Sustainable energy in urban development (SEUP): A guide to application and incentives of green buildings in Jordan: Economic point of view

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Abstract. This increase in public spending on energy production has placed an additional burden on the Jordanian economy, and the average tax payer has felt the impact, as the cost of producing this energy is transferred onto the national budget. Thus, we have arrived at an unsustainable level of growth that threatens the survivability of future generations living in Jordan. Shrinking the energy gap will be a much more manageable problem if we tackle it in two ways. First increase domestic energy production. Energy production presents its own unique challenges, as it is dependent on what resources Jordan has, whether renewable or fossilized, and the economic feasibility of utilizing those resources. Second, more efficiently use the energy currently available, as reducing the demand is not possible without negatively affecting growth.

Efficient use lies in social awareness, and supportive government regulations. As a socially aware consumer will make choices that a more aligned with reducing energy use, and government regulation will drive the economy towards an energy conscience market. The methods used to gain insight and data to support these options will be compromised of studies provided by the Department of Statics, research, and data available on the market, such as price of oil, land, labor, and equipment used in building energy infrastructure. The significance of the options used to reduce energy gaps and the data used to support the options is they form a general policy available to any governmental organization, particularly ministries, to utilize them in any manner they see fit.

Keywords: green buildings, sustainable energy, economy impact, solar collector

1. INTRODUCTION

1.1 Sustainability description and components

Sustainability is defined as the capacity for long term maintenance of wellbeing, which has ecological, economic, political and cultural dimensions. Sustainability requires the reconciliation of environmental, social equity, and economic demands. These three aspects of sustainability have come to form the foundation of how human beings have interacted with our surroundings. The manner in which any given society drives each component's interaction with the other two, determines the characteristics of growth in it. This can be seen in the Figure 1 below.

1.2 Environmental component of sustainability

The first and most obvious component of sustainability is the environmental component. This is the most critical component, as it is the basis on which the other two components are built. Comparing the environmental component to the economic will reveal that putting a value on economic capita and accurately exchange it across borders in the form of currency, goods, and services; the same cannot be done with environmental capita.

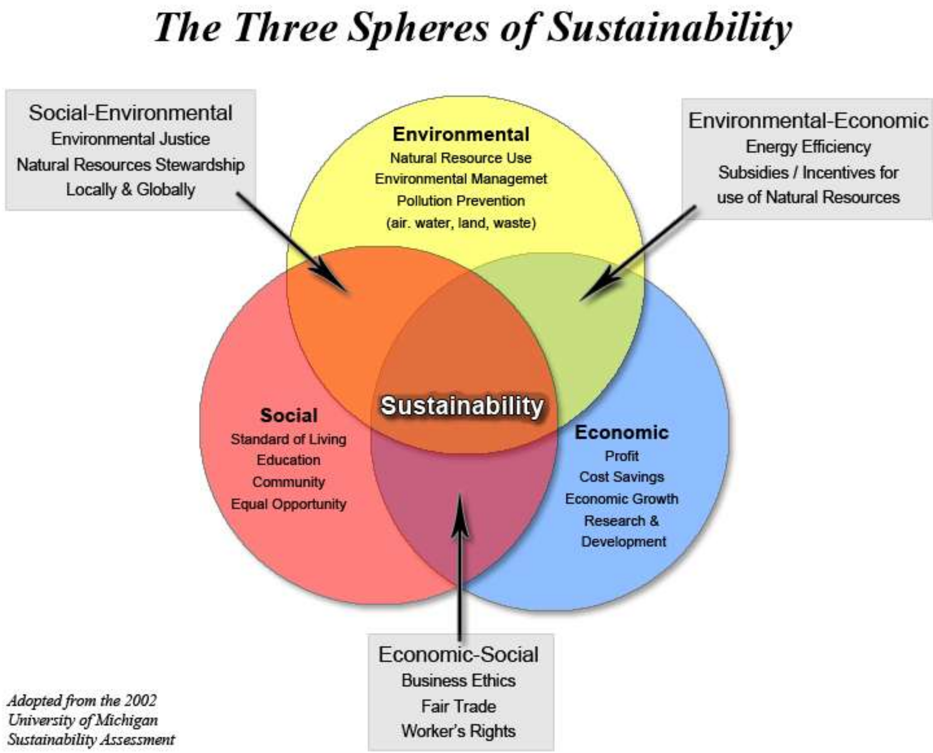

Fig. 1. Interaction of the three pillars of sustainability.

Valuing environmental capita would require creating a system with set exchange rates; this is very difficult, because identical environmental resources have different values to different countries (Ekins, 2011). The value of any environmental resource in any given country or region would depend on its existing conditions. For example, the value of a liter of potable drinking water is much higher in a water scarce country such as Jordan, than the value of the same liter of drinking water in water rich Netherlands.

The short comings of weak sustainability have led to the creation of Strong Sustainability, "which derives from a different perception that substitutability of manufactured for natural capital is seriously limited by such environmental characteristics as irreversibility, uncertainty and the existence of 'critical' components of natural capital, which make a unique contribution to welfare." Clearly, building a system of regulations to support sustainable growth must use strong sustainability as the foundation. In this sustainable system, it is necessary to define what capital will be recognized, and exchanged. For this purpose consider four types of capital, Manufactured Capital (MC), Natural Capital (NC), Human Capital (HC), and Social Capital (SC).

MC is also the simplest capital to assess in terms of Life Cycle Analysis (LCA). The current method of assessment combines input output analysis with life-cycle analysis to compute the environmental impacts of products that include their indirect, as well as, their direct impacts. Moreover, MC is the easiest capital to transfer and exchange, since it does not present the challenges of other capital pose, such as transfer of air, water, or social values.

The next capital examined is Natural Capital (NC), it is defined as: "In addition to traditional natural resources, such as timber, water, and energy and mineral reserves, natural capital includes broader natural assets, such as biodiversity, endangered species, and the ecosystems which perform ecological services (e.g. air and water filtration) that absorb and neutralize human wastes. Natural capital can be considered as the components of nature that can be linked directly or indirectly with human welfare." (Ekins, 2011). For simplicity, NC is what humans started with in this solar system. It is the single largest, most complex, and versatile capital in existence. Everything around us can be part of NC if the technology and methods to use it are available. Wind became an important source of locomotion at sea, thousands of years later it became a sources of clean renewable electricity. Solar energy has had a similar path, first as solar thermal and recently as photovoltaic.

HC is defined as: "generally refers to the health, well-being, and productive potential of individual people. Types of human capital include mental and physical health, education, motivation and work skills. These elements not only contribute to a happy, healthy society, but also to improve the opportunities for economic development through a productive workforce.” (Ekins, 2011).

SC is “related to human well-being, but on a societal level rather than individual level. It consists of the social networks that support an efficient, cohesive society, and facilitate social and intellectual interactions among its members. Examples of social capital include neighborhood associations, civic organizations, and cooperatives. The political and legal structures which promote political stability, democracy, government efficiency, and social justice (all of which are good for productivity as well as being desirable in them) are also part of social capital.”

1.3 Energy

Due to the difficulty in tracking many types of energy used in today’s urban environment, and the limited availability of individual statistical data, the analysis was confined to electrical power consumption. By considering the data given by the U.S. Energy Information Administration and the Jordanian Department of Statistics, it was found that the single largest consumer of electrical power in the Middle East, North America, and Europe is residential use followed closely by the industrial sector. Though this is not always the case, as a few years ago the industrial sector had the lion’s share of the annual energy bill. It would therefore, make sense for an energy policy to tackle both sectors first, starting with the residential.

The economic factors that drive the electrical energy demand are income and price. The income is reflected by the Gross Domestic Product (GDP) of a nation where the demand is expected to increase with the growth of economy (Momani, 2013). Global and regional policy changes may influence energy consumption, government financial policies, building regulations, taxation, and commitment to reduce Green House Gases (GHG) emission, shifting towards renewable and cleaner energy. The use of energy efficient equipment may play significant role in the variation of demand of electricity (Momani, 2013).

The global market for renewable energy is growing rapidly. Many pioneers around the world have made their communities (and cities as well) self-sufficient through renewable energy technologies. A combination of targets, policies, stimulus funds and a growing concern for energy security is at the bottom of the transformation from conventional energy to more renewable energy production.” (Sustainable Urban Energy, 2012)

1.4 Building design and standards

Residential energy use accounts for a significant portion of total energy use, which makes it a great place to start curbing energy consumption, and encouraging sustainable initiatives. “Using energy in more sustainable and efficient ways can have a major impact on mitigating climate change. One of the ways to use energy more efficiently is through sustainable building and construction.” (Sustainable Urban Energy, 2012).

Building energy standards can be used to address the energy use of an entire building or building systems such as heating or air conditioning. Energy standard is one of the most frequently used instruments for energy efficiency improvements and can play an important role in enhancing energy efficient design in buildings.” (Iwaro & Mwasha, 2010). In developing countries, building energy standards are often ineffective or much less effective than predicted. While building energy efficiency standards exist in a number of developing countries, they are often only on paper due to insufficient implementation and enforcement, corruption and other problems. In this study, a much deeper look will be taken on how to implement green building design initiatives.

2. RESULT AND DISCUSSION

The significance of this study is that it attempts to prove the feasibility of mitigation efforts of the existing gap between the amount of energy produced and the amount of energy used locally. This is accomplished by proving that the current emphasis on the individual higher energy users is a narrow minded approach. The current model supports the energy independence of the individual high energy user, while neglecting the low end users, even though the low end users outnumber the high end users by a large enough margin to make them a, overall, more significant user of energy.

2.1 Residential electric generation assumptions and parameters

The payback period for the 3.5 kW*hour system studied in this work will be approximately 9 years, which is slightly higher than the number used by the company providing the system, because this study used a lower tariff from the weighted average of the monthly tariffs, as opposed to the most commonly used tariff, and used a time value of money approach to account for inflation at 3.5%, as shown in Table 1. In addition, Table 2 shows the predicted energy output in kW*hour in the initial 15 years in service

Table 4.1. Value of adjusted investment using 3.5% inflation

Years in Service	Value of Investment Adjusted Using Inflation at 3.5% (JOD)
1	4165.875
2	4311.680
3	4462.589
4	4618.780
5	4780.437
6	4947.752
7	5120.924
8	5300.156
9	5485.661
10	5677.660
11	5876.378
12	6082.051

Table 4.2. Predicted energy output in kW*hour in the initial 15 years in service

Years in Service	Predicted Energy Output (kW*hour)
1	5825.02
2	5778.05
3	5731.07
4	5684.10
5	5637.12
6	5590.14
7	5543.17
8	5496.19
9	5449.22
10	5402.24
11	5355.26
12	5308.29
13	5261.31
14	5214.34
15	5167.36

However, if a time value approach is used to account for inflation, and an 8% bank loan, the project is no longer feasible, as inflation, interest on the bank loan, and cell degradation will make it impossible to pay back the initial cost of the system.

2.2 Higher consumption residential electric generation assumptions and parameters

The payback period for a 10kW*hour system will be approximately 2.5 years. This is slightly higher than the 2.3 years figure given by the company providing the system, because this study used a time value approach to account for inflation, without requiring external financing in the form of a loan. Tables (3 and 4) show the expected output degradation, and inflation for this hypothetical system. The tariff for this system is set at 0.271 per each kW*hour.

Table 3. Predicted energy output in kW*hour for initial 15 years in service

Years in Service	Predicted Energy Output (kW*hour)
1	18753.26
2	18602.03
3	18450.79
4	18299.56
5	18148.32
6	17997.08
7	17845.85
8	17694.61
9	17543.38
10	17392.14
11	17240.90
12	17089.67
13	16938.43
14	16787.20
15	16635.96

Table 4. Value of investment adjusted using inflation

Years in Service	Value of Investment Adjusted Using Inflation at 3.5% (JOD)
1	11,902.50
2	12,319.09
3	12,750.26
4	13,196.51
5	13,658.39
6	14,136.44
7	14,631.21
8	15,143.30
9	15,673.32
10	16,221.89
11	16,789.65
12	17,377.29
13	17,985.49

14	18,614.99
15	19,266.51
16	19,940.84
17	20,638.77
18	21,361.13
19	22,108.77
20	22,882.57
21	23,683.46
22	24,512.38
23	25,370.32
24	26,258.28

If the research team takes into account external financing through a bank loan set at 8%, then the payback period will be approximately 3 years. However, Figure 2 below shows that, there are two points of intercept between the 3 year mark and the 20 year mark. The area below the blue line, representing the monetary value of power produced, marks a grace the period when the system is producing power at a rate that can cover the loan. If any circumstances prevent the loan from being paid back during this period, when the system has been in operation for more than 20 year, the exponential increase in the cost of the loan will defeat the incentive of building the system in the first place.

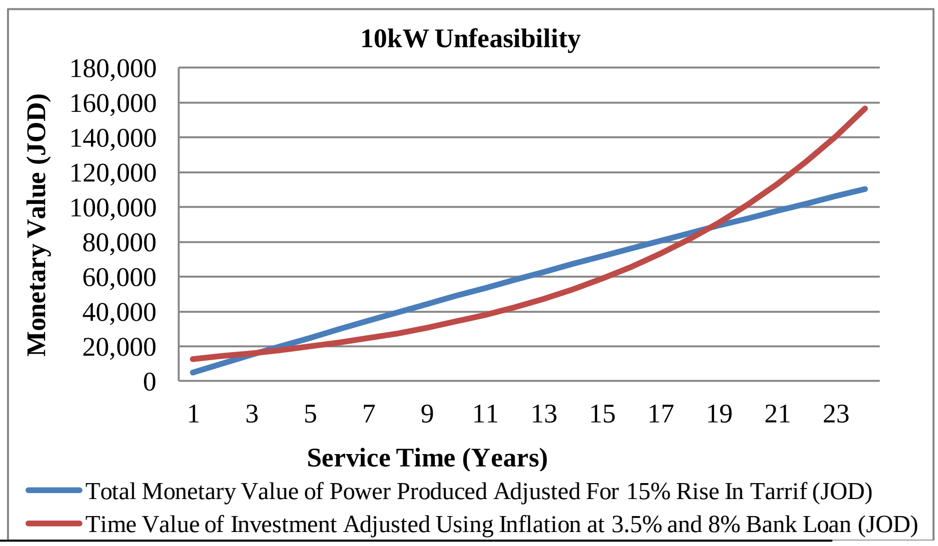

Fig. 2. 10 kW system unfeasibility (Gazania Solar Systems).

3. CONCLUSIONS

3.1 Observations

- The vast majority of energy users rely on government subsidies to afford electrical power in their homes.
- The majority of energy users is lower economic class and thus cannot afford a PV system, or a solar heater without assistance and financing.
- The continued rise in energy use by all users is adding to the financial burden on, and already strained national budget.
- Lack of clarity on regulations and support for the end user, has limited wider adoption of alternative energy measures.

3.2 Limitations

Not all the needed data was available. In addition, software for the simulation is considered proprietary, thus the study was unable to attain copies of it, nor was the research team able to dig into the parameters and code used in simulations. This is in addition to the needed approvals to work on the software package needed in this study to get information such as:

- Model limitations.
- Validation of data.
- Third party customer information.
- Engineering calculations.

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