Implementation of Renewable Energy Technologies – Opportunities and Barriers

Egypt Country Study

New & Renewable Energy Authority
Egypt

NREA

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List of Abbreviations

AEDC	Alexandria Electricity Distribution Company.
ARC	Agriculture Research Center.
ASRT	Academy of Scientific Research and Technology.
BBOE	Billion barrels of oil equivalent.
BOOT	Build Own Operate Transfer.
CAPMAS	Central Agency for Public Mobilisation and Statistics.
CNG	Compressed Natural Gas.
DANIDA	Danish International Development Assistance.
DKK	Danish Kroner
DRTPC	Development Research and Technological Planning Center.
ECEP	Energy Conservation and Environment Project.
EEA	Egyptian Electricity Authority.
EEAA	Egyptian Environmental Affairs Agency.
EESBA	Egyptian Energy Service Business Association.
EGPC	Egyptian General Petroleum Corporation.
EREDO	Egyptian Renewable Energy Development Organisation.
ERI	Electronics Research Institute.
ESCO	Energy Service Companies.
FEI	Federation of Egyptian Industries.
GDP	Gross Domestic Product.
GEF	Global Environment Facility.
GHG	Greenhouse Gas.
GNP	Gross National Product.
GoE	Government of Egypt.
GOFI	General Organisation for Industrialization.
HV	High Voltage.
IEA	International Energy Agency, OECD.
IPP	Independent Power Producers.
ISCCS	Integrated Solar Combined Cycle System.
KFW	Kreditanstalt Fur Wiederaufbau.
LE	Egyptian Pounds.
LPG	Liquefied Petroleum Gas.
LRMC	Long Run Marginal Cost.
LV	Low Voltage.
MEE	Ministry for Electricity and Energy.
MOP	Ministry of Petroleum.
MV	Medium Voltage.
MW	Megawatt.
NGO	Non-Governmental Organisation.
NIB	Notional Investment Bank.
NRC	National Research Center.
RE	Renewable Energy.
NREA	New and Renewable Energy Authority.
OECD	Organisation for Economic Co-operation and Development.
OEP	Organisation for Energy Planning.
OPEC	The Organisation of the Petroleum Exporting Countries.
PT	Piastre (1/100 LE).
PV	Photovoltaic.

R&D	Research and Development.
REA	Rural Electrification Authority.
RES	Renewable Energy Sources.
RET	Renewable Energy Technologies.
RUE	Rational Use of Energy.
SCE	Supreme Council of Energy.
SEC	Specific Energy Consumption.
SPS	Sector Programme Support.
STEG	Solar Thermal Electricity Generation.
TIMS	Tebbin Institute for Metallurgical Studies.
TOE	Tons of oil equivalent.
TPES	Total Primary Energy Supply.
TFC	Total Final Consumption.
TWh	Terawatt hour.
UHV	Ultra high voltage.
UNDP	United Nation Development Programme.
UPS	Unified Power System.
USAID	United States Agency for International Development.
USD	US Dollars.
UNEP	United Nation Environmental Program.
CSD	Commission for Sustainable Development.
SCE	Supreme Council of Energy.
DSWH	Domestic Solar Water Heating.
IPH	Industrial Process Heat.
STWH	Solar Thermal Water Heating.
STEG	Solar Thermal Electricity Generation.
BREEP	Bulk Renewable Energy Electricity Production.
ISCCS	Integrated Solar Combined Cycle System.
FAO	Food and Agriculture Organization.
GOST	General Organization for Sewage Treatment.
NGO	Non-Governmental Organization.
LBP	Large Biogas Plants.
UNFCCC	United Nation Framework Convention on Climate Change
PH	Process Heat
REFT	Renewable Energy Field testing
ASET	Arab Solar Energy Technology
BCD	Basisa social development association
CEOSS	Coptic Evangelic Organization for Social Services
DDC	Desert Development Center
Gost	General Organization for Sewage Treatment
Eos	Egyptian Organization for Standardization & Quality Control
ADB	Asia Development Bank

1. Introduction

Through the current world concern with searching about new energy resources; supporting Renewable Energy Technologies (RETs) already in use, increasing the efficiency of current systems and promoting Renewable Energy Technologies world wide, the UN and other international organisations are supporting a lot of projects and programs especially in developing countries. This report presents the results of the "Implementation of Renewable Energy Technologies, Project - Opportunities & Barriers" which was initiated jointly by UNEP, UNDP and RISØ National Laboratory and sponsored by DANIDA. UNEP Collaborating Centre on Energy and Environment at RISØ (UCC/RISØ) was the co-ordinator for the project. The Project included case studies for three countries; Egypt, Ghana and Zimbabwe. In addition to the direct results of the national studies, the project aimed to provide input to the preparatory process of the Commission for Sustainable Development (CSD) in its ninth session in 2001.

The project used case studies of renewable energy implementation projects to analyse the reasons for success or failure of specific projects or technologies. In particular the study aimed to identify possibilities for "removing" the main barriers and thus "promoting" increased implementation of (RETs), and to "generalise" the experiences from the case studies and produce results that can be disseminated and utilized further in a planned second phase.

The specific objectives for Egypt Country Study are:

- To determine, on the basis of analysis of the past experience, the barriers against implementation of RETs in Egypt, and to identify the favourable conditions and actions required for such implementation.
- To apply the knowledge gained and results of the analysis of past projects for a detailed analysis of barriers to a chosen set of potential RETs implementation projects with view to success.
- To identify specific RET projects for implementation including necessary actions to overcome identified barriers.

The study was prepared during the period from April 99 to September 2000 by a team from New & Renewable Energy Authority (NREA) staff in Cupertino with Dr. Jyoti Painuly from UCC/RISØ.
The key team members from NREA are:-

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This report presents in chapter 3, after the executive summary in chapter 2, a review of the national energy sector development plans and policies, the current status and local capabilities of the commercialized RETs applications in Egypt, and an

evaluation of the surveyed past projects. Chapter 4, 5 provides three selected RETs applications, identifies barriers, opportunities, key issues and actions necessary for implementation of selected RETs projects. The annexes 1-9 include the analysis of the responses of the interviewees for each selected applications, while annexes 10-12 present three proposals for three different applications.

2. Executive Summary

2.1 Energy Statistics and Policy

Fossil fuels, in addition to hydropower and non-commercial fuels as firewood, agricultural wastes and dried dung, are considered as the main energy resources in Egypt. Petroleum fuels (e.g. oil and natural gas) are the most important energy sources for Egypt at present and would be for many years to come. The total production of oil and natural gas has been increased about 60% over the last 18 years, where in 80/81 the total production was 33 MTOE[1]; meanwhile it became 55.482 MTOE in 98/99.

Hydropower resources are applied to supply a considerable amount of the current electric energy consumption in Egypt. The energy generated from the High dam, Aswan dams, Esna and Naga Hammady barrage power stations in 1998/99 was 15.3 TWh[2] representing 22.5% of the total electricity generated. This Hydropower is not counted within the term of renewable energy share.

Uranium and Thorium have been discovered in Egypt. Special authority for nuclear materials was established under the Ministry of Electricity and Energy to accelerate its exploration and exploitation.

The total commercial energy demand of Egypt has increased from about 3 MTOE in 1959 to 30 MTOE in 1998/1999 with an average annual growth rate of 4.57% .

The Supreme Council of Energy (SCE) is responsible for formulation of energy policy in Egypt. It consists of the ministers of electricity and petroleum, and works in consu1tations with the parliamentary committee for industry and energy. The energy policy in Egypt focuses on the following:

- Enhancement of natural gas utilization.
- Adjustment of energy prices and removal of subsidies.
- Energy conservation and efficient energy use.
- Promotion of renewable energy utilization.

2.2 Renewable Energy Strategies

In the early 1980's the government of Egypt recognised the fact that the traditional energy resources would be inadequate to meet future needs. Consequently a national strategy for the development of energy conservation measures and renewable energy applications was formulated in 1982 as an integral element of national energy planning. The New & Renewable Energy Authority (NREA) was established in 1986 to be a focal point for renewable energy activities in Egypt. The renewable energy strategy targets to supply 3% of the electricity production from renewable resources by the year 2010.

It is obvious that the implementation of such a strategy will be an essential element of the national plans for achieving sustainable development and protection of the

[1] Million Ton Oil Equivalent
[2] Terra Watt Hour

environment via upgrading energy efficiency and replacing conventional polluting resources by renewable resources.

Apart from the recognised achievement in renewable energy technologies development, demonstration and commercialisation start, the effective market penetration was below expectations. The total energy savings by renewable energy technologies count for almost 0.395 MTOE annually; over 39% of it is due to the started commercialisation of some renewable energy applications mainly Domestic Solar Water Heating (DSWH), Industrial Process Heat "IPH", and electricity generation (Solar & Wind).

To achieve the Egyptian government strategic goals, to satisfy the energy needs for the country's development plans, and to make sure that renewable energy takes its proper place in the sustainable supply and use of energy for greatest benefit of all the following measures have been set for the development of renewable energy:

- Assisting and promoting the real local, regional and global environmental benefits of renewable energy.
- Research / transfer, development, demonstration and testing of the different technologies.
- Establishing testing and certification facilities and development of local standards and codes.
- Encouraging improved information and education on renewable energy.
- Involving young people in information and studying on renewable energy with a parallel closely integrated programs.

2.3 RETs Applications in Egypt

Mostly all the solar, wind and biomass technologies and applications were demonstrated and field-tested. Other renewable energy resources and technologies are still in the research and development phase. The following section presents a brief review on the commercially exploited RETs applications in Egypt.

2.3.1 Solar Thermal Technologies:

The first action enabling the achievement of the strategic objectives was the assessment of the solar resource in Egypt, several studies and research audits indicated that Egypt enjoys excellent solar availability; the annual global solar radiation is between 900-2600 kWh/m^2. The resource assessment led to the preparation of the Egyptian Solar Atlas, which includes a typical meteorological year data and maps.

Solar Thermal technologies were identified to be among the main renewable energy technology options that can make an impact in achieving the strategy targets. Intensive efforts were directed mainly at three options:

- Solar Thermal Water Heating (STWH) for domestic and commercial sectors.
- Solar thermal systems for Industrial Process Heat (IPH).
- Solar Thermal Electricity Generation (STEG).

1. Solar thermal water heating (STWH) for domestic and commercial sectors:
In 1980, in order to introduce the technology to the Egyptian market, the Ministry of Electricity & Energy imported 1000 DSWH systems, using flat-plate collector technology. In the same year, the first private sector local manufacturing was started. Since then DSWH systems are manufactured locally. Currently about 200,000 families are using DSWH systems in Egypt.
In 1992 NREA established the out-door solar thermal laboratory which is currently the main research, testing and certification facility for solar thermal applications in Egypt. More than seven local manufacturers are now working in the field.

Over 65% of the total energy saving by renewable energies in the last decade was due to the commercialisation of solar thermal technologies, mainly domestic solar water heaters.

2. Solar industrial process heat (IPH):
The sectoral energy consumption in Egypt has always shown that the industrial sector consumes almost 50% of the total national primary energy.
Industrial process heat (IPH) accounts for more than 60% of the total industrial energy consumption distributed among the different types of industry. Several studies have been attempted to forecast the future projections of the annual demand for industrial process heat. Several scenarios have been proposed depending on expectations of the Egyptian economy structure and industry situation. Two demonstration projects were implemented by NREA and another one is under implementation.

3. Solar thermal electricity generation (STEG):
NREA has developed an ambitious program for large - scale electricity generation using Integrated Solar Combined Cycle Power Plant to help meet local electricity needs and expected electricity export to Europe.
In 1995, NREA initiated a program for Bulk Renewable Energy Electricity Production Program (BREEPP) for large-scale power generation, which focussed mainly on Solar Thermal Electricity Generation (STEG) using mature and appropriate technologies. The first Egyptian Integrated Solar Combined Cycle System (ISCCS) power plant with a capacity of 126 MW in Kuraymat is under implementation. The GEF/World Bank funded the incremental cost with a target date of operation during 2004. Two other similar projects are anticipated to be implemented before 2010

2.3.2 Photovoltaic (PV) Technology:

Electricity demand is growing rapidly in Egypt, so efforts are directed at developing the use of renewable energy technologies in rural and remote areas. Photovoltaics for electricity production and pumping of groundwater seem to be the most cost-effective option for the currently energy requirements at these areas.

Status of PV applications in Egypt:
The present use of PV in Egypt is characterised by few traditional and /or professional applications financed on commercial terms and numerous donors. In 1995, total installed capacity of PV applications was estimated to around 1MWp. Currently

however, several projects and plans totalling more than 10MWp are under preparation.

In general terms the status for PV applications in Egypt can be grouped into four categories:

- Remote / professional services (telecommunication, railroad, navigation, and or AIDS).
- Donor assisted applications (mostly water pumping & treatment).
- Private sector applications (billboards & small farms).
- NREA & other governmental body applications.

2.3.3 Wind Energy Applications

In the field of wind energy, the following preparatory activities were undertaken:

- Assessment of Wind Resource.
- Conducting financial & economic and environmental feasibility studies.
- Establishment of training programs, and
- Establishment of demonstration projects.

These were followed by an active program, started by NREA and supported by many international donors, for the implementation of large - scale grid connected wind farms. The project aims at installing 600 MW of wind turbines by the year 2010. The first 300MW are scheduled to be in operation by 2004. Sixty three (63) MW out of the 300MW have already been installed and connected to the grid.

For the purpose of training and capacity building, the Wind Energy Technology Center at Hurghada was equipped with the necessary training facilities to serve as the first training center in the Middle East and Africa, in the field of wind energy technology. Also this center is used for monitoring and testing both large and small-scale wind turbines. The center is also considered as a national and international training, research and certification center.

2.3.4 Biomass Technologies

In Egypt the total biomass resources potential reaches 40 million Ton / year. The biomass resources contribute more than 3.6 MTOE / year (primary energy). Due to the expected applications of the efficient new modern technologies on the available biomass resources this contribution effect will be increased in the future.

Status of Biomass Projects:

With few exceptions, biomass activities in Egypt have been focused mainly on small-scale biogas plants with a digester volume ranging between 5 and 50 m^3. Application of larger systems has been limited and unsuccessful.

On the large-scale level, biogas activities have not moved away from the laboratory or pilot stage, so only few larger plants were constructed. One of them was a 170-m3 digester in EL-Giza Army Camp, constructed in the beginning of the 1980 by Food & Agriculture Organization (FAO). Presently a huge biogas plant is being constructed by General Organization for Sewage Treatment (GOST), but it is not related to the Biogas programs.

Plant residues are considered the most important traditional fuel in the Egyptian rural area. So the biomass laboratories at NREA Testing and Certification Center are

equipped with an advanced briquetting system to convert ligneous plant residues into an alternative solid fuel. These briquettes are uniformly shaped easy to be transported and stored, and have better physical and combustion properties than that of the residues in their unprocessed state. They are also free of insects and diseases' carriers. Eventually this will produce an improved form of solid fuel that can be used efficiently to save more quantities of alternative energy sorts as petroleum and electricity.

2.4 Barriers & Opportunities

Based on the following criteria three RETs applications were chosen for detailed barriers and opportunities analysis:

- Adequate resource base for the RET (solar, wind, biomass, ...etc).
- Available technologies and their costs.
- Commercial viability and financing (public, private, international).
- Environmental impacts and benefits.
- Socio-economic impacts, including job creation.
- Coverage of both centralised and decentralised options.

The selected RET applications are:

- Domestic solar water heating systems.
- Electrification of remote areas using PV systems.
- Large-scale Biogas systems.

Beside the literature review, questionnaires and interviews were applied to manufacturers, organisations and agencies, users and owners, and targeted Users. Responses received through interviews / questionnaires were analysed, and the barriers were classified to these categories:

- Economic & financial barriers,
- Awareness & information barriers
- Technical barriers
- Market barriers
- Social barriers
- Institutional & policy barriers

The following are the results of analyzing the stakeholders' responses and comments for each of the three selected applications.

2.4.1 Domestic Solar water Heating Systems

Although Domestic Solar Water Heating systems are generally straightforward, questionnaires administered and interviews conducted under this project have indicated that minor faults can lead to serious problems, especially when they are not detected early.

The additional information collected from various parties revealed that there is an urgent need to restore the confidence of both existing and potential users. Many installations have not performed as expected due to low level of awareness and some technical problems aggravated by lack of maintenance.

The solar industry, until now, has not been able to prove DSWH systems as an environmentally attractive and potentially economic means of providing targeted users with hot water. The detailed barriers' analysis showed that self-sustaining DSWH market growth needs dedicated and efforts from both the industry and other interested parties.

A thorough understanding of the market situation is rather difficult, however the overall analysis shows many converging points:

- About 26.5% of the key players (users, manufacturers and experts) indicated that the economic barriers are the main barriers for DSWH industries.
- The awareness/information barriers were ranked second with about 24% of stakeholder ranking it as such.
- Technical barriers were chosen as the third most important set of barriers by about 22% of the stakeholders, however some experts and users pointed out that it would be ranked first if the DSWH systems were more common. But manufacturers argued that the lack of knowledge about the system design and operation together with seldom maintenance are the cause of the problem.

Recommended actions to remove DSWH barriers:

- Development of effective public awareness and promotion programs that depend mainly on market surveys and studies and concentrate on media especially TV and newspapers. The concept, the benefits and the operating conditions required should be clear to end-users through these media strategies.
- Allowing systems and spare parts to be available in shops and markets especially outside Cairo. This should be accompanied with availability of maintenance centres. Also dissemination and promotion of DSWH systems could be done through different exhibitions held in syndicates, hotels, clubs … etc.

Demonstrating systems can be presented in "wide impact" places, like cities councils, Clubs, big factories, conferences halls, stadiums…etc.

- Some form of federation, union or society which brings together representatives of users, companies, financial sources, policy makers and researches can be very useful to co-ordinate efforts in the a. m. aspects.
- Financial support from the governmental, private sectors and donor agencies to the DSWHS should be put in place. Availability of credit facilities with low interests and reduction of prices for competing considerations must be the main concern.
- Incentives corresponding to the subsidies given to electricity and natural gas consumers could be introduced. This may be in the form of subsidising the initial cost or reducing users taxes or electricity invoice for DSWH systems users.
- Encouraging local manufacturing by reducing taxes and customs duties on solar water heating system components in addition to production requirements and necessities.
- The current manufacturing standards and specifications should be revised carefully to include quality control and assurance components as well as proper installation requirements. New comprehensive standards are required urgently.
- A program or mechanism to solve the problem of the already installed systems in the new cities should be prepared and implemented. It should be the result of co-operation between all the responsible ministries and authorities as well as the

manufacturing companies and dealers. The program should include some mechanism for informing the inhabitants about the systems and their regular duties (cleaning and checks) and without charging them any additional costs (that is especially where the system costs were paid in several places without operating them).

2.4.2 PV Rural Electrification:

The following are barriers to the dissemination of Solar Home Systems (SHS):

- **High dissemination costs**

The target group for rural solar electrification is the population, which lives in dispersed rural dwellings, where there is low percentage of wealthy households. Dwellings are far apart so the transaction costs for commercial dissemination, installation and after-sales services are very high. These costs are estimated to be about 30% of the total costs of PV systems.

- **Lack of information**

In spite of the efforts in recent years, there is still a dearth of information regarding the services that PV can provide. PV is still only an exceptional solution in rural programmes for potable water supply.

- **Tariffs' system**

The tariff system of utilities does not reflect the real cost of rural electrification. Tariffs for electricity consumption are identical in rural and urban areas, although the costs of supplying electric energy are much higher in the countryside. In Egypt there are even lower tariffs for small consumers and this has led to a situation where rural households in particular pay small amounts for their consumption of grid electricity. The SHS as an alternative offers less comfort and less number of energy services than the grid. In addition, it is more expensive than the grid electricity. For these reasons, it could happen that rural population groups refuse photovoltaics and demand to be connected to be electrical grid.

- **Taxes and import duties**

As in many other developing countries, SHS is considered a luxurious product and therefore charged very high import duty. Sometimes, tax exemptions are limited to equipment, which is imported in the framework of co-operation projects, public projects, programmes, or the activities of Non-Governmental Organisations (NGOs). This is of course unfavourable for commercialisation. Imported equipment and materials have to be purchased in foreign currency, which may cause problems to businessmen in developing countries. If some components such as charge regulators, and batteries are produced locally, importation of these components is often charged high duties, to protect the market for local manufacturers. Such a decision may cause severe problems, if the local technology proved to be unreliable.

- **High capital costs of the PV system**

The capital of PV systems is very high especially to those people in the rural remote areas, with somewhat low standard of living, and most of them are so poor that they cannot pay for these systems. At the same time there is no suitable financing mechanism to support them.

The opportunities and the potential for contribution of PV systems in the rural development programs are:

- High potential of small villages with no access to the grid.
- The government policy plans for electrifying all small villages and attachments.
- Egypt has very high solar radiation.
- The technical and technological experiences are available.

Actions to overcome the PV rural electrification barriers are:

- Arranging high level, dedicated and continuous awareness campaigns should be launched to bring out the potential merits of PV systems and applications.
- Integrating PV rural electrification projects with other development programs.
- Instituting a national program that integrates all PV rural electrification projects.
- Manufacturers, suppliers, and agents should have their representatives and centers near the consumers.
- Creation of new financial schemes.
- More government – supported market incentives to encourage commercial development and deployment.

2.4.3 Large Biogas Plants (LBP)

The main barriers to disseminate LBP are:

- **Information and awareness barriers**:

- Lack of communication with the interest groups regarding environmental work.
- Lack of awareness about the (LBP) economic and environmental impacts

- **Institutional barriers**

- Lack of co-operation between the involved institutions and organisations.
- Absence of NGOs role

- **Economic and financial barriers**

- Competing petroleum products and electricity are subsidised and available in the countryside.
- The high capital costs of (LBP) with comparison to other organic waste treatment systems
- There is no economic evaluation for the positive environmental impact of the (LBP).
- Unavailability of land within the targeted sites.

- **Technical barriers**

- Quality problems with raw material.
- The quick change of animal growing projects activities
- The absence of national developing, adapting and manufacturing programs for LBP to fit local conditions.
- Lack of local technical experts for design and construction.
- Lack of training facilities.
- Lack of maintenance facilities

Actions to overcome the LBP barriers are:

- Setting up a co-ordinating committee for planning and implementing an action plan for LBP. Instituting a national action program for LBP implementation within a defined period to clarify whether technological development, agricultural,

environmental, co-operatives and energy - related interests, could lead forward to the creation of financially competitive LBP.

- Setting up a co-ordinating committee for planning and implementing the action plan for LBP.
- Strengthening the co-operation between the concerned ministries, authorities, institutions and organisations through involving them in the national action plan on logical basis with defined tasks (Ministry of Agriculture, Ministry of Electricity & Energy, Egyptian Environmental Affairs Agency (E.E.A.A), Social fund for development & NREA…etc.)
- Awareness about the necessity of LBP as a source of clean energy, waste treatment, economic feedback and environmental & social benefits.

2.5 Conclusion:

The case study revealed that; for the first application (DSWH) the main barriers are; the economic barriers followed by the awareness / information barriers, then the Technical and Institution barriers. For the PV rural electrification, the most important barriers are; the economic and financial barriers, the awareness and information barriers then the technical barriers.
For the third application; the large-scale biogas systems, the main barriers are the institution & capacity, economic, policy and awareness / information respectively.
According to the project results the main actions that could be taken to overcome the barriers and make use of the available opportunities are:

1- Economic / Financial

- Creation of new financial schemes for the RETs applications components and systems.
- Reducing the taxes and duties for the components and / or materials needed for RE systems.
- More government-supported market incentives to encourage further commercial development and deployment of RE technologies are needed to help overcome market reluctance to invest in RE systems.

2- Technical

Setting rules and legislation for quality assurance, standardisation, and certification for all the RE components and systems.
Manufacturers, suppliers, and agents should have their representatives and centres near the consumers and between them.

3- Information and Awareness

Development of effective public awareness and promotion programs such as demonstrating systems, some printed materials (leaflets, brochures…etc), training courses, seminars, presentations and workshops for targeted users, small-scale laboratories in schools and universities.

4- Donor's Support

The support of the international organisations is urgently needed especially for setting monetary values for emission's reduction to subsidise RETs.

3. RET projects & Energy Policies

3.1 Review of Existing Policies and Frameworks:

3.1.1 Background

Egypt is a north African/Mediterranean country extending between latitudes 22° - 33° north and longitudes of 25° - 35° east with long coasted areas on the Red Sea and the Mediterranean Sea. The total area is about one million Km^2 with more than 94% desert. The 1998 population is about 63 million persons, increasing at 2.08% rate of growth, with 55% living in rural areas of the country. Egypt's development plans require intensive programs in land reclamation, food production, industrialization, and community development. Primary energy requirements have drastically increased during the 1980's and it is expected to exceed the indigenous conventional resources in the near future.

3.1.2 Energy Statistics and Economic Indicators:

Fossil fuels can be considered as the main energy resources in Egypt, in addition to hydropower and non-commercial fuels as firewood, agricultural wastes and dried dung. Petroleum fuels; oil and natural gas "NG", are the most important energy sources for Egypt at present and for many years to come. The total production of oil and natural gas has been increased about 60% in the last 18 years, where in 80/81 the total production was 33 MTOE[3], meanwhile it became 55.482 MTOE in 98/99.

Great efforts have been exerted in the field of oil exploration since 1968. At the end of 98/99 the reserves from crude oil were 3.81 BBOE[4]. The present annual production of crude oil is in the order of 39.318 MTOE. It is expected that oil reserves in Egypt would be sufficient, at present rate, for little more than 11 years. Although.

Egypt is not a member of OPEC, oil exports represent one of the main foreign currency incomes of Egypt. The share of the petroleum sector was about 6.0 % of the total GDP[5] of Egypt in 1998/1999.

Natural gas is used as fuel and as raw material in petrochemical and fertilizer industries. It has a significant role in electricity generation in Egypt. The reserves of which are estimated to be about 7.3 BBOE. The current level of the annual gas production is in the order of 13.190 MTOE accounting for 22.39% of the total production of primary energy sources. The share of natural gas in the total fuels consumed in the thermal power stations has increased from only 4% by the end of the seventies to about 64% in 98/99, Meanwhile, it was about 33% in 80/81. It is expected that the anticipation of NG will to increase in the near future due to using hybrid energy systems, especially for electricity generation. So, a national pipeline network is already constructed to transport the gathered NG to centers of consumption.

Hydropower resources are already applied to supply a recognized amount of the current electric energy consumption in Egypt. The energy generated from the high

[3] Million Ton Oil Equivalent.
[4] Billion Barrels Oil Equivalent.
[5] Gross Domestic Product.

dam, Aswan dams, Esna and Naga Hammady barrage power stations was 15.3 TWh[6] representing 22.5% of the total electricity generated. Hydropower resources are already used to supply some of the electric energy needs. It played significant role in satisfying Egypt's energy needs in seventies by providing more than two thirds of the electricity demand. Since, the late eighties the situation has been completely reversed with using oil and NG. Also, it is not counted within the term of renewable energy resources.

Uranium and Thorium have been discovered in Egypt. Special authority for nuclear materials was established under the Ministry of Electricity and Energy to accelerate its exploration and exploitation.

The total commercial energy demand of Egypt has increased from about 3 MTOE in 1959 to about 29.541 MTOE in 1998/1999 with an average annual growth rate of 4.57%.

The total primary energy consumption was about 42.188 MTOE in year 98/99, and it is expected to be about 45 MTOE by year 2005. Figure 1 shows the growth of the total commercial energy consumption in the last five decades.

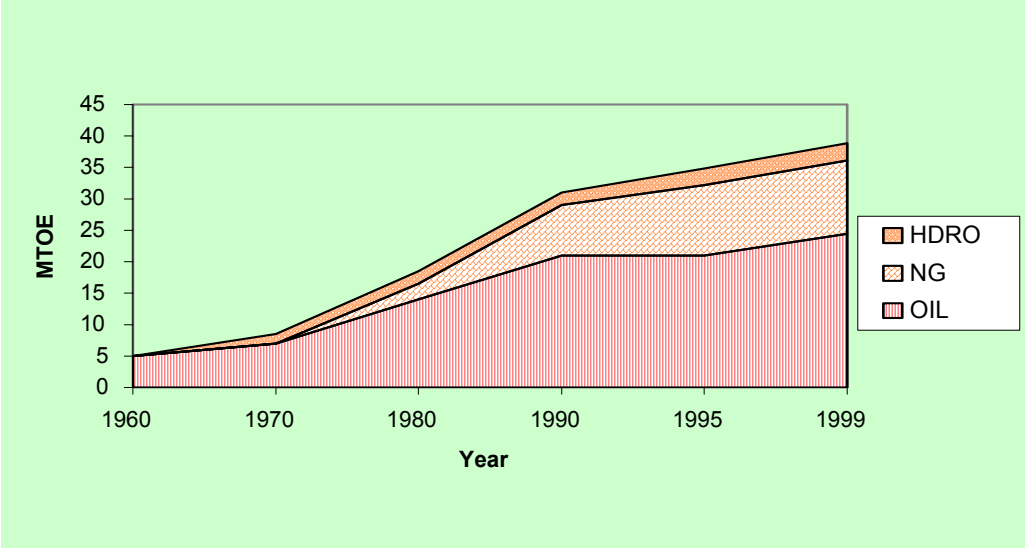


Fig. (1) The growth of the total commercial energy consumption in the last five decades.

3.1.3 Energy Policy:

The Supreme Council of Energy "SCE" is mainly preparing the energy policy. It consists of the ministers of electricity and petroleum, with consu1tations in the parliamentary committee for industry and energy. In some cases, the donors and their activities within the energy sector are influencing the policy. The energy policy in Egypt focuses on the following:

- **Enhancement of natural gas utilization.**
- **Adjustment of energy price and removal of subsidies.**
- **Energy conservation and efficient energy use.**
- **Promotion of renewable energy utilization.**

[6] Terra Watt Hour

Enhancement of natural gas utilization:

As mentioned before NG has been taking a key role in the country's energy policy, because it can improve the overall energy efficiency and environmental quality of Egypt.

The energy policy of Egypt has been developed to promote the expansion of natural gas utilization to substitute liquid fuels in various economic sectors, especially the reserved from oil is limited.

The following targets have been established:

- Increasing oil exports especially fuel oil.
- Achieving self-sufficiency in LPG[7].
- Establishing important strategic industries relying on natural gas as a fuel such as fertilizers and steel industries.
- Reducing petroleum imports of some products as gas oil used in power generation.
- Reducing environmental pollution.

To reach those targets, the following set of strategies have been pursued:

- Extending the national pipeline of natural gas grid from 1,000 km too more than 2,700 km.
- Expanding local gas market and developing gas demand including for the power plants.
- Unconventional applications are currently promoted to be natural gas based.
- Promoting foreign investments in gas exploration, and production.
- Encouraging private sector participation in different aspects of the gas indents, such as building CNG[8] fuelling stations and converting vehicles to use CNG.

Adjustment of energy prices and removal of subsidies:

Energy pricing is one of the most important and critical issues that affecting Egypt's economy. The energy prices in Egypt were kept relatively constant and even decreasing in real values for a long time since the early 1960s to the mid of the 1980s and considerably lower than the international market prices to promote industrial and agricultural growth during that time. This was done through subsidization.

The lower energy prices together with the development needs of the Egyptian economy have encouraged the consumers to consume more energy than necessary. The result was the achievement of high levels of energy consumption growth rates and increase in national energy subsidies.

Since 1986/87 the government is taking steps to reduce the subsidies by increasing the energy prices gradually to cover the Long Run Marginal Cost (LRMC) for electricity. The international traded equivalents for petroleum products and the economic costs for natural gas.

In early 1994, the weighted average electricity tariff as a percentage of LRMC was about 80% and currently the ratio is closer to 90%. The weighted average of petroleum product prices is at about 100% of the internationally traded equivalents. The gas tariffs cover about 90% of the economic costs.

[7] Liquefied petroleum gas.
[8] Compressed NG.

Energy Conservation and Efficient Energy Use:

Several organizations are currently responsible of conducting energy conservation programs in different sectors of the Egyptian economy partly through donor assistance. These activities include energy audits, fuel switching, combustion efficiency improvement, efficient use of household appliances, specific energy consumption standards for industrial products, power factor improvement, use of efficient lighting systems and energy pricing policies.

Promotion of Renewable Energy Utilization:

The government of Egypt has realized in early 1980's the fact that the traditional energy resources will fall short to satisfy their future needs. A national strategy for the development of energy conservation measures and renewable energy applications have been formulated in 1982 as an integral element of national energy planning.

The updated renewable energy strategy targets to supply (3%) of the electricity generation by the year 2010 mainly from solar and wind, with additional contributions of other RE applications such as solar water heating in both domestic and industrial sectors, water pumping and desalination by wind and photovolatic (PV) rural electrification in remote areas and biomass applications.

The growing demand for electric energy to satisfy economic and social development plans necessitates to add installed capacity reached to about 6% annauly up to 2010. This means that adding about:

800 MW	annually up to 2004
1000 MW	annually between 2005 – 2010

such expansion plans give a room enough for a considerable share of electricity generation from RE resources.

It is obvious that the implementation of such strategy will be an essential element of the national plans for achieving sustainable development and protection of the environment via upgrading energy efficiency and replacing conventional polluting resources by renewable resources.

It is due to the economic reform conditions of Egypt that development rates in different economic sectors has practiced reductions leading to lower projections of the primary energy consumption. Apart of the recognized achievement in renewable energy technologies development, demonstration and commercialization start, the effective market penetration was below expectations. The total energy savings by renewable energy technologies count for almost 0.395 MTOE annually, over 39% of it is due to the started commercialization of some renewable energy applications mainly "DSWH", "IPH", and electricity generation (Solar & Wind).

This is due to the fact that most of the efforts during the last decade has been directed towards institutional building, field testing, technology adaptation and the inception of the local industrialization of renewable energy equipment, the strategic plans are periodically reviewed and updated to accommodate the results of the on-going activities and development.

Within the frame of the energy policy to achieve the expansion of the life expectancy of conventional energy resources, diversification of energy supplies mix and limitation of future growth in greenhouse gas emissions, the electricity sector presented its 20-year plan up to 2017 through the following targets:

- Improve the generation efficiency, by reducing the specific fuel consumption from 220 grams of oil equivalent to 175 grams.
- Reduce losses in production, transmission and distribution of energy.
- Extension and renovation of power generation, particularly remote areas and new cities.
- Encourage power installations by BOOT system.
- Increase local manufacture of equipment for the electricity sector.
- Diversify sources for power production in order to preserve oil resources.

3.1.4 Targeted Actions and Measures:

To achieve the Egyptian government strategic goals, and to satisfy the energy needs for the country's development plans, Egypt has directed intensive efforts since the mid 1980's towards the following:

- Make sure renewable energy takes its proper place in the sustainable supply and use of energy for greatest benefit of all.
- Encouraging programs for developing renewable energy resources and utilization.
- Identification of appropriate mechanisms and formation of specialized bodies to effectively implement national plans in the renewable energy field.
- Promoting business opportunities for renewable energy projects and their successful implementation.
- Adopting to the extent possible measures that can help abatement of the energy sector negative environmental impacts.

As well the strategy set called for the development of renewable energy resources particularly solar, wind and biomass through specific measures for development activities including:

- Assisting and promoting the real local, regional and global environmental benefits of renewable energy.
- Research / transfer, development, demonstration and testing of the different technologies.
- Establishment of testing and certification facilities and development of local standards and codes.
- Encouraging improved information and education on renewable energy.
- Involving young people in information and studying on renewable energy with a parallel closely integrated programs.

3.1.5 Institutions and Organizations operating in the Energy Sector:

Many institutions are operating in the Egyptian energy sector. The Major Active Egyptian Organizations in the Field of Renewable Energy are:

- **Supreme Council of Energy.**
- **Ministry of Planing.**
  National Institute of Planing.

- **Ministry of Electricity and Energy.**
  New & Renewable Energy Authority (NREA).
  The Hydro-Power Authority
- **Egyptian Industry.**
  General Organization for Industrialization.
  The Egyptian Standardization Authority.
  Industrial Companies.
- **Arab Organization for Industrialization.**
- **Ministry of Education.**
  Universities.
  Foreign Relation Cooperation Unit.
- **Supreme Council of Universities.**

- **Ministry of Scientific Research.**
  Academy for Scientific Research and Technology.
  National Research Center
- **Ministry of Agriculture.**
  Agriculture Research Center.
- **American University at Cairo.**
  Desert Development Center.

3.2 Literature survey:

Reviewing the national studies and reports related to existing renewable energy projects and evaluating their situation, reasons for their success or failures the following is a summary for the commercialized technologies in Egypt.

3.2.1 Solar Thermal Technologies:

Resource Assessment: The first action enabling the achievement of the strategic objectives was the assessment of the solar resource in Egypt, several studies and research audits have indicated that Egypt enjoys excellent solar availability, the annual global solar radiation is between 1900-2600 kWh/m^2. In the Egyptian Solar Atlas, a typical meteorological year data and maps were issued, Figure 2 shows the annual average of global solar radiation in Egypt.

Encouraged by its proven rich solar resource and in view of the energy demand projections and the progress accomplished in the Egyptian industries in the last two decades, Egypt has shown great interest in solar technologies. In the following sections a review of the available information on the existing projects will be introduced.

Solar Thermal technologies were identified to be among the main renewable energy technology options that can impact in achieving the strategy targets. Intensive efforts were directed mainly to three options:

- Solar thermal water heating (STWH) for domestic and commercial sectors.
- Solar thermal systems for industrial process heat (IPH).
- Solar thermal electricity generation (STEG).

Over 65% of the total energy saving by renewable energies in the last decade was due to the commercialization of solar thermal technologies, mainly domestic solar water heaters.

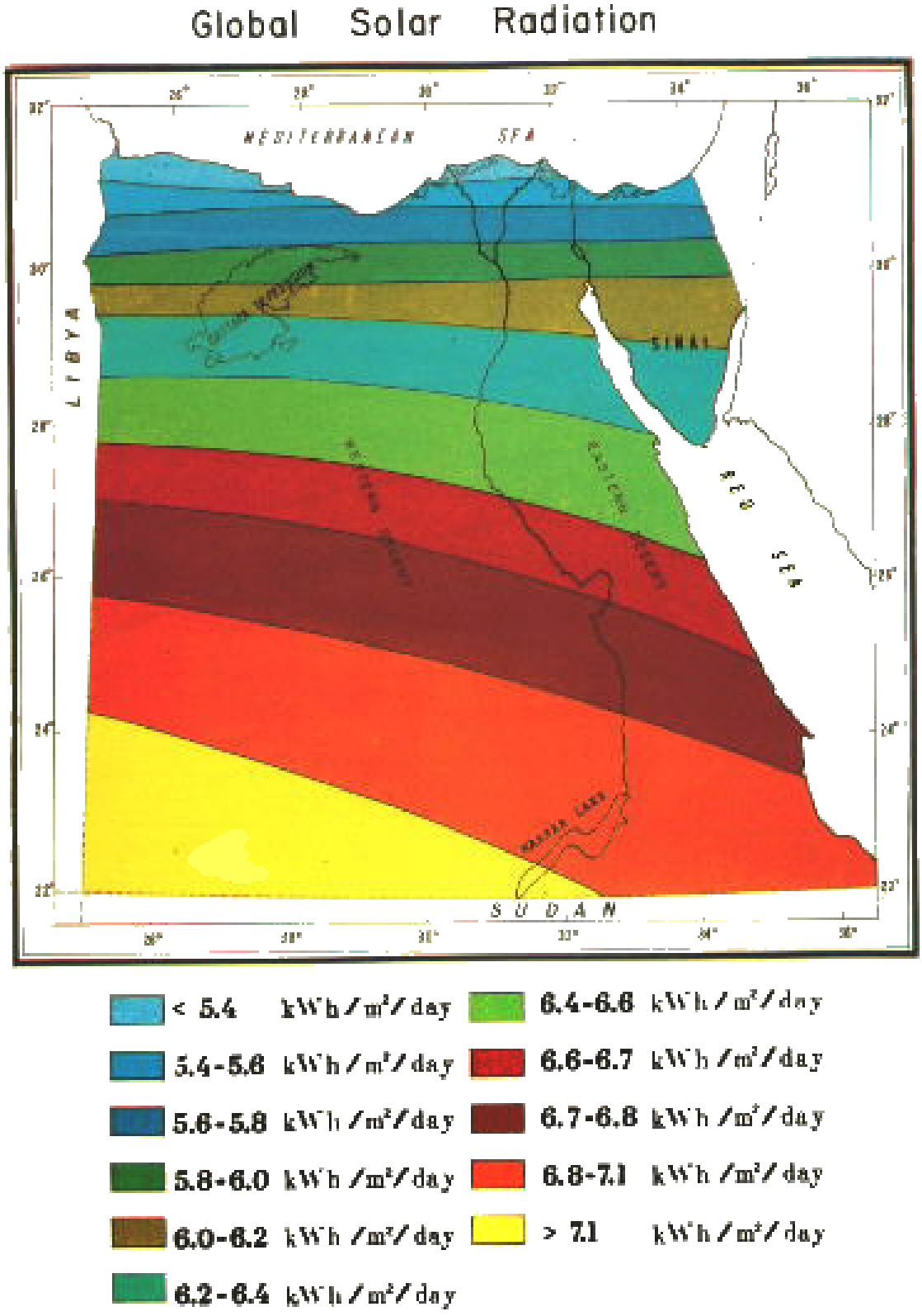


Fig. (2): The annual average of global solar radiation

3.2.1.1 Solar thermal water heating (STWH) for domestic and commercial sectors:

Solar energy can be converted to low-temperature heat up to 80^{o}C by relatively simple methods. The given temperature level conditions the scope of the applications. These include hot water supply, space heating and air conditioning in residential, public and industrial buildings and process heat for agriculture and industry. Among these domestic solar water heating (DSWH) proved to be accepted and can be applied on a reasonable scale.

In 1980, in order to introduce the technology to the Egyptian market, the Ministry of Electricity & Energy imported 1000 DSWH systems, using flat-plate collector technology. In the same year the first private sector local manufacture started. DSWH systems are manufactured locally since then. About 200,000 families are using DSWH systems currently in Egypt using about 400,000 m2 of collectors' area.

In 1992 NREA established the outdoor solar thermal laboratory which is currently the main research, testing and certification facility for solar thermal applications in Egypt.

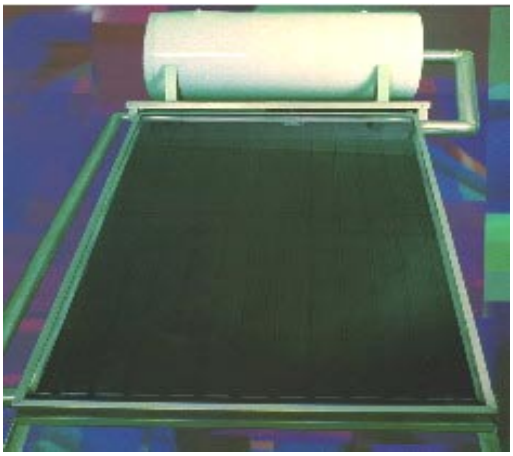


Fig. (3) An Egyptian DSWH system

Manufacturers and Major Customers:

More than 7 local manufacturers are now working in the field, most of them started in the 80s decade and owned by the private sector with relatively small investment.

The major identified customers were identified to be:

- New cities housing units.
- Tourist establishments.
- Conventional residential buildings in some cities.
- Governmental and public enterprise establishments.
- NGOs buildings.

Product and price:

DSWH systems manufactured by the various companies are approximately similar; typical area is about 2 m^2 with storage tank 150 litres and electric backup element of 2 kW. The total price of the typical 150 litres system varies from 1500 to 2200 Egyptian pounds.

Fuel Saving:

It is estimated that about 80,000 TOE are saved annually by the used DSEH systems.

Reduction in CO2 Emissions:

It is estimated that about 190,000 Ton CO_2 are saved annually.

3.2.1.2 Solar industrial process heat (IPH):

The sectoral energy consumption in Egypt has always shown that the highest consumption is in the industrial sector. The final energy consumption in Egypt in 1998 was around 47% for industry, 31% for transportation sector, 19% for residential

and commercial sectors, 1% for agricultural sector and 2% for other sectors, as shown in Table 1 and Figure 4.

Table 1. Final Energy Consumption. ***(MTOE)**

Sector	Years		
	96/97	97/98	98/99
Industry *	12.766	13.782	13.743
Household & Commercial	4.840	5.202	5.652
Transportation	7.576	8.236	9.113
Agriculture	0.304	0.317	0.32
Government & utilities	0.626	0.713	0.714
Total	26.112	28.250	29.541

* Including coal

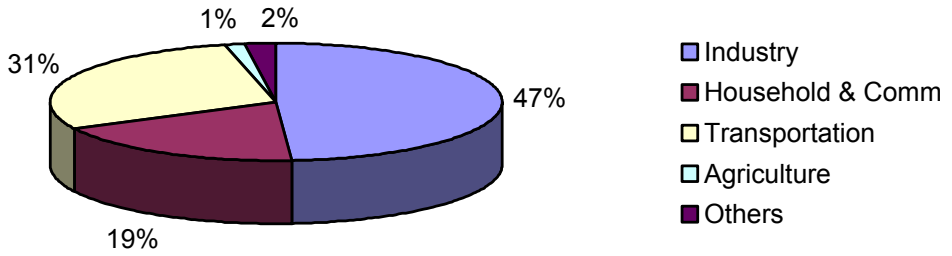


Fig. (4) Final energy consumption by Sector 1998-1999.

The industrial sector consumes almost 50% of the total national primary energy consumption. Such consumption is distributed in 1996/97 among oil fuel 54%, natural gas 25%, electricity 13%, and coal 8%. Moreover several studies have proved that about 20-30% of the industrial energy consumption is wasted due to low maintenance, inefficient processes and other reasons, with waste heat being the largest source of waste.

Industrial process heat (IPH) consumes more than 60% of the total industrial energy consumption distributed among the different types of industry. Several studies have attempted to forecast the industrial process heat demand. Several scenarios have been proposed depending on expectations of the Egyptian economy structure and industry situation.

The most agreeable and convincing estimations are as follows:

The industrial sector energy demand is expected to increase from nearly about 10 MTOE in 1995 to about 15 MTOE in 2012.

Industrial process heat demand is expected to increase from nearly about 7 MTOE in 1995 to about 10 - 11 MTOE in 2012.

Moderate temperature ranges of (80-150 ^{o}C) are estimated to have the largest percentage share of total IPH of about 50%. Followed by high temperature ranges

(>300 ^{o}C) with a share of about 40% of total IPH. Followed by low temperature ranges (<80 ^{o}C) with a share of about 7%, and finally medium temperature ranges (150-300 ^{o}C) with a share of only about 3.3%.
The chemical sector holds the largest IPH potential for temperature ranges of (80-300 ^{o}C) with a potential share of about 46% of total IPH demand of that range followed by textile sector with a share of about 37% then food sector with a share of about 11%.
For medium temperature ranges (150-300 ^{o}C), the textile sector holds the largest IPH potential of about 56% followed by food and chemical industries of a share about 36% and 5% of total IPH respectively.
For temperature ranges of (80-150 ^{o}C), the chemical sector holds the largest percentage share of about 49% followed by textile sector of about 36%, food sector of about 9%, refractory sector 3% and finally metal sector of only about 2%.
Gas oil total energy and process heat (PH) demand is expected to increase from about 1.9 MTOE in 1995 to about 2.5 MTOE in 2012. Fuel oil total energy and PH demand is expected to increase from about 3.6 MTOE in 1995 to about 5 MTOE in 2012. Meanwhile, natural gas total demand is expected to increase from nearly about 3.1 MTOE in 1995 to about 5.5 MTOE in 2012, the corresponding figures for PH demand are 1.6 MTOE in 1995 to about 2.8 MTOE in 2012.

Demonstration of Solar IPH in Egypt:

To satisfy the strategic objectives, NREA formulated a program for field-testing and dissemination of "Solar Industrial Process Heat and Waste Heat Recovery System" in the Egyptian industry. The first two projects implemented through this program are:

The Poultry Processing Plant Project:

The United Chicken Co., Ministry of Agriculture, hosts the project. Finance was through the Renewable Energy Field Testing project "REFT" jointly by NREA and USAID.

The project basic objectives are to demonstrate and field test Solar Industrial Process heat and waste heat Recovery system in food industries. It incorporated the design, construction, operation, training and testing of the system.

Fig (5) SIPH and Waste Heat Recovery Project in Food Industrial Sector

The main subsystems are Solar Water Heating System, Waste Heat Recovery System and Meteorological Data Acquisition System.

Project Energy Saving: The project saves about 345 T.O.E/yr. Treated water is also saved as a result of reuse of condensate steam.

Reduction in CO_2 Emissions: It is estimated that about 900 Ton CO_2 are saved annually.

Project Status: The project started in May 1990, and it is operating effectively since then. The average saving recorded counts for about 30% of the plant total energy consumption. Some technical problems concerning maintenance and operation were recorded and overcame by NREA and the plant staff.

Helwan Textile Project:

The Misr Helwan Textile Co., Ministry of Industry, hosts the project. Finance was through the Renewable Energy Field Testing project "REFT" jointly by NREA and USAID.

The project basic objectives are to demonstrate and field test Solar Industrial Process heat and waste heat Recovery system in Textile industries. It incorporated the design, construction, operation, training and testing of the system.

Fig (6) SIPH and Waste Heat Recovery in Textile Industrial Sector

The main subsystems: Solar Water Heating System, Waste Heat Recovery System and Meteorological Data Acquisition System.

Project Energy Saving: The project saves about 565 TOE/y in case of one shift operation.

Reduction in CO_2 Emissions: It is estimated that about 4800 Ton CO_2 are saved annually.

Project Status: The project started in Feb. 1990, and it is operating effectively since then. The acquired Operation and maintenance experiences proved to be useful for evaluation of other projects design, site selection and especially the point of the environmental conditions; (e.g. the problems of industrial smog and cement particles in the air which precipitate on collector's surface).

Studies to forecast through field energy audits the potentials of SIPH and waste heat recovery systems for six industrial sub-sectors through 24 industrial company were done. According to the studies results one company in pharmaceutical industry was selected for building solar industrial process heat plant. Conceptual design and feasibility study for the SIPH plant in the selected company is done. Conceptual design selected for the plant depends mainly on parabolic trough technologies for medium temperatures.

3.2.1.3 Solar Thermal Electricity Generation (STEG):

In 1994, NREA initiated a program for Bulk Renewable Energy Electricity Production Program (BREEPP) for large-scale power generation mainly focusing on Solar Thermal Electricity Generation (STEG) through mature and appropriate technologies.

In 1995, NREA, Egypt Electricity Authority (EEA) and the Ministry of Electricity & Energy (MOEE) completed an assessment and identification study for the Solar Thermal Electricity Generation "STEG" potentials which concluded that:

1- Total accessible potential for national grid connected "STEG" systems in Egypt is tremendous and far exceeds all practical expectations for implementation. Priority is given to the areas having higher solar radiation intensity and access to both electrical grids & natural gas network.

2- Integrated Solar Combined Cycle System "ISCCS" using parabolic trough solar technology with a conventional gas turbine combined cycle is the most appropriate system for Egypt's first plant. The choice of solar technology for the next plants will depend upon the competitive state of art and the procedure of implementation at the time of commencement.

In 1996, The Egyptian Cabinet of Ministers approved the MOEE plans for the first ISCCS power plant.

In 1997, two pre feasibility studies were performed for the first "ISCCS" plant at Kuraymat with a capacity of about (150) MW through the European Community (EC) funded *INTERSUDMED* project for "Renewable Energy Electricity Generation in The Southern Mediterranean". The studies were based on parabolic trough concentrator and central tower receiver technologies.

In this framework, Egypt officially requested Global Environment Facility (GEF) to support the project.

A grant fund of about 50 million US dollars is available from GEF to cover a substantial part of the incremental cost in comparison to the least cost conventional alternative producing the same annual electric energy.

Positive steps have been taken to implement the first Egyptian Solar Thermal Power project (ISCCS) based on Build-Own-Operate-Transfer (BOOT) systems. Starting by the selection of the World Bank as an implementing agency, contracting with the qualified consulting firm to perform the first phase of consulting services in June 1999, ending by submitting the final feasibility study report in June 2000.

The report concluded:

- The capacity of the first ISCCS is 127 MW.
- The capacity of the solar component is 31 MW.
- The produced electric energy about is about 900 GWh/year.
- The solar contribution is 9.1% of the annual generated electricity.
- The total investment is about 120 Million US Dollar.

The second phase of the consulting services will be ended by issuing the Request For Proposals (RFP) and assisting in negotiation with the best accepted offer to undertake the project in 2001. The plant is expected to be operative in 2004.

The ISCCS power plant (127 MW) is considered as a first of series of hybrid solar fossil fuel power plants targeting to install about 750 MW capacity in an overlapped time frame based on BOOT system by the year 2010 as shown in Table 2.

3.2.2 Photovoltaic Technology:

The electricity demand is growing rapidly in Egypt, so the efforts are directed to develop the use of renewable energy technologies in rural and remote areas. Photovoltaics for electricity production and pumping groundwater seem to be more relevant solution for currently energy requirements at these areas.

The present use of PV in Egypt is characterized by few traditional, professional applications financed on commercial terms and numerous donors. An estimate of the installed PV capacity presently operating in Egypt is about 2 MW and several projects and plans totalling more than 10MW are under preparation.

Table 2. Solar Thermal Electricity Generation Plan.

5 Years Development Plans	Installed Capacity			Cumulative Capacity (MW)	Annual Energy Generation at the end of the period TWh/Year
	No. of Plants	Power Capacity (MW)	Total Capacity (MW)		
1997-2002	-	-	-	-	-
2002-2007	1	127	127	127	900
2007-2010	2	300	600	727	4600
After 2010	Dissemination according to cost reduction and the level of interest of private developers				

3.2.2.1 Local Capabilities & PV Market in Egypt:

Egypt has capable groups in the different aspects related to the PV projects' implementation. These can be utilized directly or through partnership or subcontracting arrangements with the key organization, which will be involved in any project.

The different levels of local capabilities cover the following areas:

- **Studies:**
  - Identification & Pre-feasibility.
  - Full feasibility.
- **Design & Engineering:**
  - Sizing.
  - Conceptual design.
  - Detailed design.
- **Manufacturing & Suppliers:**
  - The PV modules.
  - Regulators & Inverters.
  - Batteries.
  - Civil Works & Erection.
- **Operation & Maintenance:**
  - The PV System.
- **Testing & Evaluation.**

There are at present some major companies in the Egyptian PV market, some of them are:

- ASET (Arab Solar Energy Technology): acting as system house for Siemens Solar of Germany.
- Siemens: acting as branch of Siemens Solar of Germany.
- AEG: acting as branch of AEG/DASA of Germany
- Photowatt: acting as branch of photowatt of France
- Engotech: acting as branch of Engotech of Germany
- Solarex: acting as system house for Solarex of USA

- Three privates company working in assembling PV modules and selling complete systems. Almost all components are imported except Aluminum frames and may be soon the junction boxes. The locally produced assembled modules are marketed at about 20L.E ≈ 6 USD / Wp.

There are three big battery companies competing in automotive battery market of Egypt, and they can produce solar batteries.

NREA established an advanced testing and certification center (EREDO). It has indoor and outdoor testing facilities for PV components and systems. The EREDO capabilities include the following main features:

- Testing and certification of renewable energy equipment.
- Training of engineers and technicians in thearea of testing and certification.
- Evaluation of pilot plants and demonstration projects.
- Applied R & D activities.

3.2.2.2 Status of PV applications in Egypt:

In general terms the status for PV applications in Egypt can be grouped into four categories:

Remote / professional services (telecommunication, railroad, navigation, and aids) are characterized by high internal technical competence and capacity to act independently to a certain extent. This needs high quality and satisfactory service PV systems.

Donor assisted applications (mostly water pumping & treatment) are characterized by being dispersed "pinpricks" with no plan or coordination of any Kind. Projects are treated as individual cases and there seems no attempt to put projects in a larger context.

Private sector applications (advertisement boards & small farms) are just emerging in the from of PV powered road advertisement signs and for electrification of small to medium scale farms (land reclamation). However private industries express optimism, and indicate new market sectors such as perimeter security systems (permanent lights, TV and alarms). Professional services now are suffering from many drop-outs of the grid such as primary health care clinics, non-public telecommunication links, new settlements and tourist villages on Sinai and the Red Sea coast, off-grid farms expected to come with the ongoing land reclamation programs, and other niches.

NREA & other governmental body applications:

PV projects which were done by REA:

1. Photovoltaic Powered Ice Making Plant, at Wadi El-Raiyan Lake, as shown in Figure 7.
2. PV water related applications, which were done by NREA: PV Water Pumping System at Wadi-El-Natroun. The 2.2 KW_P portable PV pumping system at El - Kanater.
   Two PV Powered Pumping units (1.8 KW_P) for irrigation in El –Mansoria.
   Pumping system and lighting at Awlad EL sheikh village (29 KW_P). Figure 8 shows the pumping system.

Fig (7). PV Powered Ice Making Plant, at Wadi El-Raiyan Lake

3. PV Water Desalination Plants:
   Water Desalination plant at El-Hamrawein on the Red Sea.
   PV Water Desalination Plant at the high Voltage Lab / Giza.
4. Telecommunication and street's lighting in NREA site at Zaafarana.
5. Egypt / United Nations.

Fig (8). PV Pumping System.

Development Program (NREA / UNDP) Activities:

- Ten PV –powered refrigerators for vaccine storage were installed since 1986 for rural health – care facilities in remote areas.
- Eight PV –powered emergency communication systems were installed at a number of locations along the Red Sea coast and the Mediterranean coast.
- A 8 KWp PV / Diesel-powered desalination unit that produces 5 cubic meters per day of potable water was installed at Abou-Ghosoon on the Red Sea coast.

***Note*:** Some of these projects are well operating, and some of them were shut down or dismantled.

PV Projects executed by others:

- Many billboards lighting all over Egypt.
- Home & Camping solar systems.
- Toll Station system with a capacity of 21.9 KWp.
- Telecom systems some of them at Toushka and Owinat.
- A solar grid connected system at South Sinai (1KWp).

Egypt has formulated strategies and goals for the use of renewable energy sources in the national energy supply, for PV's NREA set up the goal of 35 Mw installed in 2005, but with around 1Mw installed mid 1995, it may be difficult to reach this goal[9]. During the last 15 years Egypt has several efforts directed towards the development of photovoltaic technology and the applications.

3.2.3 Wind Energy Applications

In the field of wind energy NREA started to undertake internal and external scanning, in order to determine the internal strength and weakness, the external opportunities and threats. That is the base for identifying NREA's message and goals, that can maximize NREA's strengths, and make use of the available opportunities.

As a result of NREA's internal scanning, it was found out that it is crucial to undertake some preparatory activities that are given the implementation priority. These activities are mentioned but not be limited to the following:

- Wind Resource assessment.
- Conducting financial, economic and environmental feasibility studies.
- Establishment of training programs.
- Establishment of demonstration projects.

[9] Unless startting using PV pumping systems for irrigation at the west south aeras.

These activities interact and co-operate to facilitate the decision-making concerning the establishment of large-scale wind farms, on commercial basis, to achieve the following development and immediate objectives:

The development objective:

Contributions to economic development through provision of clean, cost-efficient energy through large-scale utilization of wind energy in Egypt.

The immediate objectives:

Demonstration of productive and economic potential of large wind farms at the Gulf of Suez. Development of the capacity for operation and maintenance in relation to large wind farms in Egypt.

3.2.3.1 Wind Resource Assessment:

It is a focal activity because NREA won't conduct the other list of activities unless it makes sure that wind resources in Egypt are sufficient and reliable. The Program has started since 1986, since then NREA has erected about 45 measuring station all over the Egyptian territories. As a preliminary result of NREA's efforts an Aerial distribution wind map was published, that illustrated an elementary indication of the Aerial distribution of wind energy potential in Egypt. The available information showed that Red Sea Coast especially Gulf of Suez area is one of the windiest places in the world which encourages NREA to deepen the measurements there, by conducting a wind Atlas covering both banks of Gulf Suez area.

Wind Energy Resource Atlas for Gulf of Sues:

The preliminary findings of the Wind Atlas for Gulf of Suez in Egypt, is the result of investigation of the climatic wind conditions along the Gulf of Suez, Arab Republic of Egypt. The investigations were conducted from 1991 to the date of publication (almost five years) by NREA in cooperation with RISO National Laboratory in Denmark. The observations from four meteorological stations are analyzed.

The analysis conducted in the Wind Atlas has helped NREA in the following:

- Determination of windy sites, which leads to right determination of the projects' sites.
- Provision of the accurate predictions of the wind climate at candidate sites for wind turbines along the Gulf of Suez.
- Ensuring the optimum distribution of wind turbines in the wind farm.

Wind Energy Resource Atlas for Egypt:

The above mentioned benefits encouraged NREA to extend the measurements through a new project being conducted now, it is the preparation of wind Atlas for Egypt, the project activities started in 1998, the final output of the project will be as follows:

Elaboration of extended Wind Atlas for the Gulf of Suez, including meteorological measurements, micro and meso-scale modeling and satellite imagery. Ornithological Atlas for Wind Energy Planning. Reports with recommendations for future wind farm planning and related environmental assessment. Coarse Wind Atlas for Egypt-analyzing existing meteorological data in the framework of the wind Atlas method, including evaluation of data and existing measurement stations. Preview of the Project including environmental assessment. Downwind Atlas for Egypt, including additional

meteorological measurements, micro-and meso-scale modeling satellite imagery for selected regions. It was found that one of the main important activities is the evaluation of wind farms projects, to make sure that the investment of money in large-scale wind farms is feasible, otherwise it will be more efficient to stick to the traditional ways of electricity generation. For this reason many studies had been conducted, the technical, economic, financial, and environmental feasibility had been verified. The studies proved the feasibility of establishment of large-scale wind farms at the Gulf of Suez area from the economic, financial and environmental point of views.

3.2.3.2 Training Programs:

NREA has the awareness towards the necessity of building a strong institutional infrastructure. So training has got a major priority, within NREA's activities. Many training programs were conducted abroad giving the basics of planing, design, operation, maintenance and management, meanwhile on the job training took place to give NREA's engineers the needed theoretical & practical experience. In addition NREA & RISO National Laboratories have organized a training of trainers course, in order to create self-dependence concerning the training of NREA's new comers. The Wind Energy Technology Center at Hurghada was furnished with the necessary training facilities to be the first training center in the Middle East area and Africa, in the field of wind energy technology. Also this center is used for monitoring and testing large scale and small scale wind turbines, it is considered as a Notional and international training, research and certification center.

3.2.3.3 Demonstration Projects:

The establishment of a demonstration 400 kW wind farm at Ras Ghareb on Red Sea Coast 350-km east south Cairo. The establishment of the demonstration 4.8 MW at Hurghada the wind farm is composed of various wind turbines technologies that enhances the technical capabilities of NREA Staff. This wind farm is currently connected to the Hurghada local grid. It produces almost 10 million kWh/year. Five autonomous wind/Diesel systems at the Northern Coast for electrification and water pumping purposes to serve remote areas Two of the systems are being erected. Establishment of the first wind energy technology center in the Middle East and Africa, situated in Hurghada.

3.2.3.4 On Going and future Projects:

The following list represents the on going projects at Zafarana:

60 MW wind farm through Egyptian/Danish cooperation:

Component 1: 30 MW, was contracted in Dec. 98, and officially operated in March 2001.

Component 2: 30 MW, under implementation.

85 MW wind farm through Egyptian/German cooperation.

Phase 1: 33 MW was contracted in May. 99, and officially operated in March 2001.

Phase 2: The two Governments have agreed to establish the project, the consultancy services have been already assigned, it is presumed to issue the tender document before the end of this year.

60 MW wind farm through Egyptian/Spanish cooperation.

The conceptual design has been finalized in March 99, the tender document is being prepared.

120 MW wind farm through Egyptian/Japanese cooperation.

The project feasibility study has been finalized in March.99, waiting for singing the governmental agreement. Table 3 shows the plan for wind farms'

Table 3. Wind Farms Installed capacities and Electric Energy Generation

5 Years Development Plans	Installed Capacity (MW)			Cumulative Capacity (MW)	Energy Generation Annual Energy at the end of the period TWh/Year
	Red sea	East of Oweinat	Total Capacity (MW)		
1997-2002	120	-	120	120	0.48
2002-2007	330	-	330	450	1.8
2007-2010	100	50	150	600	2.4

installations up to year 2010.

3.2.4 Biomass Energy:

More than half of the world population use wood and agricultural residues, or what we can call biomass resources, as a primary energy source for household purposes. In Egypt the total biomass resources potential reaches 40 million Ton / year. In the context of Biomass Technologies, it should be noted that Egypt is party to the United Nation Framework Convention on Climate Change (UNFCCC), that demands stabilization and reduce emissions of CO_2 and other greenhouse gases, such as methane, at present this is only demanded for OECD countries. Meanwhile, Developing countries, such as Egypt, are for the time being not under this obligation. However, in the future it may be expected that the fastest growing developing countries will be the next group to be subjected to these demands. Egypt may belong to this category. The government of Egypt is already considering setting standards for CO_2 emissions from the industrial and commercial sectors. Biogas for example is a CO_2 neutral fuel and the increasing utilization of biogas will imply fewer emissions of CO_2 and methane. However this reduction will depend on a careful handling of fresh and digested manure to avoid significant methane losses to the atmosphere. In general, it can be expected that application of biogas technology can contribute to the fulfilment of Egypt's possible future commitments under climate convention.

3.2.4.1 Biomass Resource Assessment:

Table 4 shows the biomass resources assessment, available and utilized quantities according to the recent data. It is clear that the biomass resource contributes more than

3.6 MTOE / year (primary energy). Due to the expected applications of the efficient new modern technologies on the available biomass resources this contribution effect

Table 4. Biomass potential resources, available and used quantities.[10]

Kind of wastes	Total Potential (TP)		Total available for energy		Total utilized as energy	
	MT(dm)/y	MTOE/y#	% to TP	MTOE/Y	% to TP	MTOE/Y
Agr. residues:-	**18.7**	**7.48**	**46**	**3.50**	**41**	**3.06***
Plant	**7.6**	**2.66**	**36**	**0.95**	**15**	**0.40**
Municipal	**6.6**	**1.65**	**36**	**0.59**	**5**	**0.08**
Sewage	**4.3**	**0.86**	**56**	**0.48**	**10**	**0.09****
Industrial	# #					
Total	**37.2**	**12.65**	**43.6**	**5.53**	**28.7**	**3.63**

* 65 % ; is the sugar cane - baggase used in the sugar factories as a fuel .

** A huge biogas plant of 220 000 m^3 digester volume has a 18 MW electric power generation plant is under initial starting in the El-Gabal El-Asfer sewage treatment plant for Cairo .

\# The average calorific value used in energy calculations for different kinds of wastes; plants, animals, municipals and sewage are 4000 - 3500 - 2500 - 2000 kcal/ kg dry matter (dm) receptively .

Data are not available , but it has considerable amount.

will be increased in the future.

The potential of plant residues in Egypt contributes about 50 % to the total biomass potential. Most of the utilized quantities for energy purposes in the rural area are burnt in low efficiency (less than 10 %) traditional stoves and furnaces. Moreover, the traditional way of storing the plant residues in the farms and on the roofs gives a large chance for insects and disease carriers to grow and reproduce on it and though re-attack the plants and animals again, this also causes destructive fires. The Ministry of Agriculture and the environment protection agencies have initiated and issued legislation and resolutions, which commit the farmers to dispose the plant residues through environmental safe ways. Farmers find that the easy active ways is to burn them (like cotton stalk) as soon as possible in the fields. This results in a vast loss of energy beside direct negative impact on both environment and human health. Burning of about 1.24 million Ton / year of dry cotton stalks means a great loss of energy, equivalent to 0.532 MTOE / year valued 180 million LE / year. Table 5 shows the different kinds of plant residues and its yearly quantities.

3.2.4.2 Status of Biomass Projects:

With a few exceptions, biomass activities in Egypt have been focused mainly on small-scale biogas plants with a digester volume of 5-50 m^3. Activities on larger systems were limited and unsuccessful.

[10] Proceeding of the National Forum for Biomass Energy in EGYPT, 10-11 NOV. 1999

Table 5. Available quantities of agriculture residues (1992 - 1993) [11].

No	Kind	Area 1000 feddan	Waste ton/f/yr #	Total waste Available 1000d.t/yr ##	for energy uses %	Total waste for energy use 1000d.t/yr	Total energy 1000 TOE/yr	month of cutting
1	Cotton *	884.3	1.40	1238.0	90	1114.2	**	9 - 10
2	Fruits *	911.0	0.50	455.5	80	394.4		1 - 2
3	Rice *	1282.8	1.45	1680.2	20	372.0	**	11
4	Sugar cane *	2782.4	0.50 1.80	1361.2 5170.3	85 90	1182.5 4653.3	*** **	12 - 1
5	Maize	2339.8	1.80	4211.7	65	2737.6		
6	wheat & barley	2315.1	1.45	3356.9	-	-	****	
7	Sugar beet	39.9	0.50	19.9	50	9.9	**	
8	Legumes	400.1	0.80	320.1	50	160.1		
9	Vegetables	1419.1	0.50	709.6	50	354.8		
10	Animal fodder	215.4	-	-	-	-	****	
Total		12024.9	1.55	18703.2	53	9914.8	4164.2	

* The briquetting technology can be a solution for proper plant waste treatment. The quantity available from these kinds reaches 3.1 Million Ton / year in addition to the Agro-industrial wastes such as food industry and Wood industry.

** Burnt in the fields. ; *** Used as a fuel in the sugar factory

**** It is used as an animal fodder

ton / f / yr is ton / feddan / year ; # # d .t / yr is dry ton / year

- **Small-Scale (Family) Biogas Plants:**

Potential: Estimates from the Agricultural Research Center (ARC) and National Research Center (NRC) show that there are 800 small biogas digesters installed in Egypt, less than 50% of them are in operation. Approximately 80 new plants are constructed every year. Meanwhile, the total potential for small biogas plants in Egypt is estimated as more than 1 million units.

Investment and Financing:

The investment costs for a biogas plant with 10-m^3 digester volume is approximately LE 2500. Based on the value of the biogas as an alternative to butanes or kerosene in addition to the higher fertilizer value of the digested manure, the payback period is estimated to be 5-8 years. In the present situation it is not possible for most rural Egyptian families to finance such investments without a subsidy or support. Many advantages are recognized by the end-users of biogas, but can not be calculated in traditional economic terms.

[11] Reference No. (30)

Support Programs:
Most of the small biogas plants have been installed as part of programs supported by donors or through a subsidy scheme from the ministry of Agriculture. Some plants, especially in the larger end of the small-scale spectrum, have been financed through private investments alone. A few NGOs working in rural communities, such as BSDA[12], CEOSS[13] and DDC[14], have recognized activities in the biogas project, including soft loans and subsidies, establishment of small enterprises and information campaigns. These NGOs have been supported from different national and international sources.

The End-Users:
Most of the small biogas plants are installed by rural families, typically based on manure from 4-6 heads of cattle. The largest plant applying low-tech small-scale technology was designed for manure from 100 water buffaloes. For practical reasons, e.g. easy feeding of the plant, the small biogas plants have to be installed immediately adjacent to the stables. The compact nature of old Egyptian villages leaves little free space around house and stables, limiting the possibilities for biogas plants for some families. In some cases constructing the digester under the floor of the stables has solved the problem. Families living in the outer, and less densely constructed, part of the old villages or in the new villages have sufficient space available. The rural families applying biogas technology recognized the following benefits and advantages:

- The value of the fertilizer is higher, and can substitute chemical fertilizer.
- The gas is a clean fuel that can substitute either burning of straw or dung, or the use of kerosene or LPG (Butanes).
- A number of environmental and social advantages such as:
    - Less flies and odor.
    - Less in-door pollution from burning wood or dung in the kitchens.
    - Reduce workload for the housewife.
    - Easier and more healthy manure handling system.

• Large-Scale Biogas Plants:
On the large-scale level, biogas activities have not moved away from the laboratory or pilot scale, so only few larger plants have been constructed. One of them was a 170 m3 digester in EL-Giza Army Camp, constructed in the beginning of the 1980'ies with FAO and ARC assistance, but at present there are no activities in Egypt on large scale biogas plants. An important proposal for the success of large biomass projects such as centralized biogas plants, is the possibility for selling excess power to the grid. A huge Biogas mentioned in Table 5, is constructed by General Organization for Sewage Teatment (GOST) out of the Biogas programs.

• Plant Residues Briquetting Systems:
NREA has implemented the most advanced biomass laboratories in Egypt including a set of full-scale equipment and systems for demonstration and testing of both biological (biogas) and thermal (gasification and briquetting) systems. Plant residues are considered the most important traditional fuel in the Egyptian rural area. So the

[12] Basisa Social Development Association.
[13] Coptic Evangelic Organization for Social Services.
[14] Desert Development Center.

biomass laboratories at NREA testing and certification center have been equipped with an advanced briquetting system to convert ligneous plant residues into an alternative solid fuels. These briquettes are uniformly shaped easy to be transported, stored and having better physical and combustion properties than that of the initial residues. They also are free of insects and diseases carriers. Eventually this will lead to save the biomass energy from loss to be used as an improved sort of solid fuel that can be used efficiently to save more quantities of alternative energy sorts as petroleum and electricity. Converting these residues into briquettes, as an improved solid fuel is a solution for the following: -

- Improving its physical and combustion properties.
- Increasing the efficiency of energy extraction (through improving new designs for a smokeless, cheap and efficient solid fuel cook stoves which utilizing briquettes and can be manufactured in mass production for the rural area).
- Decreasing the negative impacts due to the traditional ways of its treating, storing and utilization.
- Providing the Egyptian rural area with positive economic, environmental, development and social impacts.

NREA has used the lab briquetting system for executing three studies on the cotton stalk briquetting gave very good results and proved that there is a great need for adopting the briquetting technology for the Egyptian conditions.

Active Donors and Egyptian partners in Biogas:

The following donors and organizations are involved in biogas development in Egypt: FAO, USAID, DANIDA, Canada, Sweden and the European Union.

The following organizations are involved in biogas with the a/m donors:

ARC. - NRC.
NREA.

4. Selected RETs for the Study

4.1 Preliminary selection of RETs for Detailed Analysis:

To focus the information collection, discussions and preliminary analysis a limited number of relevant RETs, were selected using the following selection criteria:

- Adequate resource base for the RET.
- Available technologies and reasonable costs.
- Commercial viability and financing.
- Environmental impacts and benefits.
- Socio-economic impacts, including job creation.
- Coverage of both centralized and decentralized options.

According to the above mentioned criteria and based on the review of the national experiences and analysis the following RETs applications were selected:

- Domestic solar water heating systems.
- Electrification of remote areas using PV systems.
- Pumping of groundwater using PV systems.
- Biomass applications.

Preliminary Findings & Results:

As a first step to get the prospected feedback from experts and stakeholders, an advisory committee was formed consisting of experts, practitioners, relevant governmental institutions / ministries including rural agencies and other stakeholders (manufacturers, users, NGOs, financiers, etc.) covering all the selected RET's

The second step to get feedback from experts and stakeholders on the selected RET's was to prepare and conduct a set of questionnaires and interviews on the preliminary selected technologies to obtain specific information on:

- Current status of the RETs' applications in Egypt.
- Adequacies of policies and plans in the field.
- Definition of technical, economic, environmental, institutional, financial and legal mechanism barriers.

Questionnaires and interviews were applied to manufacturers, organizations and agencies, users and owners, and targeted Users. Responses received through interviews / questionnaires were analyzed and the findings were presented to the advisory committee and they are summarized in the following for each technology or applications.

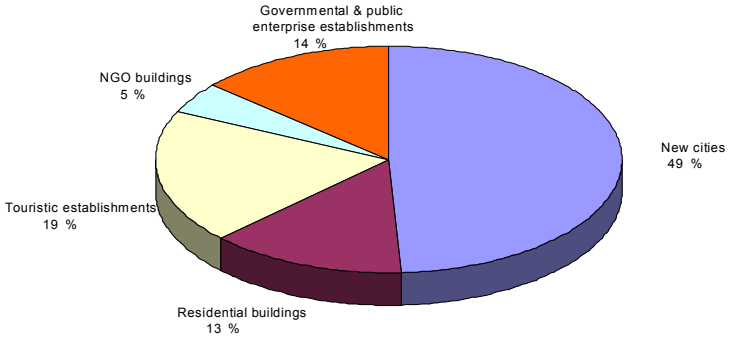
4.1.1 Solar Water Heating Systems:

Manufacturers Questionnaires & Interviews:

The first stage of the study and survey analysis revealed that the distribution of the installed DSWH systems in Egypt by the end of 1998 is shown in Figure 9, as obtained from companies' records. It can be seen that the largest portion of the market was for the new cities (49%), followed by tourist establishments (19%), then the governmental and public enterprise establishment (14%). Residential

buildings in old existing cities ranked the fourth with a percentage about 13%. At the end was the NGO buildings with a share about 5% companies' investments in the field vary from 500000 LE to about 2000,000 LE.

Fig. (9) Distribution of Solar Water Heating Systems



and about 70% of these companies are established to produce DSWHs, while about 30% of them are large companies in which solar thermal departments are small and the major activities are in the production of Electrical and gas (LPG or NG) Heaters.

Only one company is governmental. Although producing solar energy system department is not its main activity, it has the highest number of employees (about 100) in the Solar Energy Department. The number of employees for most of these companies (Engineers, technicians, workers, accountants, etc…) doesn't exceed 40 person.

The maximum production capacities vary from 3000 to 5000 typical systems (150 liters, 2m^2 collector area) and marketing is done through direct contact with customers or through tenders, there are no dealers involved. The number of sold units varies from year to year, as summerized in the following durations:

- **From 1980 to 1987:**

This was a period of starting the activity and slow rate of market penetration can be remarked. Average annual production rate for a company ranges from (500 to 1000) units.

- **From 1988 to 1993:**

A quantum leap can be noticed in the production rates. This was mainly because of the implementation of the ministerial decree for mandatory use of DSWH systems in new cities. Average annual production rates ranged from 1000 to 2500 units/company.

- **From 1994 to 1997:**

Noticeable reductions in production rates because of some technical and administrative problems led to lose of trust. Average annual production capacities are estimated to be in the range of 500 to 750 units/company.

- **From 1998 to 1999:**

Relative increase in the production rates because of solving the technical problems and expansion of new tourist villages increasing in Egypt. Annual production rates from 750 to 1500 units/company.

The interviewed sample of the manfacturers presented some notes and remarks which are classified into the following:

Profit:

The gross profit of most companies ranged from 15 to 20% which is very low. This prevents companies from expansion, development or investment in research and development (R&D). The manufacturers stated that optimum gross profit should be from 30 to 35% of the selling price.

Research and development:

Most companies don't have an individual department for R&D but some engineers are assigned for this purpose. The effect of R&D is limited because of financial limitations.

After sales services:

All companies provides the after sale services (maintenance, spare parts…etc) to its direct customers and the cost of this services is according to the agreement between client and company. Regarding the systems that were ordered by tender under the supervisory of the government which are very large quantities (thousands), companies have no commitment to provide any service because it was not included in the contracts or agreed upon between the two parties. Companies consider that the cost is very high and they couldn't afford it.

Quality Control:

All companies have a quality control departments but with a limited number of tests and measurements. They approved that the quality control tests and measures are not enough to ensure the quality of the system. Most of them go outside for testing and certification. This is done mainly in two places;

Solar thermal laboratories in NREA, and National Research Center. 90% of companies assured that NREA laboratory tests are better in judging the system performance and its quality, and they prefer to go there. However they have some concerns such as:

- The cost of testing is relatively high.
- The validity period of the certification is short (only two years) which makes the customer worried about systems.
- Companies propose that the validity period should be about 3 years but with supervising, monitoring and controlling the production line by random visits from NREA experts.

Most of the companies are not satisfied with the quality and performance of the system installed in the past. They say that the reason behind this is the old tender that gave the consideration to the lowest price without paying any attention to the quality. This made some companies in the early 90s to manipulate the quality and the proper material selection without any control, most of these companies had lost their reputation and closed. All companies requested having some kind of obligatory rules that any company works in the field should certificate its system from supervisory neuter authority to ensure the quality of the products.

Production rates:

The optimum production rates, as stated by most companies, are estimated to be from 3000 to 5000 unit annually. If this rates were achieved, the price of the unit could be decreased to be in the range from 1000 to 1300 L.E. with current costs of materials, labour …etc. Only 20% of companies accept to provide a credit

facilities at present time. This is mainly due to shortage of money liquidity, especially in the case of large quantities of units.

Barriers preventing DSWHs to be widespread:

All companies are convinced that DSWHS are not wide spread enough and the main reasons behind that are:

- Lack of customer awareness about the DSWHS advantages, taking into consideration the limited financial abilities of companies for providing advertising campaigns and also the great availability of competitive conventional types of water heaters in the Egyptian market (lower cost, subsidized consumption tariffs).
- The high initial cost of the DSWHS, especially in the absence of any credit facilities
  or development activities to reduce the price.
- The poor quality of some systems produced in the late 80s and early 90s. Most of the companies producing these systems are not working any more.

How to overcome these barriers :

All companies assured that promotion and dissemination activities are the responsibilities of the companies together with governmental support. To increase the use of DSWH Systems the companies provided the following suggestions:

- Planning, development and implementation public awareness program and advertising campaigns to convince the customers. Companies, Institutional organizations and energy planning authorities should co-operate in this respect because of its importance on the national level.
- Revising taxes and customs on solar water heating systems components and production requirements and necessities.
- Governmental support is needed to urge Banks and different financing sources to supply the required suitable financing to the DSWH systems industry and to facilitate the credit services, also to reduce the interest rates for both companies and customers.
- Some sort of subsidization for DSWHS, corresponding to the subsidy given to the electricity and natural gas consumers. This may be in the form of subsidizing the initial cost or incentives like taxes reduction or reduction of electricity invoice for DSWHs users.
- Providing financial and technical supports to the R&D activities. The objectives should be cost reduction and quality improvement. This could be done with the help of NREA capabilities.
- Obligatory legislation should be issued, stating that all working companies should certify the quality of their products in the market. The certification services should be as cheap as possible and from a qualified, trusted and authorized entity. Some penalties should exist for violation. Some supervising systems and periodical check on factories should exist. They also could be accompanied with providing advisory commitments to improve the quality.
- Organizing training courses to prepare specialized experts in each sector involved in relative activity like tender specification preparation, supervising installation and acceptance or installation and maintenance according to each sector requirements.

- Assigning a budget from the government for repairing the already installed DSWH systems in new cities building (supervised by the government) to regain the trust. Maintenance contracts prepared by experts should be signed with specific duties, tasks and penalties.
- Restoration of revival of the minstrel decree is required, which is out of order at present time. The revival should take into consideration the new private building. Also it should persist in the importance of supervision on the installation and acceptance by specialized experts especially in big tenders.
- The future plans of different ministries and organizations should be revised to encourage and increase the utilization of DSWH systems in their buildings, hospitals…etc..
- The current standards and specifications should be revised carefully. A new comprehensive one is required urgently.
- Soft loans to the young engineer and technicians should be provided through social development funds to establish centers for maintenance and marketing of DSWH systems.

4.1.2 PV Applications:

The following are the survey findings from deferent points of view:

Manufacturers:

- Customs tariffs and taxes are very high.
- There is no enough grants or loans for PV projects.
- Up till now there is no large-scale projects making PV niches visible to industrial authorities and investors.
- There is no clear national plan for manufacturing the PV system's components.

Users and Consumers:

- Some technical problems (inverters – batteries).
- Consumers are not satisfied with the power obtained from PV.
- There are no suitable DC appliances in the local market.

Targeted Users:

- The people at the targeted rural remote areas have not enough money to get these systems.
- Promotions of awareness programs are limited.

Barriers

The barriers against implementation of Photovoltaic technology in Egypt are summarised as follows:

- Cost of photovoltaic cells and systems are very expensive and are not subsidised as conventional energy.
- Problems and troubles in inverters.
- The PV market in Egypt is very small.
- There are no factories for photovaltaic cells in Egypt. There are only assembly factories.
- Since photovaltaic systems are applied at remote areas where people there are very poor don't know about PV systems , they can not maintain the photovaltaic

systems furthermore they damage the PV systems and cut the wires and connections.

Opportunities

For the two preliminary selected applications (PV electrification of remote areas &PV pumping for irrigation), the success opportunities are very high, and summerized as follows:

1. PV Electrification for rural remote areas:

- High potential of small villages with no access to the grid.
- The government policy plans for electrifying all small villages and attachments.
- Egypt has very high solar radiation.
- The technical and technological experiences are available.

2. Utilization of Very Large Scale (Multi MWs) PV Power System for Groundwater Pumping in Southern Egypt:

- The southern part has the highest solar radiation level in Egypt.
- The land is leveled and ready for cultivation.
- The groundwater is available (≈75 meters).
- Egypt's plans for new land reclamation projects consider the use of groundwater as a potential supply of irrigation water.
- The technical and technological experiences are available.
- No need for storing electricity or using inverters.

4.1.3 Biomass Technologies:

Barriers facing the dissemination of the biomass technologies

In general Biomass Technologies are not used or applied to the suitable extent because of the following barriers:

Institutional Perspectives:

- The absence of national developing, adapting and manufacturing programs for the Biomass Technologies Equipment that fit with the local conditions.
- Lack of awareness, about the Biomass Energy Technologies as ideal solution for organic residues treatment.
- The subsidized prices of petroleum products and electricity and its availability in the countryside.
- There is no economic evaluation for the positive environmental impact of the Biomass Energy Technologies.
- Absence of legislation and regulations for organic waste management.
- Absence of co-operation between the involved institutions and organizations.

Concerned Groups Perspectives:

- Financing difficulties.
- The high capital costs with comparison to other organic waste treatment systems.
- The absence of national dissemination programs.
- The absence of national direct and indirect support programs.

- Lack of successful pilot projects that can show the benefits of Biomass technologies and how can be they replicated.

Owners Perspectives:

- Lack of local technical experts for Biomass Equipment operation, maintenance and repair.

Specifically for the LBP the main barriers are:

Institutional Perspectives:

- Lack of awareness, about the Biogas Technologies as ideal solution for organic residues treatment which have positive environmental impacts and better economics on the long run.
- The quick change of animal growing projects activities.

Concerned Groups Perspectives:

- Lack of local technical experts for design and construction.

Owners Perspectives:

- Lack of sophisticated spare parts.
- Operation problems.

For the plant Residues Briquetting Systems the main Barriers are:

Institutional Perspectives:

- The necessity for developed, adapted and manufactured mobile briquetting systems that suit the local conditions to avoid the high transportation expenses to collect the plant residues at central Briquetting station and the high prices of the imported equipment.
- Some experts believe that using plant residue as a solid fuel causes great loss of biomass resources, but the briquettes can be also utilized as an improved raw material (suitable for long distance transportation and long period storing) to produce animal fodder, fertilizers, artificial wood and paper in addition to improving the plant residue combustion properties.

Concerned Groups Perspectives:

- Lack of locally developed adapted and manufactured Plant residues Briquetting Systems that fit with the local conditions.

Owners Perspectives:

- There are no owners.

Opportunities for Biomass Projects:

Large-scale Biogas Plants Projects:

- It can be stated that biogas technology is the most recommended one for energy extraction from organic wastes due to producing a significant amount of energy and keeping a large amount of organic matter and nutrients. This amount of organic matter and nutrients is very important to be recycled as a fertilizers and soil conditioner necessary to increase the soil fertility. This increases the crop production, beside its environmental positive impact. So a great attention was given to the biogas technology.
- An important proposal for the success of large biomass projects such as centralized biogas plants, is the possibility for selling excess power to the grid.

- Table 6 shows one of DANIDA / NREA studies estimates of the number of Large-scale Biogas Plants (LBP).

Plant Residues Briquetting Systems Projects:

- NREA studies on the cotton stalk briquetting gave very good results and proved that there is a great need for briquetting technology for proper plant residues treatment and adopting the briquetting technology for the Egyptian conditions is recommended.
- The available quantity of plant residues for briquetting reaches 3.1 Million Ton / year in addition to the agro-industrial wastes from Food and Wood industries. This quantity is enough for establishing more than 1500 successful Mobile Briquetting System projects.

Table 6. Estimates of the number of Large Biogas Plants (LBP).

No	Location			No. of Total Locations	Possible No. of LBP	Average size of LBP Ton/day	Prod. rate m^3CH_4/ m^3 input material	Total Mm^3CH_4 /year	Total 10^3TOE / year
Kind		**Unit**	**Size**	**A. Farms**					
1	Milking cows	Head	> 400	30	30	75	20	16.43	14.86
2	Cattle Growing	Head	> 400	25	25	75	20	13.69	12.39
3	Broiler	1000	> 800	4	4	30	30	1.30	1.24
4	Egg layers	1000	> 150	11	11	50	30	6.02	5.45
Kind			**Size**	**B. Slaughter Houses**					
5	Governorate / City		Medium	160	50	50	45	41.06	37.16
6			Big	6	6	50	45	4.93	4.46
7	Chicken			16	16	50	45	13.14	11.89
Factory kind				**C. Industry**					
8	Fruits and Vegetables			12	12	75	40	13.14	11.89
9	Beer			3	3	100	35	3.83	3.47
10	Vegetable Oil			11	11	100	35	14.05	12.72
11	Milk			9	9	100	20	6.57	5.95
City name / population				**D. Sewage Treatment**					
12	Cairo			6	12	500	20	43.80	39.64
13	Alexandria			2	1	300	20	2.19	1.98
14	1.6 Million			5	5	300	20	10.95	9.91
15	1.2 Million			3	3	200	20	4.38	3.96
16	0.8 Million			13	13	200	20	18.98	17.18
17	0.4 Million			11	11	150	20	12.05	10.90
18	0.2 Million			49	49	100	20	35.77	32.37
19	0.1 Million			63	63	50	20	23.00	20.81
City name /SW Production ton (dm)/day				**E. Solid Waste (SW)**					
20	Cairo /130 t/day			2	2	75	35	1.92	1.73
21	Alexandria /100 t/day			2	2	50	35	1.28	1.15
22	Others /60-30 t/day			22	22	20	35	5.62	5.60
TOTAL								**294.10**	**264.69**

4.2 First National Workshop:

The previous results were presented and discussed with the stakeholders in the first national workshop, which was arranged and held at the 9th of September 1999. The workshop aimed the following:

- To introduce the project to relevant stakeholders.
- To elicit information on experience and views on past RET projects.
- To get feedback on the findings from the interview /questionnaire.

The Participants were:

- Governmental institutions /ministries:
  - Ministry of Agriculture.
  - Ministry of Irrigation and water resources.
  - Ministry of Transportation.
  - Ministry of Electricity and Energy.
  - Cairo General Authority for Sewage treatment.
  - Rural Electrification Authority.
  - Tebbin Institute for Metallurgical Studies (TIMS)
  - Social Fund.
  - National Research Center (NRC).
  - Agriculture Research Center (ARC).
  - Arab Industrial Organization. (AIO)
  - Organization for Energy Planning. (OEP)
  - Energy efficiency Center.
  - Egyptian Organization for Standardization & Quality control (EOS).
  - Egyptian Industrial Union.
  - Egyptian Environment Affairs Agency. (EEAA)
  - Universities.
  - Egyptian Electricity Authority.
  - Danish Embassy (DANIDA).
  - German Embassy (KFW).
- Experts from Egypt and Germany.
- Consumers and users.
- RET applications manufacturers, installers and service firms (6 firms attended the workshop).
- Financial institutions.
- UCC/RISØ.
- NREA.

The stakeholders participated in the workshop discussed the different problems/barriers and solutions/actions required to promote the implementation of Renewable Energy Technology projects.

The following are the recommendations:

- Planning, development and implementation of public awareness programs and advertising campaigns to attract and convince the targeted customers. Companies,

Institutional organizations and energy planning authorities should cooperate in this respect.

- Obligatory legislation and regulations should be issued, stating that all working companies should have a certificate that its products are produced according to the standards specifications and qualified to be in the market. Some penalties should exist in case of violation.
- Some form of association, union or federation gathering users, researchers, companies, policy makers and financial sources should exist to coordinate efforts to get the best quality and price.
- The current standards and specifications should be revised. A new comprehensive standards and specifications are required in view of the experiences gained from the past, the quality control and quality assurance issues should be covered in detail.
- Detailed studies for different renewable energy technology options are required, containing clear and accurate estimations for financing needed and suitable conditions and mechanisms for application.
- Some sort of incentives and support should be given from both government and donor agencies to projects and industry. These could be in the form of taxes and customs reduction, cheap land, funds, ….etc.
- More cooperation between NREA and other involved authorities is urgently required. An example of this is the cooperation between NREA, agriculture and water resources authorities in the PV pumping issue.
- After sale services should be provided properly. Professional staff for installation and maintenance should be available. Some sort of marketing and maintenance centers supervised by companies and funded by both companies and donor agencies are suggested.
- It is required to have an economic evaluation for the positive environmental impact of renewable energy technologies.
- Neutral funds are required for removal of renewable technology barriers in Egypt.
- Detailed evaluation of the current existing projects are needed (their condition, performance, and efficiency, maintenance required, and spare parts availability…etc.).

4.3 Final Selection of RETs for Detailed Analysis:

Based on the information of the preliminary selected RETs gathered and using the following selection criteria, a final selection of three RETs was made for detailed analysis in those applications were carefully selected on the basis of:

- Potential for application.
- Availability of information on barriers and implementation conditions.
- Availability of technologies

The Selected Applications are:

1- Domestic solar water heating systems.
2- Electrification of remote areas using PV systems.
3- Large scale Biogas systems.

5. Detailed Analysis, Recommendations and project Proposals

Based on the former tasks, a detailed analysis of the capacity to absorb each renewable energy technology was done. Barriers were analysed and the institutional, financial and policy conditions (and changes required) to implement the selected RET applications were examined. The results of the analysis formed the basis for recommendations on specific actions to address the main barriers identified. The recommendations are accompanied by an assessment of direct and indirect effects (including environmental impacts) in order to ensure that eventual implementation the projects does not have undesirable side effects. The following sections presents the main results of the analysis performed using the data and information collected for each of the three applications; DSWH, PV applications and LBP.

5.1 Domestic Solar Water Heating Systems

Although Domestic Solar Water Heating systems are basically straightforward, the survey, questionnaires and interviews performed under this project have indicated that minor faults can lead to serious problems, especially when they are not noticed immediately. Annex 1-3 present the results.

The additional information collected from various parties, proved that there is a crucial need to restore confidence & trust of both existing and potential users. Many installations have not performed as expected due to low level of awareness and some technical problems aggravated by lack of maintenance.

The detailed analysis of the situation revealed many aspects of vital importance. Although these aspects were recognized earlier, it is now clear that these aspects should be deemed as guidelines for expected future solutions. In the following, some additional data collected from the detailed analysis are presented and followed by the categorization of barrier importance as provided by different parties. Finally some recommendations to overcome the mentioned barriers, as concluded from various parties are presented.

Current situation DSWH systems:

Table 7 below shows the specifications of typical units available in the Egyptian market :

Table 7. DSWH units in Egypt

Collector area (m^2)	Storage tank size (L/day)	No of persons
2	150 l/day	3-4
3	220	5-6
4	300	7-8
6	500	10-12
8-10	750	18-20

- The most popular system is $2m^2$ area, (150 liter/day).

- About 85%-88% of the installed systems are individual domestic water heaters (thermosiphon type without pumps, open loops systems without using heat exchangers and separate tank (horizontal or vertical).
- Concerning Hotel installations, most of them use thermosiphon, and consist of arrays of several units, according to the required load.
- Only from 12 to 15% are centralized-forced circulation systems with variety of tank sizes according to the load.

Design, maintenance & financing:

- It is noticed that most systems servicing big number of persons (Individual or centralized) are not designed well (quantity, period, water temperature). System specifications are not matching the load in most cases.
- Also in big systems, system depends mainly on the electrical heater, which is supposed to provide only less than 20% of the load. It is clear that the heater works for long periods to cover the required load. From the users opinion the system doesn't save energy (electricity, N.G, LPG.) as it was expected and that during the period of electrical heater malfunction the system efficiency is low.
- Maintenance and repairing works are not on the required level from some companies. These led some customers to call another company to provide the service. The most common problems are:
- Pumping problems in centralized systems.
- Leakage from tanks in old systems (lifetime> 8 years) due mainly to the static corrosion problem (new systems produced by several companies managed to overcome this problem by several ways).
- Non of the users had a credit facilities or loans to install DSWH systems. But the price of the system in several cases was paid in 3 or 4 payments within one-year period.

Users Status

New Cities users:

Regarding customers in new cities, where systems had been installed under the supervision of government (like the 6th of October City, New Beni-Swief City, Katamia City… etc.), the current status is that large No. of DSWH systems are not in operation because of one or more of the following reasons: -

a) Shortage of maintenance services from both users and companies.
b) Water is not always available either because the pressure is not enough to reach the roofs (no pumps), or, as noticed in some cases, valves in or out the system are closed!
c) People don't understand the nature of the system operation, which valves to open or close. Also several cases of and large quantities consumption in the early morning and wasting hot water in inappropriate manners were reported.
d) Some administrative problems had been reported. Some people tried to put the systems in the operation mode in new cities but the district engineer refused. Engineers refused because of some unsolved matters with the companies!

Users with direct contacts with Companies:

Concerning users with direct contacts with companies (no governmental supervision on installation), they are generally satisfied with the installed systems performance. The following information were obtained: -

a) Average family ranged from 3 to 5 persons.
b) Common DSWH system sizes is 150 and 300 l/day.
c) The total energy cost per month ranged from 15 to 80 L.E./moth according to the living standard.
d) Saving due to DSWH system usage: 5-20 L.E. /month.
e) Cost of typical DSWH system (common sizes):
1500 -3000 L.E. (in 1990s)
700 -1000 L.E. (in 1980s)

Several technical problems had been reported from old users. Technical problems are mainly due to:

a) leakage from tank and pipes;
b) poor finishing; and
c) improper fittings

These problems made the lifetime shorter and accelerated the degradation in system performance during the lifetime. Working companies now are trying to regain the trust by repairing and replacing the damaged components.Most companies didn't provide users with certificates or licenses from specialized authority stating that the systems produced according to standard specification or qualified to be distributed in the market. Users confirm that they should have asked about certificate or license.

Some of the users were less satisfied because:-

a) Water does not get heated up to the expected temperature compared to other types of heaters
b) Low efficiency during winter and rainy days.
c) Shorter lifetime than expected (about 8 years). Old customers stated this but they announced their satisfaction during the period of operation (before leakage from tank).

Maintenance and after sales services:

- Most users do simple regular maintenance (simple dust cleaning, leakage check and insulation check) by themselves.
- Users call companies in case of problems occurrence (water leak, glass crack or breaking …etc). The company's technical team does repairs. The cost is according to the agreement (during the guarantee period or after it).
- Most working companies respond quickly to direct customers' complaints.
- Several cases in the early 1990s were reported showing bad response from some companies (most of them are now out of the business).
- Several recent users outside Cairo have some complaints about the delay of companies' response and difficulties in finding technicians to repair.

Users in hotels and tourist villages:

Concerning users in hotels and tourist villages, most of the old users are not satisfied. The old DSWH systems were requested by large tenders to cover the whole village or hotel. The main concern in these tenders was getting the lowest price without any

attention paid to the quality differences between products and without mentioning any thing about maintenance and repairing duties.
Individually, users in hotels and tourist villages lately tried to repair and to operate the systems to reduce the high cost of electricity consumed. The growing expansion in hotels and tourist villages together with the high electricity prices yields in serious consideration from the owners to the DSWH systems. However the experience gained through the last decades makes the owners pay more attention to the specification and the company reputation. This results in the recent increase in the production rates in the respectable companies.

Potential Users/Customers

Questionnaires and interviews with many potential Users/ customers from cities and villages with varying jobs and living standers had been taking place.

- About 60% of the potential users had heard about DSWH system but their information is very limited and in most cases they confuse between the DSWH collectors and photovoltaic panels. About 90% of them had incorrect ideas about the theory, concepts and operation in the night period. Also false information about hard maintenance and concrete structure bases is observed.

Potential customers in cities:

Concerning the potential customers in cities, the following data has been collected:

- The average family varies from 4 to 6 persons.
- The average total energy cost (electricity + N.G. or LPG) for average family varies from 20 to 40 L.E. per month for about 80% of the sample.
- Only 10% consume more than 40 L.E./month.
- And also about 10% less than 20 L.E. /month.
- For about 70% of the sample the estimated cost of water heating is ranging from 5 L.E./month in the summer to 10 L.E. in winter. 20% pay more than 10 L.E./month in winter and only 10% pay less than 5 L.E. /month in winter. However experts indicate that Majority of potential users are underestimating the cost of water heating, mainly because it is rather difficult to separate the electricity consumed by the electrical water heater from the overall bill. And for those having LPG water heaters, the experts estimate that they use more than two vessels of LPG each month in winter and only one and half in typical summer month, which is commonly approximated in a conservative way to only one or two vessels. Currently the vessel price is about 5 L.E., which is consistent with the cost, provided by users. The estimated cost as explained by experts can range between 7.5 L.E. in a summer month and about 15 L.E. in a winter month for majority of users. These values are also confirmed by reported kWh consumption for a typical consumer.
- About 80% of city sample have some superficial information about DSWH systems. This is due to the fact that most of the installed systems are in the new cities around the old existing cities over the last 20 years.
- 90% from the city sample showed their willingness to buy DSWH system if it proves to be useful and effective in saving Energy especially with their feeling that it is safer than electrical or gas heaters, but not with the current high prices.
- Only 5% are showed that they are not going to buy because of the availability of other conventional trusted systems and its cheep prices. Also in view of the subsidy given to the low rates of electricity and gas consumption.

- The main reasons behind the limited use of DSWH systems in their opinion: -
    a) Lack of information about cost and benefits.
    b) High initial cost of systems.
    c) DSWH systems are not easily available in the market.
    d) Lack of credit facilities.
    e) Fear of operation and maintenance problems.
- Only 10% added the problem of the suitability of the site to install the systems (shadows, inadequate spaces, high building…etc).

Potential users in villages

Concerning the potential customers in villages, the following information has been obtained:

- The widespread manner in housing is the family house. It consists of 2 or 3 floors, gathering 3 or 4 families (8 to 12 persons and up to 18 in some cases).
- The average consumption rate is less than cities. The monthly average total energy cost only amounts for 30 to 50 L.E for the whole family house.
- About 70% of the people use water heaters (electrical or LPG types).
- Only 30% use ordinary stoves and burners for heating water. Kerosene, LPG, woods and plant wastes are used in heating water with very Low efficiency and causing pollution.
- Only about 40% have superficial incorrect information about DSWH systems.
- The main reasons retarding the dissemination of DSWH systems in their opinion are:
    a) Lack of information.
    b) High initial cost.

Price and payback periods:

- In both cities and villages potential users stressed on the point of the price. The current prices are very high and generally they will not buy a system with that price.
- Asking potential users if they think about purchasing a DSWHs what would be the preferred approximate share of solar mode in water heating, the answer was from 50 to 100% in the water-heating bill.
- The pay back periods preferred by potential users are illustrated in Table 8.

Table 8. Preferred payback period for DSWH

% users	Suggested period
30%	3 years
25%	8-10 years
45%	5 years

Less risk advantage:

- One of the major advantages stated by potential users, despite the lack of information, is that DSWH systems have less risks than the conventional electrical and gas heaters (accidents, short circuits, fires … etc). Also compared to LPG water heaters, there are no difficulties of transporting the gas bottles.

Involved Organizations:

- Most users and potential users think that all the organizations which have the interest and capability to be involved in DSWH systems program should be supervised and

coordinated by NREA only to prevent decision conflicting between different parties. The organization proposed to be involved should cover the following fields: -

- Energy planning.
- Information and media.
- Industrial development.
- Financial.

Categories of Barriers

Several interviews had been performed; different Parties (users/customers, manufacturers, and experts) answered questionnaire. The interviewees were asked to rank and categorize the main barriers and to determine the degree of importance of the detailed barriers analyzed. Regarding the main barriers, a pointing system was established according to the rank given for each barrier. The interviewees were asked to order the first 4 barriers, the 1st barrier was given 4 points, the 2nd was given 3 points, the 3rd was given 2 points, and the 4th was given 1 point. By summing the points for each barrier according to its rank, the most important barriers were determined and the percentage of their points to the total points were concluded. Finally graphs were plotted to illustrate the results.

Users/Customers End Results:

After interviewing 23 user/customer, the main Barriers facing DSWH deployment in Egypt from the Users/Customers point of view as concluded from questionnaire results are:

1. Technical Barriers (66 point)
2. Awareness/informational Barriers (61point)
3. Economic / Financial Barriers (57 point)
4. Institutional Barriers (27 point)

Fig. (10) Users/customers's Main Barriers

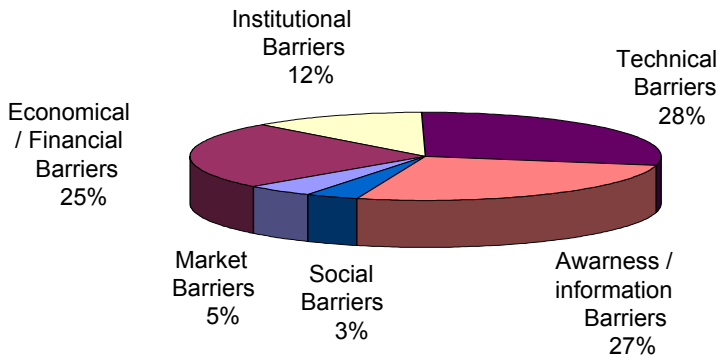


Figure 10 represents users/customers's Main Barriers. The detailed response analysis (Annex 2) indicated the following:

- Concerning technical barriers, the ranking of its sub-barriers is as follows:

1. Quality of the product is not satisfactory due to some technical problems (22 responses very important and 1 important).
2. Lack of maintenance facilities (20 responses very important and 3 important).

3. Inadequate quality control activities for most companies (19 responses very important and 4 important).

- Concerning Awareness/information barriers, the ranking of its sub-barriers is as follows:
    1. False/wrong ideas and information about system design and operation (22 responses very important and 1 important).
    2. Loss of trust among a high percentage of existing users due to some technical problems and poor after sale services (22 responses very important and 1 important).
    3. Feed back mechanisms between all related parties are inadequate (18 responses very important and 5 important).
- Concerning Economic / Financial barriers, the ranking of its sub-barriers is as follows:
    1. No credit facilities or paying schemes for customers (23 responses very important).
    2. Price is high compared to conventional systems (20 responses very important and 3 important).
    3. The payback period is high (18 responses very important and 5 important).
- Concerning Institutional barriers, the ranking of its sub-barriers is as follows:
    1. No restrict regulations, legislation, obligations and penalties on companies and related parties for different activities (design, manufacturing, tender's specifications, system acceptance, maintenance…etc.) (22 responses very important and 1 important).
    2. Lack of supporting programs for technology dissemination. Also, subsidy, incentives, tax reduction or grants from responsible authorities compared to conventional systems are not available. (21 responses very important and 2 important).

Manufacturing standards should be revised in view of current market situation and also should be completed to contain testing, quality control and certification activities (17 responses very important and 6 important).

> ***Comment:*** Contrary to the expected classification, in the economic barriers analysis the high price ranked second after the availability of credit facilities, this was conditioned with guaranteeing the quality and the performance over the lifetime and good after-sales services.

Manufacturers End Results:

After interviewing 5 manufacturing companies, the main Barriers facing DSWH deployment in Egypt from their point of view as concluded from questionnaire results are:

1. Economic / Financial Barriers (14 point)
2. Awareness/informational Barriers (11point)
3. Institutional Barriers (9 point)
4. Technical Barriers (6 point)

Fig.(11) Manufacturers Barriers analysis

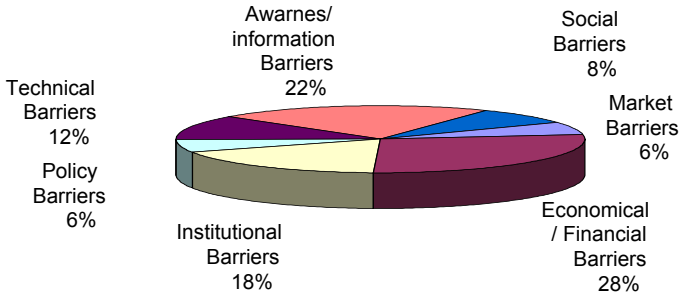


Figure 11 represents the manufacture barriers analysis.

The detailed barriers analysis (Annex 1) has indicated the following:

- Concerning Economic / Financial barriers, the ranking of its sub-barriers is as follows:
    1. No credit facilities or paying schemes for customers (5 responses very important).
    2. Lack of financial supports or financing schemes for manufacturer's (grants, loan with low interest…) to produce with lower cost (5 responses very important).
    3. Price is high compared to conventional systems (4 responses very important and 1 important).
    4. Limited financial abilities to maintain large quantities of systems as in the case of large tenders as well as to branch or expand (4 responses very important and 1 important).
    5. The payback period is high (3 responses very important and 2 important).
- Concerning Awareness/information barriers, the ranking of its sub-barriers is as follows:
    1. Loss of trust among a high percentage of existing users due to some technical problems and poor after sale services (5 responses very important).
    2. False/wrong ideas and information about system design and operation (4 responses very important and 1 important).
    3. Limited penetration among potential users due to low level of awareness (4 responses very important and 1 important).
- Concerning Institutional barriers, the ranking of its sub-barriers is as follows:
    1. Lack of supporting programs for technology dissemination. Also, subsidy, incentives, tax reduction or grants from responsible authorities compared to conventional systems are not available. (4 responses very important and 1 important).
    2. Manufacturing standards should be revised in view of current market situation and also should be completed to contain testing, quality control and certification activities (3 responses very important and 2 important).
    3. No restrict regulations, legislation, obligations and penalties on companies and related parties for different activities (design, manufacturing, tender's

specifications, system acceptance, maintenance…etc.) (3 responses very important and 2 important).

4. Lack of professional/manufacturer association to promote interest (3 responses very important and 2 important).

- Concerning technical barriers, the ranking of its sub-barriers is as follows:

1. Inadequate quality control activities for most companies (2 responses very important, 2 important and 1 not important)
2. Quality of the product is not satisfactory due to some technical problems (1 responses very important, 2 important and 2 not important)
3. Specification for Centralized/large systems components are not well designed for most existing systems (1 response very important and 4 important).

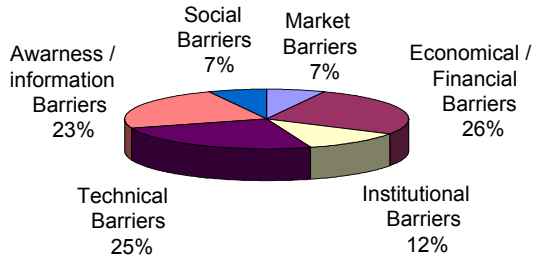
> ***Comment:*** Companies did not imply that the reasons of the loss of trust problems are induced by companies themselves, but they originate that mainly to the institutional barriers and specially the regulations and legislation regarding specifications and penalties.

Experts End Results:

Twelve experts on R.E, industry, quality assurance, standardization, economy, testing and certification have been interviewed. It was decided that they should cover all aspects and attitudes. Some sort of common opinion was recognized, and they provided an insight approach that targeted the priorities. The main Barriers Ranking was as follows:

1. Economic / Financial Barriers (32oint)
2. Awareness/informational Barriers (30int)
3. Institutional Barriers (28point)
4. Technical Barriers (14point)

Fig.(12) Experts Main Barriers Analysis



The detailed analysis (Annex 3) has indicated the following:

- Concerning Economic / Financial barriers, the ranking of its sub-barriers is as follows:

1. Price is high compared to conventional systems (11 responses very important and 1 important).
2. No credit facilities or paying schemes for customers (9 responses very important and 1 important).
3. The payback period is high (8 responses very important and 4 important).

4. Limited financial abilities to maintain large quantities of systems as in the case of large tenders as well as to branch or expand (8 responses very important and 4 important).
5. Financial risks are high compared to conventional systems (8 responses very important and 4 important).

- Concerning technical barriers, the ranking of its sub-barriers is as follows:
  1. Quality of the product is not satisfactory due to some technical problems (11 responses very important and 1 important).
  2. Inadequate quality control activities for most companies (10 responses very important and 2 important).
  3. Specification for Centralized/large systems components are not well designed for most existing systems (7 response very important and 5 important).
  4. Lack of maintenance facilities (6 responses very important, 4 important and 2 not important).
- Concerning Awareness/information barriers, the ranking of its sub-barriers is as follows:
  1. False/wrong ideas and information about system design and operation (12 responses very important).
  2. Loss of trust among a high percentage of existing users due to some technical problems and poor after sale services (12 responses very important).
  3. Feed back mechanisms between all related parties are inadequate (5 responses very important and 7 important).
- Concerning Institutional barriers, the ranking of its sub-barriers is as follows:
  1. No restrict regulations, legislation, obligations and penalties on companies and related parties for different activities (design, manufacturing, tender's specifications, system acceptance, maintenance…etc.) (11 responses very important and 1 important)
  2. Manufacturing standards should be revised in view of current market situation and also should be completed to contain testing, quality control and certification activities (9 responses very important and 3 important).
  3. Lack of supporting programs for technology dissemination. Also, subsidy, incentives, tax reduction or grants from responsible authorities compared to conventional systems are not available. (8 responses very important and 4 important).
  4. Lack of cooperation between involved authorities and organizations. (8 responses very important and 4 important).

***Comment*:** It is seen from the previous expert analysis that their ranking of barriers was similar to both consumers and companies. Which provides a very good base for tackling the barriers.

5.2 PV applications

The survey was applied to 3 different categories: manufacturers / agents, experts and users / customers. In the following we will go thorough the questionnaires / interviews results of the analysis of each category sample responses. Annexes 4-6 present the results

PV Manufacturers / Agents End Results: -

The following are the survey findings from the questionnaires and interviews performed under the project for the PV systems of the manufacturer responses.
After interviewing 8 companies, it has been found that the most important barriers facing the deployment of these systems in Egypt can be ranked as the following from their point of view: -

1. Economic/Financial barriers 41 point
2. Policy barriers 28 point
3. Market barriers 23 point
4. Social, institutional & awareness information barriers 21 point
5. Technical barriers analysis 16 point

The detailed analysis of each barrier as presented in the graphs at Annex 4 indicated the following: -

- For the economic / financial barriers, most of the manufacturers stated that this type of barriers is clarified as the first group and all the reasons mentioned in the questionnaire are considered very important. The long payback period, the low internal rate of return, the high taxes and duties on imports, were chosen as very important by all the interviewees. Also the other three financial reasons; unavailable suitable financing schemes for manufacturers, the high risk and the high rate of interest, have the same degree of importance. Some of the manufacturers mentioned the following notes: -
    - Need for unifying the taxes slices for the components of the systems.
    - There is no guarantee for revolve the money become there is market.
    - Soft loans are very essential.
    - Needs for attracting banks participation and awareness, as there is no specialist in the banks to handle the matter.
- For the policy barriers, 100% of the interviewees stated that it is very important to have and establish a governmental legal mechanism for promoting using RETs. Six of them mentioned that the problems in import of technology/equipment due to restrictive policies are also very important barriers. The same was mentioned for the subsidy of competing sources of energy.
- The third classified type of barriers; market barriers, has the following details:-
    - The reason of limited potential market for profitable operations got 5 responses as very important and one as important. At the same time 3 stated that the small size of the current market is a reason, but there is good potential market. Only two considered that the access to international markets is difficult and this very important barrier, also some manufacturers stated that need for obligatory laws for PV rural electrification is very important.

- The forth position was occupied with three different types of barriers; social, institutional and awareness & information barriers. There was a consensus that the lack of institutions to provide financing support, R&D support is very important reason or barrier. Also most of the interviewees mentioned that the lack of professional manufacturers association to promote the interest and investment in this area. The same was for the awareness and information barriers as most of the responses mentioned that the product low awareness is very important.

Inspite of the same rank given to the social barriers, the detailed analysis shows that no one gives them any importance.

PV Experts End Results

Ten of the experts were interviewed. Some of them are working only in the PV area, but others are dealing with most of RETs. Their responses to the ranking of barriers question give the following results for the four most important barriers respectively: -

1. Economic / Financial Barriers 32 Points
2. Technical Barriers 30 Points
3. Awareness / information barriers 28 Points
4. Institutional barriers 14 Point

The rest of the barriers have very limited points as shown in Annex 6 which presents also the detailed analysis and graphs of all the PV experts responses. The following are the results and some comments on these four types of barrier's analysis:

- For the economic / financial barriers mentioned in Annex 6, most of the responses were concentrated in the very important and important columns, but small numbers appeared in the not important one.
- Within the technical barriers the responses were mostly important and some were very important, but for the last one "some component are not reliable" the responses were 5 not important 1 important and 2 very important.
- The 3rd ranked set of barriers; awareness & information barriers have also the responses as important and very important only one mentioned that the information about the product inadequate with consumers is not an important barrier.
- For the institutional barriers (5 barriers stated in the questionnaire), the experts' responses mentioned that some of these barriers are not relevant such as lack of institutions to provide financing support had 1 response very important, 3 important, 1 not important and 3 not relevant. The most relatively important barrier within this group looks to be the lack of professional / manufacture associations to promote interest.

Comment: Despite the high scores very important given to the detailed barriers under the market barriers the experts interviewed did not rank them as one of the top four.

PV Users' End Results

Seven of the applications' users and targeted users were interviewed. All of them agree that there are already some important barriers, which should be overcome. The proposed ranking of these barriers types from their point of view is as follows: -

1. Economic / Financial Barriers 40 Points
2. Technical Barriers 32 Points
3. Awareness / information barriers 26 Points
4. Policy barriers 16 Point

The other three types of barriers; institutional, social and market barriers got lower score on the ranking scale. The following are some detailed analysis for the responses about the a/m four types of barriers:

- **The economic barriers:**

From the responses plotted in Annex 5, it is clear that there is a consensus that all the sub-barriers stated in the questionnaire within this type are very important especially those correspond to the high initial cost, the low prices of other competing energy sources and the difficulties in finding suitable financing schemes to purchase the PV systems.

- **The technical barriers:**

This group is ranked as the second one. The detailed responses show that both of the spare parts and after sale services represents important barriers, while 86% stated that the unreliability of some components is an important barrier. In contrary most of them agreed that the transfer of technology is not an important barrier.

- **The awareness & information barrier:**

The interviewees mentioned that the awareness and information dissemination about this technology, its formation and components is not enough and this represents an important.

- **The policy barriers:**

Inspite of giving this type the fourth position, the responses show that 99% of the interviewees stated that the three sub-barriers listed in the questionnaire; problems in import technology equipment due to restrictive policies, competing products subsidized, need for governmental legal mechanisms for promoting using R.E, are very important.

***Comment**:* although the policy barriers were ranked as the fourth are in the general ranking, they have high scores as detailed responses. For the awareness & information barriers one of the two sub-barriers has one response as not important and another one as not relevant. So it was expected to have the policy barriers ranked as no. 3 and the awareness & information barriers

5.3 Biomass systems (LBP)

For identifying the main barriers facing LBP projects. A questionnaire for LBP barrier analysis was designed to measure the interest groups response about the most important barriers that must be removed. Annex 7 and 8 show the analysis. Annex 9 shows the most important LBP barriers concluded from the questionnaire response analysis. In this Annex, the LBP study team add some other important barriers from their point of view (shaded ones).

The most important LBP barriers concluded from the analysis of the Experts and Targeted Users questianaires are:

1- Absences of national supporting, developing and dissemination programs.
2- Lack of communication and cooperation between the involved institutions, organizations and stakeholders.
3- Competing petroleum products and electricity are subsidized and available in the countryside.
4- The high capital costs of LBP with comparison to other organic waste treatment systems and financing problems.
5- Lack of awareness about the LBP economic and environmental impacts.
6- Absence of NGOs role.
7- Environmental laws are not strictly applied in strict measures.

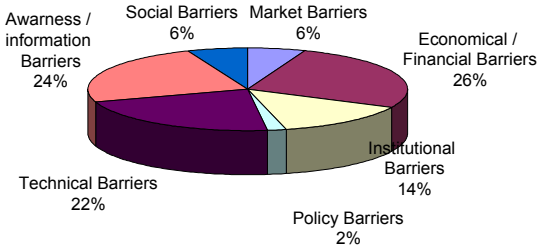
5.4 General Results and Barriers Removal

5.4.1 DSWH General Results & Recommendations:

Although using solar energy to provide hot water promptly appeal to many people, DSWH industry has had difficulties gaining a sound share of the hot water market. The industry, till now, hasn't proved DSWH systems as an environmentally attractive and potentially economic means for providing targeted users with hot water. The detailed barriers analysis showed that self-sustaining DSWH market growth needs dedicated and ongoing efforts from both the industry and other interested parties.
Frankly speaking, Consumers seek economically viable, popular, and high quality DSWH system and the industry sporadically provided that. A thorough understanding of the market situation is rather difficult, however the overall analysis shows many convergence points:

- About 26.5% of the key players (users, manufacturers and experts) indicated that the economic barriers are the main barriers for DSWH industries.
- The awareness/information barriers ranked second with about 24% of the sample.
- Technical barriers had been implied as the third with about 22%, however some experts and users pointed out that it would be ranked first if the DSWH systems were more common. But manufacturers

Fig.(13) Overall Barriers Analysis



argued that the lack of knowledge about the system design and

operation together with seldom maintenance are the cause of the problem.

- About of 13.8 % indicated that institutional barriers can be the fourth group of barriers that if removed could help to boost the market to a great extent.

The data collected and the detailed barriers analysis revealed more aspects of interest. For instant, among all barriers it was agreed that the high price compared with conventional water heating systems and lack of credit facilities is a major obstacle. These barriers can be augmented with the subsidy given to the "low bill" electricity consumers which gives a financial advantage for electric resistance water heater over DSWH in view of current system prices.

Another threat that worsen the situation more is that natural gas and LPG are the fuel of choice for new housing and since natural gas/LPG heating costs much less than electric water heating, this further reduces the market potential for DSWH systems. Consumers are usually sensitive to minimizing the costs and unless this problem is solved, it will be very difficult for the DSWH industry to create a continuous sale force.

Surveying the water heating market verifies that the DSWH industry is almost invisible throughout the supply and the distribution chain, which has serious implications for the success of DSWH industry. Unless DSWH systems are offered to consumers, the required purchasing growth cannot be achieved.

Normal market do not offer significant choices for water heaters because of the lack of perceived interest by consumers, high initial cost and lack of credit facilities of non-standard systems like DSWH systems in addition to noticed performance and consumer acceptance. The removal of the awareness and information barriers is the dominant factor in this aspect. As well as guaranteeing the quality of the system by suitable measures which involves greatly the removal of the institutional barriers.

Notwithstanding, hope still exists. The technology of DSWH systems has improved significantly in the last three years. Manufacturers control quality more rigorously. Most of technical problems led to loss of trust found a solution (tank leakage, good finishing, testing and certification centers, proper after sale services…). Actions are taken from many interesting organizations to remove barriers to efficient markets.

Recommendations and actions to be taken for overcoming the barriers:

The following recommendations and actions were concluded as a result of the previous tasks to provide the means for the removal of prominent barriers. These recommendations describe to a great extent the critical actions required in important fields to ensure the success of the DSWH technology in the Egyptian market:

a) Information and Awareness:

1- Development of effective public awareness and promotion programs that depend mainly on a market surveys and studies and concentrating on Media especially TV and newspapers. The concept, the benefits and the operating conditions required should be in clear messages.

2- Allowing systems and spare parts to be available in shops and markets especially outside Cairo. This should be accompanied with availability of maintenance centers.

3- Also dissemination and promotion of DSWH systems could be done through different exhibitions held in syndicates, hotels, clubs … etc.
4- Demonstrating systems can be presented in "wide impact" places, like cities councils, Clubs, big factories, conferences halls, stadiums…etc.
5- Some printed materials (leaflets, brochures…etc) should be available to give the customers the necessary information needed for optimum choice of DSWH system; (technicalities, advice for operation and maintenance, entrusted companies, the phone numbers of the supervisory authorities especially in the case of complaints about quality and after sale services).
6- Preparing courses, seminars, presentations and workshops for targeted users in schools, universities and clubs to introduce the DSWH and RE in general to them. Besides, these could help in creating a new generation having an interest and commitment to DSWH technology.
7- Establishing small-scale solar laboratories in schools and universities similar to physics and chemistry laboratories, and allow the students to practice the current theoretical study in this field.
8- Some form of federation, union or society gathering representatives of users, companies, financial sources, policy makers and researches can be very useful to coordinate efforts in the a. m. aspects.

b) Financial and economic measures:

1- Financial support from the governmental, private sectors and donor agencies to the DSWHS should exist. Availability of credit facilities with low interests and reduction of prices for competing considerations must be the main concern.

2- Soft loans to the young engineers and technicians could be provided through donor agencies or social development funds to establish or retrofit existing centers to maintain and market DSWH systems.

3- Incentives corresponding to the subsidizing given to the electricity and natural gas consumers can be considered. This may be in the form of subsidizing the initial cost or users taxes reduction or reduction of electricity invoice for DSWH systems users.

4- Encouraging the local manufacture by tax and customs reduction on solar water heating systems components in addition to production requirements and necessities.

5- Providing financial and technical supports to the R&D activities in development and improvement of the products.

c) Technical

1- Companies Guarantees for systems performance and quality to realize the estimated lifetime is very important.
2- Supervision on companies (Production lines, quality, and after sales service) should take place. The supervisory testing & certification authorities should be fully supported to prevent any untested and disqualified systems from being in the market.
3- Periodical checks on factories can take place. It also could be accompanied with providing advisory comments to improve the quality. This should be for small charges and with full support from the government.

4- Rules and legal mechanisms that ensure the existence of sanctions and penalties and to enforce their importance, should be firm enough regarding the quality and after sale services.
5- The current manufacturing standards and specifications should be revised carefully to include quality control and assurance activities as well as proper installation requirements. New comprehensive standards are required urgently.
6- A program or mechanism to solve the problem of the already installed inoperative systems in the new cities should be prepared and implemented. It should be the result of cooperation between all the responsible ministries and authorities as well as the involved companies. The program should include some mechanism for informing the inhabitants about the systems and their regular duties (cleaning and checks) and without charging them any additional costs (that is especially where the system costs were paid in several places without operating them).
7- Maintenance centers outside Cairo in other cities and villages should be available. It can also serve as marketing centers in this respect.
8- In case of large tenders, the supervision of NREA or experts trained and approved by NREA on tender specification and systems acceptance should be considered of vital importance. Responsible persons on preparing tenders, specification as well as supervising installations and accepting the systems should be trained and qualified properly. This is an important lesson learnt from the past.

5.4.2 PV General Results & Recommendations

From the end results of the questionnaires, interviews presented before, and from the project team experience, the main barriers to spreading-out the use of PV applications in Egypt can be ranked as follows: -

1- Financial / Economic Barriers.
2- Technical and awareness / information barriers.
3- Policy and institutional barriers.
4- Market Barriers

PV Rural Electrification:

As the application selected for the detailed study is the rural electrification using Solar Home Systems (SHS), the following barriers to disseminate this application are figured out:

a) High dissemination costs.

The target group for rural solar electrification is the population which lives in dispersed rural dwellings, where there is a low percentage of wealthy households. Dwellings are far apart so the costs for commercial dissemination, installation and after-sales-services are very high. These costs (transaction costs) are estimated to be about 30% of the total costs of a PV system. Initiatives of PV producers have to create branches in developing countries, in order to develop commercial dissemination near potential customers. This is still an exception to the rule, in spite of the important financial power of several PV producing companies. However, positive examples may be cited in Indonesia, Namibia and South Africa.

***Comments*:**

- There is a consensus that the financial and economic barriers are the most important and should be removed first.
- Although the majority of the interviewees did not rank the policy as the second one, most of the responses pointed to the importance of and need for a governmental mechanism for promoting using PV technology.
- As expected Man. ranked the market barriers, as the third barriers must be taken into consideration to be removed and related the causes to the small size of the market, limited access to international market and for PV limited involvement of the private sectors.
- They also pointed to the limited number of companies working in this field, the need for obligatory laws for rural electrification using PV. On the other hand experts stated there that is need for ambitious development plans in new areas that lack utilities.
- Some experts believe that it is not relevant to manufacture PV modules in Egypt at the current stage, as the technology is changing and still very expensive. Instead of going into manufacturing, Egypt can focus on developing auxiliary equipment i.e. batteries, controllers, inverters, etc. and developing innovations in the uses of PV systems where it can be engineered to be cost effective.
- As it is expected, experts and users ranked the technical barriers , as second and the manufacturers didn't show any response to the technical barriers and rank it at the end of barriers that must be removed. The lack of access to the technology and maintenance facilities is not relevant from their point of view.

b) Negative effects of subsidised dissemination on commercialization.

A publicly program may have disastrous consequences on a commercial program, which is just starting to develop. A typical example is the public announcement of the "1000 PV Roof Program" in Germany by Federal Ministry of Research and Technology in 1991. This caused the total instantaneous stop to commercial sales of such systems.

In order to allow the coexistence of public subsidised programs and commercial dissemination, it is necessary that the conditions of the public programs should be simple, clear, and neutral and strictly applied. Moreover, public authorities should limit their involvement to functions that could not be undertaken by private structures (for example: identification of recipient households calls for tenders, control, information, vocational training etc.). Often the strict application of these criteria is hampered by daily practice. Promises made by politicians or pressure from well-off minorities might kill the commercial marker for photovoltaics and are contrary to the objectives of regional development policy, which aim at "balancing social and regional disparities". The situation has been aggravated by the multitude of support programs, characterised by different approaches and different levels of subsidies,

sometimes executed by different organization and financing institutions in the same country (example: Morocco).

c) Lack of information.

In spite of efforts in recent years, there is still a deficit of information regarding the services that PV can provide. In some manuals for regional rural development, the chapter on electrification still tackles the question of rural electrification by proposing the grid solution alone. In the same way, PV is still only an exceptional solution in rural programs for potable water supply. Therefore, appropriate manuals of successful experiences, and long-term project results are of high value for providing information to interest groups and decision-makers.

d) Neglecting external costs when considering classic energy sources

Discrimination against photovoltaic is bound to persist unit an international consensus is found on how to integrate the external costs of fossil energy (social costs, costs of negative impact on environment) in the framework of economic comparisons with renewable energy.

e) Tariffs' system

The tariff system of utilities does not reflect the real cost of rural electrification. Tariffs for electricity consumption are identical in rural and urban areas, although the costs of electricity energy supply are much higher in the countryside. In Egypt even have an especially low tariffs for small consumers with the result that rural households in particular pay small amounts for their consumption from the grid.

The SHS as solar alternative offers less comfort and less service than the grid. In addition, it demands higher spending by customer. For these reasons, it could happen that rural population groups refuse photovoltaics and demand to be connected to be electrical grid.

f) Taxes, tariffs on importation and customs duties

As in many other developing countries, SHS is considered a luxury products and therefore charged very high importation tariffs. Sometimes, tax exemptions are limited to equipment, which is imported in the framework of co-operation projects, public projects, programs, or the activities of Non-Governmental Organizations (NGOs). This is of course unfavorable for commercialization. Imported equipment and materials have to be purchased in foreign currency, which may cause problems to businessmen in developing countries.

If some components such as charge regulators, and batteries are produced locally, importation of these components is often charged high duties, to protect the market for local manufacturers. Such a decision may cause severe problems, if the local technology proved to be unreliable.

g) Another important barrier is the high capital and production costs of the PV system especially to those people in the rural remote areas, with somewhat low standard of living, and most of them are so poor that they can not pay for these systems. At the same time there is no suitable financing mechanism to support them.

Before tackling these barriers, it seems to be more useful to present first the opportunities and the potential contribution of PV systems in the rural development programs.

The opportunities for using PV systems in rural electrification are:

- PV systems have little detrimental effect on the environment; their visual impact is modest and they do not emit any noise or polluting materials during operation.
- Stand alone PV systems have proved to be highly reliable as a means of providing power for remote communities.
- In Egypt there are many remote small villages with no access to the grid, where SHS can ideally be used.
- The government policy plans for electrifying all small villages and attachments.
- Egypt has very high solar radiation.
- The technical and technological experiences are available.
- In developing countries, PV systems can play an important role in pre-electrification and as an integral component of basic electricity supply infrastructures.
- The modular character of PV systems makes them very flexible. They are easy to install, have short installation times and the modules can be assembled to meet a wide range of power requirements.
- On recent evidence the operating and maintenance cost of PV systems should be low.

5.4.3 LBP general results & recommendations

The conditions for the success of the LBP are related to barriers that it faces. Barriers' removal may need actions on several fronts; policy changes, setting up institutional mechanisms for technology availability and upgrade, capacity building (making available skilled personnel), financing, changes in laws or designing and implementing a regulatory framework etc.

The following recommendations and actions were concluded as a result of the previous analysis. These recommendations describe to a great extent the critical actions required in important fields to ensure the success of the LBP technology in the Egyptian market:

Institutional

1- Raising a national action program for LBP implementation and setting up a coordination committee for planning and implementing the action plan for LBP.

2- Maximizing the efforts of NGOs role.

Financial and economic:

1- Establishing energy pricing policy for encouraging renewable energy to compete petroleum products and electricity that are subsidized and available in the countryside.

2- Establishing appropriate financing mechanisms for manufactures/ users by suitable rate of interest.

3- Conducting a market study for Identifying the potential number (the market) of the LBP in Egypt.

Information and Awareness:

1- Set up awareness programs about the necessity of LBP as a source of clean energy, waste treatment, economic feedback and environmental & social impacts.

2- Implementing successful pilot projects that can show the benefits of LBP to be replicated.

Environmental

1- Maximizing the efforts of environmental organizations and strictly applying for the environmental laws and regulations.

5.5 - Direct and indirect effects of RETs Projects

5.5.1 Social and Environmental Impacts of DSWH Systems

Social and environmental Considerations serve alongside the economic and energy conservation considerations in evaluating the impacts of utilizing DSWH systems. Due to the fact that more than 200,000 DSWH system are already installed all over Egypt, as well as more than 7 local manufacturers exist, the DSWH share of total energy saved by renewable energy technologies was estimated to be about 65%. The following summarizes the social and environmental consequences of utilizing DSWH systems:

- Supporting the economic and social development by saving annually more than 80,000 TOE, which is of vital importance bringing to mind the rapid population growth and the limited proven oil reserves.
- The utilization of DSWH systems helps to abate the emissions of green house gases, for example; the annual reduction in CO_2 emissions is estimated to be more than 190,000-Ton CO_2.
- Helping to solve the unemployment problem by adding more job opportunities through the local manufacturing capacities.
- Enhancing the standard of living as a result of new/improved technical capability, that supports the development of human resources.
- DSWH systems provide good design flexibility to work with/without electricity. On the other hand they can be operated in hybrid systems with other energy sources, which are quite useful options in the case of developing the rural/arid communities.
- DSWH system manufacturing industry domiciled mainly in the new industrial zones, which impose minimum effects on the local land use pattern and compatible with the local long-term regional development plans.
- DSWH system manufacturing industry is not to be thought of as a producer of any irreversible changes in the Eco-system.
- DSWH systems manufactured in Egypt use open loop theory and don't use any toxic additives and with proper design and maintenance no corrosion or leakage problems affecting the quality of or contaminating the water can occur over the system lifetime. Therefor they aren't expected to bring with them unintended consequences like air and water pollution or affect the public health.
- DSWH systems are user friendly and safer than other conventional water heating systems (less gas/LPG fire or vessel explosion, less electrical hazardous, easier maintenance, etc) which imply a more comfort life style.
- The expanded utilization of DSWH systems helps to boost the public awareness towards the necessity of exploiting the huge indigenous solar energy resource.
- DSWH systems are unlikely to produce noise effects on the neighbouring area.

- Unlike other conventional water heaters, DSWH systems can be an added value to the beauty of the building and harmonize with the landscape.

DSWH systems Financial Cost Analysis

Based on data collected earlier, the following summarizes the financial cost analysis:

- The companies' investments in the field vary from 500000 LE to about 2,000,000 LE, and gross profit of most of them ranged from 15 to 20%, mainly due to low rates of production. As clarified by companies' owners the gross profit should be from 30 to 35% of the selling price.
- A typical unit (150 litres & 2 m^2) currently costs between 1800 to 2200 LE, where the similar conventional domestic water heater (Electrical or LPG) currently costs about 400 L.E.
- The estimated annual electrical energy savings for a typical DSWH system ranged from 1400 to 1800 kWh. Using mid-point i.e. 1600 kWh can be saved annually. According to the present residential electricity prices the price for kWh for the majority of users is 0.083 LE/kWh (subsidized value).
- The reduction of the annual purchase of electricity by using a typical DSWH system can be estimated to be:

  1600 kWh/year * 0.083 LE/kWh = 132.8 LE/year.
- The estimated lifetime of the system is about 20 years (as declared by companies!), hence the DSWH typical system can save: 132.8 LE/year * 20 = 2656 LE.
- Assuming an optimistic situation where the price is 1800 LE. The incremental cost of DSWH typical system compared to conventional domestic water heating system is:

  1800 LE- 400 LE= 1400 LE
- The payback period for typical DSWH system will be:

  1400 LE / 132.8 LE/year = 10.5 years.

This analysis indicates that the present initial cost is very high (which is recognized as one of the primary barriers). The payback period associated with the initial cost is too long. The price to be attained if the optimum production rate was achieved (3000 to 5000 system annually) ranges from 1000 to 1300 LE. This will yield to a payback period from 4.5 to 6.7 years, which is relatively accepted if the system performance was guaranteed.

The previous calculations are based on residential electricity prices. However, the situation is indeed better in case of utilization of DSWH systems for commercial and tourism buildings. This is verified by the present electricity prices, which range from 0.18 to 0.43 LE according to the level of consumption.

Assuming an average price for electricity consumption (0.26 LE/kWh) the reduction in the electricity purchased annually for a typical unit would be:

1600 kWh * 0.26 LE/kWh = 416 LE/year.

Accordingly, for an initial DSWH system cost of 1800 L.E, the payback period the would be:

1400 LE / 416 LE/year = 3.4 year.

The payback period can be as far as 4.3 years if we assumed the typical system price to be 2200 LE. Commercial and tourism building users gladly received both calculated payback periods. This explains why in the last two years companies' sales

has relatively increased. Based on the estimated annual saving of electricity for a typical DSWH system (1600 kWh/year), and using the corresponding fuel saving for each kWh (according to the most recent available data for Egypt is about 227.6 gm. oil equivalent), The annual fuel saving for a typical DSWH system will be:

1600 kWh/year * 227.6 gm./kWh = 364160 gm. O. E. /year

= 364.16 kg O. E. /year.

As each kg oil equivalent produces 3.199 kg CO_2. Hence, the abatement of CO_2 emissions will be:

364.16 kg O. E. /year * 3.199 kg CO_2 = 1164.95 kg CO_2

= 1.165 Ton CO_2

For 20 years lifetime, the abatement of CO_2 emissions will be:

Ton CO_2 * 20 years = 23.3 Ton CO_2.

5.5.2 Direct and indirect impacts of PV systems

For evaluating the impacts of the PV rural electrification projects, it is not fair just to use the financial cost – benefit analysis (CBA) for project justification. In other words the cost-benefit analysis involves evaluating the costs and benefits of a project. Nevertheless, whilst the assessment of the costs has not special difficulties, the beneficiary assessment is a very difficult task, an exercise which is crucial to compute the economic rate of return of the project. There are two main kinds of benefits of rural electrification projects, the effects on the living conditions of consumers and the effects on productive or income generating activities. The quantification of the effects on productive activities has not been usually done. Indeed, this evaluation concerns usually qualitative outcomes obtained through field surveys. On the contrary, the quantification of the effects on living conditions has been extensively done[15] .

Social and Economic impacts:

Using PV technology as one of the renewable energy technologies will help in implementing the strategy of achieving sustainable development especially at the remote areas.

Implementing PV rural electrification projects will result in a new way of life for the inhabitants at these remote areas. They will have enough water for agriculture and grazing at permanent settlements. This will increase agriculture products and can help to establish some agro-industrial small projects such as crop drying and dairy products, using also renewable energy sources.

Availability of electricity especially for lighting, TV and radio sets, social centers, clinics, roads and schools, will strongly improve the standard of living and social activities. Women and children will be greatly affected by the availability of this clean energy. This will create new job opportunities for the people living there. This leads to increasing their income and accordingly the national income, Also spreading out this technology will find a good market for PV systems and components, which can encourage investors and private sector to share and take place in PV industry in conjunction with the big known companies.

[15] Reference No. (25)

Environmental impact:
The willingness to pay for electricity for the society is higher than that of individuals because the electrification of rural areas creates externalities, such as improvements in health conditions (that reduce the number of diseases) and education also global externalities such as reduction of CO_2 emissions should be considered.
There are two ways to measure the monetary valuation of the reduction in CO_2 emissions. First, the Global Environmental Facility (GEF) criterion based on the incremental method and, second, the Asian Development Bank (ADB) estimates. For PV rural electrification, the total energy produced using the PV systems can be calculated for any system size during its lifetime which is normally used as 20 years. For each kWh produced by PV, the equivalent saved oil, the corresponding abatement of CO_2 emissions can be calculated for the 20 years lifetime, then any of the above monetary valuation procedures can be used.

5.5.3 Direct and indirect impacts of using LBP

Implementing LBP projects would lead to:

- Preventing the emission of huge amount of green house gases due to the traditional ways of waste management. The traditional handling and storing of manure releases great amount of methane gas, which has very high effect to the global worming.
- Reducing the use of fossil fuels replaced by the produced biogas. The emissions of the biogas as a fuel are of lower effect than that of the fossil fuels to the world global worming.
- Reducing the use of chemical fertilizers replaced by the produced rich fertilizers that increase the soil fertility and reduce soil pollution with chemicals.
- Killing all insects & disease that are on the waste, which leads to less use of insecticide.
- Produce fertilizers, which substitute equivalent amount of chemical fertilizer.
- Produce clean energy to substitute equivalent amount of fossil fuels.
- Developing the rural area by introducing new job opportunities through LBP manufacturing, construction and operation. This would improve the standard of living and develop clean methods for manure handling, treatment and utilization.
- Technology development and dissemination by adapting & developing biogas plants suitable for local conditions and manufacturing locally the developed plants partially or totally.

5.6 Conclusion:

This case study revealed that; for the first application (DSWH) the main barriers are; the economic barriers followed by the awareness / information barriers, then the Technical and Institution barriers. For the PV rural electrification, the most important barriers are; the economic and financial barriers, the awareness and information barriers then the technical barriers.
For the third application; the large-scale biogas systems, the main barriers are the institution & capacity, economic, policy and awareness / information respectively.

In general the conclusion and the project results is that the main actions needed to overcome the barriers and make use of the available opportunities are:

1- Economic / Financial

- Creation of new financial schemes for the RETs applications components and systems.
- Reducing the taxes and duties for the components and / or materials needed for RE systems.
- More government-supported market incentives to encourage further commercial development and deployment of RE technologies are needed to help overcome market reluctance to invest in RE systems.

2- Technical

- Setting rules and legislation for quality assurance, standardisation, and certification for all the RE components and systems.
- Manufacturers, suppliers, and agents should have their representatives and centres near the consumers and between them.

3- Information and Awareness

- Development of effective public awareness and promotion programs such as demonstrating systems, some printed materials (leaflets, brochures…etc), training courses, seminars, presentations and workshops for targeted users, small-scale laboratories in schools and universities.

4- Donor's Support

The support of the international organisations is urgently needed especially for setting monetary values for emission's reduction to subsidise RETs.

5.7 Proposal of RETs Projects

As a result of this study and analysis, the following projects' proposals are identified and selected to be implemented and to test the effectiveness of the action recommended to remove the barriers of each technology or application. Annexes 10, 11 and 12 present respectively three-project proposals, one for DSWH, the second for PV systems and the third for LBP.

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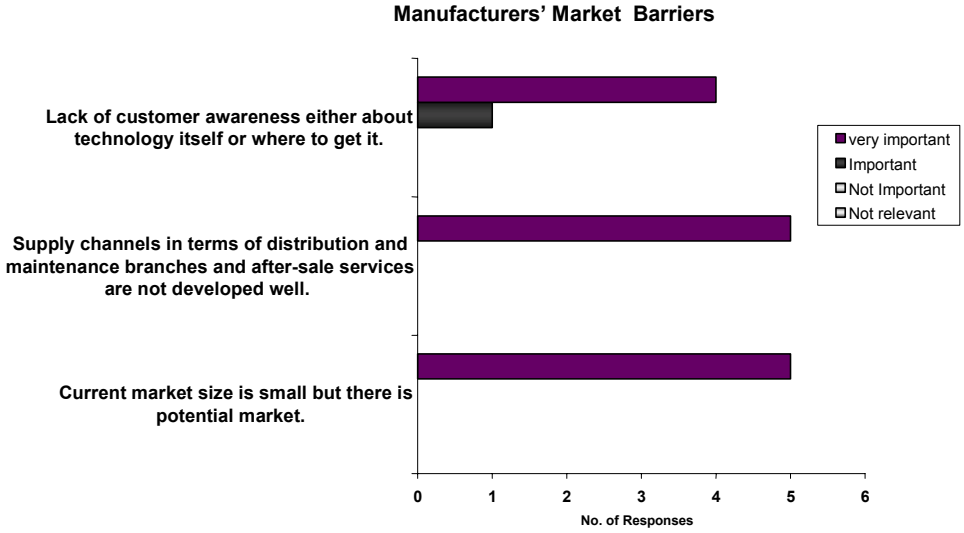
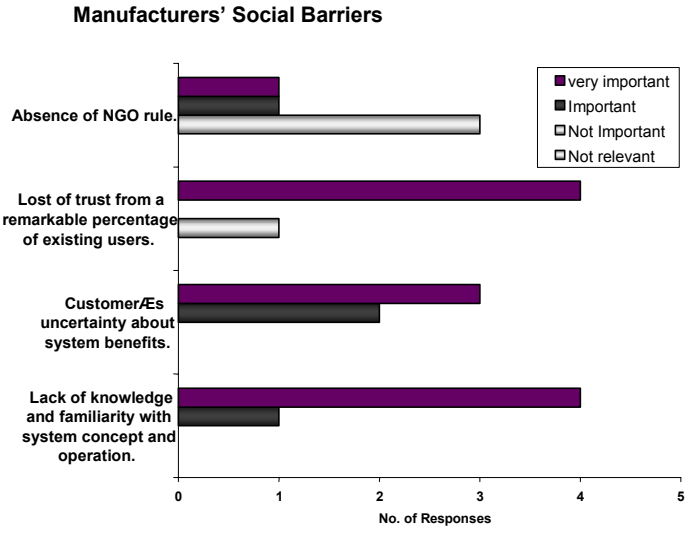
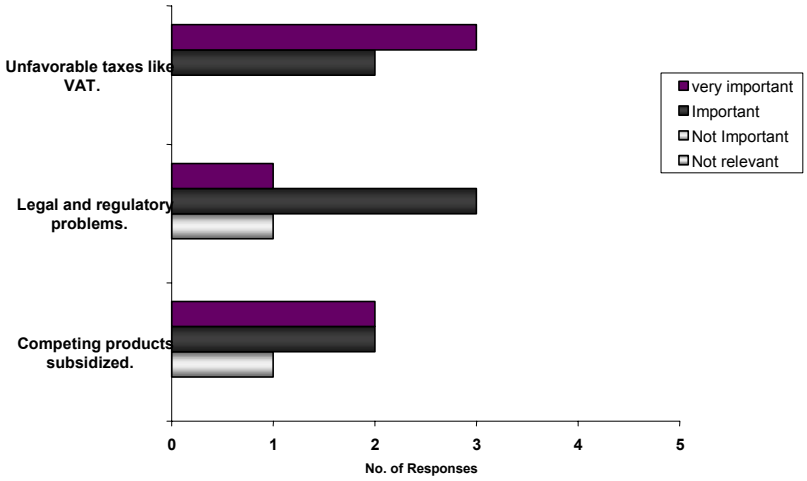
Annex 1; DSWH survey responses; manufacturers

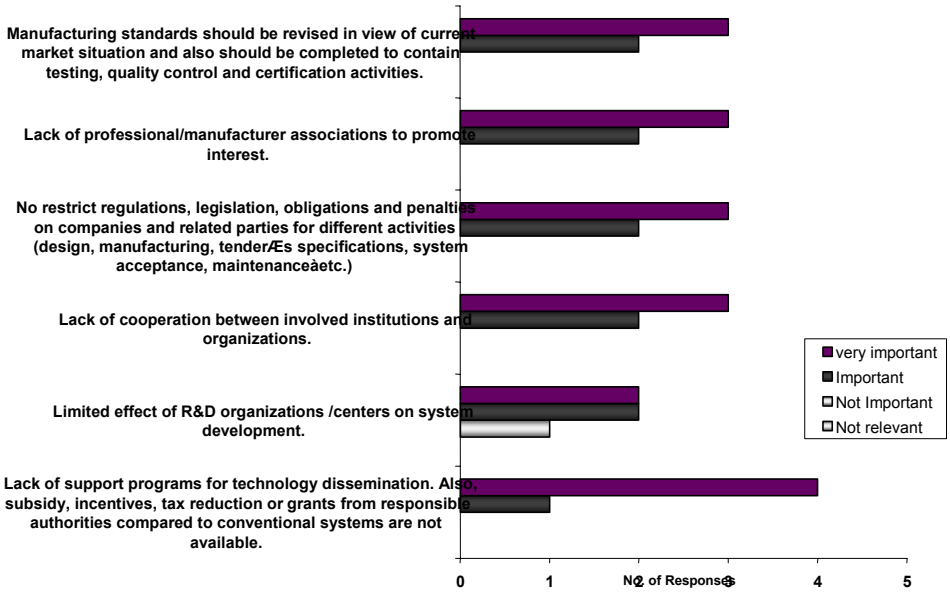




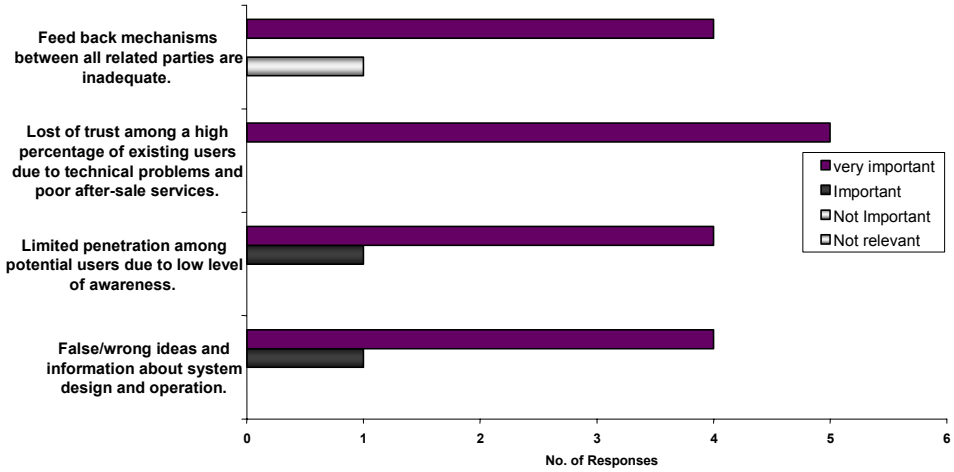
Manufacturers' Policy Barriers



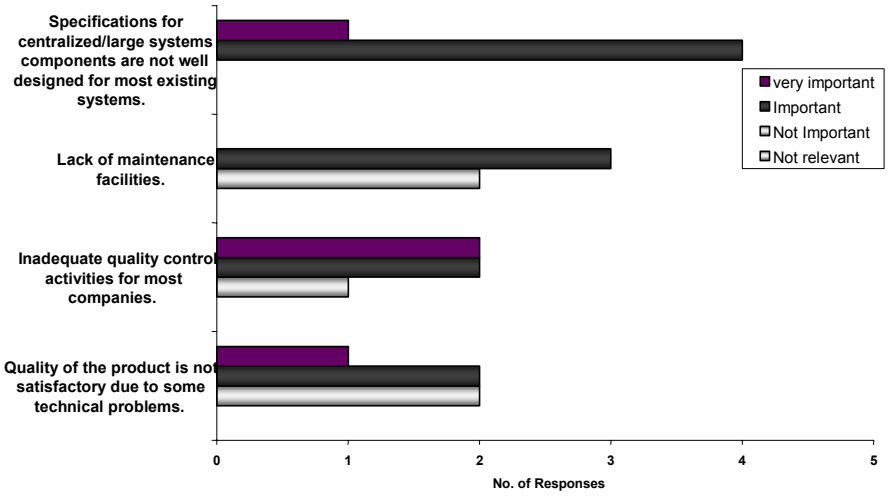
Manufacturers' Institutional Barriers

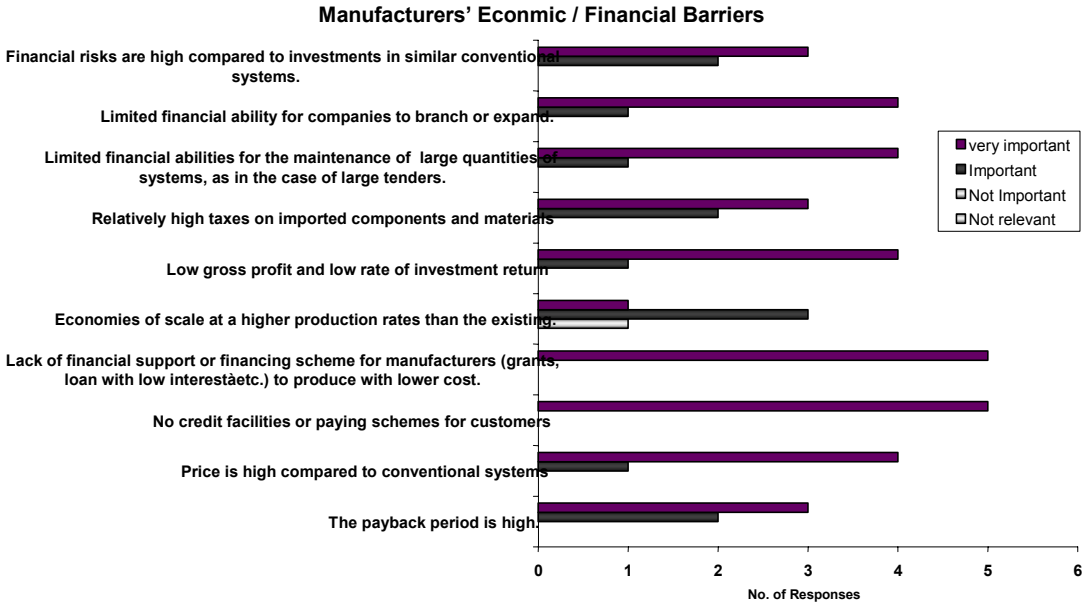


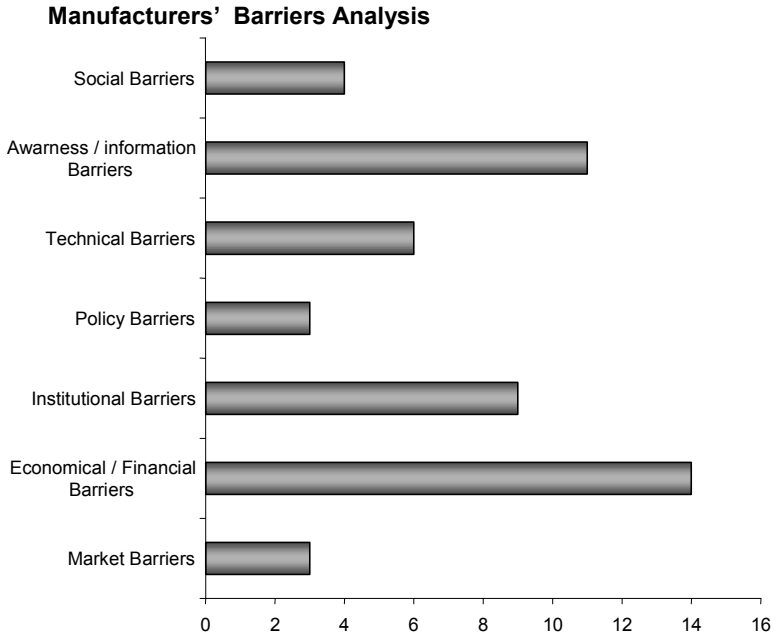
Manufacturers' Awareness / Informational Barriers



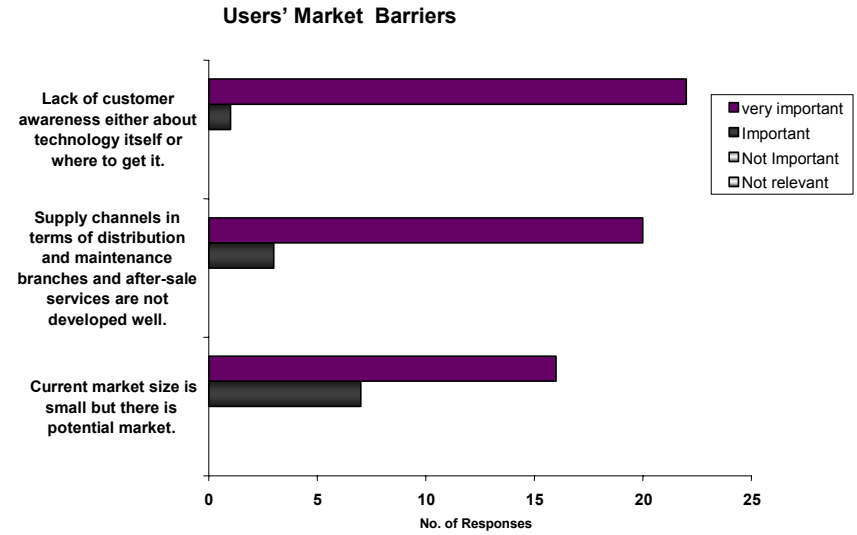
Manufacturers' Technical Barriers

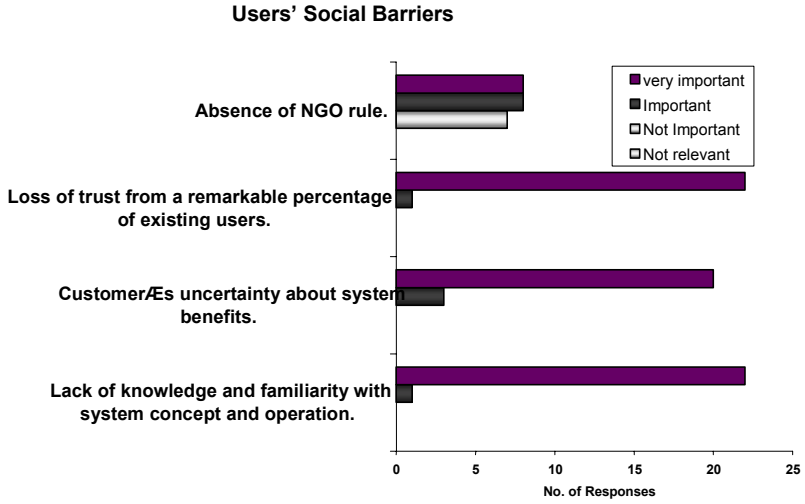



Manufacturers' Econmic / Financial Barriers
Financial risks are high compared to investments in similar conventional systems.
Limited financial ability for companies to branch or expand.
Limited financial abilities for the maintenance of large quantities of systems, as in the case of large tenders.
Relatively high taxes on imported components and materials
Low gross profit and low rate of investment return
Economies of scale at a higher production rates than the existing.
Lack of financial support or financing scheme for manufacturers (grants, loan with low interestàetc.) to produce with lower cost.
No credit facilities or paying schemes for customers
Price is high compared to conventional systems
The payback period is high.
very important
Important
Not Important
Not relevant
0
1
2
3
4
5
6
No. of Responses

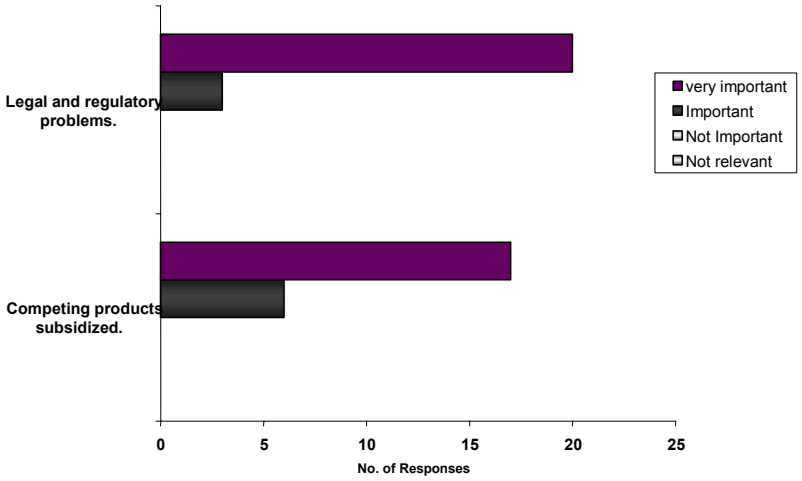

Manufacturers' Barriers Analysis
Social Barriers
Awarness / information Barriers
Technical Barriers
Policy Barriers
Institutional Barriers
Economical / Financial Barriers
Market Barriers
0
2
4
6
8
10
12
14
16

Annex 2; DSWH survey responses; users

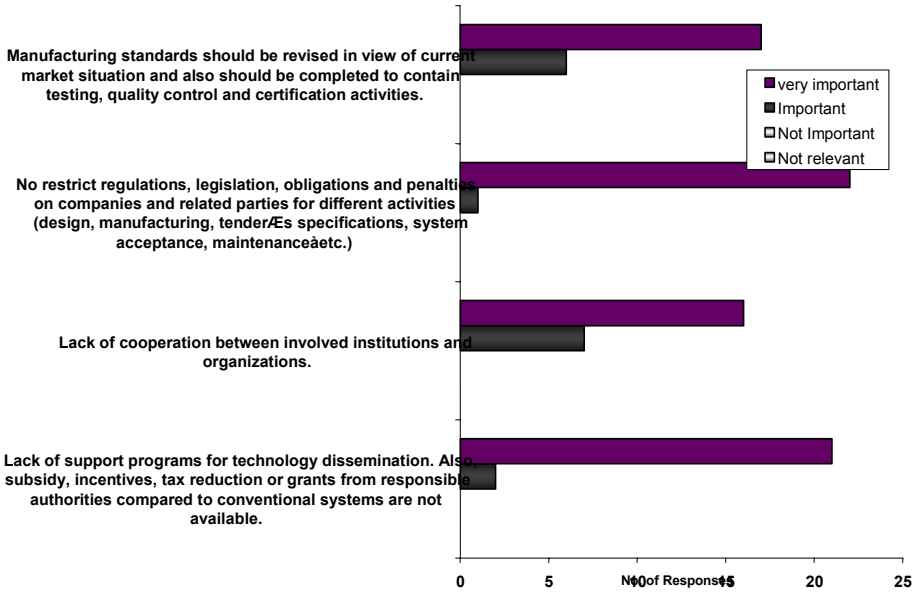




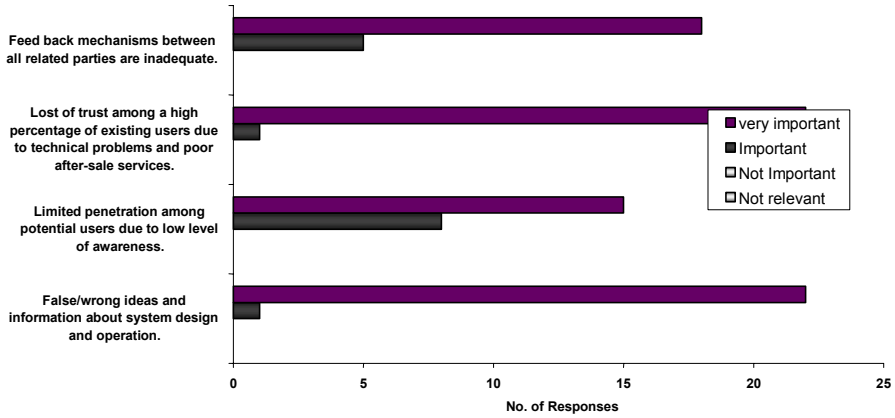
Users' Policy Barriers



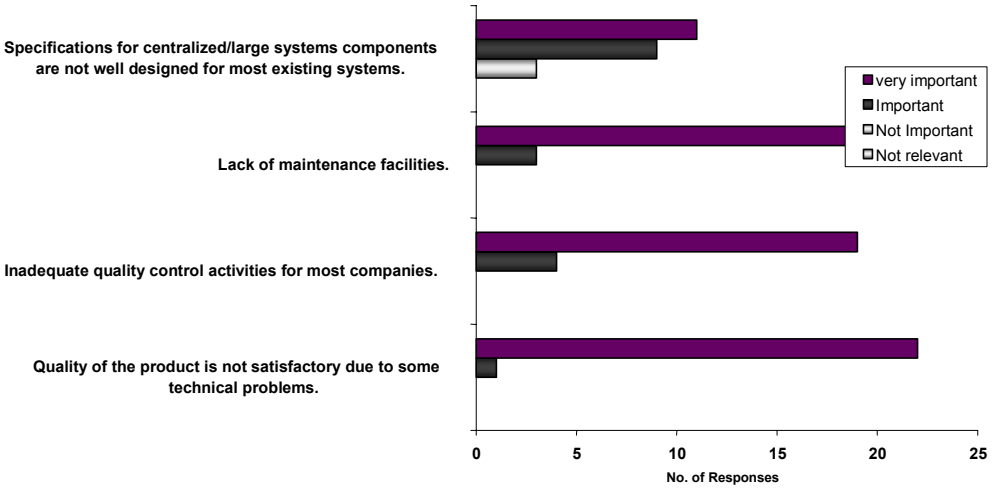
Users' Institutional Barriers

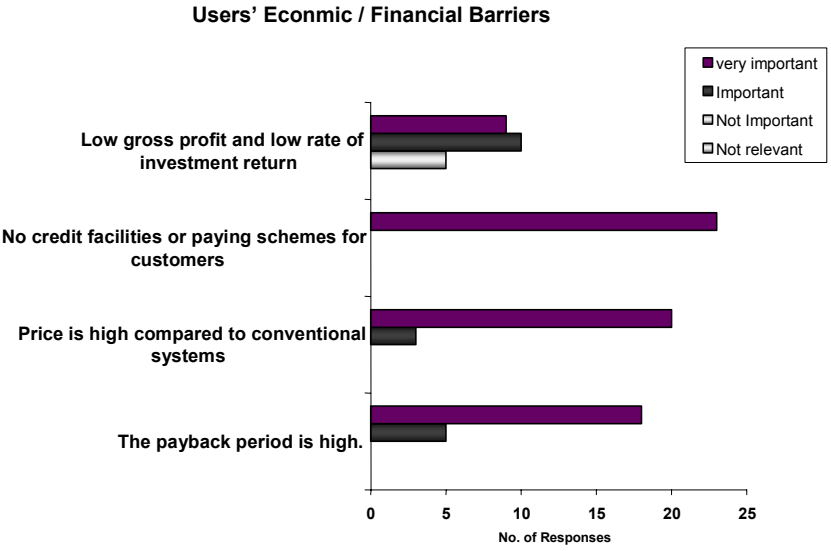


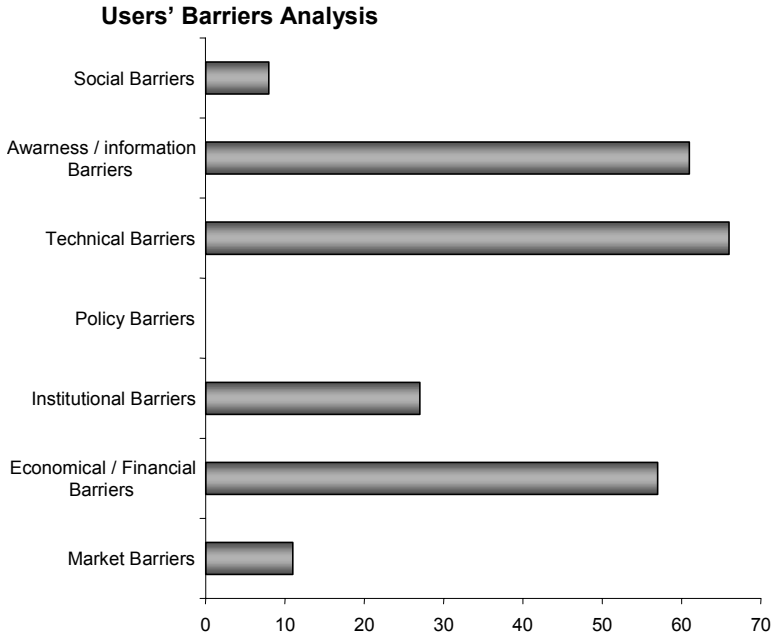
Users' Awareness / Informational Barriers



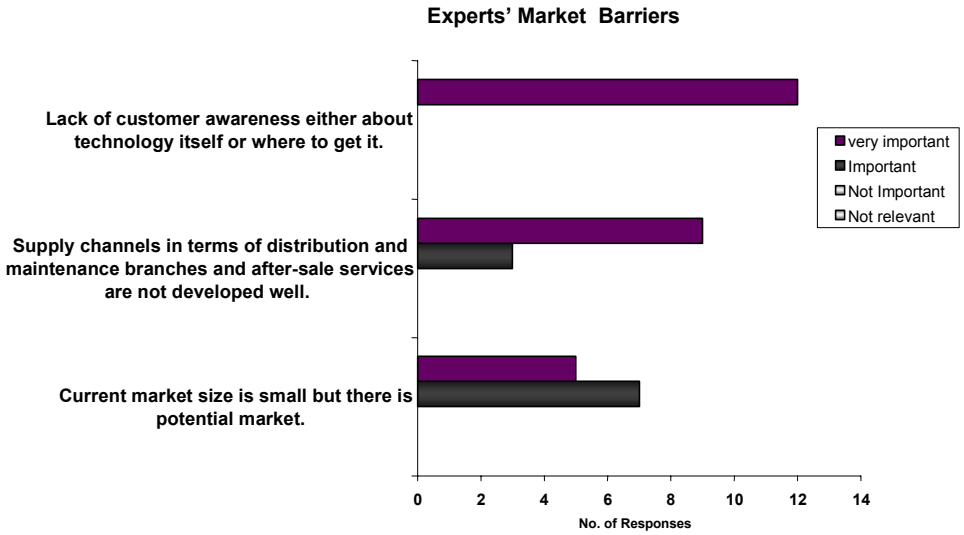
Users' Technical Barriers

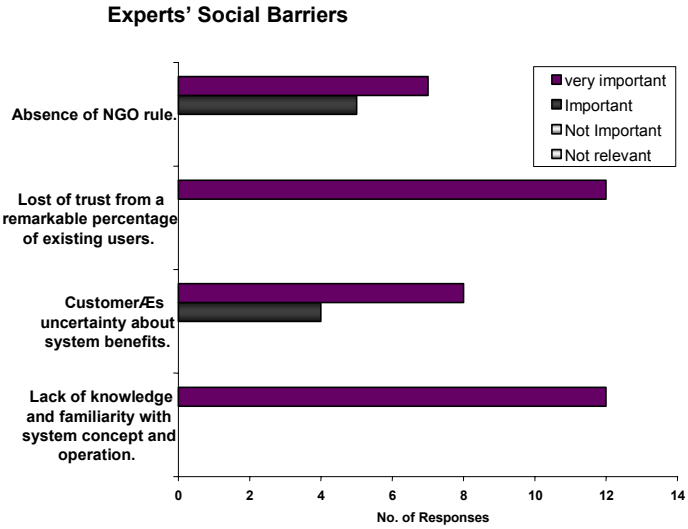



Users' Econmic / Financial Barriers
very important
Important
Not Important
Not relevant
Low gross profit and low rate of investment return
No credit facilities or paying schemes for customers
Price is high compared to conventional systems
The payback period is high.
0
5
10
15
20
25
No. of Responses

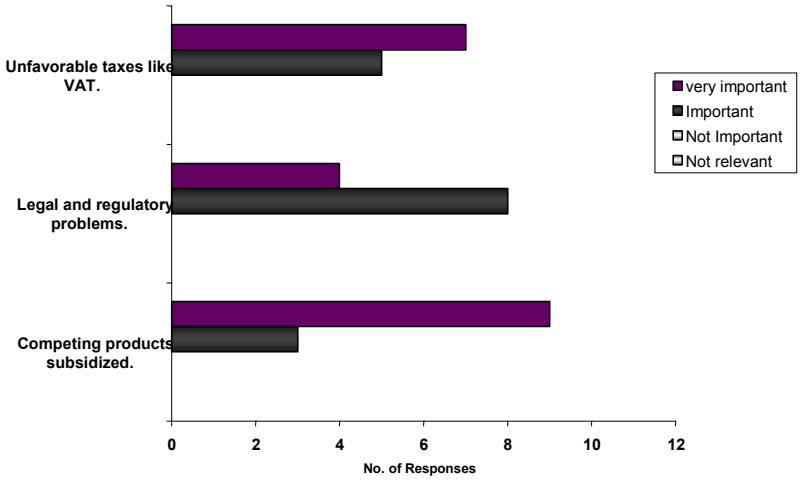

Users' Barriers Analysis
Social Barriers
Awarness / information Barriers
Technical Barriers
Policy Barriers
Institutional Barriers
Economical / Financial Barriers
Market Barriers
0
10
20
30
40
50
60
70

Annex 3; DSWH survey responses; experts

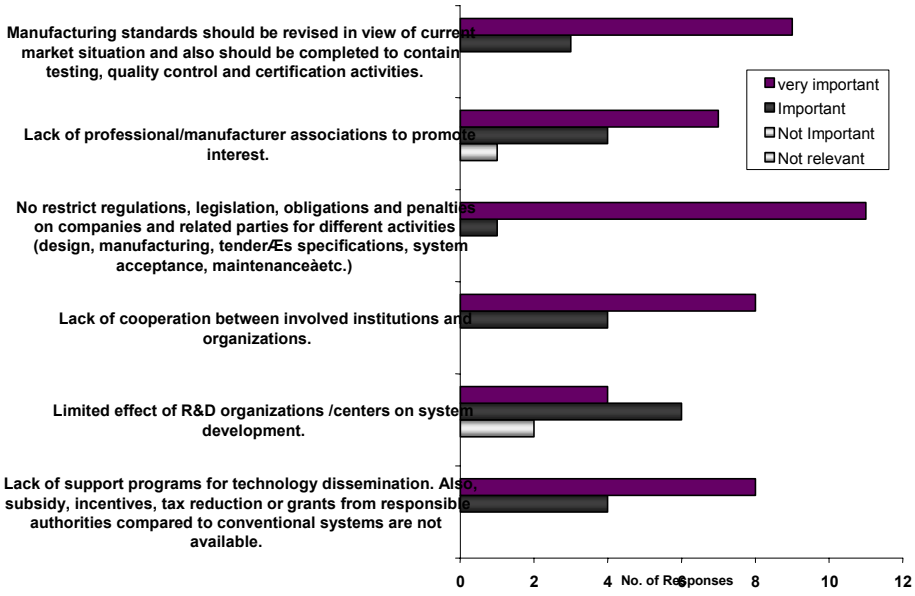


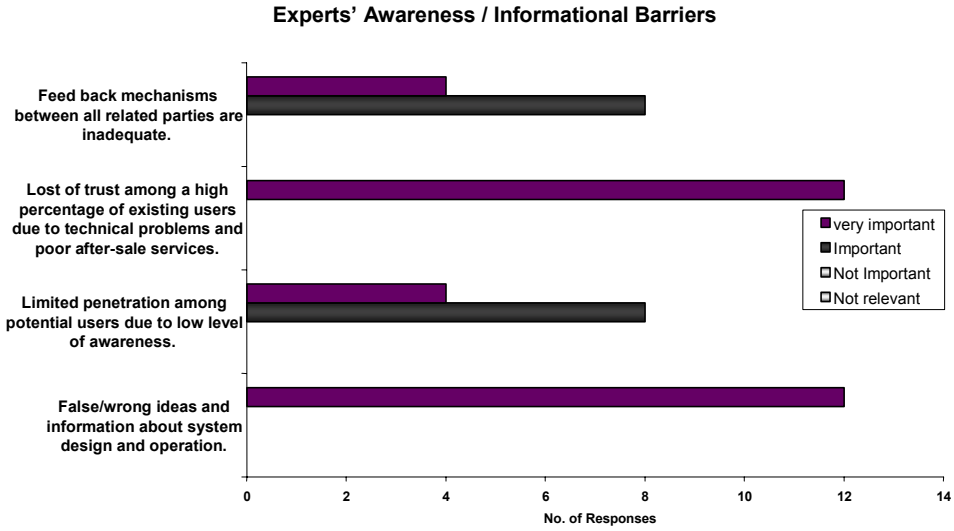


Experts' Policy Barriers



Experts' Institutional Barriers




Experts' Awareness / Informational Barriers
Feed back mechanisms between all related parties are inadequate.
Lost of trust among a high percentage of existing users due to technical problems and poor after-sale services.
Limited penetration among potential users due to low level of awareness.
False/wrong ideas and information about system design and operation.
very important
Important
Not Important
Not relevant
0
2
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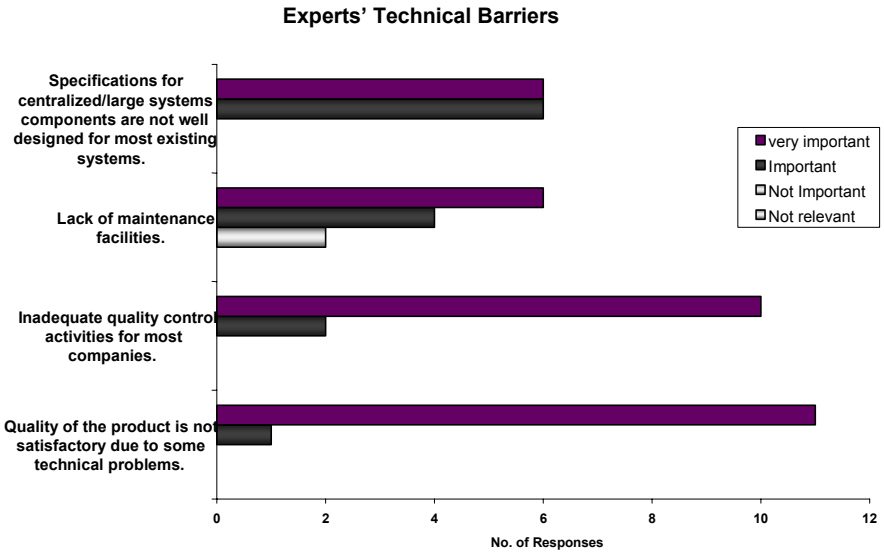
14
No. of Responses


Experts' Technical Barriers
Specifications for centralized/large systems components are not well designed for most existing systems.
Lack of maintenance facilities.
Inadequate quality control activities for most companies.
Quality of the product is not satisfactory due to some technical problems.
very important
Important
Not Important
Not relevant
0
2
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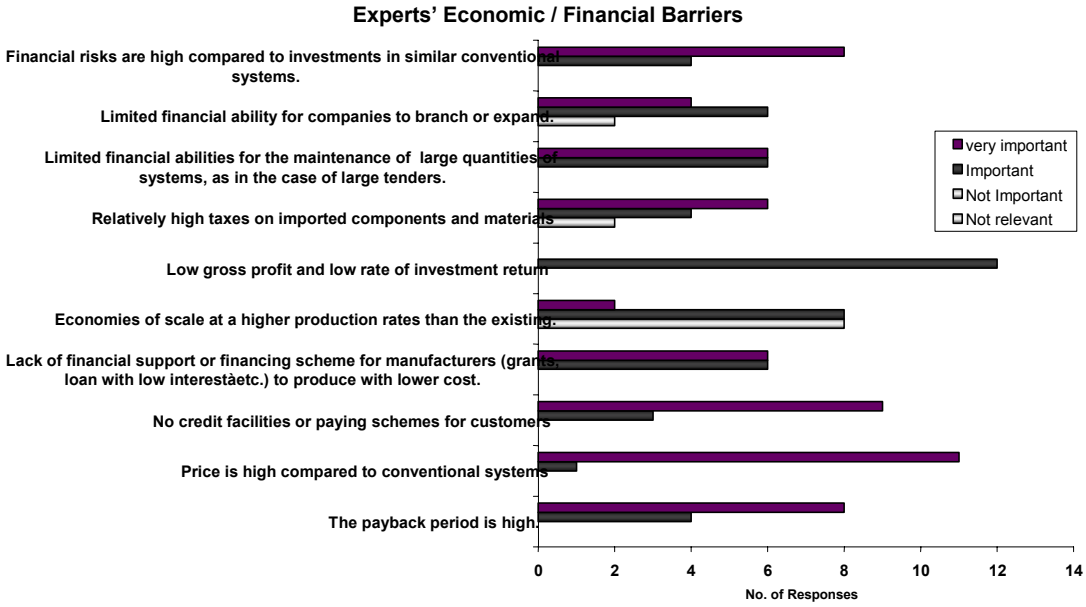
12
No. of Responses


Experts' Economic / Financial Barriers
Financial risks are high compared to investments in similar conventional systems.
Limited financial ability for companies to branch or expand.
Limited financial abilities for the maintenance of large quantities of systems, as in the case of large tenders.
Relatively high taxes on imported components and materials
Low gross profit and low rate of investment return
Economies of scale at a higher production rates than the existing.
Lack of financial support or financing scheme for manufacturers (grants, loan with low interestàetc.) to produce with lower cost.
No credit facilities or paying schemes for customers
Price is high compared to conventional systems
The payback period is high.
very important
Important
Not Important
Not relevant
0
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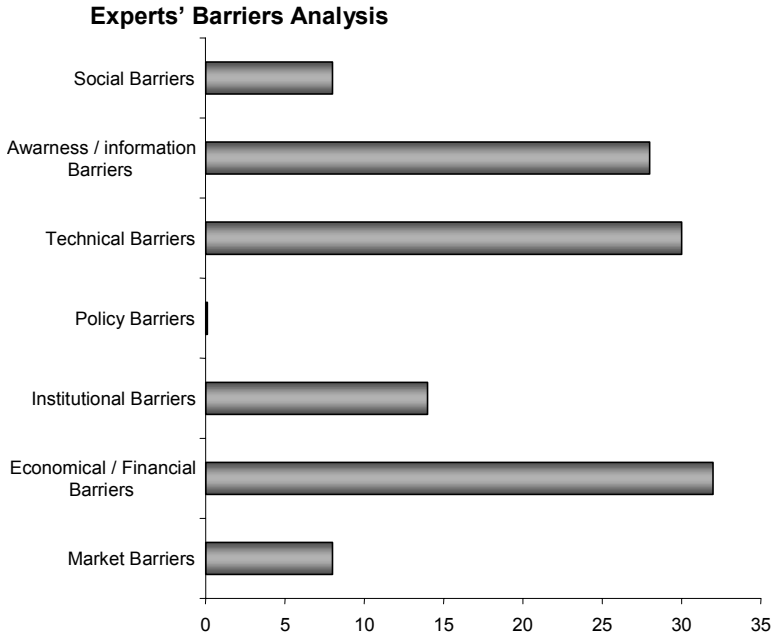
12
14
No. of Responses


Experts' Barriers Analysis
Social Barriers
Awarness / information Barriers
Technical Barriers
Policy Barriers
Institutional Barriers
Economical / Financial Barriers
Market Barriers
0
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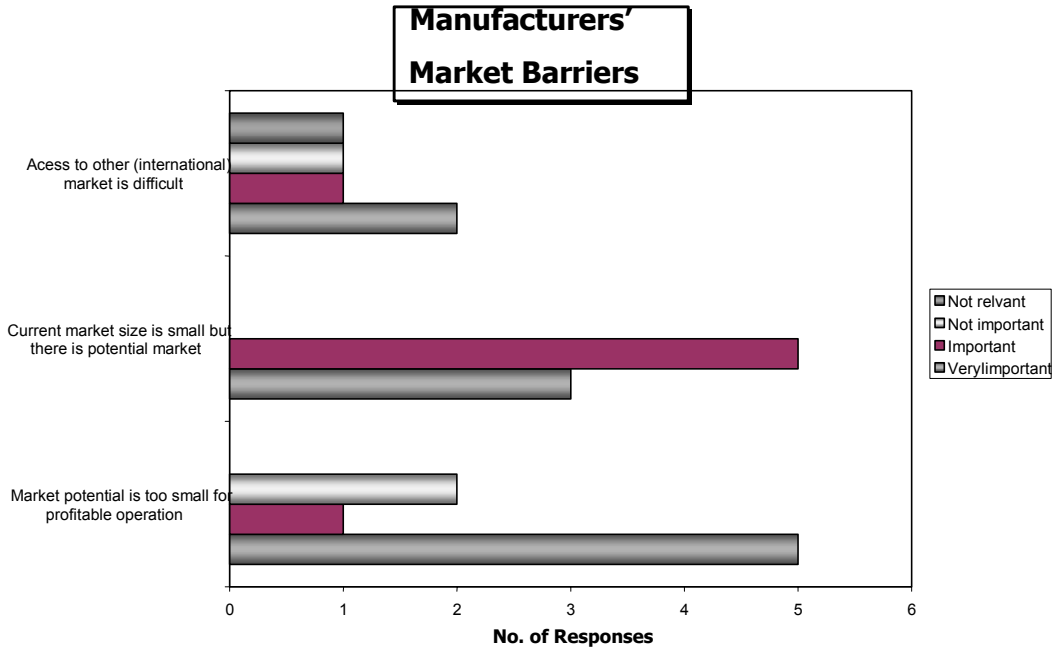
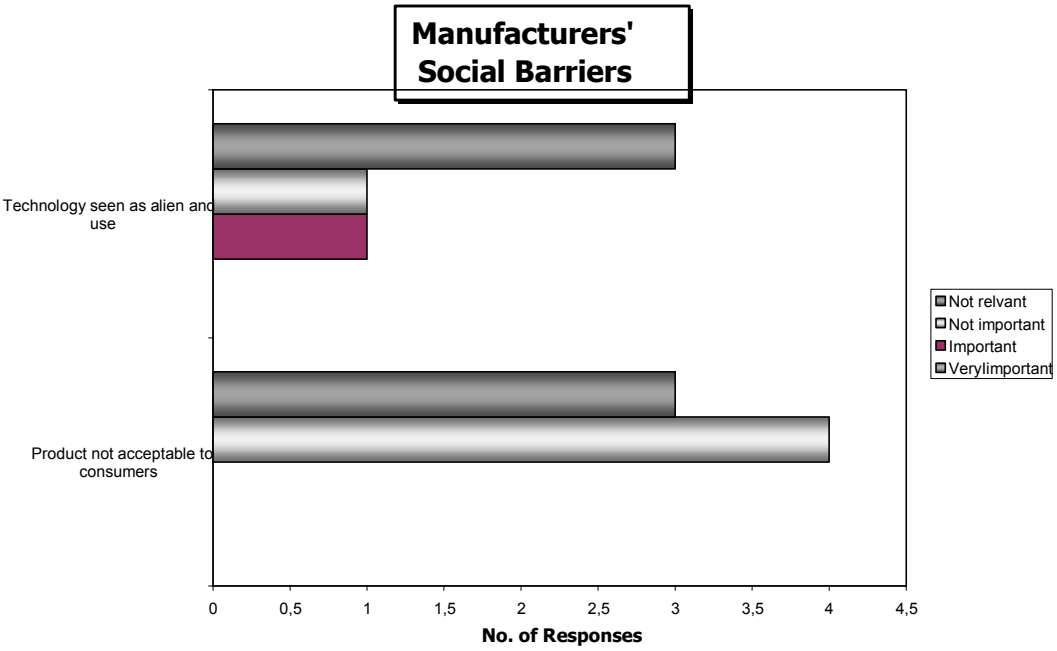
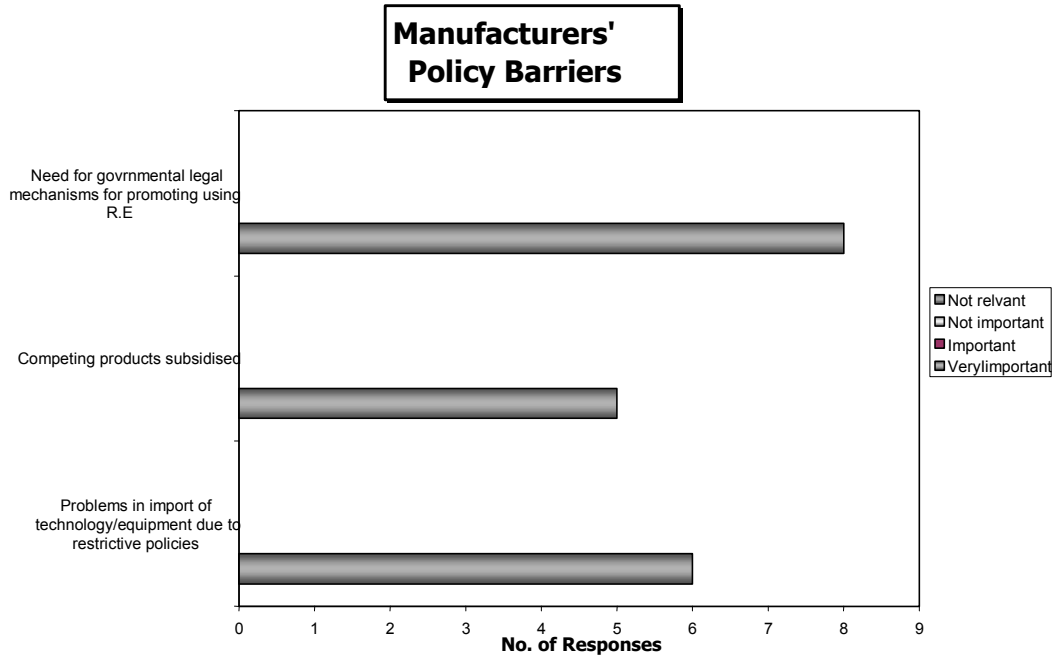
Annex 4; PV survey responses; manufacturers






Manufacturers' Policy Barriers
Need for govrnmental legal mechanisms for promoting using R.E
Competing products subsidised
Problems in import of technology/equipment due to restrictive policies
Not relvant
Not important
Important
Verylimportant
0
1
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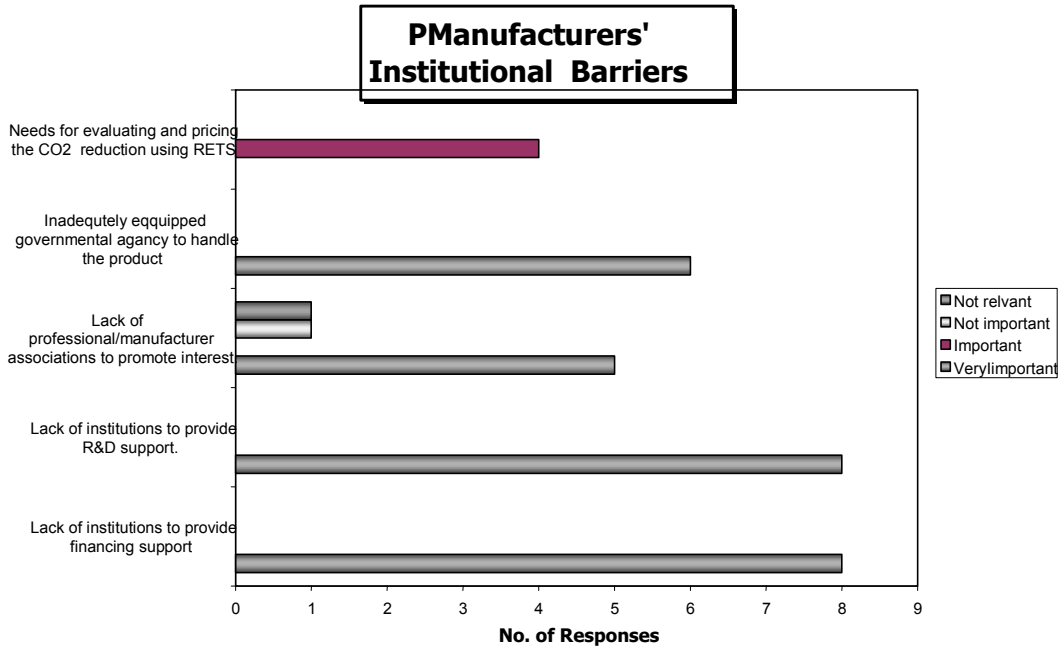
9
No. of Responses


PManufacturers' Institutional Barriers
Needs for evaluating and pricing the CO2 reduction using RETS
Inadequtely eqquipped governmental agancy to handle the product
Lack of professional/manufacturer associations to promote interest
Lack of institutions to provide R&D support.
Lack of institutions to provide financing support
Not relvant
Not important
Important
Verylimportant
0
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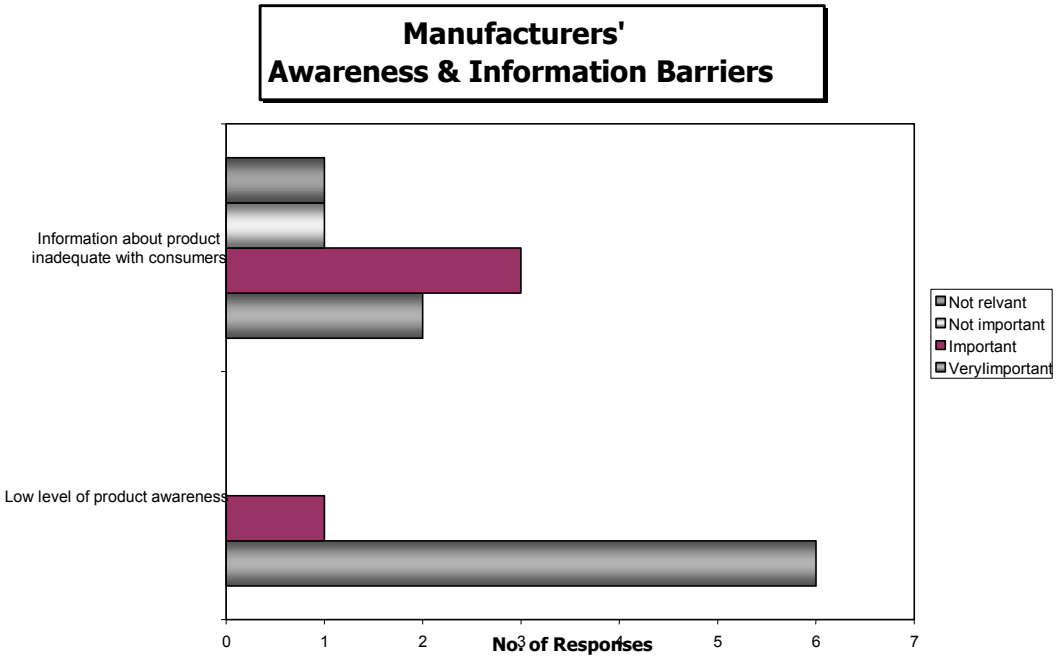
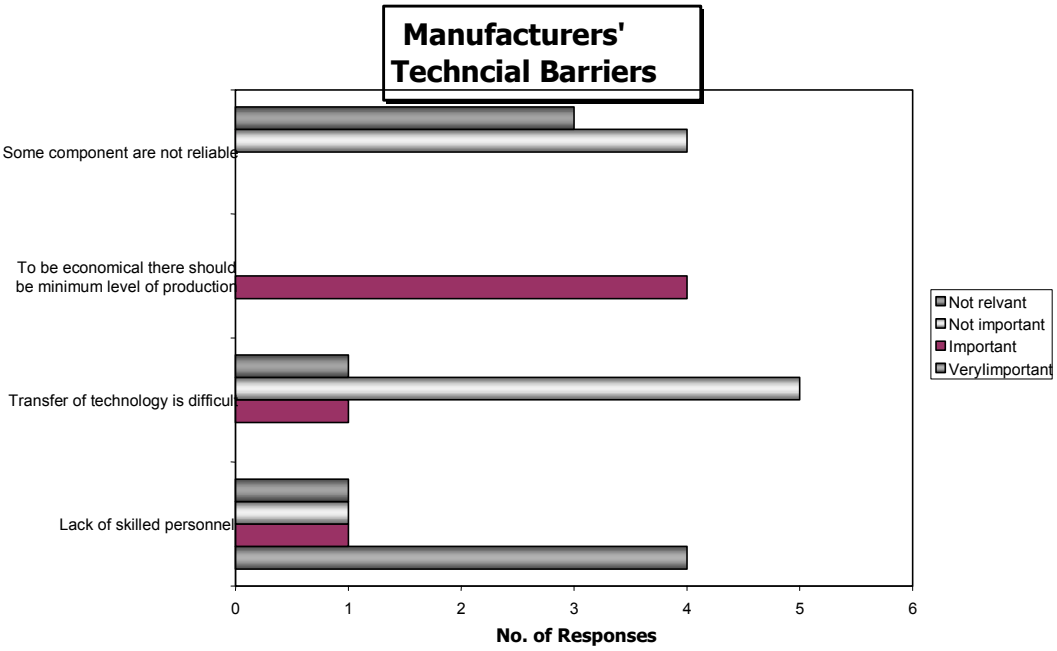
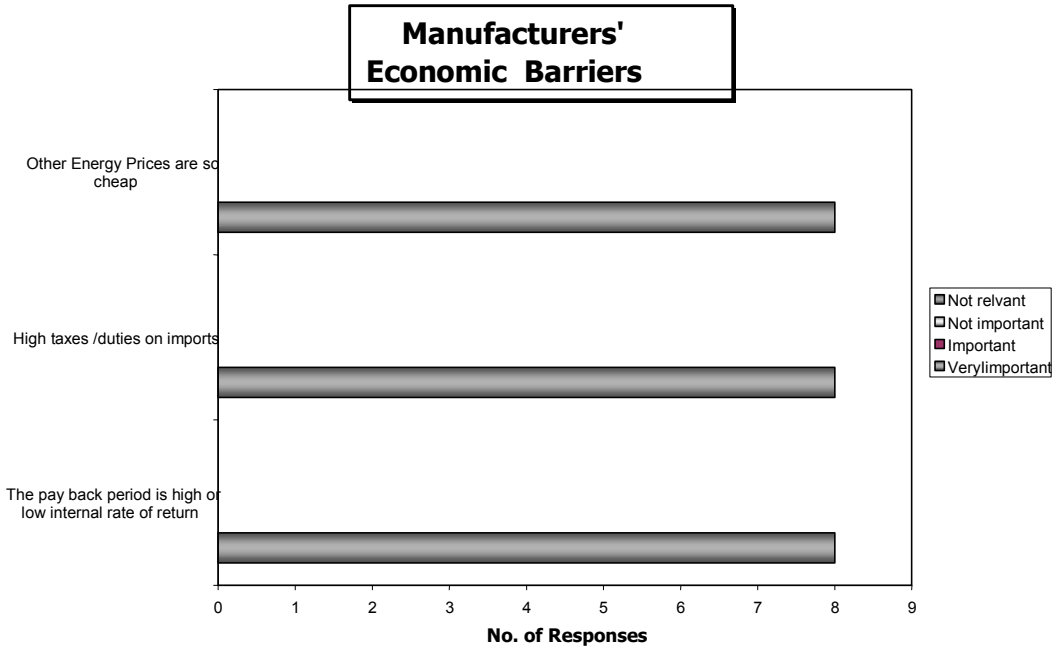
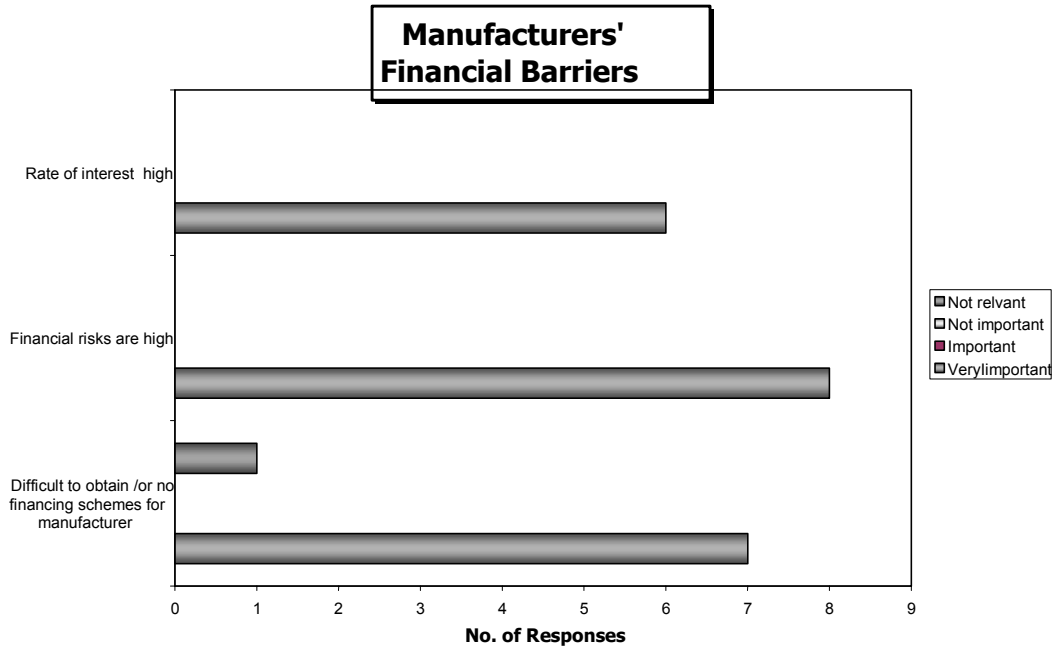
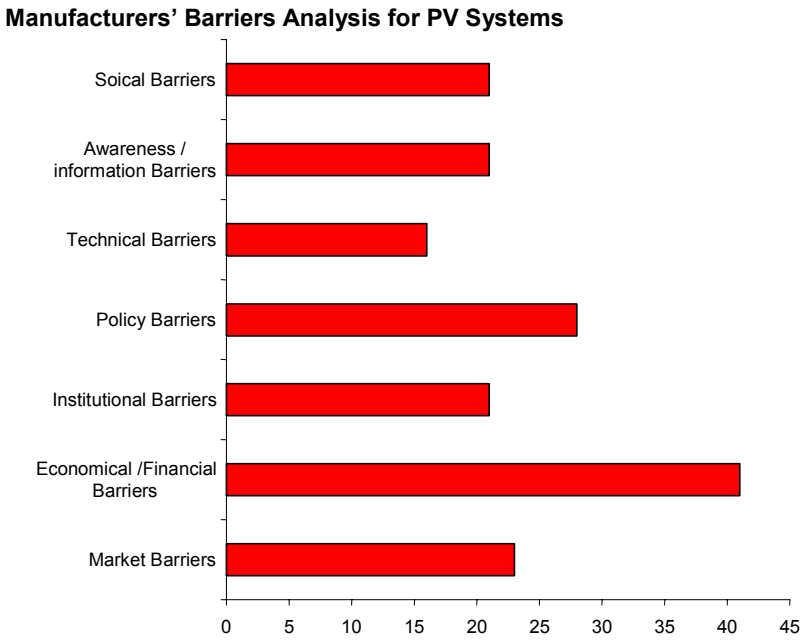
9
No. of Responses


Manufacturers' Awareness & Information Barriers
Information about product inadequate with consumers
Low level of product awareness
0
1
2
3
4
5
6
7
No. of Responses
Not relvant
Not important
Important
Verylimportant

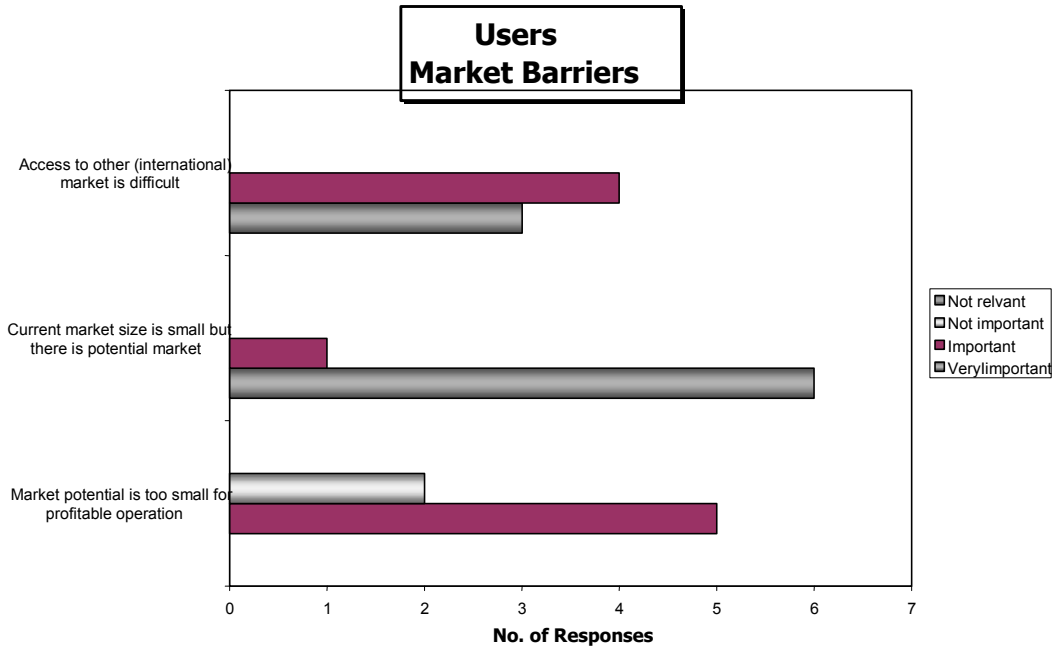

Manufacturers' Techncial Barriers
Some component are not reliable
To be economical there should be minimum level of production
Transfer of technology is difficult
Lack of skilled personnel
0
1
2
3
4
5
6
No. of Responses
Not relvant
Not important
Important
Verylimportant

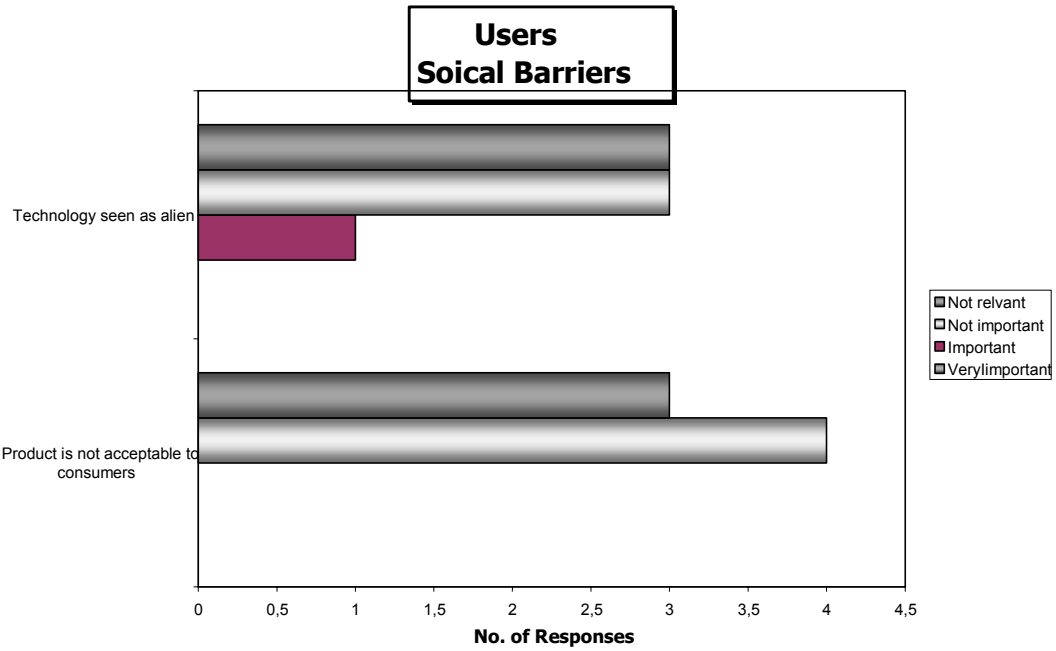

Manufacturers' Economic Barriers
Other Energy Prices are so cheap
High taxes /duties on imports
The pay back period is high or low internal rate of return
Not relvant
Not important
Important
Verylimportant
0
1
2
3
4
5
6
7
8
9
No. of Responses

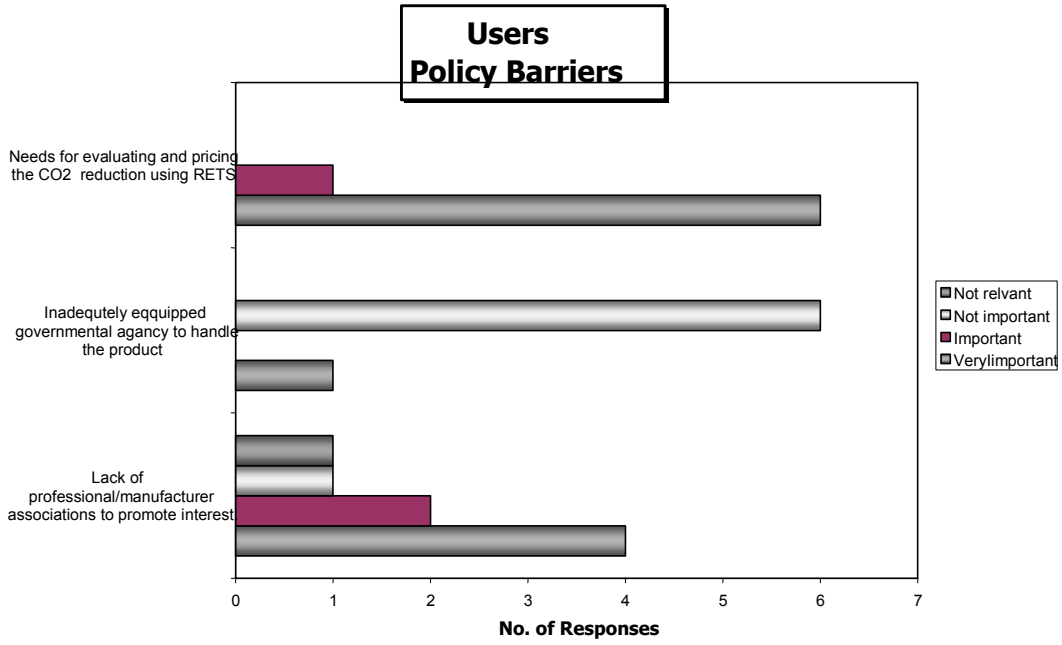

Manufacturers' Financial Barriers
Rate of interest high
Financial risks are high
Difficult to obtain /or no financing schemes for manufacturer
Not relvant
Not important
Important
Verylimportant
0
1
2
3
4
5
6
7
8
9
No. of Responses

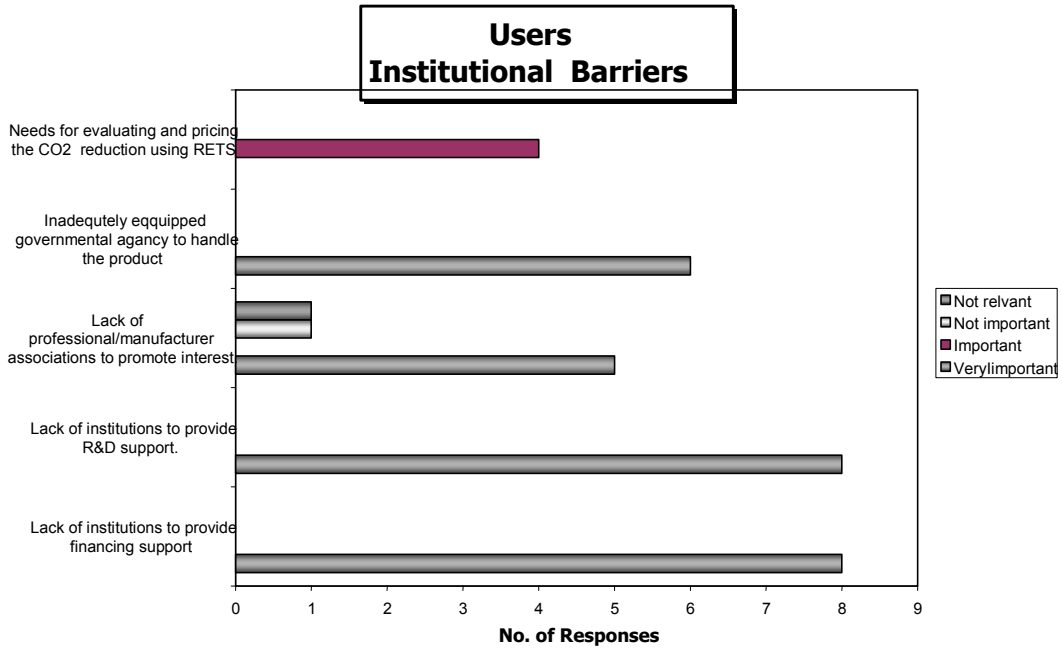

Manufacturers' Barriers Analysis for PV Systems
Soical Barriers
Awareness / information Barriers
Technical Barriers
Policy Barriers
Institutional Barriers
Economical /Financial Barriers
Market Barriers
0
5
10
15
20
25
30
35
40
45

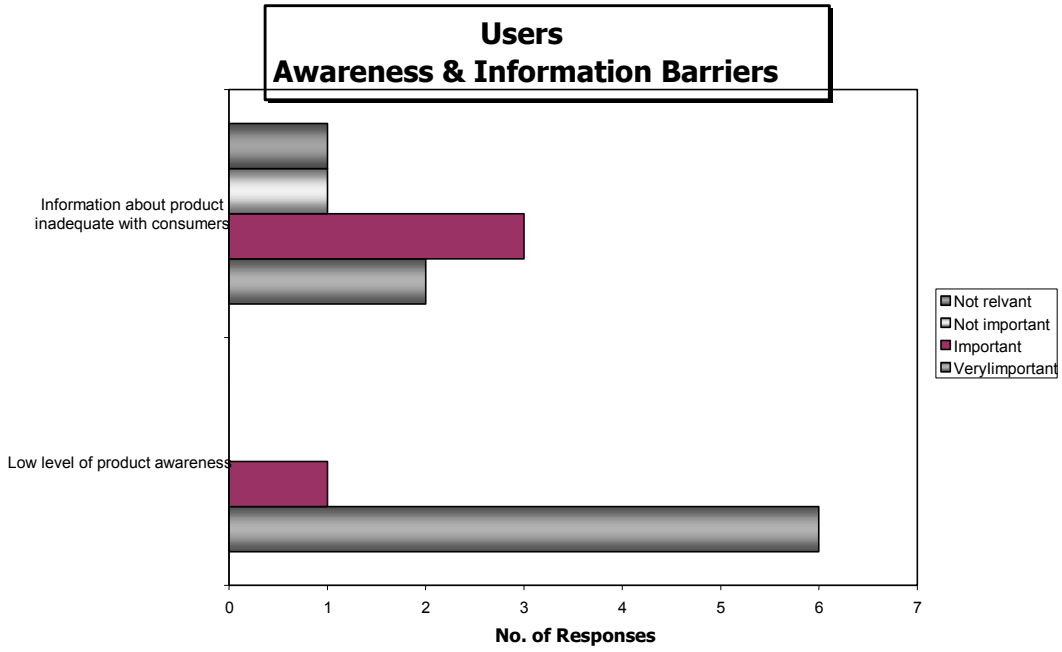
Annex 5; PV survey responses; users

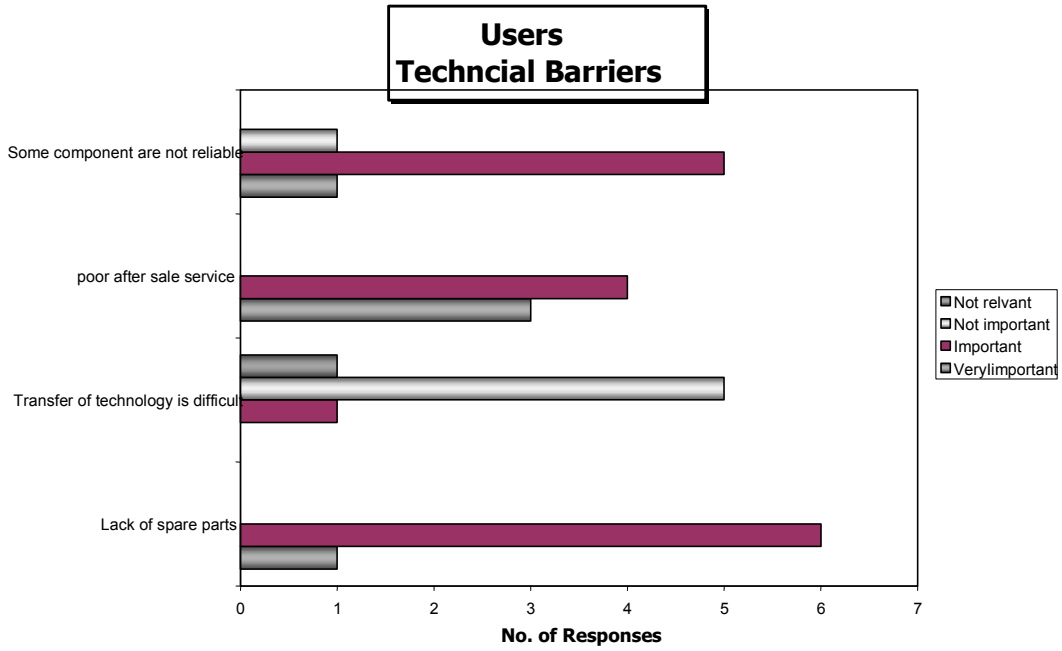


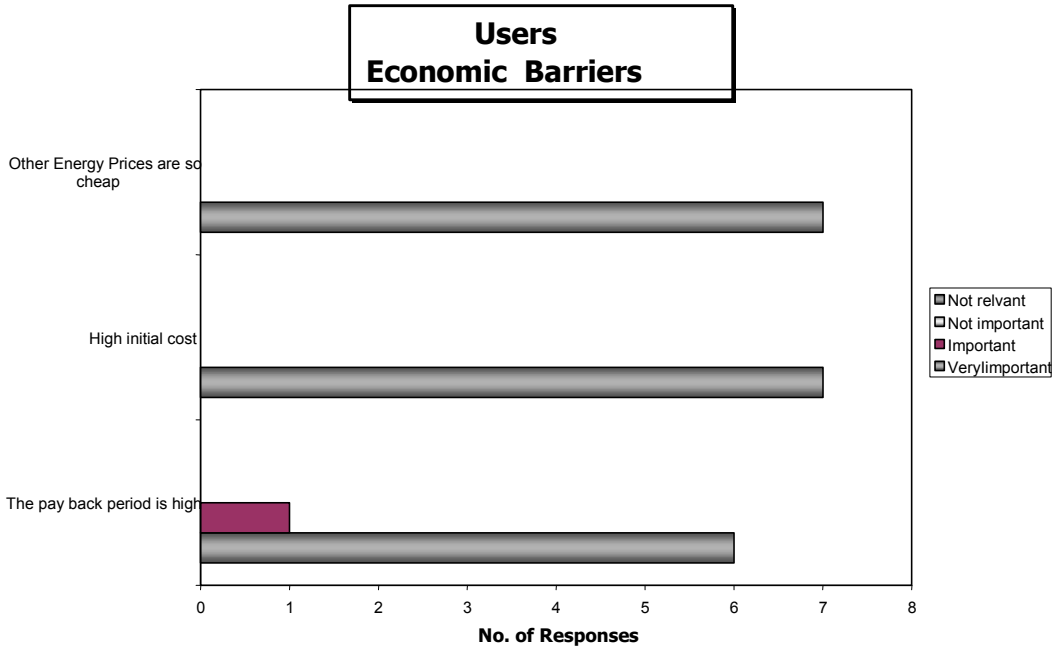


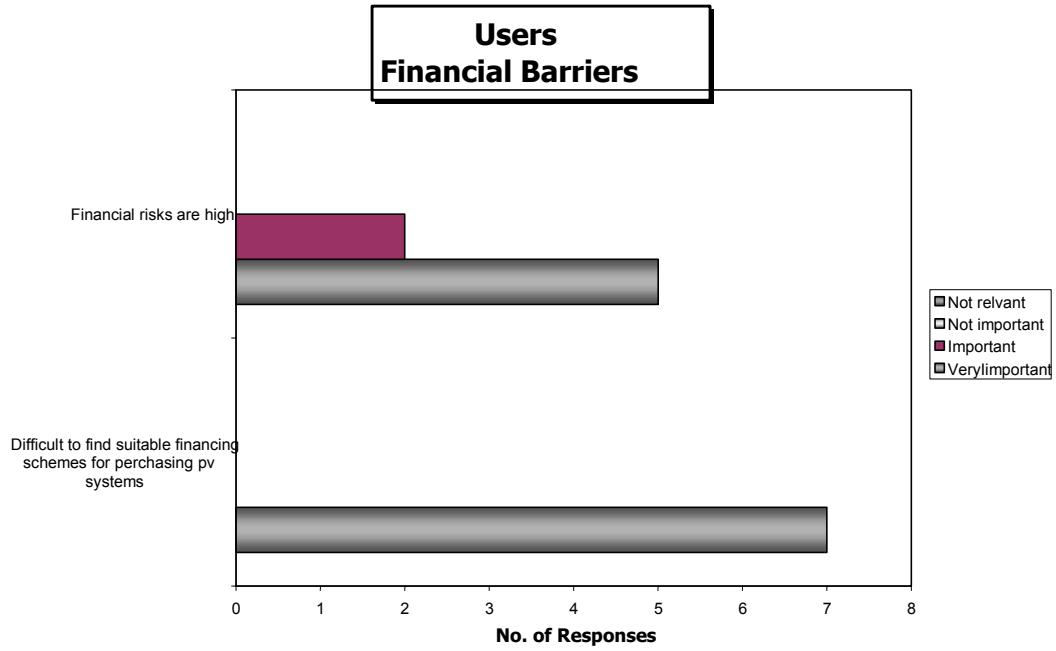

Users
Policy Barriers
Needs for evaluating and pricing the CO2 reduction using RETS
Inadequtely eqquipped governmental agancy to handle the product
Lack of professional/manufacturer associations to promote interest
0
1
2
3
4
5
6
7
No. of Responses
Not relvant
Not important
Important
Verylimportant

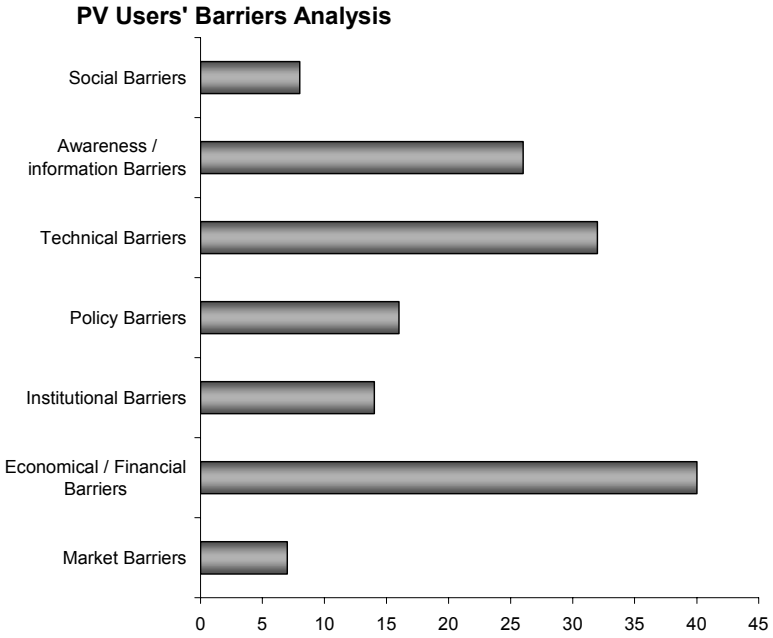

Users
Institutional Barriers
Needs for evaluating and pricing the CO2 reduction using RETS
Inadequtely eqquipped governmental agancy to handle the product
Lack of professional/manufacturer associations to promote interest
Lack of institutions to provide R&D support.
Lack of institutions to provide financing support
0
1
2
3
4
5
6
7
8
9
No. of Responses
Not relvant
Not important
Important
Verylimportant


Users
Awareness & Information Barriers
Information about product inadequate with consumers
Low level of product awareness
0
1
2
3
4
5
6
7
No. of Responses
Not relvant
Not important
Important
Verylimportant


Users
Techncial Barriers
Some component are not reliable
poor after sale service
Transfer of technology is difficul
Lack of spare parts
0
1
2
3
4
5
6
7
No. of Responses
Not relvant
Not important
Important
Verylimportant


Users
Economic Barriers
Other Energy Prices are so cheap
High initial cost
The pay back period is high
0
1
2
3
4
5
6
7
8
No. of Responses
Not relvant
Not important
Important
Verylimportant


Users
Financial Barriers
Financial risks are high
Difficult to find suitable financing schemes for perchasing pv systems
0
1
2
3
4
5
6
7
8
No. of Responses
Not relvant
Not important
Important
Verylimportant


PV Users' Barriers Analysis
Social Barriers
Awareness / information Barriers
Technical Barriers
Policy Barriers
Institutional Barriers
Economical / Financial Barriers
Market Barriers
0
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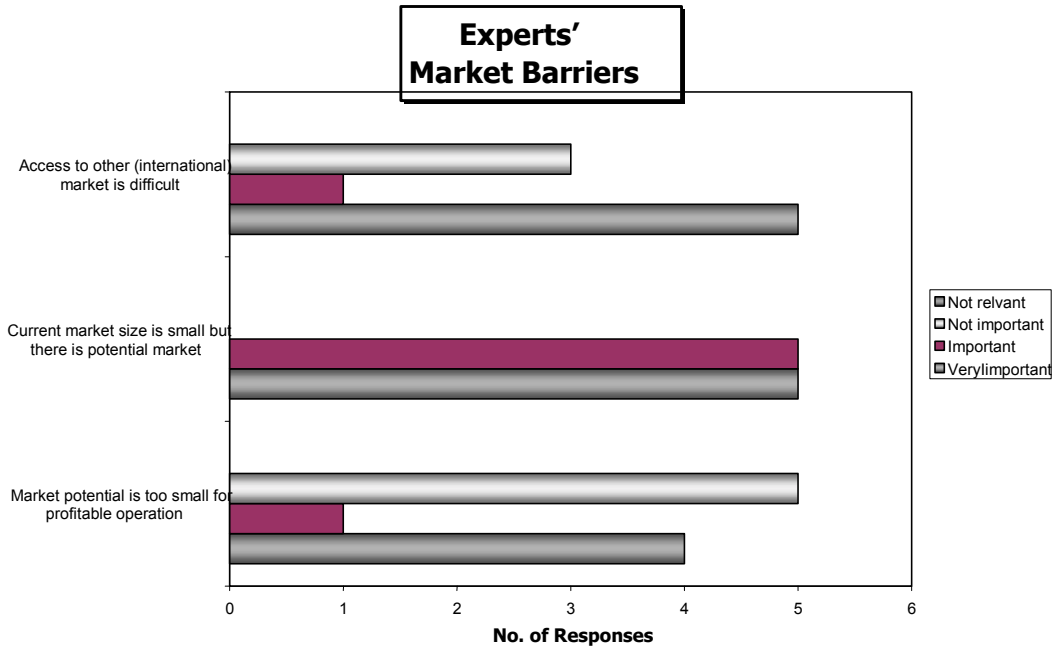
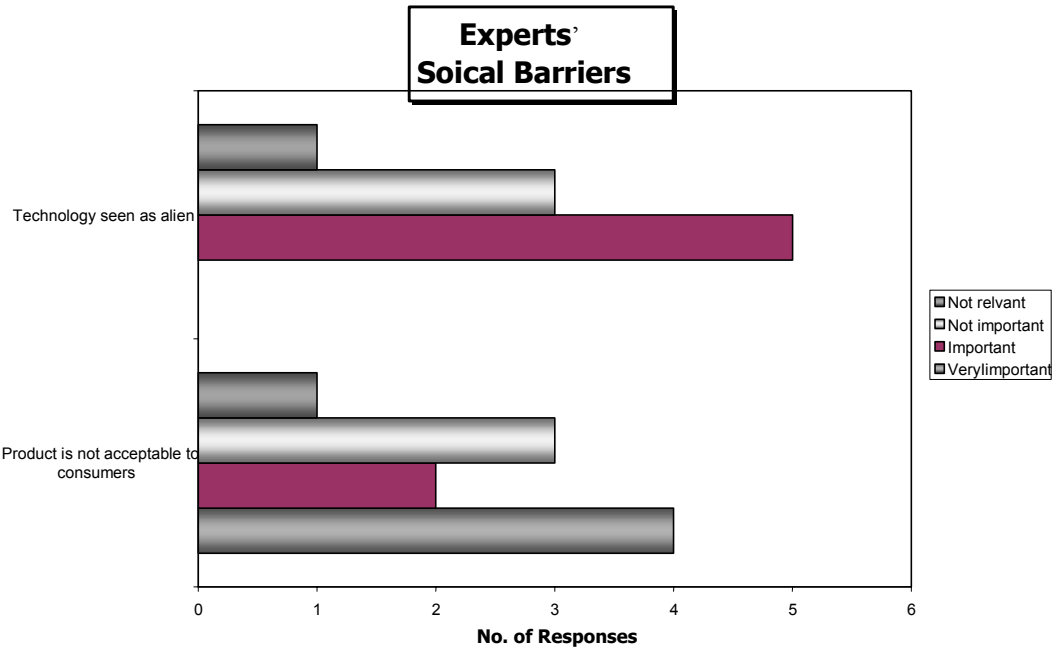
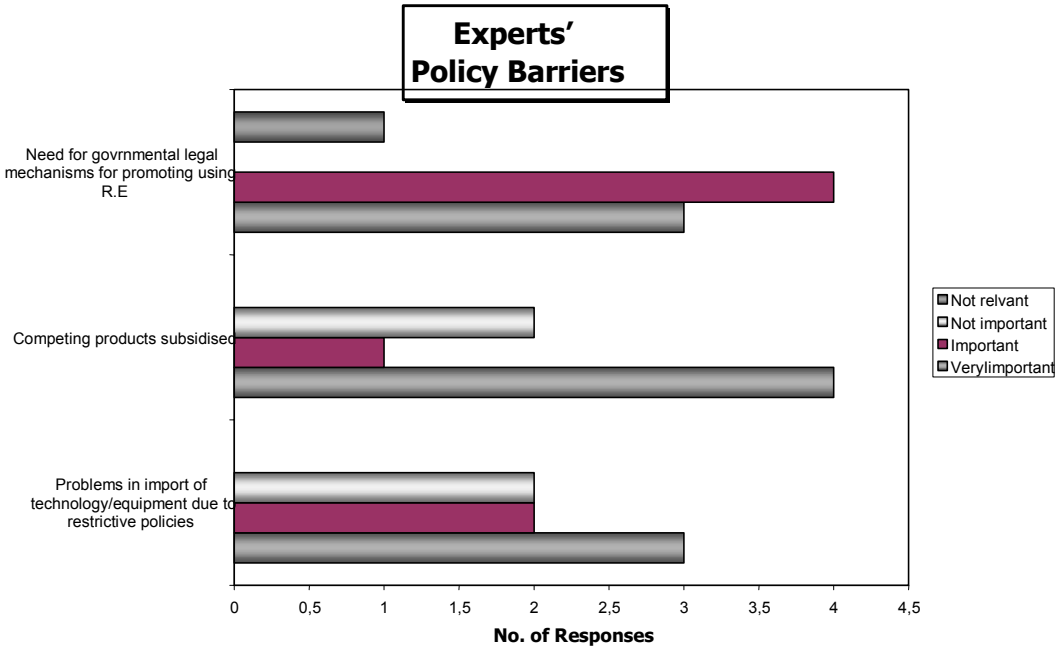
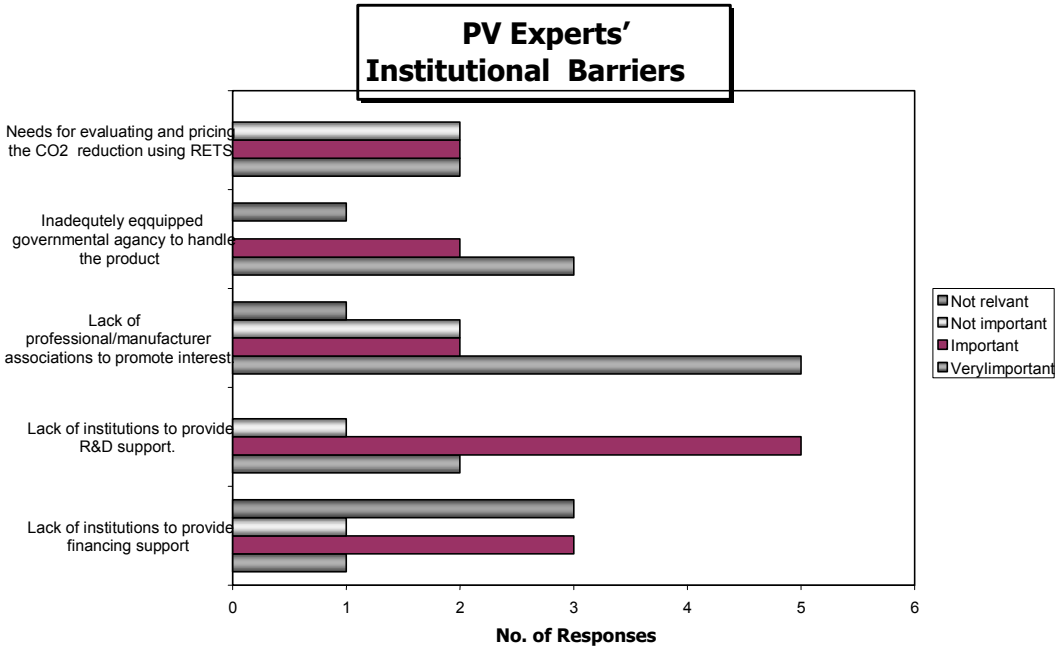
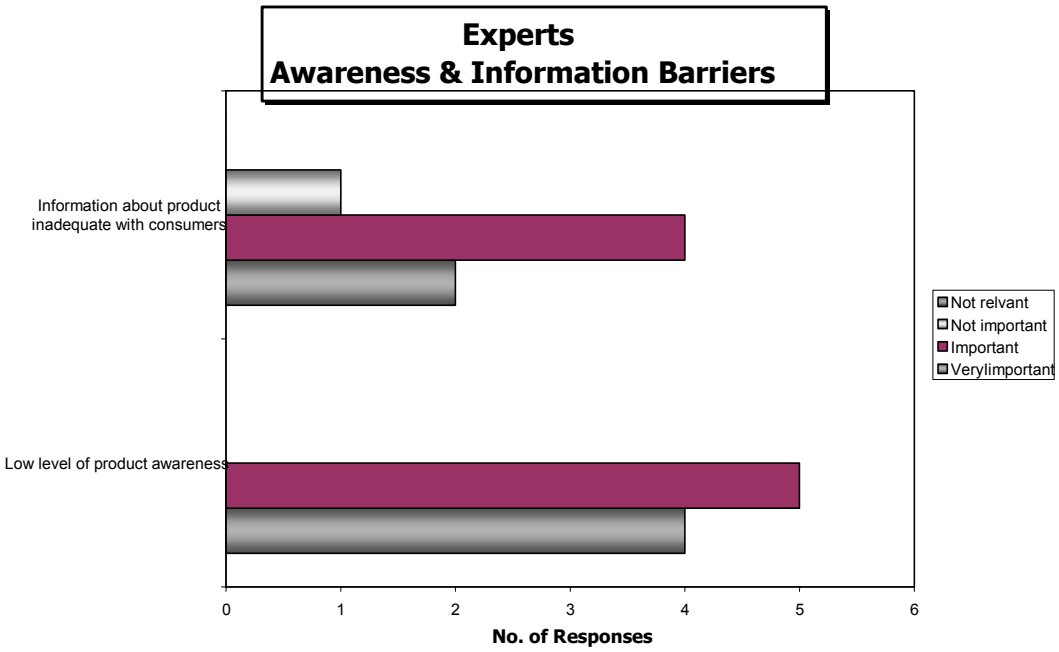
Annex 6; PV survey responses; experts

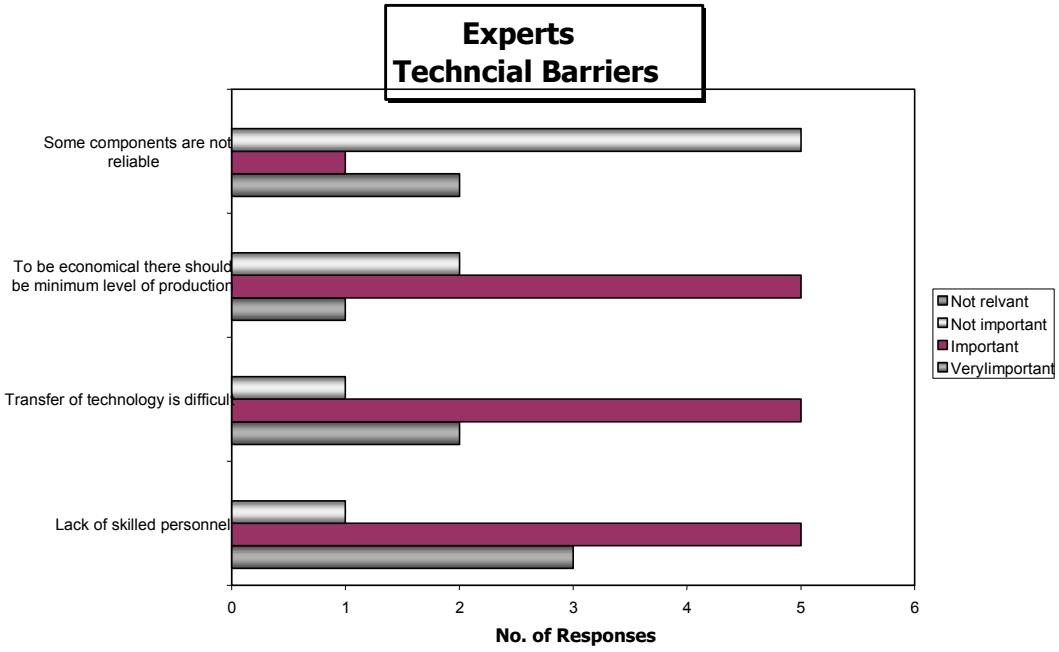


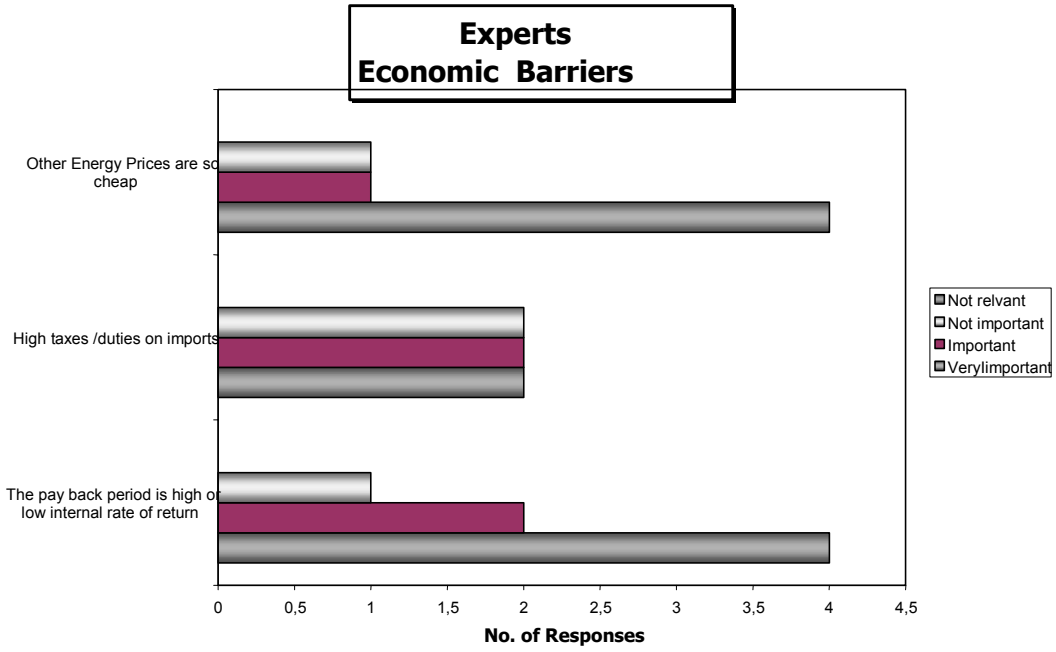



Experts' Policy Barriers
Need for govrnmental legal mechanisms for promoting using R.E
Competing products subsidised
Problems in import of technology/equipment due to restrictive policies
Not relvant
Not important
Important
Verylimportant
0
0,5
1
1,5
2
2,5
3
3,5
4
4,5
No. of Responses


PV Experts' Institutional Barriers
Needs for evaluating and pricing the CO2 reduction using RETS
Inadequtely eqquipped governmental agancy to handle the product
Lack of professional/manufacturer associations to promote interest
Lack of institutions to provide R&D support.
Lack of institutions to provide financing support
Not relvant
Not important
Important
Verylimportant
0
1
2
3
4
5
6
No. of Responses


Experts
Awareness & Information Barriers
Information about product inadequate with consumers
Low level of product awareness
Not relvant
Not important
Important
Verylimportant
0
1
2
3
4
5
6
No. of Responses


Experts
Techncial Barriers
Some components are not reliable
To be economical there should be minimum level of production
Transfer of technology is difficult
Lack of skilled personnel
Not relvant
Not important
Important
Verylimportant
0
1
2
3
4
5
6
No. of Responses


Experts
Economic Barriers
Other Energy Prices are so cheap
High taxes /duties on imports
The pay back period is high or low internal rate of return
Not relvant
Not important
Important
Verylimportant
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0,5
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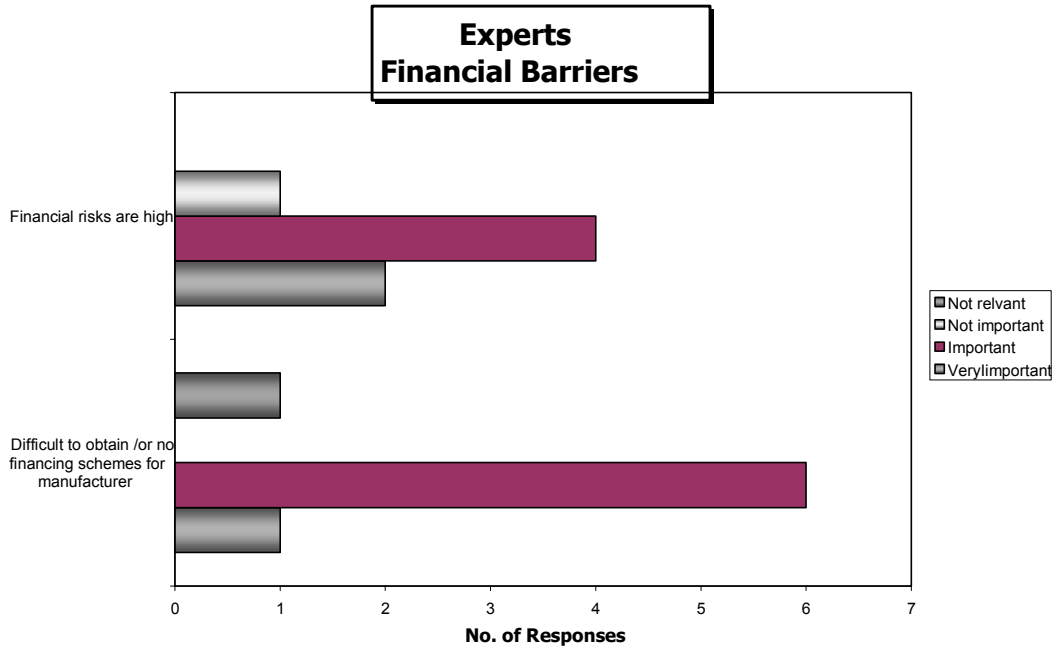
No. of Responses


Experts
Financial Barriers
Financial risks are high
Difficult to obtain /or no financing schemes for manufacturer
Not relvant
Not important
Important
Verylimportant
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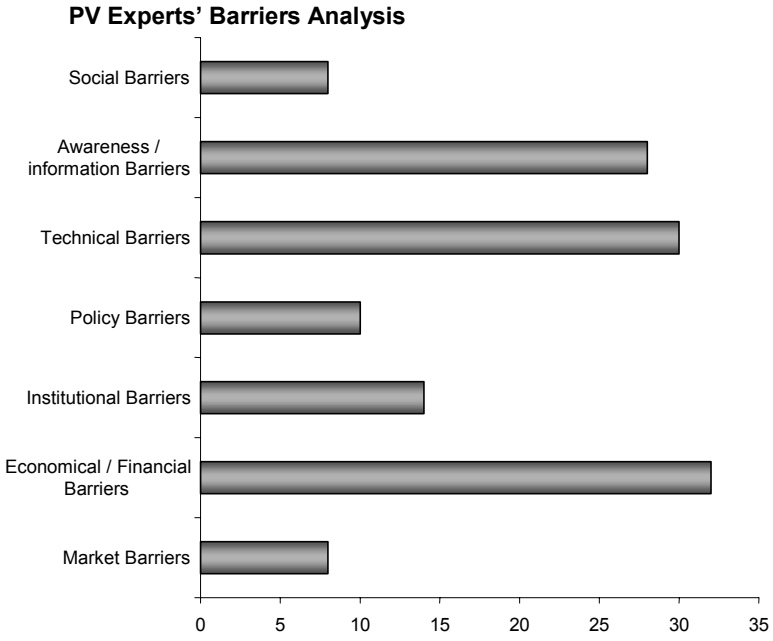
No. of Responses


PV Experts' Barriers Analysis
Social Barriers
Awareness / information Barriers
Technical Barriers
Policy Barriers
Institutional Barriers
Economical / Financial Barriers
Market Barriers
0
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10
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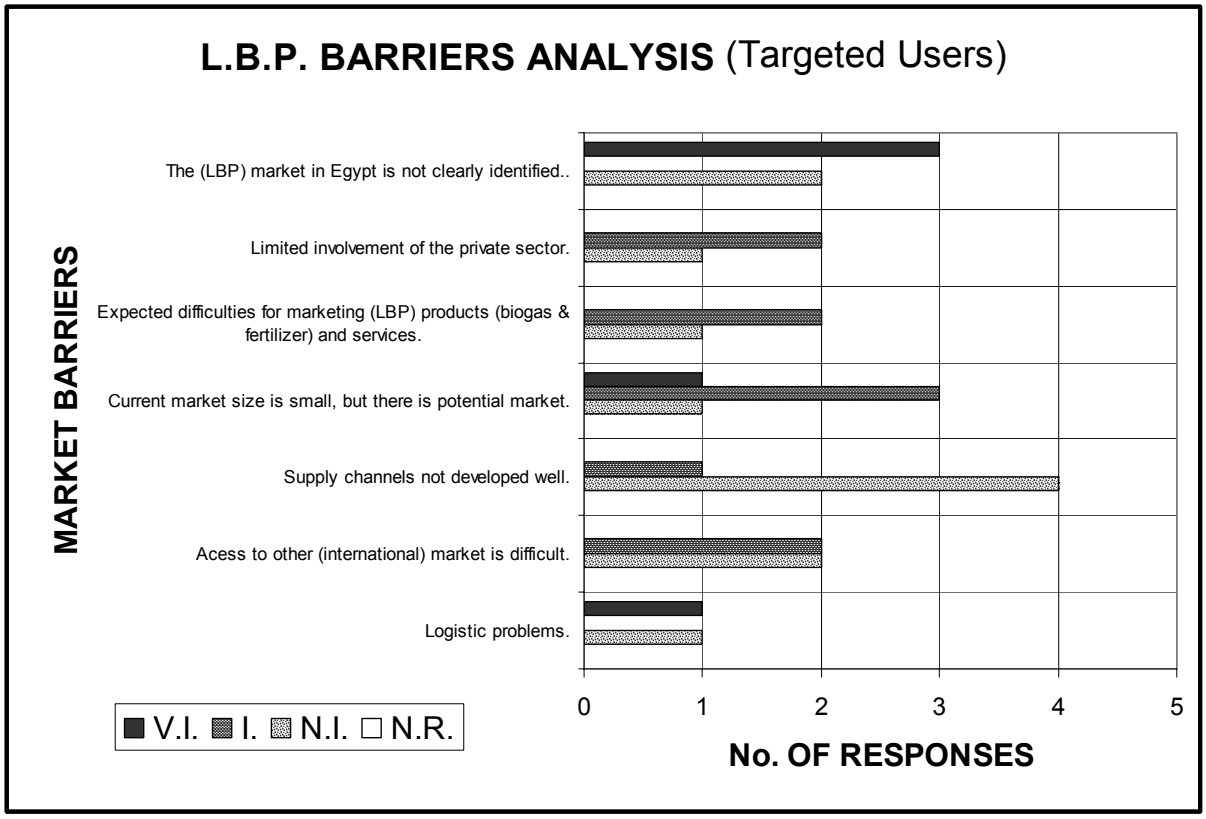
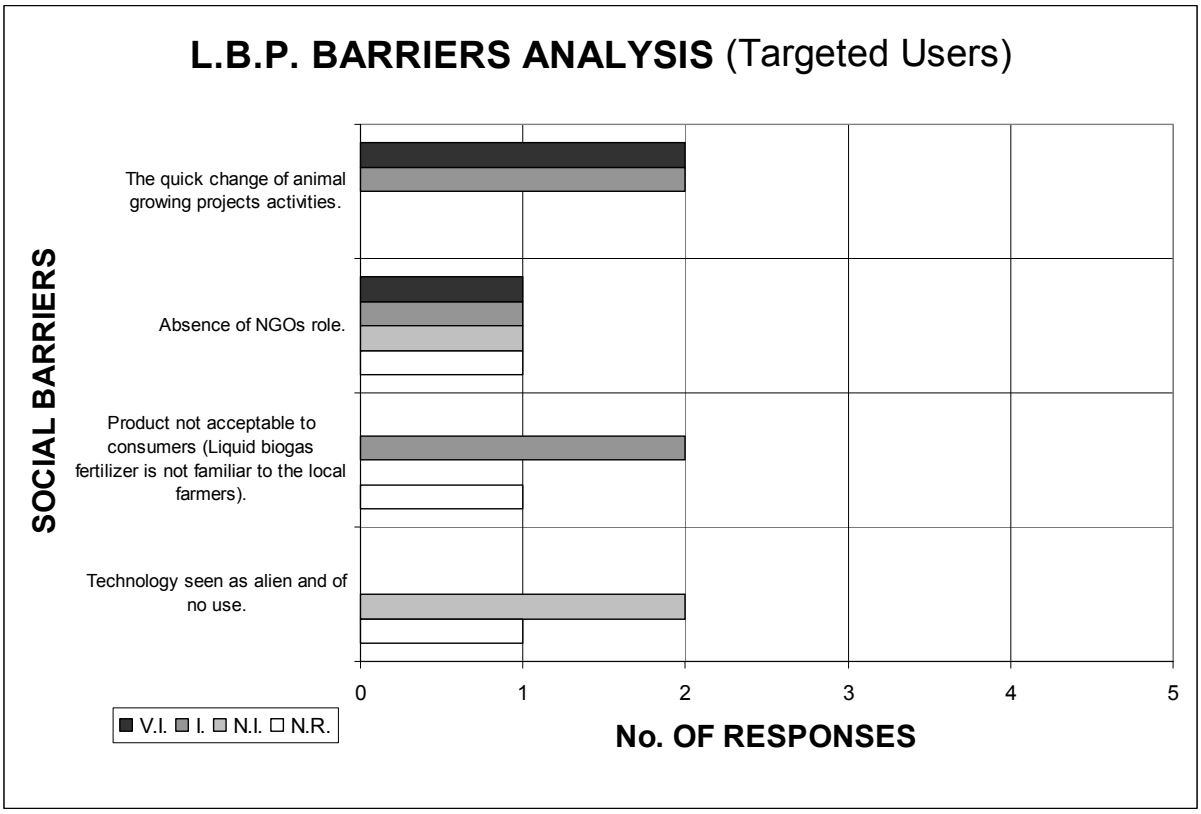
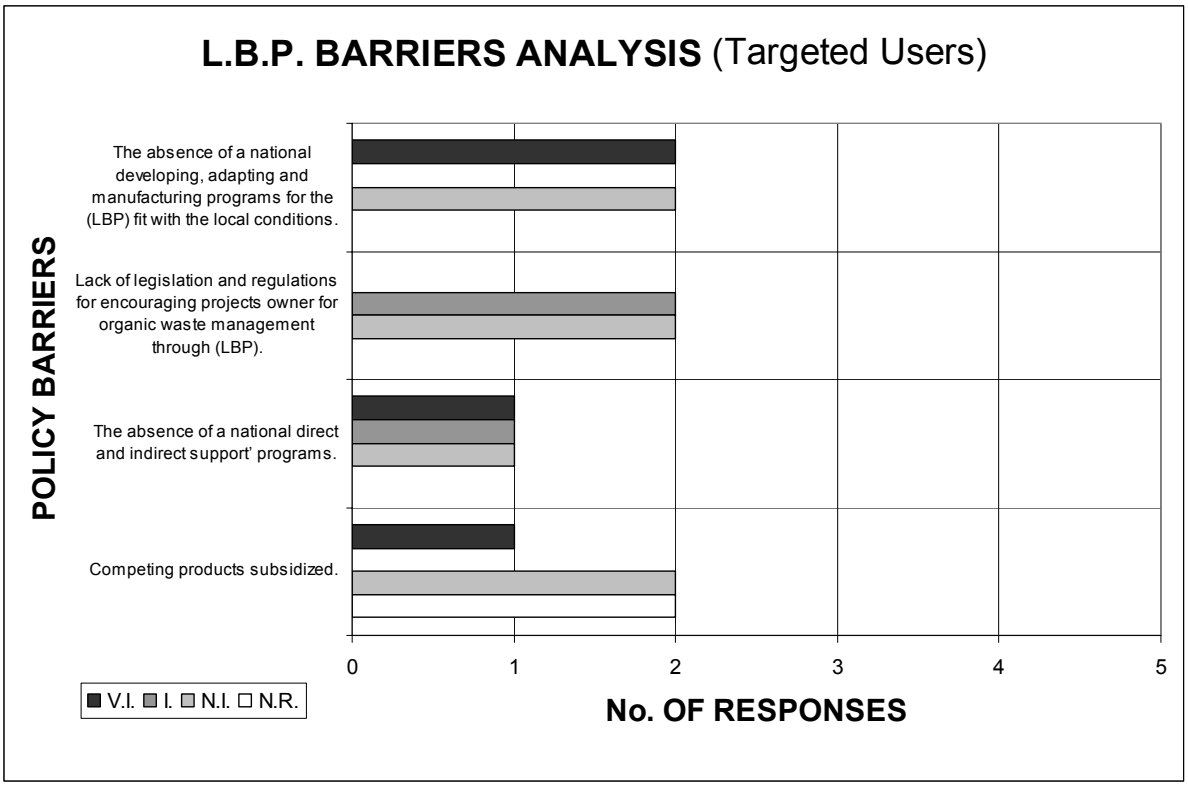
Annex 7; LBP survey responses; users






L.B.P. BARRIERS ANALYSIS (Targeted Users)
POLICY BARRIERS
The absence of a national developing, adapting and manufacturing programs for the (LBP) fit with the local conditions.
Lack of legislation and regulations for encouraging projects owner for organic waste management through (LBP).
The absence of a national direct and indirect support' programs.
Competing products subsidized.
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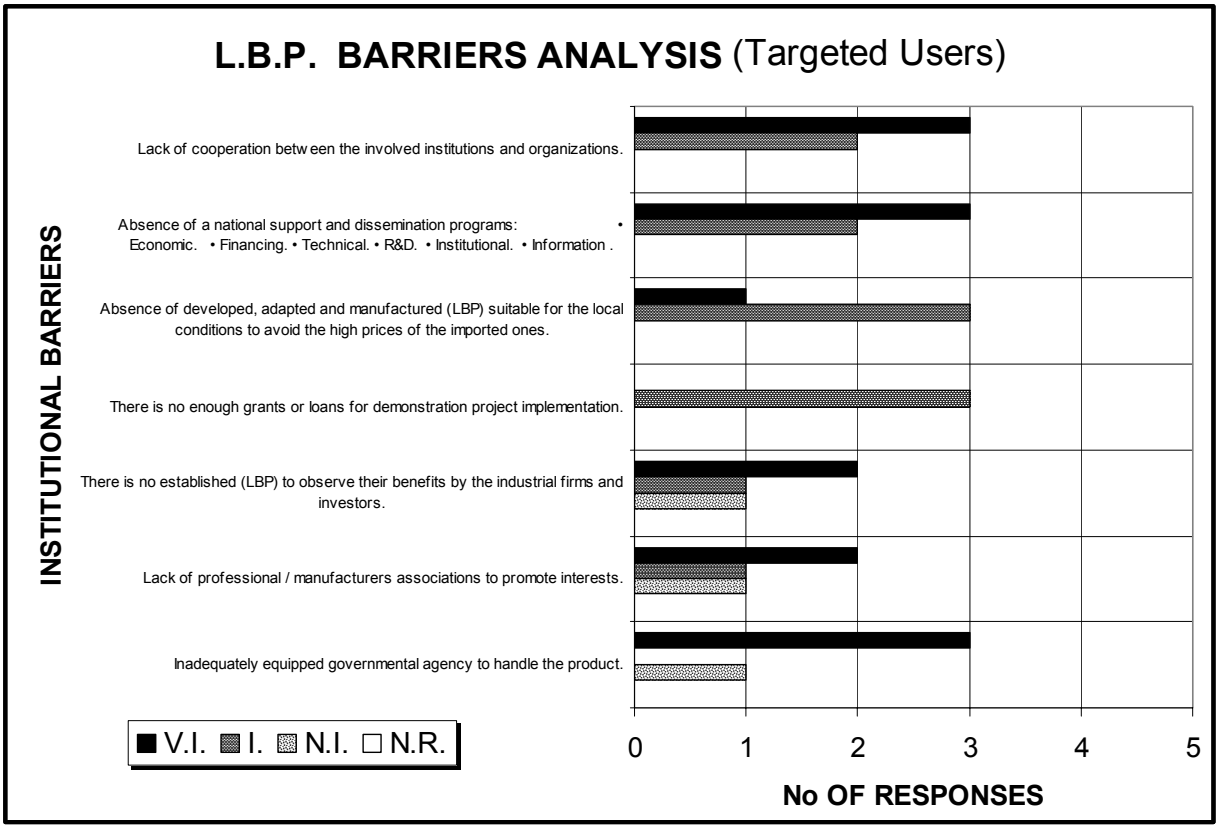
V.I. I. N.I. N.R.
No. OF RESPONSES


L.B.P. BARRIERS ANALYSIS (Targeted Users)
INSTITUTIONAL BARRIERS
Lack of cooperation betw een the involved institutions and organizations.
Absence of a national support and dissemination programs: • Economic. • Financing. • Technical. • R&D. • Institutional. • Information .
Absence of developed, adapted and manufactured (LBP) suitable for the local conditions to avoid the high prices of the imported ones.
There is no enough grants or loans for demonstration project implementation.
There is no established (LBP) to observe their benefits by the industrial firms and investors.
Lack of professional / manufacturers associations to promote interests.
Inadequately equipped governmental agency to handle the product.
V.I. I. N.I. N.R.
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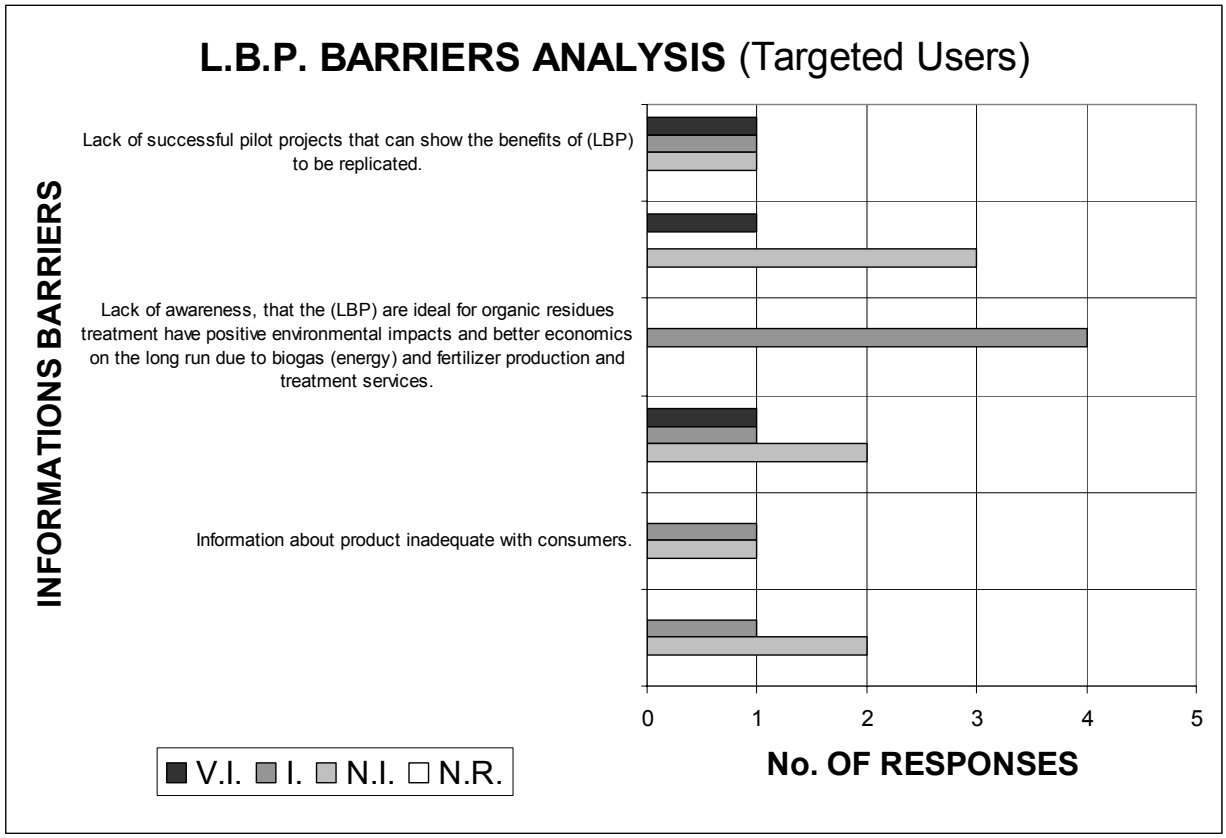
No OF RESPONSES


L.B.P. BARRIERS ANALYSIS (Targeted Users)
INFORMATIONS BARRIERS
Lack of successful pilot projects that can show the benefits of (LBP) to be replicated.
Lack of awareness, that the (LBP) are ideal for organic residues treatment have positive environmental impacts and better economics on the long run due to biogas (energy) and fertilizer production and treatment services.
Information about product inadequate with consumers.
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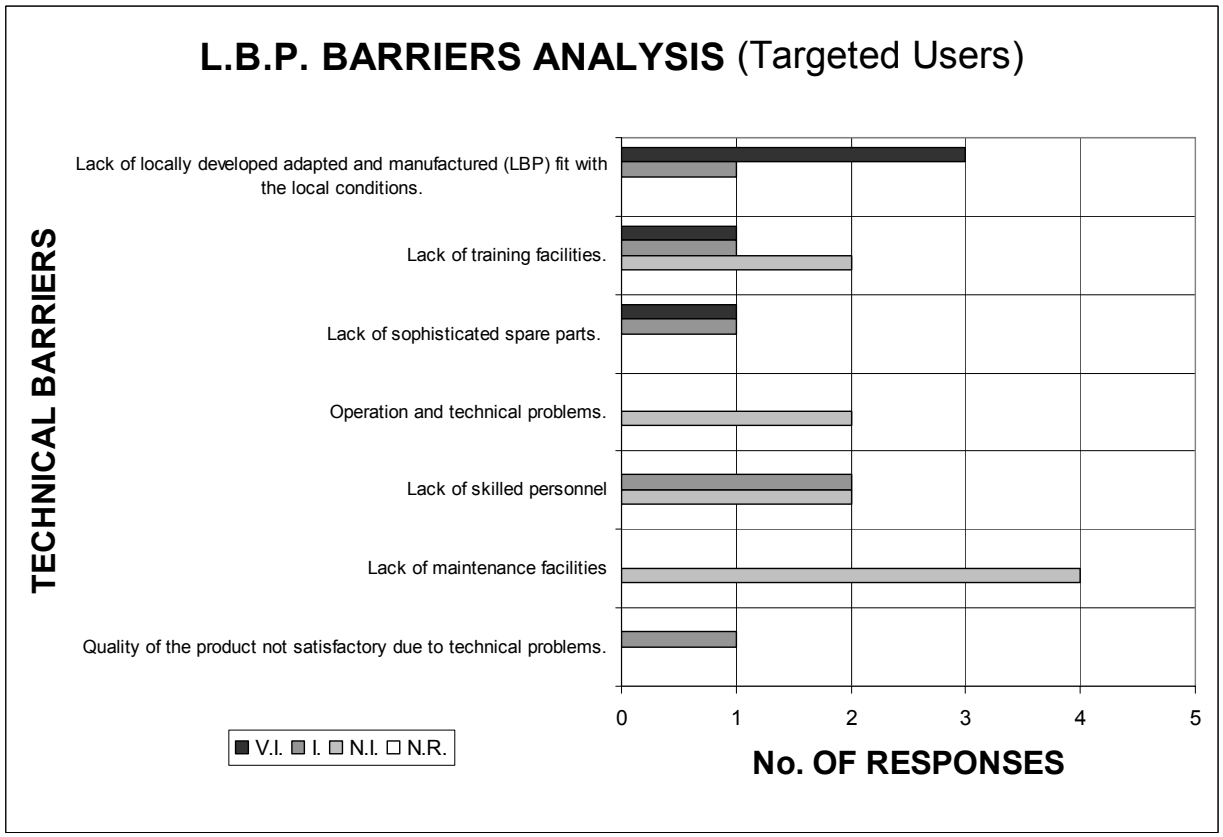
No. OF RESPONSES
V.I. I. N.I. N.R.


L.B.P. BARRIERS ANALYSIS (Targeted Users)
TECHNICAL BARRIERS
Lack of locally developed adapted and manufactured (LBP) fit with the local conditions.
Lack of training facilities.
Lack of sophisticated spare parts.
Operation and technical problems.
Lack of skilled personnel
Lack of maintenance facilities
Quality of the product not satisfactory due to technical problems.
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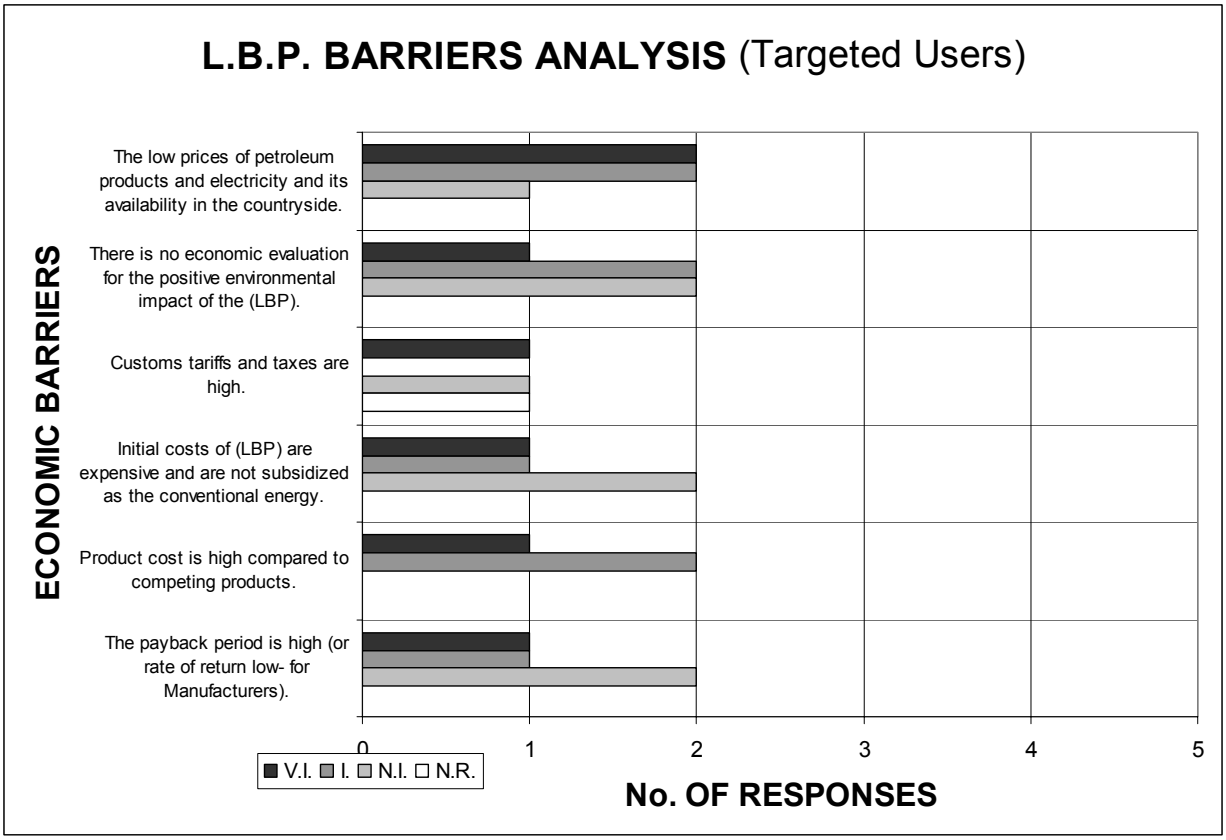
No. OF RESPONSES
V.I. I. N.I. N.R.


L.B.P. BARRIERS ANALYSIS (Targeted Users)
ECONOMIC BARRIERS
The low prices of petroleum products and electricity and its availability in the countryside.
There is no economic evaluation for the positive environmental impact of the (LBP).
Customs tariffs and taxes are high.
Initial costs of (LBP) are expensive and are not subsidized as the conventional energy.
Product cost is high compared to competing products.
The payback period is high (or rate of return low- for Manufacturers).
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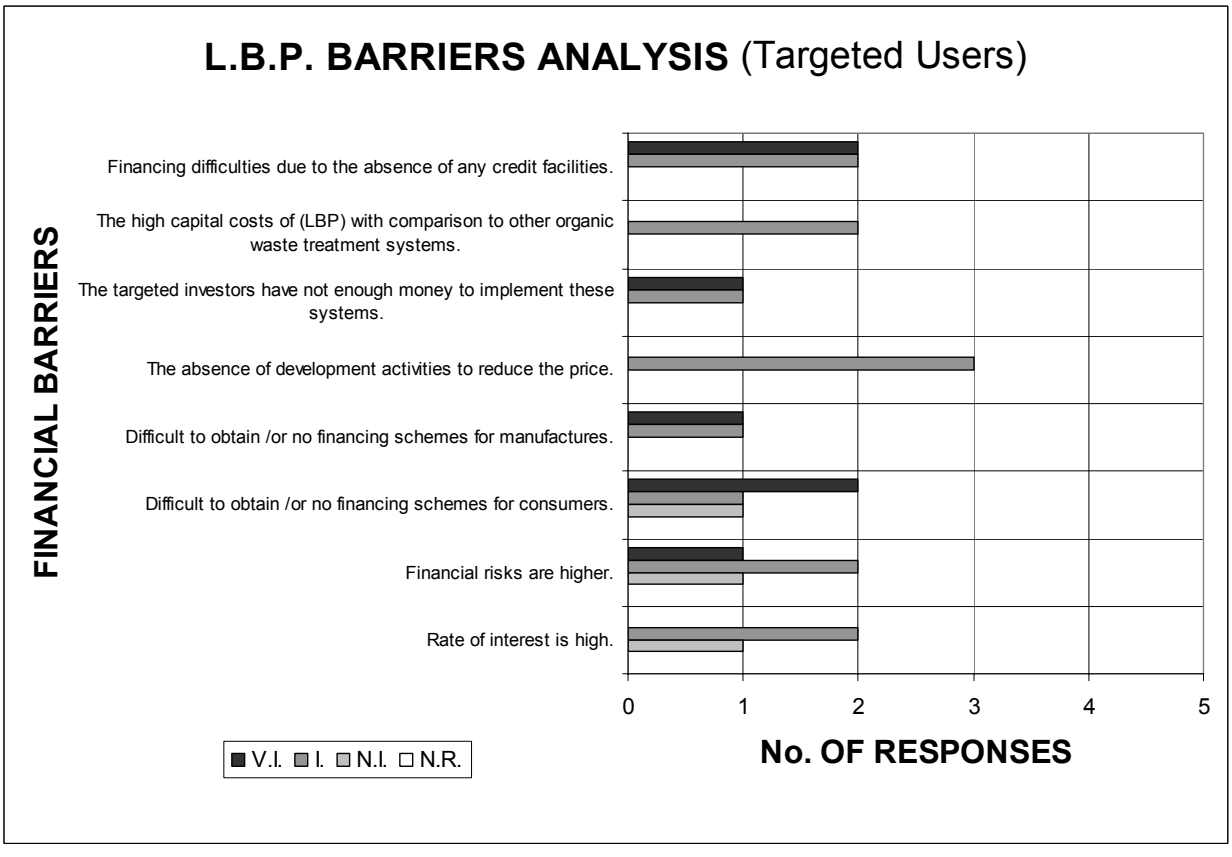
V.I. I. N.I. N.R.
No. OF RESPONSES


L.B.P. BARRIERS ANALYSIS (Targeted Users)
FINANCIAL BARRIERS
Financing difficulties due to the absence of any credit facilities.
The high capital costs of (LBP) with comparison to other organic waste treatment systems.
The targeted investors have not enough money to implement these systems.
The absence of development activities to reduce the price.
Difficult to obtain /or no financing schemes for manufactures.
Difficult to obtain /or no financing schemes for consumers.
Financial risks are higher.
Rate of interest is high.
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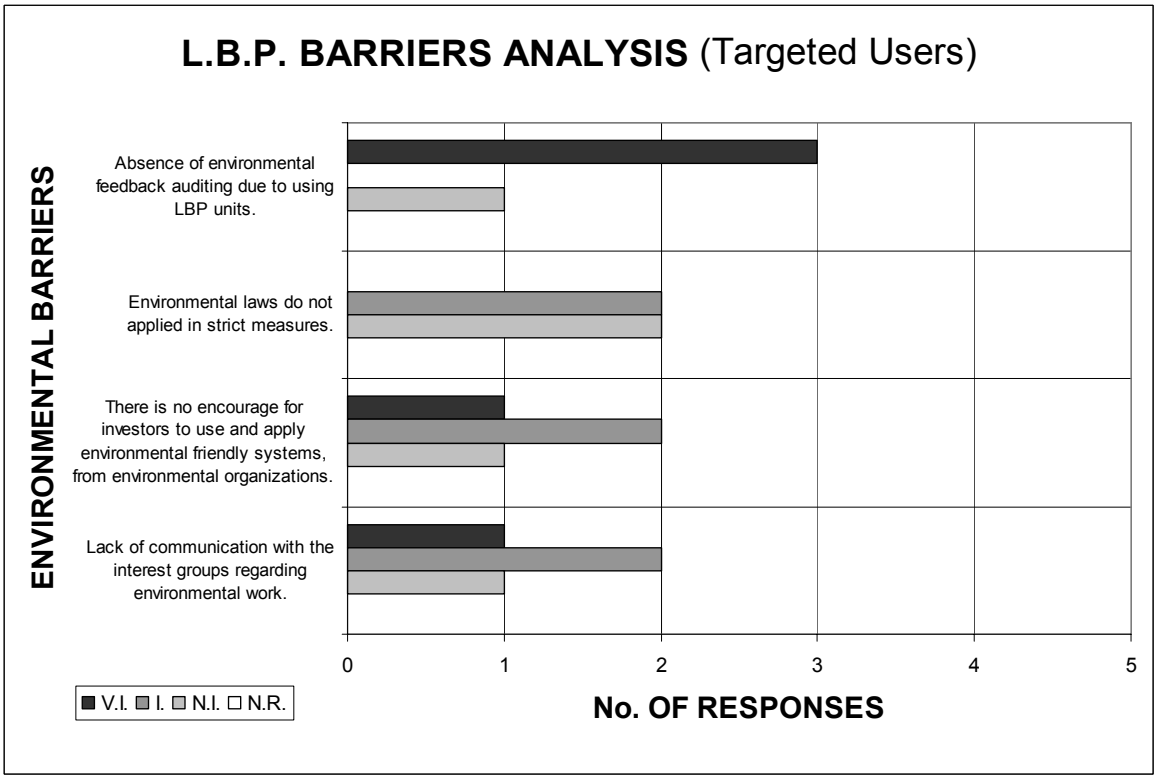
V.I. I. N.I. N.R.
No. OF RESPONSES


L.B.P. BARRIERS ANALYSIS (Targeted Users)
ENVIRONMENTAL BARRIERS
Absence of environmental feedback auditing due to using LBP units.
Environmental laws do not applied in strict measures.
There is no encourage for investors to use and apply environmental friendly systems, from environmental organizations.
Lack of communication with the interest groups regarding environmental work.
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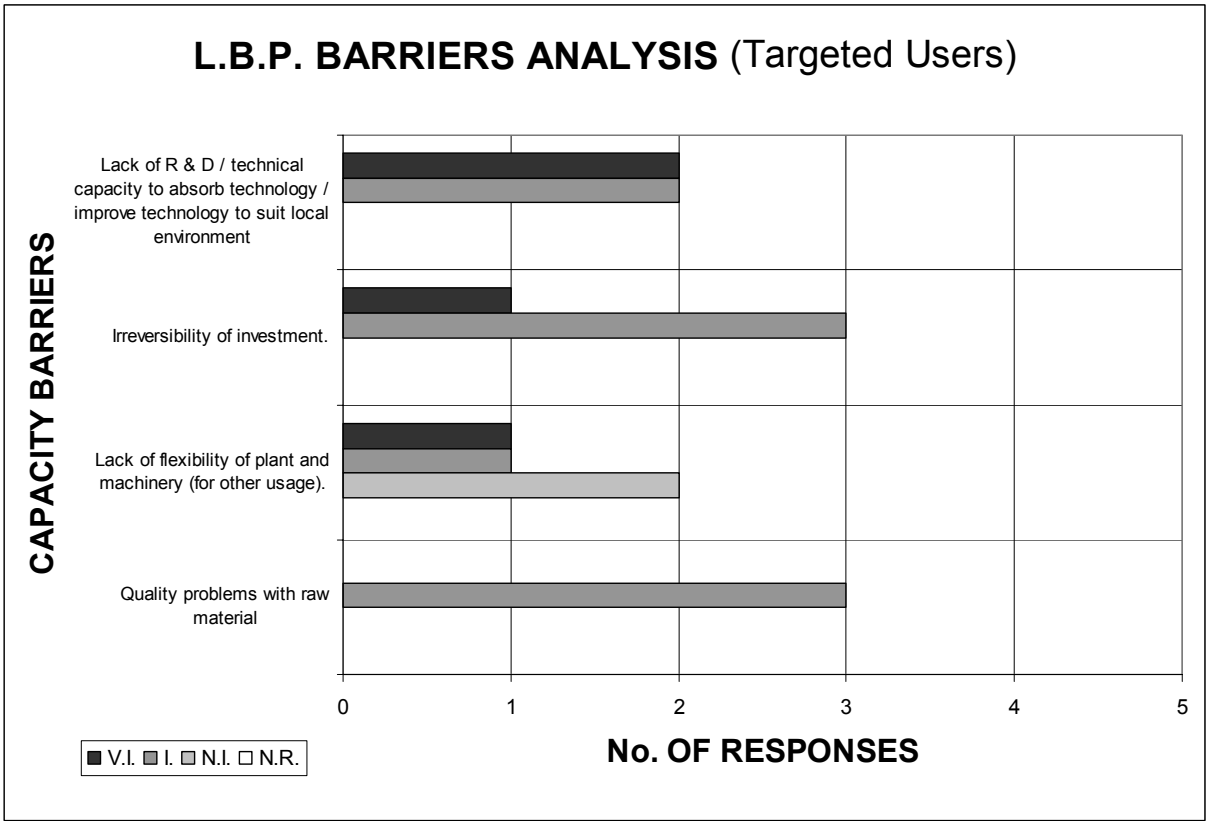
V.I. I. N.I. N.R.
No. OF RESPONSES


L.B.P. BARRIERS ANALYSIS (Targeted Users)
CAPACITY BARRIERS
Lack of R & D / technical capacity to absorb technology / improve technology to suit local environment
Irreversibility of investment.
Lack of flexibility of plant and machinery (for other usage).
Quality problems with raw material
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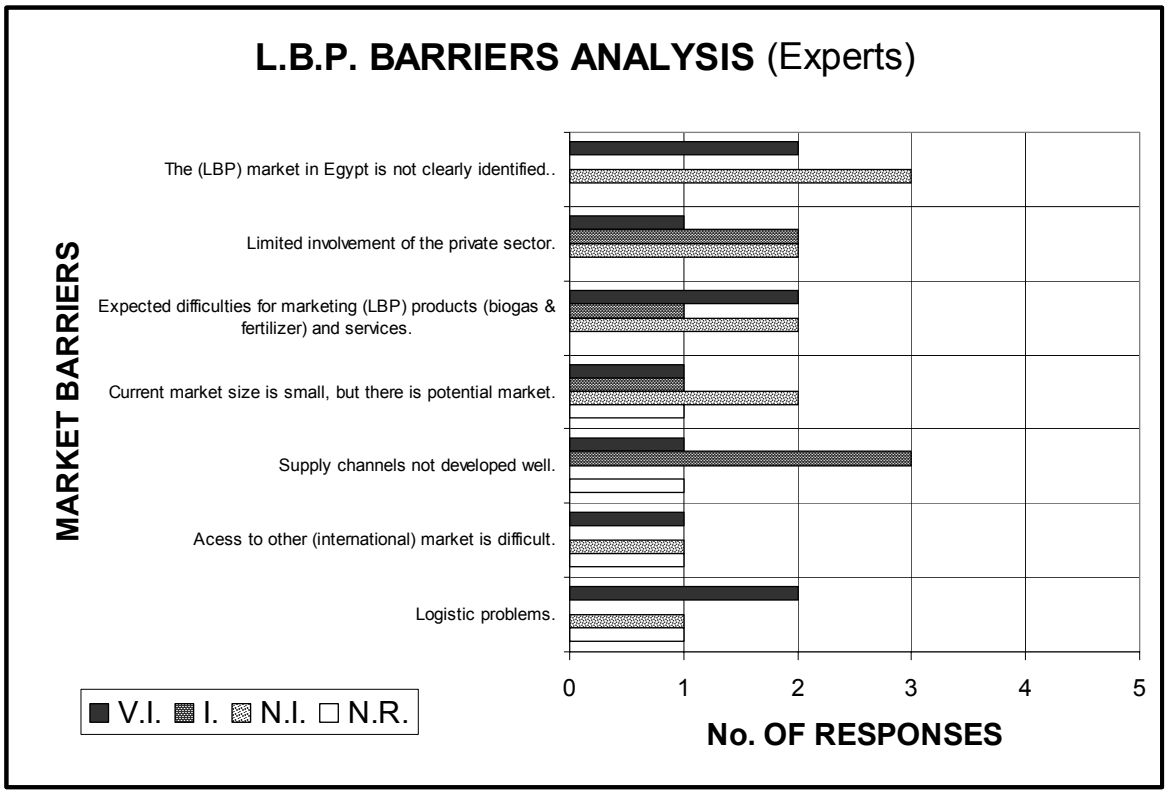
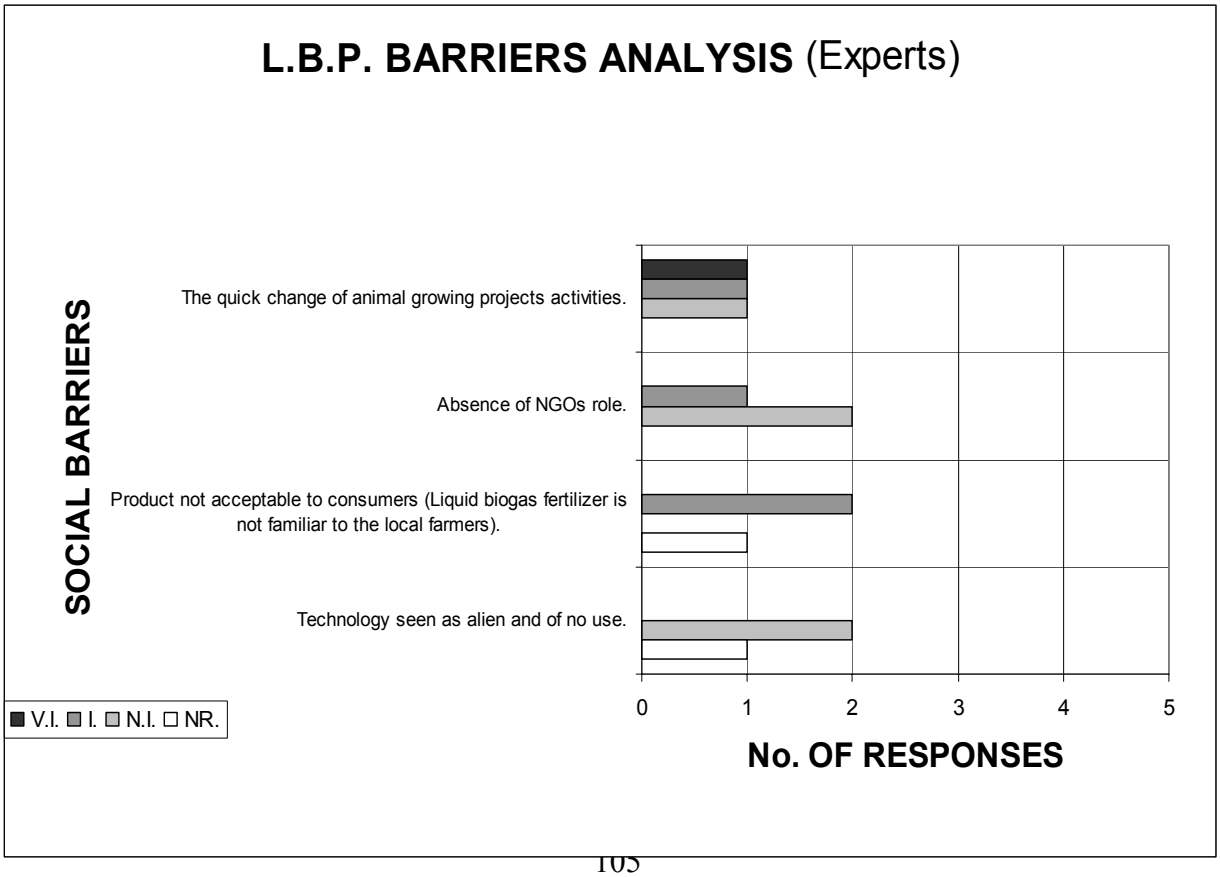
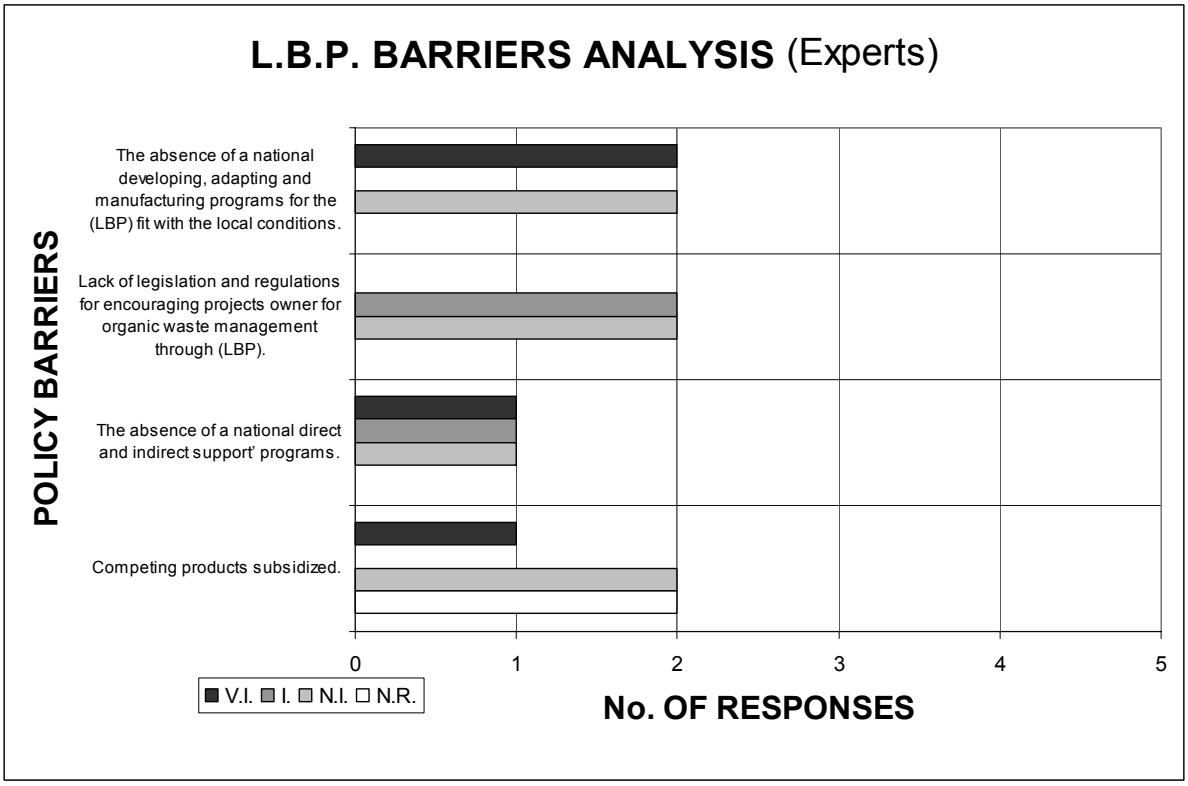
V.I. I. N.I. N.R.
No. OF RESPONSES

Annex 8; LBP survey responses; experts






L.B.P. BARRIERS ANALYSIS (Experts)
POLICY BARRIERS
The absence of a national developing, adapting and manufacturing programs for the (LBP) fit with the local conditions.
Lack of legislation and regulations for encouraging projects owner for organic waste management through (LBP).
The absence of a national direct and indirect support' programs.
Competing products subsidized.
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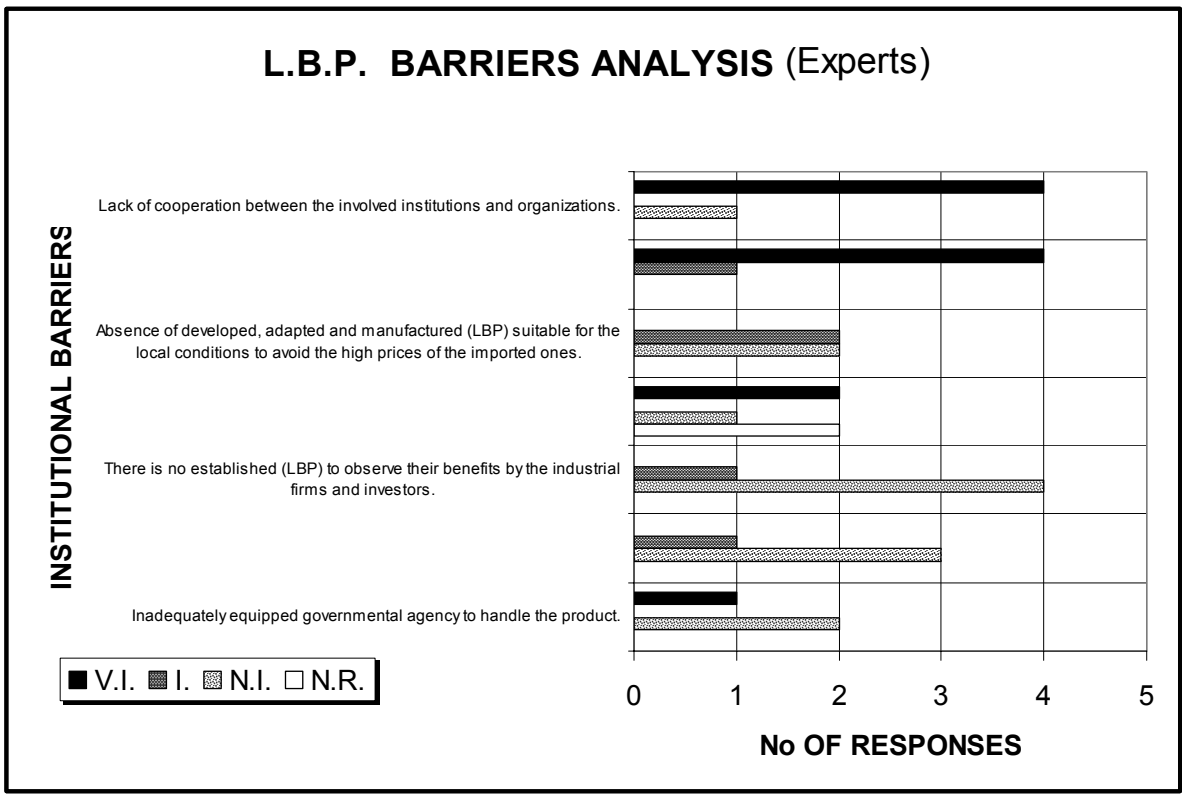
V.I. I. N.I. N.R.
No. OF RESPONSES


L.B.P. BARRIERS ANALYSIS (Experts)
INSTITUTIONAL BARRIERS
Lack of cooperation between the involved institutions and organizations.
Absence of developed, adapted and manufactured (LBP) suitable for the local conditions to avoid the high prices of the imported ones.
There is no established (LBP) to observe their benefits by the industrial firms and investors.
Inadequately equipped governmental agency to handle the product.
V.I. I. N.I. N.R.
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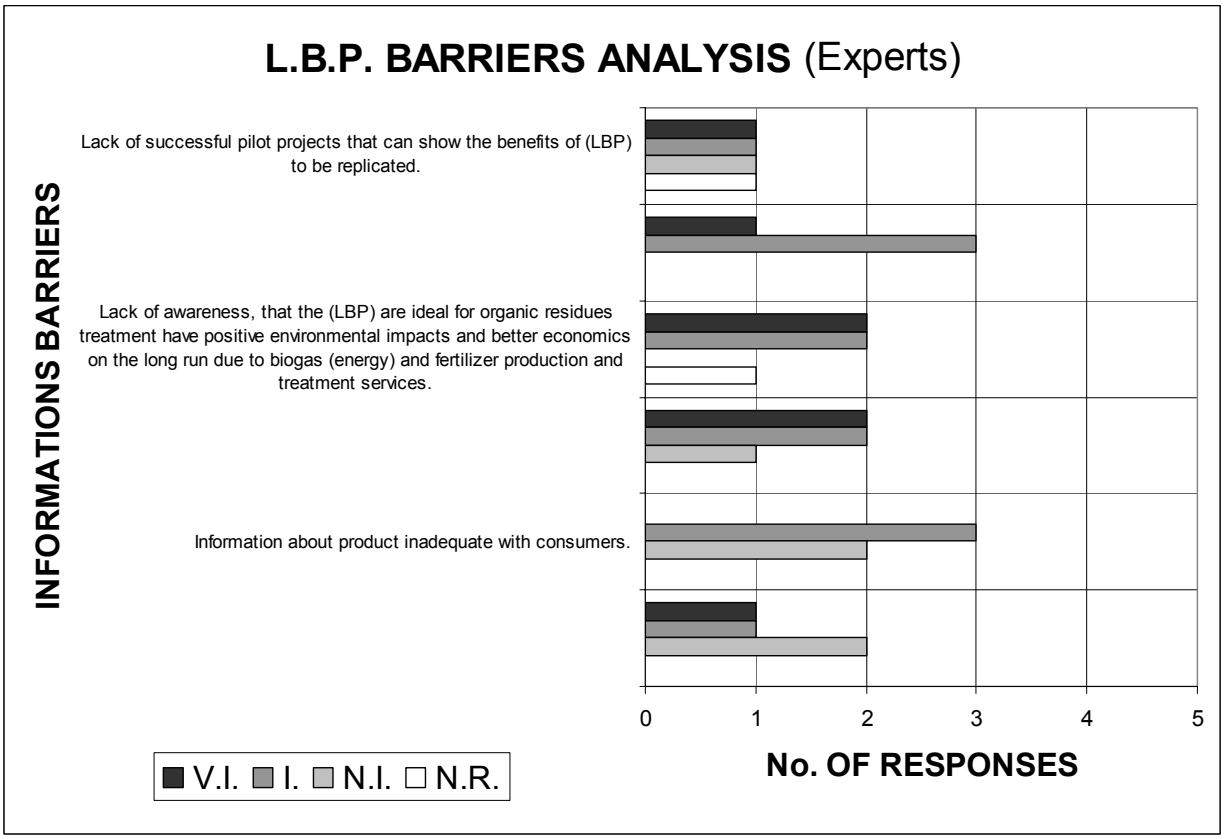
No OF RESPONSES


L.B.P. BARRIERS ANALYSIS (Experts)
INFORMATIONS BARRIERS
Lack of successful pilot projects that can show the benefits of (LBP) to be replicated.
Lack of awareness, that the (LBP) are ideal for organic residues treatment have positive environmental impacts and better economics on the long run due to biogas (energy) and fertilizer production and treatment services.
Information about product inadequate with consumers.
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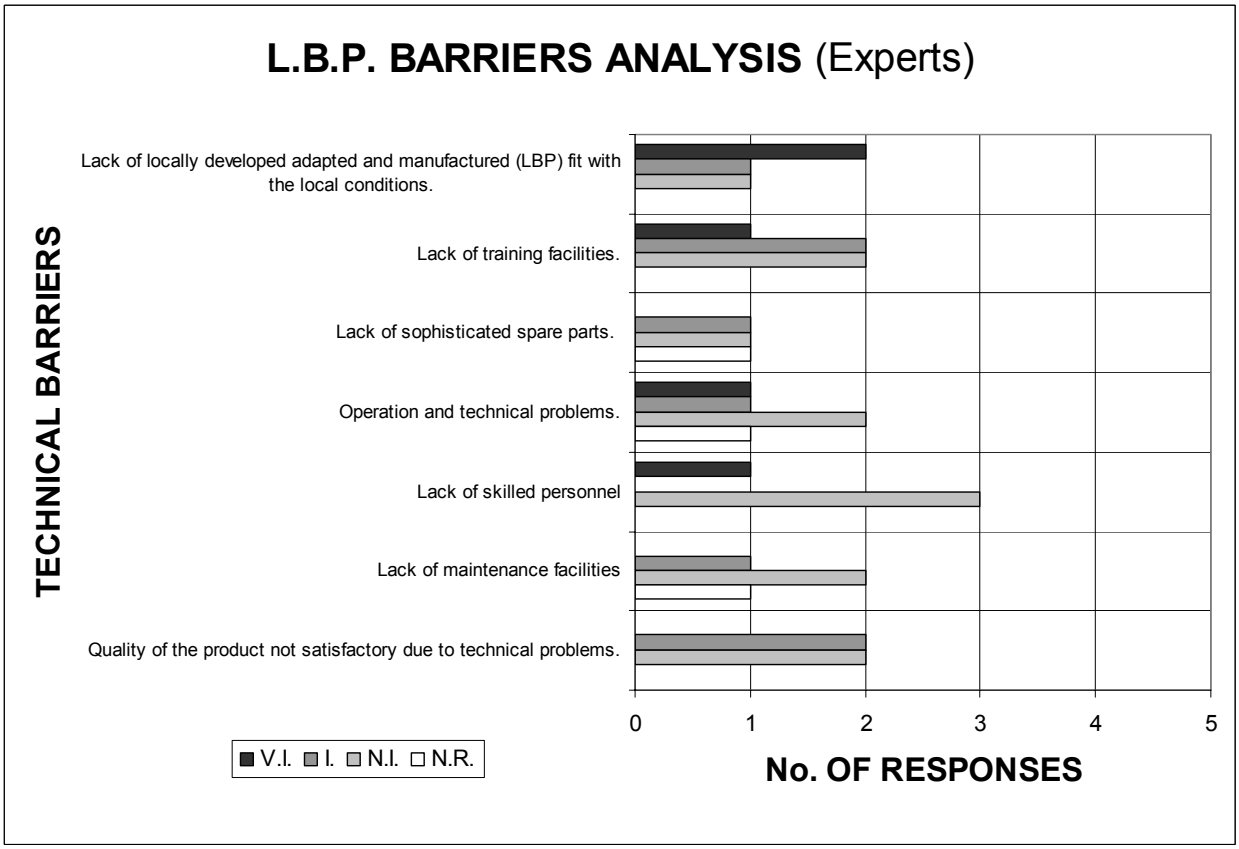
No. OF RESPONSES
V.I. I. N.I. N.R.


L.B.P. BARRIERS ANALYSIS (Experts)
TECHNICAL BARRIERS
Lack of locally developed adapted and manufactured (LBP) fit with the local conditions.
Lack of training facilities.
Lack of sophisticated spare parts.
Operation and technical problems.
Lack of skilled personnel
Lack of maintenance facilities
Quality of the product not satisfactory due to technical problems.
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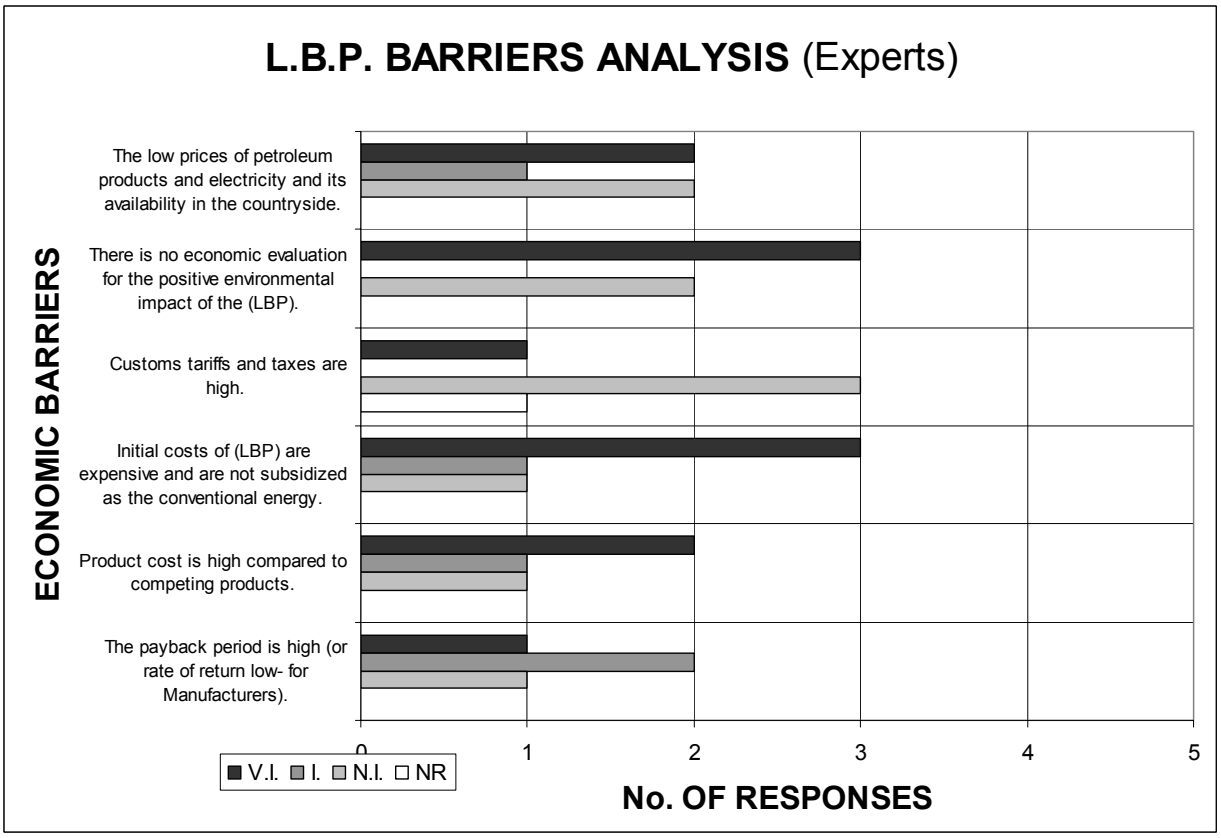
No. OF RESPONSES
V.I. I. N.I. N.R.


L.B.P. BARRIERS ANALYSIS (Experts)
ECONOMIC BARRIERS
The low prices of petroleum products and electricity and its availability in the countryside.
There is no economic evaluation for the positive environmental impact of the (LBP).
Customs tariffs and taxes are high.
Initial costs of (LBP) are expensive and are not subsidized as the conventional energy.
Product cost is high compared to competing products.
The payback period is high (or rate of return low- for Manufacturers).
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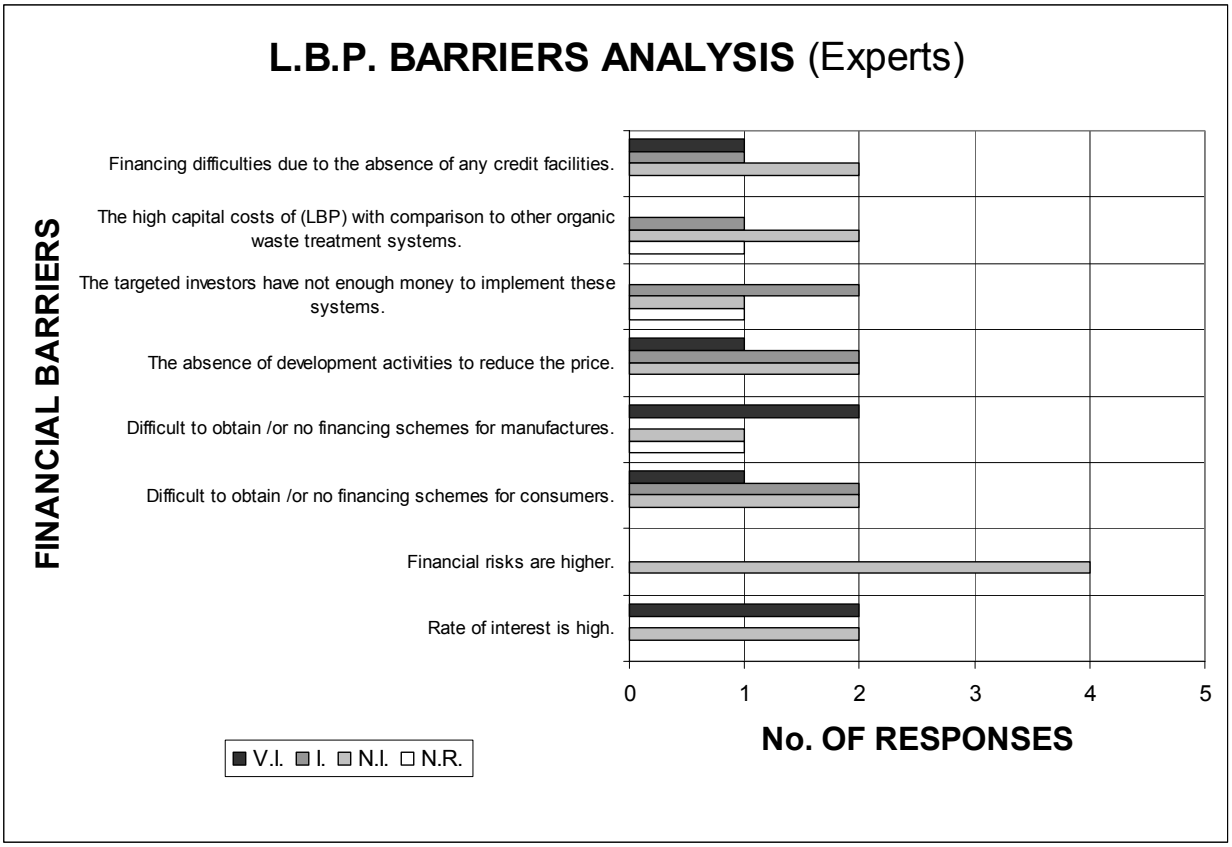
V.I. I. N.I. NR
No. OF RESPONSES


L.B.P. BARRIERS ANALYSIS (Experts)
FINANCIAL BARRIERS
Financing difficulties due to the absence of any credit facilities.
The high capital costs of (LBP) with comparison to other organic waste treatment systems.
The targeted investors have not enough money to implement these systems.
The absence of development activities to reduce the price.
Difficult to obtain /or no financing schemes for manufactures.
Difficult to obtain /or no financing schemes for consumers.
Financial risks are higher.
Rate of interest is high.
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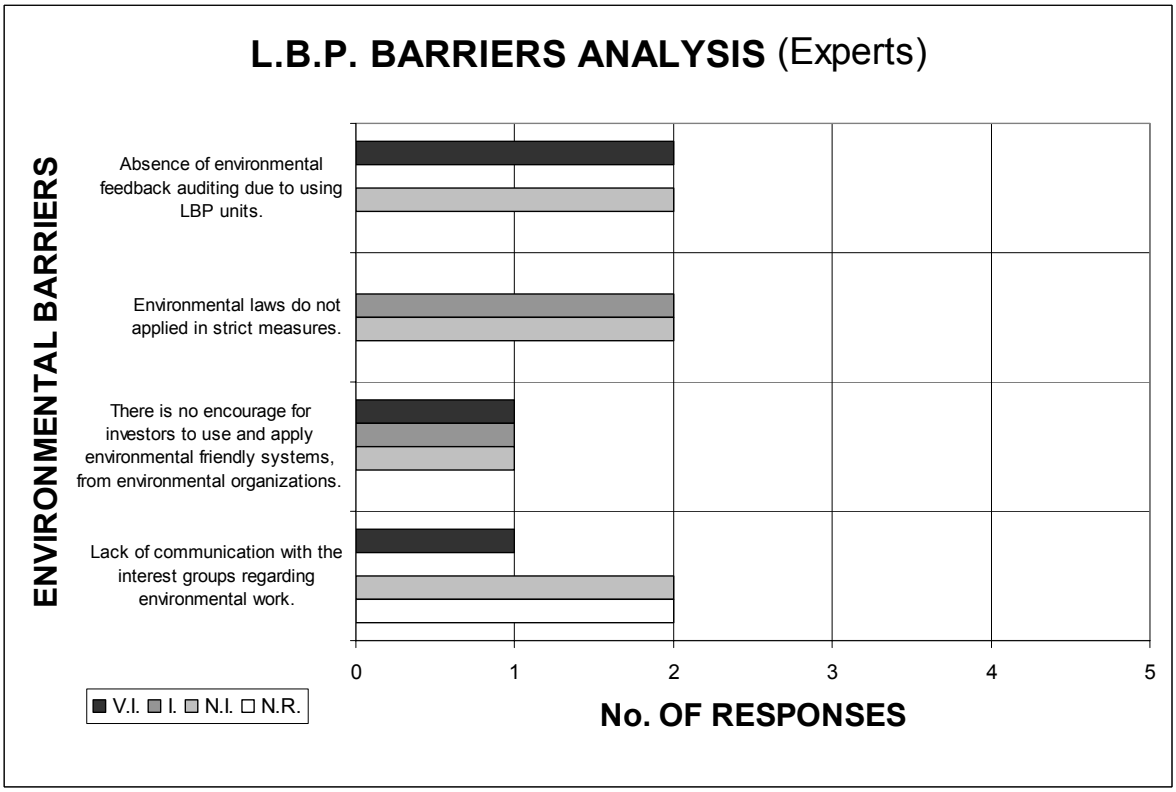
V.I. I. N.I. N.R.
No. OF RESPONSES


L.B.P. BARRIERS ANALYSIS (Experts)
ENVIRONMENTAL BARRIERS
Absence of environmental feedback auditing due to using LBP units.
Environmental laws do not applied in strict measures.
There is no encourage for investors to use and apply environmental friendly systems, from environmental organizations.
Lack of communication with the interest groups regarding environmental work.
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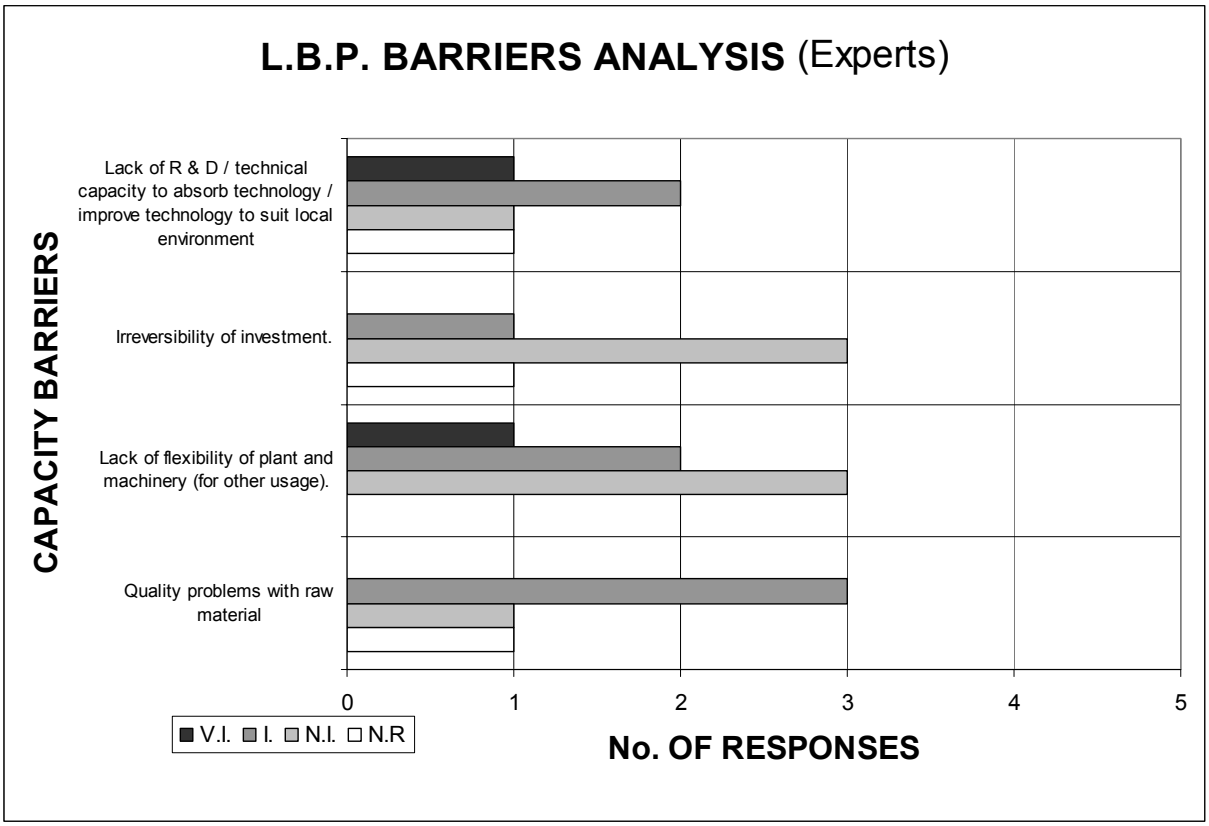
V.I. I. N.I. N.R.
No. OF RESPONSES


L.B.P. BARRIERS ANALYSIS (Experts)
CAPACITY BARRIERS
Lack of R & D / technical capacity to absorb technology / improve technology to suit local environment
Irreversibility of investment.
Lack of flexibility of plant and machinery (for other usage).
Quality problems with raw material
0
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V.I. I. N.I. N.R
No. OF RESPONSES

Annex 9; Important barriers for Large-scale Biogas Plants (LBP)

EXPERTS RESPONSE	TARGETED USERS RESPONSE
Institutional Barriers	
Absence of a national support and dissemination programs. • Economic. • Financing. • Technical. • R&D. • Institutional. • Information.	
Lack of Cupertino between the involved institutions and organizations.	There is no established ***(LBP)*** to observe their benefits by the industrial firms and investors.
Market Barriers	
The (LBP) market in Egypt is not clearly identified..	
Expected difficulties for marketing (LBP) products (biogas & fertilizer) and services	Current market size is small, but there is potential market.
Information Barriers	
Lack of awareness about the (LBP) economic and environmental impacts.	
Lack of awareness, that the (LBP) are ideal for organic residues treatment have positive environmental impacts and better economics on the long run due to biogas (energy) and fertilizer production and treatment services.	Lack of successful pilot projects that can show the benefits of ***(LBP)*** to be replicated.
Financial Barriers	
Difficult to obtain /or no financing schemes for manufactures.	Financing difficulties due to the absence of any credit facilities..
Rate of interest is high.	Difficult to obtain /or no financing schemes for manufactures.
The high capital costs of ***(LBP)*** with comparison to other organic waste treatment systems.	
Economic Barriers	
Initial costs of ***(LBP)*** are expensive and are not subsidized as the conventional energy.	The low prices of petroleum products and electricity and its availability in the countryside.
There is no economic evaluation for the positive environmental impact of the ***(LBP)***.	

Annex 9 contd…

EXPERTS RESPONSE	TARGETED USERS RESPONS
Technical Barriers	
Lack of locally developed adapted and manufactured ***(LBP)*** fit with the local conditions.	
Lack of training facilities.	Lack of maintenance facilities
Capacity Barriers	
Lack of R & D / technical capacity to absorb technology / improve technology to suit local environment	
Lack of flexibility of plant and machinery (for other usage).	Irreversibility of investment.
Quality problems with raw material	
Social Barriers	
The quick change of animal growing projects activities.	
Absence of NGOs role.	Product not acceptable to consumers (Liquid biogas fertilizer is not familiar to the local farmers).
Environmental Barriers	
Absence of environmental feedback auditing due to using LBP units.	
There is no incentive for investors to use and apply environmental friendly systems, from environmental organizations.	Lake of communication with the interest groups regarding environmental work.
Environmental laws do not applied in strict measures.	
Policy Barriers	
The absence of a national developing, adapting and manufacturing programs for the ***(LBP)*** fit with the local conditions.	
The absence of a national direct and indirect support' programs.	Competing products subsidized.

Annex 10; Project Proposal

Creation of a Financial and Technical Support Mechanism for DSWH Dissemination in Egypt

Background:

Although more than seven local manufacturers are now working in the field of domestic Solar Water Heaters (Flat Plate Collectors), the production and installation rates are very low.

The main reasons prevent DSWHs to be widespread as follows: -

High initial cost compared with traditional heaters.
Lake of customer awareness about the DSWHs advantages.
No governmental support to urge banks and different financing sources to make any credit facilities to DSWHs.
No obligation system exists for quality control, so some products of DSWHs are bad.
No guarantee of system performance during the life time.

So, the proposed project is to create a mechanism to overcome the a/m reasons.

Project description:

The project targets creation of a mechanism to co-ordinate between users, bank, consultant and manufactures for promotion of DSWHs.

The project concept is as following: -
Donors will deposit an amount of money as deposit in a bank for a period to get benefits. These benefits cover the cost of financial credit of DSWHs loans.
The bank will contract with a specialist consultant to take the necessary procedures to choose the best quality and price of the DSWHs. Also, to follow up the performance during guarantee period.
The manufacturers will guarantee their products for a period of loans by giving the bank a letter of guarantee including amount of the heater cost and a guarantee period equal to the period of loans .
The consultant will determine and control the relation between the users and the manufacturers during the period of guarantee.
The manufacturers will be responsible for maintenance and repairing any deflects which determined by consultant in their products during the period of guarantee without any additional cost.

Objectives:

Increasing the production and installation rates of DSWHs.

Supporting the economic and social development by both fuel saving and creation of new job opportunities.

Creating the public awareness towards the necessity of exploiting renewable resources.

Project plan:

Phase I : Feasibility study, creation of the mechanism, preparing the terms of reference for choice of consultant and invitation letters for donors.

Phase II : Implementation which includes the following :
Contracting with the consultant.
Advertising in TV. and news papers.
Contracting with manufacturers of DSWHs of the best quality and price.
Contracting with users of DSWHs.
Installation of DSWHs.
Follow up.

Phase III : Evaluation of the first two years period and recommendation to take into consideration in the next years.

Project Proposed Budget for Phase (I):

- Man/Month : 24 m/m
- Period : 6 Months
- Total Cost : 90.000 US$

Annex 11; Project Proposal

PV Rural Electrification

BACKGROUND

The New and Renewable Energy Authority (NREA) is the Egyptian specialized entity concerned with development and utilization of new and renewable energy in Egypt . NREA belongs to the Ministry of Electricity and Energy.

Egypt in its national strategy plan is aiming for the development of new communities, remote villages and desert areas to raise the standard of living.

Many disperse locations in Egypt include thousand of poor people who lives in harsh conditions, the problems facing those areas are concentrated in the following:

- Lack of energy means; especially for Lighting.
- Lack of potable water for daily life use.
- Lack of rural clinics for health care.
- Lack of telecommunication facilities.

Photovoltaic (PV) Solar Systems are presently considered economically advantageous only in remote applications of low power demand , where a grid-extension appears anti economic, and alternative and conventional stand-alone power sources (e. g. diesel generator set) present excessive operating costs.

The Solar Radiation

Egypt has excellent solar availability. The average global solar radiation over Egypt ranges from about 1950 Kwh / m2 / Year on the Mediterranean Coasts to more than 2600 Kwh / m2 / Year in upper Egypt, while the 90% of the Egyptian territory has an average global radiation greater than 2200 Kwh / m2 / Year.

Previous Experiences

A number of PV systems totaling more than 2 Mwp have been installed in Egypt by public bodies (New & Renewable Energy Authority and other national and international institutions) and private companies. The main application fields are water pumping, desalination, clinical refrigerators. rural village electrification and ice making. PV applications for telecommunication systems and high way advertising panels are already commercialized. A polite project for electrification of remote village using PV power systems of 28 Kwp has been implemented in 1994 for households, street lights and pumping systems. while PV application for telecommunication system are already commercialized.

SCOPE & OBJECTIVE OF THE PROJECT

The New and Renewable Energy Authority (NREA), is intending to introduce utilization of the solar PV energy for the development of rural villages and remote areas in Egypt.

The aim of proposed project is to establish an independent PV solar systems for supplying electricity for Five small rural communities in Egypt that are far from the utility grid and not include in future plans for electrification from the grid.

Economic justification of PV projects for electrification of rural areas depends on the distance from the grid, number of houses per village, energy consumption and nature of the load.

The Objective of the Project as follows:

Development Objectives

- To encourage the conversion of Bedouin's nomad way of life into permanent settlements by supplying them electricity for lighting, TV sets, telecommunication, refrigerators for foods and vaccines, water pumping and desalination.
- Reduce the pollution of the environment.
- To improve the standard of living of the rural population.
- To develop local capability for producing and / or assembling small PV systems and / or some of their components.
- Supporting the economic and social development by fuel saving, establishment of infrastructure necessary for the development in remote grid project areas and creation of new job opportunities.

Immediate Objectives

- Know how transfer concerning operation, maintenance and control.
- To develop local capabilities for operation and maintenance of PV systems
- To attract other user and owner of farms to use PV technology as meant of energy supplies for irrigation and desalination ... etc.
- To check the implementation possibility of PV systems of supplying electricity to small isolated villages with high reliability, easy operation and minimum maintenance requirements .

PROJECT BENEFITS

Environmental Benefit

- Limiting the use of kerosene lamps which constitutes a major source of pollution inside their household, thus helping to clean the environment and also decrease fire hazards.
- Utilization of PV systems instead of conventional diesel generating sets will allow to avoid the diffusion of pollutant gases in the atmosphere.

Social Benefit

- New way of life for the inhabitants at remote areas .
- Enough water for agriculture and grazing at permanent settlements.
- Increase agriculture product.
- Improving the standard of living.
- Women and children will be greatly effected by the project.

Economic Impact

- The national income of Egypt depend on oil exports therefore the fuel saving achieved by the project can provide an increase in the national income by providing the foreign currency due to oil exportation.
- Create new job opportunities and help solving the unemployment problem, that positively affect the general economic situation in Egypt.
- Encourage investors and private sector to share in PV industry.

PROJECT DESCRIPTION S

Description of the proposed sites:

- The location of the project will be in any one of the rural governorates such as North Sinai, South Sinai, New Valley, Giza and Matrouh governorates (i.e the exact villages will be define according to the plane of the Rural Electrification Authority).
- The average population level per village ranges from 200 to 300 persons constituting 25 to 30 dwellings / families each on average of 8 persons .
- The main activities of the rural villages are agriculture and / or grazing .

- Water depth in ranging from 10 -120 meters.
- Most of the village have Kerosene burners for cooking and water heating as well lamps for lighting .

- Agriculture waste and firewood are collected from near by natural plantation residues and used for bakeries , space heating and sometimes for cooking.

Outline of PV proposed applications

PV- Household Lighting System

Decentralizing power system is characterized by one independent PV power system per household , providing electricity to power DC and / or AC loads . Each household manages its own energy demand to remain within the limits of its system size and the available insulation . Those users who desire more energy can be add modules and batteries. Increased demand by one user does not affect the others.

Estimated Energy Demand per Household

PV Lighting Systems are needed for each household to meet the total demand of about 800 - 1000 Wh/day . Load to be powered in each household is as follow:-

Electric Load	Qty	Power (W)	Duration hrs/day	Energy demand Wh/day
F.lamps (DC) low voltage	4	* 11 (900-1000) lumens	6	331.2
Colour TV / Radio Set	1	100	5	500
Refrigerator	1	80	18	1440
Total				**2270 Wh/day**

If there are no refrigerator, connected only 850 watts-hrs/day.
The PV System can be made smaller and cheaper .

* 13.8 watts corresponding to 11 watts light power

- Based on the above load schedule and the radiation data of the project site , the capacity of the PV array have been estimated at 250 W_p.

PV-Street Lighting System

Street Lighting System Street Lighting System are needed by each village , Street light should be fluorescent or Sodium Vapour type of the minimum rating of 1200 lumens for 12 hours and having all required control .

Load Profile for one light pole

Electric Load	Qty	Power (W)	Duration h/day	Energy Consumption Wh/day
Lamp	1	20	12	240

Medical Center System

For each village , an individual medical center is required to provide sufficient DC power to meet the following load requirements:-

- 2 of 18/20 watts lamps for 5 hours operation.
- One 100 litres vaccine refrigerator.
- One Sterilizer.

The size of the PV array is ≈250 W_p .

Telecommunication System

A PV Power Telecommunication System is required for providing sufficient power for a range of at least 45 kms for connecting the village to main city.

Work Plan

Item \ year	1998/1999	1999/20000	2000/2001
Government Agreement			
Tendering and Evaluation			
Implementation			

Project Size & Budget

Project Size

- No. of village to be electrified /financed : 5 villages
- Estimated average size required for 5 villages : 8 kwp
- Total PV array size required for villages : 40 kwp

Estimated budget to be financed as follows:

- Equipment Hardware (FOB)	:	0.6	M USA$
- Erection Work	:	0.12	M USA$
- Transportation Cost (CIF)	:	0.042	M USA$
- Custom Clearance	:	0.09	M USA$
- Consultant Service	:	0.09	M USA$
- Spare Parts	:	0.03	M USA$
- Training	:	0.03	M USA$
- Grand Total		1.002	M USA$
	≈	1	M USA$

Annex 12; Project Proposal

A Pilot Large-Scale (Centralized) Biogas Plants (LBP)

Specification of projects will include identification of specific sites, involved parties, such as operators, utilities, users, requirements and sources of maintenance staff etc.

Problem Identified, Analyzed and Intend to be addressed by the Proposed Project:

Although organic wastes known as a source of Energy, especially in agricultural societies, organic wastes are not properly treated or utilized in Egypt. On the other hand, there are many different sources of organic wastes exist in Egypt such as chicken farms, dairy farms, industry, households, waste water, treatment plants and other. The organic wastes estimated by 40 Mil. Ton / year. Almost led directly to the drain, to lakes, to the Nil or to other water streams, left at dumps and other areas used directly as fertilizer on the fields.

Effects:

Pollution of the water sources in Egypt has been recognized as a problem leads to increasing epidemic diseases. In addition biomass potential for producing gas is not exploited. Gas from Biomass is thus today an unrevealed source of energy and there exists an economic loss both for the companies on a micro economic level and for the nation on a macro economic level. As the type of the gas is methane and it today released on the field etc. it also contributes to the discharge of greenhouse gases.

Problem:

The Large-scale Biogas plants (LBP) technology has advantages to overcome the a/m Effects. There are many barriers facing LBP projects dissemination in Egypt. The important LBP barriers were identified and its related actions and activities to remove barriers (table 1).

A specific LBP project can be proposed that will lead to implementation of these actions and test their effectiveness. The Proposed project would have a high chance of success.

It is believed that once a successful Large-scale Biogas plants (LBP) is introduced and its advantages are recognized in Egypt the dissemination and adoption of this technology will take place by itself. It is therefore proposed to establish a demonstration project in a selected dairy farm.

Project site identification:

The exact location for the project has not been decided, but demonstration plant will be established in connection with a large dairy farm in the vicinity of Cairo. A dairy-work capable of using the produced biogas for heating and treatment of the products will exist as part of the farm. The preferred farm can describe by following figures and characteristic:

Livestock: 500-1000 dairy cattle.
Imbedded dairy with energy use; producing heat-treated milk and other dairy products and at present using fossil fuels as energy source.
Has an agriculture area for internal use of produced fertilizer.
Possibility to be visited on a one day trip by car from Cairo.
Private or governmental Ownership.

These figures are used for the budget estimation.

End – of – Project Situation

The Project is subdivided into two phases:

Phase I:

- Primarily detailed design.
- Manufacturing.
- Construction,
- Commissioning of the Biogas plant and connected installations.

Phase II :

- Operating the plant.
- Preparing information material.
- Diffusion of experiences.

By the end of the first project phase the following will have been established:

- A Biogas plant for treatment and utilization of manure from the dairy cattle.
- A retrofitted unit for supplying heat, now based on Biogas.
- A combined gas engine and generator for production of electricity (optional).
- Facilities for sale and dispatching the treated fertilizer.
- Trained staff for operation and maintenance of the established installations.
- Special group at the implementing authority being in charge of the project.

After having completed the second phase following additional project elements will have been established and achieved:

- A number of reports and other information material will have been issued.
- A number of seminars will have been held.

Project Objectives:

Development Objectives:

- To set the favourable conditions and actions required for overcoming the barriers against successful implementation of biogas projects.
- To improve knowledge, skills, and confidence of interest groups so they can believe that the biogas energy technologies can contribute to national energy needs.
- To strengthen institutional capacity Cupertino for implementation biogas projects.
- To defuse the utilization of economically viable and environmentally friend technologies for energy + fertilizers production and organic waste management.
- To upgrade the Egyptian experience in the design, construction, starting up, operation, maintenance of such systems through NGOs and privet sector.
- To increase the public awareness.
- To reduce the pollution of the environment.
- To reduce the emission of greenhouse gasses as methane, which is converted to less harmful gasses giving energy after burning it as a fuel and reduce the use of fossil fuels.
- To limit the health hazards and improve the social condition for the population.
- To improve the economic situation for the private industry as well as of the nation.

Immediate Objectives and Project Strategy:

The immediate objectives are:

- Protecting the Environment by:
  - Preventing the emission of huge amount of green house gases due to the traditional ways of waste management.
  - Reducing the use of fossil fuels replaced by the produced biogas.
  - Reducing the use of chemical fertilizers replaced by the produced biogas rich fertilizers.
  - Killing all insects & disease that are on the waste.

- Economic gain through introducing a technology that will protect the environment and produce fertilizers and clean energy to substitute equivalent amount of chemical fertilizer and fossil fuel respectively.
- Developing the rural area by introducing new job opportunities and raising the income standard.
- Technology development and dissemination:
  - Adapting & developing biogas plants suitable the local conditions.
  - Manufacturing locally the developed plants partially or totally.
  - To implement 1 - 3 Centralized Biogas plants.
- Raising a national action plan for co-operation between the concerned authorities to pave the way for that technology spreading by encouraging the private sector to invest profitably in this technologies.
- To organize two weeks training program for 15-20 engineers
- To organize 2 days seminar.
- To demonstrate the technical and economic feasibility and applicability in Egypt of LBP technology in connection with dairy farms and treatment of organic fertilizer.
- To transfer Known-How to Egypt.
- To increase the awareness of Biogas technologies among Egyptian governmental and private planners and decision-makers.

The strategy of the proposed project can be describe as follows:

- A demonstration plant is established at a dairy farm easy accessible from Cairo.

It is operated with intensified surveillance for a demonstration phase of two years.

- During the construction phase one or two resident engineers/advisors with extensive knowledge of biogas plants will be in Egypt::

. Assisting in supervision of the construction works.
. Setting up a group at the implementing authority who will be in charge of the demonstration phase.
. Assist in setting up the necessary organization at the chosen dairy.
. Training in the disciplines of biogas technologies, preparation of information material etc.
. Short-term expatriates depending on the qualifications of the chosen resident engineers.

- After completion of test runs, Commissioning etc. the assigned group at the implementing authority will be responsible for assisting the operating the plant at the dairy farm as well as for:

. Gathering data and preparing reports and information material.
. Data, experiences and problems will be discussed during semi-annual sessions.

. The engineers, who were residing in Egypt during the construction phase, will participate in these sessions.
. During the session, a report describing the operation of the plant during the elapsed 6 months will be finished and presented.
. These sessions will also form the basis for the consultant to prepare the required progress reports.

After completion of the first half of the demonstration phase as well as the whole of the demonstration phase, seminars will be held. The purpose of these seminars is to transfer and diffuse knowledge, experience and awareness related to biogas technologies. Governmental planners, private and governmental decision makers, researchers, engineers, and interests groups.

Assumptions:

Assumptions are made in relation to the immediate objectives as well as the short-term development objectives.

The assumptions related to the immediate objectives are:

- That the selected farm does not change in a way that undermines this project.
- That prices for energy based on fossil fuels are increased according to the laid out plans and that the price for the sold electricity is at world market level.
- Those qualified personnel for operation and maintenance are or can be employed at the dairy farm.
- That biogas technology is adaptable in Egypt, and the project demonstrates that.
- That, the results from the project are communicated and perceived.

The assumption related to the short time development

objective is:

- That the biogas technology is accepted in Egypt and that it can and will be applied to a large extend
- That a major part of the employed and trained personnel continues to work at the farm

Recurrent Cost Implications:

Operation and maintenance of the plant as well as administration of the sale of fertilizer will result in expenses. These expenses are expected to be covered by revenue from the sale as well as by savings in electricity and other energy purchase.

Activities related to work-group sessions and seminars will also cause some expenses the first two years. These costs are included in the budget.

Further Studies:

- The possibilities of tailoring the technology to the Egyptian conditions should be examined.
- The desirable digestion process for the organic material requires heating.
- It is believed obvious that solar panels could supply much of this heat thereby increasing the efficiency of the process.
- It is also believed that electricity production, combined with biogas technologies may give the possibilities of using (waste) heat from the gas-engine for the heating of the Biomass.