Lebanese
Energy Efficient
HVAC Equipment Standard
2011

LEEHVACES 2011

LEBANESE ENERGY EFFICIENT HVAC EQUIPMENT STANDARD

TABLE OF CONTENTS

Development of the LEEHVACES 2011

The standard was created by the Lebanon Green Building Council (LGBC) with the generous funding of USAid and Amideast. The standard was also prepared with the collaboration of LIBNOR and the Order of Engineers and Architects of Lebanon.

For more information about the LGBC, visit the LGBC website at www.lebanon-gbc.org.

LGBC Board Members

1.	Dr. Samir Traboulsi	President
2.	Mr. Elie Baradhy	Vice President
3.	Mr. Aram Yeretzian	Secretary
4.	Mr. Rabih Khairallah	Public relations
5.	Mr. Youssef Ghantous	Treasurer
6.	Mr. Walid el Baba	
7.	Mr. Naji Tannous	
8.	Dr. Adel Mourtada	
9.	Mr. Hussien Salloum	
10.	Mr. Anwar Ali	

Technical Committees

Committee 1: Plan and manage development of Standard, follow up on publication
Coordinators: Dr. Samir Traboulsi, Aram Yerestzian, Walid El Baba
Members: Amal Khreis, Rima Sorour, Ziad Haddad
Support: Faez Rawas, Wassef Dabboucy

Committee 2: Lebanese HVAC market analysis and survey
Coordinator: Rabih Khairallah
Member: Nohad Boudani

Committee 3: Assessment of technical opportunities
Coordinator: Youssef Ghantous
Member: Nohad Boudani

Committee 4: Study the impact of introducing the Standard
Coordinator: Naji Tannous
Members: Riad Assaf, Ali Berro

Committee 5: Draft the Standard
Coordinator: Aram Yeretzian
Member: Todd Ashton

Committee 6: Economic and statistical analysis
Coordinator: Naji Tannous
Member: Dr. Mona Rahme

FOREWARD

This is the first edition of the Lebanese Energy Efficient HVAC Equipment Standard (LEEHVACES). As the title implies, it addresses solely energy efficiency in HVAC equipment. The standard is written with the intent that it is to be applied initially on a voluntary basis by building developers, owners, and managers. However, the standard was also written with the goal to be part of a future building code requiring energy-efficiency measures in built projects in Lebanon.

The building design, construction and operations industry has far-reaching impacts on the environment, resource allocation, and on communities at local to national levels. In the development of this standard, extensive efforts have been made to include input from stakeholders and the public. Taking these factors into account, the standard is meant to encourage the use of higher efficiency air conditioning equipment by providing prescriptive energy efficiency targets for a wide range of equipment available in Lebanon. The standard must also remain flexible and responsive to the market and community needs, and to this end the developers of the standard have established procedures for continuous maintenance and review and welcome suggestions for the improvement of this standard.

PARTICIPANTS AND CONTRIBUTORS

As stated above, there were a series of panel presentations of this standard during its development to the broader community. The parties responsible for the production of this standard would like to thank all the individuals, companies and organizations who participated in these events by providing information and feedback from their respective fields, and who by doing so contributed to the development of this standard.

The Lebanon Green Building Council, a registered non-profit, non-governmental organization in Lebanon, is responsible for having developed this standard.

METHODOLOGY

In order to insure that the LEEHVACES remains responsive to the current local conditions, while at the same time providing progressive attainable incentives to improving the efficiency of HVAC equipment in Lebanon, the technical committee undertook extensive research, including collecting survey data and modeling baseline "business as usual" and test-case scenarios. The accumulated data and analytical tools used are summarized in Appendix B and the full data, formulae and methodology is available from the LGBC at www.lebanon-gbc.org.

1. PURPOSE

The purpose of this standard is to provide minimum requirements for the selection of building air-conditioning equipment and appliances to contribute to the energy-efficient performance of building systems. This standard is intended to:

1.1 balance environmental responsibility, resource efficiency, occupant comfort, and community sensitivity, and

1.2 respond to current market conditions and encourage a shift in the market towards higher energy-efficient equipment.

2. SCOPE

2.1 This standard provides minimum criteria that:

2.1.1. apply to the following elements of *building projects*:

a. new buildings and their systems

b. portions of buildings and their systems

c. new systems and equipment in existing buildings

2.1.2. address energy efficiency of building air-conditioning equipment, including:

a. Unitary Packaged Units, Cooling only and Heat Pump,

b. VRV Systems

c. Chillers, Water & Air cooled

d. Fans

2.2 This standard shall not be used to circumvent any safety, health, or environmental requirements.

3. DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

3.1 General. Certain terms, abbreviations, and acronyms are defined in this section for the purposes of this standard. These definitions are applicable to all sections of this standard.

Other terms that are not defined shall have their ordinarily accepted meanings within the context in which they are used. (The contents of Section 3 have been taken from the document ASHRAE/USGBC 189.1, 2009.)

3.2 Definitions

Air conditioning: the process of treating air to meet the requirements of a conditioned space by controlling its temperature, humidity, cleanliness, and distribution.

annual load factor: the calculated annual electric consumption, in kWh, divided by the product of the calculated annual peak electric demand, in kW, and 8760 hours.

building project: a building, or group of buildings, and *site* that utilize a single submittal for a construction permit or that are within the boundary of contiguous properties under single ownership or effective control (see *owner*).

complete operational cycle: a period of time as long as one year so as to account for climatic variations affecting outdoor water consumption.

conditioned space: a cooled space, heated space, or indirectly conditioned space.

demand control ventilation (DCV): a ventilation system capability that provides for the automatic reduction of outdoor air intake below design rates when the actual occupancy of spaces served by the system is less that design occupancy.

densely occupied space: those spaces with a design occupant density greater than or equal to 25 people per 100 m2

design outdoor airflow rate: the minimum required rate of outdoor airflow which must be provided by a ventilation system at design occupancy.

dwelling unit: a single unity providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation

generally accepted engineering standard: a specification, rule, guide, or procedure in the field of engineering, or related thereto, recognized and accepted as authoritative.

high-performance green building: a building designed, constructed, and capable of being operated in a manner that increases environmental performance and economic value over time, seeks to establish an indoor environment that supports the health of occupants, and enhances satisfaction and productivity of occupants through integration of environ- mentally preferable building materials and water-efficient and energy-efficient systems.

integrated design process: a design process utilizing early collaboration amongst representatives of each stakeholder and participating consultant on the project. Unlike the conventional or linear design process, integrated design requires broad stakeholder/consultant participation.

minimum outdoor airflow rate: the rate of outdoor airflow provided by a ventilation system when running when all *densely occupied spaces* with *demand control ventilation* are unoccupied.

nonresidential: all occupancies other than residential. (See residential).

occupiable space: an enclosed space intended for human activities, excluding those spaces intended for other purposes, such as storage rooms and equipment rooms, that are only occupied occasionally and for short periods of time.

outdoor (outside) air: air that is outside the building envelope or is taken from outside the building that has not been previously circulated through the building.

owner: The party in responsible control of development, construction, or operation of a project at any given time.

permanently installed: equipment that is fixed in place and is not portable or movable.

residential: spaces in buildings used primarily for living and sleeping. Residential spaces include, but are not limited to, dwelling units, hotel/motel guest rooms, dormitories, nursing, homes, patient rooms in hospitals, lodging houses, fraternity/sorority houses, hostels, prisons, and fire stations.

vendor: a company that furnishes products to project contractors and/or subcontractors for on-site installation.

variable air volume (VAV) system: HVAC system that controls the dry-bulb temperature within a space by varying the volumetric flow of heated or cooled supply air to the space.

3.3 Abbreviations and Acronyms

AHRI Air-conditioning, Heating & Refrigeration Institute

ASHP Air-Source Heat Pump

ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

ASME American Society of Mechanical Engineers

ASTM American Society for Testing and Materials International

BAU Business As Usual

BMS Building Management System

Btu British thermal unit

Btu/h British thermal unit per hour

CAS Central Administration of Statistics

CDR Conseil du Développement et de la Reconstruction

cfm cubic feet per minute

cm centimeter

COP cCoefficient Of Performance

DB Dry Bulb

DCV demand control ventilation

DOE U.S. Department of Energy

DX direct expansion

EMS Energy Management System

h hour

HSPF heating season performance factor

HVAC heating, ventilation, and air conditioning

kg kilogram

k-toe kilo-ton of oil equivalent

kW kilowatt

kWh kilowatt-hour

L liter

m meter

M million

MCWB maximum coincident wet bulb

MEPS minimum energy performance standard

MERV minimum efficiency reporting value

MEW Lebanese Ministry of Energy and Water

min minute

MJ megaJoule

mm millimeter

MtCO2-e mega-tons of carbon dioxide emissions

NA not applicable

NR not required

Pa Pascal

s second

SEER seasonal energy efficiency ratio

t ton

TSBL Thermal Standards for Building in Lebanon, 2005

toe ton of oil equivalent

TR Tons of Refrigeration

VAV variable air volume

VRV variable refrigerant volume

WB wet bulb

yr year

4. HVAC EQUIPMENT

4.1 Scope. This section specifies requirements for energy efficiency for building air-conditioning equipment and appliances in new and existing buildings.

4.2 Compliance. HVAC Equipment shall comply with the following provisions:

4.2.1 Minimum Equipment Efficiency: Each type of equipment or system listed in 2.1.2 will have minimum equipment efficiencies which achieve the figures listed in the tables included in Appendix A, “Minimum Equipment Efficiency Tables.”

4.2.2 Labeling Requirements: Each piece of equipment belonging to a system listed in 2.1.2 must bear a permanent label affixed by the manufacturer and stating the relevant energy efficiency performance of the equipment.

4.2.3 Controls: Each type of equipment or system listed in 2.1.2 will be provided with, installed and operated with controls allowing the equipment or system to perform according to the minimum efficiency listed in the tables included in Appendix A.

APPENDIX A

MINIMUM EQUIPMENT EFFICIENCY TABLES

Table 1- Heating Family Equipment (Air cooled)

Equipment Type	Size Category	Characteristic	Value	Rating to
Heat Pump- Mini Split	<2.5 T	HSPF (Heating)	8.50	AHRI 210/240
Heat Pump- Split	≥2.5 T and <5 T	HSPF (Heating)	8.50	AHRI 210/240
Heat Pump- Split	≥5 T and <10 T	COP (Cooling)		AHRI 340/360
Chillers:				
Heat Pump- air cooled		COP (Cooling)	3.0	AHRI 550/590
Heat Pump- water cooled	<150 TR	COP (Cooling)	4.0	AHRI 550/590
Heat Pump- water cooled	≥150 and <300 TR	COP (Cooling)	4.5	AHRI 550/590
Heat Pump- water cooled	>300 TR	COP (Cooling)	5.0	AHRI 550/590
Boiler / Gas Oil		Efficiency	0.80	10 CFR part 430/431,

Table 2- Cooling Family Equipment (Air cooled)

Equipment Type	Size Category	COP	Rating to
Mini Split	<2.5 T	3.0	AHRI 210/240
Split	≥2.5 T and <5 T	3.0	AHRI 210/240
Split	≥5 T and <10 T	2.9	AHRI 340/360
VRV	All sizes	4.0	
Chillers:			
Air Cooled	All sizes	3.0	AHRI 550/590
Water Cooled	<150 TR	4.5	AHRI 550/590
Water Cooled	≥150 and <300 TR	5.0	AHRI 550/590
Water Cooled	>300 TR	5.4	AHRI 550/590

Table 3- Ventilation Family Equipment

Maximum allowable motor nameplate rating @ 150 Pa system pressure (Watt)

Flow (cfm)	Fan Type Propeller	Axial	Centrifugal
<100	Watt = 0.39Q + 17.8	-	-
100-300	Watt = 0.39Q + 17.8	Watt = 0.16Q - 2.88	-
300-1000	Watt = 0.026Q + 8.17	Watt = 0.22Q - 7.89	-
1000-3000	Watt = 0.04Q + 97.4	Watt = 0.094Q - 2.41	Watt = 0.21Q - 189
3000-6000	Watt = 0.21Q - 507	Watt = 0.25Q - 464	Watt = 0.16Q - 160
6000-10000	-	Watt = 0.25Q - 1168	Watt = 0.14Q - 817
10000-20000	-	Watt = 0.33Q - 2983	Watt = 0.35Q - 3195
20000+	-	Watt = 0.92Q - 14621	Watt = 0.52Q - 8291

APPENDIX B

BACKGROUND OF STANDARD AND SUMMARY OF METHODOLOGY AND RESULTS

Background of Standard

The development of this Standard takes place against a background of several trends in the building industry, of both recent and long-established appearance. The trends are often the result of larger socio-economic, cultural and environmental shifts that affect decisions made by individual consumers and design professionals on types and qualities of mechanical equipment purchased. These decisions taken collectively have significant impacts on questions such as infrastructure investment, resource allocation, public health, climate change and environmental degradation.

At a global level, climate change results in complex alterations to regional and local weather patterns and temperature trends. Broadly stated, where witnessed, rising temperatures contribute to a need for thermal control of occupied spaces, and the most common response to this need is through mechanical environmental control. Observed locally, population growth and increased urbanization contribute to the heat island effect, raising localized ambient temperatures and further increasing demand for cooling.

Modern building design has moved away from vernacular traditions which responded to local climate patterns with passive thermal control design strategies, often imposing designs based on global prototypes not tailored to the various Lebanese climate zones. This change both reflects and influences shifts in social paradigms, structures, expectations and habits that accompany increased development and rising income levels. The market survey conducted as part of the development of this Standard confirmed the anecdotal evidence that a growing share of buildings in Lebanon are equipped with air conditioning equipment. Increasing income levels increase the demand for amenities such as building air conditioning, affecting the higher income levels as well as more modest homeowners, as reflected in the fact that local banks have been offering loans specifically for air conditioning installation in recent years. The market survey also revealed that unitary air conditioning equipment prices have been falling in recent years, further expanding the use of air conditioning and increasing electrical demand.

The existing building stock in Lebanon and much of new development has low insulation levels. This places large demand on energy resources to mechanically control the indoor thermal environment of such buildings. However, legal changes have recently been implemented which create the incentive for developers to increase insulation levels by providing double walls in new construction. A more educated consumer base has begun asking for double wall construction and this increased demand will have a cumulative effect in shifting the construction industry to more energy efficient practices. It is in this spirit that the present Standard was conceived and is to be propagated.

Methodology for the estimation of the BAU trend and impact assessment due to the introduction of the MEPS and summary of results

The raw data used in the creation of this Standard is comprised of three types: first, population data and projections, second, results of a market survey conducted as part of the development of this Standard, and third, market data on energy consumption and resource costs. The available data is at times partial or not analogous between data from sequential surveys. This fact has required the use of statistical extrapolation and assumptions in order to refine the available data into consistent categories that allow the projection of the "business as usual" and test case scenarios.

The available data for primary residences is fairly complete and has been relied upon to develop the projections of total annual energy consumption by HVAC equipment. A fundamental premise has been that total annual energy load will be indirectly arrived at by assuming that the population is living all day long in the primary residence, that is, that the energy load associated with actual time spent outside the home at school, work, etc. will be represented by assuming the transfer of this load into full-time consumption at the primary residence.

Data from two sources, one a projection of the number of primary residences to the year 2030 (see Table 2, below), and the second being surveys from 2004 and 2007 on housing characteristics (Table 3), including the availability of HVAC equipment, have been combined in order to estimate the total area of cooled and heated occupied residential space in Lebanon. We assumed that the annual growth of demand on heating is the result of the natural growth of residences while the annual growth of demand on cooling is the result of the natural growth of residences and an extra demand on cooling due to other social and environmental conditions. The factor for the extra demand on cooling has been partially derived from the market survey responses.

Room sizes and number of rooms heated or cooled per residence were derived, and were used to generate the total area of heated or cooled space. These areas were entered into the Heating Degree Days and Cooling Degree Days formulae, respectively. The U-values entered in the formulae have been estimated and linked to the horizontal area of rooms.

The second family of data is on the characteristics of HVAC equipment available in Lebanon. This data is the product of the market survey conducted by the LGBC as a necessary element in the development of this Standard. The results of the market survey quantify the market share of the different families of equipment that are performing the heating and cooling of occupied space nationwide, as well as their main technical specifications (whether it is Efficiency in % or HSPF for heating, or COP or SEER for cooling). Chart 1 illustrates some of the results of this survey.

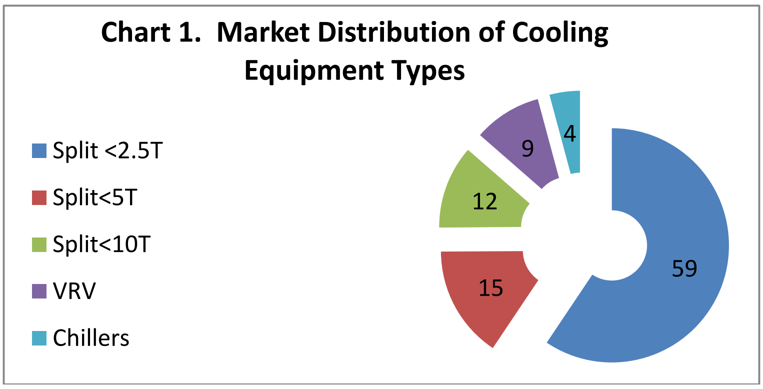
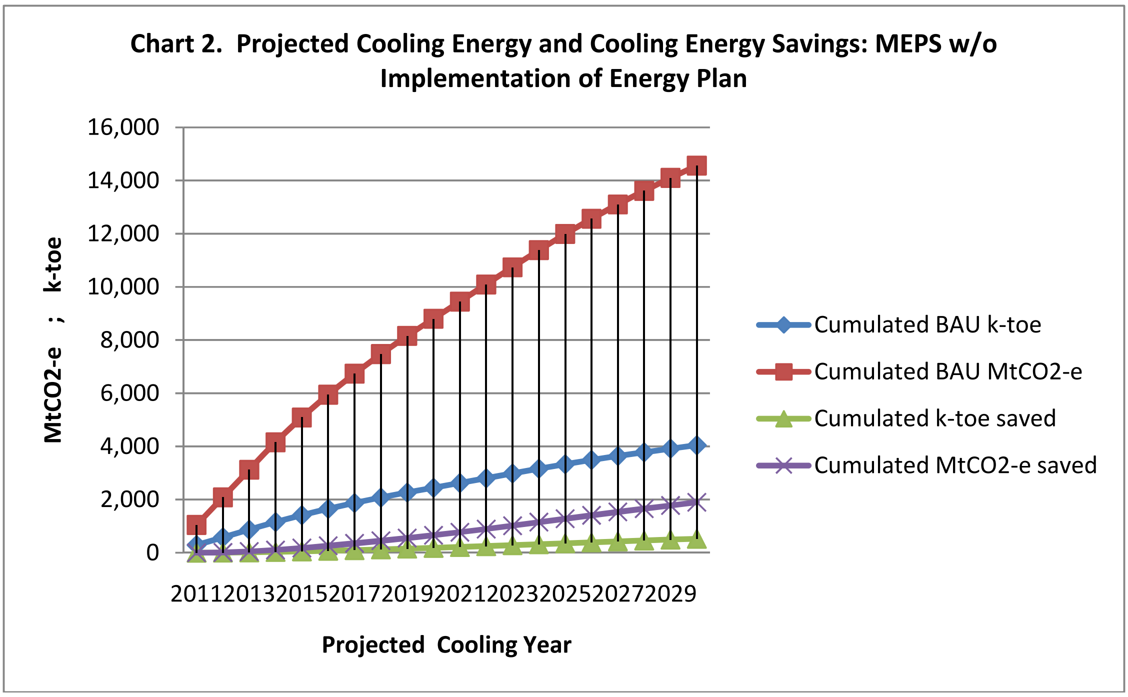
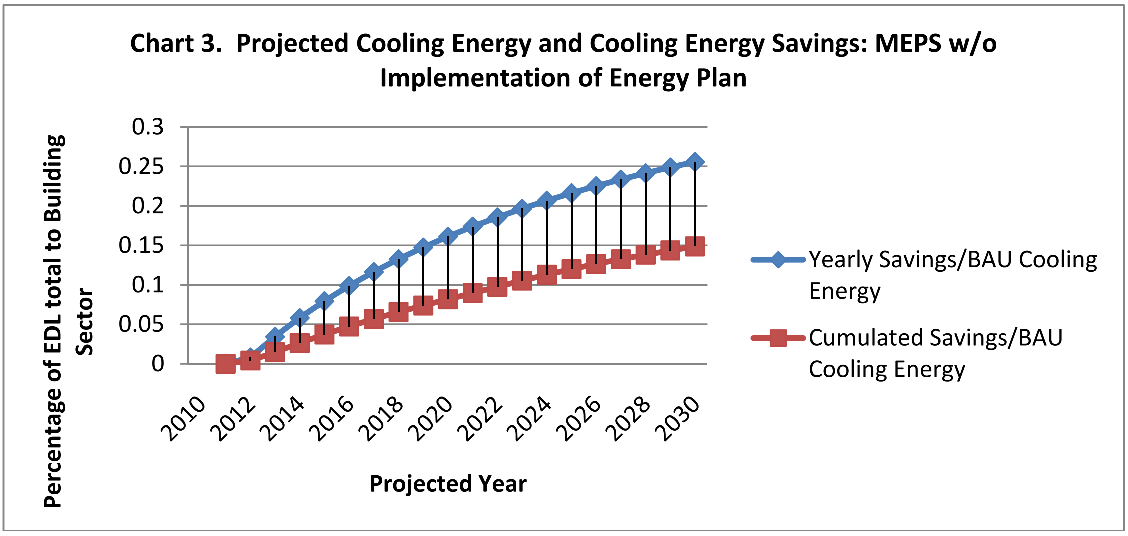


Chart 1. Market Distribution of Cooling Equipment Types

The Ministry of Energy and Water (MEW) has prepared a National Policy Plan for the Electricity Sector (NPPES), but the implementation of this plan is uncertain [1]. Therefore, two Business as Usual (BAU) scenarios have been developed, one with and one without the implementation of this plan. Likewise, the test cases for the introduction of Minimum Energy Performance Standards (MEPS) have been considered both with and without implementation of the national energy plan of the MEW.

The choice of the suggested MEPS was carefully made taking into consideration current international MEPS and other related standards like ASHRAE 90.1, and in comparing these with the availability of equipment of various performance levels in the Lebanese market. The charts below indicate the projected impact of the implementation of the MEPS values included in this Standard on the cooling load. The first pair of charts records the projections for the case when the NPPES has not been implemented.





The following pair represents the comparison assuming the implementation of the NPPES:

Chart 4. Projected Cooling Energy and Cooling Energy Savings: MEPS with Implementation of Energy Plan

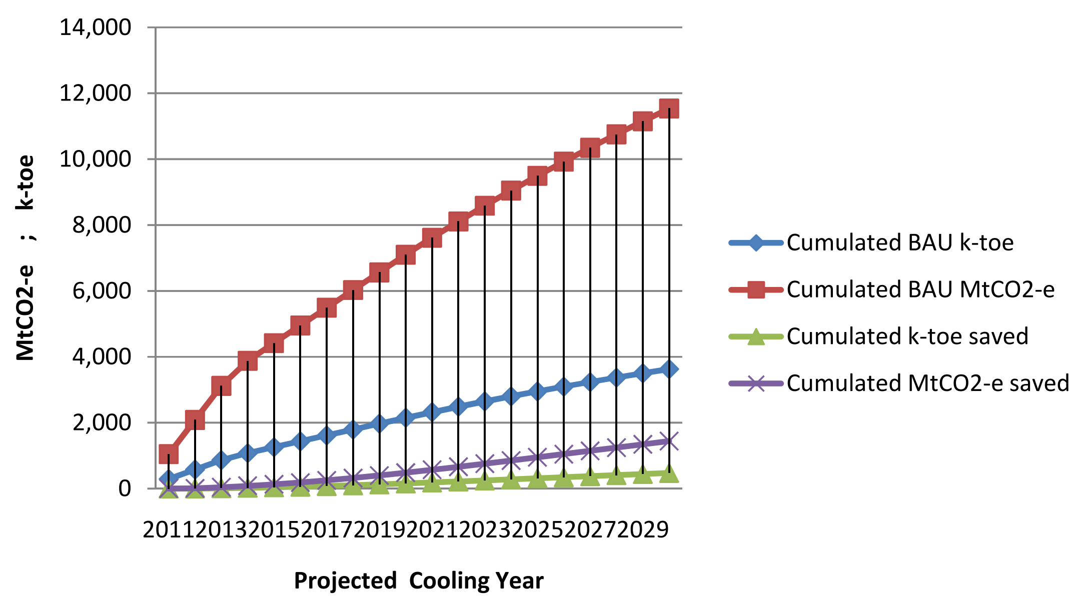
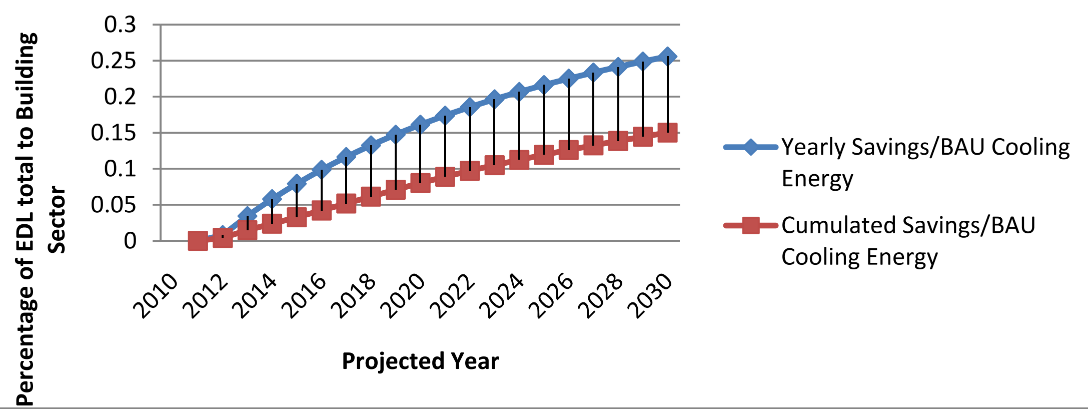


Chart 5. Projected Cooling Energy and Cooling Energy Savings: MEPS with Implementation of Energy Plan



The same analysis was conducted for the heating load, however, the impact of improving performance standards of heating equipment is minimal relative to the impact of improving performance standards for cooling equipment. The total cumulative savings of heating energy in 2030 after the implementation of the MEPS is projected at only 14.48 k-toe, while the cumulative savings of cooling energy in 2030 after the implementation of the MEPS is projected at 527 k-toe (both figures for the scenario without the implementation of the NPPES). Significant heating energy savings will not be achieved by relying on MEPS (only the substantial increase of the HSPF for the mini-splits may have a significant impact). On the other hand, one can deduct that the economy in heating can be reached by adopting a strategic plan that will shift non-efficient equipment types to highly efficient ones. Subsidies could be applied in order to implement successfully such a plan. Electric resistance heating has not been included in this Standard due to the inherent inefficiencies of the equipment. The developers of this Standard believe that the installation and use of electric resistance heating should be discouraged through education and policy decisions. Similarly, biomass stoves could be replaced by biomass boilers. However, the study of such market-wide policy initiatives is beyond the scope of this current Standard.

The analysis of ventilation equipment performance standards followed the same general methodology as for heating and cooling, however the assessment of ventilation equipment is made more complex by their interaction with the other elements of the ventilation system. The cumulative savings of ventilation energy in 2030 after the implementation of the MEPS is projected at 57 k-toe (for the scenario without the implementation of the NPPES).

The total projected impact of implementing the MEPS values included in this Standard is summarized in Table 1, below. The final MEPS values were derived after a recursive process optimizing energy savings balanced against the availability of equipment and other market trends.

The current Standard relies on both newly produced data, the market survey conducted by the LGBC, and existing demographic information from the CDR and CAS. This data has been analyzed and synthesized to project the energy savings from the application of MEPS to HVAC equipment in Lebanon over the next 29 years. The LGBC understands that this Standard is an initial attempt to quantify the impacts of the introduction of MEPS to HVAC equipment in Lebanon and welcomes any comments or questions with the aim of refining the data or analytical methods. The full documentation of the methodology is available by contacting the LGBC at www.lebanon-gbc.org.

Impact of MEPS#1 HVAC

Table 1: Impacts of Introducing MEPS#1 on all HVAC Equipments

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	%
MEPS Primary Saved Cumulated C. Energy **k-toe**	0	2	12	29	49	73	98	126	154	182	213	247	282	319	356	391	426	461	494	527	87.8%
MEPS Primary Saved Cumulated V. Energy **k-toe**	0	6	13	19	24	27	30	33	35	37	42	46	50	55	55	55	56	56	57	57	9.5%
MEPS Primary Saved Cumulated H. Energy **k-toe**	0	2	4	6	8	9	11	12	12	13	14	14	15	15	16	16	16	16	16	16	2.7%
MEPS Primary Saved Cumulated Ttl. Energy **k-toe**	0	11	29	55	81	109	139	170	201	233	269	307	347	389	426	463	498	533	567	600	100.0%
Projected toe price (USD)	623	660	696	733	770	806	843	880	916	953	990	1,026	1,063	1,100	1,136	1,173	1,209	1,246	1,283	1,319	
Projected Savings (M-USD)	0	7	21	40	62	88	117	150	184	222	266	315	369	428	484	542	602	664	727	792	

Table 2. Projected number of Residences [2]

Mohafaza	Units	2000	2010	2020	2030
	Primary	103,024	114,670	123,276	128,536
	Secondary	2,436	2,595	2,764	2,944
	Vacant	13,771	11,818	10,141	8,702
Beirut	**Total**	**119,231**	**129,083**	**136,181**	**140,182**
	Primary	345,537	404,067	458,408	505,617
	Secondary	28,336	30,725	33,316	36,126
	Vacant	102,827	90,695	79,995	70,557
Mount Lebanon	**Total**	**476,700**	**525,487**	**571,719**	**612,300**
	Primary	147,856	179,041	213,382	249,670
	Secondary	10,511	12,142	14,026	16,202
	Vacant	28,457	26,677	25,008	23,443
North	**Total**	**186,824**	**217,860**	**252,416**	**289,315**
	Primary	94,359	112,873	133,586	154,754
	Secondary	8,218	9,310	10,548	11,950
	Vacant	21,845	20,149	18,585	17,142
Bekaa	**Total**	**124,422**	**142,332**	**162,719**	**183,846**
	Primary	89,249	111,209	135,252	160,408
	Secondary	7,284	9,420	12,183	15,757
	Vacant	20,762	19,931	19,133	18,367
South	**Total**	**117,295**	**140,560**	**166,568**	**194,532**
	Primary	53,511	65,004	77,391	89,756
	Secondary	8,253	8,447	8,647	8,851
	Vacant	13,893	12,729	11,662	10,686
Nabatieh	**Total**	**75,657**	**86,180**	**97,700**	**109,293**
	Primary	833,536	986,864	1,141,295	1,288,741
	Secondary	65,038	72,639	81,484	91,830
	Vacant	201,555	181,999	164,524	148,897
Lebanon	***Total***	***1,100,129***	***1,241,502***	***1,387,303***	***1,529,468***

Note: Values of Primary, Secondary and Vacant Units were kept as they are. Formulae were used to compute the totals.

Table 3. Availability of AC in Primary Residences

Mohafaza/Caza	Total Units in 2004	Primary Units in 2004	Availability of AC in Primary Unit in 2004 [3]	Breakdown of Units per Caza 2004	Primary Units in 2007	Breakdown of AC per Caza 2007	Equivalent Yearly P.Units Evolution	Equivalent Yearly Cooling Demand Evolution [*]	Equivalent Yearly AC Evolution
Beirut	**156,801**	**101,696**	**54,263**	**100.00%**	**96,337**	**51,404**	**1.26%**	**1.50%**	**2.78%**
Baabda	197,008	146,808		39.54%	147,738	50,798	1.32%	0.50%	1.83%
Metn	180,454	134,471		36.22%	135,322	46,529	1.32%	1.00%	2.34%
Kesserouan	88,705	66,101		17.80%	66,520	22,872	1.32%	1.00%	2.34%
Jbeil	32,085	23,909		6.44%	24,060	8,273	1.32%	1.00%	2.34%
Mount Lebanon	**498,252**	**371,289**	**127,664**	**100.00%**	**373,640**	**128,472**	**1.32%**	**0.81%**	**2.14%**
Tripoli	85,187	52,484		32.33%	51,991	9,542	1.93%	1.00%	2.95%
Koura	24,692	15,213		9.37%	15,070	2,765	1.93%	0.50%	2.44%
Zghorta	24,468	15,075		9.29%	14,934	2,740	1.93%	0.50%	2.44%
Batroun	17,349	10,689		6.58%	10,589	1,943	1.93%	0.50%	2.44%
Aakkar	70,326	43,329		26.69%	42,923	7,876	1.93%	0.50%	2.44%
Bcharreh	8,172	5,035		3.10%	4,988	915	1.93%	0.50%	2.44%
Miyeh-Dennieh	33,303	20,518		12.64%	20,326	3,730	1.93%	0.50%	2.44%
North	**263,497**	**162,343**	**29,790**	**100.00%**	**160,821**	**29,511**	**1.93%**	**0.67%**	**2.61%**
Zahleh	61,771	34,691		33.75%	35,778	1,338	1.66%	1.00%	2.67%
West Bekaa	26,482	14,872		14.47%	15,338	574	1.66%	0.50%	2.17%
Baalbeck	74,712	41,959		40.82%	43,273	1,619	1.66%	0.50%	2.17%
Hermel	9,265	5,203		5.06%	5,366	201	1.66%	0.50%	2.17%

Rachaya	10,811	6,072		5.91%	6,262	234	1.66%	0.50%	2.17%
Bekaa	**183,041**	**102,797**	**3,846**	**100.00%**	**106,017**	**3,966**	**1.66%**	**0.68%**	**2.34%**
Saida	76,895	42,502		47.53%	45,583	6,778	2.26%	1.00%	3.28%
Tyre	73,126	40,418		45.20%	43,347	6,445	2.26%	0.50%	2.77%
Jezzine	11,765	6,503		7.27%	6,974	1,037	2.26%	0.50%	2.77%
South	**161,786**	**89,423**	**13,296**	**100.00%**	**95,904**	**14,260**	**2.26%**	**0.74%**	**3.02%**
Nabatieh	51,366	23,555		45.03%	25,263	2,510	2.06%	1.00%	3.09%
Bent Jbeyl	27,812	12,753		24.38%	13,677	1,359	2.06%	0.50%	2.57%
Marjaayoun	22,095	10,132		19.37%	10,866	1,080	2.06%	0.50%	2.57%
Hasbaya	12,795	5,867		11.22%	6,292	625	2.06%	0.50%	2.57%
Nabatiyeh	**114,068**	**52,307**	**5,197**	**100.00%**	**56,098**	**5,574**	**2.06%**	**0.73%**	**2.81%**
Lebanon	***1,377,445***	***879,855***	***234,056***		***888,817***	***233,187***	***1.63%***	***0.79%***	***2.43%***

[*]: Introduce in this column your estimation per Caza.

Table 4. Distribution of Primary Residences according to Number of rooms and Mohafaza, Year 2004 [4]

Number of Rooms	Beirut	Mount Lebanon	North	Bekaa	South	Nabatieh	2004 Lebanon	
1	6,268	12,124	1,591	969	2,371	803	**24,126**	2.7%
2	12,817	52,731	12,007	11,660	16,115	8,904	**114,234**	13.0%
3	17,214	80,221	34,648	32,939	25,463	17,677	**208,162**	23.7%
4	31,528	105,618	61,216	30,141	25,743	15,431	**269,677**	30.7%
5	21,518	86,081	36,691	17,349	13,591	6,140	**181,370**	20.6%
>6	12,350	34,210	15,952	9,739	6,013	3,277	**81,541**	9.3%
n.a.	0	303	239	0	129	74	**745**	0.1%
Units #	**101,695**	**371,288**	**162,344**	**102,797**	**89,425**	**52,306**	**879,855**	100.0%
	11.6%	42.2%	18.5%	11.7%	10.2%	5.9%	100.0%	

Note: Main Values of the table were kept as they are. Formulae were used to compute the totals and percentages.

<u>Assumptions:</u> >6 is 6 Rooms, and n.a. is 7 Rooms.

Number of Rooms	Beirut	Mount Lebanon	North	Bekaa	South	Nabatieh	2004 Lebanon	
1	6,268	12,124	1,591	969	2,371	803	**24,126**	2.7%
2	12,817	52,731	12,007	11,660	16,115	8,904	**114,234**	13.0%
3	17,214	80,221	34,648	32,939	25,463	17,677	**208,162**	23.7%
4	31,528	105,618	61,216	30,141	25,743	15,431	**269,677**	30.7%
5	21,518	86,081	36,691	17,349	13,591	6,140	**181,370**	20.6%
6	12,350	34,210	15,952	9,739	6,013	3,277	**81,541**	9.3%
7	0	303	239	0	129	74	**745**	0.1%
Units #	**101,695**	**371,288**	**162,344**	**102,797**	**89,425**	**52,306**	**879,855**	100.0%
Rooms #	391,346	1,418,507	655,253	388,849	318,898	184,246	3,357,099	
Rooms per P.Unit	3.8	3.8	4.0	3.8	3.6	3.5	3.8	

mean A(m^2) per P.Unit	**117.1**	**121.0**	**140.3**	**151.5**	**127.1**	**137.4**	**129.3**	**(Ref.) [5]**
	11,908,485	44,925,848	22,776,863	15,573,746	11,365,918	7,186,844	113,765,252	
A(m^2)	11,911,369	44,936,729	22,782,380	15,577,518	11,368,671	7,188,585	113,765,252	Note [a]
mean A(m^2) per P.Unit	**117.1**	**121.0**	**140.3**	**151.5**	**127.1**	**137.4**	**129.3**	**Note [b]**

Note [a]: Corrected areas to verify the summation.

Note [b]: Corrected means.

mean A(m^2) per Room	**30.4**	**31.7**	**34.8**	**40.1**	**35.6**	**39.0**	**33.9**
Cooled Rooms per P.Unit [*]	2.0	1.5	1.0	1.0	1.0	1.0	
Cooled Area (m^2) per P.Unit	***60.9***	***47.5***	***34.8***	***40.1***	***35.6***	***39.0***	

[*]: Introduce in the yellow row your estimation.

References for Appendix B

No.	Organization	Description
1	MEW	Plan strategique national pour le secteur de l'electricite, Situation actuelle, p.3
2	CDR	Schéma D'Aménagement du Territoire Libanais, rapport de phase 1, projections démographiques.
3	CAS	Housing Characteristics in 2004, Table 175-a
4	CAS	Housing Characteristics in 2004, Table 153-a
5	CAS	Housing Characteristics in 2004, Table 150
6	TSBL	Climatic Zoning for Buildings in Lebanon 2005
7	Economy Watch	http://www.economywatch.com/economic-statistics/Lebanon/GDP_Current_Prices_US_Dollars/#otheryears
8	Presidency of the Council of Ministers	Economic Accounts of Lebanon, Retrospective 1997-2007, Table 2
9	Economy Watch	http://www.economywatch.com/economic-statistics/Lebanon/GDP_Constant_Prices_National_Currency/#otheryears
10	UNDP-GEF	Status of Building Energy Codes in Lebanon, Matilda El-Khoury