Why what works – Doesn't

Barriers to adoption of *profitable* environmental technologies by municipalities, and policy solutions to overcome them

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Table of contents

ABSTRACT 3
1. INTRODUCTION 4
2. BACKGROUND 7
2.1 Environmental technologies and the energy paradox 7
2.1.1 What are environmental technologies 7
2.1.2 The saving potential from energy efficiency technologies 7
2.1.3 The energy paradox 8
2.2 Theoretical framework 9
2.3 The Swedish and Israeli energy contexts 11
2.3.1 Sweden 11
2.3.2 Israel 12
3. TECHNOLOGIES 14
3.1 Lighting 15
3.2 LED in traffic lights 17
3.3 Energy efficient appliances 18
3.4 Geothermal heat pumps 19
3.5 Heating, Ventilation and Air Conditioning (HVAC) 19
3.6 Water conservation 20
3.7 Transportation - cleaner fuels and fuel conservation 20
4. BARRIERS 22
5. FINANCING 27
5.1 Energy savings performance contracting (shared or guaranteed savings) 27
5.2 Intracting 28
5.3 Other financing options 28
6. POLICY 30
6.1 Policies relevant for central government 30
6.2 Policies relevant for local government 32
6.3 Why does is work better in Sweden? - Local governance in Sweden 33
7. DISCUSSION 35
8. SUMMARY AND CONCLUSIONS 42
REFERENCES 43

Abstract

Many environmental problems have to do with energy use, it is therefore very surprising that profitable opportunities to reduce energy consumption, awarding both economical and environmental benefits, are not more widely implemented. This paper lists examples of such technological opportunities, discusses the barriers to their adoption, and suggests policy solutions to overcome these barriers. The focus group for this research are municipalities as energy users, mainly in Israel and Sweden. The author concludes that increase use of environmental technologies is possible, many times with economic gains even in the short range. Municipalities alone cannot be expected to take upon themselves the risks and costs of adoption of these new technologies, and therefore central government has a crucial role in creating a supportive environment for such a process. The main barrier to such a development is conservatism of public officials and decision makers.

1. Introduction

Many of the environmental problems today have to do with energy use. There is a debate whether better efficiency is a satisfactory course of action, or whether what we really need is sufficiency[1]. What seems to be clear is that there is a huge saving potential in energy efficiency and some say that energy efficiency is the biggest 'clean energy' source currently available.

The 'energy chain' is composed of 4 major components leading from the generation facility to the end user: generation, transmission, distribution, end use. Better techniques for increased efficiency exist for all these components separately, that would lead to different rates of savings. This work, however, concentrates on the last stage – the end user, and specifically – municipalities. Indeed the UNDP 'Energy for Sustainable Development' report states that '[…]improved energy efficiency, especially at the point of end use […] can generally provide energy services more economically than improvements in generation or distribution' (Turkenburg, 2002, p.19).

There is increased awareness to the fact that organizations (as well as individuals) do not necessarily act rationally in decision making in relation to energy use. DeCanio notes that there is wide evidence for the existence of highly profitable energy saving opportunities, some of them showing rates of return well over 30% and have extremely low financial risk (DeCanio, 1998, and references therein). This phenomenon has been termed – 'the energy paradox'. In this work I will examine reasons for this paradox in municipalities, by looking at technologies that not only reduce environmental effects but also reduce spending and provide a payback period for the initial investment that is shorter than 2-3 years. The fact that there are technological opportunities in which the economic (and not the environmental) reason should have promoted their adoption, makes the energy paradox all the more noticeable. This is why these technologies were chosen as examples for this study.

A plethora of profitable environmental technologies exist. Most were not included in this work for lack of space or because they offered a payback period that was a bit longer than the one stated above. The lack of adoption is more apparent in situations where the major barrier **seems to be** the financial issue, or – lack of money for initial investment. I include here a chapter on financial mechanisms that can, and have been used to overcome this barrier. Lack of adoption of these technologies, despite the available financing possibilities, shows that other barriers, presented here, play a very important role in preventing large scale adoption of environmental technologies. This is why knowledge of the barriers such technologies have to face, will assist organizations and individuals trying to promote them, in better understanding the setting, and enable them to design a proper solution.

According to the UN World Energy Assessment, at the global level, only 37% of primary energy is converted to useful energy (two thirds is lost). Energy efficiency, therefore, is 'one of the main technological drivers of sustainable development world-wide' (Jochem, 2000). Energy conservation does not only mean money savings but also cleaner air, less acid rain, green house gases, production of radioactive waste, trade deficits for energy importing countries, etc. I do not try to propose environmental technologies as a magic solution to environmental problems: despite the great saving potential, technology alone cannot be a complete solution. In recent decades, rising efficiency has been outweighed by growth in demand (Camagni, Capello, Nijkamp, 1998). The rebound effect, for example, is a phenomena under which the reduced energy spending resulting

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1 See for example: Princen, T. (2003). Principles for sustainability: From cooperation and efficiency to sufficiency. *Global Environmental Politics,* 3,1,33-50

from energy efficiency allows customers to spend more on energy services, so that energy consumption at the end does not decline as would be expected initially. Many estimates exists regarding the magnitude of this phenomena (Greening, Greene, Difiglio, 2003; Reinhard and Biermayr, 2000, and references therein), but most researchers are unanimous that the way to curb it, is through the use of appropriate policy measures like energy taxes or rebates (Binswanger, 2001).

Aim

The purpose of this paper is to analyze the reasons for lack of adoption of profitable off-the-shelf environmental technologies, and suggest policy measures that should be taken by local and national governments in order to promote the use of these technologies.

The paper is looking into two countries – Sweden and Israel. After identifying possible barriers to environmental technologies in Israeli municipalities, I will use the Swedish experiences in designing a relatively successful atmosphere for adoption of such technologies, to suggest policy solutions that will fit the Israeli context, based on its own set of barriers and (lack of) energy planning infrastructure.

The overarching purpose of this paper is to point out that a paradigm change is possible; there actually *are* opportunities for environmental do-good that will not necessarily cost more money. In *The Structure of Scientific Revolutions*, Thomas Kuhn (1996) writes that a paradigm change happens when there is an accumulation of anomalies, that cannot be explained by the prevailing paradigm. I hope that the examples in this paper (technologies and municipalities that showed that profitable environmental initiatives do exist), can be regarded as proof for such anomalies, and serve as a step in the long needed and long sought paradigm change.

Structure of the paper and limits of the research

The working assumption while researching for this paper, an assumption that was later confirmed, was that most stakeholders are not aware of the barriers that prevent them from adopting these technologies and as a result cannot come up with a proper solution. Therefore, a literature review was conducted to collect a large number of barriers that have already been identified among municipalities and decision makers around the world. The following step was interviews held with different actors in the Swedish municipal and energy sectors with the purpose of increasing the collection of barriers that can be expected when trying to implement new environmental technologies. An additional purpose was to learn about the Swedish experiences in overcoming these barriers. This generated a list of policy responses that have been used, some effectively and some ineffectively. With these results, interviews were held with prominent figures in the Israeli national and local government. In most cases, and in correspondence with the working assumption stated above, the interviewees in Israel were unaware of many of the possible barriers, let alone the possible policy solutions. With the aid of the pre-collected list, it became possible to discuss the barriers and reach conclusions regarding the relevance of certain policy solutions (also pre-collected and presented in the interviews) in the Israeli energy and planning context.

The energy paradox exists for all users of energy – private users, companies, the public sector. Each sector has its own mechanisms and decision making processes regarding energy use. That implies different barriers to adoption of technologies and different potential solutions. The scope of the paper required focusing on just one of the sectors. I have chosen municipalities for several reasons:

- They are a major player in future energy conservation. One of the achievements of the Johannesburg Conference was in placing the responsibility for energy consumption management, among other things, on the local level (EU Penelope Project, 2003). Work is currently under way in EU bodies on transferring existing knowledge about energy management to the local level (EU Bacchus Project, 2002).
- They are a classic customer for environmental technologies - municipalities have a longer planning horizon than private people have and sometimes also than companies. Municipalities make large

infrastructure investments and they are less sensitive to issues of rates of return on investments. It therefore makes sense to see why they do not choose (profitable) environmentally friendly technologies for their infrastructure projects and general energy use.

Due to limits of time and scope, the research included only few municipalities in both countries, it also touched only several exemplary technologies, mainly for energy efficiency. As far as Israel is concerned, it was somewhat difficult to find high quality energy related material on Israel, mainly due to the lack of long term energy policy planning. Lastly, the evaluation of the relevance of the suggested policy solution to the Israeli context was done mainly by the use of interviews with relevant stakeholders. These interviewees, being human. could also be wrong.

Despite those limitations, the paper, I believe, makes a strong case for the existence of missed opportunities in the use of environmental technologies, and the possibility to act on them by knowledge of the barriers and introduction of relevant policy measures. It will become apparent, after reading this paper, that municipalities alone cannot create a market change, and a combination of measures, both on the local and the national level, should be used. The central government in Israel cannot continue to expect municipalities to lead the way in promotion of adoption of environmentally friendly technologies, even if they are profitable, and must implement some of the policies suggested in this paper.

2. Background

2.1 Environmental technologies and the energy paradox

2.1.1 What are environmental technologies

In this paper I will use a broad definition calling any technology that can provide current services, generate less environmental effects and still offer the same level of comfort to the user – an environmental technology. This can be applied to any field of human activity, although here the main focus will be on energy efficiency technologies.

It is of course very hard to determine the meaning of 'less environmental effect' (does nuclear technology which does not emit CO2 but generate hazardous wastes for future generations answer this definition?), especially when issues like LCA (Life Cycle Analysis) are included in the discussion. This paper, however, does not deal with this issue, and looks at barriers to these technologies, assuming it has already been established that they provide environmental benefits. The examples I will use here, are widely accepted as such.

2.1.2 The saving potential from energy efficiency technologies

There seems to be indeed a great saving potential in energy efficiency technologies. In the EU, buildings consume about 40% of total energy consumed and have a saving potential of over 20% (Stimmeder, 23 July 2003). In Sweden the potential for savings through end use efficiency differs of course from sector to sector, and depends on definitions used. While the 'overnight potential' (retrofits done before the end of the equipment's useful life) can generate 10% of savings, some sectors can generate, in the long run, savings of as much as 50 percent (Neij and Öfverholm, 2001).
In the USA, numerous studies have shown that between a quarter and a third of their current energy use can be replaced with cost-effective (positive cash flow) energy efficiency using currently available technology ('overnight potential') (Gilligan, 2002). A U.S Department of Energy study concluded that the US could reduce its projected energy use in 2020 by about 23 quadrillion Btu (25% of current energy use), with mainly voluntary programs (Interlaboratory working group, 2000). The Alliance to Save Energy projected in 2001 that "applying available energy efficiency technologies, primarily air conditioning, appliances and lighting can reduce the US DOE's (Department of Energy) forecast need for 1,300 new US power plants by more than half" (Alliance to Save Energy, 2001). Another organization (ACEEE) found in 1997 that "cost-effective energy efficient technologies could reduce projected electricity use in 2010 by 33% in the Mid-Atlantic region, while producing a net increase of about 164,000 jobs in the region" (Nadel, et al., 1997).

Savings potential is not limited to the industrial world. Manaus, Brazil is a rapidly growing city located in the heart of the Amazonian rainforest (1500 km of rainforest in all directions). Research found that on a technical basis (i.e., without political support for broader policy changes for reducing conventional energy use), about a **quarter** of conventional energy consumption can be cost-neutrally replaced with efficiency and renewable energies (Ashok, Gilberto, Ennio, & Leonardi, 1999).

Some reasons for engagement with energy efficiency, however, have less to do with the environment. It has been reported that improving energy efficiency often leads to other efficiency improvements in the organization - streamlined production process, reduced process waste, lower environmental compliance costs, increased equipment reliability, increased worker productivity and satisfaction (see below), minimization of operation and maintenance costs, etc. In addition, improving energy efficiency fuels economic growth: many more people are employed through the manufacture, installation, and maintenance of energy efficient equipment and processes than through the production of power and the extraction and production of fossil fuels (Sherry, 2003).

The Rocky Mountain Institute have tried to quantify increases in worker productivity and reported that in the cases studies examined by them, it increased by 6% to 15% after energy-efficient technologies were incorporated into the workplace (ibid.) The U.S. EPA (Environmental Protection Agency) estimates that increased productivity can result in revenues ten times higher than the energy costs savings. For an investor that is also the owner, EPA estimates that every 1$ invested in energy upgrades yields 2-3$ in increased asset value of the building (Thorne and Nadel, 2003a). In leased properties, improved lighting can increase the investor's bottom line by reducing vacancy rates, lowering operating and maintenance costs, and enhancing lease rates. The benefits can be significant – studies show that tenant turnover is an expensive cost generator for landlords, costing as much as 30 to 40% of the 5 year lease value of office space (Thorne and Nadel, 2003b). For companies, in cases where energy efficiency improvement have synergetic benefits on other aspects of the environmental performance of the company, integrating those non energy benefits into project assessment can increase the economic value of a project by a factor of two to three (Sherry, 2003).
Energy efficiency can generate social benefits as well. If we take the example of house weatherisation (e.g.: sealing unnecessary openings to reduce air infiltration, installing attic, wall, and floor insulation, wrapping water heaters and pipes with insulating material) besides benefits for the utility, we can find benefits for the households as well: increases in property value, increased safety, health and comfort, increased number of jobs, are some examples (Schweitzer and Tonn, 2002).

2.1.3 The energy paradox

Integrating 'sustainable' or 'green' building practices into the construction of state buildings is a solid financial investment. In a comprehensive analysis of the financial costs and benefits of green building, a report to California's sustainable building task force, finds that an upfront investment of less than two percent of construction costs yields life cycle savings of over ten times the initial investment. For example, an initial upfront investment of up to $100,000 to incorporate green building features into a $5 million project would result in a savings of at least $1 million over the life of the building, assumed conservatively to be 20 years (roughly the average between envelope and equipment expected life) (Kats, Alevantis, Berman, Mills, & Perlman, 2003). So why are buildings still built with very poor energy efficiency characteristics? DeCanio notes that there is wide evidence for the existence of highly profitable energy saving opportunities for both consumers and firms, some of them showing rates of return well over 30% and have extremely low financial risk (DeCanio, 1998 and references therein). If we follow an economic rationality line of thinking, we would expect organizations to try to cut energy costs. The phenomena at the bases of the fact that these technologies are only partially adopted has been named the 'energy paradox' or the 'efficiency gap' and has been the subject of rich discussions in the past 30 years (DeCanio, 1998; Weber, 1997, and references therein). Levine et al., (1994) define the efficiency gap as: 'the difference between the sum of energy savings that have a positive net present value and the energy efficiency measures which are actually implemented'.
Many researchers (mainly economists) have tried to explain the energy paradox, saying that profitable energy efficiency projects do not really exist. One reason they suggest stems from the profit maximization theory, saying that firms look for the most profitable option always, and therefore if energy efficiency could generate profits it would have already been implemented. DeCanio (1998) answers this by saying that if profit maximization was an automatic process than there would be no premium returns for better entrepreneurial skills or better management. Since management operate in an imperfect market, they cannot possibly always find the most profitable option. Another argument trying to explain the energy paradox says that these failures in choosing the right option are only apparent because transaction costs and other hidden costs reduce the seemingly high returns that can be realized from energy saving investments. I will address the issue of transaction costs further into the paper. A third argument attacks the issue from another angle, saying that even if such neglected opportunities exist, they should not be the focus of decision makers in companies or organizations because than they might miss even bigger opportunities for profit maximization that currently still escape them. They propose that social policy had better concern itself with improving profitability by controlling other, cost factors, like health care or personnel expenditures. This claim, of course, disregards the

environmental and health improvements that go hand in hand with reduction in energy use, improvements that currently cannot be accurately quantified, but that nonetheless exist.

In Praetorius and Bleyl's study (2003), one can find that the theoretical framework of New Institutional Economics (NIE) tries to explain the efficiency gap by maintaining that market results have to be examined in the context of the surrounding institutions and as a consequence of transaction costs. Institutional economists will note that current markets have incomplete information and uncertainty, and that there are costs for companies and consumers which are not immediately reflected in market prices. They then identify the following barriers for energy efficiency:

- Informational barriers: price of information, its accessibility, the ability of decision makers to get it on time, understand it, and trust it. Uncertainty about the actual future savings will lead to a decision to stay with the current (inefficient) technology.
- Financial barriers: the lack of capital to buy new energy-efficient equipment or make the required retrofits. Even if the payback period is very short, the organization needs to meet the up-front costs for the equipment at the beginning and some cannot afford it.
- Technological barriers and infrastructure: efficient technologies that may not be available everywhere or function similarly in different environments.
- Bounded rationality: decision makers, in the professional positions as well as in their private lives, don't always behave perfectly rationally in the sense of economic theory. They may prefer to take a satisfying rather than a theoretically optimal decision.

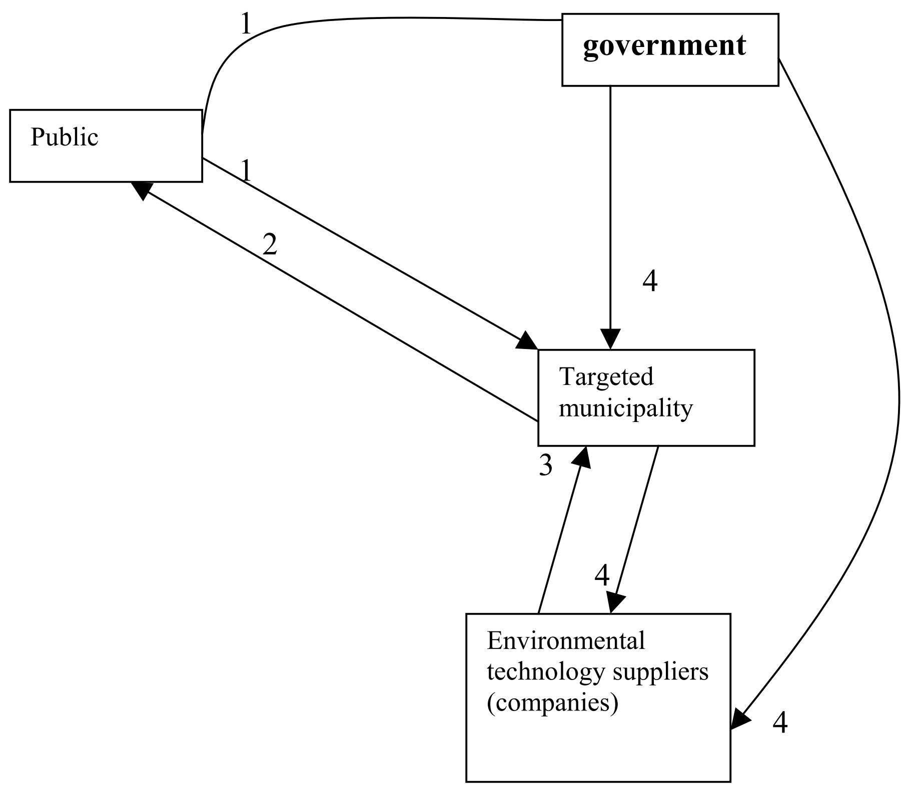
I will treat these, and other barriers further in the barriers chapter.

Many in the EU believe that the local development experts responsible for the innovative actions at local level, are in general unaware of the potentialities of clean energy technologies for the creation of new enterprises, job creation, and other sound local initiatives. This lack of knowledge presents a problem since a lot of EU resources are managed at regional and local levels. There is a gap between the replication potential of the available DG TREN (Directorate General, Energy and Transport) expertise and the existing DG TREN resources for implementation. Therefore the EU has initiated a project to search for ways to bridge the gap between the expertise of energy experts and the knowledge of local development experts (EU Bacchus Project, 2002). According to Bacchus project coordinator (Bacchus is an EU project intended to increase the capacity of the regions to develop projects financed by the Structural Funds in the fields of energy efficiency and renewable energy sources) all working groups working on the project came to the same conclusion regarding the existence of this gap. The coordinator says that development expert do not believe that sustainable energy may have any positive impact on economy, and energy expert do not have any idea on how to calculate development impact from an energy project (Antinucci, 2003).

2.2 Theoretical framework

The issue of adoption of environmental technologies has a very wide scope and includes very many stakeholders. Figure 1 describes the current situation and relationships between the major stakeholders in Israel. Figure 2, at the end of the paper, describes the improved, recommended situation, in which many more stakeholders are involved and contribute to adoption of environmental technologies through the use of policy measures or specific activities. Even a visual comparison between the two figures can show how far from the recommended condition, Israel currently is.

Figure 1: Theoretical framework – current situation



Additional stakeholders which have an effect on the barriers and solutions to adoption of energy efficiency technologies by municipalities:

- utilities
- Other municipalities
- NGOs, Energy consultants, architects, engineers
- Retailers, distributors
- Building owners and contractors
- Financing institutions

Arrow numbers:
1 – vote
2 – receive services
3 – technology suppliers
4 – regulations, standards setting

2.3 The Swedish and Israeli energy contexts

Sweden is used in this paper as an example of a relatively successful implementation of projects and policy that promotes energy efficiency. Before trying to understand the barriers that exist in both countries and the aspects of the Swedish energy sector that are enabling in many cases the adoption of energy efficient technologies, it would be beneficial to describe shortly the surrounding contexts and take a quick historical look at the development of energy policy in Sweden. The summary on Sweden is based on the book 'Building sustainable energy systems – Swedish experiences' (Silveira, 2001).

2.3.1 Sweden

2.3.1.1 Short history

After WW II, security concerns ranked very high on the agenda in Sweden, and the dependence on imported fuel became an issue of concern. In the 1960s the environmental aspect entered the political debate and added to the opposition to fossil fuels. On this background, the oil crisis of the 70s mainly served to confirm opinions about the need to use energy more efficiently. After the oil crisis Sweden started a government funded energy research program to increase energy efficiency, a program which became the second largest sectorial R&D program in the country. Later in that decade the issue of acid rain appeared on the public debate, as Swedish soils were particularly sensitive to acid rain effects. Most of the pollution came and is still coming from neighboring countries and therefore Sweden has been very active in promoting international agreements on emission reductions of certain gases and has done very well in reducing those emissions from its own territory. Sweden has been a forerunner in innovative policies designed to achieve better energy efficiency and thus reduced emissions. One such policy was green taxing – Sweden introduced tax on CO_2 emissions in the 90s, one of the first countries in the world to do so. 1996 saw the opening of the electricity market in Sweden for competition, a move that resulted in fast structural changes that included reduction in electricity prices. Sweden has one of the lowest prices of electricity among the OECD countries, and that is actually a barrier to introducing energy conservation technologies or, for that matter, renewable energy sources. That said, it is important to note that this trend has changes lately (since 2001) as electricity prices have been increasing sharply - between 40-50% in relation to January 1997 prices for household consumers (Statistics Sweden, 2003a), and around 10% for most industrial consumers (Statistics Sweden, 2003b).

2.3.1.2 Current situation

Nowadays, the switch to sustainable energy system is the most important item on the political agenda regarding energy issues with the main focus being phasing out of nuclear power and moving towards greater share of renewable energies.

It might be interesting to note that Sweden's ratification of the Kyoto protocol actually plays against the supporters of reduced energy use and reduced emissions in Sweden, since it allows the country to *increase* its emissions. Some politicians actually find it a barrier to promotion of climate friendly technologies (Tingvar, 1 august 2003).

2.3.1.3 Municipal energy policy

In Sweden, municipal energy-planning has been a part of the energy policy for more than three decades. In 1977, the Swedish government passed a law that encouraged municipalities to develop energy plans of their own. After the oil crisis of 1979, a requirement for a complementary municipal oil-reduction plan was imposed on the municipalities that were expected to convert local energy-systems from oil-based systems to alternative energy sources and use more efficient energy technologies. At the time nuclear-power plants were seen as an effective and important replacement for fossil fuels. In the mid-1980s, the Swedish government proposed a new bill that attempted to minimize oil dependency and that removed the requirement for a separate oil reduction plan. This bill was influenced by the intentions to phase-out nuclear power. Another very important aspect of that bill was the stress it put on municipalities rather the state, to integrate energy planning in their strategic processes. (Nilsson and Mårtensson, 2003) Today, every municipality in Sweden has to employ an energy efficiency consultant (they are subsidized by the government), mainly to answer questions from citizens regarding efficiency in their homes (Hackman, 14 august 2003).

Environmental policy in Sweden has a strong reliance on the municipal level. Municipal autonomy includes rights to levy taxes on the citizens and to develop local policies within most sector areas (Eckerberg, Forsberg, Wickenberg, 1998, p. 46), but still, Swedish municipalities are required to include environmental concerns in all their activities as a result of the government's environmental policy. All municipalities in Sweden implement Agenda 21 at a local level (Swedish Association of Local Authorities, 2002) and already in the end of 1996 about half of the municipalities had employed local agenda 21 coordinators. (ibid.)

2.3.2 Israel

It has been somewhat difficult to obtain high quality energy related research material in Israel. Most documents relate mainly to technological R&D, and not to the actual practical issues of implementing an energy policy. As will be explained later, Israel still has no long term national planning horizon on energy and environmental issues, not even on the academic level. This is particularly interesting since the political surrounding should have enforced Israel to strive for energy independence and maximal use of renewable energies, mainly - the abundant solar radiation. Regretfully, Israel bases its energy supply mainly on imported (fossil) fuels with the related inefficiencies and costs (also to national security) involved with energy import (Israeli Ministry of National Infrastructures, 2001a). This condition, however, can also be seen as an opportunity for increased investments in energy efficiency and renewable energy, since the need can push innovation and willingness among decision makers.

In addition to not having a national plan, Israel suffers from a twisted system of subsidies preserving the current system and preventing the use of the true cost of energy in electricity or energy pricing. It is not translating its leadership in energy technology R&D, specifically on solar and water desalinisation technologies, into market leadership or even to national implementation (Zaslavski, 1992).

While Sweden has seen several stages in the development of a national energy plan, Israel has only recently started a truly serious initiative of developing a strategic plan for the management of the energy sector (Arnon, 7 September 2003). Until now the governing bodies (Ministry of Energy which later became the Ministry of National Infrastructures) have mainly dealt (poorly, one might add) with promotion of R&D, while the issues of energy efficiency was dealt with by a small, budget less unit - the department of infrastructure resource management (formerly 'department for energy conservation') in the National Infrastructure Ministry. This department is the main governmental body in charge of energy conservation. Despite a record of successes, the budget for this department is continuously declining (from 2.48 million USD in 1986 to 0.07 million USD in 1999) and can serve as another proof of the lack of far sighted policy on energy issues in Israel (Ben-Dov, 1999). Israel does not have an established infrastructure planning authority which would operate on a systemic approach to energy, water, transportation, etc. One of the roles of such authority would be increasing R&D in the energy sphere (Zaslavski, 1992).

Energy conservation regulations in Israel are only at the beginning; for example - only in 1994 were the 'supervision on the efficiency of energy consumption' regulations put into force, demanding industry to nominate an energy supervisor in every factory (Israeli Ministry of National Infrastructures, 1993). Before then, industries were only encouraged to conserve energy. Israel currently has no form of green taxation (and according to the director of the economic department in the Ministry of Environment – will not have in the near future) (Arnon, 7 September 2003).

2.3.2.1 Current trends in Israel's energy policy

Current energy policy calls for increase use of natural gas, increased efficiency of power stations through a switch to cleaner fuels, encouraging commercialisation of clean energy production, exploiting available renewable energy options, and reducing loss of energy in transport. Efforts to promote energy efficiency in households sum up to an advisory office in the Ministry of National Infrastructures for people to call in and get advice. The ministry also supports demonstration projects for energy conservation, conducts workshops for energy professionals, and publishes information papers (Israeli Ministry of National Infrastructures, 2001d).

Israel 'enjoys' an electricity generation monopoly of the Israeli Electric Company. It is one of the strongest actors in the Israeli market and fights successfully any attempt to change the status quo. The electricity company is doing very little as far as education campaigns to educate consumers on energy efficiency, and utility offered rebates are not even on the public debate. It is the opinion of some of the interviewees for this paper, that the electricity company has a very strong interest in building new generation facilities to answer increases in demands, instead of promoting energy efficiency (Arnon, 7 September 2003, Shachnay, 9 September 2003).
Perhaps some understanding regarding the reasons for Israel's conduct with no forward looking energy policy can be gleaned from the words of the environmental ministry in a report to the COP (Conference of Parties) on climate change: 'Israel is still evolving…and has not yet reached the stability necessary for embarking on a clear course of social, demographic and economic development…The demographic instability makes it difficult to use future scenarios…Uncertainties exists regarding economic development and the future directions of industry…' (Israeli Ministry of National Infrastructures, 2001d)

2.3.2.2 Energy in the municipal context

Besides a regulation demanding that each municipality has a person in charge of energy issues, municipalities in Israel have no forward looking energy policy. There are sporadic attempts that include introduction of green building techniques for energy conservation or improved public lighting, but they are mainly pushed by concerned individuals and not by established policy (Olander, 1 September 2003).

The above description is meant to show that energy policy in Israel did not follow the same steps as in Sweden, and still has a long way to go. It is important to remember this fact when discussing barriers for dissemination of energy efficiency technologies in municipalities. Despite the fact that this work does not analyse the energy markets of these two countries it is important to be aware of the context it which their municipalities are operating.

It has been claimed that, at least in the USA, the constraint on energy improvements in the short term is not primarily technological, but insufficient implementation of existing technologies (Carlsmith, Chandler, McMahon, & Santino, 1990). In the next chapter I will review some of these technologies, that can provide the needed energy improvements, in a cost-effective way.

3. Technologies

So, are there or aren't there 'free lunches'? are there really some magic technologies that can be bought, implemented, and would generate environmental and economic savings? As simplistic as it may sound to answer 'yes' to this question, the purpose of this chapter is to expose the reader to some technologies that promise to do just that, and describe where and how they were implemented to give the promised savings. It is important to remember, though, that each case is unique, and not necessarily each technology that is described here can be copied to any other place. There are rare examples of a technology that fits all situations and can be always environmentally and economically profitable. In each case, the choice of the appropriate measure depends on local and initial conditions. Even if better insulation can usually be responsible for significant savings, new buildings that are relatively better insulated will enjoy greater savings from installation of better heat pumps or air conditioning systems for example. In other words, no direct correlation has been established between different types of measures and the economic outcome in each case. Local conditions (electricity cost, building design, codes and standards etc.) can often differ substantially between one project and another and thus render a technology that would otherwise be economic, unsuccessful (Aronsson, 1991, p.6).
There exists, nonetheless, a plethora of examples of technologies and systems that are environmentally superior to existing solutions and that can pay for themselves after very short periods of time (sometimes even immediately). They represent, in my opinion, a wide enough 'basis of evidence' that can suggest that with some innovative thinking and awareness to the possibilities that exist, profitable green solutions **can** be found.

I will describe here several technologies that are considered by most as having big potential for giving economic savings and environmental improvements. These technologies are: lighting, LED for traffic lights, energy efficient appliances, geothermal heat pumps, heating, ventilation and air conditioning, water conservation, cleaner fuels and fuel conservation. I will also include case studies describing successful implementations of these technologies.

The definition of an 'environmentally successful' technology depends on the borders of the system being examined. An interesting example was presented to me by Jonas Gräslund of Skanska (a Swedish construction-related services and project development company) (Gräslund, 15 august 2003): a heat pump is considered a good solution by many, mainly due to the compelling idea of using one unit of electricity to move 2.5 units of heat from the earth and transferring them indoors for heating. However, if one expands one's system boundaries and looks at the way the electricity used by the heat pump is generated, one might discover that it is an old coal plant that works in efficiencies of less than 40%[2]. In this case, you get in total an efficiency of less than 1 (40%*2.5=1), and therefore it would actually be better to use an oil burner, that works in efficiency of close to 1, *in the house*.
As DeCanio (1993) shows, one example for the availability of profitable saving potential is the American EPA "Green Lights" program in which companies participating in the program examine every aspect of their electricity consumption and receive in return advice on energy efficient technologies. Follow up checks that the EPA did on those companies showed that around 80% of the projects had payback period of two years or less. The technical possibility of improving energy efficiency and saving money was there, yet these projects were implemented only after firms started the cooperation with the EPA. For some reason these firms did not act upon this opportunity before the program started.

[2] The efficiency percentage is a way to tell how much of the fuel is being turned into a form of energy. The higher the number – the less fuel is used to generate the same amount of energy.

The Technologies

3.1 Lighting

(Prices quoted here are for year 1998)
One of the areas where the biggest potential lies, is lighting in commercial buildings. In the USA alone, approximately 2.785 quads (1 quad = 2.931×10^{11} kWh) of energy are used each year for that purpose. Table 1 presents an example of the saving potential.

Table 1: Saving potential from energy efficient lighting

	Lamps	Ballasts	Energy consumption (average, kWh/year)	Cost (purchasing and installing in USD)
Current technology (typical)	Four 40W T12 lamps	Two energy efficient magnetic ballasts	522	81.60
Suggested technology	Three 32W T8 lamps	One electronic, instant-start ballast	307	63.80

Source: Alliance to Save Energy, 1998

In this case, as is evident from the table, the incremental equipment cost is a **negative** (or a **saving** of) $622 million (if all such lighting devices in the USA were to be upgraded). In addition, 0.8 quads of energy will be saved in 2010, equivalent to $5.8 billion savings in energy costs. Carbon emissions would be reduced by 20.6 million tons and the cost per ton carbon saved would be a negative $285 (including the equipment and energy savings) (Alliance to Save Energy, 1998).
It is interesting to note that according to the Alliance to Save Energy, about 70% of the total stock of existing lighting devices could (technically) be upgraded to the more efficient system (data for 1998).[3]

Fluorescent Lighting
Fluorescent lamps light more than 75% of the commercial space in the USA. Lamps with electronic ballasts use 12% to 25% less electricity than with magnetic ones, make up to 75% less noise, and produce virtually no flicker. T-8 lamp and electronic ballast systems produce comparable light levels to T-12 systems while using 30% to 40% less energy. Compared to an incandescent, a CFL (Compact Fluorescent Lamp) lasts up to ten times longer and uses 75% less energy while producing the same amount of light (Sherry, 2003).

High-Intensity Discharge Lamps
High-intensity discharge (HID) lamps were developed for outdoor and industrial use, but are also used in office, retail, and other locations. HID lamps have several distinct advantages for certain applications, including long life, high light output, and relatively small size. HID lamp's main limitations are the long time required for warm up and long waiting period prior to restart. These limitations are non-barriers for outdoor municipal use for street lighting, which raises again the question – why aren't they used, at least by these institutions (ibid.)

[3] For technical descriptions and table describing lighting technologies and how much energy they can save see: www.aceee.org/pubs/a032full.pdf

Following are some short descriptions of energy saving implementations in Europe. Although not all the examples are of projects implemented by municipalities, the technology itself is the important element, and there should be no problem for municipalities as well to implement the same technology.
It is important to note that the payback periods stated here are the simple payback calculation, meaning they take into account only the saving generated through reduction in energy use. An inclusion of life cycle cost analysis incorporating maintenance, waste handling, scraping as well as other life cycle costs, would actually result in even shorter payback periods.

Box 1: lighting implementation examples (Source: EU Penelope-Bacchus, 2003)
Place: Barajas Airport, Madrid
Technology: installation of flux dimmers
Benefits: electricity reduction: 1135 MWh/year, energy cost savings of 48,000 €/year,
Simple payback period: 3.2 years

Place: SAS technical base, Norway
Technology: tuning of existing bus system
Benefits: reduction of lighting electricity by 30%
Simple payback period: 0.4 year

Place: COOP Italia (supermarket chain), city of Montecatini
Technology: change of luminaries to 55W fluorescent lamps, electronic ballasts, specular reflectors (90% reflectivity), double switch-on, and sometimes daylight responsive lighting control systems.):
benefits: Lighting electricity savings: 238 MWh/year. Energy cost savings: 26,000 €/year
simple payback period: 3 years

Place: Sassari, Italy
Technology: Centralised dimming system.
Benefits: Easier maintenance, savings of 1800 MWh/year, reduction of electricity use by 30% which translates to a saving of 172,000 €/year.
Simple payback time: 3 years.

Place: Salzburg, Austria
Technology: substituted 1069 mercury lamps with metal halide lamps and installed control systems.
Benefits: Reduction in energy consumption by 50% which translates to savings of 60,000 €/year.

Place: Hamburg, Germany.
Technology: substituted fluorescent lamps with sodium lamps in tunnels.
Benefits: reduction in energy consumption of 72%, Saved 1M kWh/year which translates to a saving of 82,000 €/year.
(Source: Bertoldi, 2003)

Place: San Jose, USA
Technology: replacement of mercury vapour lamps in all its streetlights with low-pressure sodium fixtures that use half the electricity.
Benefits: a saving of 1.5 million $/year. (Hart, 1992)

Place: city of Brasov, Romania
Technology: upgrading of public lighting.

Benefits: energy saving of 25% of annual consumption, amounting to 2004 MWh/year. 163,000 €/year energy costs savings plus 70,000 €/year maintenance costs reduction. The assurance of a comfortable luminous exterior environment for traffic and pedestrians, less light pollution, elimination of mercury from lamps.
Simple payback period: 2.15 years

3.2 LED in traffic lights

LEDs (Light Emitting Diode) are semiconductor devices that consist of a layer of electron rich material separated by a junction from a layer of electron deficient material, both sitting on a semiconductor base. When power is applied in the junction between the electron source and sink, it excites the electrons. As they return to steady state, photons of light are generated at distinct wavelengths (i.e., colors of light) which depend on the chemical composition of the dye. The die is then packaged in a form suitable for use in traffic signals. Typically a single die may be combined with a reflector to focus the light and a clear epoxy lens to protect the die. Anywhere from 120 to 600 of these "lamps" may be packaged in an array for use in a traffic signal head (Suozzo, 1998).
In the USA, an estimated 3 billion kWh in electricity could be saved annually by replacing incandescent traffic signals with LED signals.[4] 70 % of the savings could be derived from switching out red signals alone. Typical red LED balls and arrows use 90 to 95 % less power than the 150 W incandescent light source that they replace. In the USA many utilities either had or currently have rebate programs in place or offer financing for LED traffic signal retrofits (ibid.)
The fact that nor the Israeli electric company nor the government offer any assistance is a major barrier to the adoption of this technology in Israel. The Swedish government did offer assistance for LED adoption in the city of Stockholm. According to Lars Söder of the Stockholm Street Department, this was one of the biggest success factors for this project in Stockholm (Söder, 3 October 2003).

Several cities and states in the USA have estimated the payback period for LED traffic signal heads. The results varied widely on the scale of 1-7 years. The actual payback period will be a function of the utility energy cost, the actual cost of the unit, and possible financial incentives offered by utility or government organizations (Bullough, Huang, Conway, 2003).

Some other benefits besides energy savings are improved visibility and reliability (far longer service life and lower maintenance costs than traditional lamps). Moreover, LEDs can be economically powered by photovoltaics with backup batteries, to ensure availability during periods of power outages (Mills, 2003). Reduced emergency maintenance costs and liability associated with less frequent lamp burn out are some other non-energy benefits (Suozzo, 1998).

European cities have adopted this technology enthusiastically and LED traffic lights can be found today in many of them with the leading being Sweden and France. (IDAE, 2002) A typical incandescent bulb for traffic signals costs a few dollars, LED signal retrofit kits cost around $110 (Nellemose, 2003; Suozzo, 1998) but as mentioned before, payback period is relatively short (see table 2 below). Many municipalities that have retrofitted their red signals have also shifted from a yearly relamping schedule to a two-year relamping cycle, cutting their major maintenance expenditure in half (Suozzo, 1998).

Cost of green signals has also come down from more than 400$ to 110$. Maximum benefits for municipalities can be gained when they are purchased together with red LEDs since this constellation allows maximum

[4] The source contains a detailed breakdown of the projected savings

exploitation of maintenance savings (if there is no incandescent bulb on the traffic light, the relamping cycle can be longer). (Suozzo, 1998) In Israel, the ministry of transportation demands that all bulbs on a traffic light be of the same type, therefore municipalities that will want to purchase LEDs will have to buy the red, yellow and green together (Biremboim, 2003), thus enjoying the maximal maintenance savings.

Table 2 summarizes payback estimates and the cost of saved energy from retrofitting red, green, and both balls and arrows signals. Since 2003 prices of LED lamps are even lower than showed in the table, the current payback periods are probably even shorter.[5]

Table 2: LED signals energy and cost savings

	12 inch ball		12 inch arrow	
Signal type	**Red ball**	**Green ball**	**Red arrow**	**Green arrow**
Cost (USD)	150	150	75	150
Energy saving (kWh/year)	650	460	1112	121
Annual energy cost saving ($/year/signal) @ USD 0.08 per kWh	52	37	89	10
Annual additional cost saving ($/year/signal) reduced maintenance etc.	10	10	10	10
Simple payback (years) @USD 0.08 per kWh (discount rate 6%)	2.42	3.21	0.76	7.62

Source: Suozzo, 1998

3.3 Energy efficient appliances

A big potential for economic energy conservation lies in energy consuming appliances. According to Weizsäcker, Lovins, Lovins, (1997, p. 30-32) , about 30-50% of the electricity in most industrialised countries runs appliances (including household lighting, hot water and ventilation). Weizsäcker, et al. (1997, p. 30-32) provide over 2 pages of descriptions of various opportunities for Denmark, an already relatively efficient country, to quadruple the efficiency of typical household equipment.

Researches have shown that energy efficient appliances are not necessarily more expensive than inefficient models. In one example looking at refrigerators in Sweden, the research found that the most efficient model costs less per liter than some other models (Weizsäcker, et al., 1997, p.151). The same absence of correlation has been established for air conditioners, industrial electric motors, and industrial pumps. According to the authors, similar results can be shown for most major household appliances, from washing machines to stoves and from freezers to televisions (ibid.) This suggests that resource efficiency does not always cost more to achieve.

One of the barriers to wide adoption of energy efficiency appliances is the difficulty to find them or to know of their efficiency quality. In the USA, this problem was dealt with by the use of the “Energy Star Product Labeling”: products that bear the Energy Star label meet or exceed the energy efficiency program standards set by the U.S. Department of Energy and the U.S. Environmental Protection Agency, which exceed minimum national efficiency standards (Sherry, 2003).

A Danish refrigerator company developed a fridge-freezer that uses 30% less energy than its regular equivalents currently on the market. It also uses the environmental friendly ‘Isobutane’ as a refrigerant instead of the ozone

[5] For a description of dozens of successful LED case studies in the USA and other places in the world, see http://www.cee1.org/gov/led/led-case-main.php3

depleting CFCs or HFCs. The refrigerator's price is 5-6% above that of an ordinary model of the same size, which will be offset by energy savings within about two years. (Centre for the Analysis and Dissemination of Demonstrated Energy Technologies, 2003b)

3.4 Geothermal heat pumps

Geothermal Heat Pumps (GHP) use the Earth as a heat sink in the summer and a heat source in the winter, and use pipes to transfer heat from the warmer earth to the building in the winter, and discharge building heat into the cooler ground in summer (U.S Department of Energy, 1998).

GHP can provide an energy-efficient way to heat and cool houses or buildings. The can be installed virtually anywhere and according to the American EPA they are 'the most energy efficient, environmentally clean, and cost-effective space conditioning systems available'. (ibid.) In commercial buildings, new designs of GHPs are very competitive and offer lower energy and maintenance costs, aesthetic advantages, quiet operation, free or reduced-cost hot water, improved comfort, and a host of other benefits (ibid.)

GHPs use 25-50% less electricity than conventional heating or cooling systems. On average underground piping carries warranties of 25 to 50 years, and the GHPs often last 20 years or more. They can even be financed using a mortgage that creates positive cash flow from the start (if, for example, the installation adds $25 to the monthly mortgage payment, it is not impossible that the GHP will save more than $30 per month in energy costs and thus create a positive money flow from day one). On average payback times have been found to be in the range of 2-10 years in residential houses (ibid.)

There are of course also problems with the use of heat pumps. In the past, most of them used ozone depleting gases as refrigerants. These have been replaced with less damaging gases, but the effect still exists, even if smaller. In addition, one can still find old heat pumps that use forbidden gases. The recovery of the gases in a heat pump is costly and should be done by a certified technician. Oversized heat pumps increase energy use, reduce humidity removal, and shorten product life, therefore it is important to know how to buy an appropriate pump. Heat pump may have too long payback period (when compared to gas or oil furnaces) and it depends on utility costs and the local climate (Federal Energy Management Program, n.d)

Box 2: Geo Heat-pump - Implementation example:
Place: hotel in Sandhamn , Stockholm archipelago
Technology: an energy efficient heating and cooling system using a heat pump. During the warm period of the year the outdoor air and the cooling system is the heat source for the system. When it gets colder the exhaust gases from the furnace is added to the system. Even during the coldest periods the system can produce enough heat and cooling for the establishment.
Benefits: the entire system that was installed in the hotel saves 389 MWh/year. By reducing the exhaust gas temperature bigger energy loss is prevented. The exhaust gas, containing Sulphur and particles is cleaned, and fuel consumption is reduces by 30-50% leading to a reduction of CO_2 emissions in the same amount.
Simple payback period: 3.8 years.
(CADDET Infostore, 2000)

3.5 Heating, Ventilation and Air Conditioning (HVAC)

Heating, ventilation, and air conditioning is responsible for more than half of energy use in commercial buildings. Despite the complex design process required in order to create a good system, proper design, sizing, and installation will result in lower building capital costs and reduced operating costs, as well as increased occupant comfort. (Sherry, 2003)

Energize America Education Institute is a partnership between committed energy and electrical professionals and manufacturers in the energy management industry. According to them, old and inefficient HVAC, motors and drives can waste as much as 25% of the electricity supplied to them. Upgrading chillers, water pumps, fan systems and compressors typically yields a 25% return on investment after a three to four year payback period.

in addition to reducing energy costs, energy-efficient motors have service lives up to 13 times greater than standard products, resulting in long-term savings in maintenance and replacement costs (Energize America, n.d)

Box 3: HVAC - Implementation example:
Place: residential building for the elderly, Oxfordshire, UK.
Technology: a low NO_x condensing boiler instead of a previous heating system consisted of a dual fired oil/gas boiler for space heating and domestic hot water.
Benefits: the low NO_x burners were around 5% more combustion efficient than the conventional types and produced emission levels which met the strictest European requirements (in Switzerland and Germany). The new equipment also resulted in considerable fuel cost savings. Energy savings of around 240 MWh/year constituting 29% reduction in consumption were achieved.
Payback period: 1 year.
(CADDET Infostore, 1996)

3.6 Water conservation

The water sector also gives some opportunities for conservation projects with short payback time. An illustrative example would be the waterless urinals and flow regulators.

Flow regulators
A flow regulator is a component which maintains a constant flow rate, independent of line pressure. They can save about 50% of the water without any loss of comfort, reduce energy cost to heat water, and offer a payback period of 2-4 months (depending on local water costs and water usage). Flow regulators have been implemented in countless locations both in the residential sector and the commercial sector all around the world (Carmy, 15 September 2003)

Waterless urinals
Waterless urinals function on gravity flow and use absolutely no water. They connect to standard drain lines, offer an odourless restroom environment, better hygiene (bacteria that require water to live in cannot develop there), reduced maintenance and water costs savings (one urinal can save up to 150,000 litres of water a year). Payback periods are between 1-3 years (depending on local water costs and water usage). Waterless urinals have been implemented in countless locations in commercial sector all around the world. (ibid.)

San Jose municipality in California, distributed free low-flow shower heads and other water conservation devices throughout the city. The inflow to the sewer plant declined, helping to buy time for needed improvements. The city was also planning an incentive program for installation of low-volume toilets. The resulting savings to homeowners are estimated at $200 per year in addition to saving the city some $68 million in wastewater treatment facilities. (Hart, 1992)

3.7 Transportation - cleaner fuels and fuel conservation

cost effective conservation technologies exist also in the transportation sector.

Box 4: Transportation - implementation examples:
Place: an airport shuttle service operating out of London, Ontari, Canada.
Technology: propane as fuel.
Benefits: fuel-cost savings of about CAD 30,000 (USD 22,500) per vehicle, lower maintenance costs, excellent vehicle performance. Propane allows driving for longer distances without refuelling (which means that drivers can always refuel at the company's depot, rather than buying more expensive fuel at retail stations). Propane requires less space for fuel storage tanks, which is important for shuttle vehicles that need to carry luggage.

Propane is a cleaner fuel than gasoline. It should be noted that propane conversion is economically mainly for vehicles that run on long routes.
Payback period: 6-8 months, depending on the rebate given by the government for the conversion (8 months is the payback period without rebates) (Natural Resources Canada, 2003a)

Place: City of Edmonton, Canada
Technology: driver training program for vehicles operated by the municipality in order to reduce fuel consumption and emissions. The program teaches fuel-efficient and safe driving techniques to drivers through a four-hour course - two hours in the classroom and two hours on the road. Drivers are taught to reduce idling, plan more efficient routes and drive defensively. These skills, when retained and used over the long term, result in significant cost savings for the city. Environmental benefits take the form of reduced emissions of greenhouse gases and other pollutants. Drivers that have taken the course improved 'their' fuel efficiency by as much as 40% and they apply the techniques to their leisure driving as well. City officials estimate that individual drivers can save at least 300 litres of fuel per year by using fuel-efficient driving practices in their own vehicles - and even more if they can encourage others in the household to do the same. Each litre of gasoline saved prevents 2.4 kilograms of carbon dioxide from entering the atmosphere.
Economic benefits: In the first year alone, the driver training program has saved the city an estimated CAD 600,000 (USD 450,000) which represent a saving of about 1.2 million litres of fuel. Even more savings are anticipated down the road when the program is implemented in Edmonton's transit system. (Natural Resources Canada, 2003b)

Summary

Working technologies that have been implemented, that are economically profitable and that represent major environmental conservation potential, do exist than, in various economic sectors. The ones presented here, are just a small sample meant to represent the large volume of efficient technologies and systems[6]. Municipalities are obviously failing to understand and adopt these and other technologies. The next chapter will review the barriers that are the cause of this lack of adoption.

[6] For more interesting examples of success stories in the urban environment see for example:
http://www.partnerships.stockholm.se/projects_index.html
http://www.caddet.org/infostore/
http://www.penelope-save.org/front-moteur.php

4. Barriers

There is, unfortunately, a great amount of barriers facing adoption of energy efficiency technologies in municipalities. In this chapter I will review some of them, identified through a literature review and interviews with a wide array of stakeholders, conducted in Sweden and Israel.
In the discussion chapter I will include those barriers that are most important in the Israeli context, and will suggest policy resources to overcome them. While it seems like many barriers are mutual to Sweden and Israel, it is the context in which municipalities operate that makes the difference in the importance of each barrier and the policy response to it.

When looking at institutions (specifically municipalities) the barriers can be of organizational, political and personal nature. Institutional barrier models are usually not precise but rather descriptive. As Weber (1997) explains, "Barriers to energy efficiency in organizations may result from asymmetry of information, a trade off with non energy specific goals or missing responsibility with regard to energy consumption. Obstacles may occur in budgeting, in acquisition of new equipment or in operation service and maintenance […] behavioural barriers focus on individuals and their values and attitudes towards energy conservation. Obstacles may occur as lack of attention towards energy consumption, lack of perceived control or a missing link between attitude and action". I set out to look at each of these possible barriers in Israeli municipalities while trying to include technological, human, organisational, institutional and economical aspects of energy use.

The main barrier mentioned by **all** interviewees and by most literature sources is a simple human characteristic:
Conservatism - The human characteristic called conservatism has many aspects and can appear under different names (resistance to change, fear of taking responsibility, laziness, etc.) I will address these one by one in the following list of barriers. The understanding that innovative technologies are better, requires open minded thinking and use of different accounting methods – not your common features of public officials… Perhaps the main reason why LED technology, for example, is not adopted in Israel, is conservatism of the Ministry of Transportation (Biremboim, 17 September 2003). Awerbuch (2003, p. 1025) looks at the financial aspects of conservatism, saying that "traditional cost analysis will almost always suggest that the incumbent technology is a better option than the innovative one".

Common disbelief in free lunches - One of the most immediate barriers to money-saving energy efficiency projects, is the widespread belief (especially among economists) that unexploited profit opportunities do not really exist. Some of them argue that these apparent money making opportunities are actually market failures that fail to take into account the transaction costs which are bound to reduce the expected profitability of the project. DeCanio (1998) answers this claim by saying that the definition of 'transaction costs' is that they are immeasurable. In that case - it is impossible to support or to falsify the claim about them making the investment unprofitable. He also cites Koomey and Sanstad (1994) that looked at cases in which transaction costs did not seem to be the explanation of the slow diffusion of energy efficient technologies. In addition to their disbelief in 'free lunches', economists are unwilling to acknowledge shortcomings in management decision processes and therefore will not acknowledge the existence of these opportunities. Unfortunately, this line of thinking influences the thinking in the public sector as well. (DeCanio, 1998)

Cost - Energy efficient technologies are usually more expensive initially (not always though- see the section about appliances in the technologies chapter) although they repay the investment usually after several years. This forces the customer to come up with higher funds at the beginning in order to make the purchase (Turkenburg, 2002, p. 152-3)

Risk of investment - A debate exists whether energy efficiency investments are indeed free of financial risk as suggested by some (Jamet, 2002) or whether they present illiquid investments, with high transaction costs whose risk is not easily diversified away and as such should require higher rates of return than other investments (Sutherland, 1991). It has been found that actual savings tend to vary significantly from predicted savings, suggesting a high risk for investors (Greely, Harris, Hatcher, 1989). On the other hand, despite supposedly high risks, there is a whole service sector dedicated to guaranteeing specified energy savings and agreeing to accept relatively low return on investments rates, that should serve as an indication in favour of the first claim.[7]

Internalising of energy prices - One of the most obvious barriers, that requires government intervention, is the fact that energy prices do not reflect the true social costs involved with energy production and supply. Some writers say that a more efficient use of energy could be achieved through an efficient energy price, not through efforts to reduce market barriers (Sutherland, 1991).

Political life cycle - A popular belief is that due to the political life cycle, projects are required to pay for themselves within maximum of 5 years (Sherry, 2003). The reason, however, might be purely business based as even corporations do not like projects that have such 'long' payback periods (Elkayam, 7 September 2003).

Separation of capital expenditures and operating costs accounting - In cases where the above are conducted by different departments, the department performing the retrofits will not enjoy the savings enjoyed by the deployment and they therefore have a disincentive to perform capital intensive projects despite their potential cost savings (Suozzo, 1998). In Tel Aviv municipality, they are trying to minimize this phenomena by making sure that some of the savings are returned to the department that did the project (Elkayam, 7 September2003).

Little importance for energy conservation - Some municipalities are not confident that the potential energy costs savings are enough to justify going into such a project (Suozzo, 1998)

Fear of taking risk - Thiruchelvam, Kumar, and Visvanathan (2003) are describing the case of SMEs in Asia that have confidence in their own production technologies and do not believe in investing in energy efficient and environmentally sound technologies as they do not want to take any risk in matters unfamiliar to them. The same can be said for municipalities, who are run by officials who are afraid of the additional workload (Penelope-Bacchus, 2001) and do not want to take risks (Shachnay, 9 September 2003). The risk could stem from the fact that if the product or project that the official recommended fails, it will be considered the official's responsibility (Carmy, 15 September 2003).

Split incentive (or not?) - Some argue that contractors and building companies have no incentive to invest in energy efficiency, since they do not stand to profit from the savings. This situation is termed the 'split incentive' problem (Weizsäcker, et al., 1997, p. xxvi, 148). A claim to the contrary would say that builders only make what the consumer and the market want. If there were a strong market demand for energy efficiency in buildings, we would have seen more of these technologies installed (Sutherland, 1991). Skanska, a multi national construction company, uses energy efficient technologies since tenants will not be willing to pay high rent if they know their energy costs are high (Gräslund, 15 August 2003). Other construction companies in Sweden see the empty half of the glass – they say that investment in energy efficiency would mean they will have to charge higher rents from their tenants to recover the investment, and therefore the property will be less attractive (Drakenberg, 1 July 2003).

This is a complex case, since it is also possible to say that costumers do not really know what is within their ability to demand, as they are not at all aware of the technologies on the market. This is actually an imperfect market, where perfect information does not really exist and therefore we cannot really say that customers' decisions are the most efficient ones.

[7] For a detailed description of ESCOs business reasoning see the financing chapter

Municipalities are not really independent - Municipalities in Israel have to coordinate many of their activities with numerous bodies and therefore their ability to make novel independent decisions regarding, for example, public lighting - is minimal (Shachnay, 9 September 2003).

Suppliers and contractors dictating equipment use - A barrier to use of well designed lighting system is the fact that many times building owners work with electric contractors and lighting suppliers that want to push the use of products that are currently in their stock even if they are not energy efficient (Thorne and Nadel, 2003b).

Shortage of skilled personnel - An important barrier is the shortage of skilled personnel in the building sector, mainly coordinators between the design and production phases of green building (Turkenburg, 2002; Westphal-Jarnmark, 2000, p. 99). Many cities in Sweden lack the technical expertise to implement LED retrofits because their road department people are road engineers and not light engineers. (Söder, 3 October 2003)

Interest to keep the situation as it is - In Israel, the Ministry of Transportation puts hurdles on LED adoption because it involves importing and there are commercial pressures against it (either from importers of current technologies, or because the ministry people expect a payoff). (Biremboim, 17 September 2003) In the case of conversion for cleaner, energy efficient fuels (natural gas) for example, the gas companies in Israel are daughter companies of the gasoline companies and therefore if such a conversion takes place, they will be competing with themselves, therefore they do not have a drive to push it (Arnon, 7 September 2003).

Lack of innovation from the professional (field) level in the municipality - At least in Tel Aviv municipality new initiatives come mainly from management and from entrepreneurs. Very little comes from the field (the professional level). (Elkayam, 7 September 2003)

Political fear of over regulating - Local politicians are apprehensive about forming too serious regulations because it would mean that some manufacturers will be out of the market (the ones that cannot comply with the new standards) and in the local context it might not be a politically wise step. (Tingvar, 1 August 2003)

Lack of knowledge by the consulting industry - Municipalities work with big engineering companies who are many times conservative and either do not know about new technologies or do not dare to suggest them. (Olander, 1 September 2003).

Low status of energy efficiency among architects - Architects and engineers' decisions have a great effect on energy efficiency levels achieved in new buildings. Norwegian studies show however, that energy efficient architecture has a low status among Norwegian architects. There seems to be an understanding that architects are in charge of the artistic part while engineers are in charge of the technical aspects. The architectural education is partly to blame for this lack of interest in energy issues (Centre for the Analysis and Dissemination of Demonstrated Energy Technologies, 2003a).

Lack of follow-up - Lack of follow up on pilot projects is a common barrier in Israel. (Biremboim, 17 September 2003) The Ministry of National Infrastructures tried to push solar traffic lights but left it to the maintenance personnel in the municipality to deal with the product. After a year the project was neglected and it was the responsibility of the maintenance personnel to handle the consequences. The result was that they did not want to hear about it anymore nor about any other 'new' technology (Olander, 1 September 2003).

Bad experiences with earlier bad models – In Israel, previous water conservation devices for taps and shower heads used to jam and many maintenance personnel do not want to use this technology anymore. When a project was not supported throughout the implementation phase, and maintenance people encountered problems, they will usually be reluctant to hear about this technology again (Carmy, 15 September 2003).

The advantage of waiting - Since future technological advances are inherently uncertain and investments in new technology are, at least partly, irreversible, it may 'payoff' to postpone investments in energy saving and wait for the arrival of improved technologies. Government policies aimed at enhancing the adoption of new technologies through stimulation of R&D may be counterproductive since they can increase the opportunity costs of current investments (the profits from waiting for an even better technology) (van Soest and Bulte, 2001).

Many more barriers exist. Weizsäcker et al. (1997, p. xxvi, 140) composed an interesting list of what they call 'cultural barriers'. In the following list, I have added contributions from other writers as well:

Costs/financial barriers: costs of replacing conventional personnel with knowledgeable employees, financial criteria requiring efficiency to have shorter payback periods than electricity generation, energy efficiency projects are small and disperse in comparison to energy generation which makes them harder to organise and finance (high transaction costs[8]), lack of purchasing power for efficiency technologies.

Cultural/structural: customers who are ignorant about efficiency levels they could demand, obsolete regulations the specifically discourage or outlaw efficiency, the common laziness of individuals whether it is in relation to improvements in their private home or in the organization they are in charge of, lack of information even when the awareness exists (this mainly relates to - limited *readily available* information on technologies and systems), lack of training and education of politicians, administrative officers, buildings carers and occupants, insufficient guidance from national institutions, lack of local interest from the public (Eckerberg, et al., 1998), bad management culture in local authorities in Israel as they are used to have a budget that is constantly in a deficit therefore money saving is not really their top concern (Arnon,7 September 2003), the 'not from my school' attitude which basically means that everyone think they know best, and will not accept solutions that they did not come up with themselves. (Olander, 1 September 2003)

Psychological/political: the 'invisibility' of energy efficiency and pollution mitigation measures and the difficulty of demonstrating and quantifying their impacts (Worrell, Rene, Zhou, Christoph, Roberto, Robert, 2001), maintaining strong political support for these kind of initiatives through out the whole political cycle, the *perceived* high investment risk in new environmental technologies (Stockholm Partnerships, 2002).

Energy consumption, and as a result – conservation, has a big human dimension. For many people the information about energy use is too technical or detailed and they will sometimes prefer to avoid dealing with it. Many people have little experience with details of operation of electricity consuming devices and they will not pay attention to conservation possibilities or better efficiency with their operation. Decision makers in particular can be suspicious of estimates of potential energy savings given by manufacturers or energy auditors. Even after they received the information they might not take any action because different people assimilate information differently, because the credibility of the information source was questionable, or the information source communicated the information badly. Studies in the early 80s showed that only 2% of the customers in California bothered to reply to offers of free, non-committing energy audit in their homes. Researchers tried to understand how can people ignore information that was both useful and free, and they gave several explanations: lack of trust for the utility (offering the audit) as a source of information, a belief that there are no

[8] The authors name many more factors that can be included in 'transaction costs': "the cost of changing laws, standards and norms… redesigning mass products, their assembly lines and their distribution logistics… writing off sunk capital… changing infrastructures…civilised customs (including values), habits of thought and education… overcoming ignorance on the part of consumers, producers, maintenance staff… removing bureaucrats who define their jobs in terms of dinosaur procedures… creating new jobs for workers now employed in the mega-inefficiency machine, and so on" (Weizsäcker et al.., 1997, p. 140)

‘free lunches’, pure laziness, lack of awareness to the existence of the program, etc. (Stern and Aronson, 1984). One can logically guess that some of these reasons can also apply for organisations, as they are lead by people.

Organizations follow rules which direct their activities, and most decisions are the consequence of applying a set of rules to a situation. Many rules are inconsistent and they can change over time. However some scholars claim that ‘most actions in an organisation are not the result of decisions in which alternatives are considered in terms of their consequences for prior objectives[…] most actions involve finding an appropriate rule and using it.’ (ibid, p. 109) If organizations respond to environmental issues not by inventing new rules but rather by applying existing routines, (ibid.) it will be hard for *new* technologies or *new* financing mechanisms that sometimes come hand in hand with environmental technologies to penetrate. Research has shown that sometimes a routine that has developed historically continues to be used even if more suitable routines are known to exist. These historic routines sometimes make the promotion of risky or novel projects difficult. As far as rules that have the potential to facilitate environmental technologies, just like other rules – they are not always followed, and in many cases, individuals are not even familiar with them (ibid.)

Raynolds, (1997) explains that while purchasing is governed by rules and procedures, it is also influenced by the risk of violating those rules, thus appearing to waste government money or favoring one supplier over another. It is therefore understood why officials are reluctant to steer away from the normative, familiar practices and consider innovative paths. Raynolds even suggests that the more money involved in the project or the more visible the activity is – the more it applies.

Finally, we must remember that the best alternative is not always chosen by organisations. Attention of decision makers is scarce and therefore not all information is gathered, not all information and alternatives are considered, and not all values are made conscious. (Stern and Aronson, 1984, p. 112)

Looking at the whole list can be daunting. However, successful case studies from all over the world, show that they can be overcome. In the next chapter, titled ‘financing’ I will present financing options that can be used to overcome what sometimes seems to be one of the more serious barriers – lack of funding.

5. Financing

The previous work in this paper has identified the lack of initial funding and lack of financing sources as some of the main barriers for adoption of energy efficiency technologies. Indeed, many believe they cannot engage in 'expensive' energy conservation technology procurement, when the municipality does not have budgets for more basic and important things, as education or welfare. The purpose of this chapter is to show that (many) solution to this problem do exist, and in many cases they do not even demand any upfront investment from the municipality

5.1 Energy savings performance contracting (shared or guaranteed savings)

An ESCO, or Energy Service Company, is a business that develops, installs, and finances projects designed to improve the energy efficiency and maintenance costs for facilities over a time period of several years. ESCOs usually assume the technical and performance risk associated with the project. The services are bundled into the project's cost and are repaid through the money savings generated (the customer pays for the capital improvement with the money that comes out of the difference between pre-installation and post-installation energy use). (National Association of Energy Service Companies, 2003)

Box 5: ESCO example
Project: hospitals in Piemonte, Italy.
Before: total costs for the three hospitals and related health districts for fuel, maintenance, staff and electric power amounted to 2,170,100 €.
Guaranteed savings: Energy saving: 325 TOE (Ton Oil Equivalent)/year, financial:542,525 €/year. Investments realized by the ESCO: 1,885,584 €.
(EU Penelope-Bacchus, 2003) [9]

ESCOs are not a magic solution, and barriers exist to their operation and success. One such barrier is the fact that many large energy consumers are looking for only one- to two-year energy supply agreements and do not want to be locked into one supplier for the long periods usually required for these kind of contracts (Dayton, Goldman, Pickle, 1999).

Painuly et al. (2003) suggest that developing countries have tremendous potential to increase energy efficiency but face several barriers before the potential can be realised. A lack of access to appropriate financing mechanisms is one of the important barriers. ESCOs are in nascent stage in many developing countries and face several barriers that include market, finance and institutional barriers, poor energy pricing policies, high transaction costs, etc. Governments in these countries should therefore be more involved in developing a market for these companies.

ESCOs in Israel: few attempts of this business model have been made and all failed. In order for this sector to succeed ESCOs need to have a high professional ability and knowledge in energy matters. In addition, the financing institutions and the banks are very conservative and are afraid they would not be able to reclaim the equipment they left at the customer's premises in case the customer goes bankrupt. International ESCOs that are financed differently and have the professional technical know-how are not interested in investing in Israel because of the high security premium (Arnon, 7th September 2003).

[9] Titled: 'A TPF scheme at public level for environmental policies'

5.2 Intracting

Different from performance contracting, in the case of intracting the financial and technical service is delivered not by an external agent but through a unit within the same organization which acts like the ESCO, and the remuneration takes place through cross payments of budgets. (Kristof and Ramesohl, 2001)

Apart from the basic version of intracting described above, table 3 presents three other modes of intracting that can be found:

Table 3: Overview of the four modes of intracting

Intracting mode	Basic model	Profit centre	Fake privatisation	Hybrid system
Example	Stuttgart	Schwalm-Eder	Rheingau-Taunus	Frankfurt
Approach	Environmental department takes the role of the energy service provider with the technical assistance of the building surveyor's office	Responsibility for energy issues is transferred completely to an internal profit center with own budgets	Responsibility for energy issues is transferred completely to a newly created energy service enterprise which is owned by the district	Intracting and conventional third party financing are elements of an integrated concept

Source: Kristof and Ramesohl, 2001

5.3 Other financing options

Table 4 describes several other financing options available for organizations deploying energy efficiency projects:[10]

Table 4: Financing options for introduction of environmental technologies

Tool	Description
Cash Purchase	A simple cash purchase. Optimal for cash-healthy organizations seeking to avoid debt.
Cash Purchase with Incentives	Cash investment can be supplemented with manufacturer or utility subsidies. Sweden, as opposed to Israel, have made use of this tool. (Neij and Öfverholm, 2001)
Conventional Loan	Ideally loan payments will be structured to be less than projected energy savings. A down payment is usually required.
Capital Lease	Like a conventional loan, payments can be set below projected energy savings. A buyout (purchase option) is required at the end of the lease term.
Operating Lease	The lessor maintains ownership of installed equipment and monthly payments are made from energy savings. At the end of the lease term, options include renewal of the lease, purchase of the equipment, or return of the equipment to the ESCO. The main difference from capital lease is that the lease does not appear as debt on the balance sheet.

Source: Sherry, 2003

Many countries offer **grants** for energy efficiency projects, however municipality leaders are not always aware of this option. Some electric companies offer **rebates** for consumers that use, or

[10] For an elaborate description plus advantages and disadvantages of every option, please refer to the source

manufacturers that make, energy efficient equipment (Weizsäcker, et al., 1997, p. 167). Another potential source of finance is **incentives by insurance companies** designed to encourage customers to implement risk management programs in the form of energy efficiency. (Mills, 2001) Lastly, bonds are interest-bearing instruments issued by companies, governments or other organizations, and sold to investors in order to raise capital. They tend to be long-term obligations with fixed interest rates and repayment schedules. It is suggested that municipalities look at issuing **municipal bonds** as a financing source (GREENTIE, 2003).

As presented before, many more barriers exist, besides lack of funding. The next chapter - 'policy', suggests several mechanisms that have been tried in different parts of the world, and have been proven successful in promoting energy efficiency.

6. Policy

In general one could say that different players have different roles in the effort to promote energy efficiency. Governments (national and local) must establish legal and institutional frameworks, act as an example by improving energy efficiency in their own activities, develop organisational routines that will put energy efficiency on the agenda of as many sectors as possible (building, transportation, appliances etc.), establish methodologies to evaluate performance of energy services and products, and support effective agency and administrative efforts to enhance energy efficiency (International Energy Agency [IEA], Organisation for Economic Cooperation and Development [OECD], 1997a, p. 104).

Current policies often focus on high profile actions and not necessarily on the most effective course of action. Effort is spent on better technology while simpler issues like maintenance and improved operation are overlooked. Failure often occurs when planners rely too much on technology and do not consider public and user acceptance or when subsidies and grants are not reinforced by the proper technology. A good policy, therefore, would incorporate 3 essential elements:

- Focus on cost effective options for energy savings
- Encourage the acceptance of the new technology or the new pattern of behaviour by the energy users
- Make sure that consumers (decision makers, engineers) have access to resources, products and skilled assistance to help them make informed decisions (ibid, p. 167)

There is a wide literature on the subject of policies to increase energy efficiency. Despite their unquestionable importance, due to limitations of space and scope, I could not mention many important ones like policies targeted at utilities, the establishment of emission trading regimes, and more. My main guideline in the choice of policies mentioned was to concentrate on policies that would target the end user (here – municipalities), or patterns of end use of energy directly, and not through mediators.

This following list is a general list of 'best practices' policies, found to be successful in Sweden or worldwide. In the discussion following this chapter I will look into specific policy measures that can assist in overcoming the main barriers in the Israeli context.

I have separated the suggested policies into those that can (and should) be applied by the central government (e.g.: incentives, standard setting) and those that are relevant to local governments that want to promote energy efficiency technologies in their jurisdiction.

6.1 Policies relevant for central government

DSM (Demand Side Management) through tariff structures – Electricity tariff structures in most countries of the world encourage utilities to sell more electricity and are a disincentive to applying DSM measures that will reduce sales. To overcome this disincentive utility income must be de-linked from sales volume and linked to some other measures of service like implementation of an energy efficiency program (Spalding-Fecher, Clark, Davis, & Simmonds, 2002; Stern and Aronson, 1984, p. 123). Pricing that will signal the accurate value of resources being consumed can be promoted only with regulatory intervention (Praetorius and Bleyl, 2003). In Israel this is achievable since there is only one utility company, and electricity prices are determined by a governmental authority.
Barriers addressed: little importance of energy conservation, internalising of energy prices, interest to keep situation as it is.

Increasing the prices of electricity (or water use) - A possible solution that will drive adoption of energy and water conservation devices is raising energy and water prices. The government could segment the market by:

private consumption, industrial, public buildings, and create corresponding, different prices, for each segment. (Carmy, 15 September 2003)
Barriers addressed: little importance of energy (or water) conservation, internalizing of energy prices.

Technology procurement programs - The Swedish programs do not rely on government demand, instead they coordinate and direct many small and fragmented end users in the residential, services and industrial sectors, and bring purchasers and experts together to identify potential improvements. Sometimes they also support the producers financially. Technology procurement programs should be accompanied by a range of supportive activities in order to bring energy efficiency technologies to the market. (Neij and Öfverholm, 2001)
Barriers addressed: cost, conservatism, little importance for energy conservation, municipalities are not really independent, risk of investment, fear of taking risk, lack of knowledge by industry and its consultants, political lifecycle, lack of innovation from the professional level in the municipality.

Market transformation program - The objective of market transformation programs is the introduction and increased adoption of new and existing products and services. This can be achieved through the reduction of market barriers and changes in behaviour of major actors on the market. Market transformation programs are designed to motivate consumers who have already decided to make a purchase, to buy the most energy efficient model available. (Neij and Öfverholm, 2001)
According to head of economic department in Israeli Ministry of Environment (Arnon, 7 September 2003), the institutional consumer in Israel is passive and expects the legislator or the government to do everything and to bear the costs. That is, according to Arnon, the reason why market transformation or technical procurement cannot work in Israel. In addition there are business culture barriers: companies do not sit together to discuss issues that are not in their core competition area, and even more rare is cooperation between the government (national and local) and business.
Barriers addressed: cost, conservatism, little importance for energy conservation, municipalities are not really independent, risk of investment, fear of taking risk, lack of knowledge by industry and its consultants, political lifecycle, lack of innovation from the professional level in the municipality.

Increasing 'visibility' of energy consumption - An important thing to remember is the invisibility of energy consumption. It is a product (or a service) we consume quite differently from other products/services. Engineering standards, design specs, and building codes that emphasize energy consumption increase attention to such factors and make it more visible to decision makers. (Stern and Aronson, 1984).
Barriers addressed: little importance for energy conservation, low status of energy efficiency among architects, suppliers and contractors dictating equipment use, political lifecycle, interest to keep situation as it is.

Energy taxes - Energy taxes have been used in Sweden since the 1950s. Sweden also has a CO_2 tax on some fuels (Neij and Öfverholm, 2001). In Israel, it is possible that green taxing or raising of electricity prices will have almost no effect since the public is used to regular fluxes in prices due to exchange rate fluctuations. In order for price change to create a change in behavior it needs to be drastic and currently there is no one to discuss such an idea with. (Arnon, 7 September 2003)
Barriers addressed: cost, internalizing of energy prices.

Promotion of R&D and environmental technologies - The Swedish government has tried to promote energy efficiency through support for R&D. The resulted programs improved awareness for potential energy efficiency and also affected the introduction of some energy efficiency technology in industry (Neij and Öfverholm, 2001).
Barriers addressed: cost

Promotion of new saving assessment tools – The government should create and promote the use of tools to better assess the benefits and the potential savings of energy efficient technologies. Example of such tools

include Life Cycle Costs calculation (see under discussion chapter) (Centre for the Analysis and Dissemination of Demonstrated Energy Technologies, 2003c).
The launch of a new technology incurs some risks and requires an initial investment. The Swedish government is offering an additional grant to promote launch of energy efficiency technology (Neij and Öfverholm, 2001).
In Israel, on the other hand, the government allocates relatively small funds to stimulate energy efficient technology. Demonstration projects, for example, receive support of maximum USD 400,000 (Israeli ministry of national infrastructure, 2001d). For water conservation technologies, probably due to the acute shortage of this resource in the area, the rebates are bigger and the programs are more established (Carmy, 15 September 2003).
Barriers addressed: cost, little importance for energy conservation, risk of investment, lack of innovation from the professional field in the municipality.

Easing tax requirements - VAT (Value Added Tax) is a major contributor to the high initial cost of technologies. Especially in cases of technologies with long payback times, it will be helpful if VAT could be spread over several years. (Westphal-Jarnmark, 2000, p. 98)
Barriers addressed: cost, risk of investment

Budgeting staff education - Municipalities should receive financial support to educate staff so that they will be able to supply information to smaller companies and industries, and to decision makers in the municipality itself. (Centre for the Analysis and Dissemination of Demonstrated Energy Technologies, 2003d)
Barriers addressed: lack of innovation from the professional level in the municipality.

6.2 Policies relevant for local government

Providing education and information to decision makers - This can reduce their costs of acquiring information, reduce performance uncertainties, and may help to make a shift from standard purchasing practices. (Suozzo, 1998)
Barriers addressed: risk of investment, little importance for energy conservation, conservatism.

Conducting an energy audit - The first step to implementing an energy efficiency project is assessing the organization's current energy usage and demand patterns and identifying viable improvement options. This can be achieved by conducting an energy audit. (Sherry, 2003)
Barriers addressed: little importance for energy conservation, shortage of skilled personnel, lack of innovation from the professional level in the municipality.

Promotion of understanding of non energy benefits - Non energy benefits, like longer life cycle of new efficient equipment may be more important to decision makers than the energy saving, and can be used as a 'vehicle' to promote the energy efficiency agenda. (Nadel, Thorne, Sachs, Prindle, & Elliott, 2003)
Barriers addressed: little importance for energy conservation, fear of taking risks, risk of investment, political fear of over regulating.

Creating a separate clause for energy in municipality's budget - Special attendance to energy will raise awareness to its costs and will encourage innovative thinking on conservation possibilities. This will internalise concern for energy issues into the organisation's thinking processes. In order to encourage energy efficiency, it can be used as a criterion of effectiveness in measuring and allocating organisational resources. (Stern and Aronson, 1984, p. 116)
Barriers addressed: little importance for energy conservation, lack of innovation from the professional level in the municipality.

Involvement of top management - Many stress the importance of having high level management involved in making energy efficiency an organisational goal (Nilsson, 2003; Suozzo, 1998; Stockholm Partnerships, 2002; Arnon, 7 September 2003; Olander, 1 September 2003).
Barriers addressed: little importance for energy conservation, lack of innovation from the professional level in the municipalities, fear of taking risk.

Assigning responsibility - Ideally at least one high level officer in the organisation should be in charge of energy efficiency, promoting it and measuring progress towards concrete objectives (Stern and Aronson, 1984, p. 115). In Israel the law demands that every municipality have a person in charge of energy. Usually it is a junior staff member that has little influence on management. (Arnon, 7 September 2003; Olander, 1 September 2003).
Barriers addressed: little importance for energy conservation, lack of knowledge by industry and its consultants, lack of innovation from the professional level in the municipality.

Build cooperation with local NGOs - Political awareness in the city of Växjö, Sweden started when cooperation begun with the Swedish Society for Nature Conservation (an environmental NGO). The public officials in this municipality had access to 40 experts from the NGO to consult. That led to a very successful project ('fossil-free Växjö') that gave the city national and international publicity. This strengthened the environmental identity of both politicians and officials (Nilsson, 2003).
Barriers addressed: conservatism, little importance for energy conservation, shortage of skilled personnel, interest to keep situation as it is, lack of innovation from the professional level in the municipality.

Identification of motivational factors - Municipal actors would be encouraged to take energy saving measures and more specifically to start energy accounting if they have sympathy for this approach or if this approach seems attractive, rather than if economic arguments are put forward. Elected persons and politicians care for their good image, while administrative officers are more reluctant because they fear an increased load of work. (Penelope-Bacchus, 2001) These aspects should be taken into account when addressing city officials with new initiatives. (Stern and Aronson, 1984)
Barriers addressed: little importance for energy conservation.

Long range action plans - Action plans should be set for a minimum of 5 years so that they can be followed through even during changes in political or administrative leadership, and will allow the adoption of technologies that have payback periods longer than the incumbent leader's term of office. (EU Penelope Project, 2003)
Barriers addressed: political lifecycle.

Foot in door strategies - One of the reasons that the municipality of Ra'anana in Israel is very interested in implementing environmental technologies, is that they started the process of ISO 14000 (an international environmental management standard) a few years ago. This process got senior management in the municipality involved in issues relating to the environmental performance of the municipality and gave support to individuals and departments that were trying to push environmental technologies. ISO 14000 can be seen as a 'foot in the door' strategy, that creates an open channel to top management for environmental issues. (Olander, 1 September 2003)
Barriers addressed: conservatism, little importance for energy conservation, fear of taking risk, bad experiences.

6.3 Why does is work better in Sweden? - Local governance in Sweden

Some unique aspects of local governance in Sweden allow municipalities to have many points for intervention in energy consumption aspects. They can optimize the location of a new residential area with respect to solar or wind conditions, decide on standards for energy efficiency in buildings or the nature of the heating system in the area, for example. The local governments autonomy in Sweden is strong, as local authorities are responsible for nearly all public businesses and are often the meeting place for various networks of companies and consumers. Most municipalities in Sweden have an energy advisor by law. Local authorities can demand, for example, use of renewable energies by power companies, use of certain type of fuels by traffic companies, and they are potentially a big player in green procurement efforts (Nilsson, 2003). This description can raise interesting ideas on how to imitate the Swedish model of local governance in order to promote use of environmental technologies in other countries.

It might be interesting to note that when comparing older and more recent municipal energy plans in Sweden, a shift of focus in energy systems can be observed (as described in table 5). The system boundaries have widened from 'efficiency in buildings' and local heating plans to 'efficiency in the whole municipal energy-system' and district heating (Nilsson and Mårtensson, 2003).

Table 5: Main objective for national energy policies and key words for the energy plans from different eras

	1997-1984	**1985-1997**	**1997-1999**
Main objective of energy policy	Oil reduction	Reduction of energy use	Renewable energy sources
Key words for the plans representing the era	Nuclear power Local heating systems, efficiency in buildings, alternative energy technologies	Efficiency District heating, reduction of fossil fuels, phase-out of nuclear power Reduction of emissions	System optimisation Agenda 21, Wind power and biomass Sustainable development

Source: Nilsson and Mårtensson, 2003

I presented here a long list of possible policy measures to promote energy efficiency. It is up for the interested municipality, government or social organisation to choose which of these policies can fit the local conditions and could make the biggest effect.

7. Discussion

In this section I will look at the most significant barriers to adoption of environmental technologies in Israeli municipalities, and for each show what can be done to overcome this barrier. The solutions offered require either central policy measures (national government) or changes in procedures and policies of municipalities themselves. Many of them have been used successfully in Sweden and other places in the world.

The barriers that will be discussed are presented in table 6:

Table 6: Major barriers to adoption of environmental technologies by Israeli municipalities

Barrier number	Barrier description
1	Lack of initial funding or knowledge how to get it
2	Poor standards
3	Lack of awareness
4	Transaction cost
5	Uncertainties About Performance
6	Small scale demonstration projects
7	Small and unique markets
8	Disincentives to conserve
9	Lack of rebates, subsidies and incentives
10	Lack of coordination
11	Accounting techniques
12	Use of money saved

Graph 2 (at the end of this chapter) describes how policy measures to these barriers integrate to form an improved situation. The numbers on the dashed arrows correlate to the numbering in table 6 and in the following discussion. The dashed arrows indicate activities that do not exist yet in Israel, thereby hindering adoption of environmental technologies. It is particularly useful to look at this graph in comparison to graph 1 that describes the current situation, and see the differences.

Barrier 1 - ***Lack of initial funding or knowledge how to get it***
Many municipalities do not have the money to invest in projects that will pay back after more than two years. Besides the capital constraints, there can be lack of access to ,or knowledge of, alternative financing mechanisms (Sherry, 2003).

Policy response: Making financing more easily available
Providing rebates or financing will allow municipalities to learn about the technology and see its performance demonstrated. When municipalities get to know the technology there are increased chances that they will be more willing to finance it on their own (Suozzo, 1998).

Policy response: Introduction of innovative financing mechanisms
The Financing chapter in this paper suggests options for financing solution for energy efficiency projects. These options do not exist everywhere and therefore the first step should be to introduce them where they are missing.[11]

[11] For suggestions on how to promote Intracting, for example, see Kristof and Ramesohl, 2001

Barrier 2 – ***Poor standards***
Many name the building codes as one of the most efficient mechanisms to reach energy efficiency in buildings. (Tingvar, 1 august 2003) Lack of standards reduces customers' ability to compare between products and services, and allows the manufacturers to choose the (usually) cheaper non-efficient options. (Stern and Aronson, 1984)
In Israel, local standards and legislation depend on national legislation. Municipalities cannot demand stricter requirement than those appearing in national standards (Elkayam, 7 September 2003).

Policy response: Setting standards
The Swedish government has set efficiency standards that not only promote, but also ensure a base level of energy efficiency. This type of regulation usually succeeds in eliminating the worst products or services from the market although customers tend to view it as a requirement that must be met rather than a starting point. To avoid this situation, standards must be continually updated.
Building codes in Sweden have proved to be very effective in accelerating energy efficiency (NUTEK, 1995). Engineering standards, design specs, and building codes that emphasize energy/cost ratios or other energy considerations increase attention to such factors, and make energy more visible to critical personnel in the organization.
Complying with energy efficiency standards can be required for every new construction or retrofitting. Once they are imposed on designers, the search for compliance induces an automatic effect of energy efficient choices (Martins, Amaral, Marques, 2001). It might be interesting to note that in the USA and Sweden, for example, building codes and standards are developed on the national level and administered and enforced at the local level (Sherry, 2003; Gräslund, 15 August 2003).

Barrier 3 - ***Lack of awareness***
This is a recognized problem in which decision makers are not even aware of the existence of other possibilities (Turkenburg, 2002). While researching for this paper it became apparent that most of the decision makers in municipalities and in governmental offices in Israel, are not even aware of the existence of some widely adopted technologies (like LEDs) despite the familiarity of the professional level (traffic engineers working in municipalities) and mid-level management in the field of lighting and transportation with these technologies.
Mere knowledge of the existence of a technology, however, is far from being sufficient, since managers need to have detailed information about available options in order to take a decision (Hackman, 14 august 2003).

Policy response: Supply of information to raise the awareness to energy efficiency topics
This will also inform personnel about technological possibilities. The LIP (Local Initiative Program) initiative in Sweden, allocated part of their budget to 'knowledge transfer'. They organized, and paid for study tours and seminars for many actors in the municipal energy sector. When all costs are paid for, investors and customers were interested and came to listen. (Hackman, 14 august 2003)

Barrier 4 - ***Transaction cost***
The ability of public officials to translate their willingness and interest in putting energy-efficient purchasing into practice is "directly related to the quality, specificity and comprehensiveness of the information easily available to them about energy-efficient products". (Raynolds, 1997) Currently, this information is not presented in an easily understood format, and therefore transaction costs (costs of collecting information, making decisions, monitoring the performance of the investment) are too high. (Turkenburg, 2002)
Not all researchers agree that transaction costs are indeed a major contributor to the energy paradox: Hein and Blok (1995) estimate transaction costs for energy efficiency projects in firms in Netherlands to be between 3-8% of the investment.

Policy response: Establishment of an energy agency
The enhancement of institutional support to energy efficiency projects relates mainly to increase access to information and finance. Governments usually are not involved in these issues and companies are wary due to high transaction costs. A network of central and distributed energy agencies (EAs) that will disseminate information on energy efficient technologies and innovations can address this issue.
Experience from Europe and Central America suggest that EAs can contribute to reducing energy consumption significantly, by strengthening the links between energy policy, financing and implementation, and the final consumer. (Praetorius and Bleyl, 2003) A Study on the potential of energy agencies in developing countries showed that they are an essential tool for information and innovation dissemination. This study stresses, however, that an appropriate *design* of such an EA is crucial for success (ibid.)
The International Energy Agency also supports this idea and states that energy efficiency agencies should gather and disseminate information about relevant technologies and examples of success stories, should develop and implement energy efficiency programs, and cooperate with peers in order to create large enough market demand (IEA, OECD, 1997a). Other researches suggested similar roles for *utilities* that wish to promote energy efficiency (Vine, 2000).

Some of the reasons for the lack of EAs in Israel could be the lack of demand or expression of interests in energy efficiency from the private sector. Energy costs are marginal and businesses prefer not to get into it. In addition there isn't much awareness among senior management to environmental issues (Arnon, 7 September 2003).

Barrier 5 - ***Uncertainties About Performance***
Despite the proven performance of some of the technologies (i.e. LEDs in Stockholm) (Söder, 3 October 2003), public officials seem to be very afraid to trust manufacturers' data, mainly for fear of liability. (Suozzo, 1998) Many times decision makers are not even aware of the successful implementations in other cities (Olander, 1 September 2003). Turkenburg (2002) suggest that uncertainties about resource availability (for example silicon for PV cells) can also be a barrier. Energy efficiency technologies find themselves in a vicious cycle – due to their low penetration in the marketplace, reliable and/or trustworthy information about their cost or performance is usually not available to many of the key market players and that prevents them from purchasing these technologies. (Vine, 2000)

Policy response: An independent review body
The U.S. EPA's "Environmental Technology Verification" (ETV) program was designed to verify the performance of innovative environmental and other technologies through public-private testing partnerships. The main reason for this project is the need for an independent, objective and high quality source of performance information in order for interested customers to be able to make informed decisions, and the need of innovative technologies to find ways to penetrate a conservative, risk-avoiding environmental marketplace. EPA's independent science advisory board stated in a recent report: "The scarcity of independent and credible technology information is one critical barrier to the use of innovative environmental technologies [...]Verification testing information provided by the ETV program fulfils an essential need of the environmental technology marketplace" (U.S. EPA, 2003).

Barrier 6 - ***Small scale demonstration projects***
Remmen (1995) describes the limited efficiency of small scale demonstrations by environmental ministries, focusing on small scale adjustments instead of major improvements as a barrier to dissemination of such technologies. Israeli entrepreneurs 'enjoy' a very small budget for demonstration purposes of energy efficiency technologies, which usually allows erections of small installations only (current budget affords 1,750,000 NIS=USD 400,000 per project). (Israeli ministry of national infrastructure, 2001d)

Policy response: Deploying targeted demonstration projects
Financed by the government, municipality or the entrepreneur, such demonstration projects can give the municipality and the manufacturing company (in case of a new technology) the needed first-hand experience with the technology, which can answer many questions about the performance and quality (Suozzo, 1998).

In a recent EU conference on local energy action, a particular point was made on the importance of the awareness of the final energy consumer. The consumer needs to 'feel' the benefits from energy saving in his/her everyday life. Information exchange and awareness raising should therefore always be a central part of every project (European Union Directorate General TREN, 2002). The city of Philadelphia, for example, made available a simple lifecycle calculator, for all interested so that savings can be properly estimated (Suozzo, 1998).

Barrier 7 - ***Small and unique markets***
Technologies that have matured and been perfected for mass production in one country may not be the best choice for the smaller scale of production or different operating environment encountered in others. This barrier is quite common in Israel which is characterized by warm climate and relatively small market. This discourages many developers and established companies from trying to enter this market, for cost-benefit reasons (Olander, 1 September 2003).

Policy response: This does not really have a solution in Israel, however, an interesting possible response could be: Green institutional procurement
Large institutions have great influence on the adoption of technologies through their procurement policies as they can send powerful messages to the markets. Globally few organizations realize the tremendous potential of their purchasing activities. According to a 'World Watch' report, harnessing institutional purchasing may be one of the most powerful tools available for shifting patterns of production and consumption toward sustainability. (Mastny, 2003) Due to the small Israeli market, it might be that only concentrated institutional procurement can create enough of an incentive for technology manufacturers.

Barrier 8 - ***Disincentives to conserve***
In Israel it is very common for a specific year's budget to be determined by the institution's expenditures in the previous year, so that if the institution reduces its energy costs, it might lead to cuts in their annual budget.

Policy response: Allowing savings to remain in the department that achieved them
Tel Aviv municipality is currently in the process of creating a budget management system, in which the departments themselves will be reimbursed for savings generated through their initiatives (e.g.: The lighting unit will get some of the savings generated from the use of energy efficient lighting). (Elkayam, 7 September 2003)

Barrier 9 - ***Lack of rebates, subsidies and incentives***
As mentioned earlier, the issue of rebates by utilities or local/national government is of major importance. The fact that nor the Israeli electric company nor the government offer any assistance is a major barrier to the adoption of energy efficient technologies in Israel.
In Stockholm, LED technology was so successful because rebates were given by the government, so that money did not have to come only from the municipality's budget. (Söder, 3 October 2003)

Policy response: Incentives giving program
There are two main types of incentive programs authorities use to promote energy efficiency: resource acquisition (convincing consumers to replace still functional energy equipment with more efficient equipment) and market transformation (trying to convince the owners/contractors of new facilities to use the most energy efficient equipment). A combination of the two is sometimes the best option in order to achieve the maximum

benefits of energy efficiency possibilities (Neij and Öfverholm, 2001). In Israel, some believe that a market transformation program will never work due to the Israeli business culture. (Arnon, 7 September 2003)
It might be important to note some barriers to this approach: Commercial/industrial customers have a decision cycle for equipment replacement, of a few months, however it might be very hard to penetrate them in the right moment on this cycle, and therefore the only way to reach them is through awareness raising. This has to compete with huge advertising campaigns of other equipment on the market that is not really energy efficient. Even if customers are reached with the message at the exactly right moment, many customers cannot afford to buy energy efficient equipment. Large institutions with minimal budgets for maintenance or capital for improvements are one example. (Gilligan, 2002)

Policy response: Subsidies
Subsidies have been applied where initial price of the product was too high to allow immediate market penetration. Subsidies start as 'artificial' price reduction but later can result in real cost reduction due to increased product acceptance and demand. (Neij and Öfverholm, 2001)

Barrier 10 - ***Lack of coordination***
A lack of coordination between departments may result in a failure to fully value the system-wide benefits of energy efficiency improvements. An example could be the installation of improved road lighting from which the road maintenance department gains as well, due to reduced road maintenance and traffic accidents (Sherry, 2003). The lack of coordination can be expressed also by lack of networking and information sharing between municipalities on the national and international level. (Stern and Aronson, 1984)

Policy response: Networking and information tools
Use could be made of ICT (information and communication technology) to enhance cooperation. Encouraging networking among professionals and among decision makers is an important feature. (Stern and Aronson, 1984; Suozzo, 1998)
In a recent conference that summarised the Penelope project (European project for promotion of energy efficiency and renewable energy sources through partnerships between the national and the local/regional levels), the main theme was experience replication. The idea of learning from experience has encouraged several organisations to create databases of success stories. [12]

Policy response: Use of business and regional municipal associations
Business and municipal associations should encourage members to apply energy efficient technologies and operations, particularly in changing routines and adapting activities to certification schemes. They should also be encouraged to communicate the results of the successful projects in a way that will enable easy and simple imitation. Using the resources of trade and professional associations can be of great use as they are power multipliers and can reach many stakeholders with relative ease. (IEA, OECD, 1997a, p. 104)

Barrier 11 - ***Accounting techniques***
The accounting rules that are used by the organization are of high importance to the prospects of a suggested energy conservation project. The weight given to initial capital costs, costs of maintenance, and costs of operation in the accounting of projects costs can be important to a decision.

Policy response: Use of Life-Cycle Costing
Life Cycle Costing (LCC) is a method of assessing a product or project's value based on its initial capital cost and operating costs over its useful life. It includes assessment of annual energy and maintenance costs, fuel price

[12] For examples of such databases and sources see: Stockholm partnerships, 2003, CADDET web site - http://www.caddet-energy efficiency.org/, and CADDET book series titled 'Learning from experience'

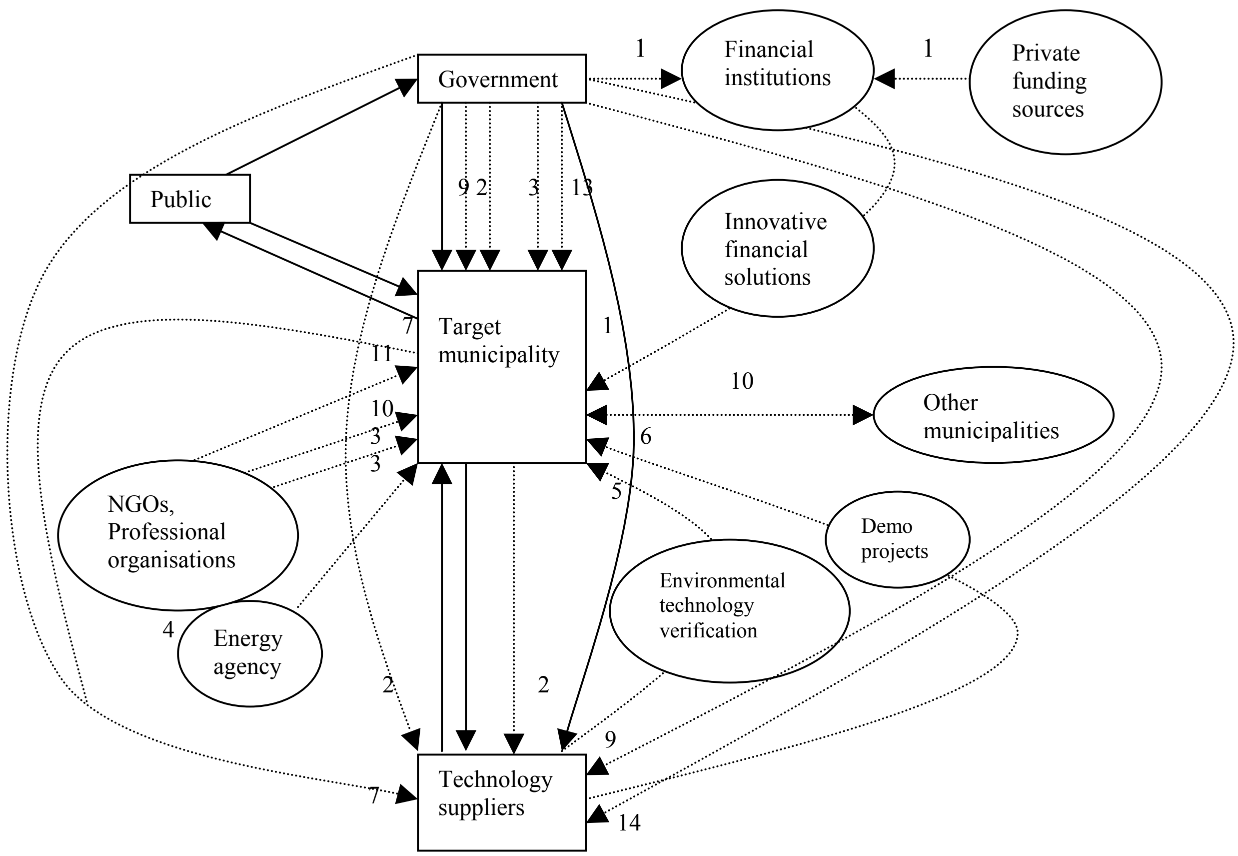
increases, inflation, equipment replacement costs and salvage or disposal costs. An LCC analysis may, in most cases, reveal, that despite higher purchase costs, energy-efficient products are more cost effective than less efficient ones over the product's life time. (Sherry, 2003)
High level public officials interviewed in Israel confessed that the use of this method is very rare (Arnon, 7 September 2003; Elkayam, 7 September 2003; Olander, 1 September 2003) and most of the managers and decision makers have never even heard of it. This, in comparison to the wide use of it by construction companies and municipalities in Sweden (Gräslund, 15 august 2003; Lundberg, 13 august 2003).

Barrier 12 - ***Use of the money saved***
Some municipalities that have adopted energy efficient projects have encountered an unexpected problem - possible uses of the saved money were not clear.

Policy response: Allowing independent use of money
Schools can give the teachers autonomy of decision. Public buildings can use more targeted methods like rewarding the maintenance stuff when they assist in energy conservation (Penelope-Bacchus, 2001).

As an epilogue to this chapter I wish to discuss another aspect, that has to do with the promotion of energy efficiency in general, and not with specific barriers and policies.
Brookes (2000), tries to prove that the economically justified improvement in energy efficiency will lead to higher levels of energy consumption at the economy-wide level than in the absence of any efficiency response. Brookes tries to show that there is no case for singling out energy, from among all the resources available to us, for efficiency maximization, meaning – that we may just as well focus on raising the efficiency of capital or labor, for example. The main idea behind these claims is that any action imposing constraints on resource use will inevitably have an economic cost in the shape of a reduction in production and consumption possibilities. Basically, we would just be transferring the burden to another group. This is a very 'economically-based' analysis of the issue, (as is evident from another section in that paper: 'This makes raising energy efficiency simply part of economic optimization' p. 356), since it is unable to justly quantify (and therefore properly discuss) the market failures existing in each alternative. Can we really say that the fact that we have less consumption possibilities (a statement which is questionable in itself, since barriers on conventional energy manufacturing lead to growth in renewable energy sector), is more problematic (in which terms? human lives?) than the immeasurable number of people that turn sick or die from pollution related diseases induced by current energy production techniques? Just the fact that this number is immeasurable makes any claim that stems from a comparison of benefits and risks between this number and economic activity, void.

Figure 2: recommended situation, new stakeholders, policy measures and actions



Arrow Numbers:

1 - Making financing more easily available
2 - Setting standards
3 - Awareness raising, information supply, professional advice
4 - Establishment of energy agency
5 - Establishment of an independent review body
6 - Deploying demonstration projects
7 - Green institutional procurement
8 - Policy response is internal to the targeted municipality and cannot be shown here
9 - Incentives, rebates
10 - Networking and coordination
11 - Promotion of use of LCC
12 - Green taxes
13 - Promotion of R&D

8. Summary and conclusions

This paper has addressed the paradox in which *profitable* environmental technologies (mainly energy efficiency) are not adopted. The target group of the study was municipalities and the surrounding stakeholders in the municipal energy sector. The paper looked at Sweden as a model for a relatively successful implementation of environmental technologies, and showed, using case studies in Sweden and the world, that such profitable technologies do exist and that there *are* actually 'free lunches' (at least in this context). It than addressed the main barrier – lack of budget for the initial investment in the new technology, and showed various financing mechanisms that can be used in order to address this barrier. The paper than concentrated on the Israeli context, identified numerous other barriers, and suggested policy solutions to overcome them. There are many differences between Sweden and Israel, that can explain the larger scale adoption of environmental technologies in the latter as opposed to the former (the city-wide implementation of LED in traffic lights in Stockholm thanks to government subsidies and knowledge and awareness of city officials, while in Israel many have never even heard of the technology, is just one example). The two countries, nonetheless, share many of the barriers and as a result can often use the same policy solutions. It is crucial for those interested in promotion of these technologies to be aware of the barriers they will be facing and learn from other nations' experience about possible solutions. This is why, in the final chapter, I have looked at the most significant barriers in Israel and suggested appropriate policies, considering past experiences in Sweden and the world, and the Israeli energy and environmental planning context.

Municipalities in Israel, as anywhere else, stand to benefit greatly from adoption of environmental technologies. In order to achieve that, however, they need to undergo a deep change in organizational culture and implement new and innovative policies. Central government has a crucial role in the promotion of such technologies as some of the policies required can only be implemented on the national level. Without central government support the chances for individual municipalities to take upon themselves the risks and costs of adoption of new technologies are slim, and these technologies are destined to failure.

The main barriers identified here, in the Israeli context, were: higher cost of environmental technologies, lack of initial funding, lack of energy standards, lack of awareness, lack of governmental subsidies and incentives, high transaction costs, uncertainties about performance of new technologies, and various reasons that create disincentives to conserve energy. The energy paradox is not a phenomena we have to live with - all these barriers can be overcome. It is not an immediate process, and it requires commitment and innovative thinking of all levels of governance. Making financing more easily available, setting standards and building codes, awareness raising campaigns, establishment of an energy agency, and changes to project evaluation methods are some examples of steps that could be taken.

Granted, there are risks in implementing new environmental technologies since they are relatively new on the market. That fact however, should not stop us from starting to adopt the *policies* that can promote such technologies. The risks for policy makers in adopting the suggested measures are relatively low, the prize, however, is immeasurably high. They may generate for the first time a long planning horizon and novel budgetary thinking, which would open the door for the adoption of many more environmental technologies that currently, due to short sightedness of leaders, are deemed uneconomic and therefore – impractical.

Successful examples of innovative policy and financing measures, presented in this paper, can serve as a proof that the energy paradox is not a predicament and it can be solved in the 'real world'. Energy efficiency can be increased if policy makers truly wish it, many times even with economic benefits in the short term.

The one barrier which I find to be the hardest to overcome, is conservatism, characterizing many, if not most, public officials. There is no 'policy measure' that can overcome that, and it is probably the reason why ideas expressed in this paper, will take time to be implemented.

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