A2a ELECTRICITY CONSUMPTION IN THE RESIDENTIAL AND COMMERCIAL SECTORS

A2a.1 INTRODUCTION

The residential and commercial sectors consumed in 1994 -base year of our analysis- 30% of the final energy consumption, which is 30×10^6 Gigajoules, and in turn produced 1737 Gg of CO2 [1].

The concerned ministries for the energy sectors- Ministry of Petroleum (MOP), Ministry of Hydraulic and Electric Resources (MOHER) as well as Ministry of Environment (MOE) and the « Conseil de Developpement et de la Reconstruction (CDR) » did not foresee at the short or long term any policy for the management of the demand that could lower the consumption of energy and consequently CO^2 emissions [2].

The only efforts so far are concerned with the management of the supply:

- At the level of oil products: restructuring of stockage, improvement of the distribution, rehabilitation of ports, etc.....
- At the level of electricity sector: improving the power plants efficiency, introduction of the natural gas for the combined cycle turbines, improving the grid in order to optimizing the technical losses.

A2a.2 STRUCTURE OF THE SECTOR

A2a.2.1 Electricity Consumption

The following analyses of the electricity structure and consumption for both residential and commercial sectors will be based on a study done in 1992 by “Electricite de France (EDF)” for the account of the CDR and “Electricite du Liban (EDL)” [3].

For this issue, the EDF surveys show:

- The Energy consumption per equipment and year (1991) (table A2a-1)
- The rate of household equipment in residential and commercial sectors for 1991 in Lebanon (table A2a-2).

Following these data, we brought up the necessary corrections in order to establish 1994 data as the base year for our study:

- The rate of household equipment in residential and commercial sectors for 1994 (table A2a-3) .
- The structure of the low voltage electricity demand for household equipment in the residential and commercial sectors (table A2a-4) & (figureA2a.1).

A2a.2.2 NON ELECTRICITY CONSUMPTION

In fact, another survey was done by a private consultant bureau "Dams and Moore" [4] on energy consumption of non-electrical equipment in the residential sector (table A2a-5).

By analyzing this survey, we found out that electricity comes in the first order in our interest, regarding the high potential of energy saving and consequently of CO_2 emissions reduction, than come the other non-electrical equipment. Also in the second part of chapter 2 we approach the building envelope along with thermal needs such as heating and air conditioning which explain why our concern will be limited to the electrical equipment only in this part.

A2a.2.3 BREAK DOWN OF THE ELECTRICITY CONSUMPTION IN THE RESIDENTIAL AND COMMERCIAL SECTORS

By analyzing table A2a-1, A2a-2, A2a-3 we found out that the most consuming equipment and which represent 80% of the total electricity consumption are:

- Electrical heaters (for space heating) 31%.
- Electrical domestic hot water 22% (same terminology is used for hot water used for sanitary purposes in commercial & residential sectors)
- Air conditioning A/C 13%
- Lighting 8,5%
- Refrigerator 6%

Note that oil boilers for heating are the most consuming equipment for non-electric energy consuming equipment in the residential and commercial sectors.

Finally and since there are no specific policies for the management of demand in Lebanon, the energy efficiency in the residential and commercial sectors is slightly and slowly improved by the introduction of some efficient equipment due to the dynamic of the market such as:

- Heat Pumps air conditioners (reverse cycle) with micro-processors and inverter compressors.
- Low consumption lamps: compact fluorescent lamps.
- Solar Domestic Hot Water Systems.

But with different payback times, penetration rates and incremental cost.

A2a.3 ELECTRIC ENERGY DEMAND INCREASES IN THE RESIDENTIAL AND COMMERCIAL SECTORS: BASE CASE (BUSINESS AS USUAL)

A2a-3-1 BASIC HYPOTHESIS

Following the basic data for the base year 1994 already mentioned and from certain number of socio-economic and demographic official parameters and indications obtained (Bank of Lebanon, UNDP, etc.) we foresee the increase in demand in the electric energy in the residential and commercial sectors at short term (year 2000), medium term (year 2015) and long term (year 2040). All this in case no specific rational management being adopted: < business as usual>. In this context, we have adopted 2 scenarios :

1- in function of a slow economic development (average annual increase rate of GDP = 3%). This scenario will be called « scenario low base case ».

2- in function of a strong economic development (average annual increase rate of GDP = 6%). This scenario will be called « scenario high base case ».

Note: hereafter, we foresee the equipment penetration rate in the residential sector will increase with GDP increase. The equipment penetration rate in the commercial sector is independent from GDP increase.

We should note here too that the equipment penetration rate from 1991 till 1994 will note vary too much since these 2 years were very close to 1990, the end of the civil war in Lebanon and especially that the electricity sector was totally damaged which made it useless for people to buy electric equipment. Starting 1995, and after the rehabilitation of the electricity sector, an economic boom started to show in the country which will explain the high penetration rate after 1994.

A2a.3.2 SCENARIO ''LOW BASE CASE ''

Data Base:
- Number of household units in 1994: 720800
- Number of commercial units in 1994: 201400
- Electrification rate in the residential sector in 1994: 95%.
- Electrification rate in the commercial sector in 1994: 98%.

Parameters:
- GDP increase rate: 3%.
- Average household growth rate: 1,5%.
- Energy/GDP elasticity in the commercial sector: 1 (estimated by EDL and justified later in our study).

- Electrification growth rate:

Electrification growth rate:	1994	2015	2040
- Residential	95%	100%	100%
- Commercial	98%	100%	100%

A2a.3.2.1 Residential equipment penetration rate

	2000	2005	2015	2040
Refrigerator	70%	90%	100%	100%
Classic	100%	100%	100%	100%
efficient	0%	0%	0%	0%
DHW	50%	60%	70%	70%
Electric	100%	95%	90%	85%
Solar	0%	5%	10%	15%

Lighting	100%	100%	100%	100%
Incandescent	90%	80%	70%	50%
Compact fluo.	10%	20%	30%	50%
Air conditioning	30%	40%	50%	60%
A/C cool + heat	90%	95%	95%	95%
A/C cool	10%	5%	5%	5%
Electrical heater	18%	15%	10%	5%
Convector*	100%	100%	100%	100%

N.B See Appendix A2a-1 for other electrical equipment penetration rate.

* by convector we mean the conventional radiator with electrical heater. After the rehabilitation of the electricity sector and the economic boom, people are shifting more & more to heat pump A/C for heating & cooling purposes and for saving energy too (coefficient of performance of heat pump is 2.5 relatively to electric heater convectors which is only 1).

A2a.3.2.2 Commercial equipment penetration rate

	2000	2005	2015	2040
Refrigerator	30%	50%	80%	90%
Classic	100%	100%	100%	100%
efficient	0%	0%	0%	0%
DHW	10%	20%	50%	70%
Electric	100%	95%	90%	85%
Solar	0%	5%	10%	15%
Lighting	100%	100%	100%	100%
Incandescent	90%	80%	70%	50%
Compact fluo.	10%	20%	30%	50%
Air conditioning	20%	50%	70%	80%
A/C cool + heat	80%	95%	95%	95%
A/C cool	20%	5%	5%	5%
Electrical heater	20%	15%	5%	0%
convector	100%	100%	100%	100%

N.B See Appendix A2a-1 for other electrical equipment penetration rate.

A2a.3.3 SCENARIO " HIGH BASE CASE "

Data base:

- Number of household units in 1994 is 720800
- Number of commercial units in 1994 is 201400
- Electrification rate in the residential sector is 95%
- Electrification rate in the commercial sector is 98%.

Parameters

- GDP increase rate is 6%
- Average household growth rate is 1,5%
- Energy/GDP elasticity in the commercial sector is 1.

- Electrification growth rate in 1994 2015 2040
- The residential sector 95% 100% 100%
- The commercial sector 98% 100% 100%

A2a.3.3.1 Residential equipment penetration rate

	2000	2005	2015	2040
Refrigerator	75%	95%	100%	10%
Classic	100%	100%	100%	100%
efficient	0%	0%	0%	0%
DHW	55%	65%	75%	85%
Electric	100%	95%	90%	85%
Solar	0%	5%	10%	15%
Lighting	100%	100%	100%	100%
Incandescent	90%	80%	70%	50%
Compact fluo.	10%	20%	30%	50%
Air conditioning	35%	45%	55%	75%
A/C cool + heat	90%	95%	95%	95%
A/C cool	10%	5%	5%	5%
Electrical heater	18%	15%	10%	5%
convector	100%	100%	100%	100%

N.B See Appendix A2a-2 for other electrical equipment penetration rate.

A2a.3.3.2 Commercial equipment penetration rate

	2000	2005	2015	2040
Refrigerator	30%	50%	80%	90%
Classic	100%	100%	100%	100%
efficient	0%	0%	0%	0%
DHW	10%	20%	50%	70%
Electric	100%	95%	90%	85%
Solar	0%	5%	10%	15%
Lighting	100%	100%	100%	100%
Incandescent	90%	80%	70%	50%
Compact fluo.	10%	20%	30%	50%
Air conditioning	20%	50%	70%	80%
A/C cool + heat	90%	95%	95%	95%
A/C cool	10%	5%	5%	5%
Electrical heater	20%	15%	5%	0%
convector	100%	100%	100%	100%

N.B See Appendix A2a-2 for other electrical equipment penetration rate.

A2a.3.4 RESULTS

These preceding data (energetic consumption, economic parameters, penetration and electrification rate, etc....) were used as inputs in the LEAP computer program which lead to the outputs in the energy demand for the different scenarios adopted and for different term dates:

- The forecast in the electric energy demand per equipment for the residential sector in the low base case (table A2a-6) and high base case (table A2a-8) as well as for the commercial sector in the low base case (table A2a-7) and high base case (table A2a-9).

- The final data are summarized in table 2-10 as well as in figures A2a-2 and A2a-3.

A2a.4 ELECTRIC ENERGY DEMAND INCREASE IN THE RESIDENTIAL AND COMMERCIAL SECTORS WITH MITIGATION POLICIES: MITIGATION CASE

A2a.4.1 BASIC HYPOTHESIS ''OPTIONS PROPOSED ''

As specified in paragraph A2a.2.3, the most consuming electric equipment in the residential and commercial sectors are:

- Electric heaters (for heating)
- Electric DHW
- Lighting
- Refrigerators

In this context, we should note that the usage of electric heater for heating would decrease naturally in Lebanon in the coming years since fioul boilers and heat pumps air conditioners are becoming more and more popular.

In fact, air conditioning is developing rapidly in both residential and commercial sectors in Lebanon and very little could be done in order to improve the energy efficiency of this market since all A/C units are now very efficient in energy consumption (micro-processors, rotary and screw compressors, DC inverter compressors at variable speed, etc.)

In our opinion, the interesting equipment to be developed in
Lebanon using energy efficient policies are:

1- Solar domestic hot water replacing electric domestic hot water
(See table A2a.11 and appendix A2a-3)

2- Energy efficient refrigerator replacing ordinary refrigerator
(See table A2a.12 and appendix A2a-4)

3- Compact fluorescent lamps (low consumption) replacing incandescent lamps
(See table A2a.12 and appendix A2a-5)

Note: hereafter, we foresee the equipment penetration rate in the residential sector will increase with GDP increase. The equipment penetration rate in the commercial sector is independent from GDP increase. But in both residential and commercial sectors, efficient equipment penetration rate will increase with GDP increase (solar domestic hot water, efficient refrigeration, compact fluorescent lamps).

A2a.4.2 SCENARIO '' LOW MITIGATION CASE ''

The database is the same as « Low base case ».
Refer to paragraph A2a.3.1 excluding the rate of penetration of refrigerators, DHW and lighting that become:

A2a.4.2.1 Residential equipment penetration rate

	2000	2005	2015	2040
Refrigerator	70%	90%	100%	100%
Classic	100%	80%	70%	50%
efficient	0%	20%	30%	50%
DHW	50%	60%	70%	70%
Electric	100%	85%	65%	30%
Solar	0%	15%	35%	70%
Lighting	100%	100%	100%	100%
Incandescent	85%	65%	50%	25%
Compact fluo.	15%	35%	50%	75%

N.B See Appendix A2a-6 for other electrical equipment penetration rate.

A2a.4.2.2 Commercial equipment penetration rate

	2000	2005	2015	2040
Refrigerator	30%	50%	80%	90%
Classic	100%	80%	70%	50%
efficient	0%	20%	30%	50%
DHW	10%	20%	50%	70%
Electric	100%	85%	70%	30%
Solar	0%	15%	30%	70%
Lighting	100%	100%	100%	100%
Incandescent	85%	65%	50%	25%
Compact fluo.	15%	35%	50%	75%

N.B See Appendix A2a-6 for other electrical equipment penetration rate.

A2a.4.3 SCENARIO ‘’ HIGH MITIGATION CASE ’’

The database is the same as « high base case »
Refer to paragraph A2a.3.1.2 excluding the rate of penetration of refrigerators, DHW and lighting that become:

A2a.4.3.1 Residential equipment penetration rate

	2000	2005	2015	2040
Refrigerator	75%	95%	100%	100%
Classic	100%	75%	60%	40%
efficient	0%	25%	40%	60%
DHW	55%	65%	75%	85%
Electric	100%	80%	70%	20%
Solar	0%	20%	30%	80%
Lighting	100%	100%	100%	100%
Incandescent	85%	60%	40%	10%
Compact fluo.	15%	40%	60%	90%

N.B See Appendix A2a-7 for other electrical equipment penetration rate.

A2a.4.3.2 Commercial equipment penetration rate

	2000	2005	2015	2040
Refrigerator	30%	50%	80%	90%
Classic	100%	75%	65%	40%
efficient	0%	25%	35%	60%
DHW	10%	20%	50%	70%
Electric	100%	80%	50%	20%
Solar	0%	20%	50%	80%
Lighting	100%	100%	100%	100%
Incandescent	85%	60%	40%	10%
Compact fluo.	15%	40%	60%	90%

N.B See Appendix A2a-7 for other electrical equipment penetration rate.

A2a.4.4 RESULTS

These preceding data (energetic consumption, economic parameters, penetration and electrification rates, etc.) were used as inputs in the LEAP computer program which lead to the outputs in the energy demand for the different scenarios adopted and for different term dates:

- The forecast in the electric energy demand per equipment for the residential sector in the low mitigation case (table A2a.14) and high mitigation case (table2.15) as well as for the commercial sector in the low mitigation case (table A2a.16) and high mitigation case (table 2Aa.17).

- The final data are summarized in table A2a.18 as well in figures A2a.4 and A2a.5.

A2a.5 COMPARISON BETWEEN BASE CASE (BUSINESS AS USUAL) AND MITIGATION SCENARIOS

Comparing the adopted different scenarios (See table A2a.19) we note:

a) A reduction in the energy consumption around the year 2040 of at least 20% and that between « Low base case » and « Low mitigation case » scenarios and consequently an equal reduction of CO2 emissions.

b) A reduction in the energy consumption around the year 2040 of at least 25% and that between « High base case » and « High mitigation case » and consequently an equal reduction of CO2 emissions.

A2a.6 NECESSARY STRATEGIES FOR THE APPLICATION OF PROPOSED OPTIONS IN THE « MITIGATION SCENARIOS »

In parallel to the steps that will be mentioned below to allow the development of the three proposed options, we have detailed the incremental cost in order to implement such options (see figures A2a-6a and A2a-6b).

The 2 main barriers for the quick development of the previously mentioned options in Lebanon are:

a) The high prices of the equipment on the local market.
b) The relatively low cost of the electricity.

These 2 barriers lead often to high payback times (8 years for the solar domestic hot water system for exemple) See appendix A2a.3, A2a.4 and A2a.5.

Consequently, steps to be adopted for accelerating the diffusion of options in question are:

A2a.6.1 AT SHORT AND MEDIUM TERMS

a) Electricity price that reflects the real production cost.
b) Establishment of a quality control system such as certificates and labels of quality in order to better guide the consumer.
c) Training of technicians on energy saving issues and especially in the solar domestic hot water equipment.
d) Develop new customs policies and laws in favour of the performing equipment instead of the consuming one.
e) Awareness campaigns.

A2a.6.2 AT LONG TERM

a) Establishment of quality norms.
b) Development of local industries especially solar domestic hot water and efficient refrigerators.
c) Developing a loan system for credit sales of energy performing equipment at low rates for the industrials, the contractors and the Consumers.
d) Establishment of regulations in the residential and commercial sectors for installing solar domestic hot water systems.
e) Integrating in the energy pricing the notion of the » depollution cost »

References

[1] See page 1-8 table 1.11 of the final report of the National Inventory of Greenhouse gases (1998).

[2] Refer to:

- Horizon 2000 for Reconstruction and Development Conseil du Develop-pement et de la Reconstruction (1995).
- Assessment of the State of the Environment final report (1995). Mediterranean Environmental Technical Assistance Program (metap).
- Electricite du Liban: Business Plan (1996 - 2002).

[3] Estimation de la Demande d'Energie Electrique Pour le Systeme Libanais - Electricite de France International juin 1992.

[4] Etude du bureau Dams and Moore etablie en 1994 pour le compte de l'EDL .