Energy Efficiency, Renewable Energy Targets, and CO_2 Reductions Expected by 2020

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ABSTRACT

National efforts started in 2007 to meet the challenge of increasing oil prices. The Renewable Energy (RE) and Energy Efficiency (EE) Law (13) was issued temporarily in 2010 and in its final form in 2012. Subsequently, several bylaws and regulations were issued to facilitate the implementation of EE and RE measures and projects in Jordan. These actions will move the energy sector towards achieving the energy goals for 2020, while no tools have been developed to measure the CO_2 reductions. The specific actions by the national energy plans will be reviewed, and the expected CO_2 emission by 2020 will be presented. This will also measure the transition to a clean energy economy, energy mix paradigm shift, and required energy education shift to meet the increased demand for the EE, RE and CO_2-free energy educated clean technologies workforce.

INTRODUCTION

The world has more than 200 countries. Most of them import fossil fuels to meet their energy demands. The developed nations started their EE and RE technologies development during the seventies.

Most of the countries in the world are facing some of the following issues: rise in the cost of energy prices, increase in population, rise in energy intensity per capita, and environmental concerns. Jordan will be discussed in this article as a case study for a developing country that has worked rapidly during the past six years to change the energy mix and reduce the effect of the economic crisis due to the increase in energy

prices, and to ensure that a healthy productive environment is available for future generations.

Jordan started their EE and RE in 2008 after the global financial crisis. To meet the increasing prices of oil, a policy was set for the gradual removal of energy subsidies and for connecting the selling price of energy to international prices of oil.

Subsequently, solutions were needed to increase the efficiency of generating stations, change the energy mix in the country, develop the energy efficiency codes and regulations, identify the baseline, set targets to increase EE and RE in the energy mix, and reduce dependency on fossil fuels.

Energy Status in Jordan

The Ministry of Energy and Mineral Resources (MEMR) Energy Facts and Figures report 2014 [1] indicates that Jordan imports 97% of its energy requirements and 3% its local production. The primary energy needs are around 8,157,000 tons oil equivalent (toe). Eighty-two percent of the primary energy is crude oil and products, 3% is coal, 1% is coke, 2% is renewable energy, 11% is natural gas, and 1% is imported electricity.

Jordan's 2020 Primary Energy Sources Targets

The national policy [1] is to reduce imported crude oil and products from 82% to around 52-55% by 2020, keep the use of coal at around 3-5%, increase the renewable energy share in the energy mix to 10%, increase natural gas to 20%, reduce imported electricity, and start using the oil shale reserves for up to 10%.

Electric Energy Consumption

The household sector in Jordan consumes 43% of the generated electricity, 24% is consumed by the industrial sector, 17% commercially, 14% for water pumping, and 2% for street lighting. The exact numbers for the consumption of electricity can be taken from the electricity company's annual report [2], and are shown in Figure 1.

Jordan's 2020 Renewable Energy Targets

The National Plan that was developed in 2007 called for 7% of primary energy mix to be RE by 2015 and 10% by 2020. The recent RE targets reported by the MEMR are 1000 MW from wind, 600 MW from solar and 50 MW from biomass by 2020.

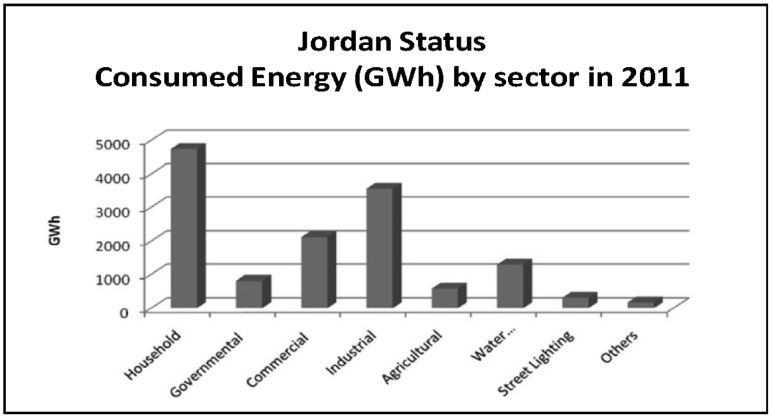

Figure 1: Jordan Electricity Consumption Per Sector

Jordan's Current Renewable Energy Projects

Table 1 shows the current RE projects in solar and wind that are at different stages of development. This is approximately 50% of the revised announced targets, but it is far from the 10% RE percentage in the energy mix that was first announced in 2007 as the target for the 2020 energy mix.

STAKEHOLDERS

Public

The major stakeholders in the public sector are shown in Figure 2. Energy sector policies are set up by the Ministry of Energy and Mineral Resources. The electricity sector is regulated by the Electricity Regulatory Commission (ERC), and the electricity is generated by the different generation stations. Then it is transmitted by the National Electrical Power Company, and finally it is distributed by the electricity distribution companies.

Private

The private sector is the leader of the economy, and its leaders need to develop the right tools to develop the EE and RE sectors. The major stakeholders are shown in Figure 3.

Universities started their own energy programs, and at least ten training centers are offering RE and EE courses. The Association of Energy Engineers already has a chapter in Jordan and more than 300 engineers

Table 1: Expected Renewable Projects

S#	Project Name	MW
	Wind	
1	Taffila Wind	117
2	Maan Wind	66
3	Fujeij	99
4	Lamsa	100
	Subtotal Wind	382
	Solar	
1	Kawar Consortium	50
2	Catalyst Private Equity	20
3	EJRE Projects	20
4	SunEdison Hellas SA	20
5	Evolution Solar	20
6	Shamsuna Power Company	10
7	Clean Energy Concepts	10
8	Ennera	10
9	Bright Power Group	10
10	Martifer Solar, S.A	10
11	Scatec Solar	10
12	Greenland Alternative Energy	10
13	Philadelphia Solar	10
14	Spanish Grant	3
15	Queira	65
16	Expression of Interest #2	200
17	Residential and Commercial	12
	Subtotal Solar	490
	Total Wind and Solar	**872**

took the Certified Energy Manager® CEM®, Carbon Reduction Manager (CRM), and Renewable Energy Professional (REP) courses.

Suppliers are bringing new material onboard to take advantage of the 0% customs and 0% taxes on EE and RE systems. This is one of the major industry drivers.

Developers started planning for RE projects after the issuing of the Expression of Interest (EOI# 1) in July 2011, where 68 companies submitted their interest in studying and executing wind and solar projects and 12 companies signed power purchase agreements (PPA) with NEPCO on March 31, 2014.

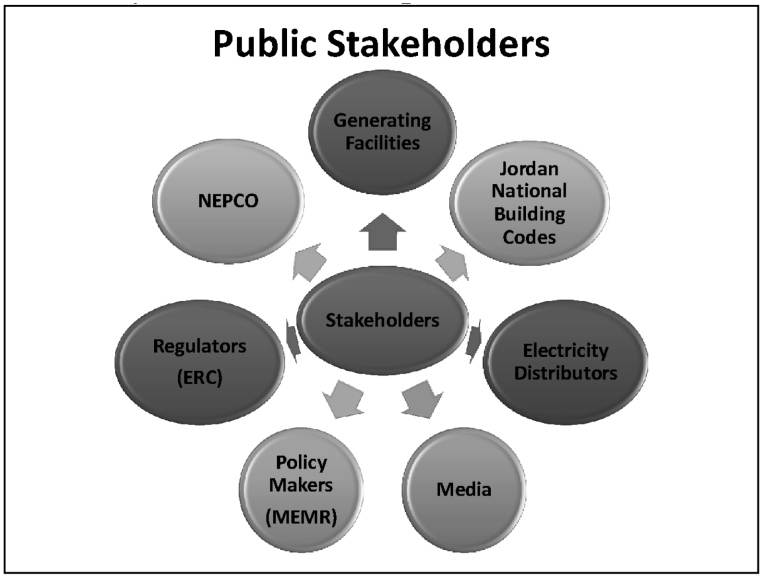

Figure 2: Public Stakeholders in the Energy Sector

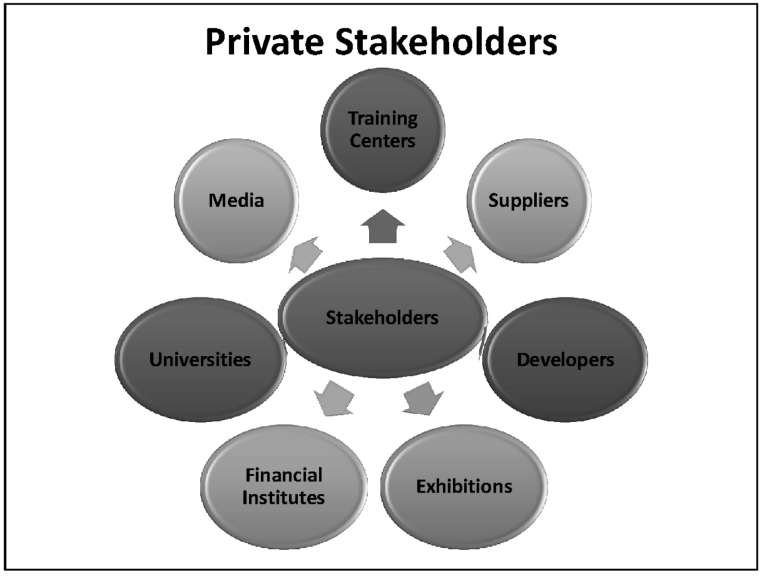

Figure 3: Private Stakeholders in the Energy Sector

National and international media have been reporting on solar and wind renewable energy projects in Jordan on a daily basis for the last 3 years. National and international exhibitions and conferences are taking place every month. This facilitates networking and communication between the stakeholders and increases the likelihood of moving towards a clean economy.

Clean Technology Workforce

The population distribution in Jordan is shown in Figure 4 which indicates that 3 million people are studying, and about 2.4 million people can be enrolled in the workforce.

The Department of Statistic's main indicators report shows that 38.2% of the people have been unemployed for more than 12 months, and that 48.8% of the people ages 15-24 are unemployed.

EE and RE projects are good for the economy because they employ thousands of people during construction, and they will need hundreds of people during operation and maintenance of the system.

Social and Environmental Factors

The region is undergoing a difficult time with ongoing wars in Syria, Iraq and Gaza. This is driving hundreds of thousands of people to move to Jordan. More than a million people crossed Jordan, and around 600,000 Syrians are living in camp cities in the north of the country. Prota-

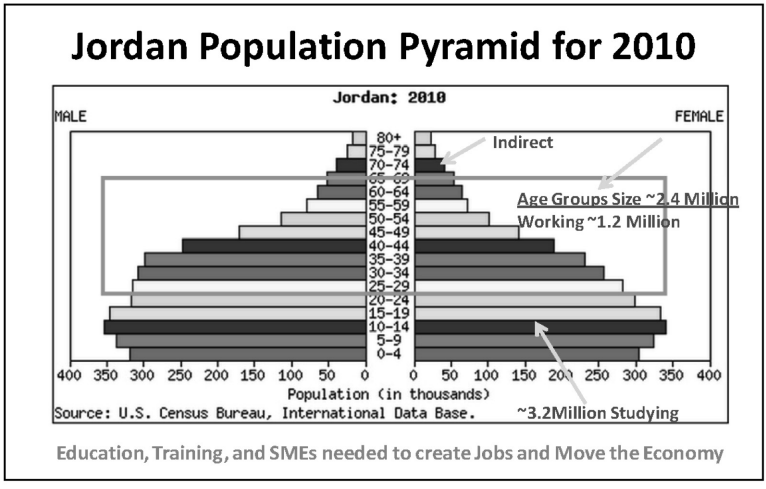

Figure 4: Jordan Population Pyramid

cabins supplied to camps have PV systems equipped with batteries. More than 200,000 people in Iraq are leaving their cities because of the weak government, and that is creating a major problem in the region. This will greatly increase fossil fuel prices unless the other OPEC countries can level them. On the other hand, this will reduce the level of stability that is highly important for national development of utility-scale projects. Another major problem is that the war in Gaza is hampering the development of the RE sector because people are not concentrating on the development of their energy systems.

REGULATORY SECTOR

The regulatory system is the basis for the development of the EE and RE sectors. The REEEL (13) year 2012 was developed in 2008/2009 and was issued in its temporary form in 2010. It was approved and issued in its final form in 2012. Subsequently two bylaws—bylaw (10) for custom and tax exemption and bylaw (73) for energy efficiency—were issued. The overall major laws and regulations are shown in Figure 5.

Wheeling regulations were later issued to regulate the generation of RE at a location far from the point of consumption. The RE Guide was issued by the Electricity Regulatory Commission (ERC) at the same time that the REEEL was issued. This assisted consumers in completing

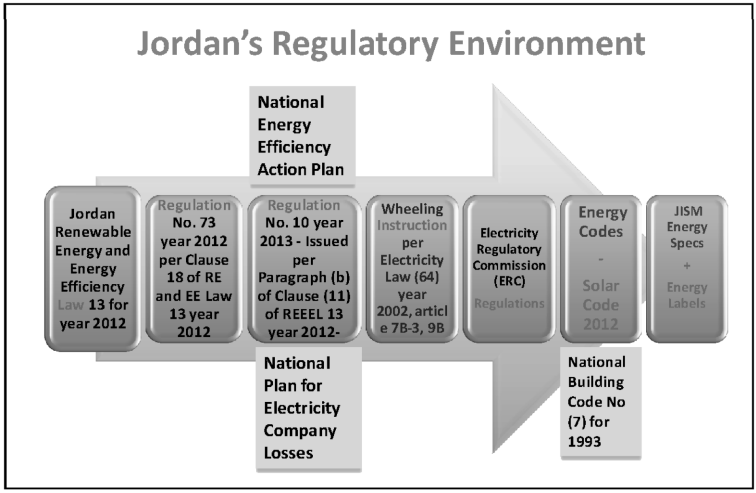

Figure 5: Energy Sector Regulatory Environment [4]

the process of requesting installation of an RE system, review, making changes, and commissioning.

The Jordan National Building Council (JNBC) that is operating under the Ministry of Public Works and Housing (MoPWH) also issued the Solar Code in 2012 that outlines the mandatory requirements for the installation of solar water heaters and solar PV.

The Jordan Standards and Metrology Organization (JSMO) works on energy labels for different electrical equipment, and starting July 01, 2014, electrical equipment entering Jordan was required to bear energy labels.

The National Energy Efficiency Action Plan (NEEAP) was approved by the cabinet in June 2013, and it calls for several projects to be implemented to achieve the EE targets. NEEAP will be revised every two years to use the lessons learned from its implementation, and to improve the performance of the plan.

Construction work in general is governed by the National Building Law (7) for the year 1993. The law calls for a fine between 100-3000JOD (1JOD = $1.4USD) for each violation of the requirements of the National Building Codes issued by JNBC.

The electricity companies are facing continuous losses because of rising fuel prices. To cover losses, a national strategy plan was set forth to increase electricity prices from 2014 to 2017, raising money from large-end consumers in different sectors. The small consumers will not be affected in this plan.

Natural Mineral Resources

The MEMR will continue the development of natural resources, especially natural gas and oil shale. Several agreements have been set forth with international companies to develop the large reserves of oil shale.

A new law for minerals will be issued in its final form. It was reviewed by the public in early 2014.

COST OF ELECTRICITY

The cost of electricity started increasing in 2008 following the removal of fuel price subsidies. Each sector has its own electricity tariffs: residential, ordinary, TV and radio, commercial, banks, telecommunication, small industrial, medium-size industrial, large industrial, agricultural, water pumping, hotels, street lighting, army, port, and agricultural and commercial mixed.

Residential

The residential sector has a stepped-up tariff that has been increasing since 2008. There are seven categories for the residential sector, and the tariff for each category is shown in Table 2.

Table 2: Residential Electricity Tariff

YEAR (USD/KWh					
2017	**2016**	**2015**	**2014**	**QTY (Kwh/month)**	**Tariff Category (Kwh/month)**
46,2	46,2	46,2	46,2	160	1 - 160
100,8	100,8	100,8	100,8	140	161 - 300
120,4	120,4	120,4	120,4	200	301 - 500
159,6	159,6	159,6	159,6	100	501 - 600
263,2	245	228,2	212,8	150	601 - 750
313,6	292,6	271,6	253,4	250	751 - 1000
414,4	399	379,4	362,6		above 1000

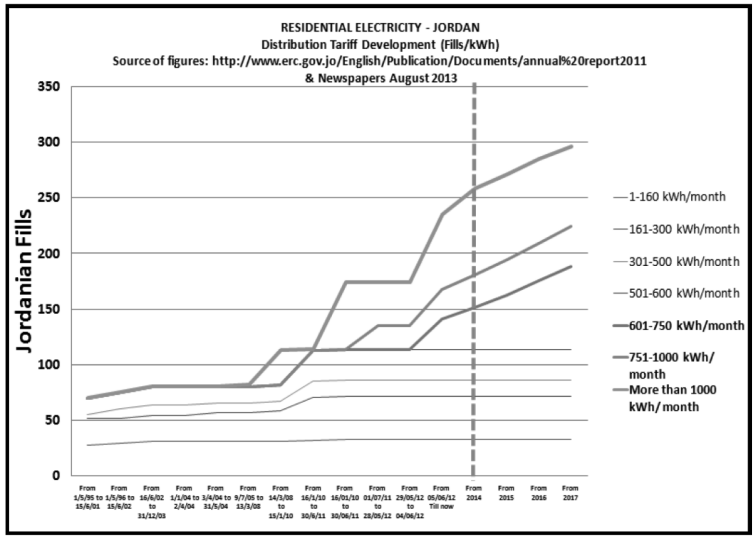

Figure 6: Historical and Planned Electricity Tariff for the Residential Sector (1995-2017)

Normal

Large consumers such as universities, hospitals, NGOs, and government buildings have a similar stepped-up tariff. This is shown in Figure 7. Large consumers in this category will experience a 5% increase between 2014 and 2017.

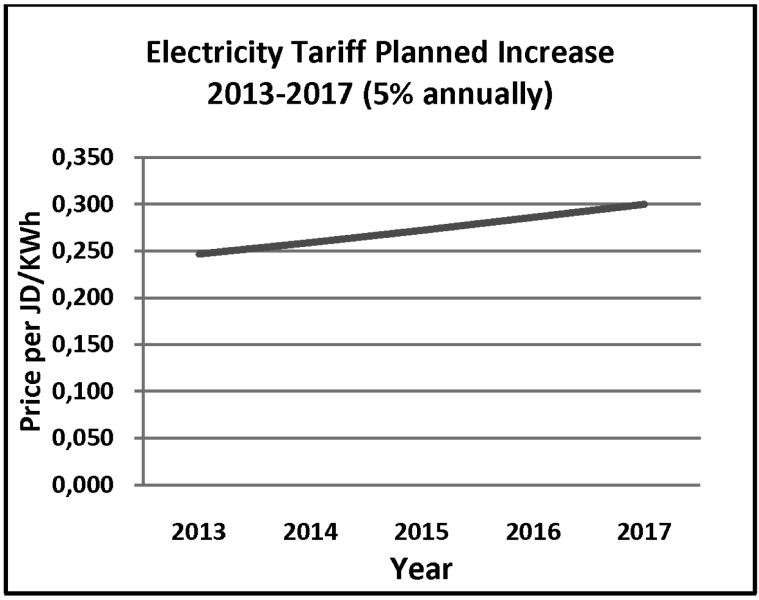

Figure 7: Planned Electricity Tariff for the Normal Sector Category

Industrial

The industrial sector has five different categories: small, under 10,000 kWh/month; small, over 10,000 kWh/month; medium; large; mining and large other. Each of these sectors will undergo different tariff increases during the next four year. Figure 8 shows the current cost of electricity and the stepped-up expected increase.

RENEWABLE ENERGY RESOURCES

RE resources depend on the geographical location of the area and local meteorological conditions. To explore the economical feasibility of the RE resource, measurements must be taken for at least 12 months. Several engineering firms require that measurements are taken for 3 years before data are used in the design of utility-scale projects.

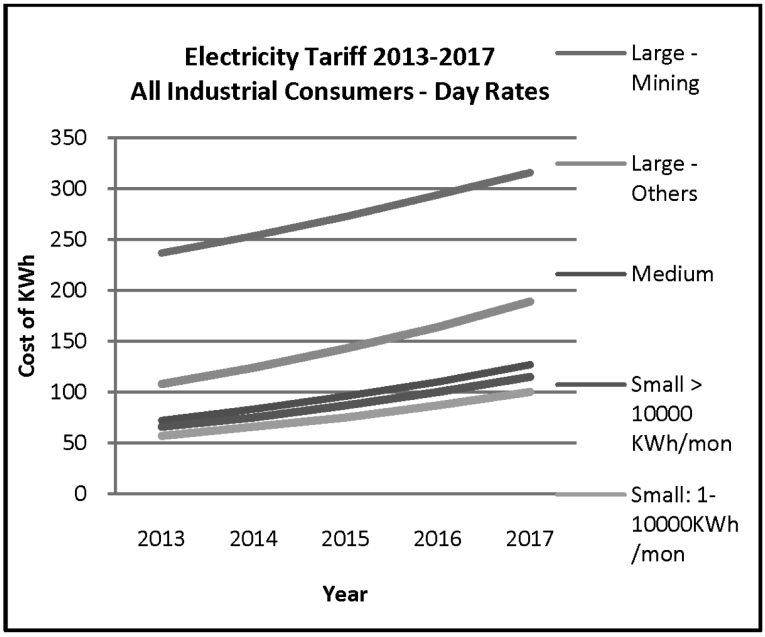

Figure 8: Planned Electricity Tariff for the Five Industrial Sector Categories

Climatic Conditions

Jordan has three distinct climatic conditions: 90% of the land is desert where it is hot and dry, 6% of the land is hilly and mountainous (this is where 80% of the population lives), 4% is Dead Sea area and Ghor where it is hot and humid.

Wind

Wind RE has been used in Jordan since the late 1990s. Two wind farms are available in the north since 1998 with a total capacity of 1.4 MW. The wind energy measurement stations have been collecting data at different heights for the past 30 years. A wind map is available in Jordan based on the collected measurements at around 40 locations. Currently, there are several projects under study and two under construction. Wind energy is the biggest resource that will be used in Jordan to achieve the 2020 RE targets.

Wind turbine generator (WTG) technologies have changed in the past 10 years, and the current hub height for a WTG is over 90 meters with a capacity between 2-3.5 MW. There is no sector-wide study that

can provide a reasonable estimate of the available wind resources in Jordan. But the available resources far exceed the required total demand and the grid capacity necessary to handle these loads. It is expected in the future that technology will advance to take the hub heights even higher—over 100-120 meters—thus, the wind speed will be increased, and the generation capacity will be increased from the same resource.

Solar

Jordan has over 300 days of sun, and the solar map of Jordan indicates that the farther south you go, the higher the solar resource. There are three types of technologies that can be used:

Solar Water Heaters (SWH)

SWH have been used in Jordan since the 1970s, and they are the best RE technology used since then. Over 1,000,000 m^2 of SWH have been installed since then, and Jordan is one of the top ten countries in the world in SWH use. The penetration rate per capita can be improved to follow the countries in the region, especially Cyprus which has the largest per capita penetration rate. Regulations making SWH mandatory for certain residences and offices were implemented in 2013, but the types of technologies and the technical solutions were not available. Solar water heaters for multi-family use must be adopted to increase the penetration rate. In addition, solar roofs must be designed by architects to utilize the roofs of buildings and the south elevation in a better way in urban areas.

Solar Photovoltaic (PV)

This was used in rural areas and border control points for the past 20 years, and the on-grid regulations became effective on December 2012. There are approximately 600 systems installed with a total capacity of 12 MW. Utility-scale projects are under development, and it is expected that 200 MW will be constructed within the next 18 months.

International prices are declining, and it is expected that it will become more affordable for a larger segment of the consumers. Currently, the payback period for large consumers is around 30 months.

Solar Concentrated Solar Power (CSP)

Jordan has excellent resources for CSP in the south. The current cost of technology is high, and it will not break even with the feed-in

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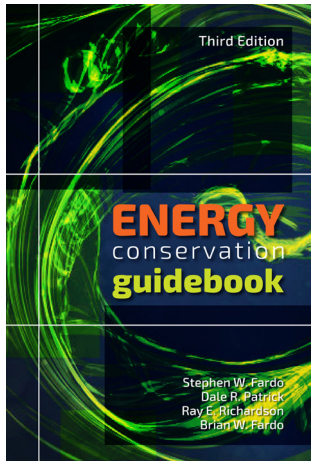

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tariff (FIT) that the government will pay for electricity generated from CSP. That is why this can be attractive in specific cases when energy storage is needed, so it is an attractive option to the government with the continuous increase in fossil fuel prices. The solar map for Jordan is shown in Figure 9.

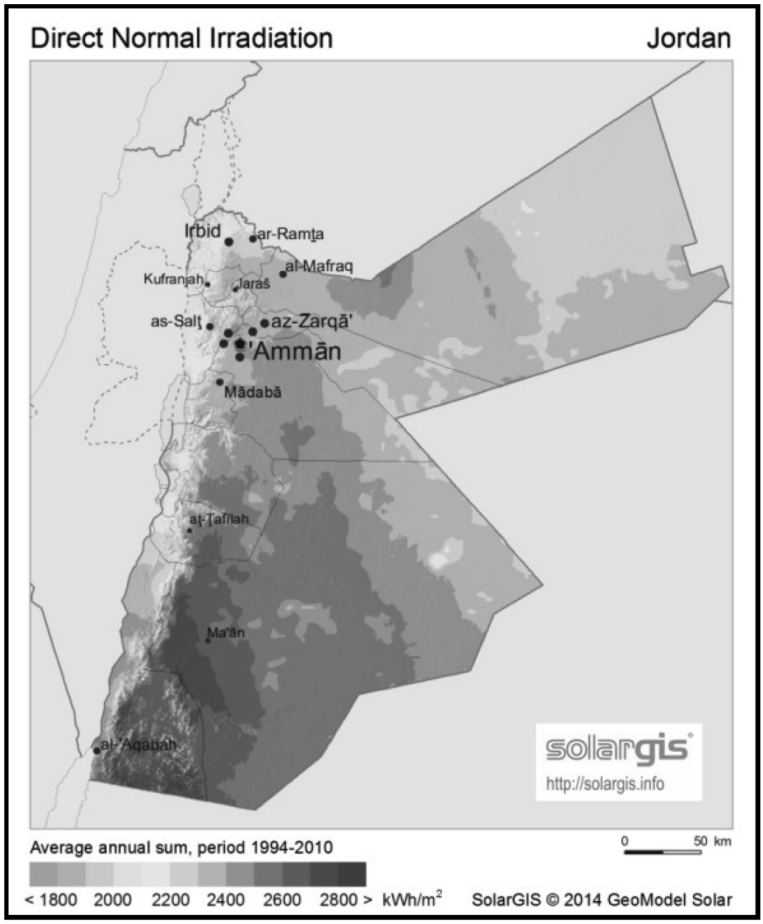

Figure 9: Solar Map—Direct Normal Irradiance

Solar data measured at the Industrial Park in Ma'an for 3 years show an average DNI of around 2,700 kWh/m^2 annually. This is one of the highest readings in the world.

Geothermal

This is available at several locations in Jordan, but the cost of technology is high. Nevertheless, Jordan has the largest shallow geothermal installation in the MENA region, and this can be an attractive option in the future as well because of the continuity of this resource. Contrary to other types of RE, it is not an intermittent resource. The importance of this resource will increase with the development of this technology and the reduction of the LCOE.

Hydro

Jordan has small water power resources and only one dam generating hydro power. There are no upcoming projects or studies announced for the generation of hydro power. King Talal Dam in the northern part of the country reports about 6 MW of hydro power.

Biomass

The world is still thinking about the sustainability of biomass renewable energy, but actual waste-to-energy RE development is progressing towards complete utilization of waste. Performance in developed countries varies, and development in Jordan is still weak because of the major issue of segregation of waste at the point of collection. At this time, around 10,000 scavengers are collecting the waste that can be recycled directly from garbage bins on a daily basis. Jordan has a pilot project for cultivating the Jatropha plant which has high oil content. This was not taken to a commercial scale because of technology cost and the effect of the plant on the soil.

Pilot projects are available in Jordan, and the 2020 goals call for the installation of 50 MW of biomass in the country.

ENERGY EFFICIENCY MEASURES

All sectors of the economy use energy and are in need of EE measures to reduce their consumption and operational costs. Therefore, the following major sectors will be studied in this research.

Residential

The annual utility bill at a typical house in Jordan can be calculated based on the published data in the MEMR Facts and Figures Report 2014 as 1,249 kilograms oil equivalent per capita primary energy

consumption and 2,235 kWh per capita electricity consumption [1].

According to an EPA publication, the typical house's annual energy bill in the USA is as shown in Figure 10. The percentage contribution of each of these categories might not be the same worldwide, but typical homes in Jordan will have a similar challenge in adopting energy efficiency measures to reduce energy needs in each of these categories.

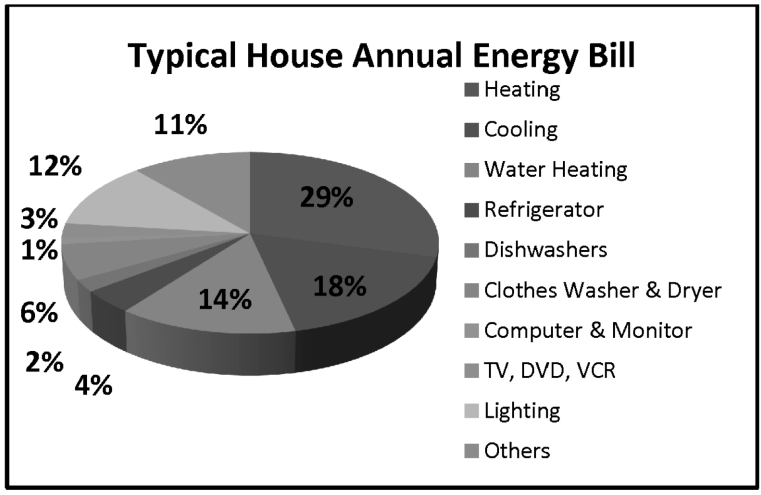

Figure 10: Typical Home Annual Energy Bill

Heating and cooling can be improved by adopting the mandatory requirements of the national building codes. At the same time, codes must be revised every 2-3 years to improve the requirements and living conditions for residents and implement the lessons learned. The REEEL and the subsequent bylaw 73 calls for mandatory implementation of the Jordan National Building Codes related to energy after 3 years from the issuing of the bylaw. This duration will end in September 2015. The major codes can be seen in Figure 11 [4].

As shown in Figure 12, continuous development of the key stakeholders affecting energy consumption in the residential sector is needed to achieve the EE measure [5].

Industrial

There are different sizes of industries in Jordan. The large industries consume about 10% of the electricity consumption. These

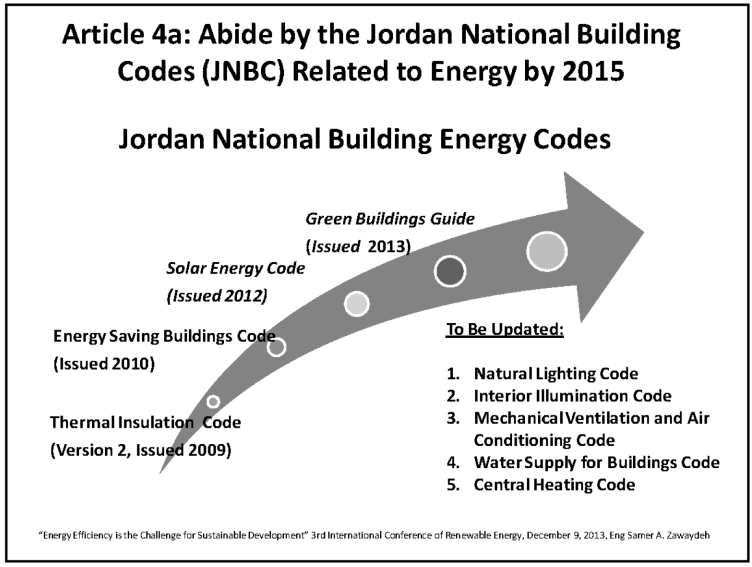

Figure 11: Main Energy Codes in Buildings

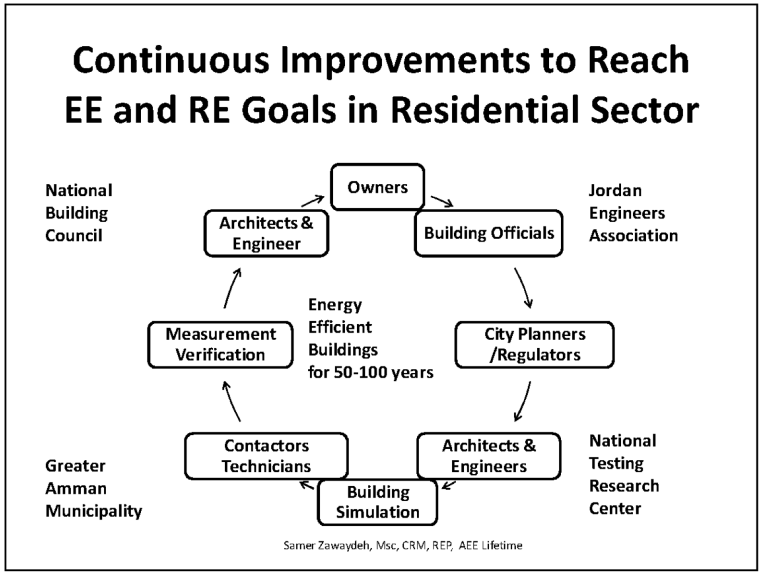

Figure 12: Continuous Improvement for the Supply Chain Cycle

industries will have to adopt renewable energy resources to offset the continuous increase in fossil fuel prices. The average payback period for such systems is 3-4 years, and the main obstacle at this time is technical and economical feasibility studies. Figure 13 is a picture of the largest installation in the industrial sector at this time—a 0.5 MW PV rooftop system.

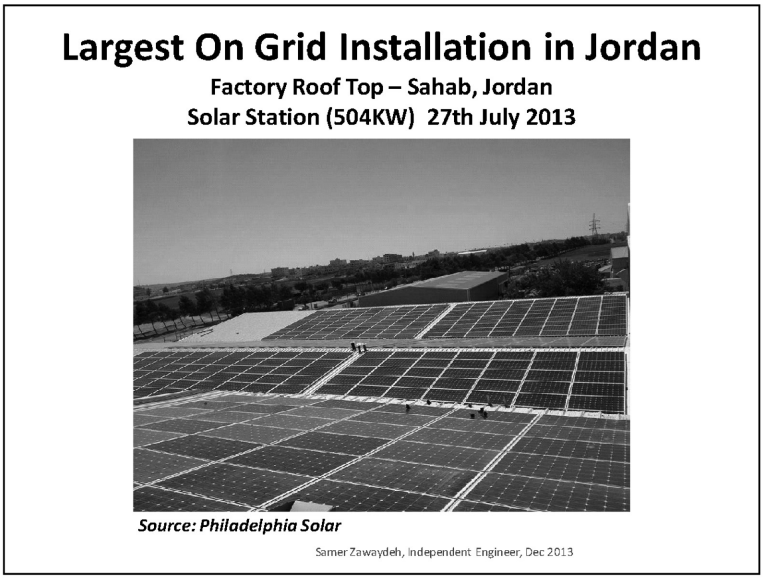

Figure 13: Industrial Rooftop PV Project

This situation will change in the next 3-5 years, and more RE projects will come online using utility-scale wind as well.

Developing of the gas sector is another option for the industries, and the challenge will be to secure the uninterrupted supply of gas for these industries. An LNG storage facility at the port of Aqaba is planned.

Transportation

Fifty-one percent of the final energy consumption is by the transportation sector [1] as shown in Figure 14.

Several initiatives like developing the rail between cities and using the rapid bus system were started in the past 10 years, but these were not executed. Hybrid cars were allowed in the past few years, and as of 2013, Jordan has 30,000 hybrid cars, of the 1.7 million in use. This

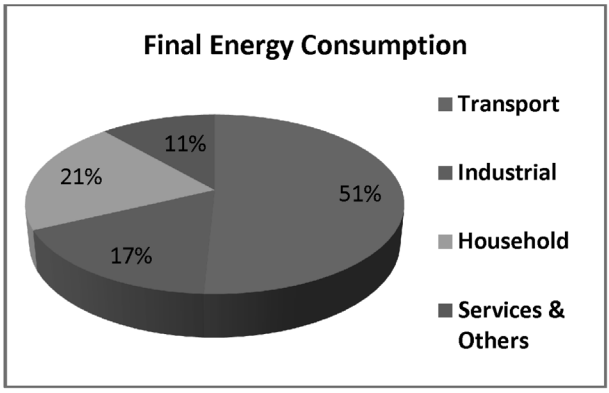

Figure 14: Final Energy Consumption by Sector

is the most important sector to concentrate on because of the large consumption of final primary energy.

Infrastructure in the major cities needs development and renovation to adapt to continuous growth and to increase in population. The country must adopt better performance cars to reduce the energy consumption as well. These are key for energy efficiency.

CO_2 FOOTPRINT

The CO_2 emissions are reported by the countries to the International Energy Agency on a yearly basis. Figure 15 shows the gram CO_2 emissions/kWh from electricity generation reported by Jordan to the International Energy Agency (IEA), 1990-2010 [8]

Total carbon emission in the country has been increasing due to increases in population and energy intensity. The 2011 report showed 19.8 million tons CO_2 per year.

The outlook for global change in emissions largely depends on the countries with large populations like China, India, the USA, Indonesia and Pakistan, and areas with large energy consumption like the USA, China and the EU.

Methane Emission

In addition to CO_2, there are several other gases. The MEMR issues estimated quantities of methane CH_4 emission from the energy usage in different sectors. Reported numbers for each of the major sectors are shown in Table 3.

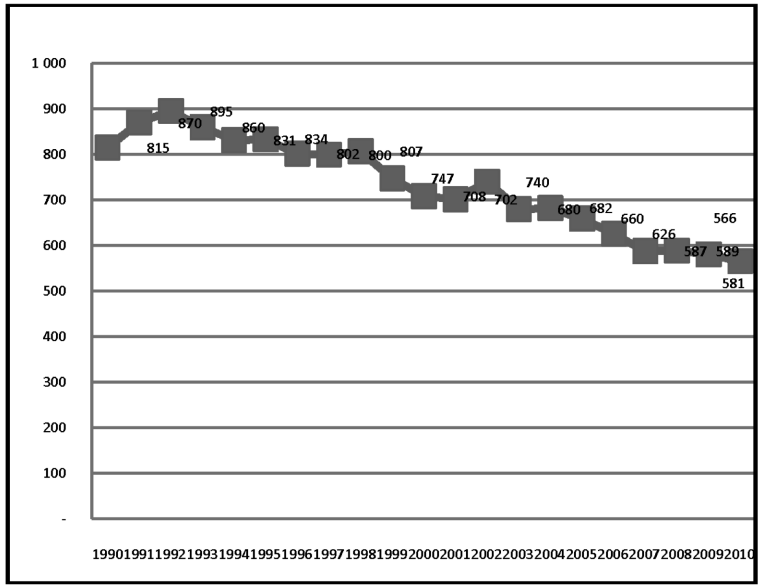

Figure 15: Gram CO_2 Emission/kWh

Table 3: Residential Electricity Tariff

Sectors	2009	2008	2007	2006	2005	2004
Household	117.9	112.9	108.3	103.8	99.4	95.2
Industrial	97.1	94.6	92.2	89.9	87.6	85.4
Transportation	2343.8	2239.1	2140.4	2046.5	1956.9	1868.5
Commercial	96.2	89.3	82.4	76.1	70.2	64.8
Transformation	495.6	480.1	392.4	314.8	220.9	210.3
Agricultural	97.3	94.7	92.3	89.8	87.4	85.2
Total	**3247.9**	**3110.7**	**2908.0**	**2720.9**	**2522.4**	**2409.4**

Source: Ministry of Energy and Mineral Resources

Climate Change Mitigation

Mitigation is a human intervention/action to reduce the sources or enhance the sinks of greenhouse gases to reduce the potential effects of global warming. Jordan has been the leading country in the region in reporting the GHG and abiding by international protocols since the 1990s.

Second National Communication (SNC)

This was issued in 2009. According to the SNC, the sectoral breakdown of the GHG emissions in Jordan is shown in Figure 17.

The energy sector is responsible for 74% of GHG emissions in Jordan. That is why RE and EE measures, in addition to being fuel saving, will contribute to the reduction of the GHG.

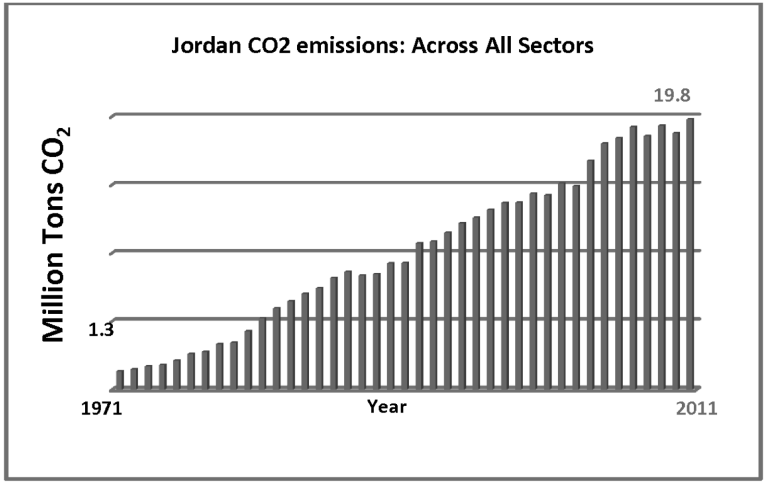

Figure 16: Jordan's CO_2 Emission 1971-2011

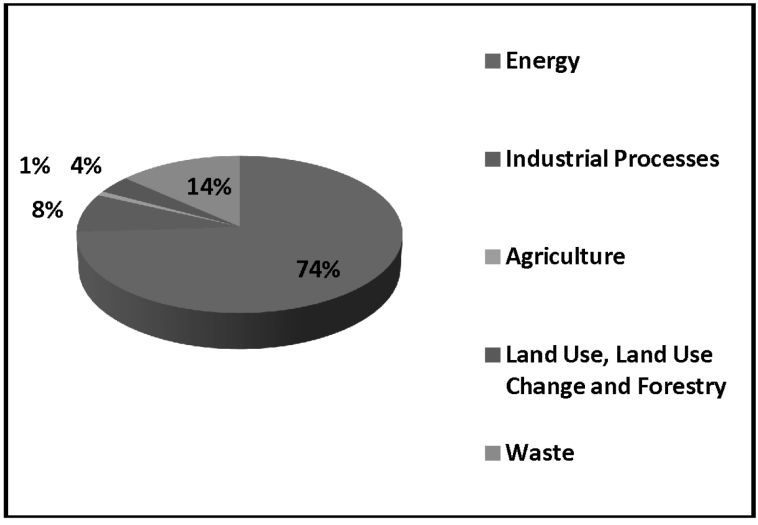

Figure 17: Jordan's GHG Emissions, by Sector, Reported by SNC

Third National Communication (TNC)

This document is under preparation by the team of experts in Jordan and the UNDP, and was to be issued by the end of 2014. This contains different mitigation scenarios based on the expected increase in demand, available technologies at the time of writing the report, and GHG emissions reported in the past.

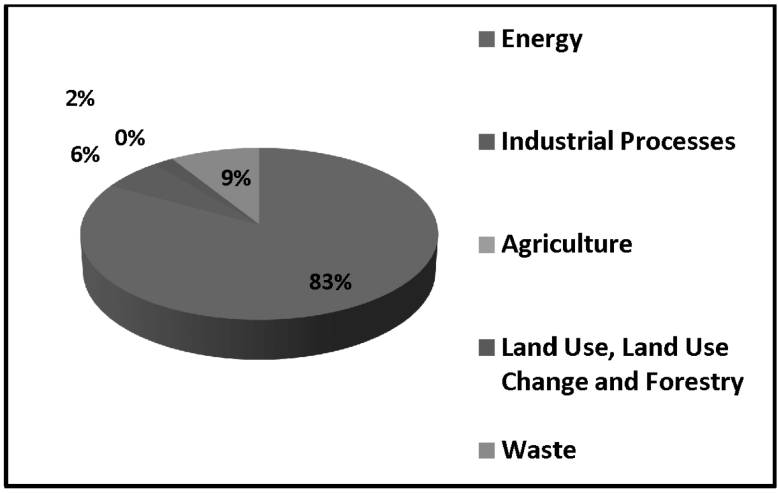

Figure 18: Jordan's Sector-wise 2040 GHG Emissions Expected in TNC

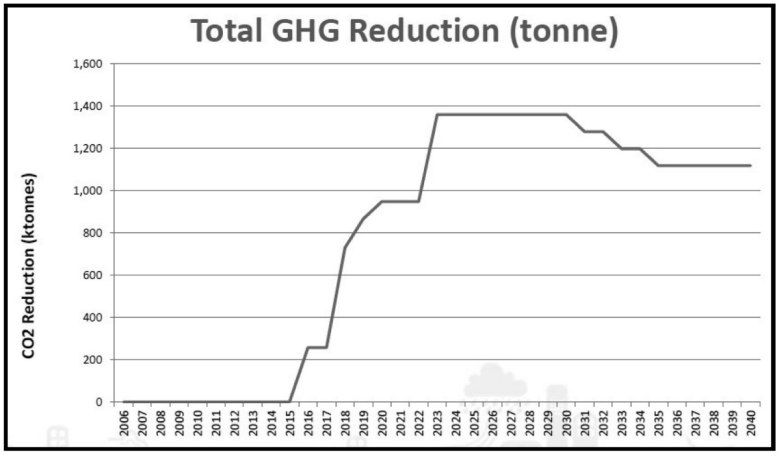

Figure 19: Jordan's 2040 GHG Emissions Reduction Expected in TNC, by Sector

Different measures will be taken to reduce the GHG by using RE and EE measures and by changing the policies and regulations in addition to changing the strategies to meet the demand in each sector.

Clean Development Mechanism Projects

The UNFCC website indicates that Jordan has three CDM projects. The fuel switching project of the Aqaba Thermal Power Station (ATPS) reduces 397,163 metric tonnes CO_2 equivalent per annum; the Samra Combined Cycle 300 MW project reduces 301,873 metric tonnes CO_2 equivalent per annum; and the Amman Gabawi Landfill Gas to Energy project reduces 212,064 metric tonnes CO_2 equivalent per annum. The CDM allows emission-reduction projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO_2. These CERs can be traded and sold, and used by industrialized countries to a meet a part of their emission reduction targets under the Kyoto Protocol.

ESIMTATED CO_2 REDUCTIONS

Several measures are under implementation to reach the 2020 goals.

Energy Efficiency

The National Energy Efficiency Action Plan was approved in June 2013, and several projects will be implemented to achieve this plan. The plan will be revised every two years to implement the lessons learned at each stage. Based on this plan, the estimated energy efficiency will be 2%. Hence, if the electricity demand for the residential section is not increased, and the plan is implemented, minimum expected reduction will be as shown in Table 4.

Table 4: CO_2 Emission Reduction Due to EE

GWH/ year	Efficiency	Estimated CO2 (Ton/GWH)	No of Years	Total Reductions (Ton CO2)
6126	0,02	566	6	416077,92
6126	0,04	566	4	554770,56
6126	0,06	566	2	416077,92
Total				1,386,926

Solar Water Heaters

Based on the MEMR report [1] the amount of solar thermal available is reducing 140,000 toe per year. This is saved by the solar water heaters (SWH) that are installed in the country. The estimated CO_2 reduction is calculated based on the Solar Heat Worldwide Report 2011 [14] shown in Table 5. The estimated 5% increase is conservative because the installed area is over 1 million m^2, and yearly manufacturing is around 60,000 m^2.

Table 5: CO_2 Emission Reduction Due to SWH

toe/ year	Efficiency	Estimated CO_2 (Ton/ toe)	No of Years	Total Reductions (Ton CO2)
140000	1	3,1	8	3472000
7000	1		7	151900
7000	1		6	130200
7000	1		5	108500
7000	1		4	86800
7000	1		3	65100
7000	1		2	43400
7000	1		1	21700
		Total		4,079,600

Wind Energy Projects

The planned capacity to be installed by 2020 is around 1000 MW. The projects listed below are already known to the public sector and the reduction of CO_2 is reported by the companies in their feasibility studies. Based on this, estimated reductions are 3.1 million tons of CO_2.

Table 6: CO_2 Emission Reduction Due to Wind

Project Name	Size	Operation Date	CO_2 Emission Reduct. (Ton)	No of Yrs	Total Reductions (Ton CO2)
Taffila	117	2016	400000	5	2000000
Ma'an	66	2016	220000	5	1100000
Fujeij	99	2018	220000	2	440000
Lamsa	100	2018	220000	2	440000
Total	382				3,100,000

Solar Energy Projects

These projects are in the final stages of financial closure, and it was expected that construction of 200 MW would start by the end of 2014. The estimated CO_2 reductions due to the solar energy projects are shown in the Table 7.

Table 7: CO_2 Emission Reduction Due to Solar

Project Name	Size	Operation Date	CO_2 Emission Reduct. (Ton)	No of Yrs	Total Reductions (Ton CO2)
EOI#1	200	2016	200000	5	1000000
EOI#2	200	2018	200000	3	600000
Misc	100		100000	2	200000
Total	382				1,800,000

So the overall estimation is around 10,000,000 tons of CO_{2e}. Emissions will be reduced due to the RE and EE measures implemented since the start of the REEEL in 2012.

FINANCE IS VITAL

Finance of the paradigm shift into adopting EE and RE is the engine that will ensure this transition. Several initiatives were begun during the past four years. Several major banks started "green loans" to give reduced interest rates on EE and RE projects. The Central Bank of Jordan issued the clean technology loan for projects under 14 million USD. This will give local banks the opportunity to finance RE and EE projects at reduced interest rates.

Several international donor agencies started loans and grants to support the green economy. The European Bank for Reconstruction and Development (ERBC) opened branches in Jordan in 2012 and is providing grants up to 70% that will allow the feasibility study of EE and RE projects.

The International Finance Corporation (IFC) in collaboration with another eight financial institutions created a loan to finance the first wind energy farm using the mega watt turbines, and the 117 MW Taffila wind farm started construction in Dec. 2013. It will generate 400 GWh

per year from wind.

In general, investors do not consider the life cycle cost analysis of the EE and RE projects, and they are still looking at the initial costs. This habit is hindering progress towards a de-carbonized economy.

JREEEF

Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) was created to support the increase of EE and RE projects to ensure energy and carbon reduction. The first project was the distribution of 5,000 solar water heaters (SWH) to 70 community-based organizations (CBOs). In return, these CBOs gave the SWH to 70 households for very small loans. These CBOs will be responsible for managing the loans and keep the process rotating to benefit all the households in the community. Hence, it will reduce the need for hot water in that community, reduce CO_2 emissions, and ensure a healthier environment at the same time.

Grants

To make it a bit more real for people, several donor organizations are installing small systems at rural communities for the public. This will reduce their electricity needs by 25-100%.

Non-government organizations are great at spreading word-of-mouth information to people who are interested in EE, RE and the environment. In addition, the Jordan Chamber of Commerce installed a PV system to show their members. The Jordan Housing Development Association did install a PV system as well, to spread the word. With more than 1,000 NGOs registered under the Ministry of Environment, they are one of the key drivers. Most of them depend on donations and grants from larger commercial organizations.

BEYOND 2020

Meeting the 2020 target as soon as possible will be the primary goal. Reducing the demand by adopting EE targets will help to meet the RE targets. The targets for EE and RE must be studied by the technical and the financial sectors to determine what is feasible. Major issues are national electricity grid development, the technical expertise necessary to integrate more renewables, and the equipment to develop or renovate.

Technology is the Answer

The availability of economical technologies that can fill energy needs and satisfy demand is the main driver that will increase the penetration of clean technologies such as EE and RE into the energy mix.

It is crucial that the upcoming generation is educated in science, technology, math and engineering. Everyone will be involved in the paradigm shift towards green economy.

Recommendation for the Building Sector

There is a big opportunity to develop the building sector, and that depends on the availability of resources. Some of the recommended development is:

- Increase energy efficiency in codes every 3 years following the international code such as Directive 2010 31 EU on energy performance in buildings [9]
- Identify annual energy baseline
- Develop existing buildings EE code requirements
- Develop human resources
- Continuous public awareness campaigns
- Enforce buildings' energy codes in construction according to Bylaw No. (73) for year 2012, The Bylaw on Regulating Procedures and Means of Conserving Energy and Improving Its Efficiency, Issued by virtue of Article (18) of the Renewable Energy and Energy Efficiency Law No. (13) for year 2012 [10]
- Online buildings' energy performance databases
- Harness free energy
- Adopt energy efficient architecture designs such as the recommendations outlined in AREE—Aqaba Residence Energy Efficiency, the complete experience [11]
- Make solar roofs mandatory in buildings
- Develop more indicators related to energy, and monitor the progress on a yearly basis [16] to serve as a baseline for development of RE and EE and reducing CO_2 emissions.

Renewable Energy Potential

A study was conducted by the author [7] based on the current primary energy consumption and increase in demand, and the available technologies. Future energy needs can be covered by the solar PV and CSP technologies using around 100 km^2.

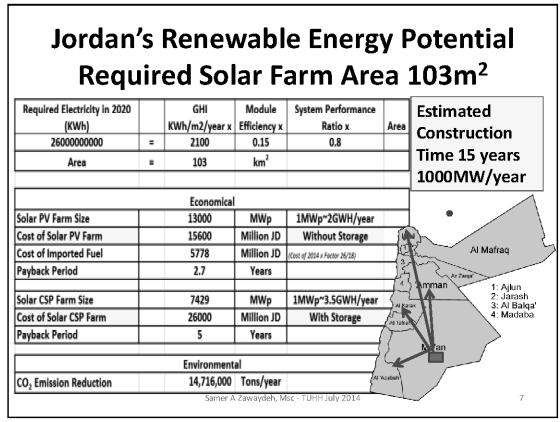

Figure 20: Jordan's RE Solar Potential

SUMMARY AND CONCLUSIONS

The regulatory framework is the key baseline in any country for the development of the RE and EE sectors. In the next few years, further development will take place in the regulatory sector, implementing the lessons learned since the issuing of REEEL (13) for year 2012. Technical solutions will need to be available to implement the regulations. These technical solutions must be backed by financial institutions with developed regulations that support clean technology projects. CO_{2e} reductions will continue to increase through the adoption of more EE and RE, and reducing the demand through awareness campaigns and complete supply chain support.

Problems with adopting EE and RE solutions pertaining to locally available technologies and site conditions will remain until better technologies are available commercially. Consumer awareness and behavior change will be a major key in solving this problem.

We can't avoid future increases in fuel prices, so the bottom line is to reduce dependency on fossil fuel and increase use of RE resources. We can also reduce demand by using EE measures.

Energy awareness, increased knowledge, and creating an energy baseline are starting points for solving the economical and environmental problems of fossil fuel based energy. We must use a different language with the end user to show them how to calculate the life cycle cost for EE and RE projects and compare it to the current options.

We must develop future frameworks while considering energy, because energy is integrated within the economic sector. Renewable energy will take a bigger and bigger share. Industries need to develop their own EE and RE projects to meet their local needs.

Connecting the national electricity grid with neighboring countries is an issue needing further development. At the same time, we must consider energy storage solutions.

The expected reduction in CO_2 emissions due to the implementation of RE and EE and mitigation measures is around 10 million tons.

Developments in Jordan will prove to be a template for leadership in the Middle East and North Africa (MENA) regions to follow in developing their EE and RE regulations and national targets, and they will make a significant contribution to developing these markets.

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