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Kontakt/Contact
ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics
Düsternbrooker Weg 120
24105 Kiel (Germany)
E-Mail: *rights[at]zbw.eu*
https://www.zbw.eu/econis-archiv/

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Energy Efficiency Standards and Labels for Cold Appliances in Jordan

Alwiyah Abd Alfattah[1], Ahmad Sakhrieh[2,3]*, Ahmed Al-Ghandoor[4]

[1]Department of Mechanical Engineering, The University of Jordan, Amman 11942, Jordan, [2]Department of Mechanical Engineering, The University of Jordan, Amman 11942, Jordan, [3]Department of Mechanical and Industrial Engineering, American University of Ras Al Khaimah, UAE, [4]Department of Industrial Engineering, The Hashemite University, Zarqa, 13115, Jordan.
*Email: ahmad.sakhrieh@aurak.ac.ae

ABSTRACT

In the last few years, Jordan has experienced an expansion in the number of electrical appliances. In order to reduce energy consumption in the residential sector, Jordan has to consider implementing minimum energy efficiency standards (MEES) for electrical appliances in the coming years. This study provides background on the benefits of, and steps needed to support introduction of EES and labeling in Jordan. Furthermore, this study attempts to predict the amount of energy that will be saved in the residential sector by implementing MEES for the cold electrical appliances (refrigerators and freezers). This study concentrates on cold electrical appliances because it was found that cold appliances are about 32.7% of total household electrical energy consumption in Jordan. Four scenarios for replacing the old appliances have been suggested and analyzed. It was found that the net saving from 2011 to 2020 will be approximately 4451.17 GWh. The associated CO_2 emission reduction during the 10 years is expected to reach 2221 (1000 ton). In addition, the reduction of customer bills will reach 320 million JD based on the worst scenario.

Keywords: Energy Efficiency, Standard, Appliances, Jordan
JEL Classification: Q4

1. INTRODUCTION

The minimum energy efficiency standard (MEES) is a tool for improving the energy efficiency of appliances and equipment. MEES sets the minimum levels of energy efficiency which a product must meet to be sold in the Jordanian marketplace. An energy efficiency label contains information which is attached to manufactured products indicating the product's energy efficiency rating or estimated annual energy use in order to provide consumers with the necessary data to make an informed purchase. Improved appliance efficiency is important for personal financial reasons e.g., lowering electricity consumption. Also, improved efficiency is important for environmental reasons; because it reduces the consumption of electricity which in turn reduces air pollution by minimizing greenhouse gas emissions.

Lawrence Berkeley National Laboratory's (LBNL) Energy Efficiency Standards (EES) group has performed technical and economic analyses of refrigerator-freezer for the U.S. Department of Energy (DOE) since 1979. These analyses formed the bases of the efficiency standards established by DOE in 1989 and 1997 (which became effective in 1993 and 2001, respectively). Refrigerator-freezers manufactured after July 2001 typically consume about 30% less energy than the maximum energy use allowed under the 1993 efficiency regulations (Meyers et al., 2003). In 2008, LBNL completed an updated study of the historic and projected impacts of U.S. residential appliance standards.

In 2005, DOE confined its updated analysis for the two most popular product classes of refrigerators: Top-mount refrigerator or freezers without through-the-door (TTD) features and side-mounted refrigerator-freezers with TTD feature. Depending on assumptions regarding the impact that standards would have on market efficiency, amended standards at the 2005 ENERGY STAR levels were estimated to yield between 2.4 to 3.4 quads from 2005 to 2030, with an associated economic impact to the U.S economy from a burden or cost of $1.2 billion to a benefit or saving of $3.3 billion. The Energy Independence and Security

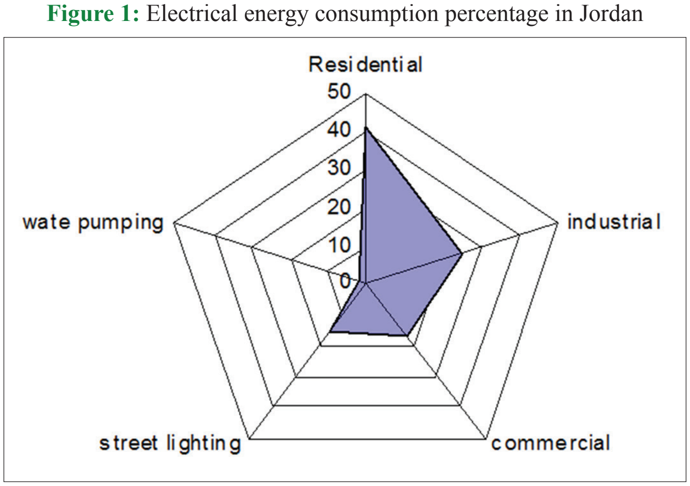
Act of 2007 (EISA, 2007), signed into law on December 19, 2007, required that the DOE published a final rule no later than December 31, 2010, to determine whether to amend the standards in effect for refrigerators, refrigerator-freezers, and freezers manufactured on or after January 1, 2014 (Meyers et al., 2004). The situation of the global refrigerator market was analyzed. It was found that Germany offers the most lead market advantages in the refrigerator-producing industry, followed by Korea and Italy (Cleff and Rennings, 2016).

Brennan and Palmer (2013) examine how an energy efficiency resource standards compares to policies oriented to meeting objectives, such as reducing greenhouse gas emissions, correcting for consumer error in energy efficiency investment, or reducing peak demand absent real-time prices.

Energy consumption of household appliances has become a target for energy efficiency improvements. Electricity consumption increased significantly in the past few years. In 2010, total electricity consumption in Jordan reached 12,843 GWh (Ministry of Energy and Mineral Resources, 2010), which is 7.42% higher than the preceding year. Consumption of household appliance in this same year (5219 GWh) is about 41% of the total electricity consumption as shown below in Figure 1. Immediate benefits for energy saving can be realized by improving building efficiency and appliance standards, while solving the Jordan's energy challenges is a long-term proposition.

In Jordan, a study has been conducted in 2008 in order to analyze the historical, current and future fuel and electricity consumption within the residential sector. It was shown that the electricity and fuel demand were expected to rise approximately 100% and 23%, respectively within 10 years. Consequently, associated greenhouse gas (GHG) emissions resulting from residential sector are predicted to rise by 59% for the same period (Al-Ghandoor et al., 2008). Most households in Jordan do not employ efficient appliances. The study demonstrated that significant potential energy and environmental benefits are a result of adopting high efficiency standards. The worst scenario expected the net saving of 61.4 million US$ per annum, will be achieved in 2018 (Al-Ghandoor et al., 2009). Consequently, the associated CO_2 emissions reduction will be approximately 180 million ton per year.

Figure 1: Electrical energy consumption percentage in Jordan



This study will present the potential of implementing MEES on annual saving of electricity from cold appliances in the residential sector according to field survey conducted in Amman and Zarqa. The impact of implementing MEES will investigate and expect significant impact in the future electricity consumption and associated GHG emission for residential sector in Jordan. Furthermore a cost-benefit analysis of implementing MEES for these appliances and its environmental impact will be conducted. The calculation is based on the growth of energy consumption in residential sector during 2010-2020.

2. METHODOLOGY

The data necessary for the study are the electricity consumption and pollution values of Jordanian household appliances. The historical electrical energy consumption for residential sector for the period 1985-2010, were used to predict future electricity consumption in the residential sector using polynomial curve fitting for 10 years period (2011-2020). The electrical energy data for the period 1985-2010 was obtained from the Ministry of Energy and Mineral Resources (MEMR, 2010). As shown in Table 1, the electrical energy consumption in the residential sector has increased year by year along with the total electricity consumption of the country. CO, CO_2 and NO_X values were obtained from the Department of Statistic (DOS, 2009). These data are summarized in Table 2. It is clear that all mentioned pollutants are increasing every year. A questionnaire was used to obtain the third part of the data, i.e. house appliances data. House owners provided estimates for typical usage of each household appliance.

The sample size is step in the planning of the survey. The selected confidence interval was 95%, it means that if we repeat the survey 100 times we would expect the answer to any question to vary between the chosen margin of error in 95 out of 100 times. Response percentage, the percentage of people who give a particular answer to a question in a survey, was 85% and the margin error value was ±5%. The size of the total population for the target sample of this study of Amman and Zarqa city population was 3,350,700. According to the numbers shown above, the calculated

Table 1: Electrical energy consumption for residential sector in Jordan

Year	Total energy consumption (GWh)	Residential energy consumption (GWh)
1985	2151	655
1990	3089	874
1995	4785	1411
2000	6133	1981
2005	8712	2989
2010	12843	5219

Table 2: CO, CO_2 and NO_X emissions in Jordan

Fuels	Emission (ton metric 000/Year)		
Year	CO_2	NO_X	CO
2006	20766.9	127.0	537.4
2007	20712.4	130.1	566.9
2008	21387.7	135.0	598.0
2009	21996.2	140.5	630.0

sample size was 196 surveys. The sample was taken randomly from different areas and house types (e.g. floor) and different social situations. The total collected surveys were 210.

Using MATLAB a fourth degree polynomial is found to be the best curve to predict electricity consumption in the future years with an adjusted R^2 of 0.995. This curve has the formula:

$$Y=636.05+6.65X+10.77X^2-0.72X^3+0.02X^4 \quad (1)$$

3. ANALYSIS

Figure 2 shows the contribution of home appliances in energy consumption in Amman and Zarqa as obtained from the survey data. The used electrical energy inside houses depends on the lifestyle, the family size and the size and age of appliances. The energy consumption of the appliances in household is reflected directly on the electricity bill. The power consumption in Wattage of different electrical appliances is used to compare the cost of running different appliances.

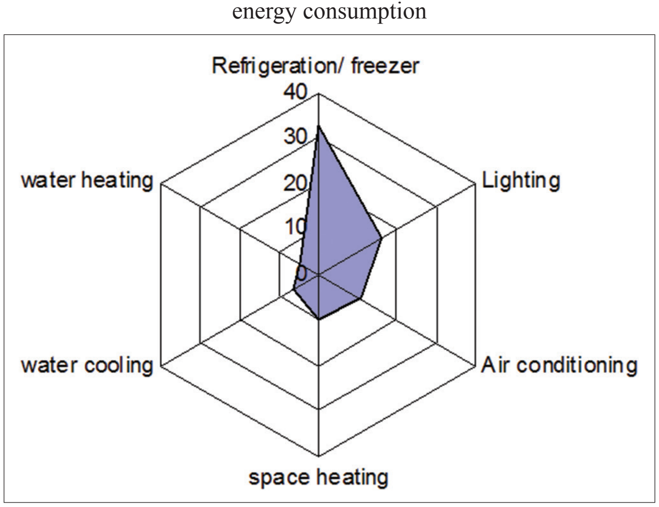
The following formula was used to estimate the annual energy consumed by a specific appliances:

AEC=(Appliance Watt) (Hour per day) (Day per year)

In order to evaluate electricity saving and the environmental impact resulting from implementing MEES, four different scenarios are suggested for each appliance.

- Scenario 1: The market share for the new efficient models of Class A, B and C will take a yearly constant of 25% and 75% for ordinary models.
- Scenario 2: The market share for the new efficient models of Class A, B and C will take a yearly constant of 50% and 50% for ordinary models.
- Scenario 3: The market share for the new efficient models of Class A, B and C will take a yearly constant of 75% and 25% for ordinary models.
- Scenario 4: The market share for the new efficient models of Class A, B and C will take full share.

Figure 2: Energy consumption of appliances from total residential energy consumption



The market share of the efficient models for Classes A, B and C is divided to 40%, 40%, and 10%, respectively. Table 3 represents the considered market share percentages for all classes for each scenario. Each scenario will be applied for cold appliances electricity consumption in Jordan.

As a first step, energy consumption analysis was performed for different home appliances. It was found that refrigerators and freezers are in the first place. Followed by lighting, air conditioning, space heating (electric heater), water cooling (cooler) and water heating (electric boiler) respectively. In this study we will apply MEES for cold appliances (refrigerator, freezer) as they are the main electricity consumers in the residential sector in Jordan.

Energy efficiency classes are divided to 5 main Classes A, B, C, D and E. Each class has an energy efficiency index or ratio. The index or ratio range is dependent on the appliance type. Defining the class make it possible to compare energy consumption of energy efficient and normal appliances. Energy efficiency classes and energy efficiency ratio or index are shown in Table 4.

Energy saving can be calculated for each appliance according to the following formula:

$$\text{Energy saving}=\{(E_t-E_0)+(E_0*R)\}\ CP*MS*SF \quad (2)$$

Where, E_t is the predicted electricity consumption for year t, E_0 is the electricity consumption for the base year (2010), CP is the contribution percentage, MS is the market share, SF is the safety factor and R is the replacement factor. The first part of equation (E_t-E_0) represents the increase in the electricity consumption from the base year (2010) due to the increase of electrical appliances. The second part (E_0*R) represents the consumed energy by the replaced appliances due to damaging, ending of the life cycle or increasing the concerning about MEES effect on the electrical utility bill. The replacement factor assumed to be increased by 10% every year to reach 100% at the end of 2020 that is mean all

Table 3: Market share percentage for all classes for each scenario

Scenario	Efficient model (%)			Ordinary model (%)
	Class A	Class B	Class C	
Scenario 1	10	10	5	75
Scenario 2	20	20	10	50
Scenario 3	30	30	15	75
Scenario 4	40	40	20	75

Table 4: Proposed energy efficiency classes and energy efficiency index/ratio value of cold appliances

Energy efficiency class	Energy efficiency index% (EEI) for refrigerator/freezer
A	I<55
B	55<I<75
C	75<I<90
D	90<I<100
E	100<I<110

European Commission, 2010

old appliances will be replaced by the new one have one of the three selected energy efficiency Class A, B or C. The input data are summarized in Table 5.

The potential of saving amount indicated using saving factor. The saving factor value changed according to appliance efficiency class and appliance type. The saving factor formula for refrigerator and freezer is shown as follows:

$$SF=(AEC_C-AEC_a)/AEC_a \quad (3)$$

Where, AEC_C is the annual energy consumption for specific energy class, AEC_a is the annual energy consumption average in Jordan.

$$AEC_a = \left(\sum_1^n AEC\right)/n \quad (4)$$

Where, n is the number of appliances. That is given from the collected data.

The annual energy consumption for specific energy class can be determined from its related energy efficiency index [6].

$$AEC_C=(EEI)(V) \quad (5)$$

Where, AECs is the annual energy consumption standard, V is in the net internal volume of storage space in the cabinet, in L. The average volume for refrigerator according to surveyor is about 710 L.

$$V=Base\ area*High \quad (6)$$

Implementing the minimum energy efficiency will not only affect electricity consumption but also environmental impact (e.g. gaseous emission such as nitrogen oxides, sulphur oxides and greenhouse gases). In this research, only greenhouse gas emissions, represented by carbon dioxide are considered. The projected reduction in CO_2 emissions can be calculated based on direct relationship between electricity generation and CO_2 emission: Higher rate of energy consumption means more CO_2 release to atmosphere. Table 6, shows the emitted gases for unit electricity generation in Jordan for the previous period 2002-2009.

The emission of CO_2 coefficient of electricity generation was calculated based on the weighted average of all power generation per fuel type divided annual CO_2 emission over the annual generated electricity of all plants in Jordan during 2010 and assumed to be constant to the next 10 years shown in Table 7.

$$COE = \left(\sum_1^{Fuel\,Type} electricity\,generated \times COF\right) / \sum_1^{Fuel\,type} electricity\,generated \quad (7)$$

Where COF is the emission CO_2 factor for each fuel type was used in electricity generation.

The total reduction in CO_2 emission given by the formula:

$$TCOE=ES\times COE \quad (8)$$

Table 5: Input data

Symbol	Description	Value
Y_0	Base year	2010
E_0	Energy consumption at base year	5219 GWh/year
T	Life span (study period)	10 year
P	Average electricity price	72 fills/kWh
COE	CO_2 emission	0.49 CO_2 kg/kWh

Table 6: Fossil fuel emission for unit electricity generation

Fuels	Emission (ton metric 000/year)		
	CO_2	NO_x	CO
2002	17742.2	108.9	433.7
2003	18600.0	113.7	457.7
2004	19493.0	118.2	483.3
2005	20107.0	122.2	509.5
2006	20766.9	127	537.4
2007	20712.4	130.1	566.9
2008	21387.7	135	598
2009	21996.2	140.5	630

Table 7: CO_2 emission for unit electricity generation

Year	Total (GWh)	CO_2 emission (ton metric 000/year)	kg/kWh
2002	8132.0	17742.2	2.18
2003	7994.6	18600.0	2.33
2004	8967.9	19493.0	2.17
2005	9654.0	20107.0	2.08
2006	11120.2	20766.9	1.87
2007	12999.1	20712.4	1.59
2008	13768.0	21387.7	1.55
2009	14207.8	21996.2	1.54
2010	14682.8	-	-

The reduction amount in electricity bill associated to the reduction on energy consumption and the energy prices which are changes according to the global fossil fuel price. The prices also different according to the energy consumption in households, in this study the energy prices are assumed to be fixed and constant for the next 10 year. The average price for the different household energy consumer ranges considered 72 fills/kWh.

$$SU=ES\times P \quad (9)$$

Where, SU is saving in utility bills, P is energy price (fills/kWh).

4. RESULTS

4.1. Reduction in Electrical Energy Consumption

In this research MEES were implemented for cold appliances (refrigerator, freezer and combination) in Jordanian residential sector based on the collected data. These appliances accounted for about 32.7% of household electricity energy consumption in Jordan. The majority of cold appliances used in Jordanian residential sector were old as noticed during survey.

The resulted saving amount is the minimum amount which can be saved due to implementing MEES for household appliances. Figure 3 shows the amount of saved energy for the years 2011-2020 for the four scenarios. Through the years, the amount of saved energy will be increase due to increase number of houses which used efficient appliances, moreover the number of old appliances replacing by efficient model will be increased. Implementing MEES based on Scenarios 1, 2, 3 and 4 till the year of 2020 will save about 4451.7, 8903.4, 13,355.1 and 17,806.8 GWh, respectively, at the end of year 2020.

These calculation will be effective for the next 10 year, after that new calculation have to be made because the awareness of people on efficient model and how it will affect their utilities and bills.

The saving energy by applying different scenarios was increased during the years based on the calculation. Scenario 4 represents the highest saving percentage in respect to all other scenarios by the end of. The market share of each scenario divided over the energy efficiency class A, B and C are by 40%, 40% and 20% respectively, in order to enhance the number of efficient model in the market.

4.2. Reduction in CO_2 Emission

In addition to the evaluation of the impact of implementing MEES on energy consumption, the environmental impacts were evaluated as represented by CO_2 emission. CO_2 emission due to electricity generation in Jordan increases gradually. CO_2 emission was increased by 54% from year 2002 to 2009 due to increasing electricity demand. If electric energy consumption remained at the same level without adopting MEES, CO_2 emission would reach 2.6 times of that of 2009. CO_2 emission will grow at lower rate if MEES according to the four scenarios is implemented.

CO_2 emission percentage due to electricity generation in Jordan was calculated based on used fuel mix in electricity generation. CO_2 emission produced is approximately 0.499 CO_2 kg/kWh. Table 8 presents average CO_2 emission factor and fraction of electricity generation for each source in Jordan.

Using efficient cold appliances will reduce emitted gasses as a result of reducing electricity consumption. Table 9 presents the predicted future reduction of CO_2 emission for the four scenarios. The contribution on reducing CO_2 emission was 50.1% from total reduction for each scenario. The annual CO_2 reduction would be about 454, 907, 1361 and 1814 ton metric 1000/year for Scenario 1, 2, 3 and 4, respectively, by year of 2020.

4.3. Reduction in Electrical Utility Bill

Since it is expected that electrical energy consumption would reduce when implementing MEES for the future sold appliances in the market and when replacing old models by efficient models, electrical utility bill would reduce. The electricity price increases due to the increase of global fossil fuel prices. In this work the electricity cost was assumed constant at rate 72 fills/kWh.

Figure 4 shows the effect of implementing MEES on electricity bills according to the four suggested scenarios.

Table 10 shows the annual reduction in utility bill by implementing MEES were the total saving at the end of 2020 for the Scenario 1, 2, 3 and 4 were about 320.5, 641.0, 961.6 and 1282.1 million respectively.

5. CONCLUSIONS

This study presented a polynomial fitting regression for electricity consumption in the Jordanian residential sector.

Figure 3: Annual electrical energy saving by implementing minimum energy efficiency standards for cold appliances for four scenarios

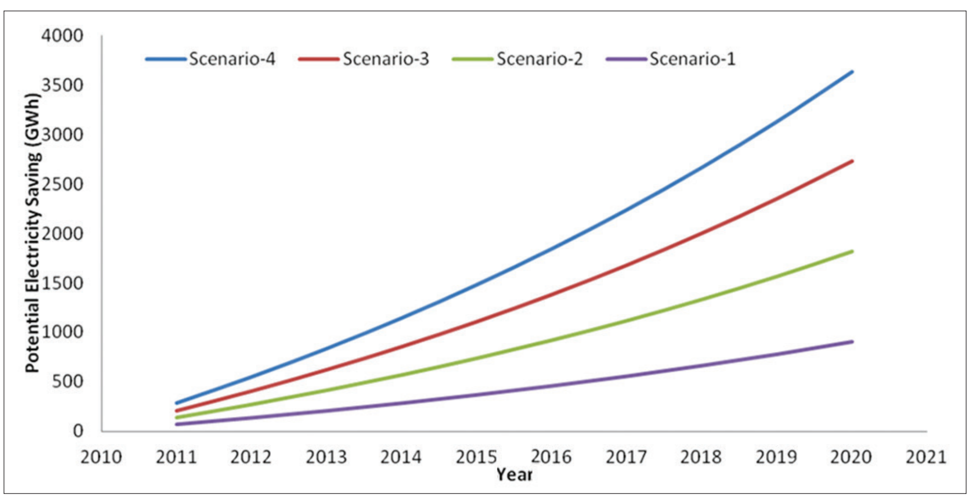


Table 8: Average CO_2 emission factor and fraction of electricity generation for each source in Jordan (2010)

Source	CO_2 emission (kg/MJ of Fuel)	Electricity generation (GWh)	Total consumption (ktoe)	Total consumption (TJ)	CO_2 emission (10^6 kg)
Diesel	0.067	435.5	106.0	4438.0	297.3
HFO	0.075	3628.2	883.0	36969.4	2772.7
Natural gas	0.038	9339.5	2273.0	95166.0	3616.3
Renewable	0.000	2.65	0.7	30.6	0
Total	-	13406.2	3262.7	136604.0	6686.4

Table 9: Environmental impact by implementing minimum energy efficiency standards for cold appliances

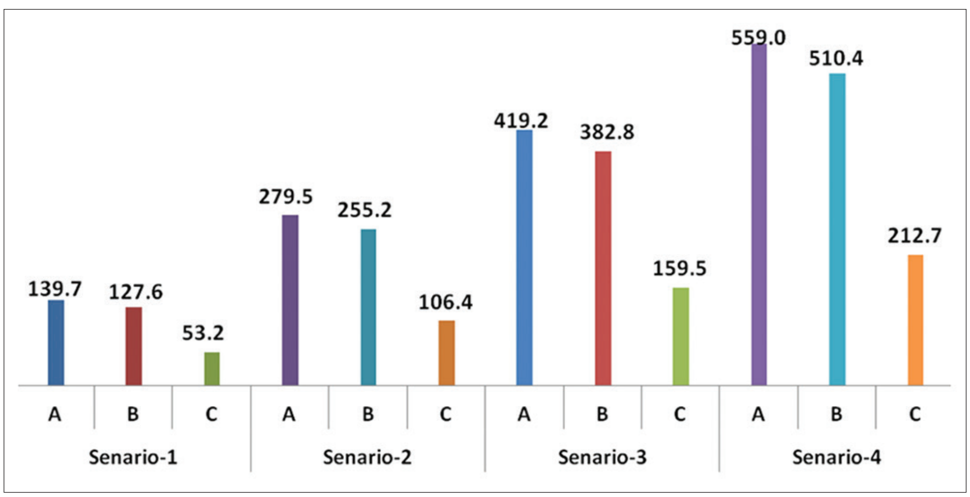
Scenario	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Scenario 1	35	68	104	143	185	230	279	333	391	454
A	15	30	45	62	80	100	122	145	170	198
B	14	27	41	57	73	92	111	133	156	181
C	6	11	17	24	31	38	46	55	65	75
Scenario 2	70	137	208	285	369	460	559	666	782	907
A	31	60	91	124	161	201	244	290	341	396
B	28	54	83	114	147	183	222	265	311	361
C	12	23	35	47	61	76	93	110	130	151
Scenario 3	106	205	312	428	554	690	838	998	1172	1361
A	46	89	136	187	241	301	365	435	511	593
B	42	82	124	170	220	275	334	398	467	542
C	18	34	52	71	92	115	139	166	195	226
Scenario 4	141	273	416	571	738	920	1117	1331	1563	1814
A	61	119	181	249	322	401	487	580	681	791
B	56	109	166	227	294	366	445	530	622	722
C	23	45	69	95	123	153	185	221	259	301

Table 10: The annual saving amount (million JD) by implementing MEES for cold appliances of the four scenarios

Scenario	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Scenario 1	5.1	9.8	15.0	20.6	26.6	33.2	40.3	48.0	56.4	65.4	320.5
Scenario 2	10.2	19.7	30.0	41.2	53.3	66.4	80.6	96.0	112.8	130.9	641.0
Scenario 3	15.2	29.5	45.0	61.8	79.9	99.6	120.9	144.1	169.2	196.3	961.6
Scenario 4	20.3	39.4	60.0	82.4	106.5	132.8	161.2	192.1	225.5	261.8	1282.1

MEES: Minimum energy efficiency standards

Figure 4: The saving on the utility bills amount (million JD) by implementing minimum energy efficiency standards for cold appliances



The developed model has been proved to be adequate with R^2 and adjusted-R^2 of 99.6% and 99.5% respectively. The energy consumption has been increasing because of increasing numbers of the used electrical appliances in households and the ever increasing population and incoming people from other countries due to the political situation. Therefore, the implementation of MEES effect was studies and a calculation was made for the cold appliances, most energy consuming appliances inside the household.

Implementing MEES for Jordanian cold appliances was found to be very beneficial for the government, environment and customer. At worst scenario, it is found that the net saving from 2011-2020 was approximately 4451.7 GWh by the end of year 2020, the associated CO_2 emission reduction during the 10 years increase gradually to reach 454 (1000 ton) in 2020. In addition, the reduction of customer bills was reaching 65.4 million JD in 2020.

Energy consumption could increase much more than this study due to the political situation, which will lead to increase in kingdom's population in an unexpected manner therefore, implementing the MEES for the electrical household appliances in Jordan, should be carried out so as to reach the desired energy saving once the standards are implemented. Inefficient products will be pushed out of the market and replaced by efficient products. The standard indirectly will also reduce the amount of environmental pollution. The customer will pay higher purchase prices for appliances, but will get lower electricity bills.

REFERENCES

Al-Ghandoor, A., Al-Hinti, I., Jaber, J.O., Sawalha, S.A. (2008), Electricity consumption and associated GHG emissions of the Jordanian industrial sector: Empirical analysis and future projection. Energy Policy, (36), 258-267.

Al-Ghandoor, A., Jaber, J.O., Al-Hinti, I., Mansour, I.M. (2009), Residential past and future energy consumption: Potential savings and environmental impact. Energy Policy, (13), 1262-1274.

Brennan, T.J., Palmer, K.L. (2013), Energy efficiency resource standards: Economics and policy. Utilities Policy, 25, 58-68.

Cleff, T., Rennings, K. (2016), Are there first mover advantages for producers of energy-efficient appliances? The case of refrigerators. Utilities Policy. DOI: 10.1016/j.jup.2016.03.004.

Department of Statistic. (2009), Environmental Statistics. Amman, Jordan: Department of Statistic.

Department of Statistic. (2009), Annual Environmental Statistics. Amman, Jordan: Department of Statistic.

Energy Independence and Security Act (EISA). 110th Congress; 2007.

Meyers, S., McMahon, J.E., McNeil, M., Liu, X. (2003), Impacts of US federal energy efficiency standards for residential appliances. Energy, 28(8), 755-767.

Meyers, S., McMahon, J.E., McNeil, M., Liu, X. (2004), Realized and Prospective Impacts of U.S. Energy Efficiency Standards for Residential Appliances: 2004 Update, Lawrence Berkeley National Laboratory, Report No. LBNL-56417.

Ministry of Energy and Mineral Resources. (2010), Annual Report. Amman, Jordan: Ministry of Energy and Mineral Resources.

Ministry of Energy and Mineral Resources. (2010), Energy Balance. Amman, Jordan: Ministry of Energy and Mineral Resources.

Ministry of Energy and Mineral Resources. (2010), Sectors Energy Consumption Distribution. Amman, Jordan: Ministry of Energy and Mineral Resources.