B. The Transport Sector

Option 1: Improving Technical Status of the Fleet

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	86	Transport sector contributes to 20-25% of the CO_2 emissions from burnt fossil fuels. Other transport-related GHG include N_2O and CFC and HCFC from AC systems.	30
Efficiency improvement and energy saving	25	90	Improving vehicle maintenance and engine tuning greatly reduces emissions of GHGs and other pollutants by up to 30%. This leads to substantial energy and cost savings.	22.5
Capital Investment	10	65	Establish a vehicle I&M programme requires capital investment for the purchase and installation of testing units.	6.5
Operation and maintenance cost	10	50	To keep motor vehicles in proper operating conditions, and thereby maintaining returns in terms of lower GHG emissions, regular spending on labour, materials and spare parts will be required.	5
Option sustainability	10	60	Sustainability will depend on financial, technical and regulatory support. Vehicle maintenance requires annual investment by all stake holders	6
Payback period	5	50	Payback period is not easy to specify since I&M should be a continuous process	2.5
Societal and economic benefits	5	80	Proper maintenance and periodic inspection can reduce costs for items such as fuel and spare parts, and also increase the vehicle's resale value and extend its lifespan. Additionally, demand for vehicle servicing and for I&M centers will generate jobs.	4
			Total	**76.5**

Option 2: Improving Traffic Management

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	77	Improving traffic management reduces fuel consumption by reducing the journey delay time. Creating conditions for smoother traffic also reduces emissions of other pollutants such as CO, HC and NOx.	27
Efficiency improvement and energy saving	25	80	Modern traffic systems lead to vehicles being driven at optimum speeds in terms of energy consumption, and to having shorter trips duration.	20
Capital Investment	10	75	In order to improve traffic management, street networks have to be upgraded and properly managed. Such measures require moderate capital expenditure.	7.5
Operation and maintenance cost	10	70	Costs for maintenance of road networks could be rated as medium,	3.5
Option sustainability	10	60	The sustainability of this option is associated with national planning and expenditure, and therefore can be rated as medium.	6
Payback period	5	37	Payback period in this case is not easy to specify. In general, payback is a long- term parameter.	1.8
Societal and economic benefits	5	70	Improving traffic management will reduce vehicle maintenance and expenditure for spare parts. It will also reduce human stress and saves time by reducing trips duration.	3.5
			Total	**69.3**

Option 3: Promoting Mass Transport

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	90	Reliance on mass transport leads to substantial traffic congestion reduction and hence GHG emission reduction. Mass transport emits less per passenger/km than private vehicles and occupies less road space per passenger than cars.	31.5
Efficiency improvement and energy saving	25	80	Mass transport utilization leads to significant energy savings in terms of fuel and resources, and if well organized can improve the overall system efficiency.	20
Capital Investment	10	63	This option may require high capital investment for buses, garages, workshops, personnel, and stations.	6.3
Operation and maintenance cost	10	65	Maintenance will be required for vehicles, garages and property, at levels of annual expenditure that are rated as medium.	6.5
Option sustainability	10	80	Sustainability of this option is relatively high. After the initial effort to develop the required infrastructure, routine maintenance is generally all that is needed to achieve long-term sustainability.	8
Payback period	5	50	Payback period can span between 6 and 10 years depending on public acceptance.	2.5
Societal and economic benefits	5	68	Mass transport will improve the overall traffic system and could generate new jobs. The expansion of public transport will, however, dampen demand for taxis and minibuses.	3.4
			Total	**78.2**

Option 4: Environmental Standards and Regulations

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	70	The enactment and enforcement of environmental standards and regulations for the transport sector will improve the fleet status. This leads to efficiency improvement and GHG reduction.	24.5
Efficiency improvement and energy saving	25	60	Limits on exhaust emissions could only be met by optimizing the engine operating conditions (fine tuning). This also leads to efficiency improvement and GHG reduction.	15
Capital Investment	10	90	The costs associated with this option are relatively low.	9
Operation and maintenance cost	10	90	Operation and maintenance costs for this option are not relevant.	9
Option sustainability	10	55	This option's sustainability is considered weak because regulations must be updated periodically and their enforcement should be always maintained.	5.5
Payback period	5	50	Since to substantial capital investment is needed, the payback period is not relevant.	2.5
Societal and economic benefits	5	60	Increase in public awareness is a main benefit. Also complying with emission standards would inevitably lead to other health/economic benefits. However, the cost on public may be prohibitive.	3
			Total	**68.5**

Option 5: Urban Planning and Land Use

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	55	Enhanced urban planning leads to minimizing traffic congestion. In the long run, however, it may increase the use of private vehicles.	19.25
Efficiency improvement and energy saving	25	57	Decentralization of businesses and job centers would reduce traffic congestions, and hence GHG emissions.	14.25
Capital Investment	10	55	Urban planning requires large-scale capital investment. Benefits may be gained indirectly, however, from projects with goals other than the reduction of GHG emissions.	5.5
Operation and maintenance cost	10	90	Modifications achieved through urban planning tend to be long lasting and may require low maintenance.	9
Option sustainability	10	90	Urban planning is an ongoing project, and by its nature tends to be sustainable.	9
Payback period	5	30	This option has a long payback period.	1.5
Societal and economic benefits	5	80	Urban planning projects create employment and help to remedy housing problems. Generally it improves the living standards of citizens.	4
			Total	**62.5**

Option 6: Switching to Alternative Fuels (Natural Gas)

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	95	Natural gas has lower carbon content than liquid fuels, and hence it releases less GHG. NG Vehicles also emit lower levels of CO, VOC and HC and lead.	33.25
Efficiency improvement and energy saving	25	50	The energy content of NG is slightly higher than that of gasoline. NG Engines have longer life span than others.	12.5
Capital Investment	10	50	Considerable capital investment is required to establish infrastructure for import, storage and distribution of NG and for the vehicles conversion.	5
Operation and maintenance cost	10	80	Operation and maintenance costs will be comparable to those of gazoline. Incremental cost will be associated with tighter safety measures.	8
Option sustainability	10	95	This option is easy to sustain once the NG and its associated infrastructure are secured and established.	9.5
Payback period	5	50	Payback period for projects with such large infrastructure may span up to 15-20 years.	2.5
Societal and economic benefits	5	60	Introducing NG technology will create limited job opportunities to meet the anticipated demand for fuel storage and distribution	3
			Total	**73.75**

B.1 Summary of technology options ranking in the transport sector.

Option	Overall Score
Promoting mass transport	**78.2**
Improving technical status of the fleet	**76.5**
Switching to alternative fuels (NG)	**73.75**
Improving traffic management	**69.3**
Environmental standards and regulations	**68.5**

Urban planning and land use	**62.5**

C. The Industry Sector

Option 1: Switching to Natural Gas

No	Criteria element	Criteria weight (%)	Option Score (%)	Rational for scoring	Final Score
1	GHG reduction	35	90	Natural gas will be abundant and has low carbon content compared to fuel oil. Switching to NG in thermal power plants reduces CO_2 by about 30%.	31.5
2	Efficiency improvement and energy saving	25	85	Natural gas has combustion efficiency higher than that of equivalent oil by around 10% and resultant energy savings.	21.25
3	Investment Level	10	57	High capital investment is required initially for NG infrastructure including the construction of regional NG network.	5.7
4	Operation and maintenance cost	10	57		5.7
5	Option sustainability	10	90	Sustainability is secured by the availability of NG locally or through networking projects being constructed in the region.	9
6	Payback period	5	77	Average payback period could be from 3 to 5 years depending on the fuel availability and the cost of its transport/ storage infrastructure.	3.85
7	Societal and economic benefits	5	70	Establishment of infrastructure will create jobs and enhance NG penetration into other industries. It will also reduce imports of other fuels.	3.75
				Total	**80.75**

Option 2: Energy Efficient Systems

No	Criteria element	Criteria weight (%)	Option Score (%)	Rational for scoring	Final Score
1	GHG reduction	35	90	Reduces GHG emissions due to anticipated efficiency improvement. It has a very high impact on GHG reduction.	31.5
2	Efficiency improvement and energy saving	25	90	Very high level of expected energy savings, and efficiency improvement	22.5
3	Investment Level	10	60	High capital cost	6
4	Operation and maintenance cost	10	60	Almost Unchanged	6
5	Option sustainability	10	73	Sustainability is secured by the availability of energy efficient systems through projects being executed in the country & via official support from concerned ministries.	7.3
6	Payback period	5	60	Has a payback period of around 2-4 years	3
7	Societal and economic benefits	5	50	Create jobs & provide comfort. Reduces air pollution.	2.5
				Total	**78.8**

Option 3: Cogeneration

No	Criteria element	Criteria weight (%)	Option Score (%)	Rational for scoring	Final Score
1	GHG reduction	35	80	Cogeneration is a significant source for saving substantial amounts of energy, carbon, and money. It has a very high impact on GHG reduction.	28
2	Efficiency improvement and energy saving	25	80	Conventional electricity generation is inherently inefficient, converting only about a third of the fuels consumption of energy into usable energy. CHP systems can deliver energy with efficiencies exceeding 80%.	20
3	Investment Level	10	50	It is an attractive, rational and cost efficient energy efficient option, but has a high capital investment level.	5
4	Operation and maintenance cost	10	50		5
5	Option sustainability	10	60	Sustainability depends on the amount of power needed, thermal needs, duty cycle, space constraints, fuel availability, utility prices, interconnection issues, and emission regulations.	6
6	Payback period	5	63	The payback period is bet6ween 1-5 years.	3.15
7	Societal and economic benefits	5	80	Generating electricity on or near the point of using CHP systems avoids transmission and distribution losses and defers expansion of the electricity transmission grid.	4
				Total	**71.15**

Option 4: Boiler Improvement

No	Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
1	GHG reduction	35	90	Improvements of efficiency can be directly translated into enhanced productivity and environmental performance. The impact on GHG reduction is substantial.	31.5
2	Efficiency improvement and energy saving	25	90	The average efficiency of motors in the Lebanese industry is assumed to be 65%. Has a medium level of expected energy savings.	22.5
3	Investment Level	10	60	The current average implementation cost of the new energy efficient motor is estimated as $66/HP for the 25-50 HP range & $61/HP for the 50-100 HP range	6
4	Operation and maintenance cost	10	73	Modern systems are cheaper to maintain	7.3
5	Option sustainability	10	70	Sustainability is guaranteed due to the sustainability of the textile and food industries in the country.	7
6	Payback period	5	80	Short	4
7	Societal and economic benefits	5	40	Better environment, more reliable production	2
				Total	**80.3**

Option 5: Efficient Motors

No	Criteria element	Criteria weight (%)	Option Score (%)	Rational for scoring	Final score
1	GHG reduction	35	70	Improved efficiency leads to less fuels being burnt to supply the needed power (by up to 15%)	24.5
2	Efficiency improvement and energy saving	25	60	Energy Saving by up to 15%	15
3	Investment Level	10	70	Incremental cost is low to medium	7
4	Operation and maintenance cost	10	90	Cheaper to maintain	9
5	Option sustainability	10	80	Option highly sustainable due to long life span of new devices.	8
6	Payback period	5	70	Relatively short	3.5
7	Societal and economic benefits	5	60	Cheaper production cost.	3
				Total	**70**

C. 1 Summary of technology options ranking in the industry sector.

Option	**Overall Score**
Switching to Natural Gas	**80.75**
Boiler Improvement	**80.3**
Energy Efficient Systems	**78.8**
Cogeneration	**71.15**
Efficient Motors	**70**

D. The Waste Sector

Option 1: Composting

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	90	Aerobic composting leads to almost total reduction of CH4 emissions	31.5
Efficiency improvement and energy saving	25	70	The process may require some power for the air injection. Recovered gases may be used as energy resource.	17.5
Capital Investment	10	50	Substantial capital may be needed for the units purchase and, installation.	5
Operation and maintenance cost	10	50	Composting may require continuous maintenance.	5
Option sustainability	10	80	Option could be quite sustainable.	8
Payback period	5	50	Payback period is relatively long and hard to specify.	2.5
Societal and economic benefits	5	77	Increases environmental awareness and mitigates some social problems.	3.85
			Total	**73.35**

Option 2: Landfill

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	37	Landfills are not an effective GHG mitigation measure since effluents are not controlled.	13
Efficiency improvement and energy saving	25	80	Energy savings could be significant if recycling activities are carried out at the landfill.	20
Capital Investment	10	43	Capital will be needed for the purchase and preparation of the site for the landfill.	4.3
Operation and maintenance cost	10	47	Proper run and maintenance of a landfill could be costly.	4.7
Option sustainability	10	80	Options sustainability depends on sites availability.	8
Payback period	5	43	Payback period in the commercial sense is almost non-existing	21.5
Societal and economic benefits	5	63	Landfills may solve the garbage problem and may generate new jobs.	3.15
			Total	**74.65**

Option 3: Anaerobic Digestion

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	90	CH4 emissions are totally eliminated	31.5
Efficiency improvement and energy saving	25	90	Recovered CH4 could be use as an energy resources for various domestic and industrial applications	22.5
Capital Investment	10	50	Unit establishment will require a certain capital cost	5
Operation and maintenance cost	10	50	Proper run and maintenance of a landfill could be costly.	5
Option sustainability	10	80	Once established, it could be quite sustainable.	8
Payback period	5	70	Gas recovery in large amounts could lead to relatively short payback period.	3.5
Societal and economic benefits	5	70	High gas odor from the site could make it a non-attractive initiative for many regions.	3.5
			Total	**79**

Option 4: Reduce/Reuse/Recycling

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	80	Avoiding fuel burning leads to significant GHG emissions reduction	28
Efficiency improvement and energy saving	25	90	Large amount of energy and raw materials could be saved through recycling.	22.5
Capital Investment	10	80	No substantial capital cost is required to establish such programs	8
Operation and maintenance cost	10	80	Low maintenance cost is required	8
Option sustainability	10	80	Option is quite sustainable.	8
Payback period	5	80	Payback period is short	4
Societal and economic benefits	5	67	Leads to increased environmental awareness throughout the community	3.35
			Total	**81.85**

Option 5: Aerobic Digestion

Criteria element	Criteria weight (%)	Option score (%)	Rational for scoring	Final score
GHG reduction	35	90	CH4 recovery is very significant	31.5
Efficiency improvement and energy saving	25	70	Using recovered CH4 saves another energy resources	17.5
Capital Investment	10	50	Option requires a substantial capital cost	5
Operation and maintenance cost	10	50	Option requires a substantial operation and maintenance cost	5
Option sustainability	10	80	Option could be quite sustainable	8
Payback period	5	50	Payback period is relatively long	2.5
Societal and economic benefits	5	70	High gas odor from the site could make it a non-attractive initiative for many regions.	3.5
			Total	**73**

D.1 Summary of technology options ranking in the waste sector.

Option	**Overall Score**
Reduce/Reuse/Recycle	**81.85**
Anaerobic Digestion	**79**
Landfill	**74.65**
Composting	**73.35**
Aerobic Digestion	**73**

E. The Building Sector

Option 1: Building Envelop

No	Criteria element	Criteria weight (%)	Option Score (%)	Rational for scoring	Final Score
1	GHG reduction	35	75	Improving the thermal performance of building envelopes is a long-term strategy. But given the long lifespan of buildings, it is an effective strategy	26.25
2	Efficiency improvement and energy saving	25	85	There is an added benefit of improving human comfort in addition to saving space heating and cooling energy	21.25
3	Investment Level	10	50	Does increase the construction cost of building type, climatic zone, and energy reduction target. (25%, 40%, 60%, …etc. energy reduction target). Construction requires skilled labor, but no operation and maintenance if properly installed.	5
4	Operation and maintenance cost	10	90	No incremental cost is generally associated with well- designed envelop.	9
5	Option sustainability	10	90	Average lifespan of building is 75 years. This allows the efficiency strategy to be in place. Upgrade in performance is dependent on adopted codes and policies.	9
6	Payback period	5	60	The payback period is medium range, but acceptable in the context of the building lifespan.	3
7	Societal and economic benefits	5	70	Improved occupant comfort. Reduced bills for space heating and cooling, but initial investment cost.	3.5
				Total	**77**

Option 2: Technology Upgrade

No	Criteria element	Criteria weight (%)	Option Score (%)	Rational for scoring	Final Score
1	GHG reduction	35	70	Substantial reduction in GHG needed due to the drop in amounts of energy	24.5
2	Efficiency improvement and energy saving	25	75	Energy savings are in the range of 25-30%	18.75
3	Investment Level	10	60	Incremental costs are associated with improved building envelopes	6
4	Operation and maintenance cost	10	72	Moderate O&M cost are required.	7.2
5	Option sustainability	10	75	Option is quite sustainable	7.5
6	Payback period	5	65	Relatively long period	6.5
7	Societal and economic benefits	5	75	More efficient buildings lead to more comfort, and less levels.	3.75
				Total	**75.1**

Option 3: SHWS

No	Criteria element	Criteria weight (%)	Option Score (%)	Rational for scoring	Final Score
1	GHG reduction	35	95	SHWS consumes major portion of buildings energy, hence GHG & energy savings are very significant.	33.25
2	Efficiency improvement and energy saving	25	90	The clean combustion- free renewable solar energy offers attractive savings in terms of fuel combustion.	22.5
3	Investment Level	10	60	Moderate investments are needed	6
4	Operation and maintenance cost	10	70	Systems will require moderate O&M levels.	7
5	Option sustainability	10	90	Sustainable almost for the life span of the system (10-15 years)	9
6	Payback period	5	75	Relatively short (3-4 years)	3.75
7	Societal and economic benefits	5	80	Provides diversity in energy supply	4
				Total	**85.5**

Option 4: Efficient Lighting

No	Criteria element	Criteria weight (%)	Option Score (%)	Rational for scoring	Final Score
1	GHG reduction	35	80	Reduction by up to 30% are expected	28
2	Efficiency improvement and energy saving	25	80	Energy savings are by almost the same percentage	20
3	Investment Level	10	63	Efficient lamps are more expensive, and hence substantial capital investment will be needed for large scale applications	6.3
4	Operation and maintenance cost	10	70	No incremental cost is associated with efficient bulbs.	7
5	Option sustainability	10	80	Sustainable since efficient lighting is an evolving technology with further developments being anticipated.	8
6	Payback period	5	70	Relatively short due to the significant energy savings and longer lifetime.	3.5
7	Societal and economic benefits	5	75	Increased awareness and reduced bills.	3.75
				Total	**76.55**

Option 5: Efficient A/C

No	Criteria element	Criteria weight (%)	Option Score (%)	Rational for scoring	Final Score
1	GHG reduction	35	75	A/C constitute significant portion of the consumption	26.25
2	Efficiency improvement and energy saving	25	75	GHG and energy savings are quite significant	18.75
3	Investment Level	10	65	Moderate- to high	6.5
4	Operation and maintenance cost	10	70	No incremental cost in comparison to conventional units	7
5	Option sustainability	10	80	Highly sustainable	8
6	Payback period	5	65	Up to few years	3.25
7	Societal and economic benefits	5	70	Not remarkable except for quieter neighborhoods.	3.75
				Total	**66.5**

E.1 Summary of technology options ranking in the building sector.

Option	**Overall Score**
SHWS	**85.58**
Efficient Lighting	**77.55**
Building Envelop	**77**
Technology Upgrade	**75.1**
Efficient A/C	**66.5**

5.1 Conclusions and Recommendations

In this project, an effort has been made to assess technology needs for GHG mitigation in the major economic sectors of Lebanon. Also, a decision analysis tool has been developed to assist decision makers and experts understand the influence of various parameters that affect the technology transfer process.

The first contribution this project has made is in the development of an effective and innovative approach for technology transfer in Lebanon. This approach is based on conducting the TNA and TT as two separate activities and whose outcomes should be combined as to create a national plan on the matter. TNA is assessed through ranking matrices that examine the various technological alternatives for each sector and provide scores to facilitate ranking of the options. TT is accomplished through the development of a decision analysis tool that examines with the help of stakeholders the decision criteria, constraints and the appropriate policy options that facilitate the technology transfer process.

5.1.1 On the Level of Technology Needs Assessment:

Five sectors have been identified as major sectors contributing to GHG emissions in Lebanon. These are the power, transport, industry, solid waste, and building sectors. The evaluation was performed by experts and stakeholders individually through interviews and also collectively through a specially organized round-table meeting. Eight options have been found suitable in the power sector to mitigate GHG emissions. These options were identified from the interviews conducted with a variety of stakeholders, and from the Technical Annex of GHG inventory of Lebanon, and other studies published by UN-ESCWA and MOE. The options identified are: electricity interconnection, deployment of combined cycle technology, switching to natural gas, partial switching to renewable energy, phasing-out subsidies, demand side management programs, technology upgrading and technical loss reduction. Based on the comparative analysis made possible by the ranking tables designed for that purpose, it was found that electricity interconnection is

the most feasible option, followed by combined cycle technology, switching to natural gas and then partial switching to renewable energy.

The Transport sector was analyzed taking into account under six options. These are the promotion of mass transport, improving the technical status of the fleet mainly through the re-introduction of effective inspection and maintenance program, switching to alternative fuels, improving traffic management, updating and enforcing environmental standards and regulations and, finally, improving urban planning and land use. The analysis outcome showed that the promotion of mass transport, private or public, is the most significant option followed by improvement of technical status of the fleet and switch to alternative fuels, followed by the remaining options.

In the industrial sector, five options were identified. These are switching to natural gas, boiler improvement, energy efficient systems, co-generation, and efficient motors. It was found that natural gas option gained the first place in terms of importance followed by boiler improvement, energy efficient systems, co-generation and finally efficient motors.

In the waste sector, five options were identified as the most appropriate. The ranking of these options suggests that introducing integrated reduce/reuse/recycle projects are the most significant option for the country, followed by anaerobic digestion, then landfill (the currently- applied option), composting and finally aerobic digestion.

Finally, in the building sector, the diffusion of solar water heating systems (SHWS) turned out to be the most important option far exceeding, by its grade, other options. The next option in the order of importance is improvement of efficient lighting, followed by building envelops technology upgrade and efficient air-conditioning.

5.1.2 On the Level of Technology Transfer

Having identified technology needs and most needed technological options in each of the relevant sectors of economy, the study relied on the Analytic Hierarchy Process (AHP) technique to develop a decision analysis tool that helps explore all the influencing

variables on technology transfer, and understand the relative importance of each with respect to each other and with respect to the overall goal. In this respect, a hierarchy describing the problem was developed and consisted of three layers describing the decision criteria, constraints and policy options. Interviews were made with 20 experts and stakeholders to consider their views regarding the importance of each element in the hierarchy on technology transfer. These views were then entered into the AHP software and ranking by merit of priority was performed to all decision criteria, all constraints and all policy instruments identified for the purpose of accelerating technology transfer for Lebanon.

The AHP analysis revealed that the most important policy option is the development of suitable market based programs through incentives/ taxing process, followed by the engagement of the private sector in projects related to climate change and involving technology transfer, followed by the need to update and enforce laws and regulations and finally benefit from the programs of international donor agencies.

On the level of constraints, the AHP analysis revealed that laws, policies and legislation concerned must be updated and enforced. This constraint was ranked first, followed by availability of funding, then by public awareness. Other constraints of less importance are commerciality and competitiveness, adequacy supporting infrastructure and immaturity of technology.

On the level of decision criteria, the most important criteria were found to be in the order of importance as follows: The satisfaction of national economy efficiency was ranked first, followed by the efficient use of local human, natural and technical resources, then by insurance of environmental quality. The creation of market potential and social equity element was of less concern.

In the final Workshop organized, in the presence of perspective national and international donors, for information dissemination, a number of concept proposals covering all major economic sectors has been presented and discussed. A brief of these proposals is listed in

Appendix B. It is recommended that the Lebanese Government does its best to ensure that projects executed through its own funds or through loans or grants utilize technologies recommended by this project. This would have the effect of not only curbing GHG emissions but certainly ensure economic return. Failure to do so, will have adverse impact on both the environment and economy and will result in acquiring technology that is either outdated, or not suitable.

Finally, the Lebanese model for TNA and TT can be a replicable model for other countries to follow. It is very simple to use and to implement and its outcomes are based on interactions with relevant stakeholders. A matter that is consistent with the GEF recommendations that TNA and TT must be a country driven process.

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Appendix A

Institutions and their Representatives in the TNA /TT Project in Lebanon

+	Name	Position/Sector
1	Ms. Matilda Khoury/Office of Urban Planning	Project Manager/ Capacity Building for the Adoption and Application of Energy Standards in Buildings
2	H.E. Mr. Mohamad Kabbani	Chairman, Parliamentary Committee on Energy &Water and Transport
3	Mr. Saeed Hamadeh	Chairman of R&D Committee. Association of Lebanese Industrialists
4	Mr. A. H. Kaissi	Director General, Ministry of Transport
5	Dr. Walid Dghaili	Director of Studies, EDL
6	Dr. Motasem El-Fadel	Dept. of Civil and Environmental Engineering, AUB
7	Mr. Bassam Jaber	Water expert, Consultant to the World Bank
8	Dr. Nesreen Ghaddar	Chairperson, Dept. of Mechanical Engineering, AUB
9	Dr. Berj Hatjian	Director General, MOE
10	Dr. Saeed Chehab	Director, ALMEE
11	Dr. Hassan Cherif	Chief, Sustainable Development and Productivity Division, ESCWA
12	Dr. Lulwa Ali	ENRED, ESCWA/Transport
13	Dr. Mohamad Kordab	ENRED, ESCWA/Buildings
14	Mr. Ghattas Akl	Director of Forestry Division, MO Agriculture
15	Dr. Wafa Charafeddine	CDR
16	Mr. Najib Saab	Director General, MECTAT
17	Dr. Raymond Ghajjar	Dept. of Electrical Engineering, LAU
18	Dr. Adnan Jouni	Project Manager, Energy Efficiency Project
19	Mr. Lutfallah Hajj	Coordinator, Environment Committee, Order of Engineers, Beirut
20	Dr. Bassam Frenn	Director General, National Institute of Industrial Research

Appendix B

Concept Proposals

The following concept proposals have been prepared by the consultants and were discussed during the Workshop held on October 29, 2002, in the presence of perspective donating bodies. These proposals, that cover all five major economic sectors, will be further discussed with national and international donors for securing sufficient funding.

Concept Proposal Number 1

Project Title: A Network for National Air Quality Monitoring

Objectives: To monitor emission levels, and assess the actual impact of mitigation impacts on air quality

Baseline: Beirut Urban Transport Project

Project description: To establish an air monitoring network throughout the country, especially in regions of substantial emissions

Project main stakeholders: Ministry of Environment, private sector, academic institutions,…

Project outcome:
1. Data base on air quality and emissions rate in the country.
2. Assess impacts of mitigation options.
3. Establish partnership between stakeholders.
4. Promote public awareness on GHG emissions

Beneficiaries: MOE, academic institutions, public, NGOs

Duration: 3 years

Estimated budget: $400,000 – $500,000

Financing: International donors, private sector, academic institutions

Concept Proposal Number 2

Project Title: Centers for Inspection and Maintenance of Motor Vehicles

Objectives: To re-instate inspection and maintenance units for motor vehicles.

Baseline: Beirut Urban Transport Project

Project description: To re-establish centers for inspection and maintenance (I&M) of motor vehicles in all five districts of Lebanon, equipped with state- of- the- art technologies for tailpipe emissions measurement.

Project main stakeholders: Ministry of Interior (MoI), Ministry of Transport (MoT), Ministry of Environment (MoE), relevant governmental bodies, and private sector.

Project outcome:
1. Data base on Lebanese fleet.
2. Improved technical status of the fleet.
3. Transport fuel consumption reduction.
4. GHG emissions reduction.
5. Partnership between stakeholders.
6. Job opportunities.

Beneficiaries: MoI, MoT, MoE, relevant private and public sub-sectors.

Duration: BOT, (5 years)

Estimated budget: $800,000 – $1,000,000

Financing: International donors, relevant governmental bodies, private sector

Concept Proposal Number 3

Project Title: National Awareness Campaign on Recycling

Objectives: To promote recycling nationwide

Baseline: Recycling Project at the American University of Beirut

Project description: To promote the concept of recycling throughout the country through awareness campaign to be focused on all Lebanese schools.

Project main stakeholders: Ministry of Environment, private sector, academic institutions,…

Project outcome:
1. Reduce solid waste stream.
2. Energy conservation and GHG reduction.
3. Establish partnership between stakeholders.
4. Promote public awareness on recycling.

Beneficiaries: MOE, academic institutions, public, NGOs

Duration: 1 year

Estimated budget: $60,000 – $80,000

Financing: International donors, private sector, academic institutions

Concept Proposal Number 4

Project Title: Pilot Project on Deployment of Energy- efficient Lighting

Objectives: Energy conservation and electricity consumption reduction

Baseline: Project on Capacity Building for the Adoption and Application of Energy Standards in Buildings

Project description: To conduct a pilot project for promoting the widespread use of energy efficient lamps in houses and municipal establishments.

Project main stakeholders: Ministry of Environment, Ministry of Interior, private sector.

Project outcome:
1. Energy conservation and GHG reduction.
2. Establish partnership between stakeholders.
3. Increase public awareness.
4. Reduce expenditure of Municipalities.

Beneficiaries: MoE, MoI, public

Duration: 1 year

Estimated budget: $80,000 – $100,000

Financing: International donors, MoI, private sector.

Concept Proposal Number 5

Project Title: Electric Power Plant Energy Efficiency Improvement

Objectives:
- **To improve the efficiency of electricity generation at the power plants.**
- **To reduce fuel import**
- **To reduce environmental emissions and GHGs.**

Baseline: IPP-energy-EU, Energy Efficiency Project-UNDP.

Project description: To introduce necessary technological innovations to increase the efficiency of electricity generation. Examples include, condition monitoring equipment, boiler improvement, etc.

Project main stakeholders: EDL, Ministry of Energy and Water, CDR, MOE

Project outcome: less fuel consumption and less GHG and pollution emissions per unit of electric energy generated

Beneficiaries: EDL, the society as a whole

Duration: one year

Estimated budget: $400, 000 – $600,000

Financing: EDL in kind, International donor agencies.

Concept Proposal Number 6

Project Title: Wind Energy Atlas

Objectives:
- **To collect data about wind resources in Lebanon**
- **To establish wind atlas**

Baseline: IPP-energy-EU, Energy Efficiency Project-UNDP.

Project description: To establish wind monitoring stations in selected location in Locations in Lebanon in order to develop wind atlas in Lebanon useful for estimating the contribution of wind energy to total energy needs.

Project main stakeholders: EDL, Ministry of Energy and Water, CDR, MOE

Project outcome: Potential of wind energy resources

Beneficiaries: EDL, private sector

Duration: *one year*

Estimated budget: $200, 000

Financing: International donor agencies, private sector

Concept Proposal Number 7

Project Title: Assessment of Fuel Switching to Natural Gas

Objectives:
- **To improve the efficiency of electricity generation in the industrial power plants.**
- **To reduce fuel cost**
- **To reduce environmental emissions and GHGs.**

Baseline: *IPP-energy-EU, Energy Efficiency Project-UNDP.*

Project description: To undertake a feasibility study to examine the effects of switching to natural gas in the Lebanese industry when this gas becomes available.

Project main stakeholders: Ministry of Industry, ALIND, Ministry of Energy and Water, CDR, MOE.

Project outcome: Quantitative assessment of natural gas needs, identification of beneficiary industries, technology upgrade needs for retrofitting purposes, financial benefit assessment.

Beneficiaries: Ministry of Industry, ALIND, private industries.

Duration: *one year*

Estimated budget: $150, 000

Financing: International donor agencies, private sector

Concept Proposal Number 8

Project Title: Dissemination of Solar Water Heaters (SWH)

Objectives:
- **To promote clean technologies.**
- **To reduce electricity consumption and fuel import.**
- **To reduce consumer's electric energy bill and enhance purchasing power**
- **To reduce environmental emissions and GHGs.**

Baseline: *IPP-energy-EU, Energy Efficiency Project-UNDP.*

Project description: To select a model village and replace all electric water heaters by solar ones. Ensure capacity building in system installation, operation and manufacturing. Develop a system for long term data collection and analysis.

Project main stakeholders: Ministry of Industry, ALIND, Ministry of Energy and Water, CDR, MOE, Private sector.

Project outcome:
- **Demonstration of solar water heaters economic and environmental benefits**
- **Database for data collection and analysis**
- **Capacity building through training**

Beneficiaries: Ministry of Industry, ALIND, private industries, EDL and society at large.

Duration: *one year*

Estimated budget: $100,000- $150,000

Financing: International donor agencies, private sector