In conclusion, the shares of alternative and renewable energy sources are still much fewer compared to fossil fuel energy shares.

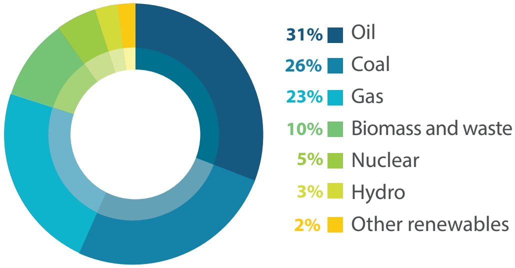
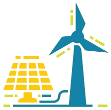


Figure 5: Shares of Primary Energy Sources Globally [18].

Oil demand will reduce after 2025 due to fuel efficiency improvements

especially in passenger cars and fuel switching mainly to electricity. Renewable energy sources will overtake coal in the power generation starting by the mid of 2020s. Upon the 2040, renewables and other low CO_2 emission sources will provide more than half of the total electricity generation.



Wind and solar PV will provide the majority of the electricity generation [19].

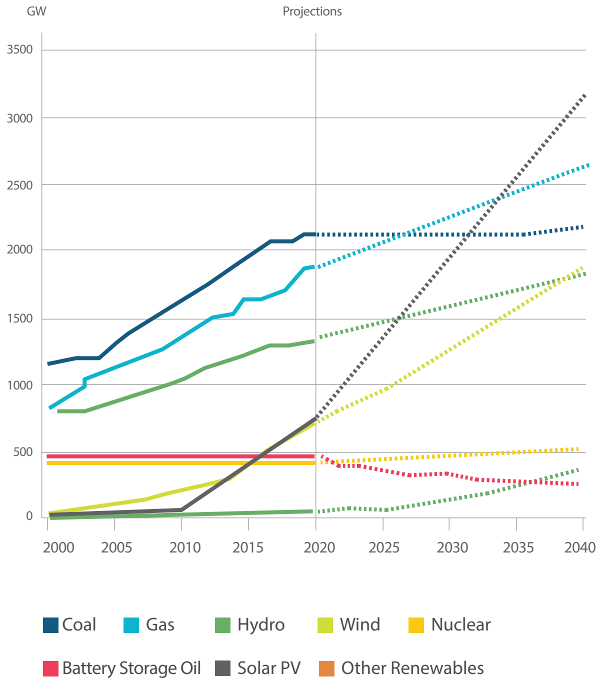
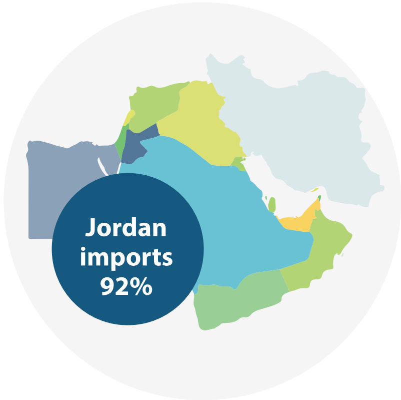


Figure 6: Power Generation Capacity by Source 2000-2040 [19].

Primary Energy Sources in Jordan



of its primary energy sources from Arab countries just like Egypt, some Gulf countries and Syria

However, the Syrian market has been stalled since 2012 [20]. The need to reduce the Jordanian dependency on imported resources was a major reason to encourage decision-makers to announce the National Energy Strategy of 2007 – 2020. The strategy has set a target of generating 10% of its energy demand from renewable energy sources by 2020 and the target is achieved [20]. The national energy strategy 2020 - 2030 sets a target of increasing the renewable energy share to 14% by 2030.

In 2019, Jordan was depending on crude oil and natural gas as the main sources for energy.

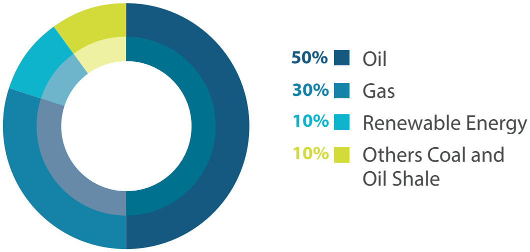


Figure 7: Shares of Primary Energy Sources in Jordan [21].

Furthermore, nuclear energy has been under study since 2007 as a source of alternative energy, and **the target is to provide 30% of Jordan's electricity** using nuclear power by 2030 [21].

Consequently, the first Jordan Research and Training Reactor (JRTR) was built in 2016 with a capacity of 5 MW in consortium with the Korean Atomic Energy Research Institute (KAERI). In addition, it was announced in 2018 that the second commercial nuclear power plant is scheduled for completion in 2025 in cooperation with many other countries [21].

Energy costs are subsidized by the government. Moreover, the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) - which is an independent entity under the umbrella of the Ministry of Energy and Mineral Resources; provides energy efficiency and renewable energy programs with subsidized costs for the public.

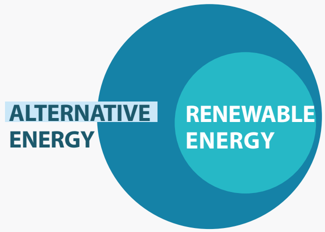
The challenge of increasing primary energy sources to meet the demands can be mitigated by energy efficiency practices. The residential sector plays a key role in this challenge which makes NetZero Energy Buildings gain higher interest as a crucial solution in this challenge.

Renewable Energy vs. Alternative Energy

Is the energy collected from the renewable sources that naturally exist along with the life of the human being such as sun, wind, tides, waterfalls and geothermal.

Refers to all energy sources after fossil fuels. It includes renewable energy, nuclear, biomass and hydrogen gas.

According to this definition, renewable energy is counted as an alternative source. However, renewable energy is the cleanest and the most environmentally friendly source between all other alternative energy sources.



Nonetheless, renewable energy produces Zero CO_2 emissions during energy harvesting, production and collection. Hence renewable energy must be pursued to offset the energy consumed by other energy sources in NetZero buildings. As illustrated in figure 8, some alternative energy sources such as biomass energy produce lower CO_2 emissions compared to fossil fuels when used to generate electricity.

Renewable energy such as solar PV, geothermal, hydropower and wind sources produce much lower CO_2 emissions compared to biomass and fossil fuel sources. Although nuclear energy sources produce low CO_2 emissions like renewable energy sources; nuclear energy is responsible for other environmental and health issues.

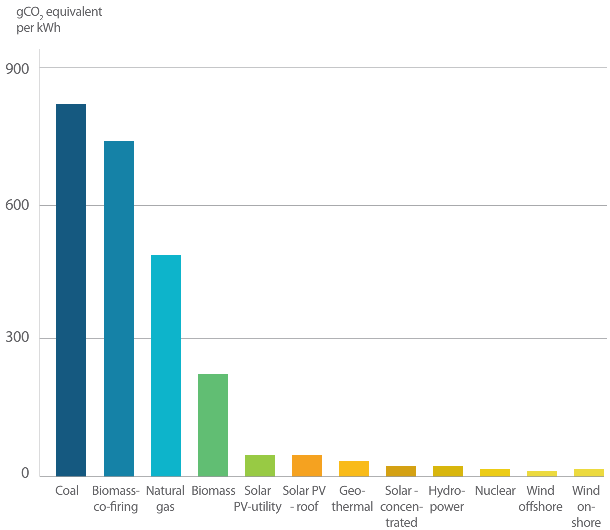


Figure 8: Average Life-Cycle CO_2 Emissions Dioxide-Equivalent Emissions for Different Electricity Generators [17].

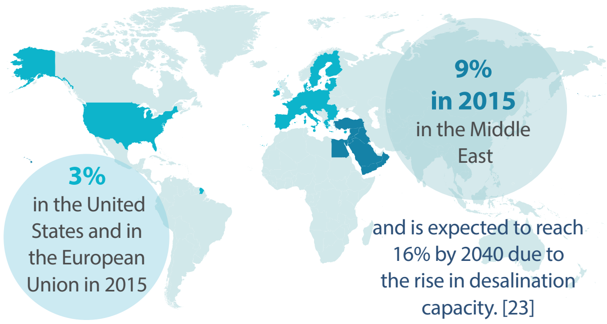
III. WATER

There is an interdependence relation of water and energy which will intensify with significant implications for the water and energy security in the coming years. As with energy resources, water resources face constraints and rising demands as a result of the population growth and climate change. [23]

Globally ,
The amount of
electricity consumption
from the water sector is
around 4%

It is predicted to remain the same percentage by 2040, however; there will be large regional differences.

The electricity share in water sector is:



In a contra versa manner,

water share in the energy sector will increase by:

nearly 60%

between 2014 and 2040.

Some energy technologies require a significant amount of water, such like biofuel production, concentrating solar power, CO_2 emissions capture and storage (CCS) and nuclear power. Switching to lower CO_2 emissions technologies and achieving water balance strategies can help manage water resources and reduce stress on water demand. [23]

Water Resources

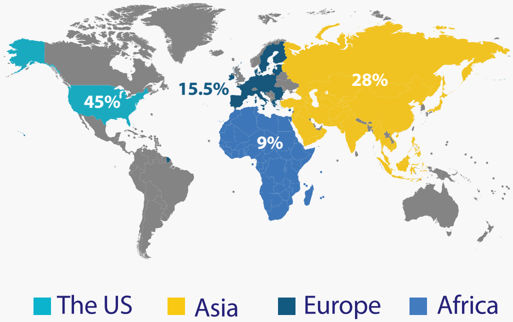
The total water resources in the world are estimated in the order of

43 750 km³/year

Distributed throughout the world according to the climatic zones and land topography.

At the continental level,

The US has the largest share of the world's total freshwater resources. [24]



The chart below shows the increase in freshwater use over the course of the past decade for agriculture, industry, and domestic uses. This dramatical increase raises awareness to the importance of adopting water efficiency measures and achieving water balance in all sectors including buildings.

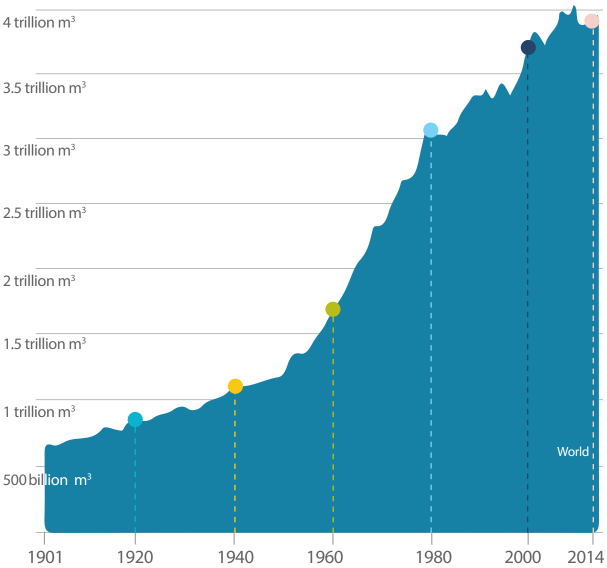


Figure 9: Global Freshwater Use 1900-2014 [25].

Water Resources in Jordan

Jordan has a water scarcity with the current supply of 100 m^3/capita compared to the world share of 500 m^3/ capita [25]. The next chart (figure 10) shows the quantities of water resources and water demands in Jordan. Sustainable resources of water are the consistent water resources which are not affected with the surrounding impacts and the climatic conditions (lack of rain for example). It includes groundwater and surface water resources. [25]

Water resources include:

On the other hand, the demands of water are municipal, industrial, tourist, and irrigation in addition to the water required for oil shale and nuclear power production. As illustrated in Figure 10, the water demands in Jordan exceed the available water resources. For instance, the quantity of total water resources in 2019 was 1064 m^3 where 868 m^3 are from freshwater (groundwater and surface water) resources, 177 m^3 from treated water, and 19 m^3 are from other resources like desalination. In the same year, the quantity of water demand was 1448 m^3 , where 723 m^3 are for municipal, industrial and tourist demands, 700 m^3 are for irrigation needs and 25 m^3 have been used for oil shale and nuclear power production. However, the governmental efforts are expected to increase water supply in the near future to meet the water demands of the country by implementing water efficiency measures and by increasing water quantities from other resources like water treatment.

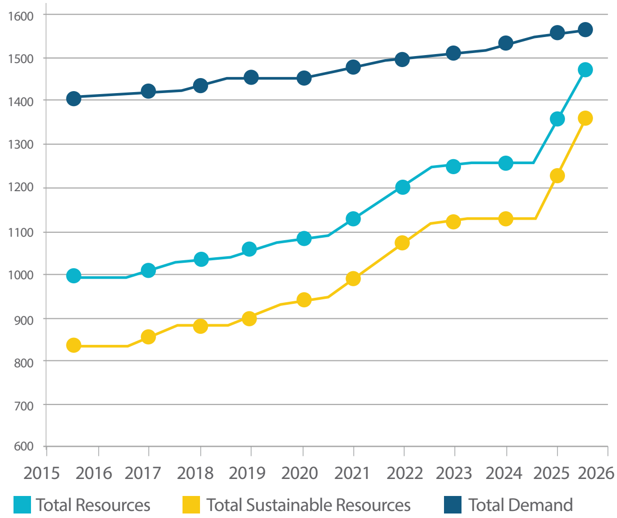
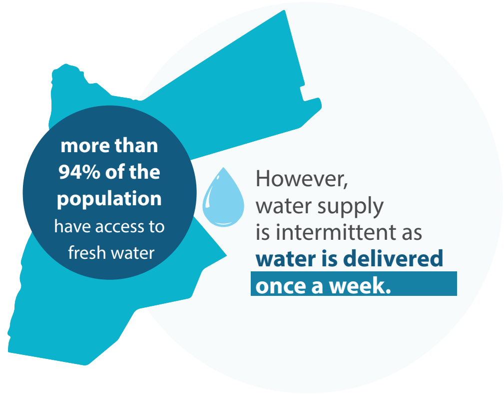


Figure 10: Development of Water Supply and Water Demand (in million cubic meters) in Jordan [25].

Jordan has a high freshwater supply, coverage rate compared to the rest of the MENA region, where:

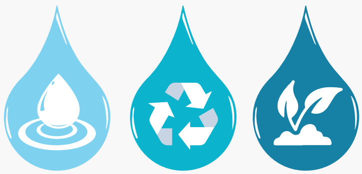


Since the operation of the Disi - Amman conveyor in 2013, the water continuity in Amman has improved, but not in the Northern governorates as their population has increased due to the influx of Syrian refugees. Unlike Aqaba which has continuous water supply from the Disi aquifer.

Resources of freshwater in Jordan are:

Underground water, desalination of seawater and small amounts of surface water

The national water policy includes wastewater treatment strategy as the sanitation covers 93% of the population.

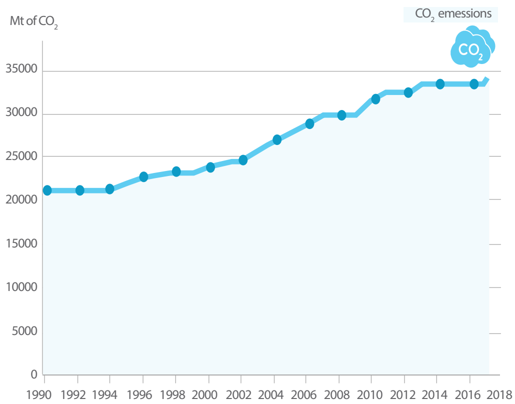


91% of treated water **is reused for agriculture**

Keeping in mind that both water and sanitation costs are subsidized. Combined, the water and sewer bills do not exceed 0.92% of the total household annual expenditures [25]. The threat of freshwater withdrawal in Jordan pushes all efforts to water-efficiency practices. The residential sector is a key factor in the challenge and transforming homes to achieve water balance, i.e. NetZero Water building; is a crucial solution.

IV. CARBON EMISSIONS

As mentioned earlier, Carbon Dioxide emissions are known as carbon emissions. The carbon emissions are globally increasing as shown in the statistics of the total carbon emissions for the whole world from 1990 to 2017 (figure 11). A total increase ratio over the provided 27 years is 60%, urges nations to take immediate actions to reduce carbon emissions and to introduce effective solutions that can mitigate the impacts of the high emissions rates.



In 2017/ CO_2 emessions: 32840.0 Mt of CO_2

Figure 11: Total carbon emission in the world 1990-2017 [26].

In Jordan,

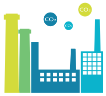
×2

carbon emissions have increased **by more than 188%** from 1990 to 2017 which is more than the double; as displayed in figure 12.

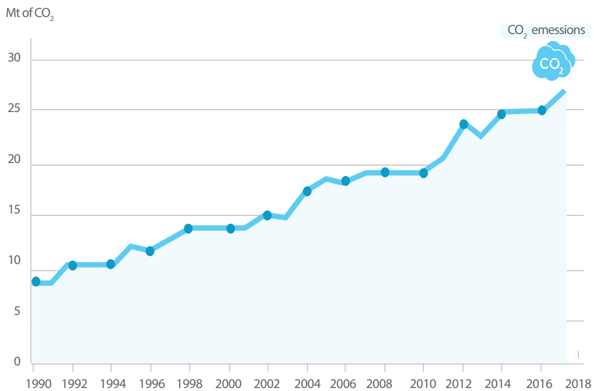
The main sources for increased CO_2 emission in Jordan are:

Buildings

Cars



Industries



In 2017/ CO_2 emessions: **26.0 Mt of CO_2**

Figure 12: Total Carbon Emission in Jordan 1990-2017 [4].

Greenhouse Gas Emissions

Greenhouse gases are released from natural sources and anthropogenic activities into the atmosphere. These gases trap heat in the atmosphere at different levels, and each gas has a different atmospheric lifetime. Each gas also has its global warming effect that can be measured in tons of Carbon Dioxide Equivalent (tCO_2e).

tCO_2e is a measure that allows you to compare the emissions of greenhouse gases relative to one unit of CO_2

The primary greenhouse gases are carbon dioxide, methane, and nitrous oxide. Essentially; scientists use Carbon Dioxide as a benchmark for measuring the heat-trapping ability of other greenhouse gases [28].

To convert the impact of other greenhouse gases into tCO_2e, we multiply the mass of emissions by the appropriate "Global Warming Potential" (GWP).

GWP represents the relative warming effect of a unit mass of a gas when compared to the same mass of carbon dioxide over a specific time period. The following table shows the GWPs of several common greenhouse gases over a 100-year time period [28].

For example, nitrous oxide has a GWP of 265, which means that one ton of nitrous oxide released warms the earth 265 times more than one ton of carbon dioxide over 100 years.

For example,

100 tons
of nitrous oxide
generated annually
by a landfill site

is equivalent to

the effect of
26,500 tCO_2
over 100 years.

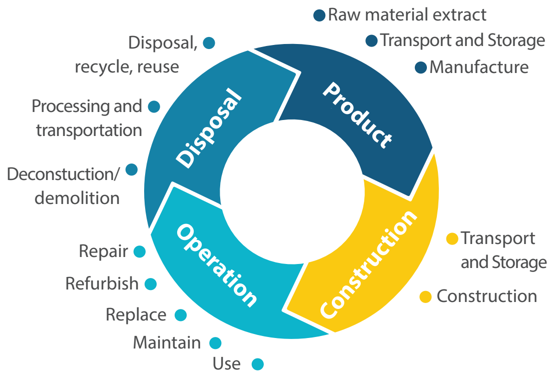
Greenhouse gas		
Chemical formula	**Common name**	**GWP (100 YEARS)**
CO_2	Carbon dioxide	1
CH_4	Methane	28
N_2O	Nitrous oxide	265
CH_2FCF_3	HFC-134a	1,300
SF6	Sulphur hexa-flouride	23,500

Table 1: Greenhouse Gases Global Warming Potential Over 100-Years [28]

Life Cycle Assessment

The Life Cycle Assessment of a building is a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the building throughout its life cycle [29].

In every stage of the life cycle of a building, carbon and other greenhouse gas emissions are released which significantly harm the ozone layer.



Buildings become more resource efficient when they are designed, constructed and operated to resource efficiency standards such as energy efficiency codes and green buildings rating systems. As a result, the carbon emissions decrease for the whole life cycle of the building including carbon emissions associated with the operational stage (from gas and electricity), energy consumed in manufacturing the materials used, their transportation, the construction activities, and the eventual demolition and disposal.

Scientists divide the carbon emissions from the building life cycle in reference to the stages of the building life cycle:

1 Cradle-to-Gate Carbon: Carbon emissions between the confines of the 'cradle' (earth) up to the factory gate of the final processing operation. This includes mining, raw materials extraction, processing and manufacturing.

2 Cradle-to-Site Carbon: Cradle-to- gate carbon emissions and transportation to the site of use emissions.

3 Cradle-to-End of Construction Carbon emissions:

Cradle-to-site carbon emissions in addition to the emissions from construction and assembly on-site.

4 Use Stage Carbon: Carbon emissions associated with refurbishment, replacement, repair and maintenance of the used materials during the operational stage.

5 Operational Carbon: Carbon emissions associated with the operational energy and water consumption while the building is occupied.

6 Embodied Carbon: Carbon emissions associated with the whole life cycle emissions of the building excluding operational carbon.

7 Life Cycle Carbon (Cradle-to-Grave Carbon): Cradle-to-end of construction emissions, use stage emissions in addition to demolition, waste treatment and disposals ('grave') emissions.

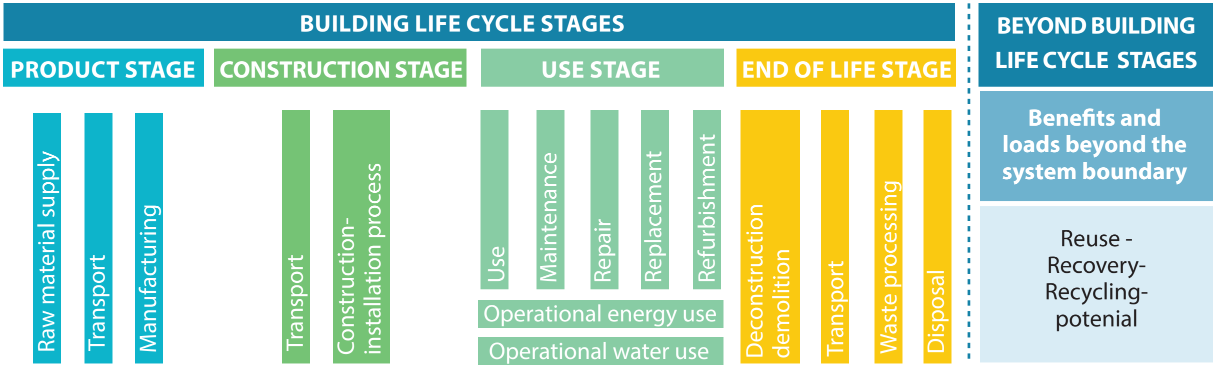


Figure 13: Building Life Cycle Stages [30].

"Beyond the Building Life Cycle Carbon Emissions" or "Emissions' savings" incurred due to reuse, recycle of materials, or emissions avoided due to using waste as a source for another process. Consideration of this stage is key for maximizing resource efficient uses of materials at the end of life. Under forthcoming updates to European standards, it will be mandatory for product manufacturers to report this stage alongside other lifecycle stages in most cases, and will also be required for building assessments. [31]

In the same context, the term Cradle-to-Cradle is related to recycled and reused materials after the end of the building life cycle. Cradle-to-Cradle is defined as the process of making a component or product and then, at the end of its life, converting it into a new component of the same quality (e.g. recycling of aluminum cans) or a lesser quality (down cycling of a computer plastic case into a plastic container, which is then turned into a building insulation board, eventually becoming waste). Carbon emission calculations associated with these materials are less than their alternatives [32].

Construction and Demolition Solid Waste Management

The type of waste in focus for NetZero Buildings is Construction and Demolition waste (waste resulting from the construction and demolition activities of the building mainly composed of construction materials).

Although some NetZero Standards and certification schemes consider the zero operational waste (also called municipal waste that is waste resulting from occupants' activities during the building operation stage), the ISO 15978 considers the sustainability of construction works and the generated waste only from the building construction materials.

The amount of **construction and demolition waste in Jordan is estimated at 2.6 million m^3/year [33].**

Construction and demolition waste management intends to reduce the waste transported to landfills by reducing, reusing or recycling strategies.

C&D materials often contain bulky and heavy materials such as:

Concrete

Trees, stumps, earth, and rock from clearing sites

Asphalt (from roads and roofing shingles)

Gypsum (the main component of drywall)

Wood (from buildings)

Plastics

Salvaged building components (doors, windows, and plumbing fixtures)

Bricks

Glass

Metals

The selection of the construction materials from the design stage will play a significant role in reducing the amount of construction and demolition waste. For example, selecting recycled and reused materials will reduce the amount of waste sent to the landfill, consequently, greenhouse gas emissions will decrease.

V. SETTING THE GOALS

The target of constructing a new building or retrofitting an existing building to a Net Zero can be achieved in three paths:

NetZero Energy Building:

It focuses on the energy consumed in a building during its operational use. Steering the building to be energy-efficient from the moment of occupancy to the end of the building life. This path excludes water and material usage. Zero Energy addresses the balance of source energy used on the site rather than emissions, where the renewable energy strategies offset the building energy consumption.

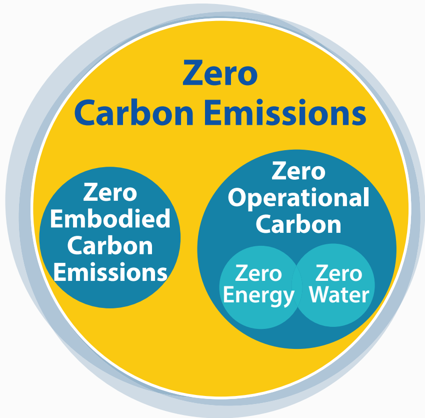
NetZero Water Building:

NetZero water occurs when a buildings' annual water balance is zero.

If the building achieves a NetZero Energy and NetZero Water; it becomes a NetZero Operational Carbon.

Net Zero Carbon Building:

NetZero Carbon buildings measure carbon emissions over the whole life cycle of the building, which is the total embodied carbon and operational carbon. It sounds to be a complicated target; however, technical tools and resources will help mitigate the mission.



02

IMPLEMENTATION OF

NETZERO BUILDINGS

I. GETTING STARTED

The decision to develop or convert a building to a NetZero Building can be taken at any time during the life of the building. The earlier this decision is made; the more flexible it is to make design modifications with less cost, this relation is illustrated in Figure (14). If a project is well planned and the NetZero building goals are incorporated in the early stages of the design, the possibility of reducing the negative impacts is greater and the cost of criteria implementation is minimized [34]. For instance, selecting the building envelope materials which contribute to achieving the NetZero goals in the early stages of the design is better than changing the building envelope materials after the operation; such a change would be costly and constrained by many limitations.

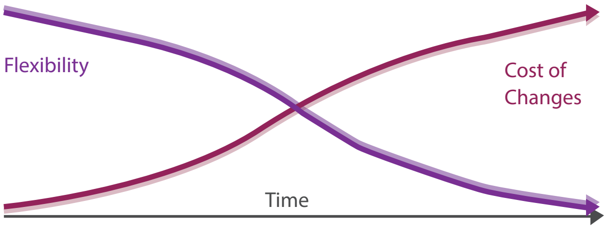


Figure 14: The Relation Between the Cost and Flexibility of Making Changes During the Life of the Building [34].

The design of a NetZero Building follows the strategies of sustainable building design which depend on the conservation, reduction, and reuse of resources. As a last resort, NetZero Buildings employ the offset strategies - such as renewable energy systems; to compensate for the building's consumption. The three main resources in focus in the approach of NetZero buildings design are:

The strategy of designing a NetZero Building consists of three steps, which needs to be followed in a down-top approach. Figure 16 illustrates the design steps. [35]

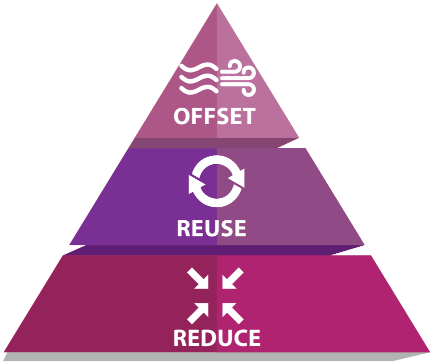


Figure 15: The Pyramid of the Three-Stepped Strategy.

The base of the pyramid is the approach of reducing the demand on the resources. The reduction and reuse approaches are attained by implementing energy, water and material efficiency measures. The offset approach is attained using renewable resources which compensate the impact of the remaining energy, water and materials. The next three sections will discuss the efficiency and the offset measures for each of the three resources. Generally; the calculations of the carbon emissions as well as the estimations of the energy and water consumptions are made in the design stage of NetZero buildings. Figure 16 illustrates the NetZero Building workflow. [36]

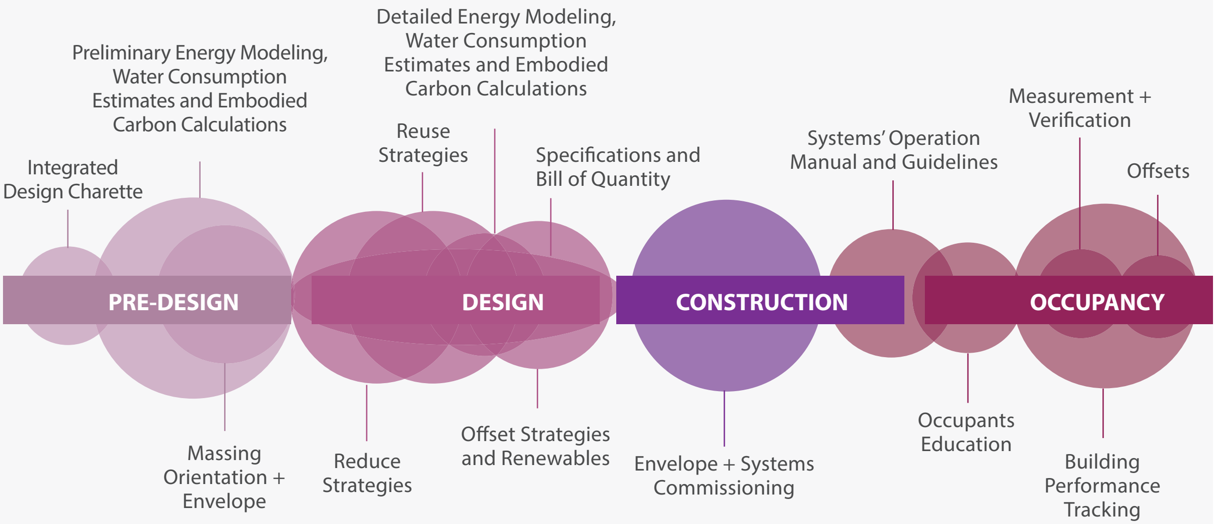


Figure 16: Net Zero Building Workflow [36].

This workflow can be implemented either for a new constructed building or for an existing building. Re-designing and retrofitting buildings is a big challenge, however, transforming them to NetZero can accomplish the highest rate of carbon emissions reduction.

NetZero for New and Existing Buildings

The targets of NetZero Building can be met either in the case of the design and construction of new buildings, or in the case of retrofitting of existing buildings.

For new buildings; a straight forward target can be identified starting from the pre-design (planning) stage or at any stage before occupancy; however, as mentioned earlier in this section; the earlier this decision is made; the more flexible it is to make design modifications with lesser cost. Because the building is not operated yet, computer software tools are used to predict the energy consumptions.

> *The software tools perform energy modeling and provide a representation of the anticipated energy consumption of a given building.*

It permits a comparison of energy performance, given the proposed energy efficiency measures, and comparing the results to the baseline measures which are given in a reference energy efficiency code such like the building energy efficiency code of Jordan, or the ASHRAE which is an international reference. [37]

Some examples of these energy modeling tools are RETScreen, eQuest, and Energy Plus Portal.

Water consumption is estimated in liters per person per day as referenced in the national building codes. Life Cycle Assessment tools are used to predict the carbon emissions associated with the construction materials. More details about life cycle assessment tools will be presented in the section of (NetZero Carbon Buildings).

For buildings in operation, energy and / or water auditing is performed before planning for the NetZero implementation in order to:

01 Ensure that the actual performance matches the design and achieves the energy and/ or water balance.

02 Help with understanding how energy and/ or water is used in the building.

03 Identify the losses and provide cost-effective ways to use the energy and/ or water within the building.

The baseline of energy and water consumption obtained from the audit is measured over the last year of operation.

A survey in the United Kingdom of over 100 built environment experts including leading architects, property developers and public and private sector building administrators, showed that:

51%
consider 'energy efficiency and decarbonization' as the **most important outcomes** for the retrofit of buildings [38].

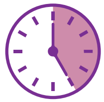
Retrofitting existing buildings is the easiest way to achieve NetZero targets of the Paris Agreement, because construction materials already exist and quantities of new materials are considerably less than those required in a new construction. [39].

When planning for the retrofit of a building, the payback period of newly adopted systems and materials is crucial. Many cost-effective measures can contribute to a high performance building.

For example;

the replacement of

6  light bulbs



turned on for 5 hours a day
from incandescentto LED bulbs
in a house

will save 5% of the cost of lighting
which equals to JD 7.2 per month

Assuming that the cost of the bulbs is JD 30, the payback period of the bulbs is only 4.2 months. [40].

For the next three sections (NetZero Energy, NetZero Water and NetZero Carbon Buildings) the introduced measures will be indicated by the symbol  when applicable to existing buildings and  when applicable to new buildings.

NetZero Applicability in Affordable Housing:

Affordable housing is a terminology used for housing of medium or below medium income families. An affordable house can be either an apartment in a residential building (Multifamily building) or a stand-alone single family building (Dar or a small villa). Affordable houses can be energy efficient by achieving green design, construction and operational principles which guarantee the best use of resources and energy saving methods, with few or no financial burdens. Once the house is green, it can achieve the NetZero goals through offset strategies. [40]

This booklet introduces measures and strategies of NetZero Building which are applicable for affordable houses. Because technology is continuously evolving, some of the introduced measures are expensive today but will become affordable in the future. It should be kept in mind that all the introduced measures contribute to reducing the climate change impact and contribute to the resilience against the increasing demand on resources (energy, water, and material). Moreover, the booklet uses the term "NetZero building" in general to indicate all types of residential buildings; either a single or a multi-family building.

II. NETZERO ENERGY BUILDING

A NetZero Energy building is achieved when the consumed energy of a building over 12 months of operation is equal to or less than the generated energy on-site or off-site over the same period.

The codes of energy efficiency provide the minimum threshold requirements to be used as a baseline reference, then the building energy measures are designed to meet or overcome the threshold. Specifically in Jordan, the Jordan National Building Codes embrace a group of standards that provide a comprehensive reference for the design of energy-efficient buildings as well as for the best installation requirements of the MEP equipment and devices.

In particular, the "Thermal Insulation Code" defines the thermal design principles for buildings in Jordan, such as the types of materials used in thermal insulation, the design requirements and design calculations. Another reference of high importance for the design of NetZero Building is the "Energy Efficiency Building Code" which provides the minimum requirements in architectural and MEP systems' design to lower energy consumption and improve thermal performance. The three stepped-strategy to accomplish a NetZero Energy Building starts by reducing energy consumptions, reusing the residual energy, and offsetting energy by renewables. Figure 17 illustrates the measures of Energy Reduction, Reuse and Offset which will be introduced to achieve a NetZero Building.

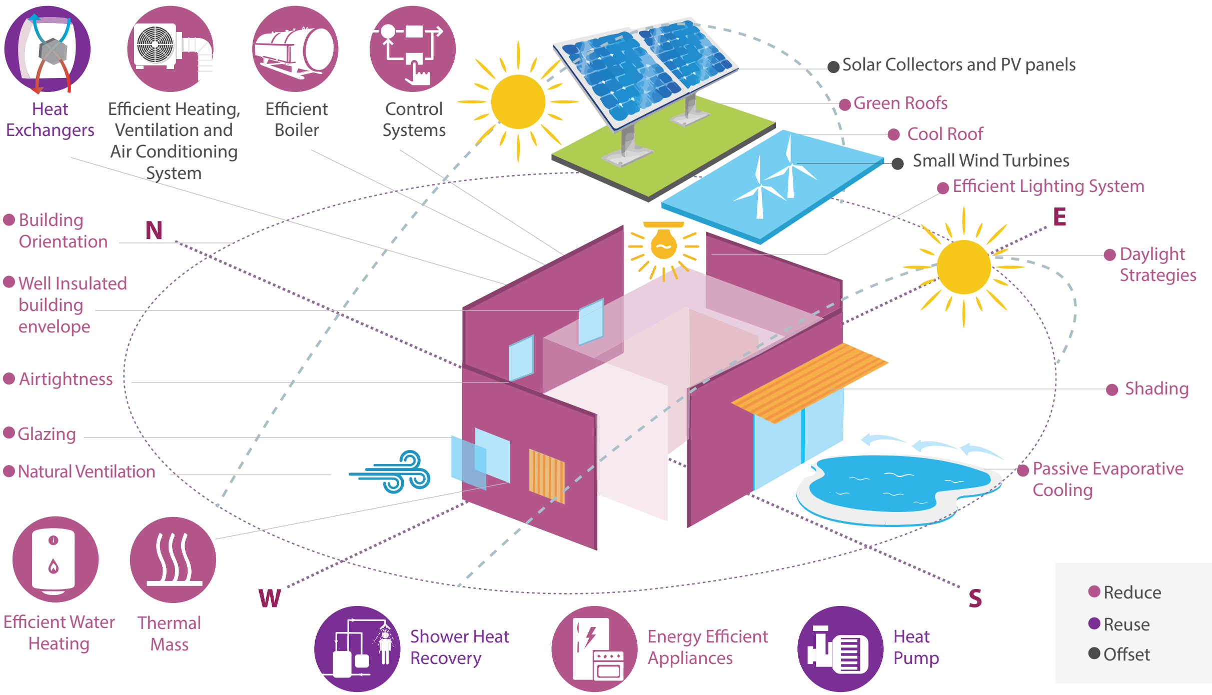


Figure 17: Measures of Energy Reduction, Reuse, and Offset to Achieve a NetZero Building [41], [42].

First - Reduce Energy

The target of NetZero Energy buildings is to lower energy consumption and generate enough energy to match or exceed the remaining energy consumptions. Therefore, the first step is to reduce the demand for energy by implementing energy efficiency measures, thus reducing the generation capacity required by renewables to reach the NetZero Energy.

In Jordan, energy needs are mainly driven by heating loads as illustrated in figure 18 which shows the general energy breakdown of sample of 400 typical residential apartments in Amman.

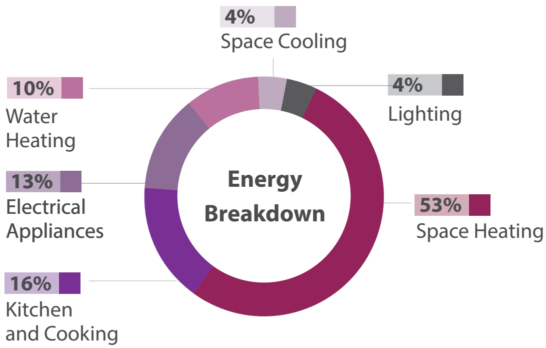


Figure 18: Energy Breakdown in Residential Apartments in Amman [43].

The energy needed for heating and cooling is defined as: "Heat to be delivered to, or extracted from, a conditioned space to maintain the intended temperature". [44].

A Net-Zero Energy building must be designed to have minimal heating and cooling energy needs. Otherwise it will require plenty of generation to compensate for these loads.

Climatic Analysis

The first step in designing Net Zero and energy efficient buildings is to analyze and understand the climatic characteristics of the area in order to implement design strategies that fit the climate and provide comfortable environments for occupants in the building.

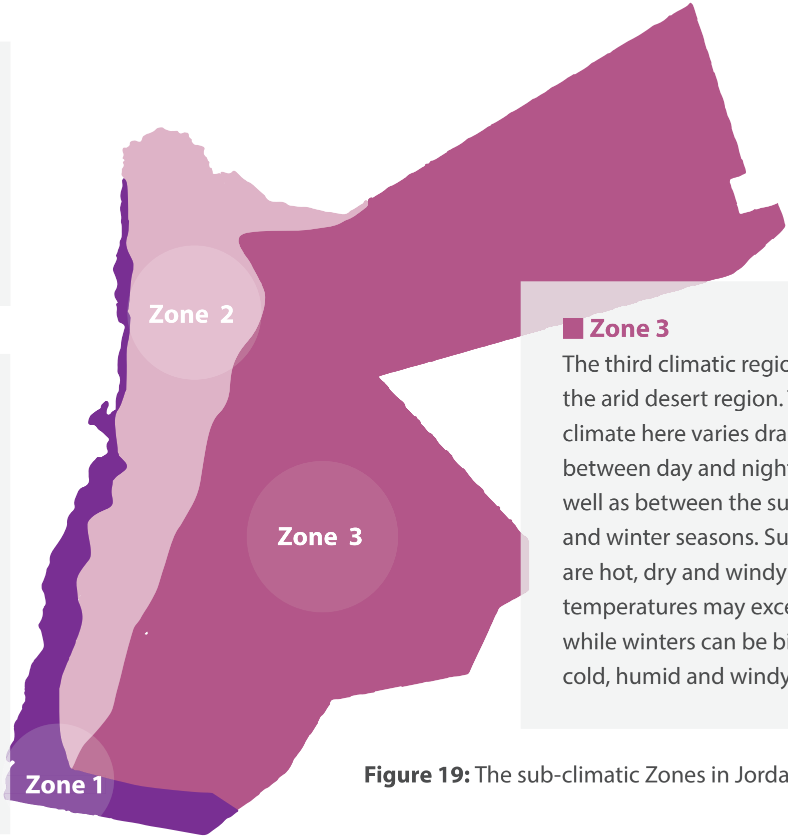
Jordan consists of three climatic zones as shown in figure 19. The climate is influenced by Jordan's location between the subtropical aridity of the Arabian Desert and the subtropical humidity of the east.

Zone 1

The first climatic region is the Rift Valley in the west which includes the Jordan Valley, the Dead Sea, Wadi Araba and Aqaba.

Zone 2

The second climatic region is the eastern highlands and the central region which include the capital Amman, Ajloun, as well as the southern parts including Al-Mujib, Karak, and Shoubak, the climate in this region is characterized by warm summers and fairly cold winters.



Zone 3

The third climatic region is the arid desert region. The climate here varies dramatically between day and night, as well as between the summer and winter seasons. Summers are hot, dry and windy where temperatures may exceed 40ºC, while winters can be bitterly cold, humid and windy.

Figure 19: The sub-climatic Zones in Jordan [46].

The distinct variations in climatic conditions in the three climatic zones within Jordan advocates for varying approaches to building energy efficiency measures [45].

Passive Design Measures

Passive design (also known as the Smart Bio-Climatic design or Climatic Design) deploys local characteristics and climate intelligently and considers the environmental aspects surrounding the building in a sustainable design. Passive design strategies are the most cost effective approach to achieve NetZero buildings as they contribute to lowering energy consumptions by providing solutions that can be implemented in the building design.

The following are the best practice measures of passive design in Jordan to reduce the energy consumption of the building:

Building Envelope

The building envelope consists of all of the building's components that separate the indoor environment from the outdoors. Building envelope includes exterior walls, foundations, roof, windows and doors.

Using roof and walls assemblies with low U-Value (low Thermal Transmittance) and high Thermal Resistance (R-value), reduces the amount of heat transfer between the inside and the outside of the building.

The Jordan Energy Efficiency Code requires a minimum U-value equal to:

- **0.57 W/m².k for a typical solid external wall assembly.**
- **0.55 W/m².k for a typical roof assembly.**

Achieving U-values lower than those specified in the Energy Efficiency Code is recommended for lower energy consumption and better thermal comfort. Lower U-value can be implemented either by choosing materials with low values of conductivity or by increasing the thickness of the assembly. [47] .

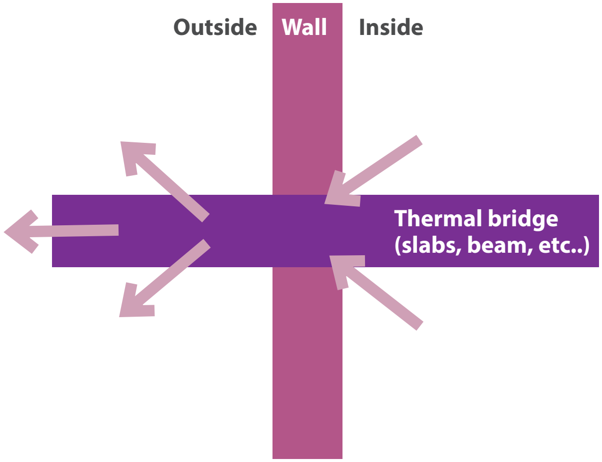
The following factors are crucial in the design of the building envelope:

Airtightness:

The building envelope must be properly sealed to avoid cracks and crevices especially around openings and at the intersections between slabs and walls. The building design must address the joints in the building envelope, and it is critical that proper implementation of these details be carried out during the construction of the building.

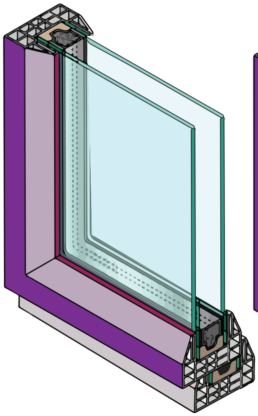
The proper installation methods can be found in the manual for each material and in the related building codes, i.e. the Jordan Energy Efficiency Code. Compact buildings have a small amount of structural connections resulting in a lower chance for thermal bridges and air leakages.

A thermal bridge occurs when a building envelope allows the heat to flow or to be channeled from warm to cold spaces, this results in a lower temperature of the interior side of the thermal bridge, and thus reduces thermal insulation of the entire construction.

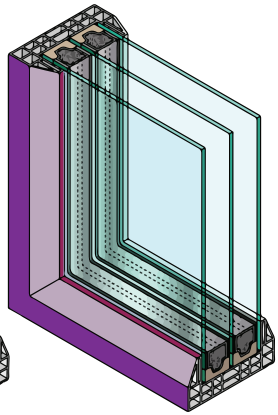


Glazing:

Windows are the weakest thermal link in the building envelope. The amount of thermal transmittace for windows is expressed in U-value. Lower U-Values can be reached by using double or tripple glazing.



Double Panes Glass



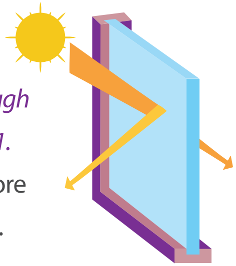
Triple Panes Glass

Some important characteristics in the selection of glazing are:

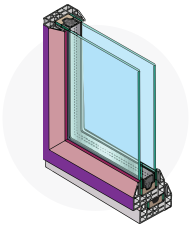
Solar Heat Gain Coeffecient (SHGC);

(Fraction of solar radiation admitted through the glass. SHGC is expresssed on a scale from 0 to 1 where the lower the SHGC is, the less solar heat it transmitts and the greater its shading ability).

Light Visible Transmittance (VT), *(is the amount of the visible portion of the light spectrum that passes through glass , expresssed on a scale from 0 to 1.* A higher VT value means there is more daylight transmitted into the space).



In Jordan, the double paned glass is the most cost-effective and energy – efficient choice.



The national energy efficiency code requires [47]:

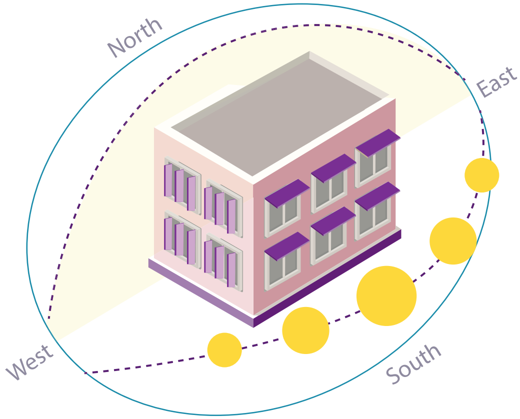
1. A minimum U-value for double glass **Aluminum frame** window of 3.4 W/m^2.k
2. A maximum **SHGC** of 0.25
3. A maximum **glazing area** of 36.4% from the total external façade
4. A minimum **VT** of 0.45.

Window and Door Frames:

Selecting window and door frames with low U-Value can limit heat losses. UPVC frames, for example, have higher thermal insulation than aluminum frames.

Building Orientation

Building orientation affects the amount of solar heat gains entering the building.



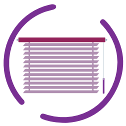
In the Northern Hemisphere, it is recommended to design the building so that the long elevation faces South-North. In this case, the South elevation will be exposed to the sun for most of the day, while the North elevation will be daylit but not exposed to direct sun radiation. However, this is not the preferred orientation in extremely hot climates such as the desertous region in

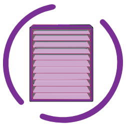
Jordan, which requires reducing the exposure to the south façades due to the hot sunny days over the course of the day. Treatment measures are usually introduced to mitigate the direct sun radiation, this is detailed in the shading measures section. The east and west elevations are exposed to direct sun only during the early morning for the east elevation, and at the sunset time for the west elevation. Reducing the east and west elevations will reduce the amount of intense solar radiation.

Shading

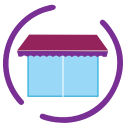
Shading is used to minimize the building's exposure to the sun and to reduce overheating.

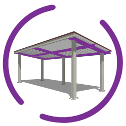
Different types of shading can be applied:


Blinds


Louvres

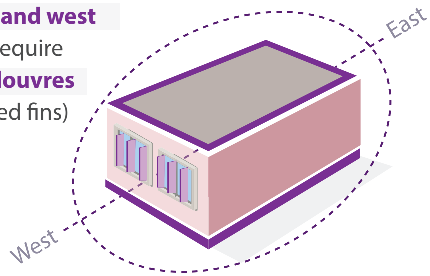

Vegetation


Overhanging facades

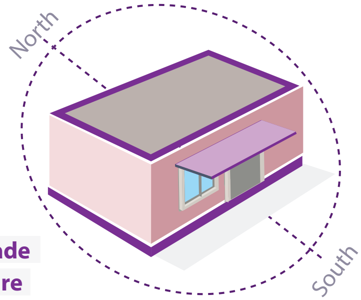

Cantilevered roofs

The type of shading selected depends on the climate, facade orientation and the design of the building.

For example,
the east and west facades require **vertical louvres** (also called fins)



South façade requires **horizontal louvres** (called overhangs)



The North façade does not require any shading.

Movable shading devices – either fins or overhangs; are preferred, in order to be removed during the cold season and allow solar gains into the building.

Daylight Strategies

Increasing the amount of daylight entering a building reduces the use of artificial lighting which consequently reduces the electricity consumption, and enhances the well-being and comfort of the occupants. In addition to selecting glazing with high visible transmittance values; some other passive design techniques increase daylight penetration such as skylights, clerestories, light shelves and atriums.

The above mentioned elements should be to properly shaded in hot climates, and properly insulated in cold climates. Other strategies for increasing daylight include designing shallow buildings (figure 20) instead of deep buildings (figure 21), which can improve the uniformity of daylight in the space.

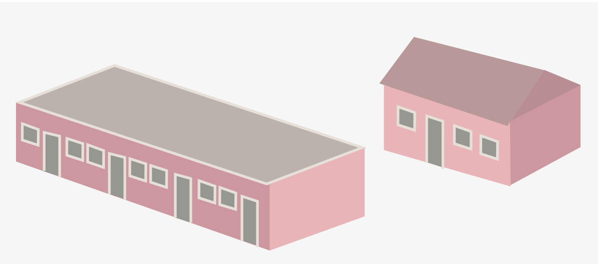


Figure 20: Shallow Plan Buildings.

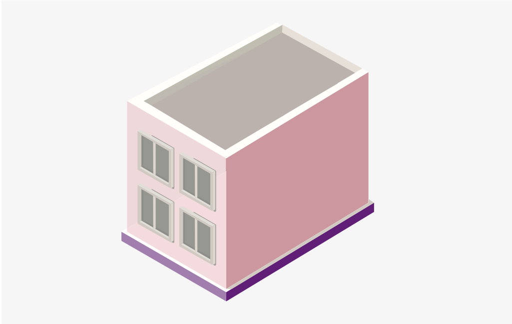
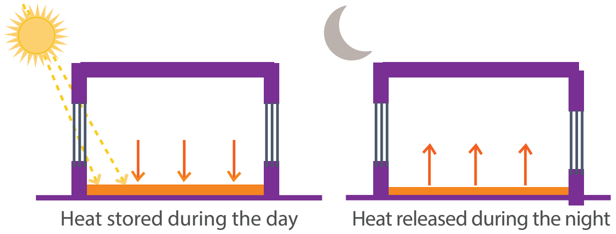


Figure 21: Deep Plan Building.

Thermal Mass

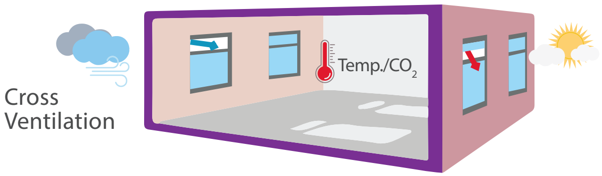
Thermal mass is a property of the mass of a building which enables it to store heat. A heavy structure is slower to heat up and is slower to cool down. On the contrary, a light weight structure has low thermal mass and is thereby faster to heat up and faster to cool down. For instance; when outside temperatures are fluctuating throughout the day, a large thermal mass building can flatten out the daily temperature fluctuations. This is because the large thermal mass of the building will absorb heat when the surroundings are higher in temperature (i.e. during the day), and release it when the surroundings are cooler (i.e. during the night).



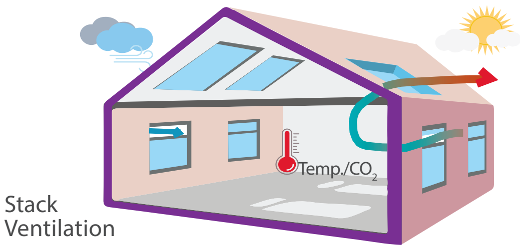
In summer; cooling the building's interior mass with night breezes to cool the internal thermal mass is useful when the night temperatures between 17-22 ˚C and with unobstructed interior to promote flow. Closing windows during the heat of the day will keep cooling in and heat out. In winter; southern glass must be exposed to winter sun during the day, that will raise the temperature of the mass while the mass will release heat at night. However; to avoid the loss of the absorbed heat at night, windows and curtains must be closed.

Natural Ventilation

Outside air is cooler during the night than during the day. Opening windows during the night allows natural ventilation into the building through cross ventilation and stack ventilation. Cross ventilation is achieved when there are operable windows on both sides of the room which allows air movement from one side to another due to the difference in air pressure.

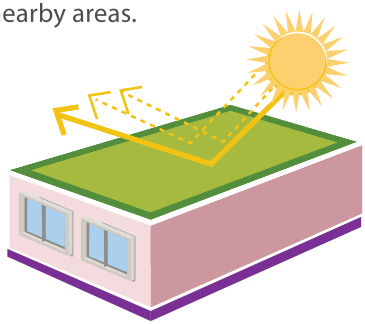


Stack ventilation occurs when there are operable windows in the room and an opening to allow air outlet at the roof. When air enters the room, it becomes warmer and exits from the roof opening.



Green Roofs

Green roofs reduce the energy needed for cooling because they reduce the amount of solar radiation on the roof, and thus reduce the heat transmitted, or absorbed by the building. Besides, green roofs decrease the heat island effect, which describes the higher temperature in some built areas compared to other nearby areas.



Cool Roofs

Cool Roofs reflect more sunlight and absorb less heat than a standard roof.

They can be made of:

Highly reflective type of paint

Highly reflective tiles

Cool roofs are beneficial because they reflect sunlight lowering the temperature of the roof. Cool roofs reduce the heat absorbed and transferred into the building, and reduce the energy required for cooling.

Passive Evaporative Cooling

The incoming fresh air is cooled when passing through or over a wetted surface. This air is used to cool down a building passively with natural ventilation as illustrated in figure 22. Another option is to use a wind catcher or an evaporative cooling tower where water at the top of the tower is evaporated, creating a downdraft of cooled air that is chanelled into the building, (figure 23). Passive evaporative cooling reduces the cooling demand and can (partly) replace mechanical cooling. This principle is suitable for hot and dry climates (deserts).

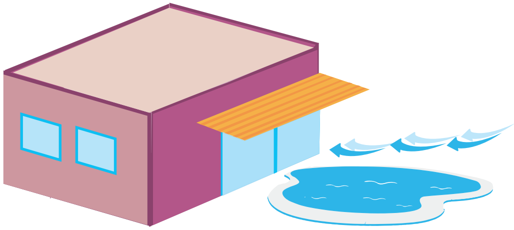


Figure 22: Water Feature in the Direction of Hot Winds.

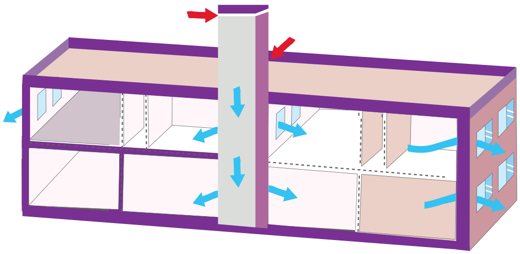


Figure 23: Natural Ventilation (cooling) by a Wind catcher.

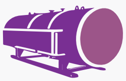
Moreover, trees provide shade whilst transpiration helps to increase the cooling effect in the surrounding.

Active Energy Efficient Systems

Active reduction is a term that refers to reducing the energy consumption of electrical and mechanical systems. The selection of energy-efficient equipment during the design of the electro-mechanical systems should focus on maximizing the energy savings. **The following guidelines provide general recommendations for some heating and cooling systems:**

Boilers

Select boilers with high-efficiency values. A boiler efficiency is measured by its Annual Fuel Utilization Efficiency (AFUE).



Gas boilers are more efficient than diesel boilers. Gas boilers AFUE **can be up to 97%** while the AFUE in diesel boilers ranges between 80-90%.

Equally important is the effectiveness of the distribution network; the lower the network losses, the more energy-efficient. In addition, when transporting hot water for Domestic Hot Water (DHW) and space heating applications from the boiler to the radiator or hot water tap, heat losses occur. By decreasing the distances of the pipes, these losses will be minimized. Pipes can be insulated from the above to prevent heat losses.

Air Heating and Cooling System

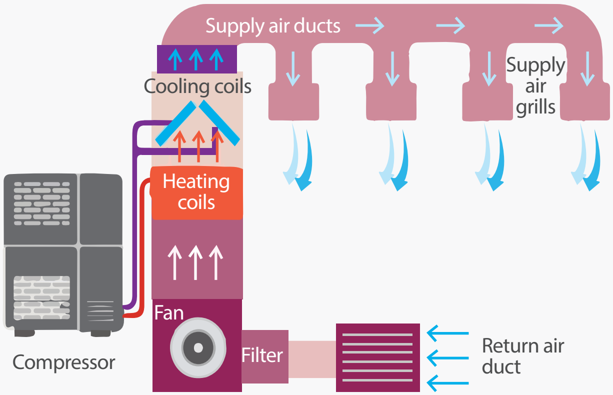
Split unit systems, Variable Refrigerant Flow systems (VRF) and packaged unit systems are the most widely used systems by Jordanian households. Select equipment with a high Coefficient of Performance value (COP).

The Coefficient of Performance is defined as the ratio of useful (or actual) heating or cooling provided to the energy (or electricity) required by the considered system.

If your system is ducted, ensure that the ducts are well-insulated and sealed.

HVAC System

Heating, Ventilation, and Air Conditioning systems (HVAC) are used to provide heating and cooling as well as ventilation in one unit or device instead of three separate units. They can be air side or water side systems. Split units, VRF and packaged units are examples of airside HVAC systems. Chillers are the most common example of water side HVAC systems.

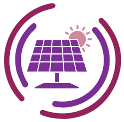


Water Heating

There are many types of water heaters:

Electric water heaters.

Water heating by combi boilers (either gas or diesel).



Solar thermal system

The solar thermal system is a renewable energy technology. However, most of the new solar technologies are hybrid electric- solar. In case of sun absence, the electric water heater is automatically turned on. The types with the highest efficiency must be selected for a NetZero Building.

Mechanical Ventilation

Passive design can guarantee high levels of natural ventilation. However, in the case of hybrid ventilation; the mechanical ventilation mechanism must be designed so it is activated only when natural ventilation fails to achieve a certain ventilation capacity. This can be done automatically with sensors that measure natural ventilation capacity or CO_2 levels inside the space. Mechanical ventilation equipment efficiency is provided in Coefficient of Performance value (COP). Usually, mechanical ventilation is part of the HVAC system.

Control Systems

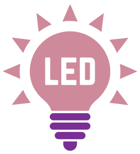
For heating and cooling systems, programmable controls like thermostats and central control systems contribute to better energy saving.

Programming the thermostat
to provide constant heating or cooling setpoint temperatures can increase energy saving.

Setting specific times for the system
to be turned on and off can ensure no excess energy will be consumed.

Building automation can also control all building systems and equipment; thus, further energy savings can be achieved.

Electric Lighting system



LED Lamps are the most efficient
type of lighting.

LED lights have a
25 times longer lifespan
than traditional light bulbs, and the **lighting quality of LED is much better** compared to other types.

LED lights' efficacy usually ranges between 80-110 lumens/watt, however; the technology is still changing and higher efficacy values can be found. [49]

Energy-Efficient Appliances (Energy Labels)

The grade of energy efficiency for home appliances is expressed with the letters A-G and called energy labels.

A+++ Label
is given to the most efficient appliances

G Label
is given to appliances with high energy use.

In order to increase energy savings to meet the target of the NetZero building, home appliances with the "A" family label must be selected.

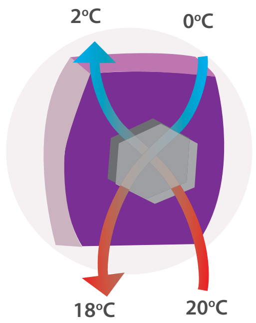
Second – Reuse Energy

Energy reuse strategies and technologies can be found in various energy applications. In general, the concept is to use the residual energy from the heating or cooling process to reduce the energy required to heat up or cool down air or water.

The most common energy reuse strategies are:

Heat Exchangers in Ventilation Systems

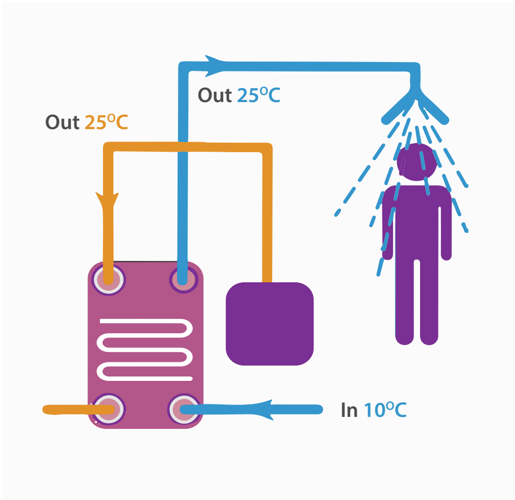
A heat exchanger is a system used to transfer heat between two or more fluids. Heat exchangers are used in both cooling and heating processes. They recover thermal energy in the return air plenum before it is pumped out of the building by the mechanical exhaust. Using heat exchangers reduces the power which is required to heat up or cool down the supply air in a space.



The most common type is **the counter-flow heat** exchanger which **has an efficiency of 90-95%.**

Shower Heat Recovery

Warm drainage water can be used to preheat the cold freshwater supply by extracting this heat by the heat recovery system.



Heat Pump

A heat pump extracts heat energy from a low-temperature heat source into higher temperature heat reservoirs, used for space heating and domestic hot water as shown in figure 24.

The Coefficient of Performance for a heat pump is very high because the output heat is much higher than the input heat, generally 4-5. The source of the heat pump varies from: ventilation return air, ground, groundwater, outdoor air, solar collectors, waste heat, etc.

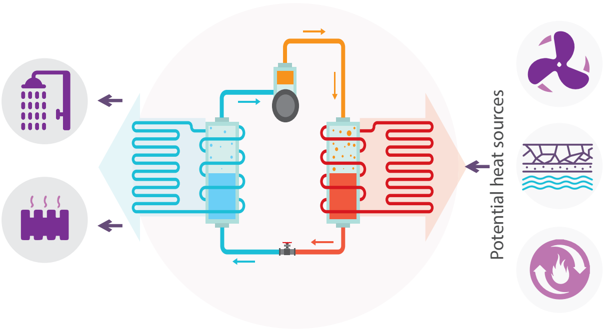


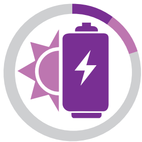
Figure 24: The Concept of the Heat Pump.

Third - Offset Energy

The third step, after the implementation of energy reduction measures and the reuse of residual energy is to offset the remaining consumption in order to achieve the balance case of the NetZero building. Energy can be generated from sun, wind and geothermal. Multiple technologies generate energy using these sources, yet the solar technologies are the most efficient and the most commonly used in Jordan.

Technologies which utilize the sun, wind and geothermal and can be used in households to generate energy on-site are:

Photovoltaic Panels



PV panels

convert solar energy to electricity

with an efficiency rating of 10-20%.

PV panels can be located on the rooftop, attached to the façade or used as shading in gardens. PV systems are used widely in Jordan from 2015 onwards, and are considered the second used renewable systems after solar collectors. The optimal orientation of PV panels is mostly to the south, and panels must be placed in unshaded areas to maximize its efficiency. However, PV plant designers make different choices for the panels orientation and location depending on the specific conditions of the building location. The cost of the PV system is reducing over time as the technology is evolving.

A simple payback calculation

for a system which **costs JD 3,000** predicts that the PV system can **return its cost in 5 years** assuming an average **monthly electricity bill of JD 50.**

Financial installments for PV systems are provided by system suppliers, local financial entities and banks. More details in this context are provided in the section titled "Jordanian National Programs towards Achieving Net Zero" in Chapter 3 of this booklet.

Figure 25: Colored PV panels on the Facade of a Building - La Cita Vita *(www.flickr.com/photos/la-citta-vita/5964294206/)*.

Solar Collectors

Solar collectors absorb solar radiation and convert it into heat. This can be achieved either by using anti-freeze fluid that runs through pipes and absorbs the heat of the sun or by using evacuated tubes. Similar to PV panels, solar collectors can be located on the rooftop (figure 26) or attached to the façade (figure 27). Solar collectors are often combined with a storage tank to provide domestic hot water demand and contribute to space heating by connecting to converters or to underfloor pipes (underfloor heating). Heat pumps can be used as heat boosters when solar collectors are used for space heating.

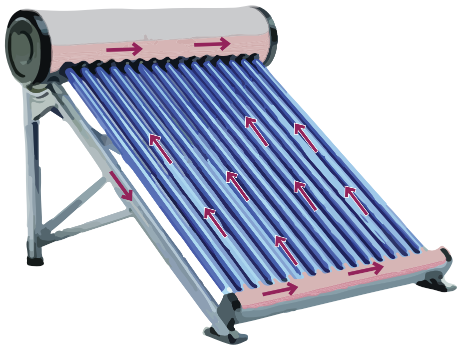


Figure 26: Rooftop Solar Collector.

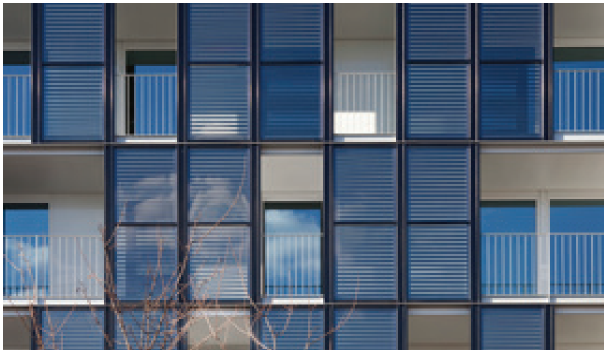
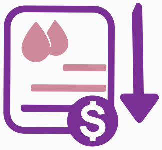


Figure 27: Evacuated Tube Collectors in the Façade [50].

Moreover, solar collectors can be used throughout all regions in Jordan. They contribute to the **reduction of water heating expenses by 70-90%,** **with a payback period of four years,** and continue to provide hot water with zero cost afterwards. [40]



Small scale wind turbine

Wind turbines convert wind power to electricity. They can be placed on roofs or in large gardens where the wind is not obstructed by the surrounding buildings, see figure 28.

Nonetheless, the output of these turbines is relatively small, since the wind inside urban areas is not consistent and powerful enough to drive the turbine.

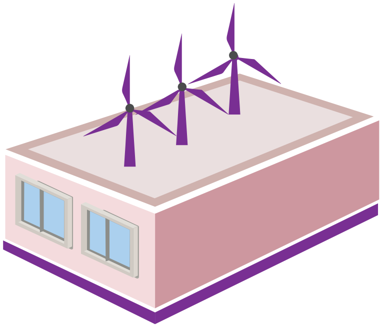


Figure 28: Small Scale Wind Turbines for Homes.

The Calculation Method Used to Offset Building Energy Consumption

Before proceeding to the design of the renewable energy plant, the amount of the consumed energy must be defined and calculated in relevance to the source- to- site ratio. The source-to-site ratio is defined as the ratio between the energy used to create the power (source energy) and the energy consumed in the building (site energy). **The following steps provide the details of the calculation method:**

Step 1: Energy Types

Define all energy types used in the building. For example; the following energy types are consumed in a single-family house.

Electricity used for cooling, lighting and home appliances

Diesel used for heating

LPG used for cooking

Step 2: Annual Energy Consumption

Find out the annual consumption for each type of energy. If the building is a new construction, energy modeling is required to estimate consumptions. In the case of an existing building, consumption is aggregated over a period of 12 months of building operation.

Example: Assume we have a house with the following annual energy consumption:

- **Electricity = 8 MWh**
- **Diesel = 2 m³**
- **LPG = 75 kg (6 cylinders X 12.5 kg)**

Step 3: Conversion of Energy Units

Convert all energy units to one common energy unit (MJ or kWh). The table below can be used for reference.

Table 2: Energy Conversion Factors to MJ and kWh [28].

Fuel	unit	Energy density	
		KWh	MJ
Natural Gas	m³	9.8	35.2
Petrol	liter	9.7	34.9
Diesel	liter	10.6	38.2
Kerosene	Kg	12.1	43.5
LPG	Kg	13.7	49.3
Coal	Kg	9.7	28.6
Dry wood	Kg	5.3	19

Back to the previous example, we can convert all energy consumptions to kWh using the table:

- **Electricity consumption = 8,000 kWh.**
- **Diesel density = 2 m³ = 2x1000x10.6 = 21200 kWh.**
- **LPG density = 75 kg x 13.7 = 1027.5 kWh.**

Step 4: Source Energy Calculation

Calculate the annual source energy balance for each energy type. The next table provides source- to- site ratio in reference to the United States average ratios, this is considering that source energy ratios in Jordan are closest to those in the United States. [16]

Table 3: Source to Site Ratios for Different Energy Types.

Energy type	Source-to-site energy ratios
On-site renewable energy	1.00
Electricity	2.8
Natural Gas	1.05
Diesel	1.01
Kerosene	1.01
LPG	1.01
Coal	1.00
Dry wood	1.00

Continuing with the same previous example, when applying the figures in this table, the total source energy consumption is:

- **Electricity = 8,000 x 2.8 = 22,400 kWh.**
- **Diesel = 21,200 x 1.01 = 21,412 kWh.**
- **LPG = 1027.5 x 1.01 = 1037.8 kWh.**

The total source energy for this house =

44849.8 kWh.

Then the amount of the generated renewable energy must compensate 44,850 kWh of consumed energy.

III. NETZERO WATER BUILDING

NetZero Water buildings are buildings where the amount of reused, treated and reclaimed water returned to the original source and used instead of potable water is equal to the building's total potable water consumption. Water balance is achieved when reused, treated and reclaimed rainwater covers or exceeds all the building's potable water needs. [52]

Water Balance =

Potable Water Consumption -

Reused, Treated or Reclaimed Water

In other words, NetZero Water Buildings are achieved when the water balance in the above equation is equal to zero. The water balance calculations exclude drinking water. The concept is different in Zero Water from Zero Energy because energy calculations take into account the efficiency of the power plant's generation while the water supply factor is not part of the water balance calculations. As mentioned earlier, water consumption of a new construction building is estimated in liters per person per day as referenced in the national building codes. For existing buildings, water bills for 12 months are used to calculate the amount of water consumption. Figure 29 illustrates the measures of water reduce, reuse and offset which will be introduced to achieve a NetZero building.

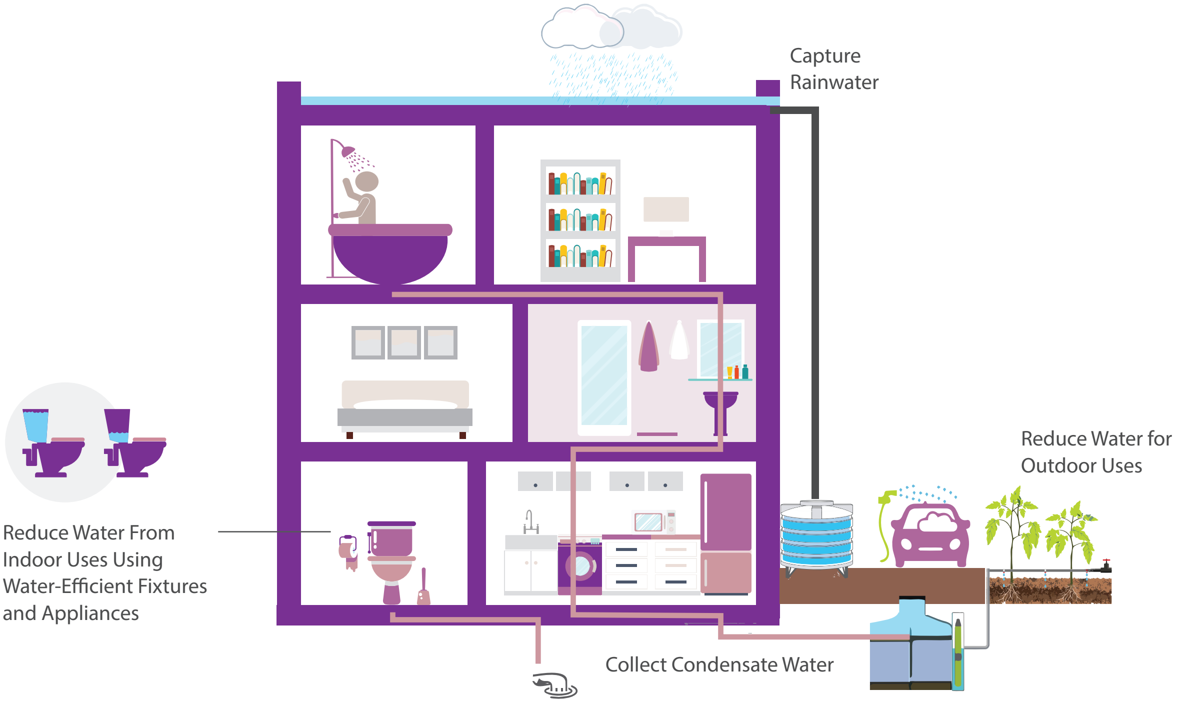


Figure 29: Measure of water reduce, reuse, and offset to achieve a netZero water building.

First - Reduce Water

The water reduction strategies can be applied for indoor and outdoor water uses.

Reduce Water from Indoor Uses:

Water-efficient fixtures and appliances are the best strategies to reduce indoor water consumption. These strategies include: installing high efficiency toilets, as well as low flow lavatory faucets, kitchen sinks and shower heads. In addition, water labeled fixtures, such as WaterSense labeled fixtures (Figure 30), are convenient choices for water-efficient fixtures and fittings which can significantly reduce water consumption, thus, contributing towards a water balance case.

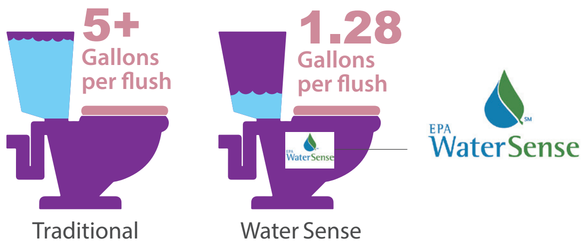


Figure 30: Water Sense Labeled Fixture.

Furthermore, water home appliances (tumble dryers, clothes washers, dishwashers, etc.) which are energy labeled should also meet water efficiency requirements (expressed in A-G labels where A+++ is the most energy efficient). Energy efficiency Label indicates water consumption but it ranks the equipment based on their energy consumption. To seek for the best water savings, the appliances with the "A" family label must be selected then select the equipment with the lower water consumptions. (figure 31).

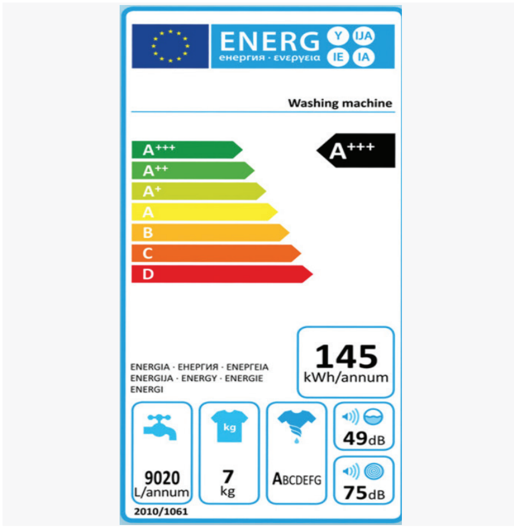


Figure 31: Energy Label- Category of A+++ for a Washing Machine.

Reduce Water for Outdoor Uses

Outdoor water use is mainly for irrigation. Using efficient irrigation systems and best practices in softscaping contribute to significant water savings. In particular, drip irrigation is the most water-efficient irrigation system.

Other strategies to to reduce water for outdoor uses include using grey water for irrigation (see the next step: Reuse Water) and planting trees and shrubs with no or low watering needs such as native and adapted vegetation.

Native vegetation: are those that have developed naturally for many years without human assistance in a specific region and evolved to the geography, hydrology, and climate of that region [54].

Examples of native plants in Jordan include:
Olive, eucalyptus and cedar trees which thrive throughout the highlands and the Jordan Valley, Rosemary and other shrubs which can be found throughout all regions in Jordan, Acacia trees and a variety of Aloe Vera plants thrive in the desert regions. [55]

Adapted plants: are species of plants originally native to other regions of the world that have become acclimated and established in a new area. These plants thrive in the new location without being harmful to existing native plants or wildlife, and are able to grow and reproduce without human intervention. [54]

Second - Reuse Water

Unlike NetZero Energy, the Reuse Water strategies not only reduce the potable water consumption but also compensate it. The reused rainwater, the collected condensate water and the treated grey and black water are the main sources that contribute to the water reuse approach.

Collecting rainwater and condensate water are the **most affordable and low cost** measures for the residential sector.

Captured rainwater

Rainwater captured from the runoff of roofs and hardscapes can be collected in separate water collection tanks. Rainwater collection tanks are provided with filters installed at water inlet pipes. Collected rainwater can be used for all indoor and outdoor water uses when water passes by a high filtration media, but not for drinking use. Figure 32 illustrates the water network connection with the rainwater collection tank.

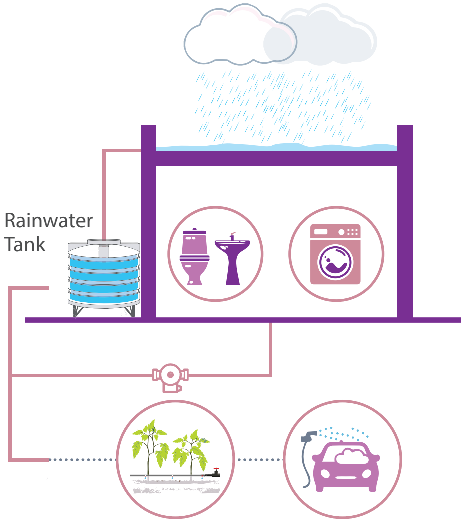


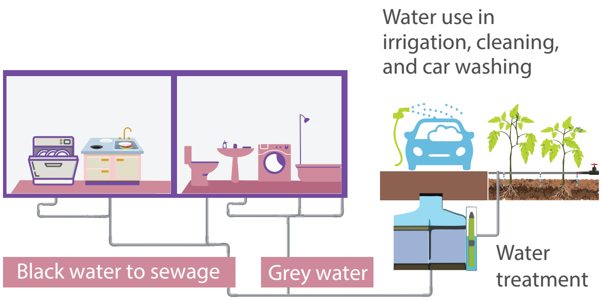
Figure 32: The Water Network Connection with the Rainwater Collection Tank.

Collected Condensate Water

Condensate water collection device is installed to collect water condensation from the cooling system. The collected condensate water can be re-used for irrigation, toilet flushing, and other uses.

Grey Water and Black Water Treatment

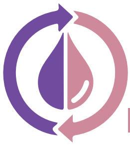
Grey water is defined as "the household waste water which has not come into contact with toilet waste, kitchen sinks or dishwashers". Black water is "All household wastewater which includes water from toilets, kitchen sinks and dishwashers".



There are multiple types of wastewater treatment plants that differ according to cost, the efficiency of treatment and the area of space required for the plant allocation. The small, localized plant is the most recent technology for homes and residential buildings. It is usually located underground and requires a small area that varies according to the capacity of the plant.

The centralized system is suitable for small community wastewater treatment plants (serving a group of buildings in a neighborhood, for example).

The cost of wastewater treatment plants is considered relatively high. The most cost efficient in this context is to benefit from treated water provided by the municipality from centralized, large scale wastewater treatment plants (serving a large area, like a city or so).



In Jordan, the quantity of **treated water** from the centralized wastewater treatment plants is **176.6 cubic meter** which accounts for **16.6% of total water resources in 2019.**

So far, these quantities of treated water are mainly used for agricultural and industrial uses but not for residential uses [25]. However, the governmental efforts are seeking to increase the quantity of treated water which could become a resource for residential uses as well. Until then, underground, localized, small wastewater treatment plant is more applicable for the residential sector.

It is important to separate the treated water from the municipality water using a dual pipe system. The end uses of treated water depend on the level of treatment. In general, toilets flushing, irrigation and cleaning are possible uses.

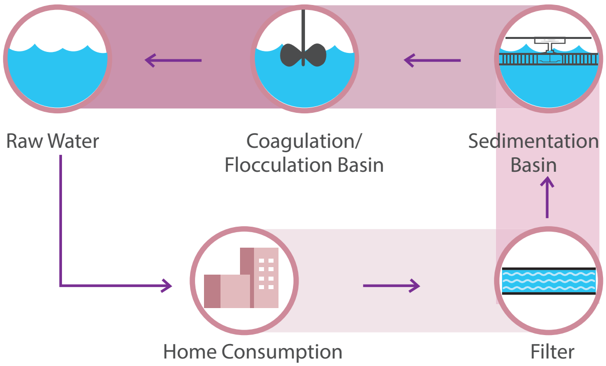


Figure 33: The treatment stages in a water treatment plant.

Third - Offset water

Implementing Water Reduction strategies in the building design can result in lowering the water consumption. The water reuse strategies are practically the water offset strategies, as well. A NetZero water building compensates the consumed potable water for all water uses but not for drinking water. To verify compliance with a water balance case; a simple calculation can be carried out for the two variables of the water balance equation; the potable water consumption and the water reused, treated, or reclaimed.

Example: A house uses efficient water fixtures, fittings and appliances. The water consumption of the house is 180 m^3 annually, assuming that 60 m^3 of collected rainwater and grey water from some household uses is filtered and reused annually and 120 m^3 of treated water is supplied to the house from a central wastewater treatment plant.

Potable water consumption = **180 m^3****

Reused and treated water =

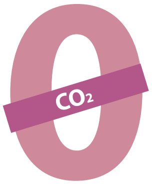
60 m^3 + 120 m^3 = 180 m^3**

Water Balance = **0**, which means that the house is a **NetZero water building**.

** The figures in this example are only to illustrate the numerical calculations.*
In 2017, the Water Supply quantity was 125 liter/ capita/ day [73]. For a small family of 4 adults; the average water consumption is around 180 cubic meters.

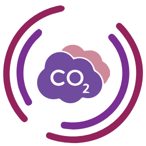
IV. NETZERO CARBON BUILDING

NetZero Carbon Buildings are highly energy efficient buildings that are fully powered from on-site and/or off-site renewable energy sources (WorldGBC).



NetZero Carbon is achieved when the amount of carbon emissions released annually is compensated **by renewables or by planting trees so that the difference** between the released carbon and the sequestered carbon over the course of the year **is equal to zero or negative.**

There are two approaches for NetZero Carbon Buildings which are associated with two types of carbon emissions:



Embodied Carbon

Operational Carbon

Calculations of embodied CO_2 emissions are based on the construction materials that make up a building. Thus, quantity surveyors are the ideal professionals to be involved in these calculations. The values of the embodied carbon associated with each of the construction materials must be researched and published for each country based on the availability of the material and the production stage rationale in that country.

The carbon emissions of the construction materials are presented in kilograms CO_2 equivalent (kg CO_2e) per unit of the material.

The data and factors associated with the construction materials are demonstrated in the manufacturer's Environmental Product Declaration (EPD) or in a generic database called "the Inventory of Carbon and Energy (ICE)".

EPD *is a standardized way of communicating the environmental effects associated with a product or system's raw material extraction, energy use, chemical makeup, waste generation, and emissions to air, soil and water [56].*

Specifying a material EPD should be provided by a qualified program operator on behalf of the product manufacturer or industry organization as outlined and referenced in ISO 14025.

The following are some leading database for materials EPD:

- Mindful Materials.
- International EPD System.
- Sustainable Minds.
- UL Spot.

The Operational CO_2 emissions is associated with the carbon emissions produced during the operational stage of the building, due to energy consumption and water use.

Approaching both Net Zero Energy and Net Zero Water in a building means that the building is Net Zero operational building. The "Use-Stage Carbon" demonstrated by maintenance, repair, replacements and refurbishments of building elements contribute to the embodied carbon calculations and not to the operational carbon calculations, although emitted in the operational stage.

First - Reduce Carbon Emissions

In order to reduce carbon emissions from construction materials we need to reduce their quantity, and select materials with the lowest carbon emissions.

The following strategies and measures contribute to reducing carbon emissions from materials:

Use Regional Materials:

Regional materials are building materials or products that have been extracted, harvested, or recovered, as well as manufactured, within the region.

The maximum distance from the site of construction to the origin of the construction materials varies amongst references.

The Jordan Green Building Guide specifies a maximum distance of 450 Km from the center of the construction site to the location of the origin of the construction materials.

Regional materials have lower transportation carbon emissions because travel distances are minimized (Figure 34). For instance, some materials produce low carbon emissions during extraction and manufacturing, however, if a material requires transportation over long distances, then the embodied carbon emissions associated with this material may become higher than its alternatives.

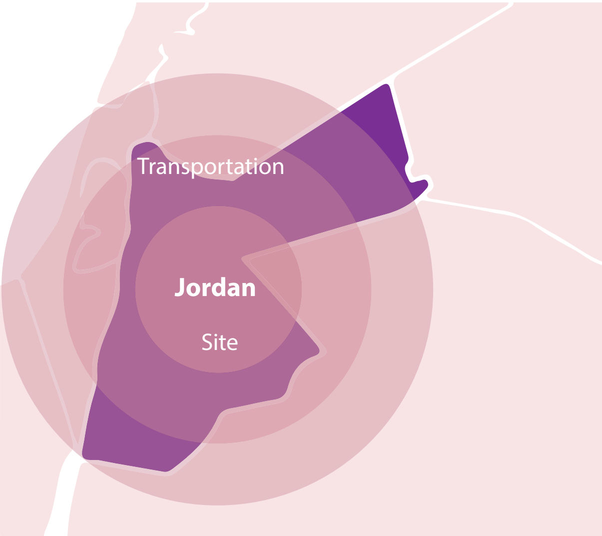


Figure 34: The Zone of Regional Materials for a Site in the Center of Jordan (Info graphic).

Use Durable Materials:

Durable materials require **less refurbishment and replacement,** thus **reduce the carbon emissions** during the building Use-Stage.

Specify Low-Carbon Products and Materials:

Cement production emits high levels of carbon and other greenhouse gases which if replaced will emit lower CO_2 emissions. The most common example is cement-free concrete. There are two common replacements for cement in concrete mixtures which have lower carbon emissions: GGBS (Ground Granulated Blast Furnace Slag) and PFA (Pulverized Fuel Ash). See figure (35)

Figure 35: A Concrete Cube with 50% GGBS Content.

Low Carbon Design Details:

Exposed concrete ceilings (Figure 36), hollow core slabs, and the use of plaster boards to dispense with paint are examples of low carbon design options because of the reduced quantity of materials used for these design details.

Figure 36: Exposed Ceiling.

Use Carbon Sequestering Materials:

Carbon sequestering materials and products are approved third-party certified materials and products which follow sustainable harvesting and extraction strategies. The embodied carbon associated with the Production Stage of these materials is less than the embodied carbon associated with their alternatives .

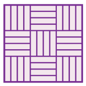
For example, the Forest Stewardship Council (FSC) certification is a sustainable harvesting standard for wood products that uses scientifically verified carbon sequestering, figure (37).

Figure 37: The Label of the Forest Stewardship Council Certification.

Second – Reuse and Recycle Materials to Reduce Carbon Emissions

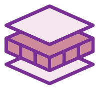
Reused Materials are materials retained in their original function for a new use without the need to be manufactured or processed again.

Examples of materials that can be reused:


Flooring Materials


Window Frames


Framework Timber


Insulation Materials

On-site reused materials have zero carbon emissions in the Production Stage and very low emissions during construction as they are re-used in the same location compared to other off-site alternatives. Nevertheless, the carbon emissions from off-site reused materials are mainly associated with distances and modes of transportation. Structural elements such as slabs, roofs, walls and partitions, can be reused as well. Furthermore, a study about reusing construction materials concluded that "glass facades, spiro facades, and wooden interior walls, are reusable elements that can substitute new products with an environmental advantage compared to new products". The study reveals the technology of reusing various structural materials for purposes other than their original use and clearly indicates the lower carbon emissions and the lower impact on climate change for the studied materials. See Figure 38. [57].

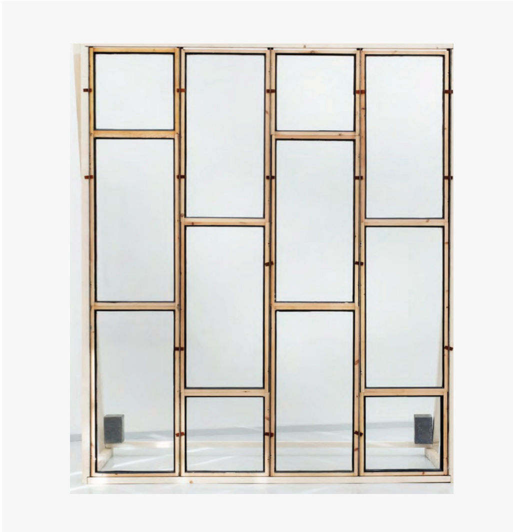


Figure 38: Prototype of Glass Interior Wall with Ornamental Wedge Fixations.

As a second option, materials can be recycled either on or off the construction site. A higher percentage of recycled content indicates that fewer raw materials were extracted. The most widely used recycled construction material is reinforced steel bars. The recycled content in steel bars varies between 25% to 90%. Reinforced steel bars are an example of cradle -to- cradle construction material.

As illustrated in figure 39, the carbon emissions associated with the production of steel with 97% recycled content is 50% less than carbon emissions from the production of steel with 25% recycled content. Unfortunately, the production of 97% recycled content steel accounts for 29% of the total global steel production compared to 71% for the 25% recycled content steel. [58]

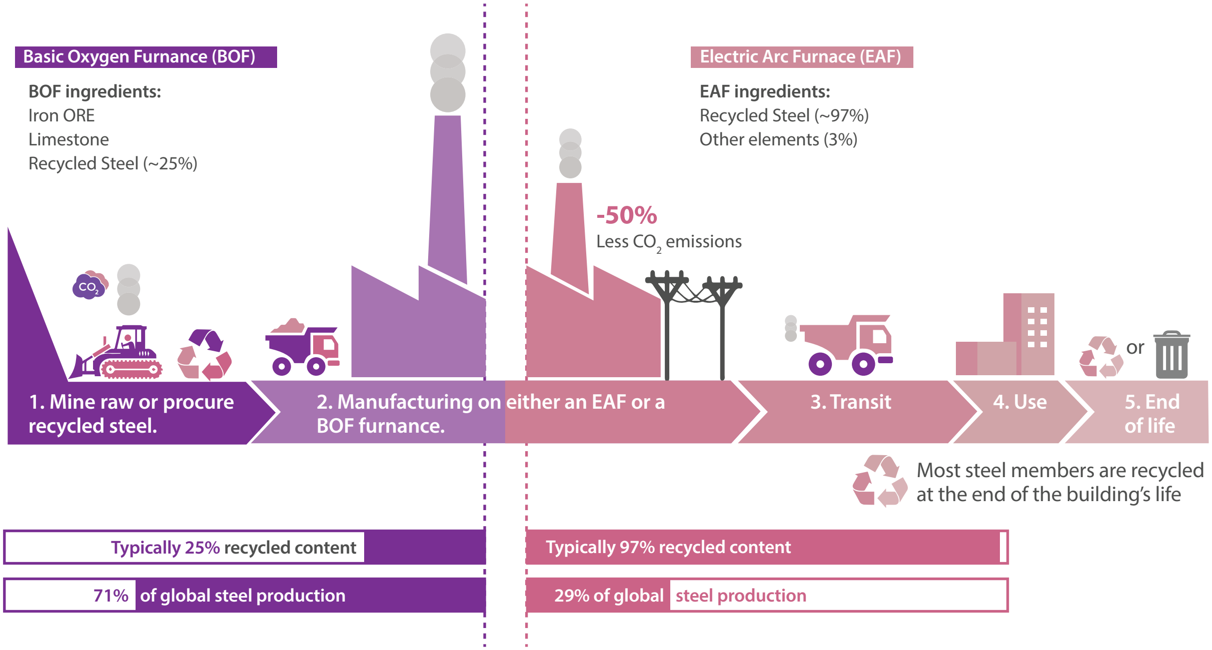


Figure 39: Carbon Impact of Steel with 25% and 97% Recycled Content [58].

A Matter of Trade-off

In some cases, reducing the carbon footprint of a material may not contribute to reducing the overall life cycle carbon footprint. On the contrary, increasing the embodied carbon associated with the Production Stage may decrease the building life cycle of the embodied carbon.

One example is adding a large thermal mass material, that is high in embodied carbon, thus reducing the building life cycle of embodied carbon by reducing heating and cooling loads.

Third - Offset Carbon Emissions

The offset strategy for carbon emissions from building construction materials is elaborated by calculating the "Embodied Carbon" associated with each material component after applying all possible reduction and reuse strategies.

The calculation methodology can be implemented by listing all construction materials and their quantities, then calculating the amount of CO2e which is associated with each stage of the material life cycle. Finally, carbon offset sources are adopted to compensate for the calculated carbon emissions.

The Calculations of Embodied Carbon

Each material or product in the building has an embodied carbon conversion factor (which is unique for each material). It provides the value of the embodied carbon emissions associated with that material, and depends on multiple considerations during the Material Life Cycle Stages. **These considerations are:**

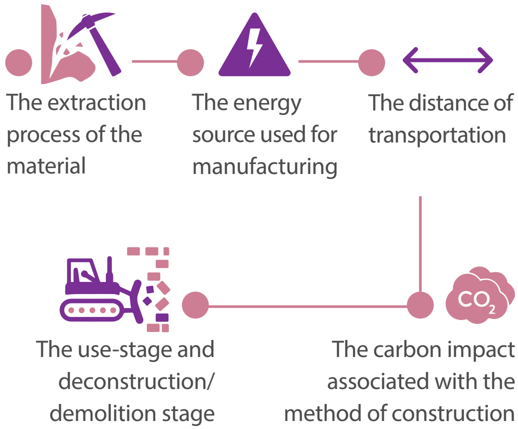


Figure 40 illustrates the carbon impacts of different insulation materials. The figure shows that the embodied carbon associated with Extruded Polystyrene is the highest among all types of insulation. The spray foam, expanded polystyrene, mineral wool and the fiberglass insulation types have considerably lower embodied carbon emissions. On the other hand, wool, dense pack cellulose, cork, hempcrete and straw bales have negative embodied carbon values which mean that these materials sequester carbon emissions. [58]

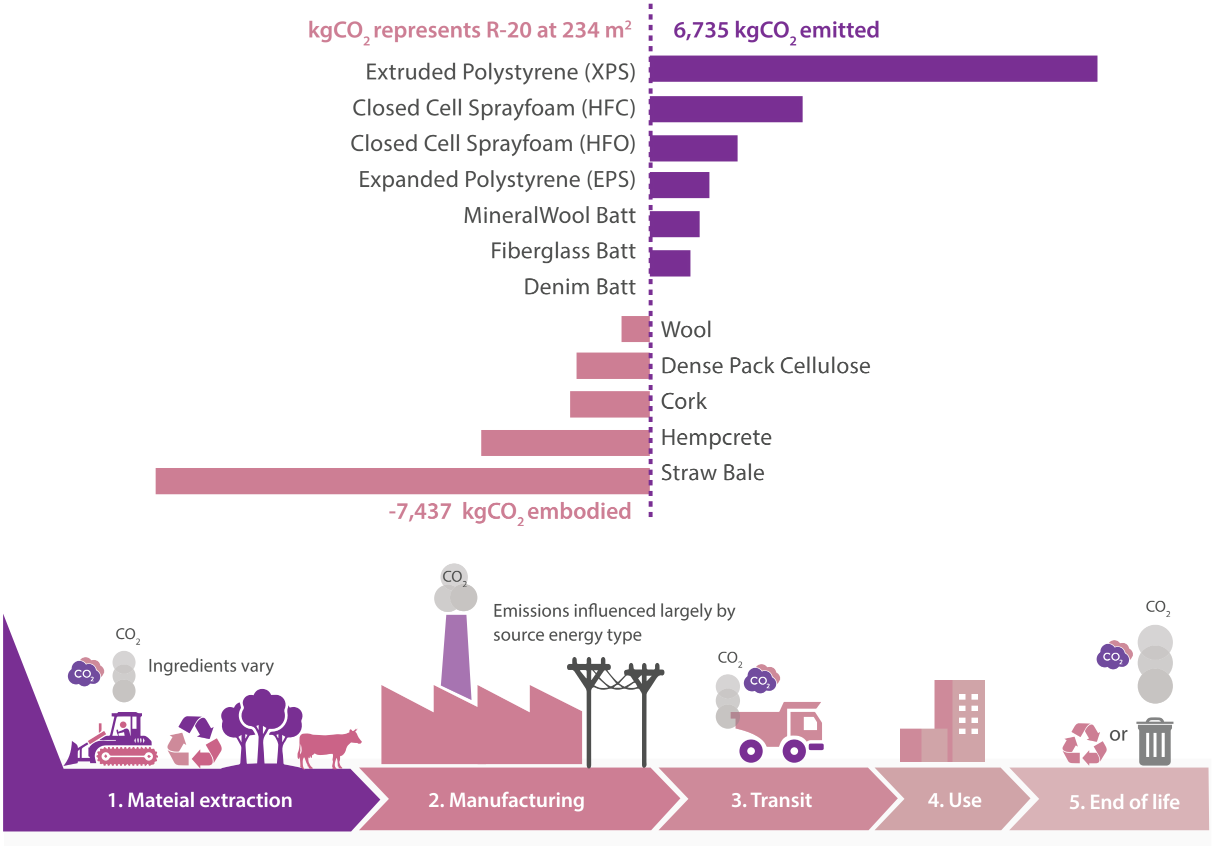


Figure 40: Carbon Impacts of Different Insulation Material [58].

Each construction material must be declared by its manufacturer to illustrate the considerations and the embodied carbon associated with each Life Cycle Stage of the material. The Environmental Product Declarations (EPDs) is the best reporting protocol for that purpose.

Setting a Baseline

The reduction in the embodied carbon of materials is calculated in comparison to a baseline case. The baseline value is assumed to be the business as usual or the most commonly used material in construction for a specific region/ country.

Example: Assume a baseline value of embodied carbon in a certain quantity of concrete is 270 tCO2e. This is considered as a baseline value for the specific quantity of concrete with 100% cement content. If the design team decides to use concrete with low cement content – assuming 50% of GGBS content instead of 50% cement content; it will result in a value of embodied carbon for the same concrete quantity equal to 200 tCO2e. Subsequently, the reduction in embodied carbon from concrete compared to the baseline of the building design is 26%. The same can be calculated for all the construction materials; the total baseline embodied carbon is compared to the total after applying embodied carbon reduction measures to find the final savings %. Carbon reduction measures can affect the embodied carbon of a project compared to the baseline case, (Figure 41).

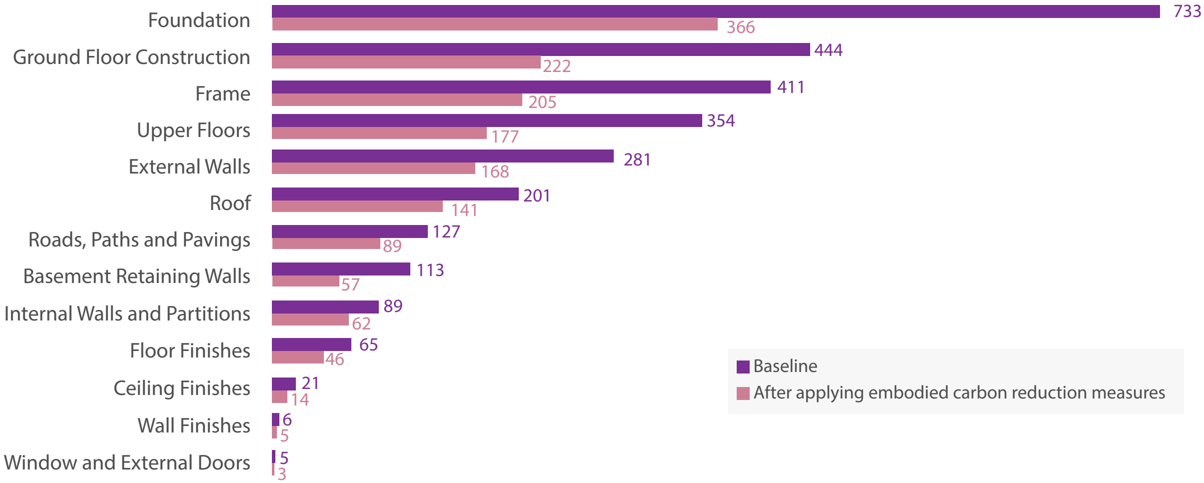


Figure 41: An Example of How Carbon Reduction Measures Can Affect the Embodied Carbon of a Project Compared to the Baseline Case [32].

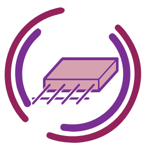
Steps of Calculations

Step 1: List of Construction Materials

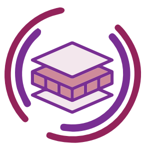
List the building materials and their quantities as detailed in a bill of quantities. The list must include, at a minimum, the following material assemblies:

Site works: excavation, exterior paving, shoring and framework.

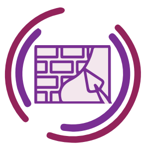
Foundation works and retaining walls.



Structural framing, reinforcement, slabs and decks.



Envelope cladding, fenestration, insulation and roofing.

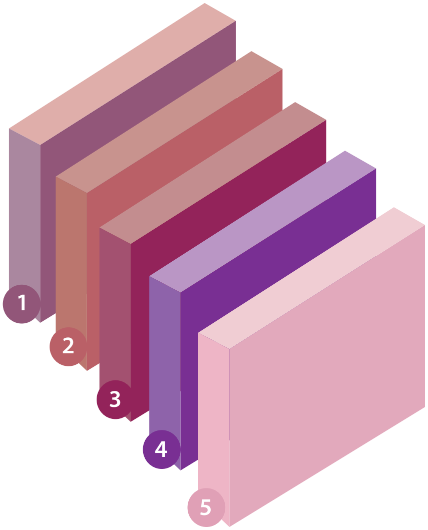


Interior finishes for ceilings, floors, walls, and partitions.

Electrical, Mechanical, plumbing and any other building systems.

Step 2: Embodied Carbon from the Production Stage

Calculate the embodied carbon from the Production stage. The following is an example of calculating the embodied carbon of an external wall in a typical residential building in Jordan:



1 Quantitiy of Stone

X

Embodied carbon conversion factor per unit of measurement for stone = Embodied carbon of stone production

2 Quantitiy of Mortar

X

Embodied carbon conversion factor per unit of measurement for mortar = Embodied carbon of mortar production

3 Quantitiy of Block

X

Embodied carbon conversion factor per unit of measurement for block = Embodied carbon of block production

4 Quantitiy of Extruded Polystyrene

X

Embodied carbon conversion factor per unit of measurement for Polystyrene = Embodied carbon of Polystyrene production

5 Quantitiy of Plaster

X

Embodied carbon conversion factor per unit of measurement for Plaster = Embodied carbon of Plaster production

Embodied carbon from the production stage of the external wall

Step 3: Embodied Carbon from Transportation

Find out the embodied carbon associated with the transportation of each material. This value depends on the transportation distance for each material and the mode of transportation. Figure 42 illustrates the relative carbon intensity of different modes of transportation.

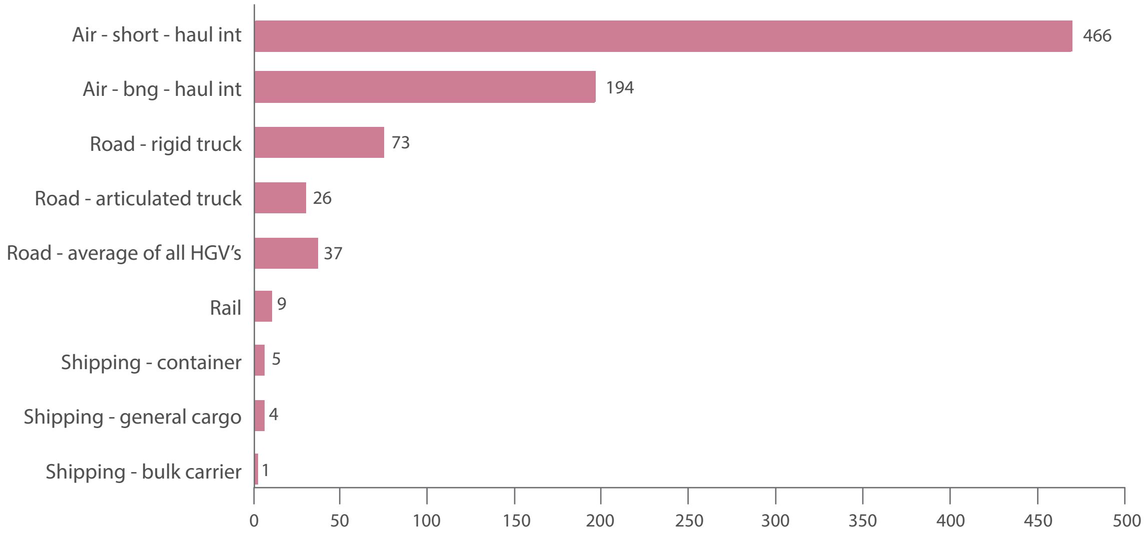
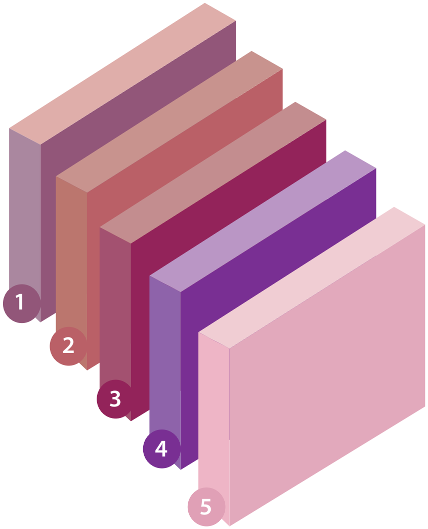


Figure 42: The Relative Carbon Intensity of Different Modes of Transportation [32].

For the same example of the external wall components, this step is implemented as follows:



1 **Stone distance of transportation**
X
Carbon emissions per km associated with the mode of transportation
=
Embodied carbon associated with the transportation of the Stone

2 **Mortar distance of transportation**
X
Carbon emissions per km associated with the mode of transportation
=
Embodied carbon associated with the transportation of the Mortar

3 **Block distance of transportation**
X
Carbon emissions per km associated with the mode of transportation
=
Embodied carbon associated with the transportation of the Block

4 **Extruded Polystyrene distance of transportation**
X
Carbon emissions per km associated with the mode of transportation
=
Embodied carbon associated with the transportation of the Extruded Polystyrene

5 **Plaster distance of transportation**
X
Carbon emissions per km associated with the mode of transportation
=
Embodied carbon associated with the transportation of the Plaster

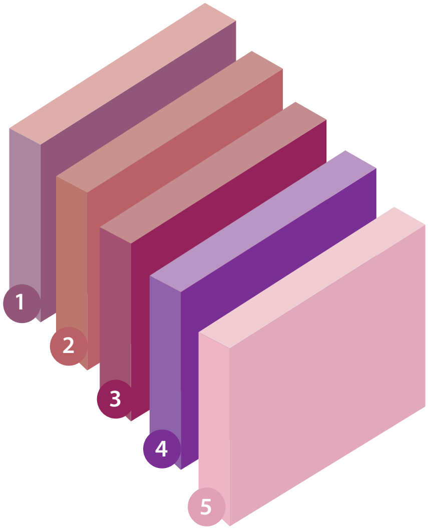
Embodied carbon from transportation of the external wall components

Step 4: Embodied Carbon from Use-Stage and Deconstruction/ Demolition Stage

Similar to step 2, calculate the embodied carbon from the Construction Stage, Use-Stage and Deconstruction/ Demolition Stage for each material separately and evaluate the final result. The embodied carbon factors of the Construction Stage, Use-Stage and Deconstruction/ Demolition Stage are assumed in the materials databases according to the typical industry use of the material or in reference to the material EPD if available.

Step 5: Total Embodied Carbon

Find the total embodied carbon associated with each material over the life cycle of the material.



1. Embodied carbon of each component in the Production Stage (Step 2)

+

2. Embodied carbon associated with the transportation of each component (Step 3)

+

3. Embodied carbon associated with the Construction Stage of each component (Step 4)

+

4. Embodied carbon associated with the Use-Stage of each component (Step 4)

+

5. Embodied carbon associated with the Deconstruction/ Demolition Stage of each component (Step 4)

=

Embodied carbon of each component [kg CO_2e or tCO_2e]

The total embodied carbon associated with the external wall = Σ embodied carbon for each component.

The final results for all materials used in building construction will be delivered as shown in Figure (43):

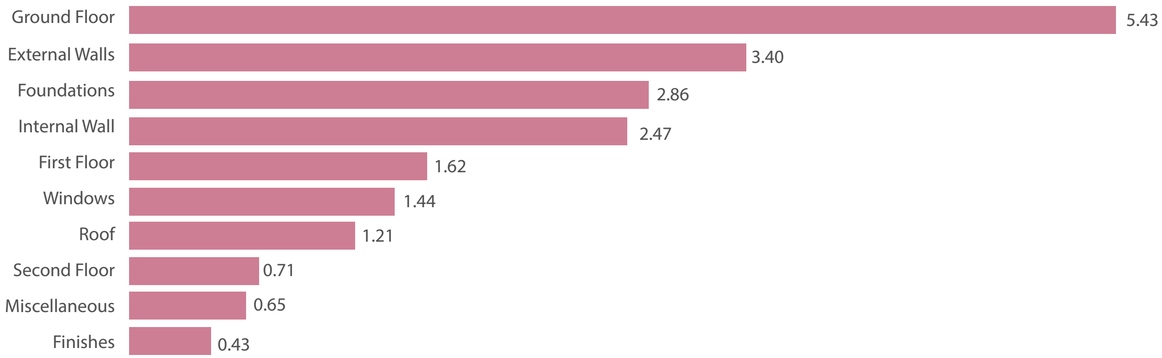


Figure 43: Embodied Carbon Assessment Results for a Very Efficient House "PassivHaus" [32].

Calculation of Embodied Carbon Emissions using Life Cycle Assessment-LCA tools

Life Cycle Assessment tools provide a wide range of materials database used in the built environment. The tools use a locally customized or internationally recognized data set for embodied carbon conversion factors associated with each material for the whole life cycle of the material. The tools also use the materials EPDs, if available, to customize data assumptions. For example, a material with a provided EPD has different embodied carbon emissions compared to the same material without a provided EPD. General data assumptions are used for materials which don't have EPDs. The users provide the materials quantities and transport distances in order to find the total $kgCO_2e$ associated with each stage of the Building Life Cycle.

The following are some of the common LCA tools:

Athena Impact Estimator

The tool allows the user to create his own material assembly and envelope configurations. The tool is flexible for use in case of a new construction or an existing building.

Environment Agency's Carbon Calculator

Free downloadable spreadsheet tool. The user provides detailed material information, travel distances and the type of transportation.

eTool

Free web-based calculator with a user- friendly interface that can either use predefined assemblies or allow users to create their own, based upon Australian product data.

One Click LCA

Web-based software with a user- friendly interface that is based on a combination of design data to establish a base case and a better performance case.

Tally

An LCA application for Autodesk-Revit that calculates the environmental impacts of building materials and compares options directly within a Revit model.

EC3 Tool

Free, cloud-based, open-access Embodied Carbon in Construction Calculator. (EC3) tool compares materials based on the associated emissions.

Offset Strategy:

Many CO_2 emissions offset sources are established worldwide. The most applicable sources in Jordan for the residential sector are:

Renewable Energy Production

Renewable energy sources are introduced to offset building energy consumption and carbon emissions.

Calculating carbon offset from renewable energy sources depends on many factors:

1. The type of the renewable energy technology.
2. The type of the generated energy.
3. The size of the renewable energy plant.
4. The efficiency of the renewable energy technology.
5. The location of installation.
6. Climate-specific conditions.

Carbon offset calculations from renewable energy sources are carried out based on the manufacturers' technical sheets of the technology in cooperation with the renewable energy design engineer.

For example,

each kWh generated from rooftop PV panels- as one source of renewable energy

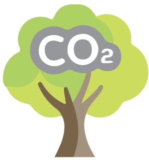
saves 0.68 kg CO_2e/year

(some figures show higher savings in carbon intensity).

On the other hand, the emissions offset from small sized wind turbines deviates from 0.008 to 0.020 kg CO_2e/year per kWh. However, this figure may rise up to 0.45kg CO_2 /year in large size turbines which are located in high wind speed regions.

Planting Trees

Some countries establish forestation or reforestation projects which are verified by a third-party certifier in order to ensure a carbon offset strategy that is environmentally friendly.



A tree can sequester

48 kgCO_2e per year.

Thus, over a building lifetime of 100 years;

one tree can sequester 4800 kgCO_2e.

Only trees are accounted as carbon offset sequesters, while shrubs and groundcovers are not considered.

Carbon Emissions from Home Energy Consumptions:

The offset strategy of energy consumption is detailed in the section of NetZero energy. Moreover, carbon emissions from energy consumption can be calculated for all energy types; the total carbon emissions can then be added to the materials carbon emissions. Consequently, the carbon offset strategy is applied to both carbon emissions sources; the consumed energy carbon and the material embodied carbon.

The table below illustrates the carbon emissions associated with different home energy types.

Table 4: CO_2 Emissions Associated with Different Home Energy Types.

Energy type	Unit	Annual Carbon Emissions (KgCO_2e)
Electricity	kWh	0.454
Natural Gas	m^3	1.92
Oil	Liter	2.76
Gasoline	Liter	2.28
Diesel	Liter	2.76
LPG	Kg	1.5

Carbon emissions conversion factors are location-specific, thereupon; the given factors in this table are for Amman - Jordan. By applying these conversion factors to the same example in section 1: NetZero Energy Building, we get the following carbon emissions:

Energy type and consumption	Associated carbon emissions kg\$CO_2$e per year
Electricity = 8 MWh	3632
Diesel = 2 m^3	5520
LPG = 75 kg	112.5
kgCO_2e/year	9264.5

The carbon emissions of 9264.5 kgCO2e/ year

are equivalent to planting

193 trees

However, this result excludes source-to-site energy emissions which are calculated using life cycle assessment tools in parallel with materials carbon emissions assessment.

It is worth mentioning that data associated with CO_2 emissions and other greenhouse-gas emissions have a margin of uncertainty. Finding country-specific estimates of CO_2 and greenhouse-gas emissions associated with fuels combustion can reduce the uncertainty in these estimates.

03

BARRIERS OF NETZERO BUILDINGS

Buildings and human activities affect the environment by consuming various natural resources and producing undesirable carbon emissions.

The statistics show that

the average Jordanian population

produced

2.6 tCO_2e

per capita

in 2017 calculated from fuel combustion only as illustrated in figure (44). *[4]*

The figure also shows that **the average embodied carbon production in the last 30 years ranges between 2.5 and 3.2 tCO_2e per capita,** which is considered steady and low compared to the average embodied carbon production per capita in the Middle East countries with an average of 6 tCO2e per capita in the last 30 years as shown in figure (45). [27]

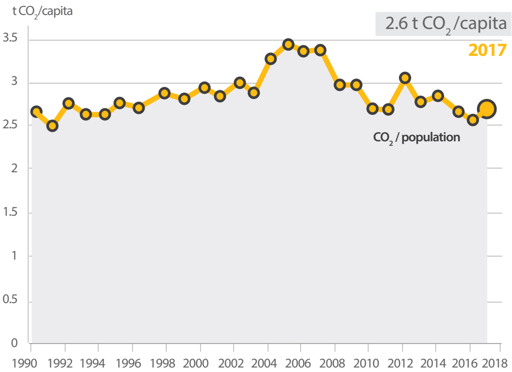


Figure 44: The average population production of embodied CO_2 emissions (CO_2e/capita) in Jordan for the last 30 years from fuel combustion only. [4]

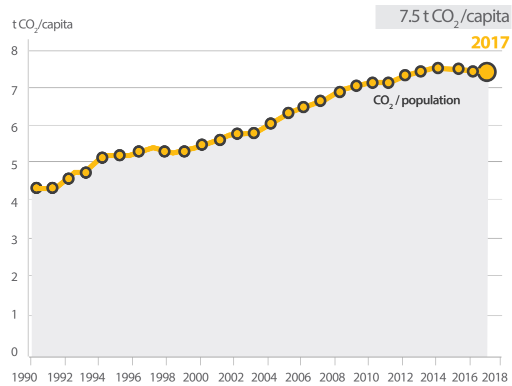


Figure 45: The average population production of embodied CO_2 emissions (CO_2e/capita) in the middle east countries for the last 30 years from fuel combustion only. [27]

In fact, the low carbon emissions per capita from fuel combustions in Jordan compared to the Middle East countries is mainly because of the significant increase in the Jordanian population after the Syrian crisis, where most refugees live in camps with negligible carbon emissions compared to the emissions from buildings in large cities like Amman, Irbid and Zarqa. These cities are the most populated cities in Jordan, which results in increased carbon emissions. Therefore, reducing carbon emissions from residential buildings is crucial and for the benefits clarified in chapter 1. This chapter will highlight the significant barriers for the implementation of NetZero buildings in Jordan – specifically for residential buildings; and the best mitigation measures linked to the barriers. Consequently, construction and operation guidelines will be presented to illustrate how to overcome the barriers associated with these two stages. Finally, international and national programs contributing to achieve a NetZero Building will be introduced.

I . BARRIERS OF NETZERO BUILDINGS

Some barriers have been identified to hinder the development of NetZero Buildings in Jordan. These barriers arise from mal-implementation during the construction stage and incorrect occupants' behaviors during the operation stage of the NetZero buildings.

The barriers to achieving NetZero Buildings in Jordan, specifically for the residential sector, can be categorized in three categories:

Social Barriers | Legislative Barriers | Technical Barriers

SOCIAL BARRIERS

1 | A general misconception about NetZero Buildings is people focus on installing renewables to offset the energy and water consumption as well as the carbon emissions, without the consideration of energy efficiency strategies.

Achieving NetZero buildings without efficiency strategies is generally a higher-cost approach. In addition, energy efficiency strategies result with multiple non-energy benefits such as improved comfort and resilience.

2 | Lack of interest and motivation to embrace NetZero buildings due to the perception that they are costly and require longer design and construction durations.

3 | Most of the efficiency measures are affordable, however renewable energy measures are costly and not incentivised.

4 | Tenants who are willing to apply the NetZero approach might face a barrier when the owner of the building is not aware of the benefits of NetZero Buildings.

LEGISLATIVE BARRIERS

1 | Lack of a comprehensive national reference that contains technical instructions about methods and implementations of NetZero Energy and Carbon buildings in Jordan. For instance, the conversion factors of the site to source ratios for energy types and the conversion factors of the embodied carbon for construction materials used in Jordan must be calculated and published. In addition it is essential to nationalize the Environmental Product Declaration (EPD) of construction materials that can be used when constructing NetZero buildings in Jordan.

2 | The Jordan Energy Efficiency Codes provide stringent regulations for energy efficiency in buildings. However, these codes are not mandatory for the residential sector (in specific, the residential buildings with a total gross floor area less than five times the roof area).

Most existing residential buildings don’t comply with the baseline requirements of energy efficiency and retrofitting these buildings to achieve the NetZero becomes more challenging and costly than if they would have been built up to standard in the first place.

3 Lack of national carbon offset programs. Such programs can sell certificates for building owners whom are looking for offset strategies to achieve a NetZero Building. Renewable Energy Certificates and Carbon Offset Certificates are examples that can guarantee that the offset sources are operated by environmental practices.

A Renewable Energy Certificate (REC) is a proof that energy has been generated from renewable sources such as solar or wind power. Each REC represents the environmental benefits of 1MWh of renewable energy generation. When a resident purchases RECs, renewable energy of the same value is generated. In the same manner, a Carbon Offset Certificate can be defined as a certificate that represents the reduction of one metric ton of carbon dioxide emissions. Figure (46) illustrates the concept of the Carbon Offset Certificates. [59]

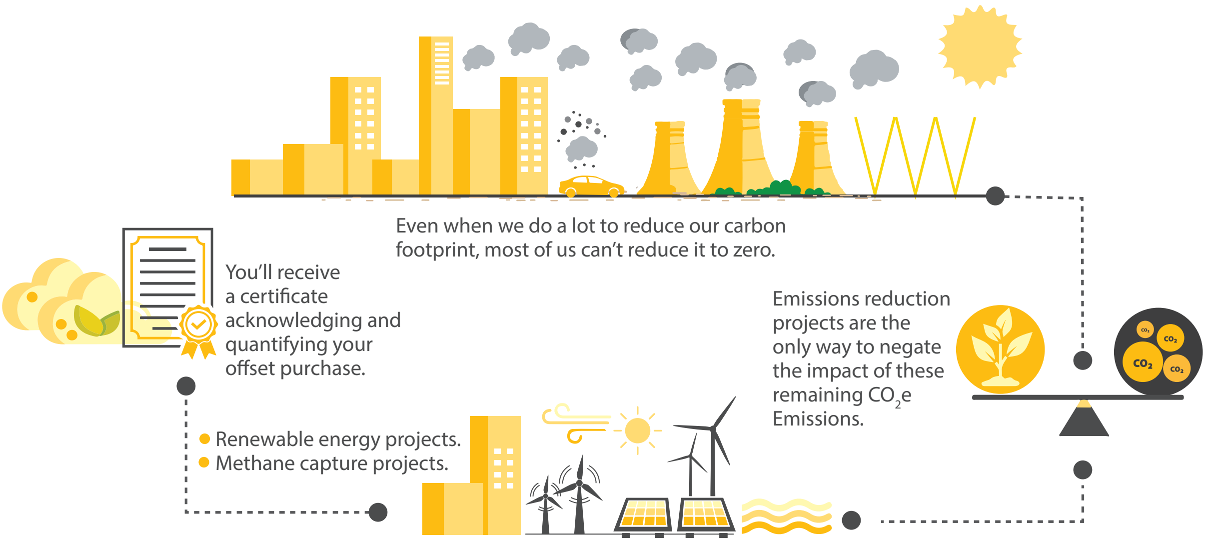


Figure 46 : The Concept of the Carbon Offset Certificates.

TECHNICAL BARRIERS

1 **Incorrect construction and operational practices** may lead to much higher energy and water consumptions as well as embodied carbon emissions compared to estimates made in the design stage.

2 **Inaccurate estimates of energy and water** consumptions and materials quantities in the design stage will lead to high deviations between the design calculations and the actual consumptions and/ or quantities.

3 **The lack of skills and expertise** across the construction sector and workers in the field of NetZero Buildings. This results with increased costs for working compared to traditional buildings.

II. MITIGATION MEASURES

The initial step in implementing NetZero practices is to eliminate and mitigate the challenges to meet the transformation requirement, then spread the practice nationally.

The following mitigation measures can be implemented to overcome the barriers of implementing a NetZero Building:

MITIGATION OF SOCIAL BARRIERS

1 **Developing code-improvement proposals** and voluntary programs that encourage and support the construction of Net Zero Buildings.

2 **Dedicating studies and research efforts** to develop national energy and material references that contain conversion factors for embodied energy and embodied carbon emissions.

3 **Developing educational and awareness programs** tailored for the concept, implementation, benefits and environmental assets of Net Zero Buildings.

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4 **Increasing governmental subsidies and incentives** for renewable energy technologies and other low carbon and efficiency products/ technologies.

MITIGATION OF LEGISLATIVE BARRIERS

1 **Initiating national carbon offset programs** which include renewable energy projects and forestation/ reforestation projects.

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2 **Collaboration of authorities** and ministries which are involved in the building construction and environmental sectors to introduce policies for encouraging the implementation of NetZero buildings. These ministries and entities include the Ministry of Environment, the Ministry of Public Works and Housing, the Ministry of Water and Agriculture, the Ministry of Energy and Mineral Resources, in addition to Jordan Renewable Energy and Energy Efficiency Foundation (JREEEF), National Electricity Distribution Company (NEDCO) and the Jordanian Engineers Association (JEA).

3 **Engaging NetZero designers and contractors in policy making.** That will allow them to reflect their experience in the field of NetZero building design and construction.

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4 **Emerging national incentives** to encourage building owners to adopt NetZero measures and applications when retrofitting and constructing their buildings.

MITIGATION OF TECHNICAL BARRIERS

1 **Developing nationally applicable templates** of robust specifications for the building components and systems which are commonly used in the NetZero Buildings.

2

Establishing a database of the latest technologies and national market trends for the most energy efficient systems and construction materials with low carbon emissions. The database should also include cost comparisons, the cons, pros, and availability of these products and technologies in the national market, in addition to the best practices and shortfalls in NetZero Building design and construction. The database can be best developed in a one-step web portal and should be updated continuously.

3

Collecting data from NetZero Building owners to evaluate the performance of their buildings by measuring and reporting Energy Use Intensity (EUI); which is the value of building annual energy consumption relative to the building built up area. The Energy Use Intensity is used as a reference to assess the energy efficiency of a building in a specific location. Evaluating energy use intensity for the building can help setting a benchmark for NetZero Buildings.

4

To mitigate construction mistakes, the contractor must follow the specifications and design guidelines. In the same way, to help mitigate operational stage mistakes, operational manuals and guidelines should be followed. The operational manuals and guidelines explain how the building functions as a whole system, and how to operate and maintain individual systems within it. Providing homeowners with a guide would increase their understanding of the best practices which would keep the systems operating at its best and would reduce the systems maintenance and turnover.

III. GUIDELINES FOR NETZERO BUILDINGS

As mentioned in the introduction of this chapter, some barriers of NetZero Buildings take place in the construction and operation stages. Taking preventive actions into consideration and improving the implementation quality will overcome these barriers.

The following section includes construction and installation guidelines for the contractors and sub-contractors to ensure proper implementation of Net Zero Buildings.

A. CONSTRUCTION STAGE GUIDELINES

The potential to reduce carbon emissions in the construction stage is considerably high compared to the potential of reduction in the operational stage. Figure (47) shows that the potential to reduce carbon emissions in the planning and design stage rises up to 30%, while in the construction stage it is around 18% compared to around 5% in the operation stage.

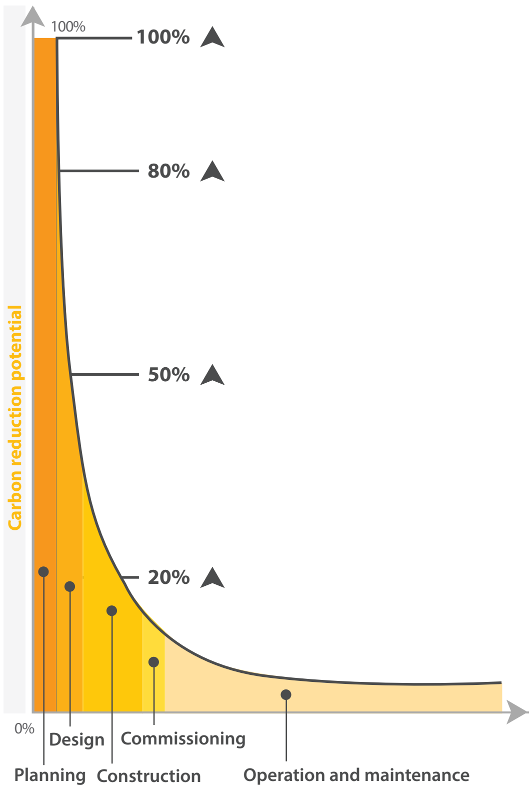


Figure 47: Embodied CO_2 emissions reduction potential at different stages of a building project. [60]

The resource efficiency measures which are presented in Chapter 2 can result with energy savings, improve your overall comfort at home, and help fight global warming. However, the proper implementation for the resource efficiency measures as planned in the design stage will ensure high potential rates of embodied carbon reduction.

The following guidelines address the key aspects for building contractors to guarantee the building is constructed as designed:

1 Make a checklist

for Net Zero Building requirements and guidelines for construction and system installations.

For example,
incorrect charging for the refrigerant level in central air conditioners can **lower efficiency by 5 – 20%**

and can ultimately cause premature component failure, resulting in costly repairs. It is estimated that 60% of central air conditions are incorrectly charged during installation. *[61]*

2 Follow the specifications

for the building envelope, and the mechanical and electrical systems to ensure they meet the requirements.

3 Follow the design details

for proper installation of the insulation. An air leakage test can be performed to guarantee that the building envelope is sealed. It can be performed using a diagnostic tool that measures the airtightness inside the building at possible leakage points such like windows and door frames.

Sealing and insulating the building envelope **can save up to 10%** of the annual energy bills. [61]

4 Comply with the relevant national building codes

for the best practice of equipment installation.

Improper installation for HVAC systems **can reduce system efficiency** **by up to 30%.** *[61]*

5 Seal the HVAC ducts properly

Ducts are used to distribute air throughout spaces of the building.

In typical houses, **about 20% of the air** that moves through the duct system **is lost due to leaks, holes,** and poorly connected ducts.

As a result, ducts lose heating or cooling produced by the equipment, thus more energy is consumed, higher utility bills and lower thermal comfort levels are achieved, regardless of the thermostat setpoint. *[61]*

6 Protect materials

which are stored on-site and installed, from moisture damage and keep them clean.

7 Verify design calculations

and enhance design selections by proposing alternative materials with lower carbon footprint (if any).

8 Conduct training programs

for the construction team and other influencing parties in the construction field. Securing skilled workforces will reduce the cost of the NetZero Building implementation.

9 Perform commissioning activities

for each system in compliance with the manufacturer procedures and instructions. It is recommended that the commissioning activities are carried out by an independent commissioning authority.

10 Issue building operation guidelines

after the installation of all building systems – i.e. at the end of the construction stage and before occupancy; to help occupants operate the systems accurately and to maintain the building properly.

COMMISSIONING

Commissioning is the process of verifying that the project's energy- related systems are installed, calibrated and performed according to the owner's project requirements, basis of design, and construction document.

Commissioning activities can be carried out by the contractor team, or by a third party authority. Commissioning is performed before occupancy, for each installed system before its operation. It is recommended for the commissioning team to be involved early in the process to facilitate a commissioning design review (reviewing design drawings at the end of the design stage but before bidding to ensure that they meet the commissioning requirements for all the commissioned systems) and a commissioning documentation review (to ensure that all commissioning documents are included in the tender documents before bidding).

The commissioning activities must be performed for the following systems:

- Heating, ventilation and Air Conditioning (HVAC) systems
- HVAC associated controls
- Lighting and daylighting controls
- Building automation systems (is any)
- Building envelope
- Stormwater management systems
- Water treatment systems
- Renewable energy systems

The commissioning process is important as it increases the liability related to the contractor for the proper installation of the system according to the owner requirements, the basis of design and the specifications. For that reason, it's vital to involve a third party commissioning authority in the process to ensure integrity and transparency.

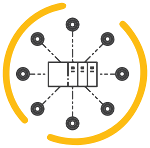
Moreover, commissioning ensures that the building meets the energy efficiency measures and benefits.

Commissioning is important in NetZero buildings for the following benefits:

- Achieve the anticipated energy savings
- Reduce systems maintenance and turn over
- Lower operational costs
- Improve building documentation
- Enhance occupants' comfort and well-being

B. OPERATION STAGE GUIDELINES

The building owners' role in accomplishing the goals of a NetZero Building starts at the beginning of the operational stage. The following guidelines address the key aspects for building owners to guarantee their building operates as designed and constructed.

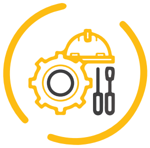


Program the thermostat and other control systems to turn systems on and off at specific times. Installing building automation systems makes system management easier, unlike the manual control which usually results with higher energy consumptions.

Collect and document all energy and water bills, in addition to the readings of electricity, thermal and water meters and submeters (if any). Using data loggers can ease the job. Using the readings of energy and water are used to verify the consumptions are not exceeding up normal readings of the building, which usually indicates that there is a failure or leakage in one of the building's systems or in the water network which requires maintenance. The readings are also used to ensure that the building is achieving the balance case as a NetZero building. More details are provided in Measurement and Verification part of this section.

Follow the manufacturer's instructions and systems' operational manuals for best practices of maintenance.

Install submeters for tracking energy use on system-level, in addition to the main utility meters of electricity and water. Submeters help to identify systems failures and maintenance issues.



Ensure continious maintenance of renewable energy systems and cleaning of PVs to ensure the system is operating with the maximum efficiency. For example, the efficiency of the PV solar panels ranges between 10-20% according to the type of the panel (mono or poly- crystalline) and the technology used by the manufacturer (furthermore, panels by the same manufacturer can be found in different specifications). The panels' efficiency reduces when panels are not clean and they degrade yearly in a percentage that is described in the manufacturer data sheet. The efficiency and the degradation factors are taken into account when designing the PV plant.

Perform measurement and verification after 12 months of building operation for the main energy and water systems.

MEASUREMENT AND VERIFICATION

Measurement and Verification (M&V) is the process of planning, measuring, collecting and analyzing data for the purpose of verifying and reporting energy and water savings within an individual building resulting from the implementation of energy and water efficiency measures.

M&V uses measurement tools and utility bills to determine the actual energy and water savings of the building. The importance of M&V arises as the best strategy to ensure that the building is on-track as a NetZero building. M&V for the building is performed by energy management engineers, in compliance with measurement and verification references. One international reference is the International Performance Measurement and Verification Protocol (IPMVP).

The basic formula of M&V is:

Energy/ Water Savings =

Energy/ Water consumption at the base condition – Energy/ Water consumption after the implementation of the energy and water efficiency measures after 12 months of operation

For new construction buildings:

the base case is the energy consumption predicted by energy modeling tools.

For existing buildings:

the base case is the annual energy consumption of the building before it is renovated.

In consequence, if measurement and verification revealed that energy savings are not being achieved, a process for corrective actions is then provided.

IV. THE COST OF NETZERO BUILDINGS

Few international studies have calculated the incremental cost (the total cost incurred due to the additional expenses) of constructing NetZero Buildings. The cost varies according to multiple factors such as the climatic conditions, building location, building type, community type (rural/urban), and the availability of governmental incentives and rebates. The amount of savings is then compared to a baseline case which is the traditional building that is built according to the minimum building design and construction criteria in the region of study (business as usual case).

STUDY 1

The incremental cost of

NetZero Energy commercial Buildings

compared to the standard construction codes in the United States ranges between:

0-15% with a payback period between 5-10 years

for energy savings between 20-50%. *[62]*

STUDY 2

A study conducted on single-family homes in four states in America has revealed that:

6.7 - 8.1%

compared to the baseline case (building codes in the United States).

The study was carried out in 2018 and shows that the same **multiple energy efficiency factors will decrease the incremental cost to become**

3.1 - 5.5% in 2030. [63]

The future reduction in the incremental cost is expected due to the decline in the renewable systems costs and the higher efficiency gains of the equipment which is a result of the evolving technology.

STUDY 3

The analysis of a third study carried out in the United Kingdom in 2018 resulted with incremental costs for both residential and non-residential buildings equal to 5%-7%.

Incremental costs for **the residential buildings, in specific** are 7% - 11% +$ as concluded in the study. [64]

In conclusion, studies are needed to cover initial cost, running cost and ROI of applying NetZero Building as an emerging green building practice in the local market across different territories of Jordan. The vision is to embed the practice in the national standards and legislation to be verified and validated for every building in the future.

V. INTERNATIONAL PROGRAMS TOWARDS ACHIEVING NET ZERO BUILDINGS

International efforts and programs have been dedicated to implementing, advancing and analyzing impacts of NetZero Buildings. There are also Certification Schemes that confirm buildings' compliance with the NetZero goals.

The most widespread programs and certifications are:

World Green Building Council- Advancing NetZero Project

WORLD GREEN BUILDING COUNCIL

Advancing NetZero Project was launched in 2015. It is a global campaign to accelerate uptake of NetZero Carbon buildings to 100% by 2050 through Green Building Councils from 15 countries around the world. The Green Building Councils have been developing mechanisms and initiatives to facilitate mass market transformation, and lead the way, inspiring the business and the government communities to follow. Besides, the Green Building Councils ensure alignment with the four key project principles illustrated in figure (48).

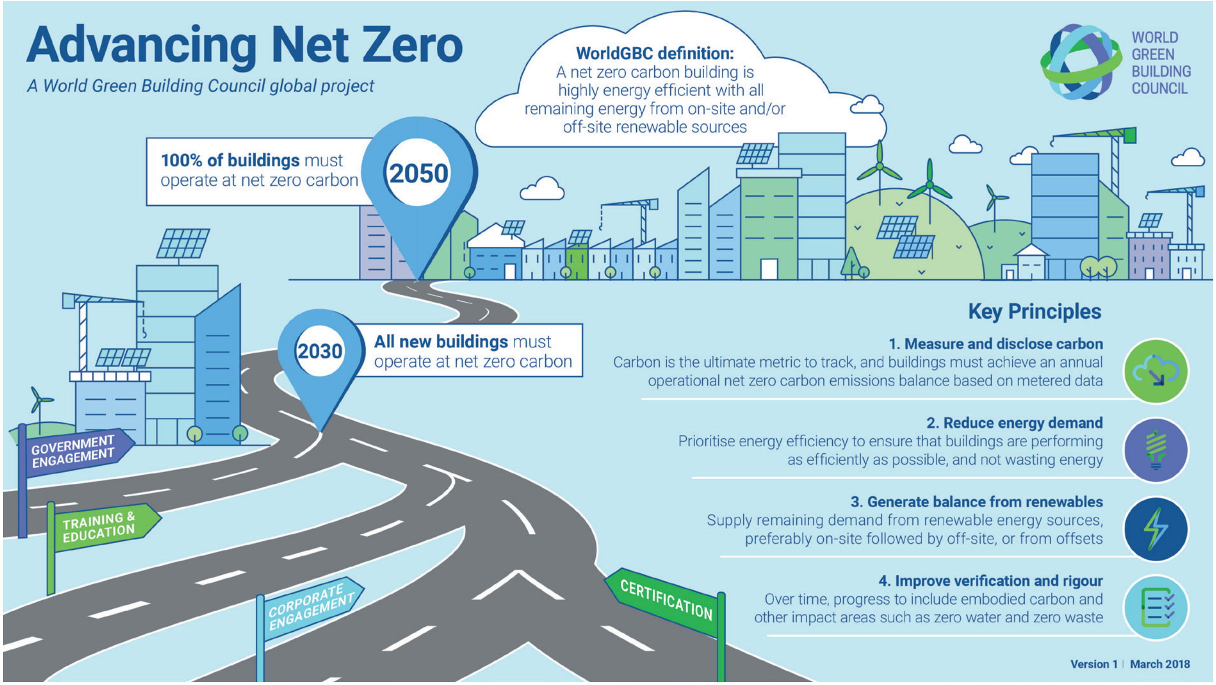


Figure 48: Definition of NetZero Buildings, Goals and Key Principles of Advancing Net Zero Global Project.

The targets of Advancing Net Zero project are:

Increase awareness and education of the urgency and achievability of NetZero Carbon buildings.

Achieve alignment and commonality between GBC approaches and certification schemes.

Expedite uptake in global markets by sharing market leadership examples. [64]

LEED Zero

LEED Zero is a new level of the certification scheme for green buildings that complements to the LEED rating system and verifies the achievement of NetZero goals. USGBC has developed LEED Zero which is open to all LEED projects certified under the Building Design and Construction (BD + C) or Operation and Maintenance (O + M) rating systems or registered to pursue LEED O+M certification. Projects can complement their existing LEED certification or LEED O+M registration with one or more of the following LEED Zero certifications:

- LEED Zero Carbon
- LEED Zero Water
- LEED Zero Energy
- LEED Zero Waste

Participants can pursue one or all of LEED Zero certifications. *[66]*

The International Living Future Institute Zero Carbon and Zero Energy Standards

The International Living Future Institute (ILFI) is the founder organization of multiple certification schemes such as Living Building Challenge (LBC) Certification, Petal Certification (PETAL), Living Certification, the Core Green Building Certification (CORE) in addition to the Zero Carbon Certification and Zero Energy Certification.

The Zero Energy Certification is based on actual, not modeled, performance during a 12 months period.

Zero Energy Certification is recognized worldwide as one of the highest aspirations in energy performance in the built environment. It was created to allow projects to demonstrate Zero Energy performance, building an advanced cohort of projects with the integrity of third- party performance certification. [67]

The Zero Carbon certification requires one hundred percent of the operational energy use associated with the project to be offset. In addition, the impact of Embodied Carbon Emissions associated with the construction and materials of the project must be detailed and offset. The projects seeking the Zero Carbon certification or the Zero Energy certification, must demonstrate the actual performance based on a 12 months period. [67]

EDGE Zero Certification

EDGE is a web based application, a standard, and a certification system. EDGE is an innovation of the International Financial Corporation (IFC) which creates intersections among developers, building owners, bands, governments and homeowners to deepen the understanding that everyone wins financially by building green.

The EDGE standard focuses on efficiency of energy, water, and embodied energy in materials. The projects must achieve a minimum saving of 20% in Energy, Water and embodied energy of materials in order to qualify for this certification. See figure (49).

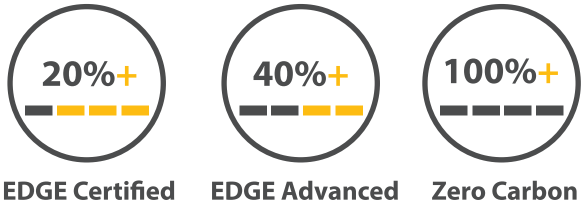


Figure 49: EDGE Levels of Certification.

The Zero Carbon Certification of EDGE is achieved by reaching at least 20% savings in water and materials, and 40% minimum saving of energy which is the level of EDGE Advanced while renewable energy and/or carbon offset can compensate 100% of the remaining energy.

New construction projects
must achieve EDGE Advanced certification with
75% occupancy for at least 12 months
to demonstrate performance and prove compliance. [68]

VI. JORDANIAN NATIONAL PROGRAMS TOWARDS ACHIEVING NET ZERO

Despite the fact that there are no mature programs that contribute to the implementation of NetZero Buildings in Jordan, there are some initiatives and energy efficiency programs and policies which are the core reference when implementing NetZero Buildings. The following are a few examples:

Jordan Green Building Council

JORDAN GBC
المجلس الأردني للأبنية الخضراء
Jordan Green Building Council

The Jordan GBC is a non-profit and non-governmental organization which provides internationally certified training programs, world- class expertise and regional and international network. The council is one of the leading entities in Jordan towards making green buildings a wide reality in Jordan. The Jordan GBC presents the green practices and concepts through its initiatives and volunteering team.

The Jordan GBC was the second in the Arab region to join the call for “Advancing NetZero Buildings” initiated by the world GBC. A committee of volunteering members is working on the development of the concept and implementation of NetZero buildings in Jordan in compliance with the world GBC framework and key principles. [69]

Jordan Renewable Energy and Energy Efficiency Fund (JREEEF)

The fund was established to meet the needs of the Kingdom to invest in various sources of renewable energy in multiple sectors such as residential, educational (schools), health (hospitals) as well as private, public, industrial and services. JREEEF’s objectives contribute to the seventh goal of the Sustainable Development Goals (SDGs) which is Clean Energy. JREEEF has carried out many programs and projects to achieve the strategic objectives. **The JREEEF programs are prompt for various sectors, such as:**

Households

LED lamps program, service water heating program, and the PV system installation program are all oriented towards the households. The implementation of the LED lamps program required home owners to substitute traditional light bulbs from their homes by energy efficient LED bulbs provided by JREEEF.

On the other hand, **homeowners submit a request to install the Solar Water Heating (SWH)** and PV systems to **get a grant up to 50%** **of the cost of the system.**

Other funding options include providing bank loans for installing these systems to homeowners. The funding loans are provided through contracts signed with 10 commercial banks.

JREEEF has launched public awareness campaigns through their presence in the social media. JREEEF has partners from business associations, NGOs, and the private sector that supports its programs including training and capacity building programs. [69]

Royal Scientific Society (RSS)

الجَمعيّة العِلميّة المَلكيّة
Royal Scientific Society

RSS is the largest applied research institution, consultancy, and technical support service provider in Jordan. RSS is a regional leader in the fields of science and technology using excellent scientific and engineering research to power economic development and social progress. [71]

In collaboration with the National Building Council, RSS has published the Jordan Green Building Guide in 2012. The guide is the first of its kind in Jordan which presents green building design and construction criteria and a certification system on a basis of five certification levels (From the higher level; A, B, C, D, and the Certified level).

The approach of the green building guide is to understand the building's total impact on the environment in six categories that provide the foundation for green building design.

These categories are:


Green Building Management


Site Sustainability


Water Efficiency


Energy Efficiency


Healthy Indoor Environment


Materials and Resources

The credits are divided into three levels:

Mandatory Requirements (MR):

Requirements extracted from the Jordanian national building codes and are related to the green building intent of the credit. Applying the mandatory requirements does not reward any points.

Obligatory Requirements (OR):

Requirements that are not mentioned in the Jordanian national building codes of practice as mandatory minimum requirements, but are essential for the green building practice.

Voluntary Requirements (VR):

Requirements that are totally voluntary for precise building types and specifications, attached to rewarded points. [72]

Greater Amman Municipality (GAM)

In 2015, GAM has established a sustainability strategy with two main goals:

- Planning, zoning and developing a city that grows efficiently and achieves the requirements of sustainability.
- Ensuring the implementation of sustainability and the utilization of renewable energy.

The implementation of these two goals has been delivered in the following actions:

Incentives for the citizens of Amman:

GAM participated in producing the Jordan Green Building Guide with RSS and the Jordan National Council. Additionally, GAM has delivered incentives for the certified green buildings. The incentives vary according to the green building level of certification and are detailed below:

1. The installment of the zoning fees for a maximum period of 6 years.

2. Evaluating tender documents and approvals by one stop shop service.

3. Installing the PV panels on building rooftops and on parking canopies without any fees.

4. The building owner is allowed to increase the building density by increasing the building floor area ratio by a percentage up to 25% varies according to the green building level of certification.

GAM has implemented solar energy projects to offset electricity consumption in:

GAM's buildings, Al Hussein theater, the city hall, and the headquarter building, in addition to the street lights of these buildings.

CONCLUSION

In 2015, Jordan agreed to the Paris Agreement which was considered an important step towards climate adaptation. The agreement brought the NetZero buildings to the fore as one of the solutions to the climate adaptation. Since the residential sector has the highest number of buildings, it plays a key role in contributing to NetZero buildings. Hence, it is the focus of this booklet.

This booklet contains three chapters. The first chapter introduces the concept of NetZero Buildings supported by some local, regional and international statistics. The second chapter explains the implementation methods of NetZero Buildings throughout three paths: NetZero Energy achieving NetZero Buildings and the required mitigations to overcome; NetZero Water and NetZero Carbon. The third chapter highlights the barriers of these barriers, followed by introducing international and national programs.

NetZero buildings enhance the indoor air quality of buildings where occupants spend more than 90% of their times. It also provides an opportunity to extend the building's lifespan, preserve energy, water and material resources.

NetZero buildings can be achieved through multiple approaches. NetZero energy is the most commonly used worldwide, and the most applicable in the residential sector in Jordan since most energy efficiency measures are affordable. Solar renewables are the most affordable offset measures in the local market because of the rapidly evolving solar technology, governmental facilities of their supply to the local market, and financial facilities and funds like the installments provided by the suppliers and JREEEF funds.

Looking ahead, NetZero Water and NetZero Carbon can become more affordable and easier to achieve by increasing awareness to the public and by training professionals, reducing costs of low carbon materials in the local market, introducing water treatment technology funds, sustaining research and code-improvements, and initiating national offset programs such as forestation and renewables farms. Developing strategies to encourage people to invest in NetZero buildings would reduce energy and water demand on a large scale.

At the fiscal level, there are a few local studies that evaluate the cost implications of implementing NetZero buildings. Cost studies help decision makers to create financial facilitations and suppliers to import materials of NetZero buildings.

Increasing the implementation of NetZero buildings requires an effective cooperation between the government and the local community. It is highly recommended to develop awareness plans as well as incentive programs to encourage building owners to construct or retrofit their buildings to NetZero.

REFERENCES:

1. United Nations Framework Convention on Climate Change, (2020). The Paris Agreement. Internet page available at: https://www.unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (Accessed 01/ 4/ 2020)
2. International Energy Agency, (2018). Global Alliance for Buildings and Construction, Global Status Report.
3. Ministry of Energy and Mineral Resources, (2018). Annual Report, Jordan.
4. International Energy Agency, Data and Statistics, Jordan CO2 emissions, Internet page available at: https://www.iea.org/data-and-statistics?country=-JORDAN&fuel=CO2%20emissions&indicator=TotCO2 (Accessed in 30/ 4/ 2020)
5. International Energy Agency, (2020). Global Energy Review: The Impacts of the Covid-19 Crisis on Global Energy Demand and CO2 Emissions.
6. Evans, Simon. (2020). "Analysis: Coronavirus set to cause largest ever annual fall in CO2 emissions", Carbon Brief, Internet page available at: https://www.carbonbrief.org/analysis-coronavirus-set-to-cause-largest-ever-annual-fall-in-co2-emissions (Accessed in 30/4/ 2020).
7. Myllyvirta, Lauri. (2020). "Analysis: Coronavirus has temporarily reduced China's CO2 emissions by a quarter", Carbon Brief, Internet page available at: https://www.carbonbrief.org/analysis-coronavirus-has-temporarily-reduced-chinas-co2-emissions-by-a-quarter (Accessed in 30/3/2020)
8. Zhang, R., Zhang, Y., Lin, H., Feng, X., Fu, T. M., & Wang, Y. (2020). NOx Emission Reduction and Recovery during COVID-19 in East China. Atmosphere, 11(4), 433.
9. New Buildings Institute, (2015). ZNE Communications Toolkit.
10. Committee on Climate Change, (2019). Net Zero Technical Report, UK. Available at: https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-report-CCC.pdf. (Accessed 24/9/2020)
11. World Health Organization, (2020). Global Health Observatory: Air Pollution. Internet page, Available at: https://www.who.int/health-topics/air-pollution#tab=tab_1 (Accessed 02/5/2020)
12. Park, J. S., & Yoon, C. H. (2011). The effects of outdoor air supply rate on work performance during 8-h work period. Indoor Air, 21(4), 284-290.
13. New Buildings Institute, (2019). Zero Energy Project Trackers.
14. Smart Energy, (2019). Global net zero energy homes market to record 28% growth. Available at: https://www.smart-energy.com/industry-sectors/energy-grid-management/global-net-zero-energy-homes-market-record-28-growth/ (Accessed on 06/ 5/ 2020)
15. Torcellini, P., Pless, S., Deru, M., & Crawley, D. (2006). Zero energy buildings: a critical look at the definition (No. NREL/CP-550-39833). National Renewable Energy Lab.(NREL), Golden, CO (United States).
16. Energy Star Portfolio Manager, Technical Reference, Source Energy. Available at: https://www.energystar.gov/buildings/tools-and-resources/portfolio-manager-technical-reference-source-energy (Accessed on 30/ 5/ 2020)
17. Intergovernmental Panel on Climate Change, (2019). Synthesis report.
18. International Energy Agency, (2019). Global Energy & CO2 Status Report, The latest trends in energy and emissions in 2018, Flagship report.
19. International Energy Agency, (2019). World Energy Outlook 2019, Flagship report
20. Ministry of Energy and Mineral Resources (2007). Jordan National Energy Strategy 2007 – 2020
21. Ministry of Energy and Mineral Resources, (2019). Energy– Facts and Figures. Jordan
22. World Nuclear Association, (2019). Nuclear Power in Jordan. Available at: https://www.world-nuclear.org/information-library/country-profiles/countries-g-n/jordan.aspx (Accessed 30/ 9/ 2020)
23. International Energy Agency, (2017). Water – Energy Nexus report, Technology Report.
24. Our World in Data, (2018). Water Use and Stress. Internet page, available at: https://ourworldindata.org/water-use-stress#renewable-freshwater-resources (Accessed 30/ 4/ 2020)
25. Ministry of Water and Irrigation, (2016). National water strategy of Jordan 2016 – 2025, Jordan.
26. International Energy Agency, Data Service, World carbon emissions. Available at: https://www.iea.org/data-and-statistics?country=WORLD&fuel=-CO2%20emissions&indicator=TotCO2 (Accessed 30/ 4/ 2020)
27. International Energy Agency, Data Service, Middle East carbon emissions. Available at: https://www.iea.org/data-and-statistics?country=WEOMIDEAST&fuel=CO2%20emissions&indicator=TotCO2 (Accessed 30/ 4/ 2020)
28. Intergovernmental Panel on Climate Change, (2014). Fifth Assessment Report
29. Environmental management, Life cycle assessment, Principles and framework, (2016). ISO14040:2006.
30. EN, B. 15978: 2011, (2011) "Sustainability of Construction works-Assessment of environmental performance of buildings-Calculation method".
31. World Green Building Council, (2019). Bringing Embodied Carbon Upfront.
32. RICS, (2012). Methodology to calculate embodied carbon of materials, information paper, IP 32/2012. Coventry, UK.
33. GIZ, (2014). Country report on the solid waste management in Jordan.

34. Bragança, L., Vieira, S. M., & Andrade, J. B. (2014). Early stage design decisions: The way to achieve sustainable buildings at lower costs, the scientific world journal.
35. Kristinsson, Jon., and Dobblesteen, Andy., (2012). Integrated Sustainable Design.
36. ARUP, (2019). Five minute guide: Zero Net Energy and Carbon.
37. United States Green Building Council, (2009). LEED reference guide for building design and construction, V3 2009 Edition.
38. PBC Today, (2020). Retrofit off Buildings Crucial to Meet Net-Zero Targets. Internet page, available at: https://www.pbctoday.co.uk/news/energy-news/retrofitting-existing-buildings/71677/ (Accessed 02/ 6/ 2020)
39. RICS, (2020). Policy report: Retrofitting to decarbonize UK existing housing stock.
40. Al-Shouha, H., 2019, Guidelines for Green Affordable Homes, Amman: Jordan Green Building Council.
41. Shamout, S. and Al-Khuraissat, M. , (2018). Your guide to building envelope retrofits for optimizing energy efficiency and thermal comfort in Jordan, Jordan Green Building Council and Frederich-Ebert Stiftung.
42. Mujally, H., (2017). Your guide to green building in Jordan, Jordan Green Building Council and Frederich-Ebert Stiftung.
43. Nazer, H. (2019). Developing an energy benchmark for residential apartments in Amman, Jordan Green Building Council and Frederich-Ebert Stiftung
44. de Normalización, C. E. (2008). EN ISO 13790: Energy Performance of Buildings: Calculation of Energy Use for Space Heating and Cooling (ISO 13790: 2008). CEN.
45. Johansson, E., and Ouahrani, D. et. al.(2009). Climate conscious architecture and urban design in Jordan-towards energy efficient buildings and improved urban microclimate. Report, 12.
46. Internet image. Available at: https://books.openedition.org/ifpo/docannexe/image/4871/img-2.jpg (Accessed 30/ 4/ 2020)
47. Ministry of Public Works and Housing, (2010). Jordan Energy Efficiency Code.
48. Definition and Types of Thermal Bridges, (2020). Internet page, available at: https://www.insulationshop.co/definition_and_types_of_thermal_bridges.html (Accessed 15/ 6/ 2020)
49. Sanford, S., (2014). Energy Efficient Lighting, University of Wisconsin. Madison, USA.
50. Internet image. Available at: http://www.philippon-kalt.fr/ (Accessed 15/ 6/ 2020)
51. Bloemendal, M. (2018). The hidden side of cities: Methods for governance, planning and design for optimal use of subsurface space with ATES.
52. United States Green Building Council, (2019). LEED Zero Program Guide.
53. UNEP, I., & TNC, W. (2014). Green infrastructure: guide for water management.
54. Clement, Lou., El Paso Master Gardener. Why We Landscape with Native and Adaptive Plants. Internet page, available at: https://txmg.org/elpaso/learn/gardening-in-el-paso-articles/why-we-landscape-with-native-and-adaptive-plants/ (Accessed 02/ 7/ 2020)
55. King Hussein official website, Jordan wildlife and vegetation. Web page, available at: http://www.kinghussein.gov.jo/geo_env2.html#Fauna (Accessed 02/ 7/ 2020)
56. United States Green Building Council, (2013). LEED reference guide for building design and construction.
57. Manelius, Anne,. Vandkunsten Architects, (2017). New Practices for High-Level Reuse, Rebeauty Nordic Built Component Reuse.
58. Carbon Smart, Carbon impacts of steel. Available at: https://materialspalette.org/steel/ (Accessed in 02/ 7/ 2020)
59. Terrapass, Carbon Offsets Explained. Available at: https://www.terrapass.com/climate-change/carbon-offsets-explained (Accessed in 02/ 7/ 2020)
60. United Kingdom Green Building Council, (2019). Net Zero Carbon Buildings: A Framework Definition.
61. Energy Star, A Guide to Energy-Efficient Heating and Cooling. Available at: https://www.energystar.gov/products/tools_resources/a-guide-to-energy-efficient-heating-and-cooling-%28hvac-guide%29 (Accessed 02/ 7/ 2020)
62. Review Energy, Commercial NetZero Energy Buildings. Available at: https://Reviewenergy.com/commercial-NetZero-energy (Accessed 12/ 5/ 2020)
63. Petersen, A., Gartman, M., & Corvidae, J. (2019). Rocky Mountain Institute. The Economics of Zero-Energy Homes: Single-Family Insights.
64. Centre for Sustainable Energy, (2018). Cost of carbon reduction in new buildings.
65. World Green Building Council, (2020). Advancing Net Zero. Internet page, available at: https://www.worldgbc.org/advancing-net-zero (Accessed 20/ 7/ 2020)
66. United States Green Building Council, LEED Zero verifies net zero goals https://www.usgbc.org/programs/leed-zero (Accessed 20/ 7/ 2020)
67. International Living Future Institute, Zero Energy Certification. Internet page, available at: https://living-future.org/zero-energy/ (Accessed 20/ 7/ 2020)
68. EDGE Buildings. Internet page, available at: https://edgebuildings.com/certify/ (Accessed 20/ 7/ 2020)
69. Jordan Green Building Council. Internet page, available at: http://www.jordangbc.org/ (Accessed 20/ 7/ 2020)
70. Jordan Renewable Energy Development, (2017). Decentralized Renewable Energy Solutions in the MENA Conference, Egypt.
71. Royal Scientific Society. Internet page available at: https://www.rss.jo/ (Accessed 20/ 7/ 2020)
72. Awadallah, T., Habet, S., Mahasneh, A., and Adas, H., (2011). Royal Scientific Society and National Energy Research Center, Green building guideline of Jordan, Conference paper.
73. Greater Amman Municipality. Internet page, available at: https://www.ammancity.gov.jo/ar/gam/green.aspx (Accessed in 20/ 7/ 2020)

Members & Services

Design & Supervision Services

Dar Al-Handasah Consultants
Platinum Membership
Key Services:
Design and Construction Supervision
Contact Information:
Phone: (06) 590 3060
Website: www.dar.com

Consolidated Consultants Engineering and Environment (CC)
Platinum Membership
Key Services:
Design and Supervision
Contact Information:
Phone: (06) 4612377
Website: www.ccjo.com

Spacia Systems
Silver membership
Key Services:
Design and Supervision
Contact Information:
Phone: (00962) 777788212
Website: www.spacia.com.jo

Holy Rock and Green Flag (HRGF) Engineering Consultancy
Silver Membership
Key Services:
Engineering Consultancy Services
Contact Information:
Phone: (06) 4200204
Website: www.hreo-c.com

Arab Center for Engineering Studies (ACES)
Silver membership
Key Services:
Site and geotechnical investigation, materials technology and testing, quality control of projects, special studies, land and marine surveying, and chemical and environment testing.
Contact Information:
Phone: (06) 5810940
Website: www.aces-int.com

Adaa Sustainability Development Consultants
Silver Membership
Key Services:
Design and Supervision
Contact Information:
Phone: (00962) 79 724 3133
Website: www.adaaconsultants.com

Seyam Architects
Silver Membership
Key Services:
architectural / Engineering Company
Contact Information:
Phone: (00962) 79 9992 627
Website: www.seyamarchitects.com

Minerva for Engineering Studies and Consulting Ltd.
Silver Membership
Key Services:
Consultation and Supervision
Contact Information:
Phone: (00962) 79 656 6669
Website: www.minervaesc.com

Ruqn Al Handasa
Silver Membership
Key Services:
Consulting Engineers
Contact Information:
Phone: (06) 4653344
Website: www.ruqn.com

Abu Assi Contracting Est.
Silver Membership
Key Services:
Design and Supervision
Contact Information:
Phone: (00962) 7 9552 2328
Website: www.facebook.com/AbuAssi-Contracting/

Sterling BIM
Silver Membership
Key Services:
Delivering a wide range of services with BIM through working across sectors on all the project stages
Contact Information:
Phone: (06) 5523126
Website: www.sterlingbim.com

Mostaqabel Engineering and Environmental Consultants
Silver Membership
Key Services:
Design and Construction Supervision
Contact Information:
Phone: (06) 592 3602
Website: www.mostaqbal.jo

Inside Out Design
Silver Membership
Key Services:
Design and Supervision
Contact information:
Phone: (00962) 795305060
Website: www.insideoutjo.com

Construction Services and Materials

Arab Technical Construction Co.
Silver Membership
Key Services:
Design and Supervision
Contact Information:
Phone: (06) 567 3424

Arab Italian Waterproofing and Insulation Industries Co.
Silver Membership
Key Services:
Construction and Manufacturers
Contact Information:
Phone: (06) 533 2145
Website: www.aiwin-jo.com

Moka`ab Constructions
Silver Membership
Key Services:
Building Construction
Contact Information:
Phone: (06) 5538854
Website: www.mokaab constructions.com

Satchnet
Silver Membership
Key Services:
Manufacturing
Contact Information:
Phone: (06) 4651524
Website: www.satchnet.com

Hand Over Projects
Silver Membership
Key Services:
Lead earth construction builders in Egypt
Contact Information:
Phone: +201007179089
Website: www.handoverprojects.com

Tabaa Contracting/Tabbaa Constructions Group
Silver Membership
Key Services:
Construction services, maintenance, renovation work and refurbishment
Contact Information:
Phone: (06) 581 8000
Website: tabbaaconstructions.com

Consolidated Contractors Company Limited Jordan
Silver Membership
Key Services:
Leads the industry in the adoption of new technology to improve construction efficiency and enhance project controls.
Contact Information:
Phone: (06) 4658403
Website: www.ccc.net

Suppliers and Providers

Don Construction Products
Silver Membership
Key Services:
Construction material
Contact Information:
Phone: (06) 5338891
Website: www.dcp-int.com

Jordan Sipes Paints Co. ltd
Silver Membership
Key Services:
Construction paints
Contact Information:
Phone: (06) 4201292
Website: www.sipes.net

Arab Technical Group
Silver Membership
Key Services:
Arab Technical Group in an engineering trading company that offers high-quality products and innovative solutions for the heating, cooling and renewable energy markets.
Contact Information:
Phone: (06) 5 517 711
Website: www.atgco.com

Petra Engineering Industries Co
Silver Membership
Key Services:
Cooling and heating systems
Contact Information:
Phone: (06) 553 1508
Website : www.petra-eng.com

Ata Rabah for Aluminum - Eylaf
Silver Membership
Key Services:
Windows, doors, interior partitions, and shutters
Contact Information:
Phone: (06) 541 1222
Website: www.atarabah.com

Qatrana Cement Company
Silver Membership
Key Services:
Construction cement providers
Contact Information:
Phone: (06) 580 2000
Website: www.qatranacement.com

Energy and environmental solutions and services

Eco Engineering and Energy Solutions - EcoSol
Silver Membership
Key Services:
Energy and Environment consulting
Contact Information:
Phone: (06) 533 0070
Website: www.ecosol-int.com

Hanania Solar Systems-Ideal Solar Energy Co.
Silver Membership
Key Services:
Solar energy integrated solutions providers
Contact Information:
Phone: (06) 5333003
Website: www.hanania.jo

ETA-max Energy and Environmental Solutions
Silver Membership
Key Services:
PV systems, energy management and energy training services
Contact Information:
Phone: (06) 5850770
Website: www.eta-max.com

Izzat Marji Group
Silver Membership
Key Services:
Heating systems, air conditioning systems, sanitary ware, bathroom and kitchen fixtures, plumbing systems, fixing systems and power tools, solar photovoltaic and acrylic solid services: Energy and sustainability and sustainability consulting, solar thermal systems
Contact Information:
Phone: (06) 5357733
Website: www.marji.jo

JOECO LLC
Silver Membership
Key Services:
Environmental solutions, consulting, training and workshops
Contact Information:
Phone: (00962) 791219010
Website: www.joeco-jo.com

AJB - high-tech LTD
Silver Membership
Key Services:
Building Automation Systems, Fires and security system, other building services
Contact Information:
Phone: (06) 5 527 778
Website: www.ajbautomation.com

Building Doctor
Silver Membership
Key Services:
Non-destructive testing and building physics, thermography, and air tightness
Contact Information:
Phone: +971 (0) 45517140
Website: www.buildingdoctor.ae

Legal Advisors

Andersen Tax and Legal Jordan
Golden Membership
Key Services:
Legal Consultancy
Contact Information:
Phone: (06) 565 4393
Website: www.andersenTaxLegal.jo

Educational Institutions

Islamic Cultural Society
Silver Membership
Key Services:
National and International Education
Contact Information:
Phone: (06) 464 1 331
Website: www.islamic-ec.edu.jo

Jubilee School
Silver Membership
Key Services:
National and International Education
Contact Information:
Phone: (06) 5238 216
Website: www.jubilee.edu.jo

Financial and Economic services

The Housing Bank for Trade and Finance
Platinum Membership
Key Services:
Banking financial services
Contact Information:
Phone: (06) 552 1011
Website: www.hbtf.com

Logistics and Shipping

Aramex International
Silver Membership
Key Services:
Independent voluntary organisation that is devoted to the conservation of Jordan's natural resources
Contact Information:
Phone: (06) 5515111
Website: www.aramex.com

Trading and Retail Companies

Majid Al Futtaim Group
Platinum Membership
Key Services:
Shopping malls, communities, retail and leisure.
Contact Information:
Dubai, United Arab Emirates.
Website: www.majidalfuttaim.com

Marketing and Advertising

Jordan Land Magazine
Silver Membership
Key Services:
Marketing services – Comprehensive economic magazine dealing with real estate and construction. It is the first magazine focused on the real estate sector through its coverage and distribution in the Arab world and MENA region.
Contact Information:
Phone: (06) 5511680
Website: www.jordanland.net

SADDA marketing & business solutions
Silver Membership
Key Services:
Marketing services – marketing, branding, public relations, and online business solutions studio
Contact Information:
Mobile: (00962) 79 9088996
Website: www.sadda.jo

Inspection and Standardization

TUV
Silver Membership
Key Services:
Inspects validity of TUV AUSTRIA certificates in Jordan
Contact Information:
Phone: (06) 5686771
Website: www.tuvaustria-jo.com

BDO
Platinum Membership
Key Services:
Audit and assurance, tax services, business services and outsourcing, risk management and risk advisory services as well as wide range of advisory and consulting services
Contact Information:
Phone: (06) 5816033
Website: www.bdo.com.jo

Associations and Environmental Organisations

The Royal Society for the Conservation of Nature (RSCN)
Silver Membership
Key Services:
An independent voluntary organization that is devoted to the conservation of Jordan's natural resources.
Contact Information:
Phone: (06) 533 7931
Website: www.rscn.org.jo

SEEDS Platform Co.
Silver Membership
Key Services:
Innovative online networking community/platform who advocate for a greener environment.
Contact Information:
Phone: +965 99912930
Website: www.seedsplatform.com

Getting Involved

Established in 2009, the Jordan Green Building Council is a member-based Civil Society and cross-sector Non-profit, Non-Governmental organization registered at the Ministry of Social Development. It received its “Established Member” status after the formal acceptance of the World Green Building Council in April 2012.

Its Mission is to: Promote and advocate for the adoption of the Green Built Environment Practices, leading towards making Green Buildings a widespread reality in Jordan. Our Council is part of a global network of more than 74 GBCs worldwide and holds the authority to represent the World Green Building Council (WGBC) in the Hashemite Kingdom of Jordan. The Jordan Green Building Council is currently the Vice Chair of MENA (Middle East and Northern Africa) Regional Network.

Jordan GBC has evolved to be a global leader in this field and will continue to serve and make the Kingdom proud. This representation has turned out to be a great opportunity to enhance the Kingdom’s position as a leader in this field and now the Jordan GBC can contribute effectively in the development, implementation and dissemination of the Green Built Environment policies globally.

To become a member or a volunteer in Jordan Green Building Council, all you have to do is to visit our location in Amman and register.

We offer training programs and awareness sessions all year long among many other services. So if you’re an individual, a professional, an organization, a start-up or a well-established company, please come and join our journey.

JORDAN GBC
المجلس الأردني للأبنية الخضراء
Jordan Green Building Council

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The awareness process happens through four major processes: Firstly, and most importantly the membership and networking; where we seek potential members in the green sector of Jordan in order to shed the light on the most important services, products or internal processes that are Eco friendly though sharing their own experiences using our green promotion and networking platforms.

Secondly, the Green Academy which is meant to enhance the public's awareness and education by being committed to proving high quality education in green practices and processes in order to train professionals to develop, manage and successfully execute green projects. Jordan GBC builds these capacities through professional workshops and trainings realted to Green Buildings.

Thirdly; Outreach activities and events where customized to serve different target groups to suit their awareness needs in order to send the message of Eco friendly buildings and build environment. The outreach events can target School student, universities, engineers of different fields.

Lastly, Reserach and Innovation; we constantly work on developing the council through researching potential for projects and engaging different stakeholders from mutiple sectors.

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