3.2 Residential, Commercial and Institutional Sector: Building Envelopes

3.2.1 Background

The energy consumed by the residential, commercial and institutional sector for space heating and cooling amounted to 13.77 x 10^6 GJ in 1994. As shown in Fig.3, this energy was derived from three sources: electricity, gas/diesel oil and wood. Where by the amount of electricity used corresponded to 27% of total country electricity-supply, and the amount of gas/diesel oil used corresponded to 15% of total country imports of gas/diesel oil.

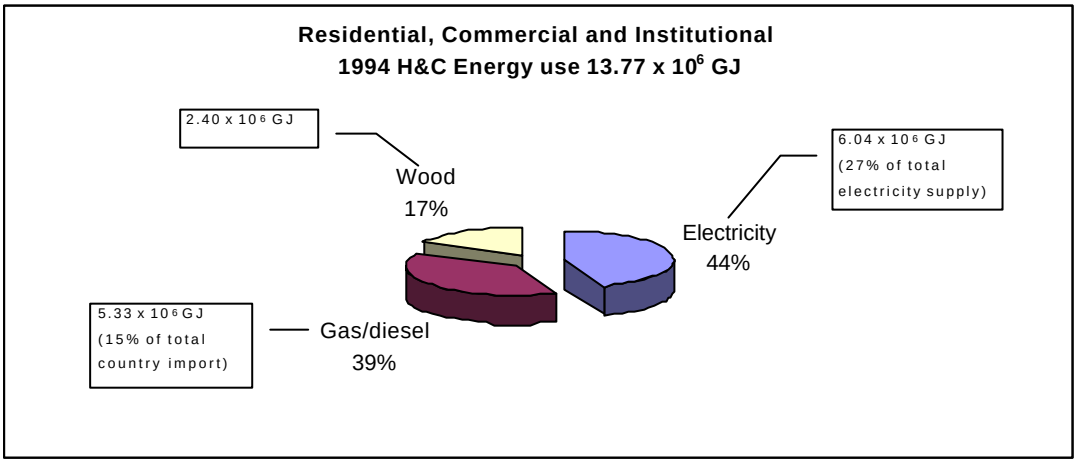

Fig.3: 1994 heating and cooling energy demand.

Building envelopes, and depending on their thermal characteristics play a key role in determining the amount of energy used for the provision of occupant thermal comfort. Although this is the case, the Lebanese building law has so far lacked any reference to the thermal performance of building envelopes.

Nevertheless there has been a recent governmental commissioning of a study concerned with the upgrading of the thermal performance of building envelopes in Lebanon. The specified upgrading suggestions are expected to bring about a 25% energy reduction on space heating and cooling needs.

This study, once approved, is intended to serve as a voluntary guideline only, given the numerous prevalent barriers that hinder its adoption and application. This in turn limits the possibilities of national energy reduction benefits, which are calculated to be 3.2% from total heating and cooling energy used between 1994 and 2040.

The current analysis takes this guideline as a point of departure, and assesses the potential national energy reduction that could be achieved as a result of a proposed barrier removal strategy, which will activate application rate and hence reduce the overall energy used for

space heating and cooling.

3.2.2 Forecast

Based on a series of input data and assumptions, two baseline scenarios have been considered (Fig.4). The forecast results for the period 1994 – 2040 revealed the following:

- Under a low baseline scenario of 3% energy growth rate for space heating and cooling, the associated total energy consumption between 1994 and 2040 will be 1339 x 10^6 GJ, and will result in the emissions of 208 750 Gg of CO_2. Where as the yearly average energy demand will be 28.48 x 10^6 GJ/yr, and will result in the emission of 4 442 Gg of CO_2/yr.

- Under a high baseline scenario of 4% energy growth rate for space heating and cooling, the associated total energy consumption between 1994 and 2040 will be 1771 x 10^6 GJ, and will result in the emissions of 276 236 Gg of CO_2. Where as the yearly average energy demand will be 37.68 x 10^6 GJ/yr, and will result in the emission of 5877 Gg of CO_2/yr.

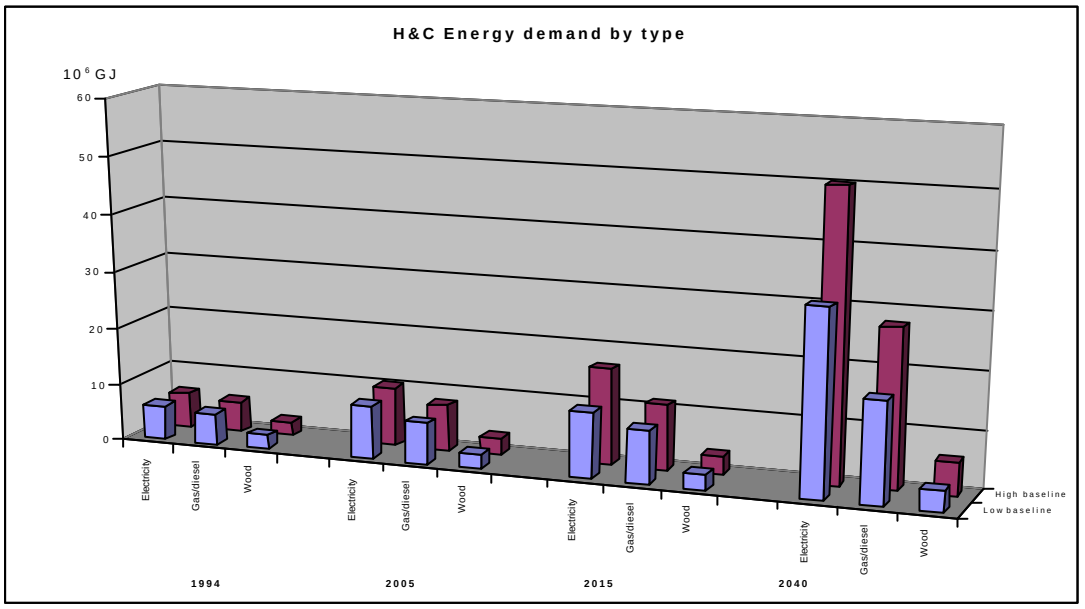

Fig.4: Forecast of heating and cooling energy demand by type.

The proposed mitigation strategy consists of increasing the penetration rate of guideline application for new buildings through appropriate national barrier removal activities and programs. Two mitigation scenarios are proposed:

- The first scenario assumes a 10% penetration rate from 2000 to 2005, a 30% penetration rate up to 2015, and a 70% penetration rate until 2040.

- The second scenario assumes a 20% penetration rate from 2000 to 2005, a 60% penetration rate up to 2015, and a 100% application until 2040.

As shown in Figs. 5 and 6, mitigation scenario 1 can achieve a 10% reduction in energy use for space heating and cooling between 1994 and 2040, and mitigation scenario 2 can achieve a 15% energy reduction.

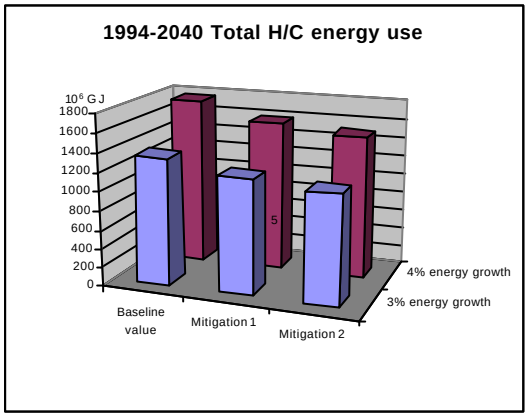

Fig.5: Total 1994 to 2040 energy use.

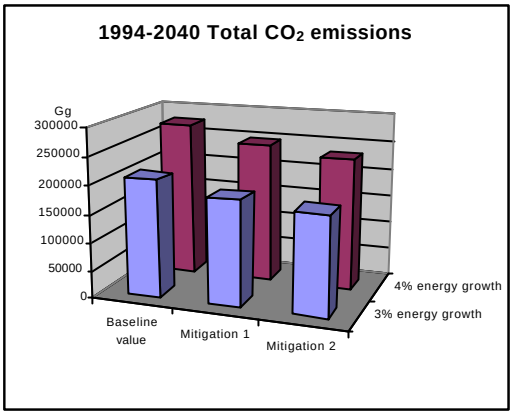

Fig.6: Total 1994 to 2040 CO_2 emissions

The cost benefit evaluation of mitigation scenarios 1 and 2 (calculated using the annualized cost concept) revealed the following: (Fig.7)

- For 3% energy growth rate, and 10% discount rate: Mitigation scenario 1 can save a total of 21 million tons of CO_2 at a cost of 106 US$/ton of CO_2 saved. Mitigation scenario 2 can save a total of 31 million tons of CO_2 at a cost of 112 US$/ton of CO_2 saved.

- For 4% energy growth rate, and 10% discount rate: Mitigation scenario 1 can save a total of 28 million tons of CO_2 at a cost of 80 US$/ton of CO_2 saved. Mitigation scenario 2 can save a total of 42 million tons of CO_2 at a cost of 85 US$/ton of CO_2 saved.

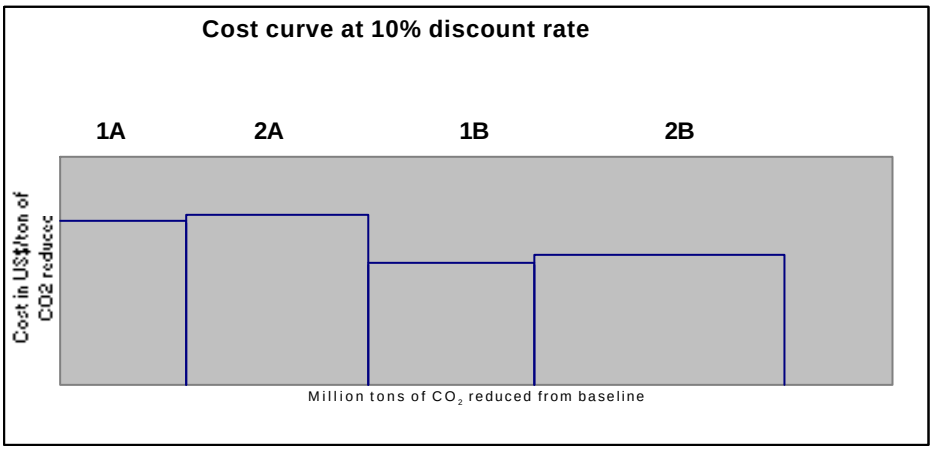

Fig.7: Cost curve for mitigation options 1 and 2 at 10% discount rate

1A: Mitigation scenario 1, energy growth rate 3%.
2A: Mitigation scenario 2, energy growth rate 3%.
1B: Mitigation scenario 1, energy growth rate 4%.
2B: Mitigation scenario 2, energy growth rate 4%.

3.2.3 Conclusions

In terms of energy conservation strategy, upgrading the thermal performance of building envelopes is a strategy whose impact is felt on a long-term basis. In this respect, mitigation scenario 2 revealed much higher CO_2 emissions reductions at minimal additional cost per ton of CO_2 saved.

3.2.4 Project proposals

The recently developed Thermal Building Guideline which aims at enhancing the thermal performance of building envelopes, and thus of reducing the energy consumed for space heating and cooling, faces numerous barriers that hinder its adoption and application. The main barriers are the following:

- ***Information and Know-how barrier:*** **Unfamiliarity with subject matter among professionals, policy makers and consumers; Uncertainty about the effectiveness of the new technology (Energy reduction versus new problems of construction details or space overheating)**
- ***Economic barrier:*** **Uncertainty with economic and environmental implications; Initial incremental cost of conservation measure.**
- ***Institutional barrier:*** **Lack of trained personnel; Lack of adequate verification mechanism.**

Consequently, there seems to be two main projects needed in this sector:

- **Capacity Building project** aimed at providing the needed foundation of supportive policy makers, informed consumers, skilled professionals, and trained personnel.
- **Market based program** aimed at overcoming the initial incremental cost and at activating market demand.

Recommendations for future work

- The analysis has been performed based on the assumption of 25% reduction on heating and cooling energy needs per building unit. A detailed simulation of study cases is needed for the various climatic zones in order to determine more accurately the potential of energy reduction.
- The specifications of the Thermal building guideline were recommended based on historical precedent in other countries. Further work is needed to update the specifications based on an economic cost-effective approach.
- The analysis has considered the potential of static building envelope conservation measures. A further multi-parameter assessment that looks at the overall potential of passive heating and cooling techniques for the Lebanese climate is needed.
- Assessment of the potential of microclimatic interventions such as increasing green cover along the coastal zone as a means of reducing the urban heat island effect, and thus reducing cooling energy needs.
- This analysis has assumed that both the residential and commercial uses will rely on partial heating and cooling. Further data refinement in terms of differentiating between residential and commercial energy uses and energy growth rates is needed.

- The analysis did not account for additional energy reductions due to the natural improvement of the efficiency of HVAC equipment.
- The cost-benefit assessment of this analysis looked at the national level; a further assessment of the consumer pay back period is needed.