Material and Energy Requirements for Sustainable Development in Saudi Arabia

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***Abstract*—The proposal sheds light on the material requirements for the sustainable development of Saudi Arabia by considering various sustainability issues.**

Also, the proposal discusses about the existing sustainable technologies, materials along with a discussion of what currently needs to be done in the area of sustainable technologies. Development is often not so visible to the users of technology but this lies at the heart of many importance advancements.

Creating the engineering and the science which is required for a prosperous sustainable future will take a long time. Hence, we need to leading edge research and then educating the forthcoming generation of engineers and scientists that are needed to protect the technological leadership of the world.

I. Introduction

THE purpose of this proposal is to raise awareness on how the development of the land and energy can lead to sustainability by using a holistic approach of construction while also minimizing the impact of development during the lifetime.

There are a wide range of sustainability issues covered in this proposal such as energy efficiency, draining, waste management and biodiversity. The proposal sheds light on the material requirements for the sustainable development by considering various sustainability issues.

In the second half, the proposal discusses about the existing sustainable technologies, materials along with the discussion of what currently needs to be done in the area of sustainable technology.

II. Purpose and Scope

Adapting to the climatic changes is now been considered as one of the most pressing challenges faced by the planet. This proposal is a guideline which will be considered for material planning proposals. The aim is to ensure that there is a minimal impact on the environment in response to the climatic changes while planning for mitigation and adaptation of its effects (Kuhlman & Farrington, 2010).

Nevertheless, the way a development is constructed has a major role to play in delivering this goal. Finally, it would be ensured that the new developments are built in compliance with high standards of sustainable construction and designs. Therefore, it is focused on a number of areas: (Emas, 2015).

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1) Recycling and waste- to minimize the waste production and maximizing the idea of recycling and reuse .
2) Construction and demolition - Maximizing the idea of recycling and reuse of the demolition waste while minimizing the use of primary materials.
3) Floor risk-reducing vulnerability to flooding.
4) Development ratings – Complying with the necessary code for Sustainable homes.
5) Materials- Enabling the use of materials with a minimal environmental impact.
6) Energy- Making use of less energy and more of renewable energy.
7) Water- Improving the extent to which the water is used efficiently and saving water resources.
8) Pollution-reducing the damage to the environment through water, air and noise pollution.
9) Biodiversity- Safeguarding wildlife and preserving the natural features.
10) Secure design-making use of designs and layouts that are aimed at reducing the crime level and fear of criminal activities.

III. Objectives

The predominant objective is to meet the sustainable development needs. Sustainable development is defined as the development that responds to the needs of the present without overlooking the needs of the forthcoming generation. Sustainability can be positioned around environment, economy, and society and when all the three overlap, a product or a service then becomes sustainable (Emas, 2015). The detailed objectives are:

1) To develop the exchange of innovation and knowledge in the value chain along with energy efficiency in the industry.
2) To develop solutions that reduce the carbon footprint of glass, cement, and ceramic.
3) To give solutions that show advantages of industrial co-operation and help the regulators to elevate financial, regulatory and organizational framework .
4) To promote the existing and the future prospects of sustainability and energy policy.
5) To include the dimensions of trade that develops talking the global context into consideration, which includes the use of policies and the impact of environment, society, and economy on the environment.
6) To increase understanding and awareness among the policy makers regarding the actual and the future benefits of sustainability so that the aims and objectives can be achieved.

IV. Status

The Statutory Development Plan is going to be the starting point that will help in determining the planning applications for the use or development of the land.

Once it has been adopted, it will provide additional details on the implementation that the applicants must follow in order to make sure that all the requirements of the policy are being met.

Also, it will work as a framework of guidelines for the policy makers both at the national and the local level.

V. How does this fit with the local development framework

The Sustainable Practice Development provides details on the implementation of the policies that are aimed at ensuring that the new development complies with the high criteria of sustainable designs (Harris, 2003).

1) Waste Recycling
2) Re-use and Recycling of Aggregates
3) Flood Risk
4) Sustainable Design and Construction:
5) Renewable Energy
6) Water Supply, Drainage and Quality
7) Air Quality
8) Noise
9) Biodiversity in New Developments
10) Designing Safer Places

VI. What are the benefits of Sustainable Development?

The long-term advantages of sustainable development may not be obvious to the developers who are under tremendous pressure to derive profits from the projects. Nevertheless, different types of researches have shown that any development that integrates long-term development are able to get higher values and higher rents. For instance, there are many occupiers of the development who desire to have an attractive working environment and living, low energy costs and take part in their surroundings. They will also look for reassurance that the development can be resold in the future. In order to satisfy these needs, the investors, residents, and businesses are often willing to pay more (Feil & Schreiber, 2017). There are a number of advantages of sustainable development. For the developers, these benefits may include the following:

1) Reduced construction costs- a minimal wastage of construction materials will lead to improved profitability.
2) Increased returns- Those developments that are of high quality are more likely to be demanded more by the buyers.
3) Better reputation- Local people welcome development by the developers who show a good track record of caring for the environment.

VII. Corporate Policy and Community Plan

It is evident to state that the council also has a sustainability policy which aims towards preserving a more sustainable community.

In addition, the plan of the local community seeks to respond to the needs of the local communities in such ways that are not harmful to the natural health and build environment.

The community plan contains the following strategic priorities:

1) Amplified use of sustainable drainage systems
2) Improvement in the local quality of the environment
3) Enabling the use of recycling
4) Protection of biodiversity
5) Promoting the use of sustainable transport
6) Enabling the use of energy conservation measures
7) Encouraging the use of sustainable agricultural practices

VIII. Summary of requirements

A. Waste and Recycling – To reduce the development of waste and increase the use of recycling

Type of development: all development

Relevant local policy: recycling of waste

Requirements that should be considered by the developers in the sustainable development: provision of recycling and waste storage facilities.

How should the requirement be demonstrated: sustainable construction and design statement.

B. Construction and Demolition - Maximum the use and recycle of wastage

Type of Development: All Development

Relevant Local Policy: Reuse and Recycling

Requirements that should be considered by the developers in the sustainable development: Using recycled material instead of primary material in the new development

How should the requirement be demonstrated: Sustainable construction and design statement.

C. Flood Risk - Reducing the vulnerability to flooding

Type of Development: All development.

Relevant Local Policy: Risk of Flood.

Requirements that should be considered by the developers in the sustainable development: Using urban sustainable drainage systems.

How should the requirement be demonstrated: A Flood risk assessment wherever possible.

D. Materials - enabling the use of materials with low impacts on the environment

Type of Development: All major development.

Relevant Local Policy: Sustainable construction and design.

Requirements that should be considered by the developers in the sustainable development: Incorporating the onsite renewable energy equipment.

How should the requirement be demonstrated: Energy Assessment within the sustainable construction and design.

E. Water - Conserving the water resources

Type of Development: All development.

Relevant Local Policy: Water drainage quality.

Requirements that should be considered by the developers in the sustainable development: Using high standards of

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water and rainwater recycling.

How should the requirement be demonstrated: Sustainable construction and design statement.

F. Bio-Diversity - protecting and enhancing the wildlife

Type of Development: All development.

Relevant Local Policy: Geo-diversity and Bio-diversity.

Requirements that should be considered by the developers in the sustainable development: Enhancing the Bio-diversity and Geo-diversity.

How should the requirement be demonstrated: Sustainable construction and design statement.

G. Secure design

Type of Development: All development.

Relevant Local Policy: Promoting safer practices.

Requirements that should be considered by the developers in the sustainable development: Adopting the practices and principles of "Secure by Design" Award.

How should the requirement be demonstrated: Using a design and access statement.

H. Energy - Using less energy and making the use of renewable energy

Type of Development: All major development.

Relevant Local Policy: Renewable energy.

Requirements that should be considered by the developers in the sustainable development: Using On-site renewable energy tool to minimize Co2 emissions by 30 percent.

How should the requirement be demonstrated: Assessment of energy within sustainable design and construction, Renewable energy form.

I. Pollution - reducing the damage to the environment caused by air

Type of Development: All development.

Relevant Local Policy: Quality of Air Noise.

Requirements that should be considered by the developers in the sustainable development: Does not cause harm to the quality of air, There should be a lack of exposure to the noise sensitive development.

How should the requirement be demonstrated: Air quality assessment where necessary, Noise assessment where required.

J. Development rating - to use the required code of sustainable homes

Type of Development: Major new building residential, Major new building non-residential.

Relevant Local Policy: Sustainable construction and design, Sustainable construction and design.

Requirements that should be considered by the developers in the sustainable development: Code of sustainable homes "level 3", And level 4 from 2010, Zero carbon ratings.

How should the requirement be demonstrated: Submitting a certificate before construction under the code of sustainable homes, Submitting a design stage certificate before the construction and submitting a post-construction review.

IX. Energy Requirements
Future Solar Markets in Saudi Arabia

The sector of solar power in Saudi Arabia is assumed to increase aggressively in the forthcoming years. It is expected that by 2032, the demand for power will surpass 120GW every year and the country plans to supply nearly half of the demand with the help of renewable and nuclear power.

The target of Saudi Arabia is to generate 17.35 GW of Solar power by the end of 2022 and in the coming 20 years, the plan is to produce 30 percent of its power needs with the help of solar energy source. By 2032, about 54 percent GW of the renewable power capacity would be mounted in the country whereas almost 41 percent GW of the capacity is expected to be installed from the solar energy only. Out of 22.6 percent which is the targeted yearly share of electricity generation from the solar power by 2032, about 11.7% to 17.1 percent is to be expected by CSP plants and the remaining share may be given by the PV plants. There had been an agreement which was signed in 2014, August by The Chinese National Nuclear Corporation (CNNC) along with King Abdullah related to Atomic and Renewable energy to work together on the development of the nuclear and renewable energy in the Kingdom.

It is evident to state that Saudi Arabia has the potential to generate solar power at the minimal cost of energy when compared with other solar markets which are highly mature because of the presence of great solar irradiance, vast availability of land and a low-cost finance. Currently, it is easy to reach solar LCOE within the range of 70 USD up to 90 USD for every MWh for the plants that are greater than 10MW and expected to lessen 50 USD to 70 USD for every MWH by the end of 2020. Furthermore, a significant amount of pollutants coming from the traditional power plants can be saved when these plants are replaced with the solar power plants. This means that an extensive amount of damage is caused by these emissions from the conservative power plants which can be saved using solar plants (Pazheri et al., 2014).

X. Localization and Investment

A relatively cheaper and a feasible scenario would be exchanged nuclear reactors with the power plants of CCGT.

Additional 30 GW of the gas turbines will be required so that the intermittency of renewable resources can be covered. The accumulated investments that would be needed for the third scenario would total $150 billion which is almost half of what is required by the plan.

If there is a high penetration of the renewable energy in Saudi Arabia, then it should go together with the localization of some of the parts of the value chain. For the PV, Localizing the Balance of Systems (BOS) might be the first step. This includes wiring, monitoring installation, and equipment, trackers, the second step, however, could be building manufacturing facilities in Saudi Arabia.

The capital that could be required to create a 1GW per year PV may range from $1 billion up to $2 billion. To begin with a 500 MV plant and raising the capacity of the

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plant by 500 MV every year, the size of the plant may reach to a capacity of 7 GW by 2030.

A usual PV plant would need 2 people per MW in the stage of construction, 7 persons for the operations, 1 person for the maintenance. By the end of the completion of the project, 57000 people should be employed directly (Diner, 2000).

XI. Sustainable Technology

The advocates of bio fuels have asserted that with the help of bio-fuels, there is a reduced dependence on fossil hydrocarbons. Carbon taxes on the other hand, are designed so that they can stimulate a low carbon economy. Lastly, the designed for recycling aims to meet the demand of those materials that put less pressure on the natural resources, and instead, the put restriction on the light weighed materials as much cannot be recycled (Diner, 2000).

Smart Materials

The thermo-dynamic materials

Being the material of motion, ever smart material consist of an energy material in one form or the other for transformation to take place.

The energy type that is transferred determines the state of material, the pressure, the density or the internal energy will also change.

Also, the quantity of energy which is transferred to produce the change can be determined by the properties of the material. This relationship controls the behavior all every material which includes the smart phones (Addington, 2018).

Fuel cells tend to have higher efficiency as compared to gas engines and diesels. Moreover, most of the fuel cells operate in a silent manner as compared to the internal combustion engines. Fuel cells can help to reduce or eliminate pollution which is caused by the burning of fuels, and for hydrogen fuelled fuel cells, water is the only by-product (Aldenholt, 2017).

Lithium-ion is known to be a low maintenance battery, and this a benefit that cannot be claimed by other chemistries. There is no requirement of the scheduled cycling and memory to increase the battery life. Furthermore, the self-discharge is lesser than half as compared to nickel-cadmium, which makes lithium well-suited for current fuel gauge applications. These cells cause little or no harm when they are disposed (Chen et al., 2009).

Solar Technologies

A greater energy from sunlight raids the earth in only one hour (13 terawatts) as compared to all the energy that is consumed by the human annually. Sunlight is known to be an important source of carbon-neutral energy and increases to grow at a very rapid rate. Engineers and material scientists can provide materials-based solutions to capture free and infinite energy directly from the sunlight to meet the needs of the world (Saji&Korade, 2013). Currently, around 0.02% of the electric power in the United States is taken from the solar energy even though a solar energy farm which covers only 1.6 percent of the US land area can meet the demands of the local energy needs. Engineering and material science gives the potential to increase the amount of electricity which is generated from the solar power. Nevertheless, there are a variety of solar energies that can be used to effectively take the energy from the sun (Ashby, 2018).

A. Photovoltaics (PV)

Photovoltaic directly transforms the energy from the sun into electric power. There has been a tremendous amount of growth over the past decade which is greater than 30 percent every year, and surprisingly, the cost of electricity tends to decrease. The recent growth in this technology has been driven by minimum costs due to higher efficiency (Ashby, 2018).

Material Research and Development for Photovoltaic technology.

According to Ranabhat (2016), there is a need to increase the efficiency of solar cell by improving the cell deigns and material properties. This can be achieved by:

1) Developing or identifying alternative materials that are not toxic or abundant in nature.
2) Create the novel nanoscale surfaces so that reflection can be reduced and complete spectrum of light can be achieved.
3) Increasing the lifetime of the Photovoltaic by responding to the material aging issues.
4) Decreasing the cost of manufacturing and cerate effective methods to recycle the solar materials at end of life.
5) Bridging the gap between the research and the commercial cell efficiencies so that the cost of power from the modules can be reduced.

B. Concentrating Solar Power

This is a reflector which is used to concentrate the sunlight that generates increased temperature to heat the fluids that drive the steam turbines which can produce utility scale electric power. The three major types of CSP are the parabolic trough, power tower systems and dish. A reflective mirror is sued by each to direct sunlight on the fluids such as water, molten salt and gas (Gereffi et al., 2008). Nevertheless, material research is needed to:

1) Make the optical materials better for the reflectors that have greater durability and low cost.
2) Make thermal energy storage materials that have improved heat capacity.
3) Make the corrosion resistance of materials better in contact with molten salt.

XII. What Major Innovations Are Needed With Current Technologies to Achieve Sustainability?

A. Waste disposal requirements

Create new classes of the structural materials that are capable of working at the temperatures of 700°F, which is comparatively greater than that of today's light water reactors.

Make innovational computational materials performance key enablers to transform new materials into cutting-edge reactor systems.

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Development of the proliferation resistant nuclear fuel by advancing in coating nd ceramics technology and coating

Make new materials that are made up of nuclear waste for the geological life time (Gereffi, 2008).

B. Improving the efficiency of hydrogen powered fuel system

Cost effective materials which are resistant to hydrogen assisted cracking

Come up with reversible metal hybrid, making the energy storage capacity of traditional hydrogen storage capacity better. This energy storage capacity is ten times higher when compared with Lithium-ion batteries (Maroufmashat& Fowler, 2017).

C. Energy efficient buildings

Using the phase change materials which have the capability or releasing and storing large volumes of energy in floor, roofs and walls. This therefore, saves energy and levels the therming profile (Maroufmashat& Fowler, 2017).

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XIV. Conclusion

The relationship between the energy technologies and materials research on which we rely for our current and future need is very clear.

Material development and research is known to be a global pursuit. It takes into account a broad variety of engineering and science domains that involves the researchers across government, industry, and academia laboratories.

Sustainable material; development is often not so visible to the users of technology but this lies at the heart of many importance advancements.

The inventions of the past took a lot of time and a patient investment in the infrastructure and the people for conducting scientific research.

Creating the engineering and the science which is required for a prosperous sustainable future will take a long time.

Nevertheless, this may mean devoting in the leading edge research and then educating the forthcoming generation of engineers and scientists that are needed to protect the technological leadership of the world.

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