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Country Report Lebanon

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<th>Full Form</th>
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<tr>
<td>AFD</td>
<td>Agence Francaise de Development</td>
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<td>ALMEE</td>
<td>Agence Libanaise pour la Maîtrise de L'Energie et de L'Environnement</td>
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<td>AUL</td>
<td>Arts,Science &amp; Technology University in Lebanon</td>
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<td>BRT</td>
<td>Bus Rapid Transit</td>
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<td>CBL</td>
<td>Central Bank of Lebanon</td>
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<td>CCGT</td>
<td>Combined Cycle Gas Turbine</td>
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<td>CEDRO</td>
<td>Community Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon</td>
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<td>CDM</td>
<td>Clean Development Mechanism</td>
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<td>CER</td>
<td>Certified Emission Reduction</td>
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<td>CFL</td>
<td>Compact Fluorescent Lamp</td>
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<td>CNG</td>
<td>Compressed Natural Gas</td>
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<td>CSP</td>
<td>Concentrated Solar Power</td>
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<tr>
<td>CTF</td>
<td>Clean Technology Fund</td>
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<td>DANIDA</td>
<td>Danish International Development Agency</td>
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<td>DSM</td>
<td>Demand Side Management</td>
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<td>DNA</td>
<td>Designated National Authority</td>
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<td>EBPM</td>
<td>Evidence Based Policy Making</td>
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<td>EDL</td>
<td>Electricity of Lebanon, Public Establishment</td>
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<td>EE</td>
<td>Energy Efficiency</td>
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<td>EHV</td>
<td>Extra high voltage</td>
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<td>EIA</td>
<td>Energy Information Agency</td>
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<td>EPC</td>
<td>Energy Performance Contract</td>
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<td>ESCO</td>
<td>Energy Service Company</td>
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<td>EU</td>
<td>European Union</td>
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<td>g</td>
<td>gram</td>
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<td>GEF</td>
<td>Global Environment Fund</td>
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<td>GHG</td>
<td>Green House Gas</td>
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<td>GJ</td>
<td>Giga Joule</td>
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<td>GWh</td>
<td>Giga Watt hours</td>
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<td>HV</td>
<td>High Voltage</td>
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<td>IBRD</td>
<td>International Bank for Reconstruction and Development (Worldbank)</td>
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<td>IDA</td>
<td>International Development Agency</td>
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<td>IEA</td>
<td>International Energy Agency</td>
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<td>IISD</td>
<td>International Institute for Sustainable Development</td>
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<td>IPP</td>
<td>Independent Power Producer</td>
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<td>IRI</td>
<td>Industrial Research Institute</td>
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<td>JICA</td>
<td>Japanese International Cooperation Agency</td>
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<td>kWh</td>
<td>kilo Watt hours</td>
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<td>LCEC</td>
<td>Lebanese Center for Energy Conservation</td>
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<td>LEED</td>
<td>Leadership in Environmental and Energy Design</td>
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<td>LIBNOR</td>
<td>Lebanese Norms Institute</td>
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<td>LNG</td>
<td>Liquefied Natural Gas</td>
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<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
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<td>LAU</td>
<td>Lebanese American University</td>
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<td>LRT</td>
<td>Light Rail Transit</td>
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<td>LSES</td>
<td>Lebanese Solar Energy Society</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>LV</td>
<td>Low Voltage</td>
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<td>MED-EMIP</td>
<td>Euro-Mediterranean Energy Market Integration Project</td>
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<td>MED-ENEC</td>
<td>Euro-Med Project on Energy Efficiency in the Construction Sector</td>
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<td>MEW</td>
<td>Ministry of Energy and Water</td>
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<td>MENA</td>
<td>Middle East and North Africa</td>
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<tr>
<td>MMBTU</td>
<td>Million British Thermal Units</td>
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<td>MOET</td>
<td>Ministry of Economy and Trade</td>
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<tr>
<td>MV</td>
<td>Medium Voltage</td>
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<td>MW</td>
<td>Megawatt</td>
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<td>NEEREF</td>
<td>National Energy Efficiency and Renewable Energy Fund</td>
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<td>NET PV</td>
<td>Net Present Value</td>
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<td>NGO</td>
<td>Non-Governmental Organisation</td>
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<td>ONL</td>
<td>National Litani Authority</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Cooperation and Development</td>
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<td>PIN</td>
<td>Project Idea Note</td>
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<tr>
<td>PPA</td>
<td>Power Purchase Agreement</td>
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<tr>
<td>PSA</td>
<td>Production Sharing Agreement</td>
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<td>RCREEE</td>
<td>Regional Centre for Renewable Energy and Energy Efficiency</td>
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<td>RE</td>
<td>Renewable Energy</td>
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<td>SWH</td>
<td>Solar Water Heater</td>
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<td>TBE</td>
<td>Theory Based Evaluation</td>
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<tr>
<td>toe</td>
<td>tons of oil equivalent</td>
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<tr>
<td>UNDP</td>
<td>United Nation Development Program</td>
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<td>USAID</td>
<td>United States Agency for International Development</td>
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1. **Project Synopsis**

The “Regional Centre for Renewable Energies and Energy Efficiency (RCREEE)” was formally established June 25, 2008 through the signing of the “Cairo Declaration of Intentions on Establishment of a Regional Centre for Renewable Energies and Energy Efficiency (RCREEE)” by representatives of its member states: Algeria, Egypt, Jordan, Lebanon, Libya, Morocco, Palestine, Syria, Tunisia and Yemen. The overall objective of RCREEE is, through its interventions, to achieve:

a) rapid implementation of cost-effective policies and instruments for the increased penetration of renewable energy (RE) and energy efficiency (EE) technologies and practices in member countries; and

b) increased market shares of companies and plants located in MENA-countries on the markets for technologies and services related to RE and EE in the MENA and EU regions.

For the first five years of operation, RCREEE receives financial support from the Governments of Egypt, Germany and Denmark. The European Commission (EC) supports RCREEE through two regional programs: “MED-EMIP” and Phase II of “MED-ENEC”. Member countries will contribute financially by increasingly co-financing the costs of the participation of national officials in RCREEE seminars and workshops.

The present project is the first project support to RCREEE from the Danish Government. It is part of RCREEE’s overall effort of providing member state administrations with better information and new planning tools and processes. It supports RCREEE in the development of a website which offers access to a complete subject-ordered list of member state RE&EE laws and regulations, reviewed policy documents, selected background and evaluation reports deemed to represent state-of-the-art high quality analytical work as well as discussion blogs on topics deemed to be of general interest for RCREEE governments. The project has four specific objectives:

1. Policy planners and policy decision makers in RCREEE member states provided with information on the economic, technical and environmental impacts of the policies and instruments used for the promotion of RE&EE in RCREEE countries.

2. RE&EE policy planners and consultants from the RCREEE member states strengthened in the application of methodologies for the execution of "evidence based policies", "theory based evaluation", "economic analysis of policy instruments" and the "integration of climate policy benefits in national energy planning".

3. Policy planners and policy makers in RCREEE member states provided with recommendations for how the policy making process in their countries can be adjusted to improve the information basis for decision taking by policy makers.

4. Policy planners and policy makers in RCREEE member states obtain an overview of how their EE&RE technology policies compare with the efforts of other countries in the region.

The project objectives will be achieved through the following activities to be performed in each of the ten RCREEE member countries.

- Data collection
- Five day country mission for information gathering and discussions with national stakeholders
- A half-day seminar on methodology at the end of the country mission
- A country report on EE and RE policy development
- A three day workshop on policy development for EE and RE
In parallel and supporting the above activities, the project will gather the pertinent information on EE and RE in each member country and make them available through the RCREEE website in an organised manner. Likewise the methodology on evidence based policy development and theory based policy evaluation will be discussed and extended in each country and their relevance and applicability will be illustrated through case studies. On the basis of the country reports, a regional report will be prepared, which will allow policy makers and decision makers in all RCREEE member countries to see the status of their EE and RE policies in a comprehensive regional context.

The activities will be carried out by the project core team of four international experts assisted in each country by a national specialist. The three day workshop will be held by the national specialists at the end of the project (December 2009) using the material and the methodological case studies developed throughout the project.

Lebanon was visited by the project team from 5 to 8 August 2009.

The following sections in this report reflect the impressions gained by the project team through the discussions held during the course of the mission and all the information that has been available to the team. The main purpose of this country paper is to stimulate new thought on EE and RE policy development in Lebanon. We give no emphasis to a comprehensive description of the Lebanese energy sector, but Chapter 2 summarises the main characteristics, further details are given in Annex 7. Chapters 3 and 4 compare Lebanese and international practice in the promotion of Energy Efficiency and Renewable Energies respectively. Chapter 5 gives two practical case studies in the Lebanese context for evidence based policy making and theory based evaluation, one each for EE and RE policies. Chapter 6 finally offers some thought about institutional reform.
2. Summary of Energy Situation in Lebanon

Lebanon is importing more than 95% of the energy consumed. Total primary energy supply of about 5 Mtoe is dominated by fossil fuels; crude oil products contributing about 90 percent. Lebanon also imports small amounts of electricity. Energy imports put a high economic burden on Lebanon. The costs of oil imports are in the range of US$ 1 bn. annually, with Electricité du Liban (EDL) paying about half of this amount. The GDP of Lebanon was US$ 24.6 bn in 2007.

Electricité du Liban (EDL) is the state-owned Lebanese power utility. Only some concessions for energy production were given to smaller companies. There is no privatisation or liberalisation in Lebanon, although the World Bank recommended respective steps.

Electricity consumption was 10 TWh in 2006 with imports contributing about 10 percent. Generation capacity grew moderately in the past decade: from 1999 to 2006 about 13 percent of new capacity was added.

On governmental level, the Ministry of Energy and Water (MEW) is the sole responsible ministry for energy matters. In cooperation with different international organisations the “Lebanese Center for Energy Conservation Project (LCECP)” was conducted, aiming to establish a body to foster energy efficiency. However, currently there is no energy efficiency legislation in force. Lebanon already introduced solar water heaters and compact fluorescent light bulbs (CFLs) on the consumer level.

Lebanon does not have a general strategy on its future energy system. Such a strategy would be valuable to make the link between sustainable energy supply and general economic development.
3. Comparison of Lebanese Practice with International Practice in Energy Efficiency

This section attempts to compare the present status of energy efficiency with international practice. Public policy intervenes to correct market failures, in the case of energy efficiency the most common failures are: distorted energy prices, external costs, poor access to technical information, agent-principal problems, budgetary constraints and excessive risk aversion, poor skills of investment appraisal. Policy instruments are intended to correct or compensate for these distortions. The most common among these instruments can be categorised as:

Corrective Measures
- Price Reform
- Institutional and legal reform
- Labelling
- Dissemination of information
- Research, development and demonstration
- Financial incentives
- Support for energy service companies (ESCOs)

Compensating Measures
- Standards
- Mandatory measures (e.g. compulsory audits and management obligations)
- Corporate agreements
- Efficiency obligations
- Transport and spatial planning

Normally these instruments should be combined within an overall strategy that sets out objectives and targets and defines the combinations of instruments that are expected to achieve the targets.

The following discussion reflects this taxonomy.

3.1 Strategy

Strategy sets out objectives and targets and defines the combinations of policy instruments that are expected to achieve the targets.

There is no official strategy for energy efficiency in the Lebanon. The responsible Ministry is the Ministry of Energy and Water and there is within the Ministry a specialised agency for energy efficiency known as the Lebanese Centre for Energy Conservation (LCEC). LCEC, with the sustained support of UNDP, has engaged in many activities in energy efficiency that are described later in this report.

With the intention to build upon the results of all these activities and the accumulated data and experience, from different ongoing energy projects, the Ministry of Finance in collaboration with the Ministry of Energy and Water has initiated a project through UNDP to develop a Sustainable Energy Strategy (SES) for the Lebanon. This project is largely funded by the Ministry of Finance ($500,000), but with a small participation ($100,000) of the UNDP. The intention is to help develop, promote and adopt the sustainable energy strategy. The project aims to use the data and information collected from all ongoing EE & RE projects to ultimately assist the government in performing energy studies and strategies. The project also aims to stimulate an enabling environment of financial mechanisms and legisla-
tive reforms to encourage a market transformation towards sustainable energy use.

SES is claimed to be built on evidence based analysis covering technical, economic and financial feasibility. The participation of the Ministry of Finance is important because of the crucial role of financial incentives in promoting sustainable development and the obvious implications for public finances.

CEDRO III also plays a part in setting the national energy strategy. Specifically, it assists in setting up the Lebanese Renewable Energy Strategy by studying the various renewable energy issues, specifically:

- Wind atlas where the app. Potential of wind in Lebanon will be known (company notified and contract under way)
- Bioenergy assessment for Lebanon (tender document posted online)
- Hydro power assessment/potential for Lebanon
- Solar power potential

### 3.2 Legal Reform

The proper implementation of energy efficiency requires an energy efficiency law that justifies the purpose of the activity, establishes a clear focus in government, assigns the responsibilities of actors, makes provision for an agency and specific instruments.

The following list contains the most frequently occurring provisions in such laws:

- Recognising energy efficiency as an appropriate subject of legislation and regulation
- Identifying and communicating in a policy document or national plan the principles of energy efficiency policy
- Identifying through technical analysis the potential for saving and prioritizing the sectors with highest potential
- Defining policy interventions to promote energy efficiency e.g. fiscal and financial incentives, tradable certificates, and regulations
- Drafting of legislation to implement policy interventions
- Setting penalties for default
- Creating institutional structures to promote energy efficiency
- Assigning staff in proper numbers and with proper qualifications to the institutions and ensuring adequate finance for the institutions
- Drafting national programmes for short and long-term management of energy efficiency
- Assigning responsibility to promote energy efficiency at national, regional and municipal levels
- Monitoring and evaluating progress

There is no Energy Efficiency Law in Lebanon at present. The LCEC has developed and is promoting a Law on Energy Conservation. This is at present being reviewed within the Ministry of Energy and Water. The time for review, approval and for its adoption by Parliament is uncertain, but will be at least two years and maybe five. The Law needs to pass through the Council of Ministers then it is submitted to Parliament, where it will be referred to the Committee of Public Works before a vote of the General Assembly.

The Law would establish an autonomous Lebanese centre for Energy Conservation and would specify its functions, duties and powers. It would require mandatory audits for establishments above a certain
threshold and would set out procedures to apply mandatory standards for energy use in industry. There appears to be some duplication with the SES.

3.3 Price Reform

It is well established that energy demand is price sensitive, especially demand for electricity. The most reliable results come from industrialised countries. Price reform will save large quantities of energy, especially in the long-run and can make a substantial reduction in GHG emissions from countries with distorted prices. Subsidies put a large strain on public accounts and weaken foreign trade balances. They also tend to devastate the state-owned enterprises that are normally a victim of the practice.

There is no significant energy production in the Lebanon and fuels are imported at international prices. They are not subsidised in any way. The power system though is heavily subsidised; tariffs have remained unchanged for the last fourteen years and are now well below the costs of production. The difference comes from the state budget.

The average recovery of EDL at the moment, from sales that are billed and paid, is about $87/MWh. But much electricity used is not paid for (about 28%) and there are rather high levels of technical losses (about 12% in the combined transmission and distribution systems). The average revenue per unit of electricity generated was about $53 / MWh; this compares to an average production cost of EDL in 2008 of $180 / MWh, more than three times the average revenue. The loss has decreased somewhat in 2009, but it is still high and the reprieve will be temporary. The marginal cost, depending upon assumptions about fuel choice, technology and needs for network expansion are probably $150 /MWh or higher.

The domestic tariffs are especially heavily subsidised; consumers up to 100 kWh / month pay 35 Lebanese Pounds (LP) per kWh, which equals about $23 / MWh; consumers from 100 to 300 kWh / month pay 55 LP/kWh ($38 / MWh) for the electricity in that block; consumers from 300 to 400 kWh / month pay 80 LP / kWh ($53 / MWh). Subsequent blocks are more or less at or above cost. Industry pays 80 LP / kWh at night; 112 LP / kWh during the day and 320 LP / kWh at peak. It is subsidised in comparison to marginal cost, but far less than are domestic consumers.

Much of industry is not connected to EDL because the system is too unreliable; these factories use their own diesel generators. Factories that are grid connected use diesel generators to cover grid failures, which are frequent, and to generate during peak times to avoid peaking charges. Many domestic consumers are also connected to private diesel generators; these are often community generators owned by private companies that sell power (illegally) to cover grid outages.

The consequences of this very poor and unreliable, but heavily subsidised, power system are several. One is that EDL is bankrupt and has been for many years; it is not in a condition to launch any serious DSM programmes. Another consequence is that price signals to consumers are highly distorted. At times when consumers receive power from the grid, most domestic consumers will see prices well below marginal costs. If they own private generators than their marginal costs will be determined by the cost of diesel oil to fuel the generators and this could be $200 - 250/ MWh or more depending upon international prices. So the marginal cost to the consumer is very variable. Poorer consumers on the whole are less likely to have standby connections. Standby connections are often sold by the MVA connection and are not metered. Then again private consumers will face very low marginal costs. The consumers who do not pay at all also are unlikely to be moved to energy efficient choices.
Electricity sector price reform is an essential part of any strategy to bring EDL to a proper technical and financial condition. It is also desirable to support efficient energy use within the domestic sector.

3.4 An Agency

Many countries have found it useful to establish a specialised institution to prepare initiatives, draft regulations, monitor progress, ensure compliance, administer funds and perform other administrative activities. It will not necessarily be the only institution with powers in the area. If fiscal incentives are adopted then these will be managed through the office responsible for taxation, but there will still be a need to confirm the technical acceptability of the investment. Compliance with standards for equipment and boilers will normally be performed by special corps of inspectors already engaged in standards work. The regulator would normally enforce any specific obligation on electricity networks.

Despite the need to involve existing institutions, it is often considered useful to create a specialised agency. This agency would typically have the following responsibilities.

- Developing and disseminating targeted information to specific categories of users
- Organising training; liaison with universities and professional bodies
- Developing energy efficiency standards
- Conduct of surveys; analysis of data and maintenance of database
- Conducting or managing programmes of certification and labelling
- Liaising with other state institutions (e.g. Taxation offices and inspectorates)
- Administering energy efficiency funds
- Specifying mandatory audits; certifying and/or licensing energy auditors
- Designing short-term and long-term energy efficiency programmes
- Monitoring, evaluating and reporting on the implementation state activities and private initiatives
- Designing and proposing new interventions as opportunities are identified

Legislation would probably be needed to establish such an agency and to specify its duties.

The Lebanese Centre for Energy Conservation began life as the Lebanese Centre for Energy Conservation (LCECP) and this has been the main actor in energy efficiency in Lebanon for the past fifteen years. This UNDP financed project was originally designed in 1992, as a part of the emergency rehabilitation and reconstruction plan for Lebanon in parallel with the rehabilitation of the country’s electricity sector and with the intent to moderate the expected increase in electricity demand. At the time there was virtually no experience of energy efficiency in the country and the project set out to provide certain basic infrastructure for mounting an energy efficiency campaign. In particular it aimed to:

- Establish the Lebanese Centre for Energy Conservation
- Provide the engineering and energy marketing services needed to promote energy efficiency as a commercial reality
- Assist the GoL in strengthening its capacities to formulate policy and to communicate with users

Among the significant achievements of the project were activities to;

- Launch marketing campaigns for solar water heating and for energy audits
- Assess potential financial mechanisms and get some going
- Start work on identified target appliances for standards, including solar water heating
- Conduct training on energy audits; audit installations and begin work on selected sites
- Identify potential ESCOs in Lebanon and create a link with regional and international ESCOs
- Supervise the installation of 500 solar water heaters
- Initiate preparation of an Energy Efficiency Law
- Supervising and funding more than 120 energy audit studies in Lebanon
- Marketing and awareness raising on energy efficiency and energy conservation

The project started in February 2002 and is expected to end on 31st December, 2009. It is implemented by MEW and funded by a grant from GEF of $3.4 million, plus contributions from MOEW of $0.6 million and a small participation from the private sector of $15,000.

The project has an attractive website and publishes a quarterly newsletter. It has audited some 125 clients and claims energy efficiency gains of 15-20% from energy management activities instituted at several sites as a consequence of the audit. It has recommended adoption of the EU labelling scheme for white goods and has engaged in some promotional work in schools and with the general public, experts and parliamentarians. It has conducted several promotional campaigns for specific energy saving activities, most recently the National Campaign for Energy Efficiency Lamps, launched in November, 2008. The newsletters show a strong capacity building and promotional work with frequent workshops and outreach activities.

In 2007 the work of the LCECP was complemented by the CEDRO project – the Community Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon (South, Bekaa and Akkar). The objective of this project is to support recovery activities through the implementation of an energy efficiency and renewable energy programme. To achieve this, the project will install energy efficiency and renewable energy equipment in selected public buildings and facilities (schools, hospitals, municipal street lighting, etc.) in three target areas (South, Bekaa and Akkar) that were highly affected by the July 2006 conflict. The project will monitor the impacts of the installed equipment on the beneficiaries’ energy bills and will create a basis of evidence for future national sustainable energy strategies.

The project is funded through a $2.7 million grant from the Lebanese Recovery fund made available by the Government of Spain. It is directly executed and implemented by UNDP through a project management unit working with MOEW and the donor. It began in October 2007 and was scheduled to end in June 2009. The types of projects envisaged include individual and collective solar systems, energy efficient lamps, PV street lighting, energy audit implementation and roof insulation.

CEDRO I was succeeded by CEDRO II with somewhat similar intentions to support recovery, reconstruction and reform activities through the implementation of end-use energy efficiency and renewable energy projects, but also with a broader goal to establish an enabling environment for the conversion of all public sector buildings and facilities into energy efficient modalities and to extend the basis of evidence for policy. The project is funded by the Government of Spain with a grant of $3.5 million and is again directly executed and implemented by UNDP; it is intended to run from January 2009 to January 2011.

In 2009, the LCECP was converted from a UNDP project to a national agency. The operation of the Centre is not affected, and UNDP will continue funding for the next 5 years, but the status of the Centre within the country will be somewhat strengthened.

The LCECP is also promoting a new law to enhance the independence of the Centre. The law would establish the Lebanese Centre for Energy Conservation (LCEC) as an independent registered body with the Ministry of Interior, but still linked to the Ministry of Energy and Water. The Minister would draw up strategy, monitor its implementation and provide a budget, but the Centre would otherwise act
In fact this change of status would be achieved also by the proposed new Law on Energy Conservation; the reason for two laws is presumably that the second law concerning only the status of the centre may be passed more easily.

### 3.5 Standards and/or Labels

The obligation on manufacturers and importers of equipment to label goods or to meet specified standards is a policy measure introduced to overcome the market failure caused by asymmetric information. Potential users of equipment, faced with a choice of designs, may not have the skills and information to understand the consequences of their choice. They may be tempted to choose low-cost equipment with high energy consumption in preference to higher price options that perform better. Manufacturers may not have an incentive to provide this information if they think that their comparative market advantages do not include greater efficiency than competitors. Labelling and standards are not exclusive; goods can be obliged to meet a certain minimum standards and then labelled according to their performance when it exceeds the standard. Labelling and standards both require testing facilities and protocols; both require rigorous and competent enforcement.

The LCECP project proposed to investigate standards for:

- Solar water heaters
- Compact fluorescent lamps
- Refrigerators
- Split room air conditioners
- Gas and electric water heaters

LCECP has proposed label prototypes for refrigerators, split room air conditioners and the compact fluorescent lamp. The proposed refrigerator label is in both English & Arabic and is based on the Tunisian categories and label, which in turn followed EU practice. The design of the proposed label is under discussion with focus groups. The standards governing the three categories of appliance have been accepted by LIBNOR and were implemented in November, 2007. They are voluntary at present. There is a need to improve enforcement for the label and the standard programme if it is to be made mandatory. In parallel LCECP will launch a consumer information programme to educate consumers on both the new standards and how to read and use the new label.

LCECP is also working with LIBNOR on a scheme of minimum efficiency performance standards for each size or class of the selected appliances.

**Standards for buildings are an important special case because:**

- The rate of new building in developing countries is far higher than anywhere else in the world
- Buildings are large consumers of energy
- Buildings last for decades and will determine energy use for a very long time
- Large improvements in the energy efficiency of buildings can be achieved at low cost
- Developers will not normally make those improvements because of various chronic market failures
- The principal-agent dilemma is especially acute
In Lebanon, it appears that energy efficiency building codes have been developed, in part with the assistance of UNDP / GEF, but these have not been incorporated into law and practice.

The lack of energy codes and thermal building standards, institutional structure, information and public awareness, and professional expertise are the main barriers to the improvement of the poor thermal performance of buildings in the country. The UNDP / GEF project entitled “Capacity Building for the Adoption and Application of Thermal Standards for Buildings set out to remedy these matters; it took place during February 2002 – December 2007. It was implemented by the General Directorate of Urban Planning in the Ministry of Public Works and Transport working with the Order of Engineers and Architects-Beirut and the Lebanese Standards Institution.

The main purpose of the project was to develop a Thermal Standard for Buildings in Lebanon and to enable its future adoption and application through the provision of capacity building and information dissemination. Activities included:

- Development of Climatic Zoning for Buildings in Lebanon
- Development of an Energy Analysis and Economic Feasibility Study
- Development of the Thermal Standard for Buildings in Lebanon
- Development of a Technical Guide and a Software tool
- Development of a series of targeted studies including an introduction to climate and comfort in Lebanon
- Organization of a series of conferences, technical workshops and stakeholder focus groups
- Initiation of Regional coordination and synergy on energy efficient buildings

The objective to develop thermal standards for buildings in Lebanon was partially successfully. The methodology was based on modelling representative buildings and determining cost effective improvements to the building envelope. Optimal performance was determined by balancing the incremental construction cost against the savings in the cost of energy used for heating and cooling. The recommended improvement levels were tested against plausible scenarios for energy price, materials cost and inflation. The project report noted that the study was limited and that some parameters of the building envelope were not included in this study. The standard developed within the study was nevertheless adopted as a voluntary code until 2010.

In parallel a new Lebanese Building Law introduced incentives to encourage the improvement of the thermal performance of building envelopes, but these are also voluntary.

The absence of mandatory standards for energy use in buildings is regrettable because buildings are among the largest consumer of energy in Lebanon. The economic growth and recovery has engendered a massive construction effort and all these buildings have been designed and built without any regulation governing their energy use. Despite the relatively mild winters and summers that characterize Lebanon, heating remains essential in the winter (November/March) and cooling in the summer (June/September).

Several institutions contribute to governance of energy use in buildings. The Lebanese Directorate General of Urban Planning is responsible for the advancement of building laws. Municipalities at the decentralized level are important in ensuring compliance. MEW has a role to reform tariffs and ensure payment, which indirectly contribute to the successful implementation of the thermal buildings standard. The Lebanese Norms Institute (LIBNOR) is the national standards body; although standards that it issues are voluntary unless endorsed by the government. Municipalities have independent budgets and as noted are responsible for verification of standards in general during the construction of new...
buildings or through implementation of new rules for old existing buildings. The Beirut Municipality, in particular, has a larger role to play, since it issues building permits independently within Beirut for limited residential type buildings and has a large professional staff.

3.6 Financial Incentives

Financial incentives can be separated into economic and fiscal incentives. Economic incentives are aimed at encouraging investment in energy efficient equipment and processes by reducing the investment cost directly and fiscal incentives are those actions that reduce the cost indirectly through the taxation system. Economic incentives can be further divided into investment subsidies and concessional finance. Investment subsidies change the perceived cost of an investment and concessional finance changes the financing conditions. Fiscal incentives differ from other financial incentives in several ways. They do not need to be funded directly; they are funded indirectly in that they represent a loss of revenue to the state budget. Generally they are available to all who qualify according to the terms of the exemption; there is no application and award process. For this reason they are sometimes preferred as being less susceptible to corruption and to political manipulation. They can be managed through the normal tax compliance regime. In middle income countries this approach is generally only practical with companies.

A last instrument that might be included under this heading is feed-in tariffs for cogeneration. If the feed-in tariff is above the opportunity cost of electricity then the instrument does really constitute an incentive. The incentive is funded by other consumers of electricity unless a special compensation is paid from the state budget to the network. If the feed-in tariff is above the marginal cost of electricity at subsidised fuel prices, but below the opportunity cost then it is simply a regulation to correct the monopoly purchasing power of the network and the distorted fuel prices.

There does not appear to be any specific fund for energy efficiency in Lebanon, but there have been some interesting initiatives of the Central Bank of Lebanon. The Central Bank requires every commercial bank to deposit funds with it as a reserve. As part of a process of monetary easing it has permitted commercial banks to use a part of these funds at a zero percent interest rate for certain specified purposes, which include environmental beneficial practices. One scheme, based on this, is the zero interest loans for solar water heating described later.

LCEC is working with the Central Bank of Lebanon (CBL) to develop an Energy Efficiency Fund to be known as the National Energy Efficiency and Renewable Energy Account (NEEREA) based in the same principle. It may be augmented by a line of credit from the IDF. The idea is that the Fund would be administered by the CBL with LCEC acting as a technical adviser. The size of the Fund is presently envisaged as around $10 million per year. Any beneficiary would be able to apply to the Fund for loans under specified conditions at any commercial bank. The conditions for a loan would be that the investment is first sanctioned by an audit from an LCEC qualified firm. Seven such firms have been qualified by LCEC to date and more are in the process. The advantage for the commercial banks is that they can earn administration fees on the loans.

Such an initiative would require no legal innovation; it can be a simple decision of the governor of the CBL.

There is no feed-in tariff for cogeneration.
3.7 Obligations

Another approach, which may be combined with incentives, is to oblige companies to undertake energy efficiency by mandatory measures. These can be multiple and include obligations to:

- To carry out audits at regular intervals
- To report to central government database and possibly to communicate audit results to the public
- To report energy consumption, saving measures and implemented measures
- To propose action plans to implement the energy savings measures identified in audits
- To carry out certain specified measures
- To appoint an energy manager
- Mandatory certification of auditors
- Mandatory comparison of operation and investment to reference values (norms, benchmarking)

Some, or all, of these requirements may be confined to large users and made conditional on crossing a defined threshold of energy use.

Obligations can be mandatory or voluntary. Two main sets of voluntary agreements have been introduced. The first set comprises agreements between government and representative bodies of appliance manufacturers to reach specified improvements in the performance of appliances; the approach has also been extended to vehicles. The second set comprises agreements with individual industries to improve their own on-site energy performance. Industry can have various motivations to participate in these agreements. Appliance manufacturers may expect to persuade government to supplement their efforts with instruments aimed at stimulating purchases by consumers. It may in some instances be a mechanism to forestall regulation. This latter reason may also encourage participation in agreements to reduce energy use in industrial processes. Such agreements, although voluntary, may also be a condition for financial incentives.

No such obligation is envisaged at present. EDL is a partner in a project that LCEC has developed for replacing 3 million incandescent lamps around the country with CFLs. This will be submitted as a CDM project and the PIN has been registered with the DNA of Lebanon in April 2009. The idea is to divide the country into six regions and to start with an initial campaign of 500,000 in Beirut. Private investors are sort to provide the finance. It is proposed that the Ministry will own the carbon credits and they will be used first to reapy the investor and then as part of the finance for the LCEC.

This is an interesting project and it has advantages for EDL, because it reduces demand growth and therefore the investment burden of meeting demand, but it does not constitute any sort of formal obligation on EDL.

In liberalised markets an alternative to promoting energy efficiency through state financial incentives and funds is to place an obligations placed on suppliers. In this scheme a supplier or distribution network manager scheme is placed under an obligation to demonstrate programs that save specified amounts of energy related to their total supply volume. The supplier or network operator then builds the costs into his cost-base; he then has the usual interest of a commercial company in keeping his cost-base as small as possible. The requirement is enforced by the regulator; failure to comply may be penalized in proportion to the deficit between the target savings for the supplier and the amount achieved. Savings do not have to be made within the supplier's own area; they can be in fuel oil, coal or transport fuels. Such schemes can be complemented by "white certificates". In this arrangement, suppliers are obliged to demonstrate they either accomplished energy savings directly or have bought...
No such voluntary obligations exist in the Lebanon.

### 3.8 Audits and the Promotion of ESCOs

The original concept of an Energy Service Companies or ESCO is that an entity other than the energy supplier should identify, design, finance, supervise and commission projects for a client, to be compensated by a share of the energy savings achieved over a defined period. The partition of savings is determined by a special contract known as an energy performance contract (EPC). Actual practice varies widely; some ESCOs will finance the project, others will organise finance. Implementation is not easy and there are relatively few successful examples. The name ESCO is sometimes also given to companies that just provide consulting services, but do not enter into an EPC. It is important to be clear what is meant, as the latter is a much easier exercise than the former.

The Lebanese Centre for Energy Conservation and Planning was originally intended to remove barriers to the establishment of ESCOs. It has made vigorous efforts to work with the private sector to develop energy management expertise and has had some notable successes, but it does not seem to have created a self-sustaining market for ESCO activity. Banks generally lend to companies on the strength of their balance sheet, not on a project basis and they often have better connections with companies than do the ESCOs.

LCECP has been very successful in stimulating interest among private companies in the energy management business and in promoting high standards of work through its prequalification scheme. Energy audits are considered by LCECP as a main component of their strategy. The energy consumption in the industrial, commercial and governmental sectors is high and there is strong potential for energy. The technical capacity in these sectors to audit, monitor and plan energy efficiency investments is limited.

Some pilot audits were done in 2002, but the bulk of audits, amounting to some 125 factories and buildings, have been done since 2005. About 20% have lead to new investment in energy efficiency. Initially LCEC funded 100% of the audit cost then subsequently reduced that contribution to 70% and eventually to 50% as the value of the audits was established in the industrial community. Under the NEEREA scheme the cost of the audit will be 100% the responsibility of the audited entity, but the costs will be eligible to be covered within the interest free loan.

LCECP has chosen to stimulate private sector action rather than to engage itself in engineering activities. It launched a recruitment scheme for consulting energy firms to conduct energy audits with partial finance from the project. In order for an energy firm to be eligible to participate in the LCECP energy audit programme, a pre-qualification questionnaire must be completed and evaluated by LCECP. LCECP both grades the application and offers advice as to how the standing of the company can be improved in future.

LCECP collaborated in a survey of energy use in industry conducted by the Association of Lebanese Industrialists (ALI). The survey covered 627 members of ALI and was implemented by a questionnaire on energy use. The survey is comprehensive; a striking result is that energy use as a percentage of production cost varied among different industrial categories from 10% to 28%. This is a very high figure; it may be due in part to the widespread use of private generation because of the poor performance of EDL. Whatever the cause it should constitute a strong incentive to seek efficient energy use.
The CEDRO project of Spain has also a budget of $9.7 million to implement energy efficiency projects in the public sector. These are 100% grants.

3.9 Transport and Spatial Planning

More than half of the global population now live in cities and according to UN Habitat, by 2030, it will be 60 percent. Cities consume enormous amounts of energy and they have great inertia; road systems and land-use decided now will influence energy use for a hundred years. In urban metropolitan areas, transport creates a third at least of total greenhouse gas emissions. Promotion of public transport options and careful design of cities is critical for reducing emissions in cities.

No such activities were identified in the Lebanon. Indeed the reconstruction of Beirut seems to be proceeding under the dynamic of a vigorous private sector untrammelled by any planning for sustainability. The Ministry of finance is working on removing custom duties on hybrid cars.

3.10 Dissemination of Information

Access to knowledge is costly and may impede an individual or company from undertaking activities in energy efficiency. It is a legitimate role of government to generate and disseminate knowledge as a public good. We interpret the term knowledge in this context very widely to include data, technical guidance, research and demonstration.

LCEC has given priority to the dissemination of information in various ways. Some of its work on standards and labels, on clarifying performance and quality of SWH has been mentioned.

LCEC has also developed a series of public awareness promotions using space in national newspapers and on television. The marketing adverts use the same characters in a series of incidents designed to promote efficiency. Adverts have been screened on CFLs, turning off appliances and on SWH. Finance for the campaigns has been obtained in large part through donations of space and time by newspapers and TV channels. The opportunity for these organisations to be seen supporting the environment in a UN framework is apparently a sufficient motivation. The SWH campaign was estimated to have cost $1.4 million in real resources, but required only a cash expenditure of $80,000 by LCEC. Significant increases in sales of SWH were detected following the advertising campaign.
4. Comparison of Lebanese Practice with International Practice in Renewable Energy

This section attempts to compare the present status of renewable energy policy in Lebanon with international practice.

Public policy intervenes to correct market failures. In the case of renewable energy, the most common failures are somewhat similar to those identified previously for energy efficiency, but with a different emphasis. Distorted energy prices, unrecognised external costs, poor access to technical information all play a part. There is however a significant difference. Many measures of energy efficiency are cost effective, but prevented by distortions of the conventional market. This is also true of some renewable options, such as solar water heating. Many renewable energy technologies are not cost-effective even if the distortions of the conventional market are removed. They are justified by the external costs that they avoid, especially the external costs of GHG emissions. This means that they must be financially subsidised to financial incentives of one sort or another are critical to renewable policy.

In addition to these general market failures there can be specific market failures for electricity generated from renewable energy that is fed into a national grid as electricity. Excessive and unjustified costs of connection to the grid, inability to connect, disputes over responsibility for payment – these can impede renewable deployment.

Policy instruments are intended to correct or compensate for these various distortions.

4.1 Targets and Strategy

Strategy sets out objectives and targets and defines the combinations of policy instruments that are expected to achieve the targets.

Lebanon initially depended upon hydroelectric generation for electricity supply and it is still a significant contribution. Lebanon enjoys rather better access to water than neighbouring countries during a rainy season extending for 80-85 days / year, mainly between October and April. Rainfall varies considerably throughout the country; the western part is wetter and there is a substantial snowfall on the Mount Lebanon massif. Use of water for power generation is compromised by the requirement for domestic water and irrigation. Irrigation frequently takes priority over hydropower.

A quarter of the hydro power resources are being used but they contribute only to a small extent to power generation. Peak hydropower generation occurs in March, which is when the electricity demand is lowest. The Litani in the Bekaa is the most important river; the biggest hydro plant in Lebanon comprising three plants on the Qaraoun Lake is managed by the Litani River Authority: the dam confines a huge 210 million m3 reservoir and the turbines have a name plate capacity of 190 MW, but operate more usually between 80 – 170 MW according to the water flow. Two other concessions, Bared and Nahr Ibrahim have an installed capacity of respectively 17 and 33 MW. All the hydropower units are between 40 and 70 years old and are in need of renovation.

The Master Plan for EDL, developed by Electricité de France with funding from the Government of France, proposes an additional 120 MW hydropower generation, mainly coming from the extension of existing installations and some new run-of-river projects.

Lebanon has a significant wind potential, especially in the North. This can be deduced from measure-
ments of tree deformation that correspond approximately to wind speeds of 7-8 m/sec. A few small wind turbines have been demonstrated in the South, Mount Lebanon and Bekaa. The largest wind turbine is a 300 kW machine installed on Mount Lebanon. The EDL Master plan foresees that 1% of the electrical power demand might come from wind in the year 2012 increasing slowly thereafter. That will represent a generation capacity of 30 MW in 2012, then 60 MW in 2018 (1.5% of the demand). The assumed capacity factor is 23%, which will limit the contribution of wind energy to 120 GWh in 2018, or only 0.7% of the total generation.

With most of the country connected to the national grid, solar photovoltaic (PV) is not economical. There are some interesting projects under CEDRO that aim to provide standby facilities for schools using pv, but these would not be grid-connected.

Lebanon has little forest cover, but it has significant other sources of biomass, such as municipal solid waste and agricultural wastes. The Bekaa valley is the main agricultural region with a wide range of crops especially potatoes, tomatoes and sugar beet. South Lebanon is a wheat growing region and the coastal zone grows mainly fruit including citrus, bananas and vegetables. Cereals are largely produced in the north of Lebanon especially in Akkar. Some of the residues from these crops are used for animal feed, but the majority is discarded. There may be some potential for energy related products, but other applications, such as composting are more likely to be cost-effective.

CEDRO is currently undertaking studies to identify the potentials of biomass, hydro and wind energy in Lebanon.

### 4.2 Legal Reform

The main legal elements in a policy to promote renewable technologies are a clear targeted strategy or road map, a specialised agency to implement public activities and a support system specifically aimed at allocating the extra costs of the technology.

At present the electricity industry operates in a legal vacuum. Electricité du Liban (EDL) is a vertically-integrated, state owned monopoly. The legal provisions partially to reform this structure were promulgated in Law 462 of 2002. This Law set out the responsibilities of the actors in the sector. The ministry was to establish policy and plans for the expansion of generating, transmission and distribution capacity. Regulation was to be performed by the Electricity Regulatory Authority, which would have technical, administrative and financial autonomy and would issue licences for all activities. The functions of EDL would be transferred to one or more joint stock companies, for subsequent privatisation.

This Law is in principle in force, but has never actually been implemented. No regulator has ever been appointed. There is therefore no institution to issue licences for new generation. This curious condition was the consequence of a shift in the prevailing attitude to reform; from 1999 to 2002 the emphasis was on privatisation; after 2002 it appears to have shifted towards public private partnerships and corporatisation, leaving the Law somewhat behind the change in consensus.

Law 462 in any case has no articles on renewable energy. If Lebanon wishes to develop renewable resources then the law will need to be amended. Various amendments to the law are proposed to make it more applicable to present Lebanese conditions; in theory this can be done relatively easily by the submission of a note to Parliament for a vote, but it is not clear whether the necessary consensus on the future form of EDL is sufficiently strong to allow this to be done. There is a strong consensus that the sector cannot continue in its present form, but less on what the future should be. There three entities in government planning for the electricity sector; the Ministry, the Higher Council for Privatisa-
tion and the Council for Development and Reconstruction. If these entities do not agree then progress will be slow and the legal basis for grid connected renewable energy may not may available soon.

Law 462 allows up to 1.5 MW of private generation; any plant greater than 10 MW requires a licence from the Regulator and between these limits, plants require a permit. Sale of electricity is in theory always illegal.

A temporary scheme of licensing needs to be introduced to bridge the gap between the present arrangements and whatever will eventually be agreed. One interim scheme would be to appoint the regulator, and authorise the Council of Ministers to licence plant while the regulator builds up capacities and procedures. There is a precedent for this from 2007. The basic requirements would then be in place to tender for wind plant. There could still be problems over the pricing formula for electricity from renewable sources. Law 462 authorises the regulator to determine prices and there is no indication as to whether the regulator will lay on the single buyer a requirement to purchase at least cost. This could prejudice wind generation. It may be necessary to amend Law 462 to allow the single buyer to agree a PPA with a generator that is simply subject to regulatory approval.

LCEC has prepared an early draft of a Law for the Promotion of Renewable Energy, but the effort is compromised by the absence of any government strategy which makes it almost impossible to propose legal form.

4.3 An Agency

A specialised institution to make research, prepare initiatives, draft regulations, monitor progress, ensure compliance, administer funds and perform other administrative activities can be useful in promoting renewable technologies.

There is no specialised agency to promote renewable energy in the Lebanon. LCEC has done much to promote solar water heating, but this is a technology that is subject to the same kind of policies as energy efficiency. It is an investment that requires support through marketing, dissemination of information, control of quality and performance and by financial incentives.

There is no agency that systematically promotes grid connected renewables.

4.4 Standards and /or Labels

Standards would be inappropriate for large developments in renewable energy. Commercial developers are well equipped to decide for themselves on efficient and effective specifications. There is a good case for standards for small appliances such as solar heaters.

Solar water heating is relatively novel in Lebanon, but has been developing very rapidly, mainly through the efforts of the private sector, but with little concern for quality and performance of the systems installed. LCEC has attempted to help regulate this development and ensure good practice. It first completed a study of the market in country and reviewed codes and standards for solar thermal systems in use in the region and internationally. On the basis of this research it worked with LIBNOR, the national standardization body in Lebanon, to develop and to diffuse these standards.

To further advance the quality of installation of Solar Water Heaters, LCEC prepared a list of the sup-
pliers and manufacturers of Solar Thermal Water Heaters in Lebanon and developed a Guarantee of Performance that users of equipment are advised to require from the supplier and/or manufacturer of the installed equipment.

A Law of 2007 emanating from the Ministry of Public Works provides incentives for new buildings to meet specified standards for thermal performance of exterior surfaces, such as roofs, walls and windows. If the contractor conforms to the specified norms then he is allowed a greater floor area on a given site.

At present contractors are advised to design with space zoned on the roof for solar water heating and ducts for carrying pipework, but this is not mandatory. A draft Decree has been prepared that will it mandatory to provide solar water heating in new apartment building using the roof space to house the collectors. This may be expected in the programme of the new government. Mandatory retrofitting of existing buildings is considered impractical because of multiple legal and technical problems.

We understand that in practice monitoring of all building regulations is very weak. The Order of Engineers approves plans and the municipalities assign permits, but monitoring of actual compliance is almost non-existent.

4.5 Financial Incentives (Capital Support)

Many financial incentives have been used in different countries to promote renewable energy. Support can either be offered to investment or to operation. Investment support for renewables is general delivered through the same type of instruments that are used to support investment in energy efficiency, e.g. capital grants, tax exemptions, soft loans and loan guarantees. In the case of grid connected renewables it is possible also to offer support to operation either by allowing the electricity to be sold at inflated tariffs or by obliging certain parties to purchase specified volumes. These instruments are to some extent exclusive and are discussed together in the next section.

Most of the practical work that has been done on renewable energy is to promote solar hot water heating. This is commercial in the Lebanon, or very close to being so. Water heating is not a very large user of energy, but solar water heating is a proven technology that can make a useful contribution.

LCEC has been active in promoting solar thermal water heaters in the Lebanese market, providing advice on technical issues, communication and marketing. The project was assigned by MOEW as the technical supervisor of the 500 solar thermal water heaters which were donated by the Government of the People's Republic of China to the Government of Lebanon. LCEC supervised the installation of these units in the south of Lebanon including the organization of training on installation. In addition, LCEC supervised the installation of 90 solar water heaters and 12 solar heating systems donated by the Swedish International Development Cooperation Agency (SIDA) and established a nonprofit organisation and facilities.

LIBNOR has recently adopted the European Solar Water Heaters standards in Lebanon and LCEC has prepared a list of the suppliers and manufacturers and a Guarantee of Performance. The user of the appliance is advised to ask for a Guarantee of Performance from the supplier to ensure the minimum required quality of the solar water heaters. Both standards and guarantees are voluntary. The Lebanese Canadian Bank has introduced a solar loan that apparently is interest free.

The standards for SWH are at present voluntary, but a proposition is now with the Council of Ministers...
to make these standards mandatory. A grant is expected from the Government of Greece to install a solar testing centre at the Industrial Research Institute to provide the technical basis to ensure regulatory compliance with mandatory standards.

LCEC is working with the Ministry of Finance to create a Fund for households to install SWH.

4.6 Feed-in Tariffs and Obligations

Grid connected renewable energy is rarely cost-effective in its own right. It must be subsidised if it is to be developed by private industry. There are two main ways of delivering the subsidy. One is by offering higher prices than those available commercially; the other is by creating a second valuable good that represents the value of the fact that the energy is generated from renewables. The second scheme is operated by issuing certificates that certify the renewable origin and then obliging an identified group (normally suppliers) to buy them. This creates a market and therefore a price.

The offer of higher tariffs may be created by tendering a concession, it being understood that the concession will be granted however the price achieved compares to market prices for electricity. This stands in continuity with traditional processes of tendering large plants to IPPs; it allows secondary criteria, such as percentage domestic content, to be added to the evaluation criteria. It has recently been adopted by Denmark for large developments. Higher tariffs made also be operated by a feed-in tariff that is made available to any generator.

Certificate based schemes define a quantity of renewable electricity to be produced and market forces identify a price that is unknown at the outset; feed-in tariffs fix a price to be paid for renewable electricity, but it is unknown what volume will be offered.

There is no formal arrangement for determining prices for power purchased from the grid, although the practice of PPAs is implicit in the arrangements for the purchase of power from the existing hydro concessions that date from many years in the past.

As noted earlier, Law 462 needs amendment to clarify the provisions for pricing electricity from renewable sources.

4.7 CDM Finance

The Clean Development Mechanism offers operating support to projects through the provision of a market for the certificates of Carbon Emission Reduction. This is a complex project cycle, but can be useful for large projects.

On May 25 2006, Lebanon ratified the Kyoto Protocol opening up the possibility of financing of renewable energy with carbon credits. The Ministry of Environment is registered as the Designated National Authority, but the administrative infrastructure required for management of the project cycle has not yet been elaborated. Most of the mitigation potential is within the energy sector and communication between the competent Ministries may be imperfect. A PIN was developed by the JBEIL electricity company for a wind plant in Byblos of 20 MW, but the proposal appears not to have proceeded further. As noted earlier, LCEC and EDL have developed a PIN for a CFL project that has been submitted by EDL to the DNA. Altogether, there are 6 reported CDM tracks that have reached the PIN level.
4.8 Information

It is a legitimate role of government to generate and disseminate knowledge as a public good. The main need in this respect is for data on the renewable resource. It makes no sense for every developer to make their own measurements of solar and wind data. The need is especially acute for wind as the extent of the resource varies locally.

At one time there was a strong meteorological monitoring system in the Lebanon, but it was mostly destroyed and the records lost during the civil war. As of November 2007, there were seven complete synoptic stations for meteorological measurement, all reporting wind speed and direction, three agrometeorological stations and 35 climatologic stations of which ten report wind speed and direction. There are also two stations run by the American University of Beirut, one by the International Centre for Agricultural Research in the Dry Areas and three by the Ecole Supérieure d'Ingénieurs de Beyrouth; all of these measure wind speed and direction. The records are mainly short-term and partial except for the AUB, which appears to have long time series for Beirut and the Bekaa. Lebanon has abundant solar resources with an average annual insolation of 1800 - 2000 kWh/m². Solar water heating is established in the country. Solar technologies for power generation are generally expensive, although peak demand for electricity in Lebanon is driven by air conditioning and therefore coincides with high levels of insolation.

No national wind atlas has been produced and only indicative estimates are available on a few sites. The complete data necessary for the proper selection, sizing and design of equipment are not generally available. The Ministry of Energy did engage a local private investor to make a wind atlas, but there was a legal dispute over the validity of the MoU governing the arrangement and the investor was never paid; there is therefore an atlas but it is not publically available.

Under CEDRO II a tender for a wind atlas is issued at two levels. The first level will adopt a 4km grid over the entire country and then a second level will look at promising sites over a 1 km grid at 25 metres and 50 metres. The atlas is expected to be available in 2010.

4.9 Industrial Policy

It is important that countries develop their own capacity to manufacture and / or assemble renewable technologies in parallel with the investment process. This can be done by targeted research, by grants to appropriate industries and by local manufacturing obligations in tendering.

There is an active private sector in the Lebanon with very good technically and financial contacts to developers abroad. There is however no apparent systematic support through industrial policy to the fostering of indigenous capacity in renewable energy manufacturing and services.
5. Case Studies

The purpose of the case studies is to demonstrate the processes of evidence-based policy making (EBPM) and theory-based evaluation (TBE). These techniques are well-known in the literature and have been widely applied, but not generally to technical areas of policy such as energy efficiency and renewable energy. There is potential for application in these areas because the methodologies provide a systematic basis for analysis and debate among stakeholders around a common and clear statement of the policy intervention that can be maintained and improved throughout the project cycle from formulation, through implementation, monitoring and evaluation.

The basic expression of this methodology is the behavioural model that underlies our understanding of the reaction of stakeholders to the policy instrument.

5.1 Case Study 1: Evaluation of Efficient Lighting under CDM

5.1.1 Background and Context

The first example that we choose in this case for illustration is the analysis of a programme by a utility to replace incandescent lamps with compact fluorescent lamps (CFLs) using private finance that will be recovered in part through the sale of certified emission reductions (CERs).

5.1.1.1 Efficient Lighting and the CDM

The Lebanese Centre for Energy Conservation (LCEC) has submitted a Project Idea Note (PIN) to the Ministry of Environment in Lebanon in its capacity as Designated National Authority (DNA) for a project to replace incandescent lamps in residential houses with compact fluorescent lamps (CFLs). The project is conceived in cooperation with Electricité de Liban (EDL). It is envisaged to replace 3 million lamps across the country in six successive campaigns of 500,000 each, starting with Beirut.

It is envisaged that the lamps will be supplied at no initial cost by private investors and that the Ministry of Energy and Water will own the carbon emissions reductions (CERs). The Ministry will transfer the money from their sale to EDL who will use it to repay the investors. The receipts from the CERs are unlikely to cover the costs of the CFLs and EDL will be obliged to supplement them with its own resources.

5.1.1.2 Scope of the Case Study

The economic and environmental consequences of such a project are actually quite difficult to assess for several reasons:

- The wide variety of usage patterns for lights, in particular the operating hours and coincidence factor,
- The dearth of information on the ownership and usage of lights,
- The multiple tariff categories in Lebanon for sale to the residential sector,
- The distortions in prices to consumers,
- The chronic load shedding by EDL which means that any saving in electricity is immediately converted into a new sale to another customer with no reduction in generation and therefore no environmental impact,
The delays between the payment for CFLs and the receipt of money from the sale of CDRs issued under the CDM,

The multiple actors for whom the assessment must be made, i.e. the user, the financier / programme manager, EDL and the nation as a whole. The debts of EDL are covered by the state-budget, therefore, in this case study's calculations of the impact on EDL it is assumed that they are identical to that for the state budget.

The case study attempts to determine whether the design of policy is robust in two particular aspects:

• Firstly it examines whether it would be more effective to target the distribution of CFLs to specific groups of consumers,
• Secondly it examines what would be the return on capital to EDL (which for practical purposes is the state budget) from funding the investment in part from its own resources

5.1.2 Evidence-Based Policy Making

The procedure that we have proposed to implement evidence-based policy making comprises the following steps.

1. Alternative forms of intervention need to be reviewed and short-listed. Evidence of the success or failure of similar instruments in developed and developing countries needs to be studied with special emphasis on the conditions that created success and failure
2. There must always be a base-case against which alternatives are screened. Alternatives should include all available instruments.
3. All the relevant potential impacts need to be identified and where possible, quantified.
4. Impacts should be assessed in consultation with the subjects of policy.
5. The cost of compliance needs to be assessed. Consideration should be given to how these costs can be minimized. It is necessary to consider who pays the compliance costs; there are generally alternatives with different implications for equity. The procedures for compliance need to be worked out as does the procedure for monitoring impacts.
6. Indicators need to be established of what is expected from the policy measures. These indicators should cover outputs, outcomes and impacts. Intermediate indicators are important in helping understand how policies work, how measures interact and how they can be improved
7. Quantitative analysis of impacts is essential. The analytical method most commonly used is economic cost-benefit analysis.
8. Cost-benefit analysis should take into account opportunity costs of energy and external environmental costs.
9. Multi-criteria analysis maybe a useful support to decision making; sensitivity analysis is one expression of this idea.

The first five steps are discussed in this section; the formulation of indicators is discussed in the section on theory-based evaluation and the last three steps are demonstrated in the section on economic cost-benefit assessment.

5.1.2.1 Alternative Forms of Intervention

The main alternatives relate to different ways of funding the purchase of the lamps and different ways of targeting consumers. In this analysis we will consider two alternatives for the funding scheme and two alternatives for targeting the distribution among the consumers in the different tariff groups.

The alternatives for finance are:
• The lamps may be bought by the private sector as apparently is envisaged by LCEC and then repaid using money from the CERs and EDL’s own resources as needed.
• The lamps are bought by EDL and made available to consumers at half price (say); EDL keeps the revenues from the sale of CERs.

The alternatives for targeting are:

• Lamps are distributed equally among consumer groups.
• Lamps are targeted to consumers in the low tariff category, by for example distributing coupons with the electricity bills to low tariff consumers.

Combinations of these factors define four alternatives, which we name as shown.

<table>
<thead>
<tr>
<th></th>
<th>Private sector purchase</th>
<th>EDL purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equally distributed among tariff groups</td>
<td>Private-untargeted</td>
<td>Public-untargeted</td>
</tr>
<tr>
<td>Targeted to low tariff users</td>
<td>Private-targeted</td>
<td>Public-targeted</td>
</tr>
</tbody>
</table>

5.1.2.2 Base Case

For the base case we assume that a certain penetration of the market by CFLs takes place without the intervention. This will give rise to free-riders on the policy and will therefore diminish its effectiveness as the consequences would be largely independent of the policy instrument. It is normal that penetration of efficient lighting will take place preferentially in high tariff groups where the cost-effectiveness is good. The free-riders will be more numerous in these groups. Before we can assess the probable proportion of free-riders we need to know the economic performance in the absence of intervention. This is done in Section 2.3.1.

5.1.2.3 Impacts

Assumptions
We consider as a characteristic investment, the replacement of a 50 W incandescent bulb with a 16 W CFL. The cost of such a CFL in Lebanon is $2.5. We further assume that the CFL operates 1000 hours per year and lasts for 3 years. With these assumptions the financial performance of the investment for the consumers in various tariff categories are as shown in the Table 1.

<table>
<thead>
<tr>
<th>Tariff category</th>
<th>$/MWh</th>
<th>Annual saving ($)</th>
<th>Payback (yrs)</th>
<th>Assumed free-riders (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100kWh/month</td>
<td>23.33</td>
<td>0.79</td>
<td>3.2</td>
<td>0%</td>
</tr>
<tr>
<td>100 - 200kWh / month</td>
<td>36.67</td>
<td>1.25</td>
<td>2.0</td>
<td>0%</td>
</tr>
<tr>
<td>200 - 300kWh / month</td>
<td>36.67</td>
<td>1.25</td>
<td>2.0</td>
<td>0%</td>
</tr>
<tr>
<td>300 - 400kWh / month</td>
<td>53.33</td>
<td>1.81</td>
<td>1.4</td>
<td>25%</td>
</tr>
<tr>
<td>400 - 500kWh / month</td>
<td>80.00</td>
<td>2.72</td>
<td>0.9</td>
<td>50%</td>
</tr>
<tr>
<td>&gt; 500kWh / month</td>
<td>133.33</td>
<td>4.53</td>
<td>0.6</td>
<td>75%</td>
</tr>
</tbody>
</table>

Many consumers would not benefit significantly from making the investment. Only consumers in the...
highest tariff categories would strongly benefit. For the consumers in the lower categories which make
the major contribution to demand, the investment either does not pay or is marginal. It is therefore a
rational decision on their part to stay with cheap and inefficient sources of light. Implicit discount rates
in the residential sector are often very high, reflecting the difficult of low income groups to obtain
credit.

On this basis we estimate the free-rider percentages as shown in the last column of Table 1. For the
low tariff categories it is unlikely that investment will occur spontaneously; for the high tariff categories
the investments are self-evident and free-riding is likely to be a big problem. Obviously real data
should be determined by consumer survey.

The calculations are distorted by the fact that low tariff customers will use lamps for fewer hours per
year than high tariff customers. Our calculations of free-riders are therefore probably conservative.

We assume payment for CERs is received 1 year after the CFL is installed. The base case value of
CERs is assumed to be $10 / tonne CO2, but sensitivity analysis is conducted on this parameter.

**Estimation**

We can now estimate the impacts on the power system. EDL will lose the revenues from the customer
that uses the CFL. The loss will depend upon the tariff category in which the customer falls. The aver-
age realisation of EDL from each kWh generated is at present 53 $/MWh. On average therefore (al-
lowing for technical losses) EDL will see extra revenue of 53.00 / 0.875 $/MWh for every MWh of elec-
tricity saved by the CFL, i.e. about $60 / MWh. This may be more or less than it loses from the cus-
tomer that installed the CFL. The financial consequences of the purchase by the customer for EDL are
shown in the Table 2.

<table>
<thead>
<tr>
<th>Table 2: Financial Consequences of CFL for EDL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tariff category</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>&lt; 100kWh/month</td>
</tr>
<tr>
<td>100 - 200kWh / month</td>
</tr>
<tr>
<td>200 - 300kWh / month</td>
</tr>
<tr>
<td>300 - 400kWh / month</td>
</tr>
<tr>
<td>400 - 500kWh / month</td>
</tr>
<tr>
<td>&gt; 500kWh / month</td>
</tr>
</tbody>
</table>

The column marked payback is notional. It shows the payback that EDL would achieve if it bought
the lamps and gave them for free. It would be cost-effective for low tariff customers, but not for high-tariff
customers. For the low tariff group there is a mutual benefit and scope for EDL and the user to share
costs to promote an investment that is advantageous to both.

We assume that EDL will continue to be obliged to shed load over the life of the CFL and therefore
these estimates will be valid over the life time of the lamp.

Table 3 shows the paybacks to the consumer and EDL if the costs of the efficient lamp are shared
equally between the two. The Table shows that this sharing of cost would produce an attractive option
for both EDL and the consumer in the case that consumers are on concessional tariffs. It follows that
EDL has a clear incentive to target consumers in these categories.
Table 3: Payback Periods if Costs are shared

<table>
<thead>
<tr>
<th>Tariff category</th>
<th>Payback to consumer (yrs)</th>
<th>Payback to EDL (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100kWh/month</td>
<td>1.6</td>
<td>1.0</td>
</tr>
<tr>
<td>100 - 200kWh / month</td>
<td>1.0</td>
<td>1.6</td>
</tr>
<tr>
<td>200 - 300kWh / month</td>
<td>1.0</td>
<td>1.6</td>
</tr>
<tr>
<td>300 - 400kWh / month</td>
<td>0.7</td>
<td>5.5</td>
</tr>
<tr>
<td>400 - 500kWh / month</td>
<td>0.5</td>
<td>none</td>
</tr>
<tr>
<td>&gt; 500kWh / month</td>
<td>0.3</td>
<td>none</td>
</tr>
</tbody>
</table>

The benefits to the state budget are identical to the benefits to EDL because the state has to pay the losses incurred by EDL. Indeed strictly, because of this, EDL is indifferent to any action it takes on its system. For the purpose of this case study we denote the EDL / state as a single joint entity.

We assume the life of the CFL is 3 years and that during this period there is comprehensive load shedding by EDL. For the sake of the analysis we assume that 50% of the avoided electricity consumption by the CFLs is sold to customers who otherwise would have used local diesel generators and 50% is sold to consumers who would otherwise have been disconnected. The GHG emissions from small diesel generators are probably comparable to the emissions from EDL at the margin and are around 800 g / kWh. The average GHG avoided per kWh of electricity saved by CFL we therefore assess at around 400 g / kWh. For our reference lamp operating for 1000 hours a year this is about 14 kg / yr / lamp. The value of the avoided emissions would be higher if it were not for the chronic load shedding on the EDL system.

At $10 / tonne for the value of a CER these emission reductions are worth about $0.14 /lamp/year; it is clear that the carbon credits will not pay for the lamp. A private investor would need a 20% return on capital, which amounts to payments of about $1.2 per year per lamp. It is easier therefore simply to see the private investor repaid $1.2 / lamp / year for three years by EDL and for EDL to receive the value of the CERs and to make up the difference from its own resources.

The welfare benefit to the community at large is partly the reduced load shedding on the system and partly the avoided generation from local diesel generators. The value of the reduced load-shedding is the cost of Energy Not Supplied (ENS) and is very hard to assess. For the sake of illustration we assume that it is the same as the cost of electricity from a diesel generator to which we attribute a notional value of $250 / MWh. The cost of ENS might be more, but this simplifies a complex analysis.

5.1.2.4 Consultation

This policy instrument could be adopted by EDL as an internal policy that benefits its own financial situation or it could be enforced by government as a part of an energy efficiency obligation such as was analysed in the case study for Egypt.

We assume here that it is adopted by EDL on its own account. It would nevertheless be wise to consult with some relevant organisations to anticipate problems and to refine the ideas. Useful dialogue is likely with:
5.1.2.5 Compliance

Compliance is not likely to be an important concern. The only likely leakage from non-compliance is by the sale of concessional CFLs, however funded, by low income customers to high income customers for whom they have more value. This would not affect the environmental impacts, but would have consequences for the financial impact on EDL. This is probably unlikely to be a significant problem as the value of the devices is too low to warrant such transactions.

5.1.3 Theory-Based Evaluation

5.1.3.1 Methodology

Evaluation of a project depends upon an underlying belief in how actors will be affected by the policy and how they will respond. We call this belief a “behavioural model”. We specify the behavioural model as a causal sequence in which the successive steps of policy implementation are shown in the first column and then in subsequent columns are listed various indicators, risks and assumptions. The successive steps of the policy may or may not specify recognisable behavioural assumptions; it depends very much on the type of policy investigated.

The behavioural model is a formal description of the process of implementation, the concerns to be raised at each stage and the measures that are to be adopted to make everything is working as expected. It provides a structure for the analytical steps and indicates the evidence that should be sought at each stage to support assertions or on which to found analysis. It allows the issues that might affect implementation to be identified and it allows different stakeholders to debate around a clear and concrete representation of the policy. In later stages it serves as the basis for monitoring and evaluation.

5.1.3.2 Indicators

Indicators need to be established of what is expected from the policy measures. These indicators should cover outputs, outcomes and impacts. Intermediate indicators are important in helping understand how policies work, how measures interact and how they can be improved

- Inputs are the financial, human, technical or organizational resources used in the endeavour,
- Outputs are objectively verifiable indicators that demonstrate the progress made in implementing the measures,
- Outcomes are the immediate effects on the regulated subject,
- Impacts are direct measurements of the improvements that the programme is designed to bring about.
5.1.3.3 The Behavioural Matrix

The behavioural matrix for the main case where incentives for SWH are offered with private finance to fund the purchase of the lamps is shown in the Table 4. Matrices for other alternatives can be developed rather simply from this version. In the case of the targeted programmes coupons would be sent to the low tariff categories and this would need to be made explicit in the matrix.

The matrix serves to demonstrate well the large number of risks and assumptions which underlie this instrument and the need for continuous monitoring of outcomes to ensure that the policy is working as foreseen. This monitoring could be rather costly as it involves consumer surveys, but we are unable to estimate the costs involved.
<table>
<thead>
<tr>
<th>Behavioural model</th>
<th>Indicators</th>
<th>Input</th>
<th>Output</th>
<th>Outcome</th>
<th>Impact</th>
<th>Risks</th>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentive model designed</td>
<td></td>
<td>Admin time ($)</td>
<td>Agreed incentive model</td>
<td>(Y/N)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private investors sought through RFP</td>
<td></td>
<td>Admin time ($)</td>
<td>RFPs issued (Y/N)</td>
<td>• Prospective investors seek documentation and respond (#)</td>
<td></td>
<td>Investors may reject risk / return balance in proposal</td>
<td></td>
</tr>
<tr>
<td>Investors selected</td>
<td></td>
<td>Admin time ($)</td>
<td>MoU / contract with investor (Y/N)</td>
<td></td>
<td></td>
<td>Few or no proposals</td>
<td>• Terms can be agreed</td>
</tr>
<tr>
<td>CFLs purchased</td>
<td></td>
<td></td>
<td>Capital of investor ($)</td>
<td>• CFLs available (#)</td>
<td></td>
<td>• Free-riders dominate purchasers</td>
<td></td>
</tr>
<tr>
<td>Offer documents sent to customers</td>
<td></td>
<td>Admin time ($)</td>
<td>CFLs offered to customers (Y/N)</td>
<td></td>
<td></td>
<td>• Customers accept on terms offered</td>
<td></td>
</tr>
<tr>
<td>Customers purchase CFLs</td>
<td></td>
<td></td>
<td>Purchase agreement (#)</td>
<td>CFLs bought (#)</td>
<td></td>
<td>Terms are unacceptable to customers</td>
<td></td>
</tr>
<tr>
<td>Electricity savings achieved by users</td>
<td></td>
<td></td>
<td>EDL revenues affected ($)</td>
<td>• Load shedding reduced (#)</td>
<td>• GHG emissions reduced (#)</td>
<td>• Proportions of load shedding and reduced private generation can be determined</td>
<td></td>
</tr>
<tr>
<td>Repayments to investor</td>
<td></td>
<td>Cash from EDL to investor ($)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CERs received and sold</td>
<td></td>
<td>Cash to EDL ($)</td>
<td></td>
<td></td>
<td></td>
<td>• 1 year after installation</td>
<td></td>
</tr>
</tbody>
</table>

Note on symbols:  
$ indicates indicator is measured in financial terms  
# indicates indicator is measured in numbers  
Y/N indicates indicators is a yes or no observation  
? indicates indicator that cannot be quantified, but can be assesses qualitatively
5.1.4 Economic Cost-Benefit Assessment

5.1.4.1 Methodology Applied

The analysis considers the following levels:

- **Level of the users**: The benefits for the CFL users is analysed by taking into consideration the different tariff categories. It is assumed that each tariff category corresponds to different income categories with their specific capacities to invest in CFL and respective return requirements.

- **Level of the electricity system operator**: The impacts upon EDL are determined by determining the impacts upon the company’s revenues.

- **Level of the Lebanon economy**: The impacts of the CFL programme upon the Lebanese economy is determined by valuing the electricity savings either by the economic cost of electricity not served or by avoided cost of generation.

The case study makes an important simplifying assumption: It is assumed that each tariff-group corresponds to a defined income group and for each income group assumptions are made regarding the behaviour and decisions to buy CFLs.

5.1.4.2 Assumptions and Data Base

A summary of the key-data and the assumptions for the case study are given in the following Tables 5 and 6.

**Table 5: Summary of Key-Data**

<table>
<thead>
<tr>
<th>Savings per CFL unit</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Hours annual operation</td>
<td>1000 hours</td>
</tr>
<tr>
<td>- Savings per lamp</td>
<td>34 W</td>
</tr>
<tr>
<td>- Annual savings</td>
<td>34 kWh</td>
</tr>
<tr>
<td>Price of the lamp</td>
<td>2.5 $/lmp</td>
</tr>
</tbody>
</table>

**Programme data**

| - Total number of CFL | 3.0 million units |
| - Cost per unit       | 2.5 $/unit        |
| - Costs for the lamps | 7.5 million $     |
| - Programme handling  | 40%                |
| - Total programme costs | 10.5 million $   |

**Value of CERs**

| - Value of CO2 | 10.0 $ / t CO2 |
| - Use of electricity savings |          |
| + Replacement of diesel | 50% |
| + Reduction of ENS | 50% |
| - CO2 of diesel generators | 800 g / kWh |
| + Average CO2 savings | 400 g / kWh |
| - CO2 credit per lamp/year | 0.14 $/lamp / year |

**Average subsidy level**

| 70% |

| Value electricity not served (ENS) | 0.25 $ / kWh |
| Alternative public supply | 0.08 $ / kWh |
The assumptions by tariff groups in Table 6 describe the behaviour for the electricity users and the impacts upon the revenues of EDL or the state-budget:

- **Tariff:** It is assumed that each tariff group corresponds to a different income class;
- **Electricity company - marginal revenue (EC-MR):** As it was stated earlier, EDL's average revenue for kWh sold is 0.06 $ / kWh, this implies that for certain tariff groups EDL is losing revenues and for other tariff groups EDL is making additional revenues. The EC-MR column indicates the impacts of reducing electricity sales by one kWh, considering the lowest tariff group of 0.023 $ / kWh a reduction of sales by one kWh would increase EDL’s revenues by 0.037 $ / kWh. On the other side, by reducing a kWh of the 0.133 $ / kWh tariff group, EDL would lose 0.073 $ / kWh.
- **Perceived user return requirement:** For each tariff category a perceived user return requirement is defined based on an assumed time-preference (required return on investment) for consumptions. For low tariff groups the perceived costs are significantly higher as the tariffs, while for high tariff groups the perceived costs are lower than the tariff.
- **Free-rider:** It was discussed earlier, that for the higher tariff-groups the use of EDL would be attractive without any special support programme because the high tariffs would clearly off-set the cost of the CFLs.

### Table 6: Specification of Parameters by Tariff Group

<table>
<thead>
<tr>
<th>Tariff group</th>
<th>Tariff $/kWh</th>
<th>El.-Comp. - Marginal revenue $/kWh</th>
<th>Perceived user return requirement %</th>
<th>Perceived user CFL cost $/kWh</th>
<th>Free-rider %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100 kWh/month</td>
<td>0.023</td>
<td>0.037</td>
<td>50%</td>
<td>0.052</td>
<td>0%</td>
</tr>
<tr>
<td>100 - 200 kWh/month</td>
<td>0.037</td>
<td>0.023</td>
<td>40%</td>
<td>0.046</td>
<td>0%</td>
</tr>
<tr>
<td>200 - 300 kWh/month</td>
<td>0.037</td>
<td>0.023</td>
<td>30%</td>
<td>0.040</td>
<td>0%</td>
</tr>
<tr>
<td>300 - 400 kWh/month</td>
<td>0.053</td>
<td>0.007</td>
<td>20%</td>
<td>0.035</td>
<td>25%</td>
</tr>
<tr>
<td>400 - 500 kWh/month</td>
<td>0.080</td>
<td>-0.020</td>
<td>15%</td>
<td>0.032</td>
<td>50%</td>
</tr>
<tr>
<td>&gt; 500 kWh/month</td>
<td>0.133</td>
<td>-0.078</td>
<td>15%</td>
<td>0.032</td>
<td>75%</td>
</tr>
</tbody>
</table>

5.1.4.3 **Considered Variants**

The case study considers four variants of structuring the CLF suppose programme as it was defined in chapter 5.1.2.1, the variants are defined by the way the CFLs are distributed (untargeted / targeted) and which entity would implement the CFL programme (private sector / public programme), in Table 7 these variants are given.
Table 7: Definition of Variants

<table>
<thead>
<tr>
<th></th>
<th>Private sector</th>
<th>Public programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untargeted users</td>
<td>Variant 1-1</td>
<td>Variant 2-1</td>
</tr>
<tr>
<td>Targeted users</td>
<td>Variant 1-2</td>
<td>Variant 2-2</td>
</tr>
</tbody>
</table>

The respective assumptions are given in Table 8:

- **Untargeted vs. targeted:** The untargeted distribution considers a distribution of CLFs among all tariff groups, while the targeted variant concentrates the distribution of CFLs on the three lowest tariff groups.
- **CFL programme implementation:** It is assumed that the private sector operator would pre-finance and distribute the CFLs, which would imply additional programme costs of 40% of the CFL costs. If the public sector would implement the programme the additional programme costs would amount to 10%.

Table 8: Specification of Variants

a) Distribution of CFL lamps

<table>
<thead>
<tr>
<th>Tariff groups</th>
<th>Untargeted Variant 1-1 and 2-1</th>
<th>Untargeted Variant 1-2 and 2-2</th>
<th>Targeted Variant 1-1 and 2-1</th>
<th>Targeted Variant 2-1 and 2-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 130 kWh/month</td>
<td>17%</td>
<td>0.5</td>
<td>33%</td>
<td>1.0</td>
</tr>
<tr>
<td>100 - 200 kWh/month</td>
<td>17%</td>
<td>0.5</td>
<td>33%</td>
<td>1.0</td>
</tr>
<tr>
<td>200 - 300 kWh/month</td>
<td>17%</td>
<td>0.5</td>
<td>33%</td>
<td>1.0</td>
</tr>
<tr>
<td>300 - 400 kWh/month</td>
<td>17%</td>
<td>0.5</td>
<td>0%</td>
<td>0.0</td>
</tr>
<tr>
<td>400 - 500 kWh/month</td>
<td>17%</td>
<td>0.5</td>
<td>0%</td>
<td>0.0</td>
</tr>
<tr>
<td>&gt; 500 kWh/month</td>
<td>17%</td>
<td>0.5</td>
<td>0%</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>3.0</td>
<td>99%</td>
<td>3.0</td>
</tr>
</tbody>
</table>

b) Programme costs

- Private sector operator: 40% Variant 1-1 and 2-1
- Public programme: 10% Variant 2-1 and 2-2

5.1.4.4 Results of the Analysis

The key-results of the cost-benefit analysis are given in Table 9. The details of the computation are given for Variant 1-2 in Table 10.

The first rows of Table 9 summarise the general data for all variants. It can be seen that the subsidy level is fixed at 70%. This subsidy level would provide sufficient incentives to the lower tariff group (based on the assumed user return requirement). For higher tariff groups this level of subsidy is too high, resulting in a user-rent.

Impacts at the User Level

The CFL cost for the users is the same for all variants. But the user-rent is quite different whether the CFLs are distributed in an untargeted or targeted way:
• **Untargeted (Variants 1-1 and 2-1):** A certain number of subsidised CFLs is also distributed to high-tariff / income groups - for these groups the perceived CFL-costs are significantly lower than the tariffs, which results in a user-rent. A user-rent is defined as the net present value of benefits from the CFL after subsidy calculated at the time preference discount rate of the user. The free-rider effect is taken into consideration.

• **Targeted (Variants 1-2 and 2-2):** The CFLs are distributed to the low-tariff / income groups, the subsidies are sufficient to off-set the perceived CFL costs and therefore the user-rent is significantly lower.

### Table 9: Results of the Analysis

<table>
<thead>
<tr>
<th>Assessment criteria</th>
<th>Unit</th>
<th>Variants</th>
<th>Untargeted</th>
<th>Untargeted</th>
<th>Targeted</th>
<th>Targeted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Private sector programme</td>
<td>1-1</td>
<td>1-2</td>
<td>2-1</td>
<td>2-2</td>
</tr>
<tr>
<td><strong>Programme design</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of CFL</td>
<td>f / unit</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Total CFLs distributed</td>
<td>million</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Total costs of CFLs</td>
<td>million f</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Programme costs</td>
<td>million f</td>
<td>10.5</td>
<td>10.5</td>
<td>8.25</td>
<td>8.25</td>
<td></td>
</tr>
<tr>
<td>Effective programme CFL units</td>
<td>million</td>
<td>2.25</td>
<td>2.97</td>
<td>2.25</td>
<td>2.97</td>
<td></td>
</tr>
<tr>
<td>Subsidy level</td>
<td>%</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>CFL costs for the user</td>
<td>f / unit</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td><strong>Impact at the user level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost carried by the user</td>
<td>million f</td>
<td>2.25</td>
<td>2.25</td>
<td>2.25</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td>Total user rent</td>
<td>million f</td>
<td>10.62</td>
<td>3.08</td>
<td>10.62</td>
<td>3.08</td>
<td></td>
</tr>
<tr>
<td><strong>Impact upon EDL (state budget)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost carried by EDL</td>
<td>million f</td>
<td>8.25</td>
<td>8.17</td>
<td>5.00</td>
<td>5.94</td>
<td></td>
</tr>
<tr>
<td>Increase in revenues</td>
<td>million f</td>
<td>2.54</td>
<td>6.96</td>
<td>2.54</td>
<td>5.96</td>
<td></td>
</tr>
<tr>
<td>Net benefit for EDL</td>
<td>million f</td>
<td>5.71</td>
<td>1.90</td>
<td>2.46</td>
<td>1.94</td>
<td></td>
</tr>
<tr>
<td>Value of BPs</td>
<td>million f</td>
<td>0.76</td>
<td>0.76</td>
<td>0.76</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>Total benefit</td>
<td>million f</td>
<td>6.61</td>
<td>4.19</td>
<td>2.70</td>
<td>2.64</td>
<td></td>
</tr>
<tr>
<td><strong>Impact upon Lebanese economy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost for the economy</td>
<td>million f</td>
<td>10.20</td>
<td>10.46</td>
<td>8.25</td>
<td>8.17</td>
<td></td>
</tr>
<tr>
<td>Annual electricity savings</td>
<td>GW/m</td>
<td>76.6</td>
<td>100.90</td>
<td>76.5</td>
<td>101.0</td>
<td></td>
</tr>
<tr>
<td>Economic IRR (ENS valued)</td>
<td>%</td>
<td>173%</td>
<td>238%</td>
<td>225%</td>
<td>304%</td>
<td></td>
</tr>
<tr>
<td>Annual generation savings</td>
<td>million f</td>
<td>6.12</td>
<td>8.076</td>
<td>5.12</td>
<td>8.08</td>
<td></td>
</tr>
<tr>
<td>Economic IRR (generation cost)</td>
<td>%</td>
<td>34%</td>
<td>58%</td>
<td>54%</td>
<td>83%</td>
<td></td>
</tr>
</tbody>
</table>

### Impacts upon EDL / State Budget

The impacts of the CFL programme upon EDL (or the state budget) depends on the considered variants

- **Distribution of CFL:** For EDL / state budget the CFLs should be distributed in a targeted way:
  - **Untargeted (Variants 1-1 and 2-1):** The net benefit for EDL would be negative, because the high-tariff customers would reduce their consumption by using CFLs.
  - **Targeted (Variants 1-2 and 2-2):** If the CFLs would be given to the low-tariff groups EDL could reduce the sales to the loss-causing customers and the net-benefit for EDL / state budget would be positive.

- **Programme costs:**
  - **Private sector operator (Variant 1-1 and 1-2):** The higher programme costs reduce the net benefit for EDL, but even with the higher costs due to a private operator the targeted CFL programme has a net benefit for EDL.
  - **Public programme (Variant 2-1 and 2-2):** The lower programme costs would increase the net benefit for EDL in the case of a targeted CFL programme.
The values of the CERs differ among the untargeted and targeted variants due to the assumed free-rider behaviour.
Table 10: Variant 1-2 - Details of the Computation

<table>
<thead>
<tr>
<th>Tariff group</th>
<th>Tariff</th>
<th>Share</th>
<th>Units</th>
<th>Free-rider</th>
<th>Effective units</th>
<th>Required return</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$/kWh</td>
<td>%</td>
<td>million</td>
<td>%</td>
<td>million</td>
<td>%</td>
</tr>
<tr>
<td>&lt; 1000 kWh/month</td>
<td>0.0233</td>
<td>33%</td>
<td>1.0</td>
<td>0%</td>
<td>1.0</td>
<td>50%</td>
</tr>
<tr>
<td>100 - 2000 kWh/month</td>
<td>0.0387</td>
<td>33%</td>
<td>0.99</td>
<td>0%</td>
<td>1.0</td>
<td>40%</td>
</tr>
<tr>
<td>200 - 3000 kWh/month</td>
<td>0.0397</td>
<td>33%</td>
<td>0.89</td>
<td>0%</td>
<td>1.0</td>
<td>30%</td>
</tr>
<tr>
<td>300 - 4000 kWh/month</td>
<td>0.0533</td>
<td>0%</td>
<td>0.0</td>
<td>25%</td>
<td>0.0</td>
<td>20%</td>
</tr>
<tr>
<td>400 - 5000 kWh/month</td>
<td>0.0800</td>
<td>0%</td>
<td>0.0</td>
<td>60%</td>
<td>0.0</td>
<td>15%</td>
</tr>
<tr>
<td>&gt; 5000 kWh/month</td>
<td>0.1333</td>
<td>0%</td>
<td>0.0</td>
<td>75%</td>
<td>0.0</td>
<td>15%</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td>96%</td>
<td>3.0</td>
<td></td>
<td>3.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tariff group</th>
<th>Implementation</th>
<th>User cash flow</th>
<th>Required return</th>
<th>User rent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eff return</td>
<td>Rent</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>&lt; 1000 kWh/month</td>
<td>90%</td>
<td>0.4</td>
<td>-0.8</td>
<td>0.79</td>
</tr>
<tr>
<td>100 - 2000 kWh/month</td>
<td>168%</td>
<td>1.2</td>
<td>-0.8</td>
<td>1.25</td>
</tr>
<tr>
<td>200 - 3000 kWh/month</td>
<td>168%</td>
<td>1.5</td>
<td>-0.8</td>
<td>1.25</td>
</tr>
<tr>
<td>300 - 4000 kWh/month</td>
<td>255%</td>
<td>3.1</td>
<td>-0.8</td>
<td>1.91</td>
</tr>
<tr>
<td>400 - 5000 kWh/month</td>
<td>360%</td>
<td>6.0</td>
<td>-0.8</td>
<td>2.72</td>
</tr>
<tr>
<td>&gt; 5000 kWh/month</td>
<td>903%</td>
<td>9.6</td>
<td>-0.8</td>
<td>4.33</td>
</tr>
</tbody>
</table>

Programme impacts at the user level:

Programme costs: 19,600 million $
Costs carried by the user: 2,228 million $
User surplus rent: 3,1 million $

Economical, Technological and Environmental Impact Assessment of National Regulations and Incentives for RE and EE: Country Report Lebanon
### Impact upon EDL (State budget)

<table>
<thead>
<tr>
<th>Tariff group</th>
<th>EC-MR</th>
<th>Share</th>
<th>Units</th>
<th>Free-rider</th>
<th>Units</th>
<th>NFV</th>
<th>Cash flow for CFL</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100kWh/month</td>
<td>0.033</td>
<td>30%</td>
<td>1.0</td>
<td>0%</td>
<td>0.038</td>
<td>30%</td>
<td>-2.75, 3.10, 1.25, 1.25</td>
</tr>
<tr>
<td>100 - 200kWh/month</td>
<td>0.033</td>
<td>30%</td>
<td>1.0</td>
<td>0%</td>
<td>0.038</td>
<td>30%</td>
<td>-2.75, 3.10, 1.25, 1.25</td>
</tr>
<tr>
<td>200 - 300kWh/month</td>
<td>0.033</td>
<td>30%</td>
<td>1.0</td>
<td>0%</td>
<td>0.038</td>
<td>30%</td>
<td>-2.75, 3.10, 1.25, 1.25</td>
</tr>
<tr>
<td>300 - 400kWh/month</td>
<td>0.033</td>
<td>30%</td>
<td>1.0</td>
<td>0%</td>
<td>0.038</td>
<td>30%</td>
<td>-2.75, 3.10, 1.25, 1.25</td>
</tr>
<tr>
<td>400 - 500kWh/month</td>
<td>0.033</td>
<td>30%</td>
<td>1.0</td>
<td>0%</td>
<td>0.038</td>
<td>30%</td>
<td>-2.75, 3.10, 1.25, 1.25</td>
</tr>
<tr>
<td>&gt; 500kWh/month</td>
<td>0.033</td>
<td>30%</td>
<td>1.0</td>
<td>0%</td>
<td>0.038</td>
<td>30%</td>
<td>-2.75, 3.10, 1.25, 1.25</td>
</tr>
<tr>
<td>Impact of the programme</td>
<td>3.0</td>
<td>0%</td>
<td>0.0</td>
<td>0%</td>
<td>0.038</td>
<td>30%</td>
<td>-2.75, 3.10, 1.25, 1.25</td>
</tr>
</tbody>
</table>

| Carbon credits | 2.97 | 1.004 | 0.34 | 0.14 | 0.14 | 0.14 |

- **Programme costs**: 10,600 million $
  - Costs carried by EDL: 8,196 million $
  - PV revenue increase: 0,976 million $
  - Net benefit for EDL: -1,118 million $
  - Carbon credits: 1.00 million $
- **Programme impact EDL**: -0.19 million $

### Impact upon Lebanese economy

<table>
<thead>
<tr>
<th>Tariff group</th>
<th>Effective units</th>
<th>Annual savings</th>
<th>ENS 0.25 $ / kWh</th>
<th>Economic Cash Flow (ENS)</th>
<th>Gen-cost 0.08 $ / kWh</th>
<th>Economic Cash Flow (generation)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cost 1 2 3</td>
<td>Cost 1 2 3</td>
<td></td>
<td>Cost 1 2 3</td>
</tr>
<tr>
<td>&lt; 100kWh/month</td>
<td>1.0</td>
<td>33.7</td>
<td>1.0 -3.47 8.4 8.4</td>
<td>1.0 3.47 8.4 8.4</td>
<td>-3.47 2.7 2.7 2.7</td>
<td>-3.47 2.7 2.7 2.7</td>
</tr>
<tr>
<td>100 - 200kWh/month</td>
<td>1.0</td>
<td>33.7</td>
<td>1.0 -3.47 8.4 8.4</td>
<td>1.0 3.47 8.4 8.4</td>
<td>-3.47 2.7 2.7 2.7</td>
<td>-3.47 2.7 2.7 2.7</td>
</tr>
<tr>
<td>200 - 300kWh/month</td>
<td>1.0</td>
<td>33.7</td>
<td>1.0 -3.47 8.4 8.4</td>
<td>1.0 3.47 8.4 8.4</td>
<td>-3.47 2.7 2.7 2.7</td>
<td>-3.47 2.7 2.7 2.7</td>
</tr>
<tr>
<td>300 - 400kWh/month</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0 0.0 0.0</td>
<td>0.0 0.0 0.0</td>
<td>0.00 0.0 0.0 0.0</td>
<td>0.00 0.0 0.0 0.0</td>
</tr>
<tr>
<td>400 - 500kWh/month</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0 0.0 0.0</td>
<td>0.0 0.0 0.0</td>
<td>0.00 0.0 0.0 0.0</td>
<td>0.00 0.0 0.0 0.0</td>
</tr>
<tr>
<td>&gt; 500kWh/month</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0 0.0 0.0</td>
<td>0.0 0.0 0.0</td>
<td>0.00 0.0 0.0 0.0</td>
<td>0.00 0.0 0.0 0.0</td>
</tr>
<tr>
<td>Total programme</td>
<td>3.0</td>
<td>101.0</td>
<td>3.0 -10.40 25.2 25.2</td>
<td>3.0 10.40 25.2 25.2</td>
<td>-10.40 8.1 8.1 8.1</td>
<td>-10.40 8.1 8.1 8.1</td>
</tr>
</tbody>
</table>

- **Economic IRR**: 236% with ENS valued at 0.25 $ / kWh
  68% with costs of alternative supply of 0.08 $ / kWh
Impacts upon the Lebanese Economy
All four CFL programme variants would be beneficial for the Lebanese economy. The amount of the economic internal rate of return (IRR) depends on the way of valuing the electricity savings:

- Valuation with the cost of electricity not served (ENS) the higher cost of ENS (based on small generation costs of small diesel generators)
- Lower cost of ENS based on the cost of long-run additional electricity supply.

The most advantageous variant would be variant 2-2 (targeted CFL distribution with a public programme management). But even a private programme management with higher programme costs would be of interest for the national economy.

5.1.5 Conclusion

5.1.5.1 Methodology

The example shows how EBPM and TBE can help to improve the sharpness of policy options by identifying risks and assumptions through the elaboration of the behavioural model and then by suggesting policy variants that can overcome perceived difficulties. In this instance it is the targeting to small users that improves equity, enhances the financial benefits to EDL and augments the environmental impact and the welfare benefit. Such a targeting can be done by distributing coupons to small users with the electricity bill. The coupons can be redeemable at specified outlets.

The CBA also shows that a very high IRR can be achieved on the incremental expenditure by EDL in the public-financed variant. Even in conditions of severe financial stringency this could be worth examining.

The analysis could be improved by a better description of the distribution of users by size. This information must be available to EDL, but was not available to us at the time of calculation. EBPM and TBE also help define the information that is necessary to make good policy.

5.1.5.2 Incentives for CFLs as a Policy Instrument

In this case study the different elements of importance for the design and implementation of a CFL programme in Lebanon are illustrated.

There are a number of aspects, which are of special importance in the case of Lebanon and which determine the course of the analysis:

- Load shedding - shortage in supply: Due to this shortage in supply there will be always sufficient demand to offset the electricity savings due to the CFL usage. So the cost of electricity supply for EDL can be neglected.
- Tariff structure - due to the cross-subsidies it would be of commercial interest for EDL to target the distribution of CFLs to the low-tariff groups.
- Cost of ENS - due to the electricity supply shortage CFLs would have a very high positive impact upon the Lebanese economy.

There are conclusions, which are valid also for other countries:
- 37 -

- Low tariff / income groups: Low income leads to high return requirements for expenditures. This will increase the perceived costs of using CFL lamps. This has to be off-set by subsidies.
- The use of CFLs would be interest also in the case of normal supply conditions if the costs of electricity savings are lower than the cost of additional electricity supply.
5.2 Case Study 2: Instruments to Support the installation of Domestic Solar Water Heaters (SWH)

The second example that we choose in this case for illustration is the analysis of instruments to support the installation of Solar Water heaters in Lebanon. A fund with this objective has been proposed by the Lebanese Centre for Energy Conservation (LCEC) and is thought likely to be a part of the Sustainable Energy Strategy now under development. An alternative could be a tax credit given on production of evidence of a qualifying installation.

5.2.1 Background and Context

5.2.1.1 Solar Water Heating in Lebanon

Solar water heating is relatively novel in Lebanon, but has been developing rapidly, mainly through the efforts of the private sector, but with little concern for quality and performance of the systems installed. LCEC has attempted to help regulate this development and ensure good practice.

A Law of 2007 emanating from the Ministry of Public Works provides incentives for new buildings to meet specified standards for thermal performance of exterior surfaces, such as roofs, walls and windows. If the contractor conforms to the specified norms then he is allowed a greater floor area on a given site. A draft Decree has been prepared that will make it mandatory to provide solar water heating in new apartment building using the roof space for the collectors. This may be expected in the programme of the new government. Mandatory retrofitting of existing buildings is considered impractical because of multiple legal and technical problems.

The Lebanese Standards Institute, LIBNOR, has recently adopted the European Solar Water Heaters standards in Lebanon and LCEC has prepared a list of the suppliers and manufacturers and a Guarantee of Performance. The user of the appliance is advised to ask for a Guarantee of Performance from the supplier to ensure the minimum required quality of the solar water heaters. Both standards and guarantees are voluntary.

LCEC is working with the Ministry of Finance to create a Fund for households to install SWH.

5.2.1.2 Background to Financial Incentives for SWH in Lebanon

Zero interest loans for SWH already exist in Lebanon. The Lebanese Canadian Bank has introduced a solar loan that apparently is interest free using reserves made available by the Central Bank of Lebanon under a quantitative easing programme.

LCEC is working with the Central Bank of Lebanon (CBL) to develop an Energy Efficiency Fund based in the same principle. It may be augmented by a line of credit from the IDF. The idea is that the Fund would be administered by the CBL with LCEC acting as a technical adviser. Any beneficiary would be able to apply to the Fund for loans under specified conditions at nominated commercial banks.

We assume that the SWH Fund would have a similar character and would extend the existing scheme whereby loans are available at zero percent interest.
5.2.1.3 **Technical performance of SWH in Lebanon**

LCEC was assigned by MEW as the technical supervisor of the 500 solar thermal water heaters which were donated by the Government of the People's Republic of China to the Government of Lebanon. LCEC supervised the installation of these units in the south of Lebanon including the organization of training on installation.

LCEC took the opportunity presented by this programme of studying in detail the performance and use of selected units in real use. One of these studies, at Marjeyoun in South Lebanon, has been published and this policy case study draws heavily on that paper\(^1\). Data on temperature, insulation and flow of water throughout the equipment was measured by LCEC in real time over one year. The study showed that of 3092 kWh of thermal energy consumed by the household throughout the year 3049 were supplied from solar energy and only 43 kWh from the electric heater. This demonstrates remarkably good technical performance.

The financial cost of the installation was estimated by LCEC at $1200 per unit; there is no significant maintenance. This value has been adopted in our case study.

5.2.2 **Evidence-based policy making**

The procedure that we have proposed to implement evidence-based policy making comprises the following steps.

1. **Alternative** forms of intervention need to be reviewed and short-listed. Evidence of the success or failure of similar instruments in developed and developing countries needs to be studied with special emphasis on the conditions that created success and failure.
2. There must always be a **base-case** against which alternatives are screened. Alternatives should include all available instruments.
3. All the relevant potential **impacts** need to be identified and where possible, quantified.
4. Impacts should be assessed in **consultation** with the subjects of policy.
5. The cost of **compliance** needs to be assessed. Consideration should be given to how these costs can be minimized. It is necessary to consider who pays the compliance costs; there are generally alternatives with different implications for equity. The procedures for compliance need to be worked out as does the procedure for monitoring impacts.
6. **Indicators** need to be established of what is expected from the policy measures. These indicators should cover outputs, outcomes and impacts. Intermediate indicators are important in helping understand how policies work, how measures interact and how they can be improved.
7. Quantitative analysis of impacts is essential. The analytical method most commonly used is economic **cost-benefit analysis**.
8. Cost-benefit analysis should take into account **opportunity costs** of energy and **external environmental costs**.
9. **Multi-criteria analysis** maybe a useful support to decision making; sensitivity analysis is one expression of this idea.

The first five steps are discussed in this section; the formulation of indicators is discussed in the section on theory-based evaluation and the last three steps are demonstrated in the section on economic cost-benefit assessment.

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\(^1\) Assessment of energy and financial performance of a solar hot water system in a single family dwelling: case study from Marjeyoun – South Lebanon, Houri, A. Et al., LCEC2009
5.2.2.1 Alternative Forms of Intervention

Other Forms of Financial Incentive

In designing financial incentives it is generally better if the incentives are performance related so that the recipient of the incentive is more strongly motivated to ensure the activity is performed effectively. In this case, the owner has an obvious incentive to operate the system as well as possible, because the electricity bill for hot water will be reduced. The structure of the incentive therefore partially meets the requirements. The incentive is not entirely aligned with national aims; it does not fully reflect the environmental benefit, but it at least encourages good performance through the financial gain.

Electricity prices are heavily subsidised in the Lebanon for smaller domestic consumers. Consequently a small consumer faces a marginal cost of electricity that is much lower than the real cost of supply. The performance incentive is therefore much diminished and is further unaligned from the national goal. Price reform would produce much stronger motivation to households to invest and to ensure the system operated as well as possible; a carbon tax would give still better alignment.

Other possibilities for subsidising the capital expenditure on SWH are to offer fiscal incentives through the tax system. Fiscal incentives differ from other financial incentives in several ways. They do not need to be funded directly; they are funded indirectly in that they represent a loss of revenue to the state budget. Generally they are available to all who qualify according to the terms of the exemption; there is no application and award process. For this reason they are preferred by some as being less susceptible to corruption and to political manipulation. They can be managed through the normal tax compliance regime. Other financial instruments normally need to be funded explicitly.

Fiscal instruments have the same problems of targeting as most other financial incentives. Tax deductions are, for obvious reasons, most attractive to those who pay most tax. Tax credits and rebates operate a little like energy taxes in that they change the relationship between the cost of energy and the cost of capital, but whereas taxes send a broad negative signal, tax credits and rebates allow government to choose which technologies it will support. The tax laws must then define precisely which investments or activities qualify and which do not. Tax credits are generally considered fairer than tax deductions. A deduction reduces the amount of income subject to tax; a tax credit directly reduces the tax itself. Tax credits are therefore worth the same to high and low tax payers.

Financial incentives cost money, whether they be low interest loans or tax credits. The cost of tax credits accrues to the state budget and eventually to other tax payers. The cost of low interest rate loans is more difficult to pin down; it depends where the finance for the loans comes from. We assume for simplicity that the state provides the loans and that the cost is therefore the opportunity cost of that capital in other applications. The state should normally obtain benefits from either set of incentives because the subsidies paid to EDL will be affected. In practice in Lebanon, because EDL will continue to shed load regularly for several years, there will actually be relatively little change in electricity costs. The benefits will take the form of benefits to other electricity users who now have power available when otherwise they would not.

Flanking Policies

It is desirable to accompany financial incentives with flanking policies such as:

- Qualification of installers,
- Recommended performance guarantees,
- Standards for collectors,
- Awareness campaigns.
In Lebanon these policies have been implemented. Awareness campaigns and other promotional activity should be continued as the financial incentives are rolled out.

Scope

Our case study will examine tax credits and zero interest loans as alternative means of promoting SWH in the Lebanon. It will examine the reduced performance incentives arising from the subsidies to electricity prices. The case study will also provide a simple analysis of the complex relationship between the state, EDL and other consumers in a situation where the power system suffers from chronic load shedding.

5.2.2.2 Base case

The base case that we adopt is to assume that there is no financial incentive offered and that therefore the penetration of SWH in the domestic market is low.

5.2.2.3 Impacts

Assumptions

The impacts on electricity consumption by the user we take directly from the LCEC case study at Marjayoun. The impacts on GHG emissions are hard to assess. 1,000 kWh saved at the user level, would represent an avoided generation of 1,140 kWh if we assume 12.5% technical losses and a normally functioning power system. In the case of Lebanon power cuts occur somewhere in the country almost 24 hours a day. So the chances are that no generation will be avoided. Other consumers will use the power that has been saved. Those consumers divide into two groups – those that otherwise would have gone without power and those that otherwise would have bought power from a standby generator. If consumers would otherwise have gone without power then there is no saving of GHG emissions because exactly the same power is used. Assuming that EDL manages the power system in order to disconnect the minimum load, we can assume that in practice most of the power saved from the SWH will go to other consumers and there is therefore no gain to the environment.

Among the incentive schemes we consider zero interest loans, tax credits and even a combination of grant and loan schemes (the considered variants are shown in Table 12.

We assume that the present domestic tariffs for electricity remain unchanged. This is scarcely credible, but there is no clear intention to reform prices and one important aspect of the analysis is to examine how these distorted prices interact with other policy instruments, so this assumption for this purpose is reasonable.

Estimation

We assume the life of the solar system to be 20 years; we assume for the first five years there is no environmental gain but that EDL will cease load shedding in ten years and thereafter the gain can be assessed on the basis of generation displaced, which we assume to be from a steam turbine burning HFO. To this we attribute a notional emission of 600 g / kWh of CO₂ equivalent. From five to ten years we interpolate the values to represent a decrease in load shedding. The consequent saving each year in GHG emissions from an annual saving of 1 kWh of electricity is therefore as shown in Figure 1.
EDL will lose the revenues from the customer which will depend upon the tariff category in which the customer falls. The average realisation of EDL from each kWh generated is at present 53 $/MWh. On average therefore (allowing for losses) EDL will see extra revenue of 53 /0.875 $/MWh for every MWh of electricity saved by SWH, i.e. about $60 / MWh. This may be more or less than it loses from the customer that installed the SWH. For the first five years this is the relationship that will govern the benefits to EDL. After ten years, when we assume load shedding to have stopped, we can assume that the benefit to EDL will be from the electricity generation displaced, which we assume as before to be from a steam turbine burning HFO and to which we attribute a notional value of $250 / MWh. Again, from 5 to 10 years we interpolate. The consequences are shown in the Figure 2. We assume, as noted earlier, that tariffs do not change.
We can see that if the SWH is installed by a wealthy customer then EDL is likely to receive less for its electricity on average from the other customers to which it now sells; EDL then loses when high tariff customers convert to SWH. Conversely EDL gains if a low tariff category customer converts. When load shedding notionally ceases in 2020 then EDL gains in all cases because we have assumed no price reform and therefore the loss of revenue is far less than the cost of generation avoided.

The welfare benefit to the community at large is initially the reduced load shedding on the system. The value of this is the cost of Energy Not Supplied (ENS) and is very hard to assess. For the sake of illustration we assume that it is the same as the long run marginal cost of electricity from a steam turbine burning HFO and to which we attributed earlier a notional value of $250 / MWh. The cost of ENS should be considerably more, but this simplifies a complex analysis.

The benefits to the state budget are identical to the benefits to EDL because the state has to pay the losses incurred by EDL. Indeed strictly, because of this, EDL is indifferent to any action it takes on its system. For the immediate purpose we denote the EDL / state impact as a single joint entity.

5.2.2.4 Consultation

The impacts and success of regulations depend on the behaviour of the regulated subjects. It is inefficient for government to try to second-guess what these might be and it is far more effective to consult with affected parties. As well as providing information on the acceptability of a proposal, consultation can be a vital support for evidence-based decision-making.

Financial incentives to change consumer behaviour are a form of policy instrument that benefits considerably from widespread consultation. Consultation can detect weaknesses in the proposal or in the procedures that could impede or distort performance.

Consultation also indicates to concerned parties what interventions are intended and allows them to prepare to promote and to benefit from the change; this is useful and desirable.

Among the interested parties that should be consulted are:

- Affected Ministries including Ministry of Finance and its revenue arm,
- Manufacturers and contractors for SWH,
- Commercial banks,
- EDL,
- NGOs concerned with the environment and fuel poverty.

An appropriate procedure would be to consult with such bilaterally before and during the preparation of proposals and then to submit the draft proposal for consultation simultaneously to these and any other interested parties.

Responses to the consultation document should be consolidated and a reply, not necessarily to each individual comment, but to the general thrust of opinion should be provided.

5.2.2.5 Compliance

Compliance in this instance will be outsourced by the parent Ministry, either to commercial banks who will administer low interest loans, or to the taxation department who will have to ensure that submis-
sions for tax rebates actually relate to work done and to genuine installations.

The costs of compliance in the case of interest free loans can be assessed from the administrative fee charged by the banks; this should cover the administrative costs and the cost of bad loans. We have assumed 5% for this fee. Loans could of course be used to finance SWH that would have been installed in any case or may even be used for something else entirely. Some scrutiny to avoid the latter case would be included in the 5% fee, but there is inevitably some leakage. We neglect this issue.

The costs of compliance for a tax based system is harder to assess because the costs would be rolled up into the normal tax compliance procedures and are unlikely to be separated. Evidently documentary evidence from authorised sources would be required for the tax rebate to be given, but the temptation to dishonest claims is stronger than for the low interest loan, because on the one hand the tax rebate provides a lump sum on the other the loan has anyway to be repaid.

Generally the kind of scrutiny that the tax office would need to apply is similar to the level of scrutiny that banks would need also to perform. We therefore assess the compliance costs at the same level, i.e. 5% of the installation cost, or $60 per installation.

The main difference is that in the case of the loan the bank will charge the compliance costs to the consumer, whereas in the case of the tax rebate the compliance cost will be at the charge of the state.

5.2.3 Theory-based Evaluation

5.2.3.1 Methodology

Evaluation of a project depends upon an underlying belief in how actors will be affected by the policy and how they will respond. We call this belief a “behavioural model”. We specify the behavioural model as a causal sequence in which the successive steps of policy implementation are shown in the first column and then in subsequent columns are listed various indicators, risks and assumptions. The successive steps of the policy may or may not specify recognisable behavioural assumptions; it depends very much on the type of policy investigated.

The behavioural model is a formal description of the process of implementation, the concerns to be raised at each stage and the measures that are to be adopted to make sure everything is working as expected. It provides a structure for the analytical steps and indicates the evidence that should be sought at each stage to support assertions or on which to found analysis. It allows the issues that might affect implementation to be identified and it allows different stakeholders to debate around a clear and concrete representation of the policy. In later stages it serves as the basis for monitoring and evaluation.

5.2.3.2 Indicators

Indicators need to be established of what is expected from the policy measures. These indicators should cover outputs, outcomes and impacts. Intermediate indicators are important in helping understand how policies work, how measures interact and how they can be improved

- Inputs are the financial, human, technical or organizational resources used in the endeavour,
- Outputs are objectively verifiable indicators that demonstrate the progress made in implementing the measures,
5.2.3.3 The Behavioural Matrix

The behavioural matrix for the provision of low interest loans is shown in Table 11. The example illustrates how the behavioural matrix can be useful in helping identify the indicators that are necessary to ensure that policy is proceeding as planned.

The matrix can also be helpful in identifying flanking policies to cope with some of the risks and assumptions identified through the detailed breakdown of the expected behaviour and causal sequence. For example, an awareness campaign is clearly necessary to stimulate interest among prospective users and this is included within the policy as analysed. But risks are identified in the matrix to the effect that consumers may not trust the equipment, may not be able to choose among alternatives and may not believe that installed systems will perform to specification. Flanking policies to deal with these risks are the introduction of standards, the certification of installers and the provision of pro forma performance guarantees. All these flanking policies are in place in Lebanon.

The behavioural matrix is also helpful in understanding how the policy may fail and in this instance there are several risks that appear from the analysis that could reduce impact. They are:

- Because EDL cannot generate enough electricity the savings from SWH will be resold to other customers and there will be no net environmental gain
- Loans may flow preferentially to rich consumers that can afford repayments and that will achieve large benefits because they are on high marginal tariffs – these are free riders and the policy fails if they dominate (this aspect is not considered in the presented cost-benefit analysis).
- For the same reason the policy may impact badly on EDL if SWH is installed preferentially by rich consumers and the lost revenues are replaced by lower revenues from sales to EDL’s average realisation

It is apparent that there is a danger that the policy has no environmental impact, causes a cash flow to the wealthy and undermines still further the financial condition of EDL.

One possible way of managing some of these perverse effects would be to restrict loans to consumers in lower tariff groups. This would improve the impact for EDL, but would be less successful in promoting solar heating as the most likely groups to install solar water heaters are the wealthy with lower personal discount rates, much higher benefits from the installation and space on their properties for the equipment.

A behavioural matrix can also be constructed for the tax credit version. It is somewhat similar and we do not present it. An important discriminator of the two options is the relative value of the loan and the tax credit to consumers and this is a function of the personal discount rate. We study this in the following section on economic cost benefit analysis.
### Table 11: Behavioural Matrix for Financial Incentives for Solar Water Heating (Zero Interest Loans)

<table>
<thead>
<tr>
<th>Behavioural model</th>
<th>Input</th>
<th>Output</th>
<th>Outcome</th>
<th>Impact</th>
<th>Risks</th>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero interest loans available through commercial banks subject to terms and conditions</td>
<td>Administrative time ($), Preparation of documents and materials ($)</td>
<td>Operational scheme of loans developed, based on credit lines from government / donors (Y/N)</td>
<td>• Contractors understand scheme and perceive benefits for their business</td>
<td></td>
<td>• Contractors perceive financial barriers as a significant market obstacle</td>
<td></td>
</tr>
<tr>
<td>Manufacturers and contractors are encouraged to promote the instrument</td>
<td>Administrative time ($), Preparation of materials ($)</td>
<td>Training courses (#), Promotional materials (Y/N)</td>
<td>• Consumers are sceptical of claims</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness campaign launched</td>
<td>Administrative time ($), Preparation of materials ($), Time in papers and TV ($)</td>
<td>Decision to proceed or not</td>
<td>• Approach to bank (#)</td>
<td></td>
<td>• Consumers are intimidated by complexity of choice</td>
<td></td>
</tr>
<tr>
<td>Domestic consumers assess merits</td>
<td>Time of users</td>
<td>Decision to proceed or not</td>
<td>• Approach to bank (#)</td>
<td></td>
<td>• Users perceive a benefit – not evident for low tariff users</td>
<td></td>
</tr>
<tr>
<td>Domestic consumers seek loans and request application forms</td>
<td>Admin. costs of bank, included in loan ($)</td>
<td>Application forms sent to consumers(#)</td>
<td>• Consumer asks contractor for supplementary documentation (#)</td>
<td></td>
<td>• Consumers do not trust contractors to install good quality equipment and to do it well</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Consumers are able to repay loan from savings</td>
<td></td>
</tr>
<tr>
<td>Behavioural model</td>
<td>Indicators</td>
<td>Input</td>
<td>Output</td>
<td>Outcome</td>
<td>Impact</td>
<td>Risks</td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
<td>-------</td>
<td>--------</td>
<td>---------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>Applications submitted with appropriate documentation</td>
<td>Admin. costs of bank, included in loan ($)</td>
<td>Completed forms received (#)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applications accepted or rejected</td>
<td>Admin. costs of bank, included in loan ($)</td>
<td>Applications approved (#)</td>
<td>Consumers accept loan and order equipment (#)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWH installed</td>
<td>Capital and installation costs ($)</td>
<td>Completed systems installed (#)</td>
<td>Systems in use broken down by tariff group (#)</td>
<td>Most loans go to high tariff users with no need for loans (free riders)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loans are repaid</td>
<td></td>
<td></td>
<td></td>
<td>Cash flow to banks ($)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity is replaced by solar energy</td>
<td>Customer’s electricity bill falls</td>
<td>National electricity demand falls (#)</td>
<td>Electricity saved by high tariff users is resold to low tariff users at loss</td>
<td>Power system can supply all demand so saving at national level is real</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GHG savings made; welfare gains to country; gain(?) to state budget</td>
<td></td>
<td></td>
<td>Tonnes CO2 avoided</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note on symbols:
- $ indicates indicator is measured in financial terms
- # indicates indicator is measured in numbers
- Y/N indicates indicators is a yes or no observation
- ? indicates indicator that cannot be quantified, but can be assesses qualitatively
5.2.4 Economic cost-benefit analysis

5.2.4.1 Methodology Applied

The following cost-benefit analysis is performed at the following levels of consideration:

- User level,
- Level of the Lebanese electricity company / state budget,
- Level of the Lebanese economy.

The analysis considers different income groups. To simplify the analysis of this case study, it is assumed that each tariff-group is closely related to different income groups.

The considered variants for the incentive scheme are shown in Table 12. In the case of interest-free loans to the users it is assumed that the capital costs have to be covered by the EDL / state budget.

Table 12: Incentive Schemes - Considered Variants

<table>
<thead>
<tr>
<th>No intervention, the user has to pay the full cost of 1200 USD</th>
<th>Variant 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax rebate of 200 US Dollar, so that the user has to pay 1000 USD</td>
<td>Variant 1</td>
</tr>
<tr>
<td>Interest free-loan of 1000 USD with a repayment period of 10 years, the user has to pay the initial cost of 200 USD and then over 10 years 100 USD per year</td>
<td>Variant 2</td>
</tr>
<tr>
<td>Grant of 500 USD, this means the user has to cover the remaining cost of 700 USD</td>
<td>Variant 3</td>
</tr>
<tr>
<td>Grant of 300 USD with an interest free loan of 900 to be paid back over 10 years. The user does not have any upfront costs</td>
<td>Variant 3</td>
</tr>
</tbody>
</table>

5.2.4.2 Assumptions and Data Base

The assumptions taken into consideration for this case study are shown in Table 13. The unit cost for the SWH is 1,200 USD / unit and the annual electricity savings are assumed to be 3,000 kWh / year. This implies that the potential users of SWH should have a minimal annual consumption of 3,800 kWh / year. Low-tariff customers are therefore not the target group for SWH.

The tax rebate and grant schemes have to be financed by the EDL / state budget, as well as the interest charge for the loan-schemes.
Table 13: Assumptions for the Case Study

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of SWH</td>
<td>1200</td>
</tr>
<tr>
<td>Maintenance costs</td>
<td>1.5%</td>
</tr>
<tr>
<td>Compliance costs</td>
<td>1.0%</td>
</tr>
<tr>
<td>Annual electricity savings per SWH unit</td>
<td>3,000 kWh/year</td>
</tr>
<tr>
<td>Minimal annual consumption SWH user</td>
<td>3,600 kWh</td>
</tr>
<tr>
<td>Value of CERs</td>
<td>10.0 $ / t CO2</td>
</tr>
<tr>
<td>Average EDL tariff</td>
<td>0.053 $ / kWh</td>
</tr>
<tr>
<td>Losses in the EDL network</td>
<td>14%</td>
</tr>
<tr>
<td>Value of ENS</td>
<td>0.25 $ / kWh</td>
</tr>
<tr>
<td>LRMC for electricity generation</td>
<td>0.10 $ / kWh</td>
</tr>
<tr>
<td>Interest for loan scheme (EDL / state budget)</td>
<td>12%</td>
</tr>
<tr>
<td>Discount rate for economic analysis</td>
<td>10%</td>
</tr>
</tbody>
</table>

The assumptions regarding the user groups are shown in Table 14. For each user group the respective tariff, the assumed annual consumption, EDL marginal revenues are given. If low tariff customers would reduce their consumption, EDL could reduce the losses.

For each user group return requirements are assumed, which reflect the users availability of funds for investments, such as SWH. For low-tariff customers the perceived SWH costs ($ / kWh) is therefore far higher than for high tariff customers. For example, the lowest tariff group requires a 50% return on investment, this leads to perceived user costs of 0.20 $ / kWh, which is significantly higher than the tariff of 0.02 $ / kWh. Such discount rates may appear unrealistically high, but in reality small unsecured loans are very expensive².

Table 14: Assumptions Regarding the User Groups

<table>
<thead>
<tr>
<th>Tariff group</th>
<th>Tariff</th>
<th>Annual consumption kWh/year</th>
<th>EDL - Marginal revenue $/kWh</th>
<th>Perceived user return requirement %</th>
<th>Perceived user SWH cost $/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$/kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 100/kWh/month</td>
<td>0.023</td>
<td>1200</td>
<td>0.037</td>
<td>50%</td>
<td>0.2001</td>
</tr>
<tr>
<td>100 - 200/kWh / month</td>
<td>0.037</td>
<td>2400</td>
<td>0.023</td>
<td>40%</td>
<td>0.1902</td>
</tr>
<tr>
<td>200 - 300/kWh / month</td>
<td>0.037</td>
<td>3600</td>
<td>0.023</td>
<td>30%</td>
<td>0.1208</td>
</tr>
<tr>
<td>300 - 400/kWh / month</td>
<td>0.053</td>
<td>4800</td>
<td>0.067</td>
<td>20%</td>
<td>0.0921</td>
</tr>
<tr>
<td>400 - 500/kWh / month</td>
<td>0.060</td>
<td>6000</td>
<td>-0.020</td>
<td>15%</td>
<td>0.0533</td>
</tr>
<tr>
<td>&gt; 500/kWh / month</td>
<td>0.133</td>
<td>6000</td>
<td>-0.073</td>
<td>15%</td>
<td>0.0535</td>
</tr>
</tbody>
</table>

The target group for the SWH programme is shown in Table 15. Only the three highest tariff groups are envisaged, lower tariff-groups do not have sufficient annual electricity consumptions to be potential users of SWH and have very high personal discount rates.

For each group a target of 3,000 units is assumed.

---
² For example, an unsecured loan in the UK if £1000 over 2 years attracts an interest rate of 85%.

Economical, Technological and Environmental Impact Assessment of National Regulations and Incentives for RE and EE: Country Report Lebanon
Table 15: SWH Programme - Target Group

<table>
<thead>
<tr>
<th>Tariff group</th>
<th>Potential SWH user</th>
<th>Target programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100kWh/month</td>
<td>no</td>
<td>0</td>
</tr>
<tr>
<td>100 - 200kWh/month</td>
<td>no</td>
<td>0</td>
</tr>
<tr>
<td>200 - 300kWh/month</td>
<td>no</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 300 - &lt;400kWh/month</td>
<td>yes</td>
<td>3,000</td>
</tr>
<tr>
<td>&gt; 400 - 500kWh/month</td>
<td>yes</td>
<td>3,000</td>
</tr>
<tr>
<td>&gt; 500kWh/month</td>
<td>yes</td>
<td>3,000</td>
</tr>
</tbody>
</table>

5.2.4.3 Result of the analysis

The results of the analysis are discussed for the three levels introduced above: user level, EDL / state budget level / national economy level.

**User level**
The results of the analysis at the user level are given in table 16. It can be seen that the use of SWH is highly attractive for the high-tariff users. In the case of variant 4 there are immediate benefits for nearly all tariff groups (a part from the lowest group) so that an IRR cannot be determined.

The perceived costs have to be compared with the respective tariffs, this comparison results in the attractiveness of the option for each tariff group. For example, in the case of variant 4 the SWH would be attractive for 5 tariff groups. But only the three high-tariff groups have sufficiently high annual consumptions so that they can be considered as users of SWH.

The result is:

- In the case of variant 0 / 1 / 3 only the two highest tariff groups are interested, so the programme target would be 6,000 units;
- In the case of variant 2 and 4 the three highest tariff groups would be interested in the SWH, so the programme target would be 9,000 Units.

Table 16 gives then the discounted values (PV - present value) for the different indicators of the analysis at the user level.

**Electricity company level**
Table 17 shows the impact upon EDL / state budget. For each tariff-group the impacts (the net benefit for EDL / state budget) of the potential electricity savings due to SWH are given. In the case of low tariff users EDL / the state budget would benefit, while in the case of high tariff users there would be losses for EDL / the state budget.

The present values (PV) for the different programmes are given also. It is clear that in the case of the variants with the high programme target of 9,000 units the losses for EDL / state budget would be the highest. In all cases considered, the SWH programme would imply costs for EDL / state budget, because the SWH would be used only by high tariff customers which are paying tariffs higher than EDL’s average tariff.
Table 16: Results of the Analysis - User Level

<table>
<thead>
<tr>
<th>User assessment</th>
<th>Unit</th>
<th>Variant 0</th>
<th>Variant 1</th>
<th>Variant 2</th>
<th>Variant 3</th>
<th>Variant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRR at the user level</td>
<td>%</td>
<td>1%</td>
<td>2%</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>100 - 200kWh/month</td>
<td>%</td>
<td>4%</td>
<td>7%</td>
<td>9%</td>
<td>12%</td>
<td>n.a.</td>
</tr>
<tr>
<td>200 - 300kWh/month</td>
<td>%</td>
<td>4%</td>
<td>7%</td>
<td>9%</td>
<td>12%</td>
<td>n.a.</td>
</tr>
<tr>
<td>300 - 400kWh/month</td>
<td>%</td>
<td>10%</td>
<td>13%</td>
<td>25%</td>
<td>25%</td>
<td>n.a.</td>
</tr>
<tr>
<td>400 - 500kWh/month</td>
<td>%</td>
<td>18%</td>
<td>22%</td>
<td>61%</td>
<td>32%</td>
<td>n.a.</td>
</tr>
<tr>
<td>&gt; 500kWh/month</td>
<td>%</td>
<td>32%</td>
<td>38%</td>
<td>141%</td>
<td>55%</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

- Perceived costs
  - < 100kWh/month $ / kWh 0.21 0.17 0.07 0.12 0.04
  - 100 - 200kWh/month $ / kWh 0.17 0.14 0.06 0.10 0.03
  - 200 - 300kWh/month $ / kWh 0.12 0.11 0.06 0.08 0.03
  - 300 - 400kWh/month $ / kWh 0.09 0.07 0.05 0.05 0.03
  - 400 - 500kWh/month $ / kWh 0.07 0.06 0.04 0.04 0.03
  - > 500kWh/month $ / kWh 0.07 0.06 0.04 0.04 0.03

- Attractiveness for tariff group
  - < 100kWh/month no no no no yes
  - 100 - 200kWh/month no no no no yes
  - 200 - 300kWh/month no no no yes no
  - 300 - 400kWh/month no no yes no yes
  - 400 - 500kWh/month yes yes yes yes yes
  - > 500kWh/month yes yes yes yes yes

- Programme Implementation
  - < 100kWh/month units 0 0 0 0 0
  - 100 - 200kWh/month units 0 0 0 0 0
  - 200 - 300kWh/month units 0 0 0 0 0
  - 300 - 400kWh/month units 0 0 0 0 0
  - 400 - 500kWh/month units 3,000 3,000 3,000 3,000 3,000
  - > 500kWh/month units 3,000 3,000 3,000 3,000 3,000
  - Total number of units units 6,000 6,000 6,000 6,000 6,000
  - PV Electricity savings GWh 139.3 139.3 268.0 139.3 268.0
  - Cost at user level million $ 7.38 6.29 7.92 4.85 5.78
  - PV benefit at the user level million $ 14.96 14.96 10.98 14.96 10.98
  - NNPV at the user level million $ 7.48 9.57 10.66 10.21 12.80

Table 17: Results of the Analysis - EDL / State Budget Level

<table>
<thead>
<tr>
<th>EDL / State budget assessment</th>
<th>Unit</th>
<th>Variant 0</th>
<th>Variant 1</th>
<th>Variant 2</th>
<th>Variant 3</th>
<th>Variant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV per unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 100kWh/month</td>
<td>$</td>
<td>1,209.35 1,209.35 1,209.35 1,209.35 1,209.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 - 200kWh/month</td>
<td>$</td>
<td>979.76 979.76 979.76 979.76 979.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200 - 300kWh/month</td>
<td>$</td>
<td>573.76 573.76 573.76 573.76 573.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 - 400kWh/month</td>
<td>$</td>
<td>592.76 592.76 592.76 592.76 592.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 - 500kWh/month</td>
<td>$</td>
<td>56.36 56.36 56.36 56.36 56.36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 500kWh/month</td>
<td>$</td>
<td>124.72 124.72 124.72 124.72 124.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV EDL Programme costs</td>
<td>million $</td>
<td>4.56 4.56 4.56 4.56 4.56</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV EDL Impact on revenues</td>
<td>million $</td>
<td>3.87 3.87 3.87 3.87 3.87</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV EDL total impact</td>
<td>million $</td>
<td>4.43 4.43 4.43 4.43 4.43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of CO2 reduciton</td>
<td>$CO2</td>
<td>68,709 68,709 103,063 68,709 103,063</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV Value of CERS</td>
<td>million $</td>
<td>0.69 0.69 1.03 0.69 1.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV Programme impact with CERS</td>
<td>million $</td>
<td>3.74 4.83 5.69 6.47 7.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV Electricity savings</td>
<td>GWh</td>
<td>139.31 139.31 208.97 139.31 208.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

National Level

The results of the analysis for the national level are shown in Table 18. In this analysis the cost at the user level and EDL level are taken into account. The electricity savings are value at the cost of ENS / LRMC and only LRMC as it was explained earlier.
The SWH option is highly attractive for the Lebanese economy, the economic value of the electricity savings is far higher than the cost related with the SWH and the respective programme costs.

Under a national perspective the programme variants no. 2 and 4 would be the best because the additional electricity savings have a higher value than the additional costs for the promotion schemes.

### Table 18: Results of the Analysis - National Economy Level

<table>
<thead>
<tr>
<th>Assessment of SWH unit</th>
<th>Unit</th>
<th>Variant 0</th>
<th>Variant 1</th>
<th>Variant 2</th>
<th>Variant 3</th>
<th>Variant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRR</td>
<td>%</td>
<td>57%</td>
<td>57%</td>
<td>252%</td>
<td>57%</td>
<td>176%</td>
</tr>
<tr>
<td>- Value of el. Savings ENS / LRMC</td>
<td>%</td>
<td>22%</td>
<td>22%</td>
<td>41%</td>
<td>22%</td>
<td>35%</td>
</tr>
<tr>
<td>NPV</td>
<td>$</td>
<td>2969</td>
<td>2969</td>
<td>2789</td>
<td>2969</td>
<td>2969</td>
</tr>
<tr>
<td>- Value of el. Savings ENS / LRMC</td>
<td>$</td>
<td>999</td>
<td>999</td>
<td>999</td>
<td>999</td>
<td>999</td>
</tr>
<tr>
<td>Levelised costs</td>
<td>$ / kWh</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>- PV of electricity per unit</td>
<td>kWh</td>
<td>23219</td>
<td>23219</td>
<td>23219</td>
<td>23219</td>
<td>23219</td>
</tr>
<tr>
<td>- PV of costs per unit</td>
<td>$</td>
<td>1323</td>
<td>1323</td>
<td>1323</td>
<td>1323</td>
<td>1323</td>
</tr>
</tbody>
</table>

### Programme assessment

<table>
<thead>
<tr>
<th>PV of total electricity saving, GWh</th>
<th>Unit</th>
<th>Variant 0</th>
<th>Variant 1</th>
<th>Variant 2</th>
<th>Variant 3</th>
<th>Variant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.94</td>
<td>7.94</td>
<td>12.54</td>
<td>7.94</td>
<td>12.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of CERs, million $</td>
<td>0.69</td>
<td>0.69</td>
<td>1.03</td>
<td>0.69</td>
<td>1.03</td>
<td></td>
</tr>
<tr>
<td>PV of economic benefits</td>
<td>million $</td>
<td>25.09</td>
<td>25.09</td>
<td>37.64</td>
<td>25.09</td>
<td>37.64</td>
</tr>
<tr>
<td>PV user cost, million $</td>
<td>0.66</td>
<td>0.78</td>
<td>0.72</td>
<td>0.66</td>
<td>0.78</td>
<td>0.72</td>
</tr>
<tr>
<td>PV of ELD cost, million $</td>
<td>2.64</td>
<td>1.66</td>
<td>4.52</td>
<td>2.64</td>
<td>1.66</td>
<td>4.52</td>
</tr>
<tr>
<td>PV of total cost, million $</td>
<td>7.94</td>
<td>7.94</td>
<td>12.54</td>
<td>7.94</td>
<td>12.54</td>
<td></td>
</tr>
</tbody>
</table>

### Summary of the Analysis

The analysis can be summarised as follows (for this see Table 19):

- **User level:** With appropriate financial instruments, the use of SWH instead of electric water heating can be made attractive for nearly all tariff-user groups, but electricity consumers in lower tariff categories do not have high consumption of hotwater, as it is indicated by their annual electricity consumption.

- **EDL / state budget level:** For EDL / state budget the SWH will imply costs, because it will be only the high-tariff customers, who will use these devices. The analysis does not consider who will consume the electricity saved - only the direct programme impacts are considered.

- **National economy level:** For the national economy the SWH option is highly beneficial. The more units are used the better for the national economy. For this the higher programme costs of variants 2 and 4 are fully justified.
Table 19: Results of the Analysis -Comparison of Results

<table>
<thead>
<tr>
<th>Comparison of variants</th>
<th>Unit</th>
<th>Variant 0</th>
<th>Variant 1</th>
<th>Variant 2</th>
<th>Variant 3</th>
<th>Variant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Number of units</td>
<td>n.o.</td>
<td>6,000</td>
<td>6,000</td>
<td>9,000</td>
<td>6,000</td>
<td>9,000</td>
</tr>
<tr>
<td>- PV of electricity savings</td>
<td>GWh</td>
<td>135.3</td>
<td>139.3</td>
<td>205.0</td>
<td>139.3</td>
<td>205.0</td>
</tr>
<tr>
<td>- PV of CO2 reduction</td>
<td>t CO2</td>
<td>66,769</td>
<td>66,769</td>
<td>103,063</td>
<td>66,769</td>
<td>103,063</td>
</tr>
</tbody>
</table>

**User level**

| - PV cost at user level | million $ | 7.38   | 6.29     | 7.92     | 4.86     | 5.78     |
| - PV benefit at the user level | million $ | 14.06 | 14.96   | 13.50   | 14.06   | 13.50   |

**NPV at the user level**

| million $ | 7.48 | 6.57 | 10.06 | 10.21 | 12.80 |

**EDL / State budget**

| - EDL Programme costs | million $ | -0.66 | -1.65 | -4.52 | -3.28 | -8.70 |
| - EDL Impact on revenues | million $ | -3.67 | -3.87 | -2.09 | -3.87 | -2.09 |
| - EDL total impact | million $ | -4.43 | -5.52 | -6.52 | -7.16 | -8.79 |
| - Value of CERs | million $ | 0.69 | 0.69 | 1.03 | 0.69 | 1.03 |

**EDL programme impact (with CERs)**

| million $ | -3.74 | -4.83 | -5.69 | -6.47 | -7.76 |

**Economic / national assessment**

| Net economic benefit (with CERs) | million $ | 17.64 | 17.64 | 26.13 | 17.64 | 26.19 |

5.2.5 Conclusion

5.2.5.1 The Methodology

The case illustrates the value of the evidence-based approach detecting risks and assumptions associated with different instruments and in allowing rigorous comparison of different options designed to manage those risks.

It also demonstrates the immense complexity of the analysis when faced with a deficient power system and distorted prices. The introduction of financial incentives in this context creates an even more distorted environment in which the interests of users, the utility and the state are hard to assess and are likely to conflict.

When the power system is shedding load, the promotion of energy efficiency is likely to impair the financial status of the utility because measures to save energy are more attractive to higher tariff categories, so the utility loses revenue from these customers and sells the electricity saved at the average price dominated by the more numerous low tariff users.

5.2.5.2 Financial Incentives for SWH as a Policy Instrument

The subsidy of SWH brings large benefits to the Lebanese economy and of course to the users. The lower electricity demand of high-tariff customers would lead to financial losses for the Electricity Company / state budget. But considering the load shedding it can be assumed that these reductions in consumption will be compensated by the increased consumption for other purposes.

Free riders were not covered in the analysis and these are more likely to be found in the higher tariff groups, so the programme impact might be overestimated to a certain extent. If the incentives are carefully targeted then the free-rider impact can be limited. Targeted measures to the middle tariff groups were not covered in the analysis, but might be considered.
6. **Institutional Reform - Strategic Options**

The policy cycle is illustrated in the following figure.

**Fig. 3: Illustration of the Policy Process**

There are institutional needs at all stages of this cycle.

Decision-making proceeds through the general processes available in the executive and legislative branches of government. Normally policy briefs will originate from the executive and be elaborated by Ministerial departments often with analytical support from agencies of government and paid consultants and in consultation with other stakeholders. Primary legislation is debated and finally sanctioned by the legislature. In many countries Ministerial Decrees are used to elaborate on primary legislation.

This structure needs to be properly serviced with evidence and analysis if it is to work well. There is a need for an institution, or perhaps several, to gather and maintain evidence and to carry out analytical work that feeds into the formulation of policy and later guides the monitoring and evaluation and reformulation of policy. Foresight studies are a part of the evidence that should be considered in policy formulation and these should take into account the evolution of global trends and policies in energy and the environment, but also of trends beyond these disciplinary frontiers.

Implementation of policy may be conducted by Ministerial departments or nominated agencies. In developed countries, implementation is often assigned to specialist agencies. In developing countries it is more common that policy is implemented by the Ministry. Implementation will often be demanding of resources, this may be the case for some market based instruments as well as the majority of regulations.
6.1 Formulation of an Energy Masterplan and General Approach

The Sustainable Energy Strategy (SES) has yet to be formulated in Lebanon. The recently finalised and ongoing projects by LCEC, UNDP and CEDRO represent a list of direct measures for implementation. In this sense SES is an implementation strategy. However, as a first step a concise general energy strategy covering mid- to long-term energy development targets and overall goals should be phrased. Without such a background, it is difficult to justify the introduction of renewable energies and energy efficiency, especially if it puts additional costs on consumers. It would therefore be of relevance to start a discussion on governmental level about the broad direction Lebanon wants to take in terms of sustainable energy supply and consumption. This could result in a comprehensive strategy for energy. Such a strategy would precisely discuss the motivations for the deployment of renewable energies and energy efficiency. Among these are reduction of dependence on energy imports, reduction of subsidies benefitting overall economic development, climate protection and others.

From the current perspective Lebanon seems very well suited for ambitious energy efficiency policies. Especially in Lebanon it is of utmost relevance to stress the link between efficiency and renewables: renewables should on small-scale level only be used in combination with energy efficiency measures to reduce overall system costs. Such an approach could be mentioned as guiding principle in the masterplan.

For Lebanon it would be rewarding to maintain a high level of international cooperation. There is experience already existing, e.g. via CDM. This would allow Lebanon to benefit strongly from non-domestic expertise in technologies and R&D.

6.2 Improving Policy Coordination and Implementation

The Ministry for Energy and Water (MEW) is Lebanon’s major energy policy-making body, which manages and controls EDL and the National Litani Authority (ONL). The latter is responsible for constructing dams, the exploitation of hydropower plants and the operation and exploitation of irrigation works. Lebanon’s administrative system does not comprise public entities specialised on renewable energy and energy efficiency. Instead, several authorities are involved, resulting in a lack of coordination and barriers for policy implementation. For example, besides MEW, ALMEE et al. included in their 2004 draft of a national plan for the development of solar thermal energy the Ministry of Environment, the Ministry of Public Works and Transport, the Ministry of Finance as well as several local authorities.

In order to coordinate and concentrate all related government activities, the Lebanese government is recommended to foster the creation of an authority specialised on renewable energy and energy efficiency. The authority could be under the auspices of the MEW, but should also be closely linked to the Ministry of Economy and Trade (MOET) and the Ministry of Finance in order to emphasise the economic potential of both issues and to facilitate foreign direct investments.

Such direct linkage to different policy areas could make it necessary to create a board for the authority consisting of representatives of different ministries. The authority would act as governmental body that develops and fosters the formulation of policies as a strategic think tank.

The Lebanese Centre for Energy Preservation (LCEC) – whose capacities are recommended to be extended to issues related to renewable energies as well – would then act as implementing body of energy efficiency and renewable energy policies. LCEC’s experts should be assigned to follow up and monitor the implementation of adopted policies and regulations, for example by publishing status reports on the implementation of relevant regulations. In order to enable LCEC to fulfil these tasks, the government should appropriate adequate funding for the Centre.
6.3 Boosting Awareness and Capacities

While Jordan or Syria already have integrated strategies, targets or legislation related to renewable energy and energy efficiency into their national energy policy frameworks, these steps are yet to be taken in Lebanon. Although MEW representatives have repeatedly expressed their support for energy efficiency and supported activities of the LCECP, both issues are not among the Ministry’s top priorities. Currently, MEW focuses on ensuring a secure supply of fuel oil and improving infrastructure linkages to key fuel suppliers, such as Syria. However, when it comes to general decisions of infrastructure development, the integration of renewable energies has to be taken into detailed consideration to fit future supply needs.

In order to shift the focus of national energy policy the benefits of renewable energy and energy efficiency (e.g. energy security, costs) need to be communicated to Lebanese decision-makers and the public. The group of addressed decision-makers should include policy-makers, key players in the industrial sector and academia as well as NGOs. Such a comprehensive awareness strategy is needed, as Lebanon is not merely missing a regulatory and strategic policy setting for renewable energy and energy efficiency but also indicates a low level of activity in the industrial and academic sector by now. International organisations, especially the UNDP, have already implemented projects such as the LCECP, which conducted awareness campaigns. Such initiatives need to be continued and expanded with the clear objective to gradually transfer the responsibility for the implementation and continuation of the campaigns to the Lebanese government.

Besides providing awareness for renewable energy and energy efficiency, the campaigns should include capacity building elements, such as training seminars or workshops, to educate officials of relevant Lebanese authorities in designing and implementing effective and efficient policies for renewable energy and energy efficiency. The same holds true for the level of energy consumers. While introducing incentives and regulations, consumers need to get advice on the efficiency options they can use to reduce costs (see below).

These measures should involve high interaction between domestic and international experts in order to stimulate knowledge transfer and to promulgate cases of best practice. Furthermore, it is recommended to brief government officials about the benefits of international instruments for technology transfer, such as the Clean Development Mechanism (CDM), or other international funding opportunities for sustainable energy projects. As complex administrative procedures frequently constitute a barrier for setting up CDM projects, briefing governmental officials on the related administrative procedures might be considered. This step is assumed to be of high use as no CDM project was realised in Lebanon until now. So far, LCEC and EDL have merely submitted one proposal for a CDM project.

6.4 Adopting Policy Incentives and Regulations

Existing Lebanese energy legislation builds significant obstacles for the production of renewable energy by private power producers. Presently, Law 462 of 2002, which regulates the management of the energy sector, is the main energy legislation in Lebanon. At the time being, the Law prohibits non-state-owned companies to produce and feed-in electricity, which is not for private use. For instance, household feed-in is not possible without legal back up. This legal barrier needs to be removed, as a nationwide installation of renewable energy infrastructure requires investments of independent power producers (IPP) in addition to the state-owned Lebanese power utility EDL.
6.4.1 Integration of different Policy Fields

Using renewable energies and implementing efficiency measures represents the final stage of the technology chain. For Lebanon it would be of macroeconomic interest to also create incentives in other parts of the chain: For the purpose of technology development, research, development and demonstration projects should be initiated and supported in order to shape domestic technology expertise and to create examples of best practice. Regarding technology deployment, the government should take into consideration the establishment of comprehensive policy instruments for promoting renewable energy and energy efficiency.

Some Lebanese companies are active in the field of sustainable energy technologies. From perspective of industry policy and industrial development it could prove to be a successful strategy to foster the creation of new companies. As mid-term effect Lebanon would manage to provide domestic appliances.

6.4.2 Building on existing Approaches; linking Renewable Energy and Energy Efficiency

Lebanon is already experienced in renewable energy deployment in the form of solar water heaters. There is also experience in the procurement of efficiency appliances (CFLs). These are two fields that should further be used. Here it shows that the direct link between energy and end-consumers could be a powerful tool to boost sustainable energy utilisation. In terms of legislation, incentives and policy instruments, the combination of e.g. solar water heaters and energy efficiency (insulation of piping systems etc.) could prove successful. The basic approach on the combination of efficiency and renewables is that reducing overall energy demand brings down system costs for renewable energy technologies. This is especially true in the case of short pay-back periods. Such an integrated renewables-efficiency-approach on consumer level requires supplementary measures and exemplifies the need for integrated strategies and instruments: consumers need detailed information on the advantages of such approaches, therefore information campaigns are essential. The most important element of such an approach however lies on the side of energy costs: high levels of subsidisation are preventing such systems to become cost-effective. Hence a general discussion on energy subsidies needs to be initiated in Lebanon (see below).

6.4.3 Energy Efficiency Fund and Efficiency Standards and Labels

With regard to energy efficiency, adopting efficiency standards or mandating certain measures, such as thermal insulation of buildings or efficiency standards for electric appliances, are among potential policy options. Some standards have been used in Lebanon already, and they are to be made mandatory. In some fields however, there is still a lack of instruments. At the time being, the Lebanese construction law does not include provisions for heat insulation or other construction concepts, which facilitate retrofits of energy efficiency equipment. Although the Lebanese Ministry of Industry has accepted preliminary standards developed by LCECP, none have yet been adopted.

An energy efficiency fund is developed currently within LCECP (socalled National Energy Efficiency and Renewable Energy Fund (NEEREF)). In general funds proved to be effective means to foster developments. Such a fund can be supplied by tax earnings or from other sources. There is a broad bandwidth of possible fundings: loan guarantees, interest rate subsidies, training and capacity building programmes and more.

Many energy efficiency approaches can be implemented at very low costs. Due to budgetary restraints Lebanon should implement a bundle of respective measures. Among these are efficiency labels for...
household appliances, of which some have been introduced but not on mandatory basis. If once made mandatory, labelling could be supplemented by a top-runner approach, making more and more efficient appliances mandatory during the following years.

Building standards – especially in phases of reconstruction of large parts of housing infrastructures – are a very powerful approach to pave the way for a more efficient energy system. This is due to the long life-time of houses on the one side and to the large efficiency potentials on the other side. However, to make building codes and standards work they have to be mandatory and compliance has to be monitored. Such monitoring can cause high costs.

6.4.4 Targeting the Transport Sector

Currently there is no transport policy in Lebanon. However, the transport sector – including technologies (cars etc.) and infrastructures – is a key sector in terms of sustainable energy development. As parts of Lebanon are experiencing reconstruction, integrated spacial planning and transport infrastructure development should be closely linked. The goal is to create sustainable structures that allow low-intensive mobility. This is one key strategy to curb demand growth in mid- to long-term.

6.5 Energy Subsidies

At present, Lebanon’s energy sector is characterised by heavy subsidies, although the country is suffering from high costs of energy imports. Despite high debts, EDL maintains a social pricing system that provides electricity at low costs for small consumers. Low prices for electricity hide the true costs of these products and, therefore, would counteract incentives for investments in energy efficient technologies. In order to ensure an adequate impact of future policies for promoting renewable energy and energy efficiency, the Lebanese government should diminish distorting effects of the national energy pricing system. This step could significantly contribute to a reduction of the economic burden of Lebanon’s heavy reliance on energy imports.

Aiming at avoiding social distortions, it is suggested to chose a targeted approach for phasing-out energy subsidies. This process should be accompanied by measures to strengthen the population’s capability in dealing with an increase in energy prices. The United Nations Environment Programme (UNEP) et al. state that removing energy subsidies does not have to result in the abandonment of social policy goals. Instead, social policy goals could be achieved more effectively through alternative mechanisms involving direct welfare payments or investment in social services.

6.6 Summary of Recommendations

• Lebanon needs a comprehensive strategy on energy. Such a strategy should contain a discussion on the negative effects of increasing energy consumption and should also provide the general basis for energy-policy making in terms of import dependence, of domestic development potentials in the fields of renewable energies and energy efficiency and of the challenges the Lebanese society has to face in this context

• Creation of a governmental authority specialised on renewable energy and energy efficiency to coordinate and concentrate all related government activities.

• Development and implementation of a comprehensive awareness strategy to brief Lebanese decision-makers and the public on the benefits of renewable energy and energy efficiency.
Previous campaigns of the “Lebanese Centre for Energy Preservation Project” (LCECP) need to be continued and expanded with a strong role of the Lebanese government.

- Emphasising the link between renewables and efficiency to target mutual synergies.
- Realisation of capacity building measures, e.g. workshops or training seminars, to educate officials of relevant Lebanese authorities in designing and implementing effective and efficient policies for renewable energy and energy efficiency. These measures should include high interaction between domestic and international experts and brief Lebanese officials on the benefits of international mechanisms for technology transfer, such as the Clean Development Mechanism (CDM).
- Giving the possibility for non-state-owned power producers to participate in the Lebanese energy system by removal of regulatory barriers for renewable energy and energy efficiency.
- Adoption of comprehensive mechanisms for introducing renewable energy production and energy efficiency improvements.
- In order to ensure an adequate impact of future policies for promoting renewable energy and energy efficiency, the Lebanese government is recommended to reduce distorting effects of the national energy pricing system, e.g. low electricity tariffs. Such a process could be accompanied by measures strengthening the population’s capability in dealing with an increase in energy prices.
List of References

Karaki, Sami; Chedid, Riad (no year of publication given): Renewable Energy Country Profile for Lebanon, Beirut.
held at the Round Table MED 3 ENERGAIA, December 11th, 2008.
Annex 1

Mission Report
Mission Report

The country mission was successfully completed in the time span of 5 to 8 August 2009. The mission programme had been prepared with very good support from the Lebanese representative in RECREEE’s Board of Trustees.

The mission programme was as follows:

<table>
<thead>
<tr>
<th>Date</th>
<th>Programme Item</th>
</tr>
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<tbody>
<tr>
<td>5 Sept</td>
<td>Travel to Beirut</td>
</tr>
<tr>
<td>5 Sept</td>
<td>Internal project team meeting</td>
</tr>
<tr>
<td>6 Sept</td>
<td>Meeting at LCEC</td>
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<tr>
<td>6 Sept</td>
<td>Meeting with UNDP</td>
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<tr>
<td>6 Sept</td>
<td>Meeting at Ministry of Energy and Water</td>
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<tr>
<td>6 Sept</td>
<td>Meeting at Higher Council for Privatization</td>
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<tr>
<td>6 Sept</td>
<td>Meeting at EU Delegation</td>
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<tr>
<td>7 Sept</td>
<td>Half day Seminar</td>
</tr>
<tr>
<td>7 Sept</td>
<td>Internal project team meeting</td>
</tr>
<tr>
<td>8 Sept</td>
<td>Meeting at Electricity of Lebanon (EDL)</td>
</tr>
<tr>
<td>8 Sept</td>
<td>Return travel</td>
</tr>
</tbody>
</table>

Some stakeholder could not be visited, but participated in the half day seminar. A list of stakeholders is attached in the following Annex 2. Most of them (some 20 persons) attended the seminar and engaged in lively discussions.

The seminar was held in the meeting room of the Ministry of Electricity and the Director General for Energy, Dr. Fadi Comair gave a welcoming speech. The Ambassador of Denmark welcomed the participants on behalf of the Danish Government and outlined the context of the project in the Danish technical cooperation with MENA countries.

The seminar had three main objectives (1) to promote RCREEE in Syria, (2) to discuss with stakeholders the findings of the mission and (3) to introduce the participants to the ideas of Evidence Based Policy Making and Theory Based Policy Evaluation by giving a detailed presentation on that topic (Annex 5) and by presenting case studies illuminating the methodology (Chapter 5 above). Finally the seminar was used to give a preview on the three day workshop on EE and RE policy development. The presentation is attached in Annex 6.
List of Stakeholders
### List of Stakeholders

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Contact Person</th>
<th>Position</th>
<th>email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of Electricity and Water</td>
<td>Dr. Fadi Comair</td>
<td>Director General</td>
<td></td>
</tr>
<tr>
<td>Ministry of Electricity and Water</td>
<td>Mr. Mahmoud Barroud</td>
<td>Director General</td>
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</tr>
<tr>
<td>Danish Embassy</td>
<td>Jan Top Christensen</td>
<td>Ambassador</td>
<td></td>
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</tbody>
</table>
Seminar Programme
Under the Patronage of
The Ministry of Energy and Water

Danida, RCREEE, and LCEC
Have the pleasure to invite you to the seminar on:

Methodology and Policy for Energy Efficiency and Renewable Energies

Location: Ministry of Energy and Water (MEW)
Conference Room, Second Floor
Beirut, Lebanon

Friday, 7 August 2009, 9:00 - 1:00
Objective of the Seminar: The seminar serves the objective of the project to support RCREEE’s overall effort of providing member state administrations with better information and new planning tools and processes. The seminar will give an introduction to evidence based policy development and theory based policy evaluation for Energy Efficiency and Renewable Energy and the seminar will be used to discuss some preliminary findings in Lebanon.

The seminar will have the following structure:

1. Opening Speech, by Dr. Fadi Comair, General Director of Hydraulic and Electric Resources at the Ministry of Energy and Water (MEW)
2. Welcome by HE Mr. Jan top Christensen, Ambassador of Denmark
3. An Introduction to RCREEE, by Eng. Ashraf Kraidy, Senior Expert, RCREEE Interim Secretariat
4. Introduction to the Project and to the Seminar, by Dr. Florian Sauter-Servaes, Project Team Leader
5. Methodology: Evidence Based Policy Making and Theory Based Evaluation, by Professor Nigel Lucas, Senior Expert
6. Status of EE and RE Policies and their Development in Lebanon, by Mr. Ali Berro, Legal Advisor, The Lebanese Center for Energy Conservation (LCEC) and Professor Danyel Reiche, Senior Expert
7. Case study on economic policy evaluation, by Mr. Martin Ehrlich, Senior Expert and Professor Nigel Lucas, Senior Expert
8. Preview on the Three-day Training Workshop December 2009, by Mr. Martin Ehrlich, Senior Expert
9. General Discussion
10. Bilateral discussions to be continued over lunch
Presentation on Methodology
Evidence based policy making and theory based evaluation

Nigel Lucas
Contents

- Evidence based policy making
- Theory based evaluation
- The linkages
  - Theory
  - Indicators
- How we will adapt it
Evidence Based Policy Making?

- What is Evidence Based Policy Making?
- Why do we need it? What have we been doing before - making it up?
- What is evidence?
- I do not have the time or resources.
- Is it all I need?
What is Evidence Based Policy Making?

Many different definitions, but what it really means is just:

“An **approach** to policy development and implementation which uses rigorous techniques to **develop** and **maintain** a robust **evidence** base from which to develop policy options”.

All policies are based on evidence - the questions are:

- Is the evidence reliable?
- Are the processes by which evidence is turned into policy fit for their purpose?
Why do we need it?

• Policy often driven by prejudice or short-term political pressure
• Made by small groups – exhibits preferences and perceptions of this group – can be changed when group changes – may not be accepted by stakeholders - partial and unstable
• Foreign consultants and agencies often prescribe remedies from home with little thought whether they are appropriate. Mimicry is not policy.
• Agencies have their own agendas and visions that may conflict among themselves and with those of government
• Countries need well-resourced, in-house capabilities to analyse and evaluate policy and more transparent processes

• The perceived need is more stable and robust policy with greater acceptance
What is evidence?

- The evidence base must be both broad enough to develop a wide range of policy options, and detailed enough for those options to stand up to intense scrutiny.
- An evidence-based approach should show continuity between foresight, strategy, policy, and implementation.
- Evidence does not necessarily mean hard facts like scientific data, although the objectively verifiable evidence is important.
- Evidence is any information that can be used to turn policy objectives into feasible and effective policy instruments.
- Can distinguish three main components:
  - **hard data** (facts, trends, survey information)
  - **analytical reasoning** that processes data to illuminate problems
  - **stakeholder opinion** on an issue or set of issues.
- Research, analysis of stakeholder opinion, public perceptions and beliefs, cost/benefit analyses, economic and statistical modelling are important sources of evidence.
- Judgement of the quality of the methods that are used to gather and synthesise the information is vital.
Evidence and time horizons

- Often we work under pressure. Can only do what is reasonable
- Four options for research
  - Review existing research
  - Consult experts
  - Commission new research
  - Consider a wide range of fully costed and appraised options
- Operate on different time scales
Reconciling evidence and time

Longer-term policy and strategy development

- Procuring, managing and carrying out research to provide new evidence
- Scoping the issue, asking the question, deciding what sort of evidence is needed
- Interpreting & applying new or existing evidence, M&E of the policy or programme
- Assembling & communicating existing evidence

Evidence needed rapidly to answer pressing policy questions
Is it all I need?

Nine features of better policy making

• LOOK FORWARD
• LOOK OUTWARD
• INNOVATE
• SEEK EVIDENCE directly addressed by EBP&TBE
• BE INCLUSIVE
• BE JOINED UP
• MONITOR directly addressed by EBP&TBE
• EVALUATE directly addressed by EBP&TBE
• LEARN directly addressed by EBP&TBE
Good evidence is necessary, but not sufficient

There are policy processes that:

<table>
<thead>
<tr>
<th>Use good information</th>
<th>Use it well</th>
<th>Use it poorly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use poor information</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Need **evidence** and **process**
The process of evidence-based policy making (I)

• **Alternative** forms of intervention need to be reviewed and short-listed. Evidence of the success or failure of similar instruments in developed and developing countries needs to be studied with special emphasis on the conditions that created success and failure.

• There must always be a **base-case** against which alternatives are screened. Alternatives should include all available instruments.

• All the relevant potential **impacts** need to be identified and where possible, quantified.

• **Indicators** need to be established of what is expected from the policy measures. These indicators should cover outputs, outcomes and impacts.

• **Intermediate indicators** are important in helping understand how policies work, how measures interact and how they can be improved.
The process of evidence-based policy making (II)

• Impacts should be assessed in consultation with the subjects of policy
• The cost of compliance needs to be assessed. Consideration should be given to how these costs can be minimized.
• It is necessary to consider who pays the compliance costs; there are generally alternatives with different implications for equity.
• The procedures for compliance need to be worked out and for monitoring impacts.
• Quantitative analysis of impacts is essential. The analytical method most commonly used is economic cost-benefit analysis.
• Cost-benefit analysis should take into account opportunity costs of energy and external environmental costs.
• Multi-criteria analysis is a useful support to decision making
What is Theory-Based Evaluation?

- Theory-Based evaluation focuses on analysis of the **theoretical** or **logical sequence** by which a policy intervention is expected to bring about its desired effects.
- For instance, a theory-based evaluation might ask about the steps that are implicit between a policy **initiative** (e.g. introduction of minimum energy performance standards for electrical appliances) and the policy **outcome** (reducing energy and GHGs). The Figure represents the implicit theory of policy makers:

| Introduction of MEPS | Consumer is empowered to make a better judgement and change behaviour | Manufacturers are incentivised to make more efficient models | Market is transformed and inefficient devices become obsolete | Energy use and CO2 emissions fall; Domestic manufacture strengthened |

- The concept is similar to the logical framework for project evaluation, but because it depends on an explicit behavioural model it can handle not linear logical structures.
A project financed by the Ministry of Foreign Affairs of Denmark

Theory and the policy cycle

- Foresight
- Model
- Theory
- Evaluate
- Monitor
- Implement
- Evidence
- Reformulate
- Indicators
- Formulate
**Alternative theories**

<table>
<thead>
<tr>
<th>Introduction of MEPS</th>
<th>Consumers are indifferent to energy use – buy only on price</th>
<th>Manufacturers are obliged to make more efficient models</th>
<th>Market is swamped by poor quality smuggled goods</th>
<th>Energy use and CO2 emissions rise; domestic manufacture falls</th>
</tr>
</thead>
</table>

- Failure to be clear about the causal sequence by which a policy is expected to work can result in poor and even contrary outcomes
- Theory Based evaluation does not prevent us constructing a bad model but tells us what indicators we should examine to make sure things are going well
Indicators

Indicators need to be established of what is expected from the policy measures. This is vital for evaluation.

Indicators should cover:
• inputs, i.e. the financial, human, technical or organizational resources used in the endeavour
• outputs, (objectively verifiable indicators that demonstrate the progress made in implementing the measures, e.g. the creation of a minimum energy performance standard),
• outcomes (immediate effects on the regulated subject, e.g. the offer of new products and retooling of production lines) and
• impacts (direct measurements of the improvements that the programme is designed to bring about, e.g. more efficient products and lower energy use).
Intermediate indicators

- Impact indicators tell you if you are getting the results that you wanted
- Generally thought they are not sufficient in themselves
- Intermediate indicators are useful and indeed necessary to verify the underlying theory
## Indicators and the theoretical models (Labels and standards)

<table>
<thead>
<tr>
<th>Causal sequence</th>
<th>Indicators</th>
<th>Risks</th>
<th>Assumptions</th>
</tr>
</thead>
</table>
| **Development of standards and supporting measures** | - Administrative time and effort  
- Standards published and supporting measures in place  
- Consumer surveys show consumers and manufacturers change expectations | Inadequate accompanying measures; consumers unaware or unaffected | Manufacturers have confidence in regulatory system |
| **Manufacturers incentivised to make more efficient models** | - New investment and production measures ($)  
- Strengthened manufacturing capacity - inspection  
- Range of new products determined by survey |  |  |
| **Consumers choose better devices; do not seek non-compliant cheaper goods** | - Administrative time and effort in ensuring compliance ($)  
- More discriminating purchases  
- Consumers purchase better quality products — consumer and market surveys |  | Low cost non-compliant goods excluded from market |
| **Electricity consumption lowered** | - Consumer normally pays more ($)  
- Better capital stock in households — household surveys; market studies  
- Lifetime cost decreases  
- Electricity consumption decreases  
- CO2 emissions decrease  
- Manufacturing base strengthened |  |  |
## The price of carbon

<table>
<thead>
<tr>
<th>Price per tonne</th>
<th>Price per kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>0$/tonne</td>
<td>$0 / kW</td>
</tr>
<tr>
<td>2$/tonne</td>
<td>$34 / kW</td>
</tr>
<tr>
<td>10$/tonne</td>
<td>$170 / kW</td>
</tr>
<tr>
<td>50$/tonne</td>
<td>$850 / kW</td>
</tr>
</tbody>
</table>
Who pays and how?

- Energy efficiency is win-win. No real issue – it is a sensible target of public policy intervention. Lower costs; benefits to state and company.

- Renewable energy; it is not so clear. In many instances; definitely more costly than alternatives.

- Why should Lebanon pay the difference?

- If not Lebanon then who and how? CDM? Policies and Measures (PAMs)

- Without clarity on who should be and is willing to accept the additional cost , it is hard to have entirely coherent renewable policy
Economical, Technological and Environmental Impact Assessment of National Regulations and Incentives for Renewable Energy and Energy Efficiency

A project financed by the Ministry of Foreign Affairs of Denmark

A toolbox for policy formulation

1. Introduction
2. Objectives and requirements for RE&EE support schemes
3. Overview of the toolbox
   a. Evidence-based policy making
   b. Theory-based evaluation
   c. Cost-benefit analysis
4. Case studies
   a. Introduction
   b. Regulatory framework for renewables
   c. Incentive schemes for solar water heaters?
   d. Finance through the CDM (landfill)
   e. Market transformation strategy for renewables (pv)
   f. Energy efficiency obligations
   g. Energy efficiency fund
   h. Energy audits?
   i. ESCOs
   j. Labels and standards
   k. Public awareness campaigns?
5. Combining instruments
   a. Legislation
   b. Agency
   c. National strategy
6. Technical assistance
Many thanks for your attention
Preview on Information Workshop
Economical, Technological and Environmental Impact Assessment of National Regulations and Incentives for Renewable Energy and Energy Efficiency

A project financed by the Ministry of Foreign Affairs of Denmark

Preview of the Three-day Information Workshop
- November 2009 -

Martin Ehrlich
Contents of the Presentation

• Objective of the Impact Assessment Project
• Objective of the Training Component
• Audience for the Training Event
• Modules of the Training Event
• Programme for Senior Policy Decision Makers
• Programme for Policy Analysts and Consultants
Objective of the Impact Assessment Project

• To achieve:
  – Rapid implementation of cost-effective policies and instruments
  – Accelerated deployment of cost effective RE & EE technologies
  – Through:
    • Increased penetration of „evidence based“ policy formulation and „theory based“ policy evaluation

• Specific objectives of the project:
  – Comparative analysis of EE & RE policies
  – Provision of impact assessments of EE & RE policy and promotion instruments in RCREEE countries
  – Strengthening of the methodological basis for policy formulation
  – Provision of recommendations for adjustments of the policy making process
Objective of the Training Component

- Presentation of the methodological basis:
  - Evidence based policy making and planning procedures
  - Theory based evaluation and procedures for application in practice
- Country specific conclusions
- Recommendations regarding the policy making process
- Presentation of Case Studies
  - Case Study on EE promotion
  - Case Study on RE promotion
Audience for the Training Event

• 1st day: Senior decision makers
  • Presentation of the Impact Assessment Project
  • Key elements of the methodology
  • Recommendation of the country assessment

• 2nd & 3rd day: Policy analysts and RE & EE experts
  • Detailed presentation of the synthesis report and country assessments
  • Discussion of case studies with presentation of the methodological basis
**Economical, Technological and Environmental Impact Assessment of National Regulations and Incentives for Renewable Energy and Energy Efficiency**

A project financed by the Ministry of Foreign Affairs of Denmark

**Modules of the Training Event**

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Programme for Senior Policy Decision Makers

- **Presentation of the Impact Assessment Project**
  - Scope of the project and organisation
  - Value of international comparative analysis
- **Key elements of the methodological basis for policy preparation and assessment**
  - Need for a methodological basis
  - Benefits of a sound methodological basis
  - Short and long term requirements
- **Presentation of international practice**
  - Policy making process
  - Policy implementation and impact assessment
- **Result of the country review**
  - EE and RE policy making process
  - Policy implementation
  - Observations and recommendations
Programme for Policy Analysts and Consultants

• Presentation on methodological basis (international practice and practice in RCREEE countries)
  • Evidence based policy formulation
  • Theory policy evaluation
    Including: Economic evaluation of policy instruments / Integration of climate policy benefits in RE & EE policy analysis

• Presentation of case studies (including the discussion of case studies prepared by participants)
  • Presentation of selected policy instrument
  • Required theoretical framework and selected approach
  • Result of the case study
  • Comment on country-specific conditions and challenges
Information Regarding the Available Project Results

- Key-documents for RCREEE countries
- Country Reports with the assessment of EE & RE policies and instruments
- Synthesis Report
- Contacts within the RCREEE countries for networking and professional contacts
- Case Studies on evidence based policy preparation and theory based policy evaluation
Energy Situation in Lebanon
Energy Situation in Lebanon

Lebanese Energy Mix and Demand Projections

In 2006, the Lebanese total primary energy supply (TPES; 4.8 Mtoe) was dominated by fossil fuels, with petroleum products (4.4 Mtoe) representing about 91% of the total. Hydropower and combustible renewables and waste covered around 1% or 3% respectively of the TPES. The composition of Lebanon's TPES is shown following Figure 1.

![Fig. 1: Lebanon's Total Primary Energy Supply by Fuel](image)

Lebanon lacks all major traditional energy resources and, therefore, heavily depends on energy imports. The country's demand for petroleum products needs to be fully covered with imports. In 2006, net oil imports added up to 93,000 barrels per day (12,015 toe per day). Lebanon's striking reliance on oil imports and the costs of these imports are a heavy burden for the Lebanese economy. In 2002, the total costs of oil imports to Lebanon added up to more than $1 billion. Lebanon's state-owned electricity utility, Electricité du Liban (EDL), pays approximately $500 million per year for fuel imports. By comparison, the 2007 Gross Domestic Product (GDP) of Lebanon (at current prices) totalled $24.6 billion. As power demand is forecasted to grow in the coming years, the costs of energy imports are about to further escalate unless Lebanon succeeds to reduce its dependence on fossil energy imports.

Electricity

1 Publicly available energy statistics of the International Energy Agency (IEA) or the U.S. Energy Information Administration (EIA) do not give information about the share of natural gas in Lebanon's total primary energy supply. Therefore, natural gas is not included in the figure.

2 Due to several reasons, the Lebanese authorities have not provided recent data on the energy sector to the project staff. Because of this lack of data, some of the information quoted in the following sub-sections is rather old.
Lebanon’s power sector is dominated by Electricité du Liban, a vertically integrated state-owned company, with some concessions made to smaller companies. The latter include two small hydro-generation concessions and three small distribution concessions. Political problems and the destruction of large parts of the national power infrastructure during the civil war (1975-1990) have left EDL in high debts. In 2007, EDL’s debts totalled $2.4 billion. The Lebanese government passes loans in the range of $200-500 million per year in an effort to prevent EDL from going bankrupt. Notwithstanding these financial concerns, EDL offers a social pricing system with low power tariffs for small consumers. The financial problems of EDL have led to debates about possible reforms of the power sector. In 2002, the national government decided to abide by the recommendation of the World Bank to unbundle, deregulate and restructure the sector while increasing the share of private power producers. As a consequence, a regulation for restructuring the power sector (Law No. 462) was adopted, which, however, is yet to be implemented.

In 2006, total Lebanese power production cumulated to 9,287 GWh. Adding electricity imports of 929 GWh, total domestic power supply accumulated to 10,216 GWh. In the past decade, Lebanese net power production has grown by around 13% while the installed power generation capacity indicated slight variations. In 2006, the installed capacity for power generation was 2,400 MW compared to 2,225 MW in 1999. The figure below illustrates the composition of Lebanon’s 1999 power plant fleet by generation technology.

**Fig. 2: Lebanon’s Installed Power Generation Capacity by Power Technology**

Power plants equipped with steam turbines (1,063 MW) constituted by far the largest share of the Lebanese power plant sector, followed by combined cycle plants (580 MW) and gas turbine plants (306 MW). Installed capacities of hydropower plants totalled 276 MW. As Lebanese power demand exceeds supply, there are frequent blackouts during peak demand times. Facing an escalating growth of power demand in the coming years, additional power generation and distribution capacities will be needed. In 2001, Chedid et al. (2001) projected Lebanon’s installed power capacity to increase to 4,148 MW by 2015; electricity consumption is estimated to reach 14,087 GWh at the same time. However, this scenario does not take into account damages of the power infrastructure and the
economic impact resulting from Israel’s bombing in 2006. Nonetheless of this recent political event, power demand is expected to grow in the coming years. EDL is trying catch up with with the growth through implementing infrastructure projects, for example the installation of a 220 kV super grid which shall reinforce the distribution network. Furthermore, EDL has strengthened the inter-connectivity of the Lebanese grid with Syria by setting up two 220/400 kV overhead lines with an overall capacity of 400 MW.

Crude Oil and Natural Gas

As mentioned above, Lebanon is not an oil producing country and, therefore, strongly reliant on oil imports. At the time being, the transport sector consumes about 64% of the crude oil imports, followed by the residential sector (24%). International statistical surveys of energy resources of the World Energy Council (2007) and BP (2009) do not show proved recoverable oil reserves in the Lebanon. However, old and recent seismic tests, particularly in the Northern off-shore area, indicated positive results. Further tests and assessments are required to identify the potential and the competitive value of these potential occurrences.

Until 1988, the Lebanese oil sector was organised as a monopoly controlled by the government but at present, eight companies possess licenses for importing, storing and distributing petroleum products. Regulations controlling and specifying the quality of petroleum products are prepared and issued by the Ministry of Energy and Water (MEW)/General Directorate of Petroleum.

There are two state-owned refineries in Lebanon. However, both facilities are old and stopped operation in 1975 due to the civil war, the foreign occupation and other hindering political events. As a consequence, Lebanon became an importer of petroleum products whereas it used to be a refinery centre in earlier years, which upgraded parts of the crude oil exported from Saudi Arabia or Iraq by pipelines. Lebanon tries to ease the impact of potential disruptions of oil imports by storing oil in tanks, which are situated along the coast. At the time being, the capacity of storing oil products in Lebanon is more than 3.2 million barrels (410,800 toe) distributed in 210 storage tanks all over the coast. The government is planning to expand the national storage capacity through reclamation of 800,00 m² of land near Dora, a suburb of Beirut.

Similar to the oil sector, previous tests have indicated potential natural gas reservoirs in the Northern off-shore area of the country but more in-depth assessments are needed to evaluate the quantity of the reserves and their exploitability under current market conditions. At present, there is no domestic natural gas production and all natural gas, mainly LPG for domestic and commercial use, is being imported. The government has signed an agreement with Syria to cover parts of Lebanon’s natural gas demand with Syrian gas imports. Furthermore, a gas pipeline from Syria to the Deir Ammar-Beddawi power plant in the North of Lebanon was set up in early 2005. The pipeline has a capacity of 1.5 million m³ per day and might be raised to around 3 million m³ per day, according to Syrian officials. Another important linkage between Lebanon and natural gas exporting countries of the Middle East is the new “Arab Gas Pipeline” (AGP). The AGP links Lebanon with Egypt, Jordan and Syria and will include Turkey by the end of 2010.

Renewable Energy

The usage of renewable energy sources plays a rather subordinated role in Lebanon’s energy policy. There is a long tradition of hydropower generation in Lebanon, with most existing plants being between 40 and 70 years old. Including both small- and large-scale plants, their single generating
capacities range from 1.1 MW to 109.5 MW.

In 2006, hydropower contributed approximately 8% of the country’s power production. In comparison to the past, this percentage indicates a massive reduction of the relative contribution of hydropower to Lebanon’s power supply as hydropower plants produced up to 79% (1969) of Lebanon’s electricity in previous decades. The percentage of hydropower declined as growing power demand was mainly satisfied by imported electricity and thermal power stations. Increased water consumption for domestic, industrial and agricultural applications also contributed to the relative decrease of hydropower-based power. In the coming years, the share of hydropower is expected to decrease further, as rainfall is continuously declining. The Ministry of Energy and Water has developed a 10-year programme to develop national water resources (2005-2015), which, however, focuses on water needs for irrigation. In 2005, about 21 new dams with a total investment of $547 million were planned. However, only one of the dam projects will be designed for electricity production while the remaining projects are planned for water flow control and the provision of fresh drinking water.

Lebanon possesses great potential for solar energy applications. Daily sunshine hours average at 8.7 or 9.5 hours in interior or coastal regions respectively during the period from January to September. This is equivalent to a daily power generation potential ranging from 6 to 8.7 kWh per m$^2$. Due to abundant solar resources, the dissemination of solar water heating systems has been steadily evolving in the past. Figure 6 illustrates annual installations of solar water heating systems in Lebanon and the total area covered by these installations. Increasing installation rates and acceptance by the local population are mainly a result of cost savings and simplicity of use. However, acceptance has been fostered by a joint campaign of the Ministry of Energy and Water and the “Lebanon Energy Preservation Centre Project” (LCECP), which was funded by several international organisations (see section 2.5). Nonetheless, the dissemination of solar water heaters is at an early stage. In 2003, merely 2.8% of Lebanese households used solar thermal water heaters, either alone or with a back-up system, while 82% were found to use electricity-based heaters. The MEW is in the process of developing a national solar atlas to facilitate the development and promotion of further solar projects. More than 80% of the installed solar systems are locally manufactured by about ten Lebanese companies. A project titled “Applications of Solar Thermal Energy in the Mediterranean Basin” (ASTEMB) which did run until 2004 outlined scenarios for the future dissemination of solar water heaters in Lebanon and elaborated recommendations for a national plan for the development of solar thermal energy. According to the scenarios, 500,000 m$^2$ of solar collectors could be installed by 2025 in case of cost reductions, optimised conditions for collector installation, public awareness campaigns, a more balanced energy pricing system and the creation of incentives. The ASTEMB project team recommended several policy instruments for promoting the technology, such as a fund for the support of investment in solar thermal energy, creation of a solar quality label and tax exemptions. However, it seems that none of the recommendations have been implemented by the Lebanese government yet.
As no wind atlas is available, the Lebanese potential for disseminating wind turbines can be hardly estimated. So far, few individual attempts have been made on installing small-scale wind turbines (100s of watts) in the South, Mount Lebanon and Beqaa, a valley in East Lebanon. The largest wind turbine installed is a 31 kW turbine in the area of Ammiq. However, due to a lack of prior wind studies, the turbine operates at low availability rates. Another 7.5 kW wind turbine was installed in the area of Khiam, South Lebanon, but was destroyed during shellfire in 2006. Wind Energy SAL, a Middle East provider of renewable energy technologies, is in the process of installing four 4 kW wind turbines, two of which are being erected on the rooftops of residential buildings.

Energy Efficiency

Lebanon’s primary and final energy intensity are high compared to the EU-27. However, both indicators are significantly below the regional average of the Middle East.
Fig. 4: Lebanese Primary and Final Energy Intensity in Comparison to the Regional Average of EU-27 and the Middle East

In 2002, United Nations Development Programme (UNDP), the Lebanese Ministry of Energy and Water and the Global Environment Facility (GEF) started the “Lebanese Centre for Energy Conservation Project” which is running until December 2009. The initiative’s major aim was to establish the “Lebanese Centre for Energy Conservation” (LCEC) – a national centre for energy conservation. In June 2007, the Minister of Energy and a representative of the UNDP signed an agreement on establishing the LCEC. The Centre will be affiliated with the MEW and receive funding from the UNDP for a three-year period after its foundation. Afterwards, it shall be funded by the government. A draft law for this purpose is under preparation but its adoption is expected to take two to four more years. The Centre shall monitor and audit all energy consuming projects and publish certifications to all energy efficient equipment. Moreover, the Centre will elaborate strategies related to energy conservation, encouraging the use of energy efficiency equipment.

Besides establishing the LCEC, the joint project of UNDF, MEW and GEF has initiated the following activities for improving energy efficiency in Lebanon:

- Realisation of more than 85 energy audits in public buildings, including the Ministry of Energy and Water. The audit showed that the MEW could save approximately 22% of its energy bill.

- Proposal for energy efficiency standards for five appliances (electric/gas/solar water heaters, refrigerators, split room air conditioners and compact fluorescent lamps/CFL). The standards for refrigerators, water heaters and split room air conditioners have been accepted by the Lebanese Ministry of Industry which is responsible for national standards but have not been made mandatory yet

- Launching of five national awareness campaigns, including dissemination of newsletters, brochures, posters and media coverage.
- Capacity building measures, e.g. for the adoption and application for thermal standards of buildings.

- Work on the development of a national fund for energy efficiency and the development of solar micro credits.

- Fund raising for energy efficiency and renewable energy projects.

Another major project is the “Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon” (CEDRO) sponsored by UNDP and the Spanish Development Agency (AECI). The project runs for 2.5 years and focuses on the installation of efficient and renewable-based lighting systems, the implementation of energy audits and roof insulation in public buildings. In collaboration with the Lebanese Ministry of Finance, the UNDP has started a project for the development of a sustainable energy strategy for Lebanon. The first project phase involves the implementation of sustainable energy applications, energy efficiency measures and solar thermal applications in all public buildings to create a best practice model, which encourages similar investments in the private sector. The second phase involves the creation of an enabling environment in terms of financial mechanisms and legislative reforms that would encourage a market transformation towards sustainable energy use.

The Greek Embassy in Lebanon has donated approximately $1 million for a project titled “Towards Energy Efficiency Reconstruction” which supports the energy efficient reconstruction of buildings by facilitating the implementation of thermal water heaters and efficient lightning (LCECP 2009).

Similar to the projects described above, most ongoing activities on energy efficiency and renewable energy in Lebanon have been started by or with support of international donors. The national government has not yet adopted targets or regulations to promote energy efficiency in Lebanon. A draft law has been prepared based on the Tunisian energy efficiency law but is yet pending. Due to this lack of a framing policy framework which carries energy efficiency measures from a project-based approach to market dissemination, energy efficiency improvements in Lebanon proceed at a slow pace and have a rather weak impact.